Instructor's Manual

Intermediate Microeconomics

Ninth Edition

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Instructor's Manual
by
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Answers to Workouts
by
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Chapter 1

The Market

This chapter was written so I would have something to talk about on the first day of class. I wanted to give students an idea of what economics was all about, and what my lectures would be like, and yet not have anything that was really critical for the course. (At Michigan, students are still shopping around on the first day, and a good number of them won't necessarily be at the lecture.)

I chose to discuss a housing market since it gives a way to describe a number of economic ideas in very simple language and gives a good guide to what lies ahead. In this chapter I was deliberately looking for *surprising results*—analytic insights that wouldn't arise from "just thinking" about a problem. The two most surprising results that I presented are the condominium example and the tax example in Section 1.6. It is worth emphasizing in class just why these results are true, and how they illustrate the power of economic modeling.

It also makes sense to describe their limitations. Suppose that every condominium conversion involved knocking out the walls and creating two apartments. Then what would happen to the price of apartments? Suppose that the condominiums attracted suburbanites who wouldn't otherwise consider renting an apartment. In each of these cases, the price of remaining apartments would rise when condominium conversion took place.

The point of a simple economic model of the sort considered here is to focus our thoughts on what the relevant effects are, not to come to a once-and-for-all conclusion about the urban housing market. The real insight that is offered by these examples is that you have to consider both the supply *and* the demand side of the apartment market when you analyze the impact of this particular policy.

The only concept that the students seem to have trouble with in this chapter is the idea of Pareto efficiency. I usually talk about the idea a little more than is in the book and rephrase it a few times. But then I tell them not to worry about it too much, since we'll look at it in great detail later in the course.

The workbook problems here are pretty straightforward. The biggest problem is getting the students to draw the true (discontinuous) demand curve, as in Figure 1.1, rather than just to sketch in a downward-sloping curve as in Figure 1.2. This is a good time to emphasize to the students that when they are given numbers describing a curve, they have to use the numbers—they can't just sketch in any old shape.

The Market

A. Example of an economic model — the market for apartments
   1. models are simplifications of reality
   2. for example, assume all apartments are identical
   3. some are close to the university, others are far away
   4. price of outer-ring apartments is **exogenous** — determined outside the model
   5. price of inner-ring apartments is **endogenous** — determined within the model

B. Two principles of economics
   1. **optimization principle** — people choose actions that are in their interest
   2. **equilibrium principle** — people's actions must eventually be consistent with each other

C. Constructing the demand curve
   1. line up the people by willingness-to-pay. See Figure 1.1.
   2. for large numbers of people, this is essentially a smooth curve as in Figure 1.2.

D. Supply curve
   1. depends on time frame
   2. but we'll look at the **short run** — when supply of apartments is fixed.

E. Equilibrium
   1. when demand equals supply
   2. price that clears the market

F. Comparative statics
   1. how does equilibrium adjust when economic conditions change?
   2. "comparative" — compare two equilibria
   3. "statics" — only look at equilibria, not at adjustment
   4. example — increase in supply lowers price; see Figure 1.5.
   5. example — create condos which are purchased by renters; no effect on price; see Figure 1.6.

G. Other ways to allocate apartments
   1. discriminating monopolist
   2. ordinary monopolist
   3. rent control

H. Comparing different institutions
   1. need a criterion to compare how efficient these different allocation methods are.
   2. an allocation is **Pareto efficient** if there is no way to make some group of people better off without making someone else worse off.
   3. if something is *not* Pareto efficient, then there *is* some way to make some people better off without making someone else worse off.
   4. if something is not Pareto efficient, then there is some kind of "waste" in the system.

I. Checking efficiency of different methods
   1. free market — efficient
   2. discriminating monopolist — efficient
   3. ordinary monopolist — not efficient
   4. rent control — not efficient

J. Equilibrium in long run
  1. supply will change
  2. can examine efficiency in this context as well

Chapter 2

Budget Constraint

Most of the material here is pretty straightforward. Drive home the formula for the slope of the budget line, emphasizing the derivation on page 23. Try some different notation to make sure that they see the *idea* of the budget line, and don't just memorize the formulas. In the workbook, we use a number of different choices of notation for precisely this reason. It is also worth pointing out that the slope of a line depends on the (arbitrary) choice of which variable is plotted on the vertical axis. It is surprising how often confusion arises on this point.

Students sometimes have problems with the idea of a numeraire good. They understand the algebra, but they don't understand when it would be used. One nice example is in foreign currency exchange. If you have English pounds and American dollars, then you can measure the total wealth that you have in either dollars or pounds by choosing one or the other of the two goods as numeraire.

In the workbook, students sometimes get thrown in exercises where one of the goods has a negative price, so the budget line has a positive slope. This comes from trying to memorize formulas and figures rather than thinking about the problem. This is a good exercise to go over in order to warn students about the dangers of rote learning!

Budget Constraint

A. Consumer theory: consumers choose the best bundles of goods they can afford.
   1. this is virtually the entire theory in a nutshell
   2. but this theory has many surprising consequences

B. Two parts to theory
   1. "can afford" — **budget constraint**
   2. "best" — according to consumers' **preferences**

C. What do we want to do with the theory?
1. test it — see if it is adequate to describe consumer behavior
2. predict how behavior changes as economic environment changes
3. use observed behavior to estimate underlying values
   a) cost-benefit analysis
   b) predicting impact of some policy

D. Consumption bundle
1. (x_1, x_2) — how much of each good is consumed
2. (p_1, p_2) — prices of the two goods
3. m — money the consumer has to spend
4. budget constraint: $p_1x_1 + p_2x_2 \leq m$
5. all (x_1, x_2) that satisfy this constraint make up the **budget set** of the consumer. See Figure 2.1.

E. Two goods
1. theory works with more than two goods, but can't draw pictures.
2. often think of good 2 (say) as a composite good, representing money to spend on other goods.
3. budget constraint becomes $p_1x_1 + x_2 \leq m$.
4. money spent on good 1 (p_1x_1) plus the money spent on good 2 (x_2) has to be less than or equal to the amount available (m).

F. Budget line
1. $p_1x_1 + p_2x_2 = m$
2. also written as $x_2 = m/p_2 - (p_1/p_2)x_1$.
3. budget line has slope of $-p_1/p_2$ and vertical intercept of m/p_2.
4. set $x_1 = 0$ to find vertical intercept (m/p_2); set $x_2 = 0$ to find horizontal intercept (m/p_1).
5. slope of budget line measures opportunity cost of good 1 — how much of good 2 you must give up in order to consume more of good 1.

G. Changes in budget line
1. increasing m makes parallel shift out. See Figure 2.2.
2. increasing p_1 makes budget line steeper. See Figure 2.3.
3. increasing p_2 makes budget line flatter
4. just see how intercepts change
5. multiplying all prices by t is just like dividing income by t
6. multiplying all prices and income by t doesn't change budget line
   a) "a perfectly balanced inflation doesn't change consumption possibilities"

H. The numeraire
1. can arbitrarily assign one price a value of 1 and measure other price relative to that
2. useful when measuring relative prices; e.g., English pounds per dollar, 1987 dollars versus 1974 dollars, etc.

I. Taxes, subsidies, and rationing
1. quantity tax — tax levied on units bought: $p_1 + t$
2. value tax — tax levied on dollars spent: $p_1 + \tau p_1$. Also known as *ad valorem* tax
3. subsidies — opposite of a tax
   a) $p_1 - s$
   b) $(1 - \sigma)p_1$

4. lump sum tax or subsidy — amount of tax or subsidy is independent of the consumer's choices. Also called a head tax or a poll tax
5. rationing — can't consume more than a certain amount of some good

J. Example — food stamps
1. before 1979 was an *ad valorem* subsidy on food
   a) paid a certain amount of money to get food stamps which were worth more than they cost
   b) some rationing component — could only buy a maximum amount of food stamps
2. after 1979 got a straight lump-sum grant of food coupons. Not the same as a pure lump-sum grant since could only spend the coupons on food.

Chapter 3

Preferences

This chapter is more abstract and therefore needs somewhat more motivation than the previous chapters. It might be a good idea to talk about relations in general before introducing the particular idea of preference relations. Try the relations of "taller," and "heavier," and "taller and heavier." Point out that "taller and heavier" isn't a complete relation, while the other two are. This general discussion can motivate the general idea of preference relations.

Make sure that the students learn the specific examples of preferences such as perfect substitutes, perfect complements, etc. They will use these examples many, many times in the next few weeks!

When describing the ideas of perfect substitutes, emphasize that the defining characteristic is that the slope of the indifference curves is constant, not that it is -1. In the text, I always stick with the case where the slope is -1, but in the workbook, we often treat the general case. The same warning goes with the perfect complements case. I work out the symmetric case in the text and try to get the students to do the asymmetric case in the workbook.

The definition of the marginal rate of substitution is fraught with "sign confusion." Should the MRS be defined as a negative or a positive number? I've chosen to give the MRS its natural sign in the book, but I warn the students that many economists tend to speak of the MRS in terms of absolute value. Example: diminishing marginal rate of substitution refers to a situation where the *absolute value* of the MRS decreases as we move along an indifference curve. The actual value of the MRS (a negative number) is *increasing* in this movement!

Students often begin to have problems with the workbook exercises here. The first confusion they have is that they get mixed up about the idea that indifference curves measure the directions where preferences are constant, and instead draw lines that indicate the directions that preferences are increasing. The second problem that they have is in knowing when to draw just arbitrary curves that qualitatively depict some behavior or other, and when to draw exact shapes.

Try asking your students to draw their indifference curves between five dollar bills and one dollar bills. Offer to trade with them based on what they draw. In addition to getting them to think, this is a good way to supplement your faculty salary.

Preferences

A. Preferences are relationships between bundles.
   1. if a consumer would choose bundle (x_1, x_2) when (y_1, y_2) is available, then it is natural to say that bundle (x_1, x_2) is preferred to (y_1, y_2) by this consumer.
   2. preferences have to do with the entire *bundle* of goods, not with individual goods.

B. Notation
   1. $(x_1, x_2) \succ (y_1, y_2)$ means the x-bundle is **strictly preferred** to the y-bundle
   2. $(x_1, x_2) \sim (y_1, y_2)$ means that the x-bundle is regarded as **indifferent** to the y-bundle
   3. $(x_1, x_2) \succeq (y_1, y_2)$ means the x-bundle is **at least as good as** (preferred to or indifferent to) the y-bundle

C. Assumptions about preferences
   1. complete — any two bundles can be compared
   2. reflexive — any bundle is at least as good as itself
   3. transitive — if $X \succeq Y$ and $Y \succeq Z$, then $X \succeq Z$
      a) transitivity necessary for theory of *optimal* choice

D. Indifference curves
   1. graph the set of bundles that are indifferent to some bundle. See Figure 3.1.
   2. indifference curves are like contour lines on a map
   3. note that indifference curves describing two distinct levels of preference cannot cross. See Figure 3.2.
      a) proof — use transitivity

E. Examples of preferences
   1. perfect substitutes. Figure 3.3.
      a) red pencils and blue pencils; pints and quarts
      b) constant rate of trade-off between the two goods
   2. perfect complements. Figure 3.4.
      a) always consumed together
      b) right shoes and left shoes; coffee and cream
   3. bads. Figure 3.5.
   4. neutrals. Figure 3.6.
   5. satiation or bliss point Figure 3.7.

F. Well-behaved preferences
   1. monotonicity — more of either good is better
      a) implies indifference curves have negative slope. Figure 3.9.
   2. convexity — averages are preferred to extremes. Figure 3.10.
      a) slope gets flatter as you move further to right
      b) example of non-convex preferences

G. Marginal rate of substitution
   1. slope of the indifference curve
   2. $MRS = \Delta x_2 / \Delta x_1$ along an indifference curve. Figure 3.11.
   3. sign problem — natural sign is negative, since indifference curves will generally have negative slope
   4. measures how the consumer is willing to trade off consumption of good 1 for consumption of good 2. Figure 3.12.

5. measures marginal willingness to pay (give up)
   a) not the same as how much you have to pay
   b) but how much you would be *willing* to pay

Chapter 4

Utility

In this chapter, the level of abstraction kicks up another notch. Students often have trouble with the idea of utility. It is sometimes hard for trained economists to sympathize with them sufficiently, since it seems like such an obvious notion to us.

Here is a way to approach the subject. Suppose that we return to the idea of the "heavier than" relation discussed in the last chapter. Think of having a big balance scale with two trays. You can put someone on each side of the balance scale and see which person is heavier, but you don't have any standardized weights. Nevertheless you have a way to determine whether x is heavier than y.

Now suppose that you decide to establish a scale. You get a bunch of stones, check that they are all the same weight, and then measure the weight of individuals in stones. It is clear that x is heavier than y if x's weight in stones is heavier than y's weight in stones.

Somebody else might use different units of measurements—kilograms, pounds, or whatever. It doesn't make any difference in terms of deciding who is heavier. At this point it is easy to draw the analogy with utility—just as pounds give a way to represent the "heavier than" order numerically, utility gives a way to represent the preference order numerically. Just as the units of weight are arbitrary, so are the units of utility.

This analogy can also be used to explore the concept of a positive monotonic transformation, a concept that students have great trouble with. Tell them that a monotonic transformation is just like changing units of measurement in the weight example.

However, it is also important for students to understand that nonlinear changes of units are possible. Here is a nice example to illustrate this. Suppose that wood is always sold in piles shaped like cubes. Think of the relation "one pile has more wood than another." Then you can represent this relation by looking at the measure of the sides of the piles, the surface area of the piles, or the volume of the piles. That is, x, x^2, or x^3 gives exactly the same comparison between the piles. Each of these numbers is a different representation of the utility of a cube of wood.

Be sure to go over carefully the examples here. The Cobb-Douglas example is an important one, since we use it so much in the workbook. Emphasize that it is just a nice functional form that gives convenient expressions. Be sure to elaborate on the idea that $x_1^a x_2^b$ is the general form for Cobb-Douglas preferences, but various monotonic transformations (e.g., the log) can make it look quite different. It's a good idea to calculate the MRS for a few representations of the Cobb-Douglas utility function in class so that people can see how to do them and, more importantly, that the MRS doesn't change as you change the representation of utility.

The example at the end of the chapter, on commuting behavior, is a very nice one. If you present it right, it will convince your students that utility is an operational concept. Talk about how the same methods can be used in marketing surveys, surveys of college admissions, etc.

The exercises in the workbook for this chapter are very important since they drive home the ideas. A lot of times, students *think* that they understand some point, but they don't, and these exercises will point that out to them. It is a good idea to let the students discover for themselves that a sure-fire way to tell whether one utility function represents the same preferences as another is to compute the two marginal rate of substitution functions. If they don't get this idea on their own, you can pose it as a question and lead them to the answer.

Utility

A. Two ways of viewing utility
  1. old way
    a) measures how "satisfied" you are
      1) not operational
      2) many other problems
  2. new way
    a) summarizes preferences
    b) a utility function assigns a number to each bundle of goods so that more preferred bundles get higher numbers
    c) that is, $u(x_1, x_2) > u(y_1, y_2)$ if and only if $(x_1, x_2) \succ (y_1, y_2)$
    d) only the ordering of bundles counts, so this is a theory of **ordinal utility**
    e) advantages
      1) operational
      2) gives a complete theory of demand

B. Utility functions are not unique
  1. if $u(x_1, x_2)$ is a utility function that represents some preferences, and $f(\cdot)$ is any increasing function, then $f(u(x_1, x_2))$ represents the same preferences
  2. why? Because $u(x_1, x_2) > u(y_1, y_2)$ only if $f(u(x_1, x_2)) > f(u(y_1, y_2))$
  3. so if $u(x_1, x_2)$ is a utility function then any positive monotonic transformation of it is also a utility function that represents the same preferences

C. Constructing a utility function
  1. can do it mechanically using the indifference curves. Figure 4.2.
  2. can do it using the "meaning" of the preferences

D. Examples
  1. utility to indifference curves
    a) easy — just plot all points where the utility is constant
  2. indifference curves to utility
  3. examples
    a) perfect substitutes — all that matters is total number of pencils, so $u(x_1, x_2) = x_1 + x_2$ does the trick

1) can use any monotonic transformation of this as well, such as $\log(x_1 + x_2)$
b) perfect complements — what matters is the minimum of the left and right shoes you have, so $u(x_1, x_2) = \min\{x_1, x_2\}$ works
c) quasilinear preferences — indifference curves are vertically parallel. Figure 4.4.
1) utility function has form $u(x_1, x_2) = v(x_1) + x_2$
d) Cobb-Douglas preferences. Figure 4.5.
1) utility has form $u(x_1, x_2) = x_1^b x_2^c$
2) convenient to take transformation $f(u) = u^{\frac{1}{b+c}}$ and write $x_1^{\frac{b}{b+c}} x_2^{\frac{c}{b+c}}$
3) or $x_1^a x_2^{1-a}$, where $a = b/(b + c)$

E. Marginal utility

1. extra utility from some extra consumption of one of the goods, holding the other good fixed
2. this is a derivative, but a special kind of derivative — a *partial* derivative
3. this just means that you look at the derivative of $u(x_1, x_2)$ keeping x_2 fixed — treating it like a constant
4. examples
   a) if $u(x_1, x_2) = x_1 + x_2$, then $MU_1 = \partial u/\partial x_1 = 1$
   b) if $u(x_1, x_2) = x_1^a x_2^{1-a}$, then $MU_1 = \partial u/\partial x_1 = a x_1^{a-1} x_2^{1-a}$
5. note that marginal utility depends on which utility function you choose to represent preferences
   a) if you multiply utility times 2, you multiply marginal utility times 2
   b) thus it is not an operational concept
   c) however, MU is closely related to MRS, which is an operational concept
6. relationship between MU and MRS
   a) $u(x_1, x_2) = k$, where k is a constant, describes an indifference curve
   b) we want to measure slope of indifference curve, the MRS
   c) so consider a change (dx_1, dx_2) that keeps utility constant. Then

$$MU_1 dx_1 + MU_2 dx_2 = 0$$

$$\frac{\partial u}{\partial x_1} dx_1 + \frac{\partial u}{\partial x_2} dx_2 = 0$$

   d) hence

$$\frac{dx_2}{dx_1} = -\frac{MU_1}{MU_2}$$

   e) so we can compute MRS from knowing the utility function

F. Example

1. take a bus or take a car to work?
2. let x_1 be the time of taking a car, y_1 be the time of taking a bus. Let x_2 be cost of car, etc.
3. suppose utility function takes linear form $U(x_1, \ldots, x_n) = \beta_1 x_1 + \ldots + \beta_n x_n$
4. we can observe a number of choices and use statistical techniques to estimate the parameters β_i that best describe choices
5. one study that did this could forecast the actual choice over 93% of the time
6. once we have the utility function we can do many things with it:
   a) calculate the marginal rate of substitution between two characteristics
      1) how much money would the average consumer give up in order to get a shorter travel time?
   b) forecast consumer response to proposed changes
   c) estimate whether proposed change is worthwhile in a benefit-cost sense

Chapter 5

Choice

This is the chapter where we bring it all together. Make sure that students understand the *method* of maximization and don't just memorize the various special cases. The problems in the workbook are designed to show the futility of memorizing special cases, but often students try it anyway.

The material in Section 5.4 is very important—I introduce it by saying "Why should you *care* that the MRS equals the price ratio?" The answer is that this allows economists to determine something about peoples' trade-offs by observing market prices. Thus it allows for the possibility of benefit-cost analysis.

The material in Section 5.5 on choosing taxes is the first big non-obvious result from using consumer theory ideas. I go over it very carefully, to make sure that students understand the result, and emphasize how this analysis uses the techniques that we've developed. Pound home the idea that the analytic techniques of microeconomics have a big payoff—they allow us to answer questions that we wouldn't have been able to answer without these techniques.

If you are doing a calculus-based course, be sure to spend some time on the appendix to this chapter. Emphasize that to solve a constrained maximization problem, you must have two equations. One equation is the constraint, and one equation is the optimization condition. I usually work a Cobb-Douglas and a perfect complements problem to illustrate this. In the Cobb-Douglas case, the optimization condition is that the MRS equals the price ratio. In the perfect complements case, the optimization condition is that the consumer chooses a bundle at the corner.

Choice

A. Optimal choice
  1. move along the budget line until preferred set doesn't cross the budget set. Figure 5.1.
  2. note that tangency occurs at optimal point — necessary condition for optimum. In symbols: $MRS = -\text{price ratio} = -p_1/p_2$.
     a) exception — kinky tastes. Figure 5.2.
     b) exception — boundary optimum. Figure 5.3.
  3. tangency is not sufficient. Figure 5.4.
     a) unless indifference curves are convex.

b) unless optimum is interior.
4. optimal choice is demanded bundle
   a) as we vary prices and income, we get demand functions.
   b) want to study how optimal choice — the demanded bundle – changes as price and income change

B. Examples
1. perfect substitutes: $x_1 = m/p_1$ if $p_1 < p_2$; 0 otherwise. Figure 5.5.
2. perfect complements: $x_1 = m/(p_1 + p_2)$. Figure 5.6.
3. neutrals and bads: $x_1 = m/p_1$.
4. discrete goods. Figure 5.7.
   a) suppose good is either consumed or not
   b) then compare $(1, m - p_1)$ with $(0, m)$ and see which is better.
5. concave preferences: similar to perfect substitutes. Note that tangency doesn't work. Figure 5.8.
6. Cobb-Douglas preferences: $x_1 = am/p_1$. Note constant budget shares, $a =$ budget share of good 1.

C. Estimating utility function
1. examine consumption data
2. see if you can "fit" a utility function to it
3. e.g., if income shares are more or less constant, Cobb-Douglas does a good job
4. can use the fitted utility function as guide to policy decisions
5. in real life more complicated forms are used, but basic idea is the same

D. Implications of MRS condition
1. why do we care that $MRS = -$price ratio?
2. if everyone faces the same prices, then everyone has the same local trade-off between the two goods. This is independent of income and tastes.
3. since everyone locally values the trade-off the same, we can make policy judgments. Is it worth sacrificing one good to get more of the other? Prices serve as a guide to relative marginal valuations.

E. Application — choosing a tax. Which is better, a commodity tax or an income tax?
1. can show an income tax is always better in the sense that given any commodity tax, there is an income tax that makes the consumer better off. Figure 5.9.
2. outline of argument:
   a) original budget constraint: $p_1x_1 + p_2x_2 = m$
   b) budget constraint with tax: $(p_1 + t)x_1 + p_2x_2 = m$
   c) optimal choice with tax: $(p_1 + t)x_1^* + p_2x_2^* = m$
   d) revenue raised is tx_1^*
   e) income tax that raises same amount of revenue leads to budget constraint: $p_1x_1 + p_2x_2 = m - tx_1^*$
      1) this line has same slope as original budget line
      2) also passes through (x_1^*, x_2^*)
      3) proof: $p_1x_1^* + p_2x_2^* = m - tx_1^*$
      4) this means that (x_1^*, x_2^*) is affordable under the income tax, so the optimal choice under the income tax must be even better than (x_1^*, x_2^*)
3. caveats
   a) only applies for one consumer — for each consumer there is an income tax that is better

b) income is exogenous — if income responds to tax, problems
c) no supply response — only looked at demand side

F. Appendix — solving for the optimal choice

1. calculus problem — constrained maximization
2. max $u(x_1, x_2)$ s.t. $p_1x_1 + p_2x_2 = m$
3. method 1: write down $MRS = p_1/p_2$ and budget constraint and solve.
4. method 2: substitute from constraint into objective function and solve.
5. method 3: Lagrange's method
   a) write Lagrangian: $L = u(x_1, x_2) - \lambda(p_1x_1 + p_2x_2 - m)$.
   b) differentiate with respect to x_1, x_2, λ.
   c) solve equations.
6. example 1: Cobb-Douglas problem in book
7. example 2: quasilinear preferences
   a) max $u(x_1) + x_2$ s.t. $p_1x_1 + x_2 = m$
   b) easiest to substitute, but works each way

Chapter 6

Demand

This is a very important chapter, since it unifies all the material in the previous chapter. It is also the chapter that separates the sheep from the goats. If the student has been paying attention for the previous 5 chapters and has been religiously doing the homework, then it is fairly easy to handle this chapter. Alas, I have often found that students have developed a false sense of confidence after seeing budget constraints, drift through the discussions of preference and utility, and come crashing down to earth at Chapter 6.

So, the first thing to do is to get them to review the previous chapters. Emphasize how each chapter builds on the previous chapters, and how Chapter 6 represents a culmination of this building. In turn Chapter 6 is a foundation for further analysis, and must be mastered in order to continue.

Part of the problem is that there is a large number of new concepts in this chapter: offer curves, demand curves, Engel curves, inferior goods, Giffen goods, etc. A list of these ideas along with their definitions and page references is often helpful just for getting the concepts down pat.

If you are doing a calculus-based course, the material in the appendix on quasilinear preferences is quite important. We will refer to this treatment later on when we discuss consumer's surplus, so it is a good idea to go through it carefully now.

Students usually have a rough time with the workbook problems. In part, I think that this is due to the fact that we have now got a critical mass of ideas, and that it has to percolate a bit before they can start brewing some new ideas. A few words of encouragement help a lot here, as well as drawing links with the earlier chapters. Most students will go back on their own and see what they missed on first reading, if you indicate that is a good thing to do. Remember: the point of the workbook problems is to show the students what they *don't* understand, not to give them a pat on the back. The role of the professor is to give them a pat on the back, or a nudge in the behind, whichever seems more appropriate.

Demand

A. Demand functions — relate prices and income to choices

B. How do choices change as economic environment changes?
   1. changes in income
      a) this is a parallel shift out of the budget line
      b) increase in income increases demand — **normal** good. Figure 6.1.
      c) increase in income decreases demand — **inferior** good. Figure 6.2.
      d) as income changes, the optimal choice moves along the **income expansion path**
      e) the relationship between the optimal choice and income, with prices fixed, is called the **Engel curve**. Figure 6.3.
   2. changes in price
      a) this is a tilt or pivot of the budget line
      b) decrease in price increases demand — **ordinary** good. Figure 6.9.
      c) decrease in price decreases demand — **Giffen** good. Figure 6.10.
      d) as price changes the optimal choice moves along the **offer curve**
      e) the relationship between the optimal choice and a price, with income and the other price fixed, is called the **demand curve**

C. Examples
   1. perfect substitutes. Figure 6.12.
   2. perfect complements. Figure 6.13.
   3. discrete good. Figure 6.14.
      a) reservation price — price where consumer is just indifferent between consuming next unit of good and not consuming it
      b) $u(0, m) = u(1, m - r_1)$
      c) special case: quasilinear preferences
      d) $v(0) + m = v(1) + m - r_1$
      e) assume that $v(0) = 0$
      f) then $r_1 = v(1)$
      g) similarly, $r_2 = v(2) - v(1)$
      h) reservation prices just measure **marginal utilities**

D. Substitutes and complements
   1. increase in p_2 increases demand for x_1 — substitutes
   2. increase in p_2 decreases demand for x_1 — complements

E. Inverse demand curve
   1. usually think of demand curve as measuring quantity as a function of price — but can also think of price as a function of quantity
   2. this is the **inverse demand curve**
   3. same *relationship*, just represented differently

Chapter 7

Revealed Preference

This is a big change of pace, and usually a welcome one. The basic idea of revealed preference, as described in Section 7.1, is a very intuitive one. All I want to do in this chapter is give the students the tools to express that intuition algebraically.

I think that the material in Section 7.3, on recovering preferences, is very exciting. Start out with the idea of indirect revealed preference, as depicted in Figure 7.2. Point out that the optimization model allows us to predict how this person would behave when faced with a choice between (x_1, x_2) and (z_1, z_2), *even though we have never observed the person when faced with this choice!* This is a *big* idea, and a very important one. Again, drive home how the economic model of optimization allows us to make strong predictions about behavior.

Figure 7.3 is the natural extension of this line of reasoning. Given the idea of revealed preference, and more importantly the idea of *indirect* revealed preference, we can determine the shape of underlying indifference curves from looking at choice data. I motivate this in terms of benefit-cost issues, but you could also choose to think about forecasting demand for products in a marketing survey, or similar applications.

Once students understand the idea of revealed preference, they can usually understand the Weak Axiom right away. However, they generally have difficulty in actually checking whether the Weak Axiom is satisfied by some real numbers. I added Section 7.5 for this reason; it just outlines one systematic way to check WARP. The students can omit this in their first reading, but they might want to come back to it when they start to do the exercises. If your students know a little computer programming, you might ask them to think about how to write a computer program to check WARP.

The same comments go for the treatment of the Strong Axiom and checking SARP. This is probably overkill, but I found that students couldn't really handle problem 7.5 in the workbook without some guidance about how to systematically check SARP. Speaking of the workbook, the problems in this section are really fun. I am especially fond of 7.6 and 7.7. Problem 7.9 had some wrong numbers in it in early printings of *Workouts*, so people with old books should be warned.

Finally, the material on index numbers is very worthwhile. Students here about price indices and cost-of-living indices all the time, so it's nice to describe the theory that lies behind these ideas.

Revealed Preference

A. Motivation
1. up until now we've started with preference and then described behavior
2. revealed preference is "working backwards" — start with behavior and describe preferences
3. recovering preferences — how to use observed choices to "estimate" the indifference curves

B. Basic idea
1. if (x_1, x_2) is chosen when (y_1, y_2) is affordable, then we know that (x_1, x_2) is at least as good as (y_1, y_2)
2. in equations: if (x_1, x_2) is chosen when prices are (p_1, p_2) and $p_1x_1+p_2x_2 \geq p_1y_1 + p_2y_2$, then $(x_1, x_2) \succeq (y_1, y_2)$
3. see Figure 7.1.
4. if $p_1x_1 + p_2x_2 \geq p_1y_1 + p_2y_2$, we say that (x_1, x_2) is **directly revealed preferred** to (y_1, y_2)
5. if X is directly revealed preferred to Y, and Y is directly revealed preferred to Z (etc.), then we say that X is **indirectly revealed preferred** to Z. See Figure 7.2.
6. the "chains" of revealed preference can give us a lot of information about the preferences. See Figure 7.3.
7. the information revealed about tastes by choices can be used in formulating economic policy

C. Weak Axiom of Revealed Preference
1. recovering preferences makes sense only if consumer is actually maximizing
2. what if we observed a case like Figure 7.4.
3. in this case X is revealed preferred to Y and Y is also revealed preferred to X!
4. in symbols, we have (x_1, x_2) purchased at prices (p_1, p_2) and (y_1, y_2) purchased at prices (q_1, q_2) and $p_1x_1+p_2x_2 > p_1y_1+p_2y_2$ and $q_1y_1+q_2y_2 > q_1x_1 + q_2x_2$
5. this kind of behavior is inconsistent with the optimizing model of consumer choice
6. the Weak Axiom of Revealed Preference (WARP) rules out this kind of behavior
7. WARP: if (x_1, x_2) is directly revealed preferred to (y_1, y_2), then (y_1, y_2) cannot be directly revealed preferred to (x_1, x_2)
8. WARP: if $p_1x_1+p_2x_2 \geq p_1y_1+p_2y_2$, then it must happen that $q_1y_1+q_2y_2 \leq q_1x_1 + q_2x_2$
9. this condition can be checked by hand or by computer

D. Strong Axiom of Revealed Preference
1. WARP is only a necessary condition for behavior to be consistent with utility maximization
2. Strong Axiom of Revealed Preference (SARP): if (x_1, x_2) is directly or *indirectly* revealed preferred to (y_1, y_2), then (y_1, y_2) cannot be directly or indirectly revealed preferred to (x_1, x_2)
3. SARP is a *necessary and sufficient* condition for utility maximization
4. this means that if the consumer is maximizing utility, then his behavior must be consistent with SARP
5. furthermore if his observed behavior is consistent with SARP, then we can always find a utility function that explains the behavior of the consumer as maximizing behavior.

6. can also be tested by a computer

E. Index numbers

1. given consumption and prices in 2 years, base year b and some other year t
2. how does consumption in year t compare with base year consumption?
3. general form of a consumption index:

$$\frac{w_1 x_1^t + w_2 x_2^t}{w_1 x_1^b + w_2 x_2^b}$$

4. natural to use prices as weights
5. get two indices depending on whether you use period t or period b prices
6. Paasche index uses period t (current period) weights:

$$\frac{p_1^t x_1^t + p_2^t x_2^t}{p_1^t x_1^b + p_2^t x_2^b}$$

7. Laspeyres index uses period b (base period) weights:

$$\frac{p_1^b x_1^t + p_2^b x_2^t}{p_1^b x_1^b + p_2^b x_2^b}$$

8. note connection with revealed preference: if Paasche index is greater than 1, then period t must be better than period b:
   a)
   $$\frac{p_1^t x_1^t + p_2^t x_2^t}{p_1^t x_1^b + p_2^t x_2^b} > 1$$
   b)
   $$p_1^t x_1^t + p_2^t x_2^t > p_1^t x_1^b + p_2^t x_2^b$$
   c) so period t is revealed preferred to period b
9. same sort of thing can be done with Laspeyres index — if Laspeyres index is less than 1, consumer is worse off

Chapter 8

Slutsky Equation

Most books talk about income and substitution effects, but then they don't do anything with the ideas. My view is that you have to give the student enough of an understanding of an idea to be able to compute with it; otherwise, why bother?

The Slutsky decomposition is an analytical tool that allows us to understand how demand changes when a price changes. It does this by breaking the total change in demand up into smaller pieces. The sign of the overall effect depends on the sign of the pieces, but the sign of the pieces is easier to determine.

I have used the Slutsky definition of substitution effect in this chapter. This is because it is much easier to compute examples using this definition. The Hicksian definition is theoretically more elegant, but students can't compute with it until they have more advanced mathematical tools.

A large part of getting this material across is just convincing the students to read the book. The change in income necessary to compensate for a change in price is neither a difficult concept nor a difficult calculation, but it has to be repeated a few times before the students grasp it.

One way to describe income and substitution effects is to give an example based on their own consumption patterns. Talk about a student who spends all of her allowance on food and books. Suppose that the price of books drops in half, but her parents find out about it and cut her allowance. How much do they cut her allowance if they want her to keep her old consumption level affordable?

Once they grasp the idea of the substitution and income effect, it isn't hard to put them together in Section 8.4. The next real hurdle is expressing the Slutsky equation in terms of rates of change, as is done in Section 8.5. This is the way that we usually refer to the Slutsky equation in later chapters, so it is worthwhile going through the algebra so they can see where it comes from. However, if you don't want to go through the algebraic computations, just make sure that they get the basic point: the change in demand can be decomposed into a substitution effect (always negative, i.e., opposite the direction of price change) and an income effect (positive or negative depending on whether we have a normal or inferior good).

I usually skip the Optional sections in this chapter, but they are there for reference if needed. I like the tax rebate section, but it is a little sophisticated. Emphasize the idea that even if you give the money from the tax back to the consumers, the demand for the good will go down and consumers will be left worse off.

Slutsky Equation

A. We want a way to decompose the effect of a price change into "simpler" pieces.
   1. that's what *analysis* is all about
   2. break up into simple pieces to determine behavior of whole

B. Break up price change into a **pivot** and a **shift** — see Figure 8.2.
   1. these are hypothetical changes
   2. we can examine each change in isolation and look at sum of two changes

C. Change in demand due to pivot is the **substitution effect**.
   1. this measures how demand changes when we change prices, keeping purchasing power fixed
   2. how much would a person demand if he had just enough money to consume the original bundle?
   3. this isolates the pure effect from changing the relative prices
   4. substitution effect *must* be negative due to revealed preference.
      a) "negative" means quantity moves opposite the direction of price

D. Change in demand due to shift is the **income effect**.
   1. increase income, keep prices fixed
   2. income effect can increase or decrease demand depending on whether we have a normal or inferior good

E. Total change in demand is substitution effect plus the income effect.
   1. if good is normal good, the substitution effect and the income effect reinforce each other
   2. if good is inferior good, total effect is ambiguous
   3. see Figure 8.3.

F. Specific examples
   1. perfect complements — Figure 8.4.
   2. perfect substitutes — Figure 8.5.
   3. quasilinear — Figure 8.6.

G. Application — rebating a tax
   1. put a tax on gasoline and return the revenues
   2. original budget constraint: $px^* + y^* = m$
   3. after tax budget constraint: $(p+t)x' + y' = m + tx'$
   4. so consumption after tax satisfies $px' + y' = m$
   5. so (x', y') was affordable originally and rejected in favor of (x^*, y^*)
   6. consumer must be worse off

H. Rates of change
   1. can also express Slutsky effect in terms of *rates of change*
   2. takes the form
$$\frac{\partial x}{\partial p} = \frac{\partial x^s}{\partial p} - \frac{\partial x}{\partial m} x$$
   3. can interpret each part just as before

Chapter 9

Buying and Selling

The idea of an endowment is an important one, and I wanted to devote a whole chapter to it rather than give it the cursory treatment it gets in most books. It is somewhat unnatural in a two-good context, so it is worth pointing out to students that artificiality and emphasizing that the concept of an endowment does make perfectly good sense in a more general context.

Emphasize the statement in Section 9.3 that an increase in the value of the endowment allows for greater consumption possibilities of both goods. You'll be happy you did this when you discuss present value! Be sure to explain why a consumer would necessarily prefer an endowment with higher value, while she may or may not prefer a consumption bundle with higher value.

The section on price changes is a very nice application of revealed preference arguments. Students often appreciate this idea a lot more after seeing these applications.

The Slutsky equation treatment in this chapter is quite neat, but a trifle involved. Point out that in the original treatment of the Slutsky equation money income didn't change when prices changed—only the purchasing power of the money changed. In this chapter, where consumers get their money from selling their endowments, money income *does* change when purchasing power changes, and this effect has to be accounted for.

I have found that blowing up Figure 9.7 and carefully stepping through the movements is a big help in seeing this point. Point out that if we take away the budget line through point C, we have the standard diagram of the previous chapter. The movement from D to C is the only new thing that has been added in this chapter.

If you've got a group that is pretty comfortable with abstraction, the treatment in the appendix to this chapter will be of interest. It gives an *exact* derivation of the Slutsky equation in this case.

Section 9.7 gives a very short example of the Slutsky equation when an endowment is present. Point out how the result comes solely from the maximization hypothesis, and how hard it would be to figure this out without some analytic tools. That's the point of analytic tools like the Slutsky equation: they make this kind of calculation mechanical so that you don't have to reproduce a complicated path of reasoning in each particular case.

The last topic in the chapter is the analysis of labor supply. The first thing we do is manipulate the budget constraint so it fits into the framework studied earlier. Emphasize that this is a common strategy for analysis: arrange the problem at hand so that it looks like something we've seen before. Also, it is useful to emphasize the interpretation of the endowment in this context: the endowment is what you end up consuming if you don't engage in any market transactions.

Once the labor supply problem has been put in the standard framework, we can apply all the tools that we have at our disposal. The first one is the Slutsky equation. In Section 9.9 I go through a mistaken analysis, and then correct it to give the right analysis. I think that this is appropriate in this case, since so many people get the labor supply analysis wrong. A backward-bending labor supply curve is not a Giffen phenomenon. The supply curve of labor slopes backward because the endowment of leisure is worth more when the wage rate rises, and this can lead to an increased consumption of leisure due to the income effect.

The overtime example is really a dandy illustration of substitution effects. I sometimes introduce the idea by considering the following paradox: if an employer increases a flat wage by some amount, and pays a higher wage for all hours worked, his employees could easily end up choosing to work less. But if the employer pays the *same* increased wage as an overtime wage, the employees will never choose to work less, and will likely choose to work more. Isn't it paradoxical that giving the workers more money (via the flat wage increase) results in less labor forthcoming? Seen in terms of substitution effects and revealed preference, it all makes very good sense, but without those ideas, this common phenomenon can seem very confusing.

Buying and Selling

A. Up until now, people have only had money to exchange for goods. But in reality, people sell things they own (e.g., labor) to acquire goods. Want to model this idea.

B. Net and gross demands
   1. **endowment**: (ω_1, ω_2) — what you have before you enter the market.
   2. **gross demands**: (x_1, x_2) — what you end up consuming.
   3. **net demands**: $(x_1 - \omega_1, x_2 - \omega_2)$ — what you actually buy (positive) and sell (negative).
   4. for economists gross demands are more important; for laypeople net demands are more important.

C. Budget constraint
   1. value of what you consume = value of what you sell.
   2. $p_1 x_1 + p_2 x_2 = p_1 \omega_1 + p_2 \omega_2$
   3. $p_1(x_1 - \omega_1) + p_2(x_2 - \omega_2) = 0$
   4. budget line depicted in Figure 9.1. Note endowment is always affordable.
   5. with two goods, the consumer is always a net demander of one good, a net supplier of the other.

D. Comparative statics
   1. changing the endowment
      a) normal and inferior
      b) increasing the value of the endowment makes the consumer better off. Note that this is different from increasing the value of the consumption bundle. Need access to market.
   2. changing prices

   a) if the price of a good the consumer is selling goes down, and the consumer decides to remain a seller, then welfare goes down. See Figure 9.3.
   b) if the consumer is a net buyer of a good and the price decreases, then the consumer will remain a net buyer. Figure 9.4.
   c) etc.
3. offer curves and demand curves
   a) offer curves — what consumer "offers" to buy or sell
   b) gross demand curve
   c) net demand curves (and net supply curves)

E. Slutsky equation
1. when prices change, we now have three effects
   a) ordinary substitution effect
   b) ordinary income effect
   c) endowment income effect — change in the value of the endowment affects demand.
2. three effects shown in Figure 9.7.
3. the income effect depends on the *net demand*.
4. Slutsky equation now takes the form

$$\frac{\partial x_1}{\partial p_1} = \frac{\partial x_1^s}{\partial p_1} + (\omega_1 - x_1)\frac{\partial x_1}{\partial m}$$

5. read through proof in appendix.

F. Labor supply

G. Two goods
1. consumption (C)
2. labor (L) — maximum amount you can work is $\bar{L}$
3. money (M)

H. Budget constraint for labor supply
1. $pC = M + wL$
2. define $\bar{C} = M/p$
3. $pC + w(\bar{L} - L) = p\bar{C} + w\bar{L}$
4. define leisure $R = \bar{L} - L$; note $\bar{R} = \bar{L}$
5. $pC + wR = p\bar{C} + w\bar{R} = p\bar{C} + w\bar{L}$
6. this is just like ordinary budget constraint
7. supply of labor is like demand for leisure
8. w/p is price of leisure

I. Comparative statics
1. apply Slutsky equation to demand for leisure to get

$$\frac{\partial R}{\partial w} = \text{substitution effect} + (\bar{R} - R) \times \text{ income effect}$$

2. increase in the wage rate has an ambiguous effect on supply of labor. Depends on how much labor is supplied already.
3. backward bending labor supply curve

J. Overtime
1. offer workers a higher straight wage, they may work less.
2. offer them a higher overtime wage, they must work at least as much.
3. overtime is a way to get at the substitution effect.

Chapter 10

Intertemporal Choice

This is one of my favorite topics, since it uses consumer theory in such fundamental ways, and yet has many important and practical consequences.

The intertemporal budget constraint is pretty straightforward. I sometimes draw the kinked shape that results from different borrowing and lending rates, just to drive the point home. It is good to spell out the importance of convexity and monotonicity for intertemporal preferences. Ask your students what savings behavior would be exhibited by a person with *convex* intertemporal preferences.

The difference between the present value and the future value formulation of the budget constraint can be seen as a choice of numeraire.

The comparative statics is simply relabeled graphs we've seen before, but it is still worth describing in detail as a concrete example.

I think that it is worth repeating the conclusion of Section 10.6 several times, as students seem to have a hard time absorbing it. An investment that shifts the endowment in a way that increases its present value is an investment that *every* consumer must prefer (as long as they can borrow and lend at the same interest rate). It is a good idea to express this point in several different ways. One especially important way is to talk explicitly about investments as changes in the endowment $(\Delta m_1, \Delta m_2)$, and then point out that any investment with a positive net present value is worthwhile.

Emphasize that present value is really a linear operation, despite appearances. Given a table of present values, as Table 11.1, show how easy it is to calculate present values.

The installment loan example is a very nice one. It is good to motivate it by first considering a person who borrows \$1,000 and then pays back \$1,200 a year later. What rate of interest is he paying? Show that this rate can be found by solving the equation

$$1000(1 + r) = 1200,$$

which can be written as

$$1000 = \frac{1200}{1 + r}.$$

It is then very natural to argue that the *monthly* rate of interest for the installment loan is given by the i that solves the equation

$$1000 = \frac{100}{1+i} + \frac{100}{(1+i)^2} + \ldots + \frac{100}{(1+i)^{12}}$$

There are (at least) two ways to compute the yearly rate. One way is to follow the accountant's convention (and the Truth in Lending Act) and use the formula $r = 12i$. Another, perhaps more sensible, way is to compound the monthly returns and use the formula $1 + r = (1 + i)^{12}$. I followed the accountant's convention in the figures reported in the text.

The workbook problems for this chapter are also quite worthwhile. Problem 11.1 is a nice example of present value analysis, using the perpetuity formulas. Problem 11.6 illustrates the budget constraint with different borrowing and lending rates.

Intertemporal Choice

A. Budget constraint
1. (m_1, m_2) money in each time period is endowment
2. allow the consumer to borrow and lend at rate r
3. $c_2 = m_2 + (1 + r)(m_1 - c_1)$
4. note that this works for both borrowing and lending, as long as it is at the same interest rate
5. various forms of the budget constraint
   a) $(1 + r)c_1 + c_2 = (1 + r)m_1 + m_2$ — future value
   b) $c_1 + c_2/(1 + r) = m_1 + m_2/(1 + r)$ — present value
   c) choice of numeraire
   d) see Figure 10.2.
6. preferences — convexity and monotonicity are very natural

B. Comparative statics
1. if consumer is initially a lender and interest rate increases, he remains a lender. Figure 10.4.
2. a borrower is made worse off by an increase in the interest rate. Figure 10.5.
3. Slutsky allows us to look at the effect of increasing the price of today's consumption (increasing the interest rate)
   a) change in consumption today when interest rate increases = substitution effect + $(m_1 - c_1)$ income effect
   b) assuming normality, an increase in interest rate lowers current consumption for a borrower, and has an ambiguous effect for lender
   c) provide intuition

C. Inflation
1. put in prices, $p_1 = 1$ and p_2
2. budget constraint takes the form

$$p_2c_2 = m_2 + (1 + r)(m_1 - c_1)$$

3. or

$$c_2 = \frac{m_2}{p_2} + \frac{(1+r)}{p_2}(m_1 - c_1)$$

4. if π is rate of inflation, then $p_2 = (1 + \pi)p_1$
5. $1 + \rho = (1 + r)/(1 + \pi)$ is the real interest rate
6. $\rho = (r - \pi)/(1 + \pi)$ or $\rho \approx r - \pi$

D. Present value — a closer look
   1. future value and present value — what do they mean?
   2. if the consumer can borrow and lend freely, then she would always prefer a consumption pattern with a greater present value.

E. Present value works for any number of periods.

F. Use of present value
   1. the one correct way to rank investment decisions
   2. linear operation, so relatively easy to calculate

G. Bonds
   1. coupon x, maturity date T, face value F
   2. consols
   3. the value of a console is given by $PV = x/r$
      a) proof: $x = r \times PV$

H. Installment loans
   1. borrow some money and pay it back over a period of time
   2. what is the true rate of interest?
   3. example: borrow $1,000 and pay back 12 equal installments of $100.
   4. have to value a stream of payments of $1,000$, -100, ..., -100.
   5. turns out that the true interest rate is about 35%!

Chapter 11

Asset Markets

This chapter fits in very nicely with the present value calculations in the last chapter. The idea that all riskless assets should earn the same rate of return in equilibrium is a very powerful idea, and generally receives inadequate treatment in intermediate micro texts.

I especially like the arbitrage argument, and showing how it is equivalent to all assets selling for their present values. The applications of the Hotelling oil price model and the forest management model are quite compelling to students.

One interesting twist that you might point out in the forestry problem is that the *market* value of the standing forest will always be its present value, and that present value will grow at the rate of interest—like any other asset. However, the value of the *harvested* forest will grow more rapidly than the interest rate until we reach the optimal harvest time, and then grow less rapidly.

The problems in *Workouts* are quite practical in nature, and it is worth pointing this out to students. Emphasize that present value calculations are the meat and potatoes of investment analysis.

Asset Markets

A. Consider a world of perfect certainty. Then all assets must have the same rate of return.
   1. if one asset had a higher rate of return than another, who would buy the asset with the lower return?
   2. how do asset prices adjust? Answer: **Riskless arbitrage.**
      a) two assets. Bond earns r, other asset costs p_0 now.
      b) invest $1 in bond, get $1 + r$ dollars tomorrow.
      c) invest $p_0 x = 1$ dollars in other asset, get $p_1 x$ dollars tomorrow.
      d) amounts must be equal, which says that $1 + r = p_1/p_0$.
   3. this is just another way to say present value.
      a) $p_0 = p_1/(1 + r)$.
   4. think about the process of adjustment.

B. Example from stock market
   1. index futures and underlying assets that make up the futures.
   2. no risk in investment, even though asset values are risky, because there is a fixed relationship between the two assets at the time of expiration.

C. Adjustments for differences in characteristics
   1. liquidity and transactions cost
   2. taxes
   3. form of returns — consumption return and financial return

D. Applications
   1. depletable resource — price of oil
      a) let p_t = price of oil at time t
      b) oil in the ground is like money in the bank, so $p_{t+1} = (1+r)p_t$
      c) demand equals supply over time
      d) let T = time to exhaustion, D = demand per year, and S = available supply. Hence $T = S/D$
      e) let C = cost of next best alternative (e.g., liquified coal)
      f) arbitrage implies $p_0 = C/(1+r)^T$
   2. harvesting a forest
      a) $F(t)$ = value of forest at time t
      b) natural to think of this increasing rapidly at first and then slowing down
      c) harvest when rate of growth of forest = rate of interest. Figure 11.1.

E. This theory tells you relationships that have to hold between asset prices, given the interest rate.

F. But what determines the interest rate?
   1. answer: aggregate borrowing and lending behavior
   2. or: consumption and investment choices over time

G. What do financial institutions do?
   1. adjust interest rate so that amount people want to borrow equals amount they want to lend
   2. change pattern of consumption possible over time. Example of college student and retiree
   3. example of entrepreneur and investors

Chapter 12

Uncertainty

This chapter begins with the idea of contingent consumption and an insurance market example. Make sure that you define "contingent" since a lot of students don't know the term. (The definition is given in the book.) The emphasis in this first section is on the idea that exactly the same tools that we have used earlier can be used to analyze choice under uncertainty, so it is worth talking about what happens to the budget line when the price of insurance changes, etc.

The expected utility discussion is reasonably elementary. However, it is often hard to motivate the expected utility hypothesis without seeing a lot of applications. I put it in since some schools might want to have an elementary treatment of the subject for use in other courses, such as finance courses.

The easiest application of expected utility theory that I could think of was the result that expected utility maximizers facing actuarially fair insurance would fully insure. In the Information chapter I talk about moral hazard and adverse selection in insurance markets, and those might be fun ideas to touch on in class discussion.

The last three sections on diversification, risk spreading, and the role of the stock market are important economic ideas. I usually discuss these ideas in verbal terms and skip the details of the expected utility material. This seems like a reasonable compromise for a general purpose intermediate micro course.

Uncertainty

A. Contingent consumption
1. what consumption or wealth you will get in each possible outcome of some random event.
2. example: rain or shine, car is wrecked or not, etc.
3. consumer cares about pattern of contingent consumption: $U(c_1, c_2)$.
4. market allows you to trade patterns of contingent consumption — insurance market. Insurance premium is like a relative price for the different kinds of consumption.
5. can use standard apparatus to analyze choice of contingent consumption.

B. Utility functions
   1. preferences over the consumption in different events depend on the probabilities that the events will occur.
   2. so $u(c_1, c_2, \pi_1, \pi_2)$ will be the general form of the utility function.
   3. under certain plausible assumptions, utility can be written as being linear in the probabilities, $p_1 u(c_1) + p_2 u(c_2)$. That is, the utility of a pattern of consumption is just the expected utility over the possible outcomes.

C. Risk aversion
   1. shape of expected utility function describes attitudes towards risk.
   2. draw utility of wealth and expected utility of gamble. Note that a person prefers a sure thing to expected value. Figure 12.2.
   3. diversification and risk sharing

D. Role of the stock market
   1. aids in diversification and in risk sharing.
   2. just as entrepreneur can rearrange his consumption patterns through time by going public, he can also rearrange his consumption across states of nature.

Chapter 13

Risky Assets

The first part of this chapter is just notation and review of the concepts of mean and standard deviation. If your students have had some statistics, these ideas should be pretty standard. If they haven't had any statistics, then be sure to get the basics down before proceeding.

The big idea here is in Figure 13.2. In mean-standard deviation space, the "budget constraint" is a straight line. Again, all of the technical apparatus of consumer theory can be brought to bear on analyzing this particular kind of choice problem. Ask what happens to the "price of risk" when the risk-free rate goes down. What do students think this will do to the budget line and the portfolio choice? Don't let them guess—make them give reasons for their statements.

Section 13.2 is a little bit of a fudge. I do give the actual definition of beta in a footnote, but I don't really go through the calculations for the Capital Asset Pricing Model.

The idea of the risk-adjusted interest rate and the story of how returns adjust is a nice one and should be accessible to most students who understood the case of adjustment with certainty.

It might be worth pointing out that participants in the stock market take all this stuff very seriously. There are consulting services that sell their estimates of beta for big bucks and use them as measures of risk all the time.

Risky Assets

A. Utility depends on mean and standard deviation of wealth.
   1. utility $= u(\mu_w, \sigma_w)$
   2. this form of utility function describes tastes.

B. Invest in a risky portfolio (with expected return r_m) and a riskless asset (with return r_f)
   1. suppose you invest a fraction x in the risky asset
   2. expected return $= xr_m + (1-x)r_f$
   3. standard deviation of return $= x\sigma_m$
   4. this relationship gives "budget line" as in Figure 13.2.

C. At optimum we must have the price of risk equal to the slope of the budget line: $MRS = (r_m - r_f)/\sigma_m$
   1. the observable value $(r_m - r_f)/\sigma_m$ is the price of risk
   2. can be used to value other investments, like any other price

D. Measuring the risk of a stock — depends on how it contributes to the risk of the overall portfolio.
   1. β_i = covariance of asset i with the market portfolio/standard deviation of market portfolio
   2. roughly speaking, β_i measures how sensitive a particular asset is to the market as a whole
   3. assets with negative betas are worth a lot, since they reduce risk
   4. how returns adjust — plot the market line

E. Equilibrium
   1. the risk-adjusted rates of return should be equalized
   2. in equations:

$$r_i - \beta_i(r_m - r_f) = r_j - \beta_j(r_m - r_f)$$

   3. suppose asset j is riskless; then

$$r_i - \beta_i(r_m - r_f) = r_f$$

   4. this is called the Capital Asset Pricing Model (CAPM)

F. Examples of use of CAPM
   1. how returns adjust — see Figure 13.4.
   2. public utility rate of return choice
   3. ranking mutual funds
   4. investment analysis, public and private

Chapter 14

Consumer's Surplus

This chapter derives consumer's surplus using the demand theory for discrete goods that was developed earlier in Chapters 5 and 6. I review this material in Section 14.1 just to be safe. Given that derivation, it is easy to work backwards to get utility.

Later in the chapter I introduce the idea of compensating and equivalent variation. In my treatment, I use the example of a tax, but another example that is somewhat closer to home is the idea of cost-of-living indexes for various places to live. Take an example of an executive in New York who is offered a job in Tucson. Relative prices differ drastically in these two locations. How much money would the executive need at the Tucson prices to make him as well off as he was in New York? How much money would his New York company have to pay him to make him as well off in New York as he would be if he moved to Tucson?

The example right before Section 14.9 shows that the compensating and the equivalent variation are the same in the case of quasilinear utility. Finally the appendix to this chapter gives a calculus treatment of consumer's surplus, along with some calculations for a few special demand functions and a numerical comparison of consumer's surplus, compensating variation, and equivalent variation.

Consumer's Surplus

A. Basic idea of consumer's surplus
   1. want a measure of how much a person is willing to pay for something. How much a person is willing to sacrifice of one thing to get something else.
   2. price measures marginal willingness to pay, so add up over all different outputs to get total willingness to pay.
   3. total benefit (or gross consumer's surplus), net consumer's surplus, change in consumer's surplus. See Figure 14.1.

B. Discrete demand
   1. remember that the reservation prices measure the "marginal utility"
   2. $r_1 = v(1) - v(0)$, $r_2 = v(2) - v(1)$, $r_3 = v(3) - v(2)$, etc.
   3. hence, $r_1 + r_2 + r_3 = v(3) - v(0) = v(3)$ (since $v(0) = 0$)
   4. this is just the total area under the demand curve.
   5. in general to get the "net" utility, or net consumer's surplus, have to subtract the amount that the consumer has to spend to get these benefits

C. Continuous demand. Figure 14.2.
   1. suppose utility has form $v(x) + y$
   2. then inverse demand curve has form $p(x) = v'(x)$
   3. by fundamental theorem of calculus:

$$v(x) - v(0) = \int_0^x v'(t)\,dt = \int_0^x p(t)\,dt$$

   4. This is the generalization of discrete argument

D. Change in consumer's surplus. Figure 14.3.

E. Producer's surplus — area above supply curve. Change in producer's surplus
   1. see Figure 14.6.
   2. intuitive interpretation: the sum of the marginal willingnesses to supply

F. This all works fine in the case of quasilinear utility, but what do you do in general?

G. Compensating and equivalent variation. See Figure 14.4.
   1. compensating: how much extra money would you need *after* a price change to be as well off as you were before the price change?
   2. equivalent: how much extra money would you need *before* the price change to be just as well off as you would be after the price change?
   3. in the case of quasilinear utility, these two numbers are just equal to the change in consumer's surplus.
   4. in general, they are different ... but the change in consumer's surplus is usually a good approximation to them.

Chapter 15

Market Demand

It would be logical to proceed directly to discussing the theory of the firm, but I wanted to take a break from pure optimization analysis, and discuss instead some ideas from equilibrium analysis. I think that this switch of gears helps students to see where they are going and why all this stuff is useful.

The most important idea in this chapter is elasticity. Elasticity was introduced earlier in Chapter 6, but I never did anything much with it there. Here we can really put it through its paces. The calculations here are all pretty standard, but I'm more careful than usual to distinguish between elasticity and the absolute value of elasticity.

If you use calculus, make sure that you compute elasticities for the linear and log-linear cases.

I love the Laffer curve example in the appendix. Here are some totally trivial elasticity calculations that give a major insight into a big policy issue. I really push on this example in class to show people how what they have learned can really help in making informed judgments about policy.

Market Demand

A. To get market demand, just add up individual demands.
   1. add horizontally
   2. properly account for zero demands; Figure 15.2.

B. Often think of market behaving like a single individual.
   1. **representative consumer** model
   2. not true in general, but reasonable assumption for this course

C. Inverse of aggregate demand curve measures the MRS for each individual.

D. Reservation price model
   1. appropriate when one good comes in large discrete units
   2. reservation price is price that just makes a person indifferent
   3. defined by $u(0, m) = u(1, m - p_1^*)$
   4. see Figure 15.3.
   5. add up demand curves to get aggregate demand curve

E. Elasticity
1. measures responsiveness of demand to price
2. $$\epsilon = \frac{p}{q}\frac{dq}{dp}$$
3. example for linear demand curve
   a) for linear demand, $q = a - bp$, so $\epsilon = -bp/q = -bp/(a - bp)$
   b) note that $\epsilon = -1$ when we are halfway down the demand curve
   c) see Figure 15.4.
4. suppose demand takes form $q = Ap^{-b}$
5. then elasticity is given by
$$\epsilon = -\frac{p}{q}bAp^{-b-1} = \frac{-bAp^{-b}}{Ap^{-b}} = -b$$
6. thus elasticity is constant along this demand curve
7. note that $\log q = \log A - b \log p$
8. what does elasticity depend on? In general how many and how close substitutes a good has.

F. How does revenue change when you change price?
1. $R = pq$, so $\Delta R = (p + dp)(q + dq) - pq = pdq + qdp + dpdq$
2. last term is very small relative to others
3. $dR/dp = q + p\,dq/dp$
4. see Figure 15.5.
5. $dR/dp > 0$ when $|e| < 1$

G. How does revenue change as you change quantity?
1. marginal revenue $= MR = dR/dq = p + q\,dp/dq = p[1 + 1/\epsilon]$.
2. **elastic**: absolute value of elasticity greater than 1
3. **inelastic**: absolute value of elasticity less than 1
4. application: Monopolist never sets a price where $|\epsilon| < 1$ — because it could always make more money by reducing output.

H. Marginal revenue curve
1. always the case that $dR/dq = p + q\,dp/dq$.
2. in case of linear (inverse) demand, $p = a - bq$, $MR = dR/dq = p - bq = (a - bq) - bq = a - 2bq$.

I. Laffer curve
1. how does *tax revenue* respond to changes in tax rates?
2. idea of Laffer curve: Figure 15.8.
3. theory is OK, but what do the magnitudes have to be?
4. model of labor market, Figure 15.9.
5. tax revenue $= T = t\bar{w}S(w(t))$ where $w(t) = (1 - t)\bar{w}$
6. when is $dT/dt < 0$?
7. calculate derivative to find that Laffer curve will have negative slope when
$$\frac{dS}{dw}\frac{w}{S} > \frac{1-t}{t}$$
8. so if tax rate is .50, would need labor supply elasticity greater than 1 to get Laffer effect
9. very unlikely to see magnitude this large

Chapter 16

Equilibrium

Some people have suggested that it would make more sense to save this chapter until after deriving supply curves, but I still feel that it is in a better position here. After all, the students have seen labor supply curves and net supply curves earlier in the course, and it isn't any shock to see demand and supply treated together now.

The first part of the chapter is pretty standard, although I go to extra pains to be clear to emphasize the idea of the inverse demand and supply curves. I tell the students that the inverse functions describe the same relationship, but just from a different viewpoint.

The treatment of taxes is more thorough than is usually the case. I like the idea of looking at taxation in several different ways. It is a good idea to emphasize that there are really *four* different variables in a taxation problem: the demand price p_d, the supply price p_s, the amount demanded q_d, and the amount supplied q_s. When confronted with a tax problem, the *first* thing you should do is write down the relationships between these four variables.

The most typical set of relationships is

$$p_d = p_s + t$$
$$q_d = q_s$$

But other relationships are possible. For example, if a tax-in-kind is levied, as in the King Kanuta problem in the workbook, then the amount demanded will be *different* than the amount supplied. In fact the only systematic way to work out the King Kanuta problme is to be very careful about writing down the relationships among the four variables.

You should emphasize that the incidence of the tax doesn't depend on the legal requirements of who is responsible for paying the tax. The Social Security tax is a really nice example for this. The Social Security tax is based on 15% of the nominal wage. The employer "pays" half of the tax and the worker "pays" the other half. But of course, this is a fiction. Show the students how we could redefine the nominal wage so that the worker paid all the tax or the employer paid all the tax, and leave the take-home pay of the worker unchanged.

This leads naturally to a discussion of the real incidence of a tax, the ideas of "passing along a tax," and so on.

I like to use the old red pencil/blue pencil example at this point. If red pencils and blue pencils are perfect substitutes in consumption and production, what is the impact of a tax on red pencils? There is a big output effect—consumption and production of red pencils would drop to zero. But what is the effect on consumer utility and producer profits? Zero—consumers and producers just substitute to other activities. This leads naturally to the idea of measuring the impact of a tax via consumer and producer surplus, as is done in Section 16.8.

The two examples that end the chapter, the market for loans and the food subsidies, are really wonderful examples and deserve careful discussion. I like to point out to the students how confused they would be in trying to understand these examples without the analytic methods of economics.

Equilibrium

A. Supply curves — measure amount the supplier wants to supply at each price
  1. review idea of net supply from Chapter 9

B. Equilibrium
  1. competitive market — each agent takes prices as outside his or her control
     a) many small agents
     b) a few agents who think that the others keep fixed prices
  2. equilibrium price — that price where desired demand equals desired supply
     a) $D(p) = S(p)$
  3. special cases — Figure 16.1.
     a) vertical supply — quantity determined by supply, price determined by demand
     b) horizontal supply — quantity determined by demand, price determined by supply
  4. an equivalent definition of equilibrium: where inverse demand curve crosses inverse supply curve
     a) $P_d(q) = P_s(q)$
  5. examples with linear curves

C. Comparative statics
  1. shift each curve separately
  2. shift both curves together

D. Taxes — nice example of comparative statics
  1. demand price and supply price — different in case of taxes
  2. $p_d = p_s + t$
  3. equilibrium happens when $D(p_d) = S(p_s)$
  4. put equations together:
     a) $D(p_s + t) = S(p_s)$
     b) or $D(p_d) = S(p_d - t)$
  5. also can solve using inverse demands:
     a) $P_d(q) = P_s(q) + t$
     b) or $P_d(q) - t = P_s(q)$
  6. see Figure 16.3. and Figure 16.4.

E. Passing along a tax — Figure 16.5.
  1. flat supply curve
  2. vertical supply curve

F. Deadweight loss of a tax — Figure 16.7.
1. benefits to consumers
2. benefits to producers
3. value of lost output

G. Market for loans
1. tax system subsidizes borrowing, tax lending
2. with no tax: $D(r^*) = S(r^*)$
3. with tax: $D((1-t)r') = S((1-t)r')$
4. hence, $(1-t)r' = r^*$. Quantity transacted is same
5. see Figure 16.8.

H. Food subsidies
1. buy up harvest and resell at half price.
2. before program: $D(p^*) + K = S$
3. after program: $D(\hat{p}/2) + K = S$
4. so, $\hat{p} = 2p^*$.
5. subsidized mortgages — unless the housing stock changes, no effect on cost.

I. Pareto efficiency
1. efficient output is where demand equals supply
2. because that is where demand price equals supply price.
3. that is, the marginal willingness to buy equals the marginal willingness to sell.
4. deadweight loss measures loss due to inefficiency.

Chapter 17

Measurement

The purpose of this chapter is to "bridge the gap" between the undergraduate theory and econometric classes. It can be covered in a lecture or two and can fit in almost anywhere in the course once you have covered the basics.

I describe the 5 basic things you do with data: summarize, estimate, test, forecast, and predict. Most students will already be familiar with tables and bar charts. Conditional expectation is likely a novel term, but the concept is pretty clear if you use concrete examples.

Simpson's paradox is great fun. Wikipedia has other examples that can be used.

I give a brief introduction to the logic of hypothesis testing, but it is necessarily quite incomplete.

The real meat comes in demand estimation. Here I try to relate the theory of demand estimation to what is done in practice, which is to run an experiment. If we have to use observational data, then we would normally have to worry about identification, which I discuss extensively. I raise the important issue of causal inference, but that is mostly just to make the students aware of the concept, since I can't do a lot with it in this short chapter.

Measurement

A. What do you do with statistics?

B. Example: Coffee consumption
   1. Summarize: how many cups of coffee consumed per person per day?
   2. Estimate: what is the elasticity of demand for coffee?
   3. Test: do men and women drink the same amount of coffee on average?
   4. Forecast: What will the price of coffee be next year?
   5. Predict: What will happen to consumption of coffee if a tax is imposed?

C. Summarizing data with tables and graphs
   1. Summary statistics (mean, median, model)
   2. Conditional mean: an average over those observations that satisfy some other condition

D. Simpson's paradox
   1. Coffee example, admissions example

E. Hypothesis testing
  1. Do men and women drink the same amount of coffee on average?
  2. Sampling variation
  3. Logic of testing: if men and women do drink the same amount, how likely would it be to see a difference as big as we see in the data?
  4. (If the students have taken statistics you might talk about t-tests.)

F. Estimating demand using experimental data
  1. Importance of randomized treatment
  2. Controlling for systematic effects (e.g., weather)
  3. Effect of treatment on population versus effect of treatment on the treated
  4. Experiment should be as close as possible to the proposed policy

G. Estimating demand using observational data

H. How does demand for coffee in the U.S. change as price changes?
  1. Regression analysis: conditional expectation again
  2. How was the data generated?
  3. Did someone choose the price or was it generated by the impersonal forces of supply and demand?

I. Specifying demand function
  1. p_1 = price of coffee, p_2 = price of everything else, m = income.
  2. Demand for single consumer $= D(p_1, p_2, m)$.
  3. Can divide by p_2 to get demand for $= D(p_1/p_2, m/p_2)$
  4. Think of p_2 as being a price index
  5. Demand depends on real price and real income
  6. Add up to get aggregate demand
  7. Functional form: linear, log-linear, semi-log

J. Specifying statistical model
  1. Error term: cumulative effect of other factors
  2. Critical assumption: price and expenditure are not correlated with error
  3. What happens if *only* the price changes, holding everything else constant?
  4. This is the causal effect of price change
  5. Ideally, you run an experiment
  6. In this case, it is reasonable to think that supply-side factors like weather, political events, and transportation costs are what move the price

K. Identification problem
  1. Is demand shifting or supply shifting (or both?)
  2. What can go wrong?
     a) When income is high, consumption is high, price sensitivity is low and firms raise prices
     b) When income is low, consumption is low, price sensitivity is high and firms cut prices
     c) The estimated demand curve slopes the wrong way!
     d) Omitted variable bias
     e) Easy fix in this case, but not so easy in other cases

L. Policy evaluation
  1. Natural experiments
     a) Oregon health care
     b) Police and crime

Chapter 18

Auctions

This is a fun chapter, since it brings in some real-life examples and non-obvious points about a widely-used form of market. The classification is straightforward, but it would be good to ask the students for examples of common-value and private-value auctions. (If there is a resale market, the distinction may be a bit blurred.) You might talk about online auctions like eBay.

The bidding rules are pretty straightforward as well. The interesting part is the section on auction design, which deserves some careful treatment. It is useful to describe the source of inefficiency in the profit-maximization case. Essentially the profit-maximizing monopoly seller restricts expected output, just as the ordinary monopolist restricts actual output.

The Vickrey auction argument is very nice—a little bit abstract, but not too hard to prove.

It is worth going over the bidding ring example in Chapter 24 here, just to show how collusion can work.

Finally the Winner's Curse is a nice story. I know one person who auctions off a jar of pennies, which is a nice common-value auction. He always makes money on the auction, a good example of the winner's curse!

Auctions

A. Auctions are one of the oldest form of markets
   1. 500 BC in Babylon
   2. 1970s offshore oil
   3. 1990s FCC airwave auctions
   4. various privatization projects

B. Classification of auctions
   1. private-value auctions
   2. common-value auctions

C. Bidding rules
   1. English auction, reserve price, bid increment
   2. Dutch auction
   3. sealed-bid auction
   4. Vickrey auction (philatelist auction, second-price auction)

D. Auction design
   1. special case of economic mechanism design
   2. possible goals
      a) Pareto efficiency
      b) profit maximization
   3. Pareto efficiency in private value auction
      a) person who values the good most highly gets it
      b) otherwise would be Pareto improvement possible
   4. Case 1: seller knows values $v_1, \ldots, v_n$
      a) trivial answer: set price at highest value
      b) this is Pareto efficient
   5. Case 2: seller doesn't know value
      a) run English auction
      b) person with highest value gets the good
      c) Pareto efficient
      d) pays price equal to second-highest value
   6. profit maximization in private-value auctions
      a) depends on sellers' beliefs about buyers' values
      b) example: 2 bidders with values of either \$10 or \$100
      c) assume equally likely so possibilities are (10,10), (10,100), (100,10), or (100,100)
      d) minimal bid increment of \$1, flip a coin for ties
      e) revenue will be (10,11,11,100)
      f) expected revenue will be \$33
      g) is this the best the seller can do?
      h) No! If he sets a reserve price of \$100 he gets (0,100,100,100)
      i) expected profit is \$75 which is much better
      j) *not* Pareto efficient
   7. Dutch auction, sealed-bid auction
      a) might not be Pareto efficient
   8. Vickrey auction
      a) if everyone reveals true value will be efficient
      b) but will they want to tell the truth?
      c) Yes! Look at special case of two buyers
      d) payoff = $\text{Prob}(b_1 \geq b_2)[v_1 - b_2]$
      e) if $v_1 > b_2$, want to make probability = 1
      f) if $v_1 < b_2$, want to make probability = 0
      g) it pays to tell the truth (in this case)
      h) note that this is essentially the same outcome as English auction

E. Problems with auctions
   1. susceptible to collusion (bidding rings)
   2. dropping out (Australian satellite-TV licenses)

F. Winner's curse
   1. common value auction
   2. assume that each person bids estimated value
   3. then most optimistic bidder wins
   4. but this is almost certainly an overestimate of value
   5. optimal strategy is to adjust bid downward
   6. amount that you adjust down depends on number of other bidders

Chapter 19

Technology

Here we start our discussion of firm behavior. This chapter discusses the concepts that economists use to describe technologies. Almost all of the material here is quite straightforward, especially given all of the exposure that the students have had to indifference curves, utility functions, etc.

Since students are by now quite familiar with Cobb-Douglas utility functions, you should be sure to emphasize that monotonic transformations are no longer warranted, since now the value of the production function represents some real, physical amount of output. Of course, you could choose to measure the output in different units, in which case the parameters of the production function would change. But given the units of measurement, we don't have any choice about how to measure production.

The new ideas are the ideas of the short and long runs, and the idea of returns to scale. These ideas will show up several times in the next few chapters, so the initial discussion is rather brief. In the workbook we give several examples of technologies and ask about their return-to-scale properties. It's a good idea to work one or two examples to show the students what is going on.

Technology

A. Need a way to describe the technological constraints facing a firm
   1. what patterns of inputs and outputs are feasible?

B. Inputs
   1. factors of production
   2. classifications: labor, land, raw materials, capital
   3. usually try to measure in flows
   4. financial capital vs. physical capital

C. Describing technological constraints
   1. production set — combinations of inputs and outputs that are feasible patterns of production
   2. production function — upper boundary of production set
   3. see Figure 17.1.
   4. isoquants — all combinations of inputs that produce a constant level of output
   5. isoquants (constant output) are just like indifference curves (constant utility)

D. Examples of isoquants
   1. fixed proportions — one man, one shovel
   2. perfect substitutes — pencils
   3. Cobb-Douglas — $y = Ax_1^a x_2^b$
   4. can't take monotonic transformations any more!

E. Well-behaved technologies
   1. monotonic — more inputs produce more output
   2. convex — averages produce more than extremes

F. Marginal product
   1. MP_1 is how much extra output you get from increasing the input of good 1
   2. holding good 2 fixed
   3. $MP_1 = \partial f(x_1, x_2)/\partial x_1$

G. Technical rate of substitution
   1. like the marginal rate of substitution
   2. given by the ratio of marginal products
   3. $$TRS = \frac{dx_2}{dx_1} = -\frac{\partial f/\partial x_1}{\partial f/\partial x_2}$$

H. Diminishing marginal product
   1. more and more of a single input produces more output, but at a decreasing rate. See Figure 17.5.
   2. law of diminishing returns

I. Diminishing technical rate of substitution
   1. equivalent to convexity
   2. note difference between diminishing MP and diminishing TRS

J. Long run and short run
   1. All factors varied — long run
   2. Some factors fixed — short run

K. Returns to scale
   1. constant returns — baseline case
   2. increasing returns
   3. decreasing returns

Chapter 20

Profit Maximization

I start out the chapter with a careful definition of profits: you must value each output and input at its *market* price, whether or not the good is actually sold on a market. This is because the market price measures the price at which you *could* sell the input, and thus measures the true opportunity cost of using the factor in this production process rather than in some other use.

I give some commonplace examples of this idea, but more examples won't hurt. It's good to get this idea across carefully now, since it will make it much easier to discuss the idea of zero long-run profits when it comes up. This idea is usually a stumbling block for students, and a careful examination about just what it is that goes into the definition of economic profits helps a lot in getting the point across.

The material on stock market value is something that is left out of most texts, but since we have had a careful discussion of asset markets, we can draw the link between maximizing profits and maximizing stock market value.

The rest of the material in the chapter is fairly standard. The one novel feature is the revealed profitability approach to firm behavior. This section, Section 18.10, shows how you can use the fact that the firm is maximizing profits to derive comparative statics conclusions. If you have treated revealed preference in consumption carefully, students should have no trouble with this approach.

Profit Maximization

A. Profits defined to be revenues minus costs
   1. value each output and input at its market price — even if it is not sold on a market.
   2. it could be sold, so using it in production rather than somewhere else is an **opportunity cost**.
   3. measure in terms of flows. In general, maximize present value of flow of profits.

B. Stock market value
   1. in world of certainty, stock market value equals present value of stream of profits
   2. so maximizing stock market value is the same as maximizing present value of profits
   3. uncertainty — more complicated, but still works

C. Short-run and long-run maximization
   1. fixed factors — plant and equipment
   2. quasi-fixed factors — can be eliminated if operate at zero output (advertising, lights, heat, etc.)

D. Short-run profit maximization. Figure 18.1.
   1. max $pf(x) - wx$
   2. $pf'(x^*) - w = 0$
   3. in words: the value of the marginal product equals wage rate
   4. comparative statics: change w and p and see how x and $f(x)$ respond

E. Long-run profit maximization
   1. $p\,\partial f/\partial x_1 = w_1$, $p\,\partial f/\partial x_2 = w_2$

F. Profit maximization and returns to scale
   1. constant returns to scale implies profits are zero
      a) note that this doesn't mean that economic factors aren't all appropriately rewarded
      b) use examples
   2. increasing returns to scale implies competitive model doesn't make sense

G. revealed profitability
   1. simple, rigorous way to do comparative statics
   2. observe two choices, at time t and time s
   3. (p^t, w^t, y^t, x^t) and (p^s, w^s, y^s, x^s)
   4. if firm is profit maximizing, then must have

$$p^t y^t - w^t x^t \geq p^t y^s - w^t x^s$$
$$p^s y^s - w^s x^s \geq p^s y^t - w^s x^t$$

   5. write these equations as

$$p^t y^t - w^t x^t \geq p^t y^s - w^t x^s$$
$$-p^s y^t + w^s x^t \geq -p^s y^s + w^s x^s$$

   6. add these two inequalities:

$$(p^t - p^s)y^t - (w^t - w^s)x^t \geq (p^t - p^s)y^s - (w^t - w^s)x^s$$

   7. rearrange:

$$(p^t - p^s)(y^t - y^s) - (w^t - w^s)(x^t - x^s) \geq 0$$

   8. or

$$\Delta p \Delta y - \Delta w \Delta x \geq 0$$

   9. implications for changing output and factor prices

Chapter 21

Cost Minimization

The treatment in this chapter is pretty standard, except for the material on revealed cost minimization. However, by now the students have seen this kind of material three times, so they shouldn't have much difficulty with it.

It is worthwhile emphasizing the difference between the unconditional factor demand functions of Chapter 18 and the conditional factor demand functions of Chapter 19. Here we are looking at the best input choice holding the physical level of output fixed. In Chapter 18 we looked for the best input choice holding the price of output fixed, where the level of output is adjusted to its most profitable level.

The material on returns to scale and the cost function is important to get across, as we will refer in future chapters to cases of increasing average cost, decreasing average cost, etc. It is important to be able to link these ideas to the returns-to-scale ideas discussed in earlier chapters.

The material in Sections 21.4 and 21.5 lays the groundwork for ideas that will be further explored in the next chapter. Both sections are just exploring various definitions. Section 21.4 will be used in discussing the shapes of short-run and long-run cost curves. Section 21.5 will be used to distinguish between two different concepts of fixed costs in the short and long runs.

Cost Minimization

A. Cost minimization problem
   1. minimize cost to produce some given level of output:
$$\min_{x_1,x_2} \; w_1x_1 + w_2x_2$$
$$\text{s.t. } f(x_1,x_2) = y$$
   2. geometric solution: slope of isoquant equals slope of isocost curve. Figure 19.1.
   3. equation is: $w_1/w_2 = MP_1/MP_2$
   4. optimal choices of factors are the **conditional factor demand functions**
   5. optimal cost is the **cost function**
   6. examples
      a) if $f(x_1,x_2) = x_1 + x_2$, then $c(w_1,w_2,y) = \min\{w_1,w_2\}y$
      b) if $f(x_1,x_2) = \min\{x_1,x_2\}$, then $c(w_1,w_2,y) = (w_1+w_2)y$
      c) can calculate other answers using calculus

B. Revealed cost minimization
  1. suppose we hold output fixed and observe choices at different factor prices.
  2. when prices are (w_1^s, w_2^s), choice is (x_1^s, x_2^s), and when prices are (w_1^t, w_2^t), choice is (x_1^t, x_2^t).
  3. if choices minimize cost, then we must have

$$\begin{aligned} w_1^t x_1^t + w_2^t x_2^t &\leq w_1^t x_1^s + w_1^t x_2^s \\ w_1^s x_1^s + w_1^s x_2^s &\leq w_1^s x_1^t + w_2^s x_2^t \end{aligned}$$

  4. this is the **Weak Axiom of Cost Minimization (WACM)**
  5. what does it imply about firm behavior?
  6. multiply the second equation by -1 and get

$$\begin{aligned} w_1^t x_1^t + w_2^t x_2^t &\leq w_1^t x_1^s + w_1^t x_2^s \\ -w_1^s x_1^t - w_1^s x_2^t &\leq -w_1^s x_1^s - w_2^s x_2^s \end{aligned}$$

  7. add these two inequalites:

$$\begin{aligned} (w_1^t - w_1^s)(x_1^t - x_1^s) + (w_2^t - w_2^s)(x_1^t - x_1^s) &\leq 0 \\ \Delta w_1 \Delta x_1 + \Delta w_2 \Delta x_2 &\leq 0 \end{aligned}$$

  8. roughly speaking, "factor demands move opposite to changes in factor prices"
  9. in particular, *factor demand curves must slope downward.*

C. Returns to scale and the cost function
  1. increasing returns to scale implies decreasing AC
  2. constant returns implies constant AC
  3. decreasing returns implies increasing AC

D. Long-run and short-run costs
  1. long run: all inputs variable
  2. short run: some inputs fixed

E. Fixed and quasi-fixed costs
  1. fixed: must be paid, whatever the output level
  2. quasi-fixed: only paid when output is positive (heating, lighting, etc.)

Chapter 22

Cost Curves

Now we get to the standard meat and potatoes of undergraduate microeconomics. The first section lays out the rationale behind U-shaped average cost curves. To me the most natural rationale is constant fixed costs and increasing average variable costs.

The link between marginal costs and variable costs is left out of a lot of books, but is important for understanding producer's surplus.

I am very keen on the cost function $c(y) = y^2 + 1$, and use it in a lot of the examples. Be sure to go over its derivation and show how it gives rise to the various cost curves.

The material on how to get the long-run cost curve from the short-run cost curve is pretty straightforward. It may be a little easier to first do Section 22.5, and then draw in a lot of extra short-run curves to get to the diagram in Figure 22.7.

Cost Curves

A. Family of cost curves
1. total cost: $c(y) = c_v(y) + F$
2. $$\frac{c(y)}{y} = \frac{c_v(y)}{y} + \frac{F}{y}$$ $$AC = AVC + AFC$$
3. see Figure 20.1.
4. marginal cost is the change in cost due to change in output $c'(y) = dc(y)/dy = dc_v(y)/dy$
   a) marginal cost equals AVC at zero units of output
   b) goes through minimum point of AC and AVC. Figure 20.2.
      1) $$\frac{d}{dy}\frac{c(y)}{y} = \frac{yc'(y) - c(y)}{y^2}$$
      2) this is negative (for example) when $c'(y) < c(y)/y$