Microeconomics

Matilde Cappelletti

Fall 2026

About the course

Book: Hal Varian, Microeconomic Analysis, 3rd edition, Norton, International Edition, 1992.

Lectures: slides cover the book chapter by chapter. Last slide contains a list of the homework exercises for that chapter. We will discuss the exercises in class.

Assessment: One midterm (20%), a group presentation (20%), and a final exam (60%).

Fenix: you can find all the material in the folder “All you need” (EN), including a syllabus with an overview of the program and further details. Slides and mock midterms/exams will be updated in due time.

How to contact me: cappelletti@iseg.ulisboa.pt

When: Tue 6–9pm and Thu 9.30–11pm

More information on the syllabus

Program

- Consumers: Chapter 7, 8 and 10

Ch 7 Utility maximization

Ch 8 Choice

Ch 10 Consumers' surplus

- Firms: Chapter 1 unto 5

Ch 1 Technology

Ch 2 Profit maximization

Ch 3 Profit function

Ch 4 Cost minimization

Ch 5 Cost function

Program

- Markets: Chapter 13 and 14

Ch 13 Competitive markets

Ch 14 Monopoly

We will use some concepts from Chapter 26 (Mathematics) and 27 (Optimization) throughout the course. We will review basic concepts in the math refresher.

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Common Derivative Rules

Common Function	Function	Derivative
Constant	c	0
Line	x	1
	ax	a
Square	x^2	2x
Power	x^n	n x^{n-1}
Square Root	$\sqrt{x}$	$\frac{1}{2}x^{-1/2}$
Any Root	$x^{1/n}$	$\frac{1}{n}x^{(1-n)/n}$
Exponential	e^x	e^x
	a^x	ln(a) a^x
Logarithms	ln(x)	1/x
	$log_a(x)$	1/(x ln(a))

Other Rules: Chain Rule

$$y = f(u) \quad u = f(x) \tag{1}$$

Chain Rule

$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$

Example

- $y = (2x + 4)^3$
- $y = u^3$ and $u = 2x + 4$

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Example

- $y = (2x + 4)^3$
- $y = u^3$ and $u = 2x + 4$
- $\frac{dy}{du} = 3u^2$ and $\frac{du}{dx} = 2$
- $\frac{dy}{dx} = 3u^2 \cdot 2 = 3(2x + 4) \cdot 2 = 6(2x + 4)^2$

Other Rules: Product Rule

$$f(x) = u(x) \cdot v(x) \tag{2}$$

Product Rule

$f'(x) = u'v + uv'$

Example

- $f(x) = \underbrace{(3x - 5)}_{\text{u(x)}} \cdot \underbrace{(4x + 7)}_{\text{v(x)}}$

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Example

- $f(x) = \underbrace{(3x - 5)}_{\text{u(x)}} \cdot \underbrace{(4x + 7)}_{\text{v(x)}}$
- $u' = 3$ and $v' = 4$
- $f'(x) = 3(4x + 7) + 4(3x - 5) = 12x + 21 + 12x - 20 = 24x + 1$

Other Rules: Quotient Rule

$$f(x) = \frac{u(x)}{v(x)} \tag{3}$$

Quotient Rule

$f'(x) = \frac{u'v - v'u}{v^2}$

Example

- $f(x) = \frac{(3x-5)}{(4x+7)}$

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- $f(x) = \frac{(3x-5)}{(4x+7)}$
- $u' = 3$ and $v' = 4$
- $f'(x) = \frac{3(4x+7)-4(3x-5)}{(4x+7)^2} = \frac{41}{(4x+7)^2}$

Exercise 1.a - Partial Derivative

$$f(x, y, z) = xy^2 + x^3y - z \tag{4}$$

- $f_x = \frac{\partial f}{\partial x} = y^2 + 3x^2y$

Exercise 1.a - Partial Derivative

$$f(x, y, z) = xy^2 + x^3y - z \tag{4}$$

- $f_x = \frac{\partial f}{\partial x} = y^2 + 3x^2y$
- $f_y = \frac{\partial f}{\partial y} = 2xy + x^3$
- $f_z = \frac{\partial f}{\partial z} = -1$

Exercise 1.b

$$f(x, y) = lnx + \sqrt{y} \tag{5}$$

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- $f_x = \frac{1}{x}$
- $f_y = \frac{1}{2}y^{-\frac{1}{2}}$
  - Simplify it further: $= \frac{1}{2\sqrt{y}}$

Exercise 1.c

$$f(x, y) = xy^2(12 - 3x - 2y) \tag{6}$$

Product Rule

f'(x) = u' v + u v'

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- $f_x = y^2(12 - 3x - 2y) + xy^2(-3)$
  $= y^2(12 - 3x - 2y - 3x) = 2y^2(6 - 3x - y)$

- $f_y = 2xy(12 - 3x - 2y) + xy^2(-2)$
  $= 2xy(12 - 3x - 2y - y) = 6xy(4 - x - y)$

Exercise 1.d

$$f(x, y) = \frac{3x}{x^2 + y^n} \tag{7}$$

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Quotient Rule

If $f(x) = \frac{u(x)}{v(x)}$, then $f'(x) = \frac{u'v - uv'}{v^2}$

- $f_x = \frac{3(x^2+y^n) - 3x(2x)}{(x^2+y^n)^2}$
  $= \frac{3x^2+3y^n-6x^2}{(x^2+y^n)^2} = \frac{3(y^n-x^2)}{(x^2+y^n)^2}$

- $f_y = -\frac{3x \cdot ny^{n-1}}{(x^2+y^n)^2}$

Exercise 2.a - System of Equations

$$A : x - 3y + 6z = -1$$
$$B : 2x - 5y + 10z = 0$$
$$C : 3x - 8y + 17z = 1$$

Solving by elimination: Calculate $2A - B$ and $3A - C$ to eliminate x

- $A' : 2A - B = -y + 2z = -2$
- $B' : 3A - C = -y + z = -4$

Subtract B' from A', this way you eliminate y:

- You get: $z = 2$
- Plug it in, for instance into B' to get: $-y + 2 = -4$, leding to $y = 6$
- In equations A (or B/C), you can plug in the values of z and y to obtain $x = 5$

Exercise 3.a

$$f(x) = x^2 \dot{h}(g(x)) \text{ where } h(g(x)) = A - 2g(x) \text{ and } g(x) = x + y + z \tag{8}$$

Chain Rule

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$$\begin{aligned} f'(x) &= 2x \cdot h(g(x)) + x^2 \cdot h'(g(x)) \cdot g'(x) \\ &= 2x \cdot (A - 2g(x)) + x^2 \cdot (-2) \cdot 1 \\ &= 2x(A - 2(x + y + z)) - 2x^2 \\ &= 2x(A - 3x - 2y - 2z) \end{aligned}$$

Exercise 3.b

$$f(x) = 3x\dot{h}(g(x)) - cx \text{ where } h(g(x)) = 4\big(g(x)\big)^{-1} \text{ and } g(x) = ax + by + z \tag{9}$$

$$\begin{aligned}
f'(x) &= 3h(g(x)) + 3xh'(g(x)) \cdot g'(x) - c \\
&= 3 \cdot 4\big(g(x)\big)^{-1} + 3x(-4\big(g(x)\big)^{-2}) \cdot a - c \\
&= \frac{12}{g(x)} - \frac{12ax}{g(x)^2} - c \\
&= \frac{12\big(g(x) - ax\big)}{g(x)^2} - c \\
&= \frac{12(ax + by + z - ax)}{(ax + by + z)^2} - c \\
&= \frac{12(by + z)}{(ax + by + z)^2} - c
\end{aligned}$$

Exercise 4.a

$$\frac{4x - 12}{6x - x^2 - 9} \tag{10}$$

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$$\frac{4x-12}{6x-x^2-9} \tag{10}$$

$$\iff \frac{4(x-3)}{-(x^2-6x+9)} = \frac{4(x-3)}{-(x-3)^2} = \frac{4}{3-x}$$

Exercise 4.b

$$\frac{2x+6}{x^2-9} \div \frac{x^2+6x+9}{(x-3)(x+3)} \tag{11}$$

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$$\frac{2x+6}{x^2-9} \div \frac{x^2+6x+9}{(x-3)(x+3)} \tag{11}$$

$$\iff \frac{2(x+3)}{x^2-9} \div \frac{(x+3)^2}{x^2+3x-3x-9} = \frac{2(x+3)}{(x^2-9)} \cdot \frac{x^2-9}{(x+3)^2} = \frac{2}{x+3}$$

Exercise 4.c (at home)

$$\frac{x^2 - 13x + 42}{14 - 2x} \tag{12}$$

$$\iff \frac{(x^2 - 14x + 49) + (x - 7)}{2(7 - x)} = \frac{(x - 7)^2 + (x - 7)}{-2(x - 7)} = \frac{(x - 7)(x - 7 + 1)}{-2(x - 7)} = \frac{6 - x}{2}$$

Exercise 4.d (at home)

$$\frac{2x-4}{x^2-1} \div \frac{x^2-4}{x^2+3x+2} \tag{13}$$

$$\iff \frac{2(x-2)}{(x-1)(x+1)} \div \frac{(x-2)(x+2)}{(x+1)^2+(x+1)} = \frac{2(x-2)}{(x-1)(x+1)} \cdot \frac{(x+1)(x+1+1)}{(x-2)(x+2)}$$
$$= \frac{2}{x-1} \cdot \frac{x+2}{x+2} = \frac{2}{x-1}$$

What is economics?
An introduction to this course.

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Economics is a **social science**: social sciences study human behavior.

Ask someone on the street what separates economics from political science or sociology, and they will likely say economics studies **money, prices, interest rates, profits**, while political science studies politicians and elections, and sociology studies groups.

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There is some truth to this, but it misses the point: economics is not defined by a **subject matter**, it is defined by a **common approach** to problems.

Economists have studied firm and consumer behavior, inflation, unemployment – but also voting, marriage, and the family. What unites all of this is the **marginalist** (or **neoclassical**) approach.

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This approach lets us derive **predictions** about behavior that can, in principle, be **tested** with **data** using econometric techniques.

Example: the grocery store

Consider what I should buy at the grocery store.

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- **Principle 4:** if next week I buy a different cart, it is because I have less money, or something available last week is not available this week (or vice versa).

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Lesson: if we define preferences over a rich enough set of allocations, we can usually find preferences that *are* stable.

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- **Only real opportunities matter:** doubling all prices and my budget does not change what I can afford, so it should not change what I choose.

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We will formalize exactly these kinds of assumptions – completeness, transitivity, continuity, monotonicity, convexity – in the next chapter.

Testable implications and comparative statics

Once structure is added, we can make **predictions** about behavior in response to changes in the environment.

Example: if my grocery budget increases, I will buy **more of at least one item** – since I spend all of my money (Walras' Law) and there is always some good I would like more of (monotonicity).

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- **Comparative statics:** deriving what happens to people's **choices** in response to changes in things they do **not** choose (e.g., income, prices).

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3. Observe what people actually do (analyze data with econometric techniques).

- If behavior matches predictions $\rightarrow$ the theory is **supported** (never *proven*).
- If not $\rightarrow$ back to the drawing board: Were preferences different than assumed? Were people not optimizing? Was there a missing constraint? Did the environment change in a way we failed to model?

Summary: what is economics?

Economics is the social science that explains human behavior as arising from **consistent (often maximizing) behavior subject to constraints**.

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In the last weeks of class, you will present papers that will develop theories and test them with data.

Consumer behavior

We start the course with the **theory of the consumer**: consumer behavior will be modeled based on utility-maximizing decisions, while considering the underlying economic constraints.

Later in the course, we will see the **theory of the firm**, where firm behavior is modeled based on profit-maximizing or cost-minimizing decisions, while considering the underlying technological constraints.

Many of the same tools (constrained optimization, duality) will be useful here as well.