Building Economic Models

Topic 1

Comm 220 • Fall 2014

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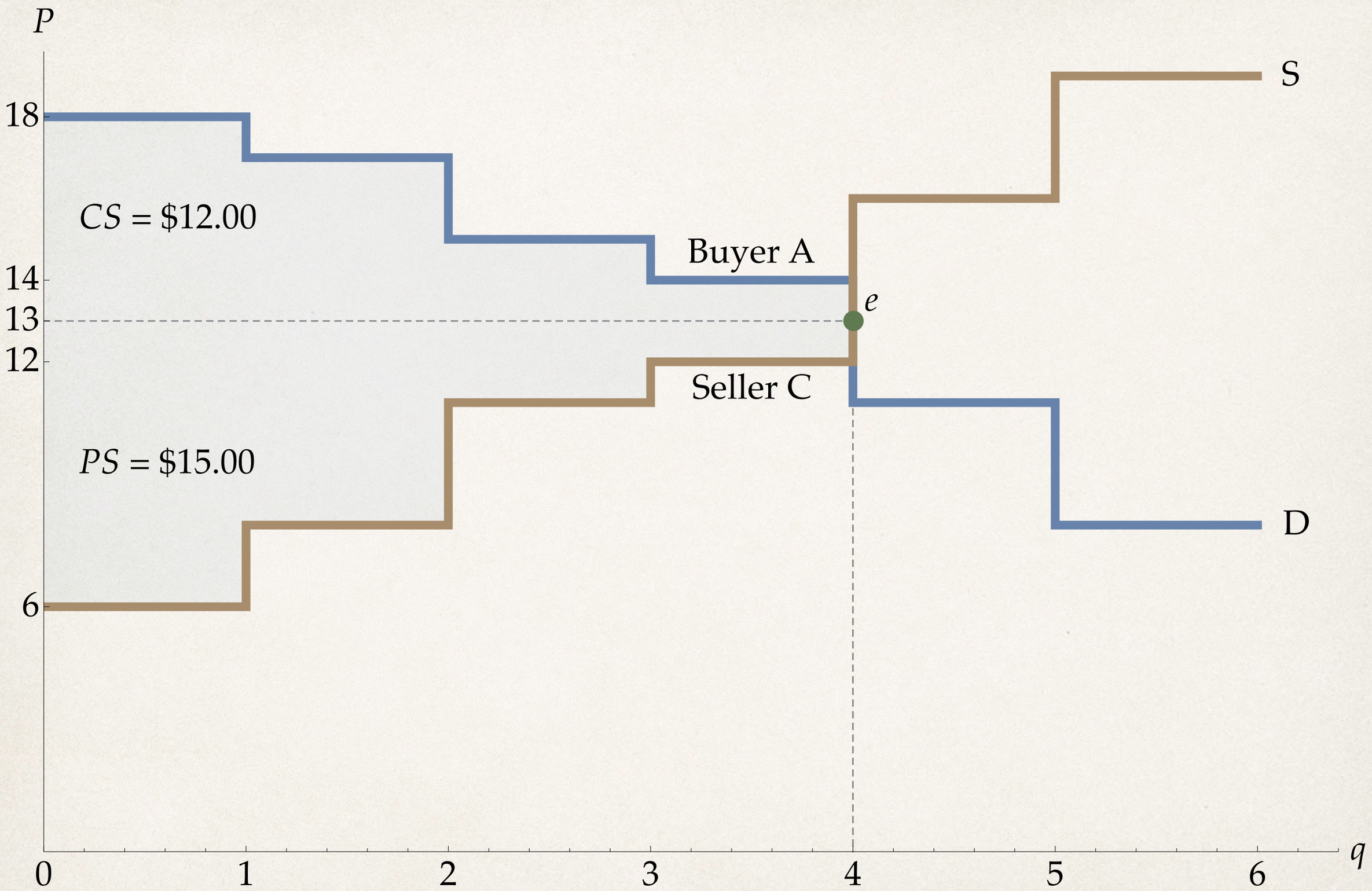
Model Building & Behavioural Economics

Kahneman, Daniel; Jack L. Knetsch, and Richard H. Thaler, "The Endowment Effect, Loss Aversion, and Status Quo Bias," *The Journal of Economic Perspectives*, 1991, Vol. 5, No. 1, 193-206.

An experiment in trading tokens

Redemption value		Cost	
Buyer A	$14	Seller A	$16
Buyer B	$17	Seller B	$6
Buyer C	$18	Seller C	$12
Buyer D	$11	Seller D	$8
Buyer E	$15	Seller E	$11
Buyer F	$8	Seller F	$19


P
18
14
13
12
6
CS = $12.00
PS = $15.00
Buyer A
Seller C
e
S
D
0
1
2
3
4
5
6
q

A variation of the first experiment

- 100 buyers and 100 sellers
- Each seller is endowed with one I-Love-Concordia coffee mug that has a sticker price of $13.89 (taxes included, *merci*)
- Public information (common knowledge?)

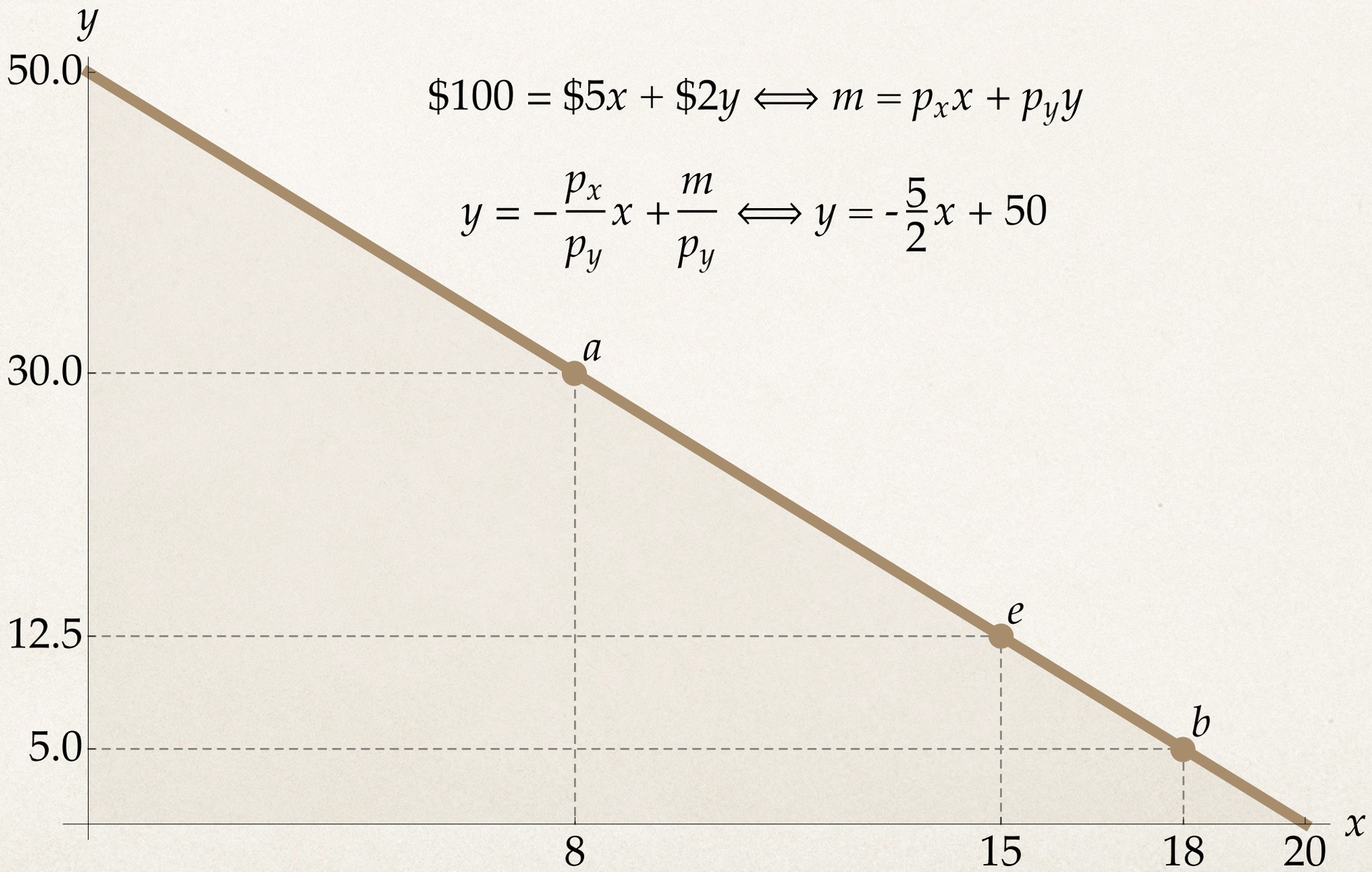
A digression on types of markets

- Walrasian or call market
- Posted-offer auction (grocery store)
- English auction (eBay?)
- Vickrey auction (project tenders)
- Bilateral market (FX in the old days)
- Continuous double oral auction (TSX)

Utility Theory

Topic 2

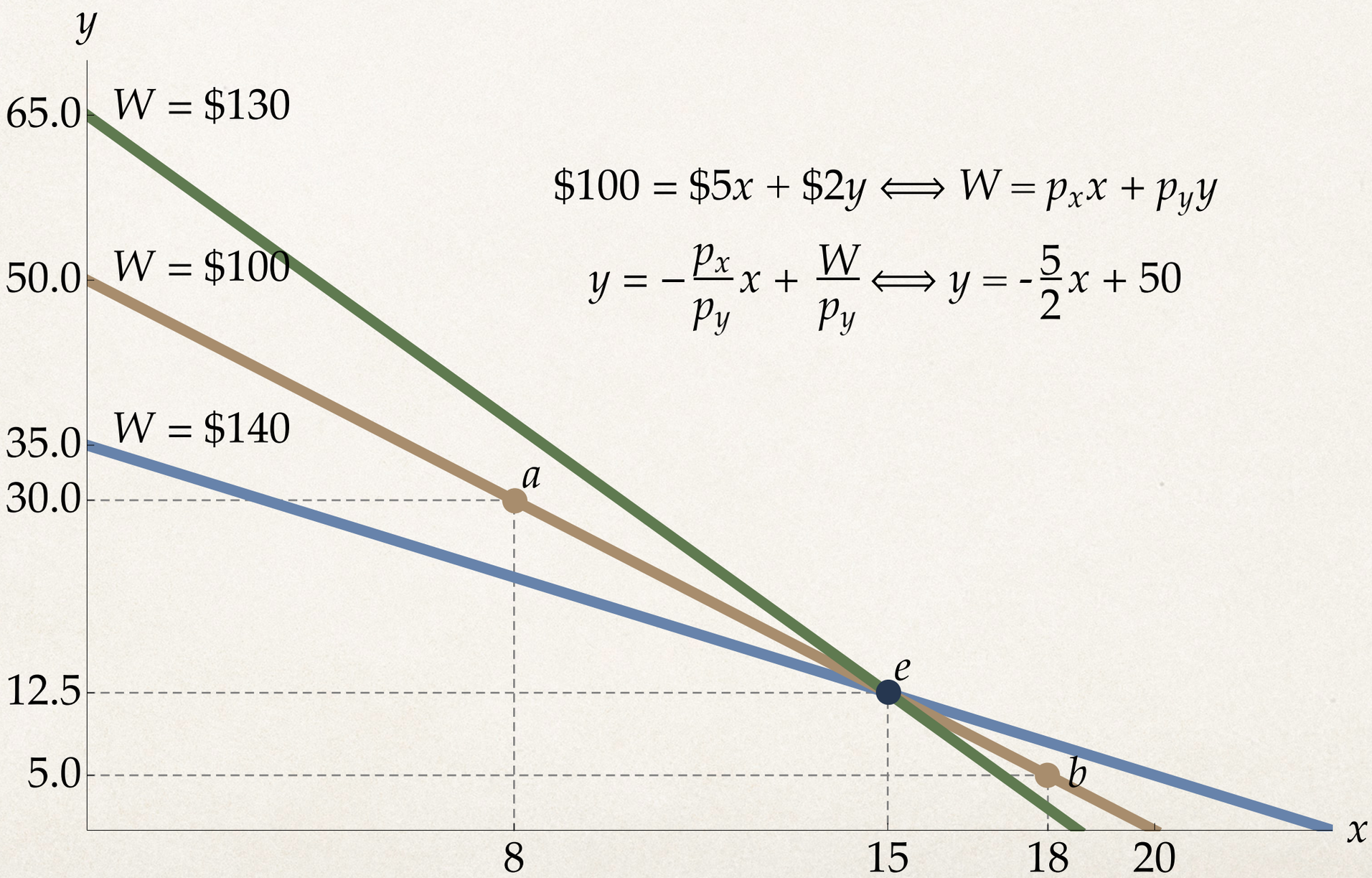
Income constraint



$$\$100 = \$5x + \$2y \iff m = p_x x + p_y y$$

$$y = -\frac{p_x}{p_y}x + \frac{m}{p_y} \iff y = -\frac{5}{2}x + 50$$

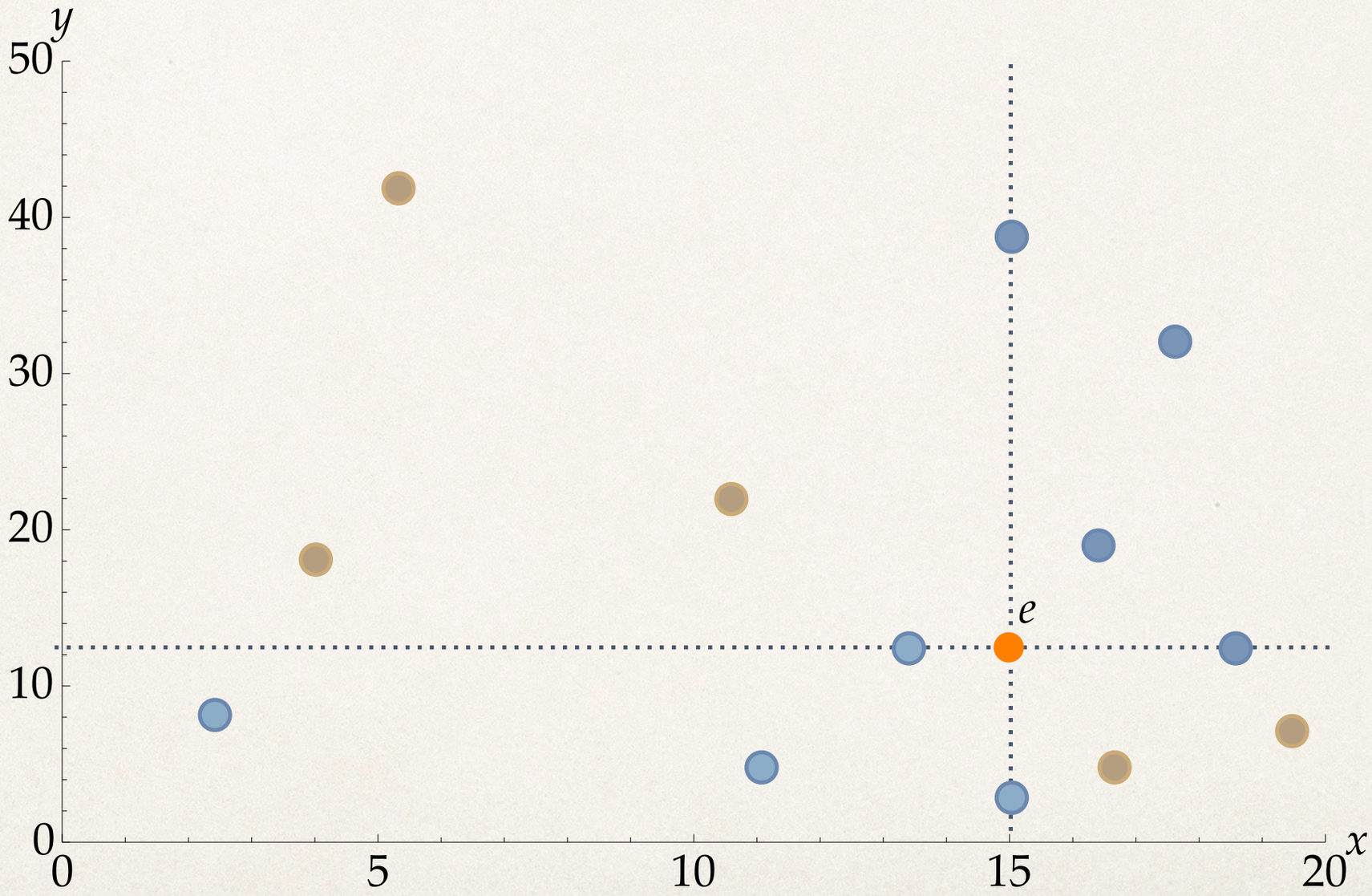
Wealth constraint



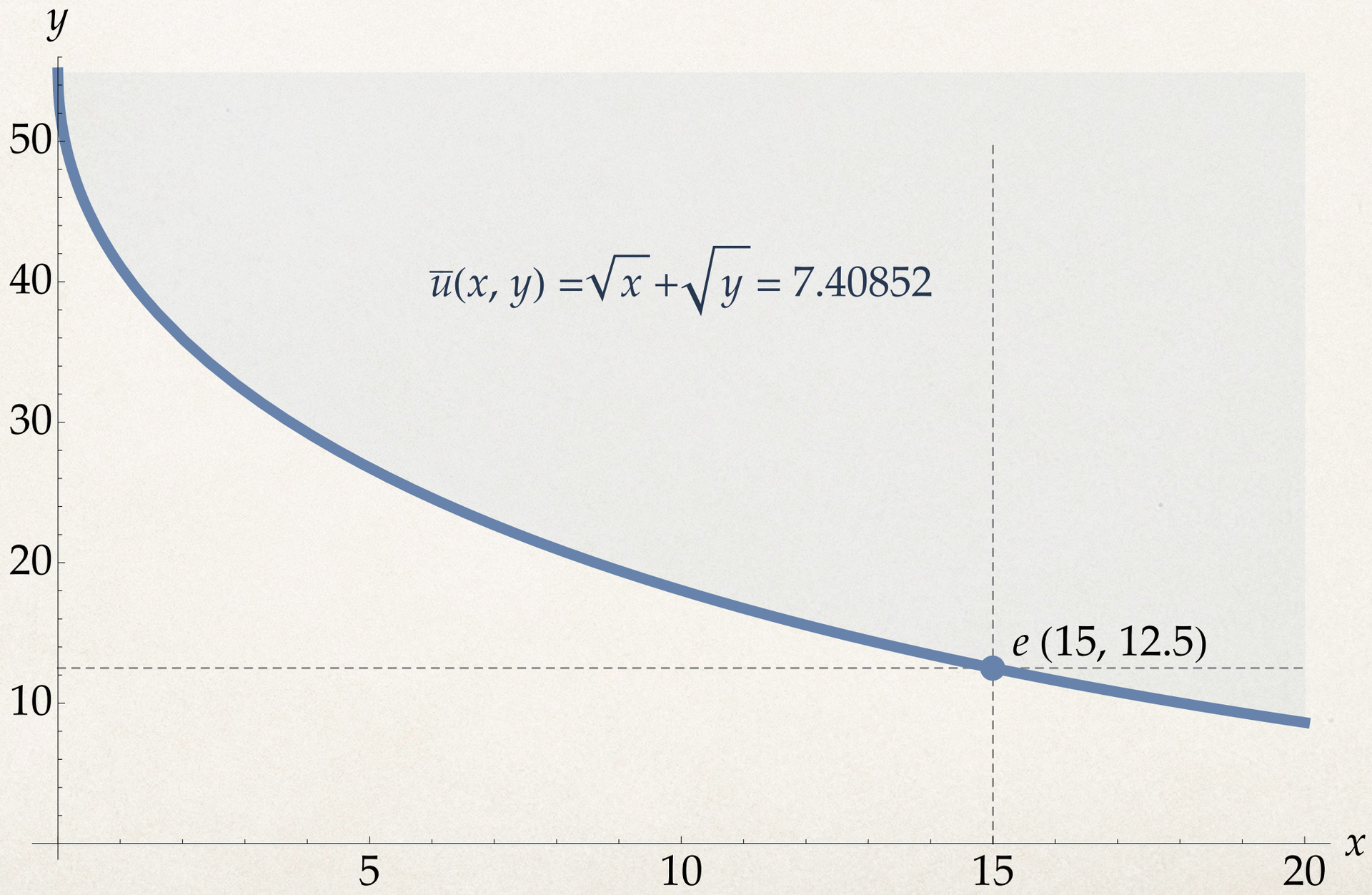
$$\$100 = \$5x + \$2y \iff W = p_x x + p_y y$$

$$y = -\frac{p_x}{p_y}x + \frac{W}{p_y} \iff y = -\frac{5}{2}x + 50$$

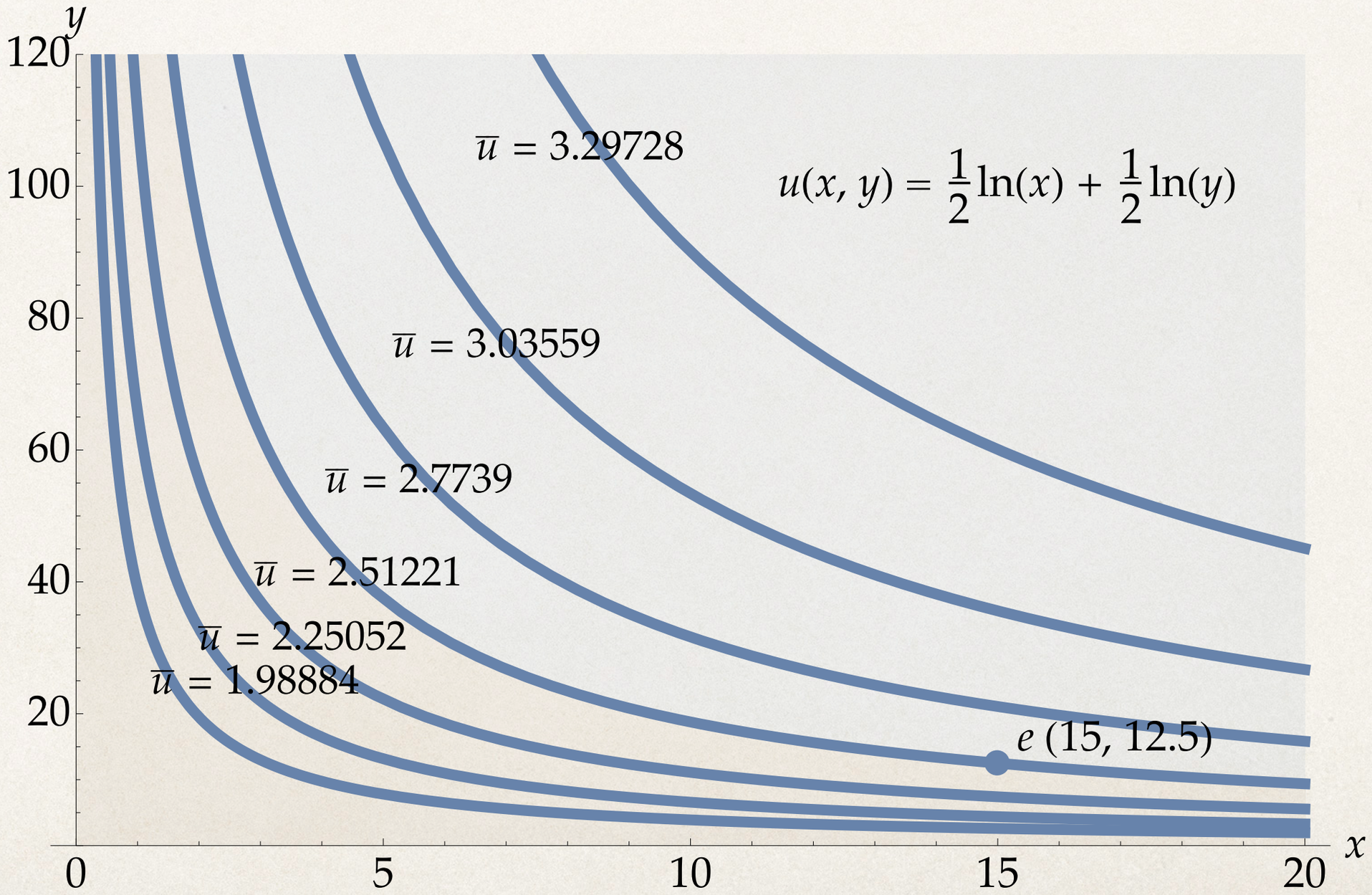
Preferences {tastes}



Indifference curve



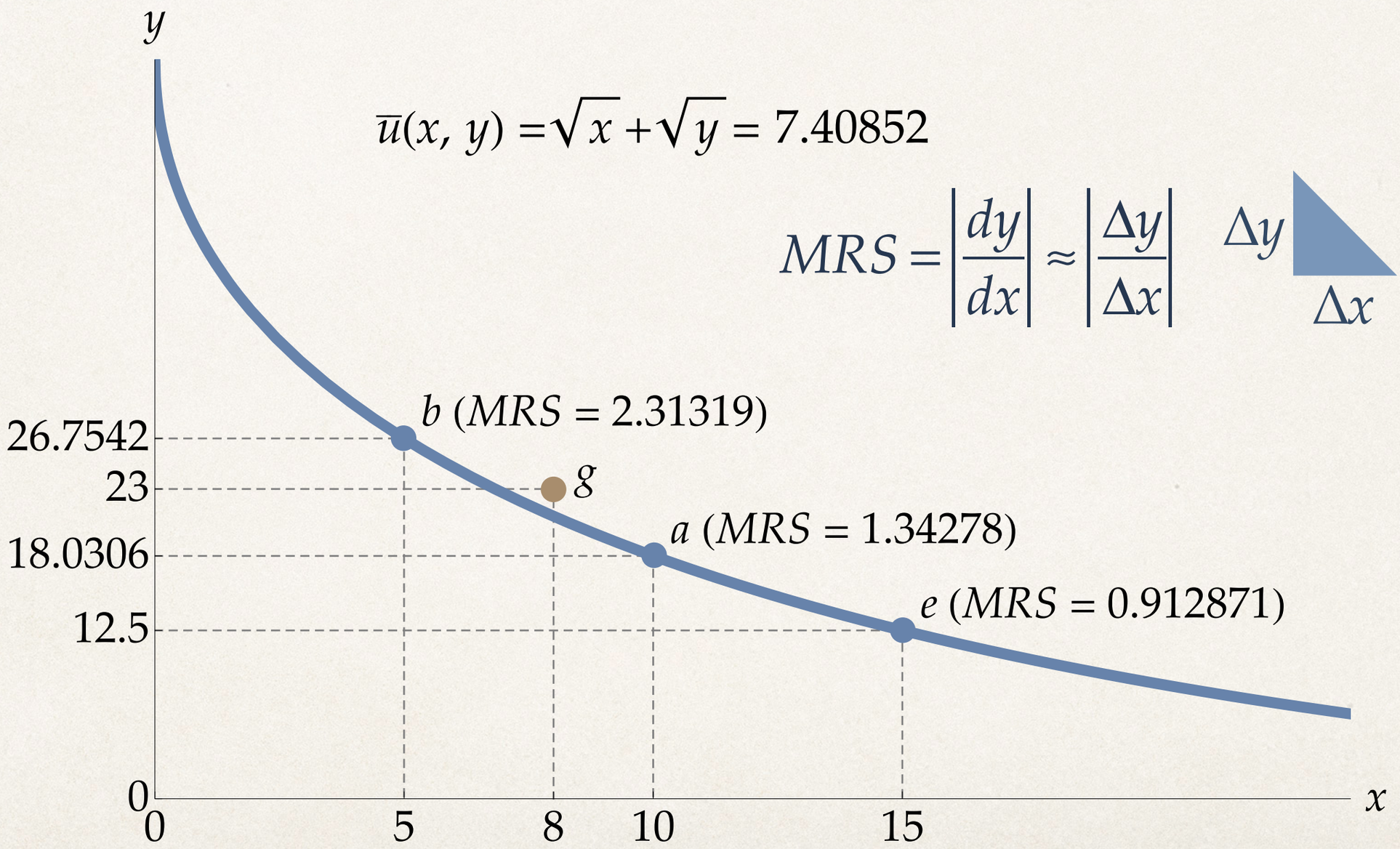
Indifference map



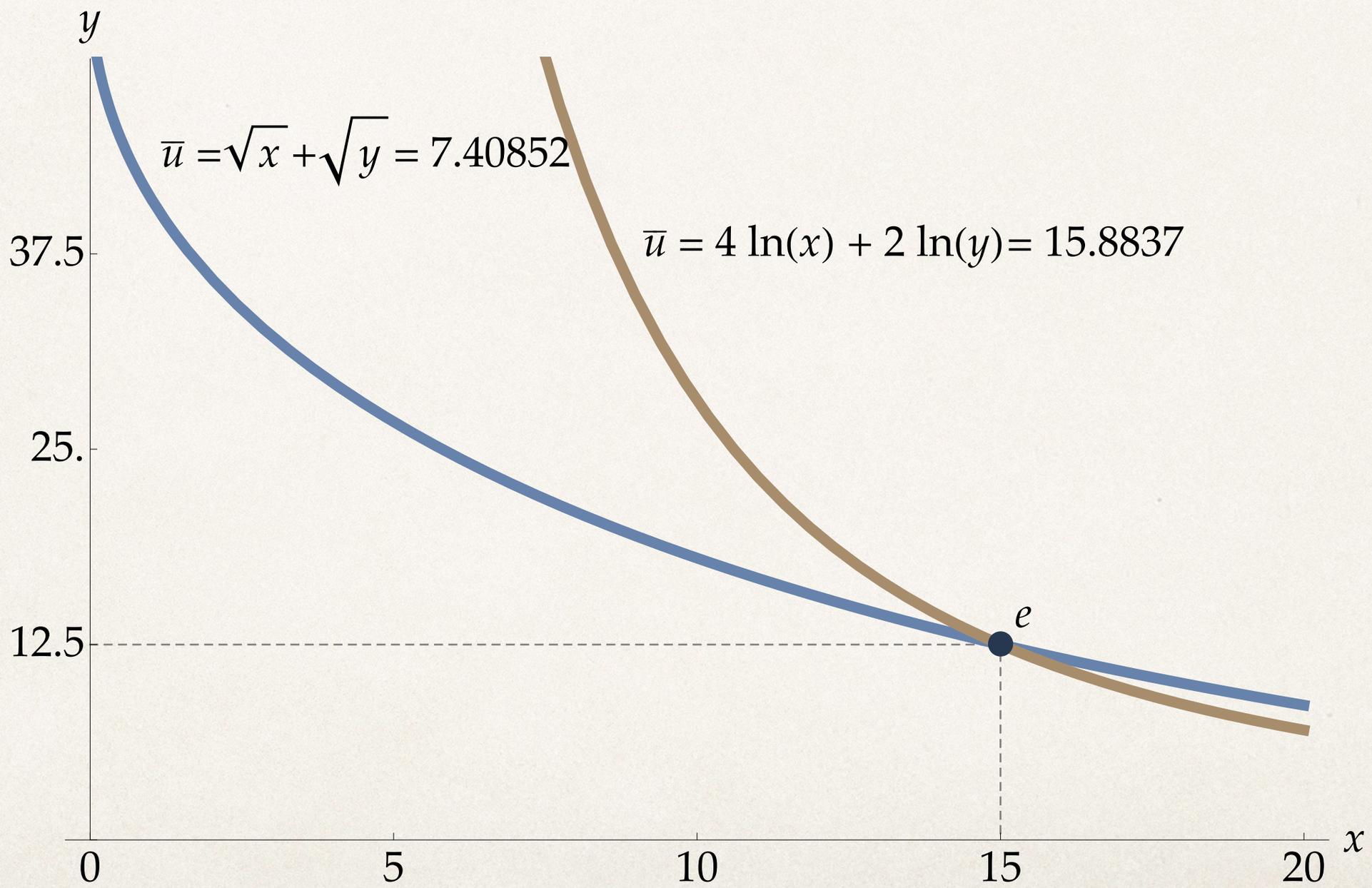
Marginal rate of substitution

$$\bar{u}(x, y) = \sqrt{x} + \sqrt{y} = 7.40852$$

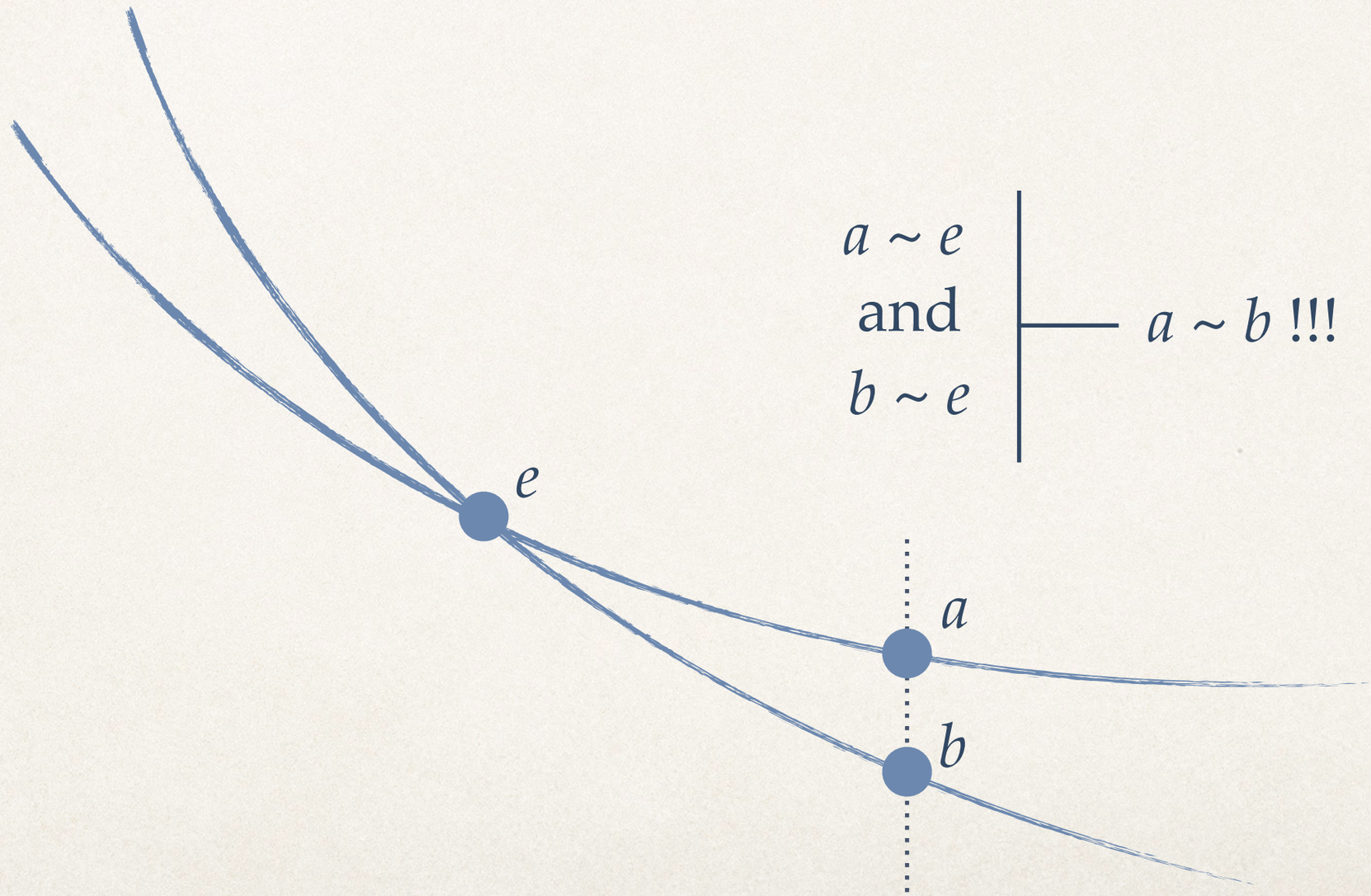
$$MRS = \left|\frac{dy}{dx}\right| \approx \left|\frac{\Delta y}{\Delta x}\right|$$



You and me

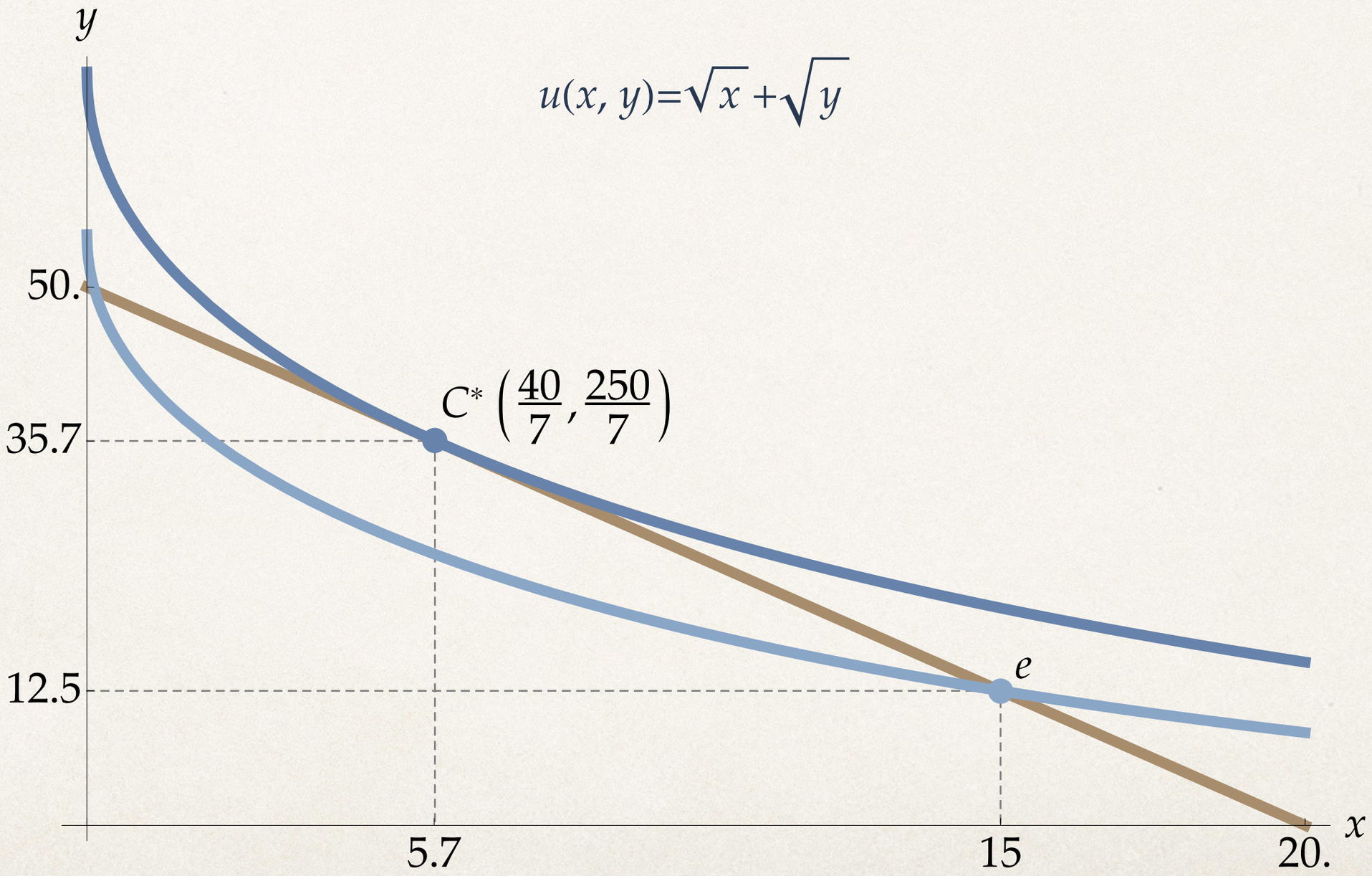

y
$\bar{u} = \sqrt{x} + \sqrt{y} = 7.40852$
$\bar{u} = 4 \ln(x) + 2 \ln(y) = 15.8837$
37.5
25.
12.5
e
0
5
10
15
20
x

Yours can’t cross



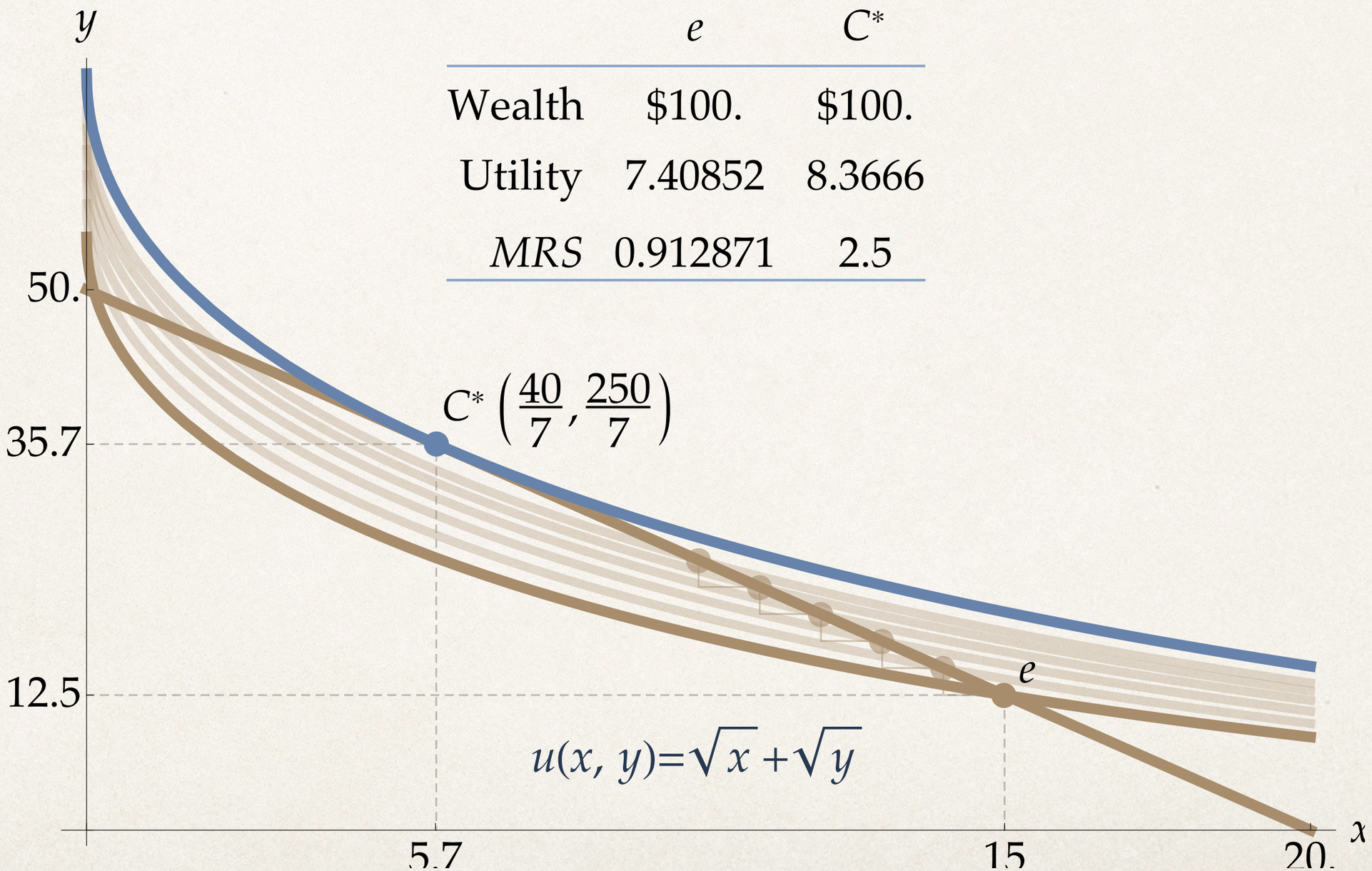
Consumption optimum

$$u(x, y)=\sqrt{x}+\sqrt{y}$$



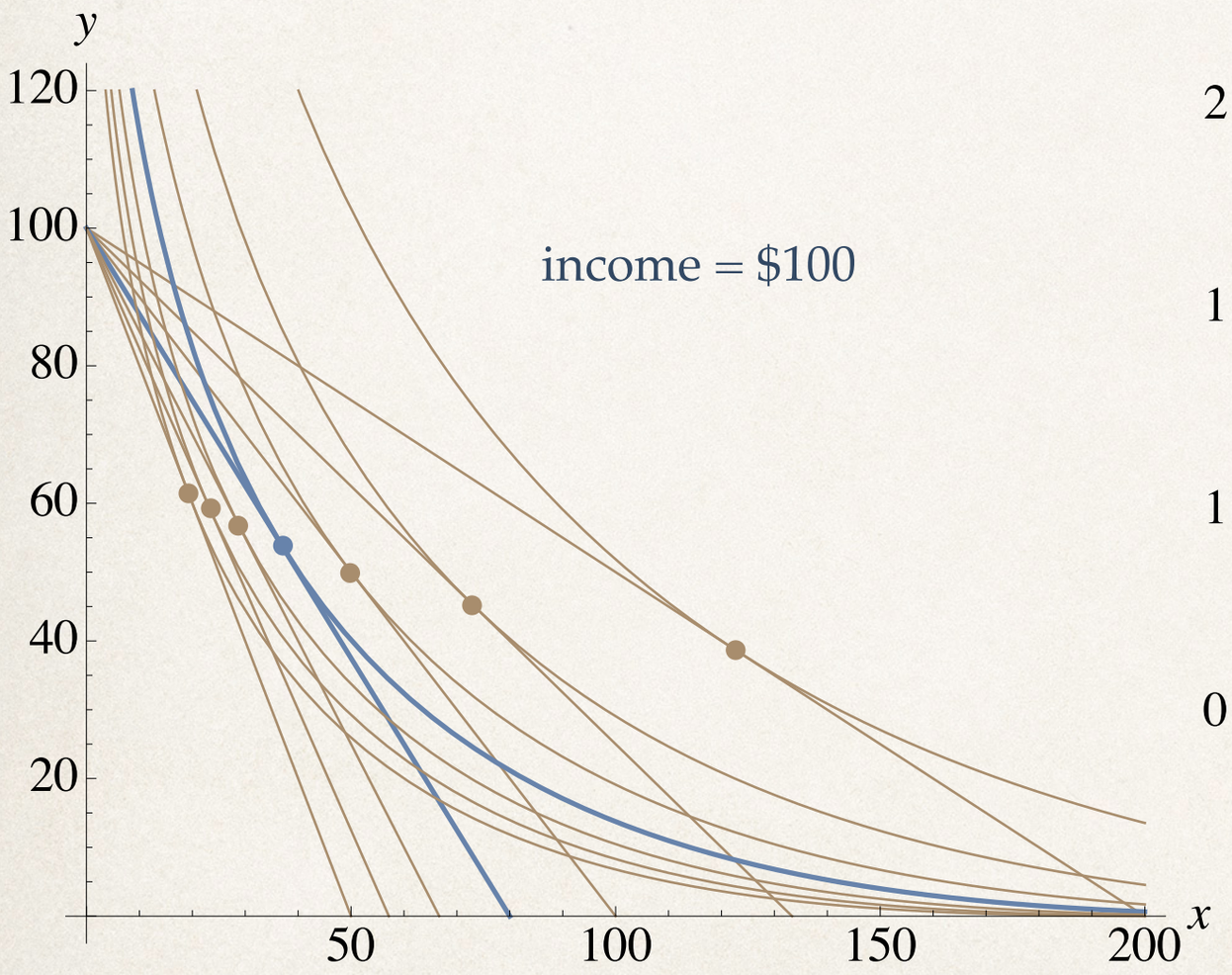
Consumption optimum detail

	e	C^*
Wealth	\$100.	\$100.
Utility	7.40852	8.3666
MRS	0.912871	2.5

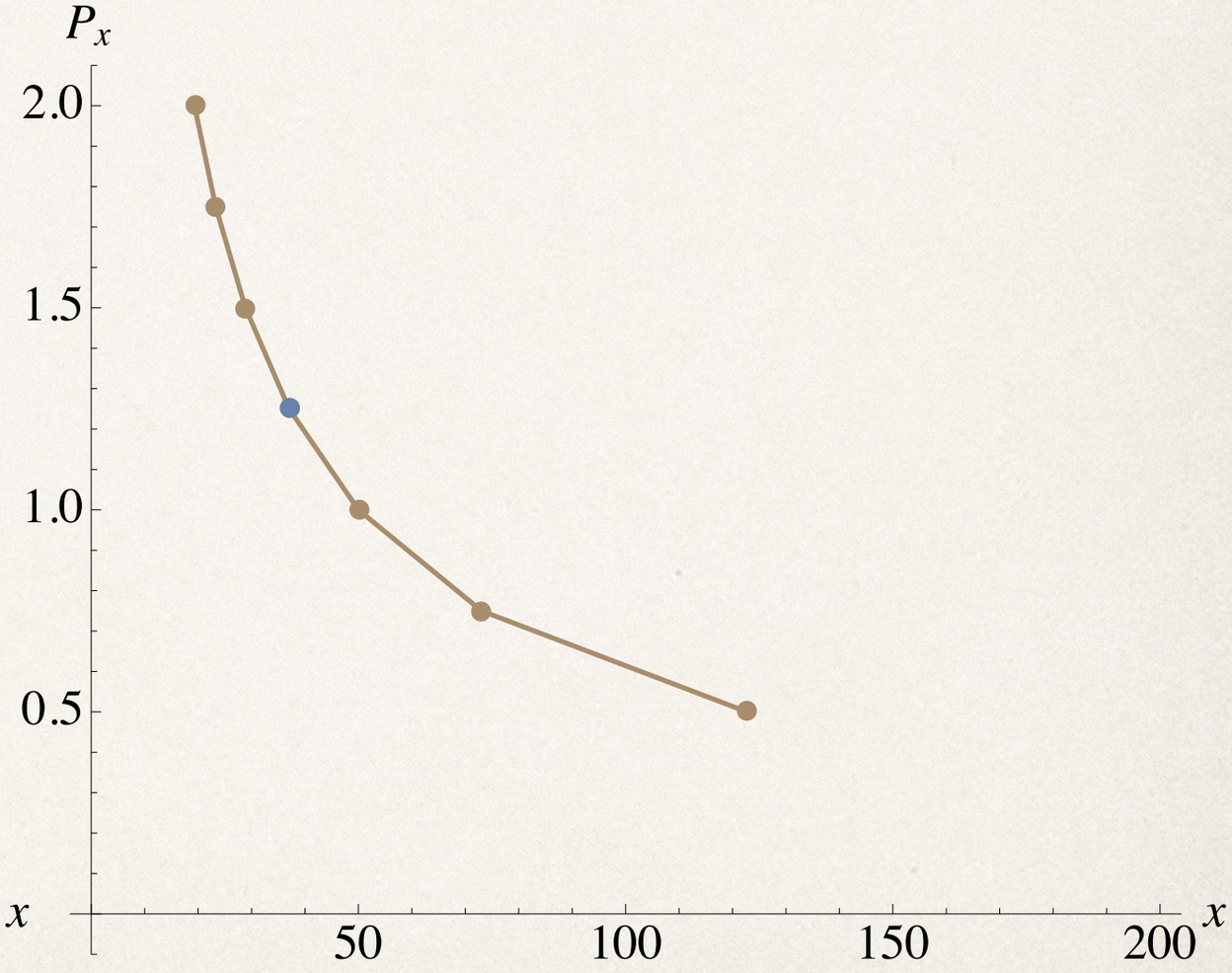


Indifference curves to demand

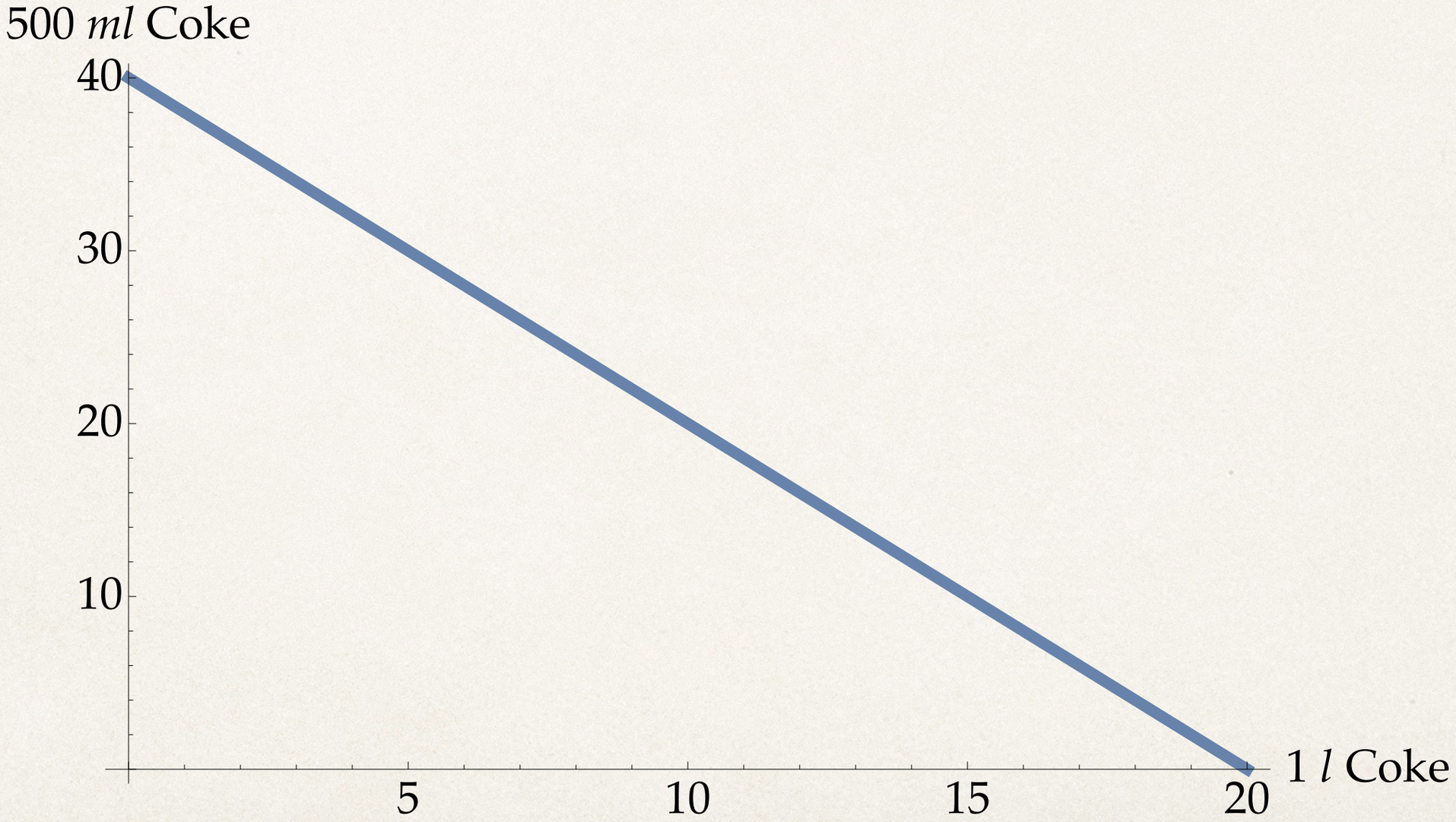
$u(x, y) = x^a + y^a = x^{0.4} + y^{0.4}$



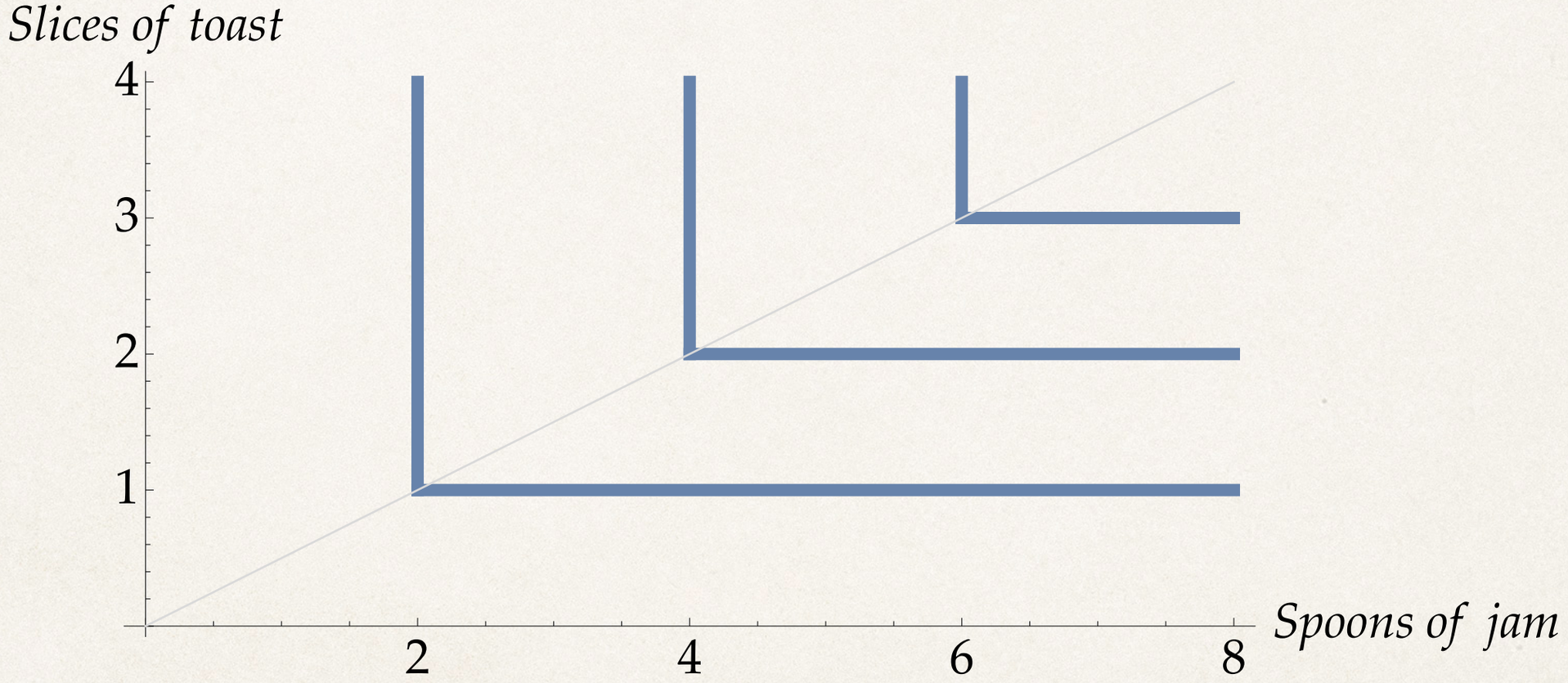
Demand for x



Linear preferences?



Corner preferences?



Rationality

Homo-economicus

What it is

- You know what is best for you
- Utility
  - If you chose it, you must have preferred it
  - If you did it, you must have wanted to
- In your dealings with others
  - You take into account (your beliefs) about what motivates them

A date for Friday night

- Is altruism as rational and selfish as conspicuous consumption?
- "Blatant Benevolence and Conspicuous Consumption," *The Economist*, August 4, 2007

Don’t pick the peaches!

- If they were any good, someone else would have already picked them
- Your expectations are rational in that you behave *as if* you know the true or underlying economic model

What's your IQ?

- Guess a number from 0 to 100, as close as possible to two-thirds of the average guess

Nash Equilibrium & Rationality

Nash equilibrium

- A pair of strategies is a Nash equilibrium if each player's choice is optimal *given* the other's choice

- An equilibrium is Nash if there is no incentive to deviate from a choice *given* the other player's choice

Nash equilibrium

- Lucy:— If Ricky chooses right, I'd choose bottom.
- Lucy:— If Ricky chooses left, I'd choose top.
- Ricky:— If Lucy chooses top, I'd choose left.
- Ricky:— If Lucy chooses bottom, I'd choose left.

A pair of strategies is a Nash equilibrium if each player's choice is optimal *given* the other's choice.		Ricky	
		Left	Right
Lucy	Top	8, 5	4, 2
	Bottom	6, 4	7, 3

Dominant strategies are also Nash

- Lucy:— If Ricky chooses right, I'd choose bottom.
- Lucy:— If Ricky chooses left, I'd choose bottom.
- Ricky:— If Lucy chooses Top, I'd choose right.
- Ricky:— If Lucy chooses bottom, I'd choose right.

A strategy is dominant if the optimal choice of each player does not depend on what the other player does.		Ricky	
		Left	Right
Lucy	Top	6, 2	4, 3
	Bottom	8, 4	7, 5

The Prisoner's Dilemma

- Lucy:— If Ricky stays quiet, I'd fink.
- Lucy:— If Ricky finks, I'd fink too.
- Ricky:— If Lucy stays quiet, I'd fink.
- Ricky:— If Lucy finks, I'd fink too.

A Nash equilibrium is not necessarily Pareto efficient.

		Ricky: Fink	Ricky: Quiet
Lucy	Fink	-4, -4	0, -7
Lucy	Quiet	-7, 0	-1, -1

You do Nash

- Create an example where
  - A Nash equilibrium does not exist
  - There is more than one Nash equilibrium

Behavioural Economics

Heuristics and biases

- Thaler, Richard, H., 2000, "From Homo Economicus to Homo Sapiens," *The Journal of Economic Perspectives*, 14(1): 133-141.

- Wishful thinking, overconfidence, false consensus effect, the curse of knowledge

Insensitivity to sample size

- Forty-five babies are born each day in a big hospital
- Fifteen are born each day in a small one
- As you know, roughly 50 percent of all babies are girls
- For one year, the big and small hospital recorded the number of days on which more than 60 percent of the babies born were girls
- Which hospital do you think recorded more such days?
  - The bigger (21) The smaller (21) About the same (53)

Misconceptions of chance

- Which sequence of coin tosses is most likely?
- H-T-H-T-T-H
- H-H-H-T-T-T
- H-H-H-H-T-H

Do we know what we want?

- Kahneman, D. and R. Thaler, 2006, "Utility Maximization and Experienced Utility," *The Journal of Economic Perspectives*, 20(1): 221-234.

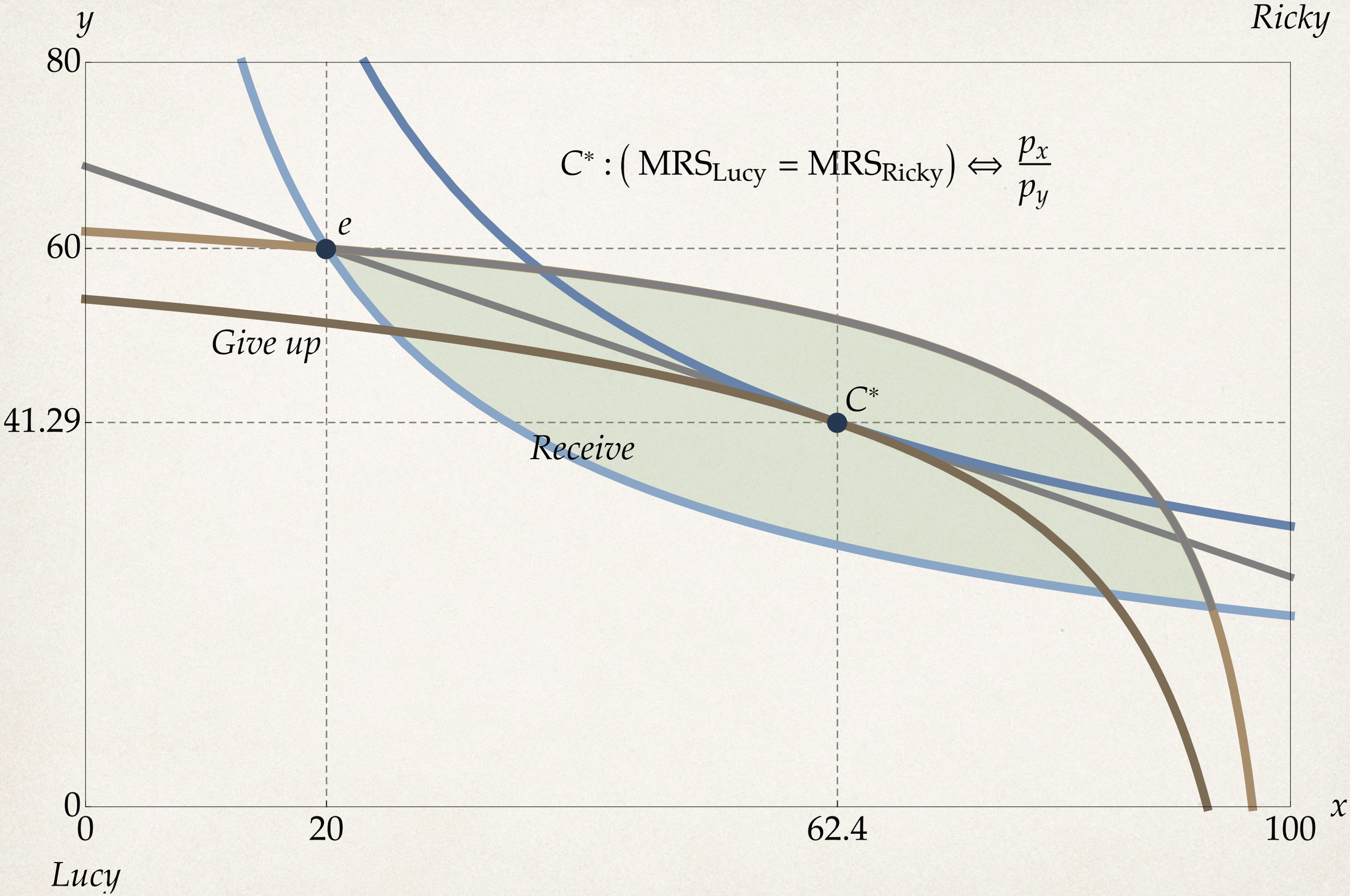
- The utility we experience does not always correspond to the choices we make

  - The good life in California and *focussing illusion*

  - Colonoscopies and the *peak/end rule*

Welfare

Topic 3



Pareto Optimum

The whole package

- General equilibrium
- Pareto optimum
- Arrow's Impossibility Theorem
- The First Welfare Theorem of Economics

Liberty & investment

- Feast or famine? What explains the gap? Technological progress? Climate and disease?

- Economic freedom:— low taxes, protection of private property, freedom of contract, free trade & monetary stability

- The freest invest twelve times as much as the least free and attract fifty times more foreign direct investment

- Top: Hong Kong, Singapore, America, Britain & New Zealand. Basket cases: Venezuela, Myanmar, Russia, and Congo-Brazzaville

- Fraser Institute report. See *The Economist*, 17 July 2004, page 71.

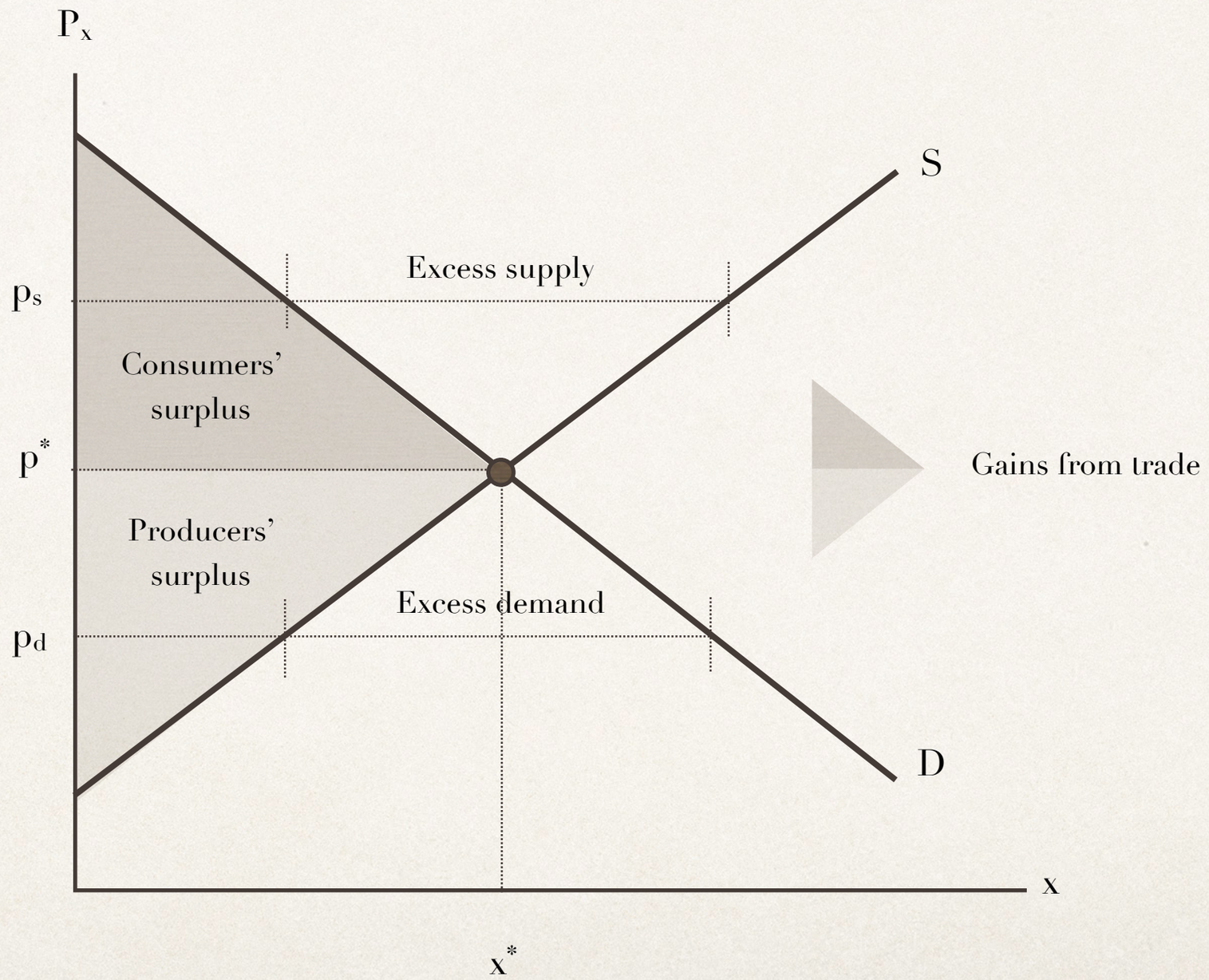
Liberty & happiness

- John Kenneth Galbraith, 1967

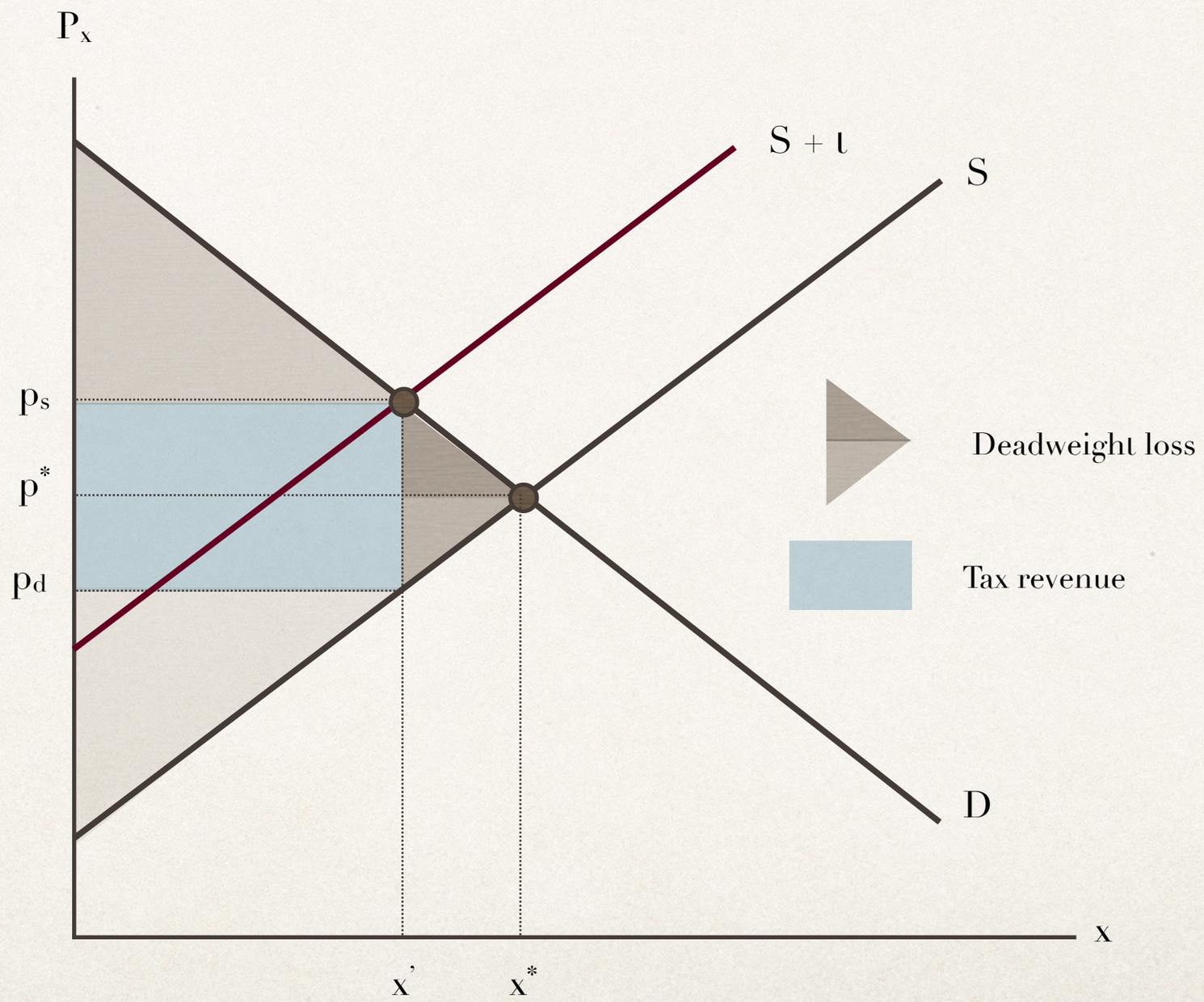
- Concern whether technology is always good; whether economic growth is always good; whether firms must always expand; whether consumption of goods is the principle form of happiness; whether idleness is wicked

- Or less concern if the system plays a diminishing role as we get wealthier and turn our attention to aesthetic goals

Pareto optimum compared to supply and demand



Deadweight loss



Information

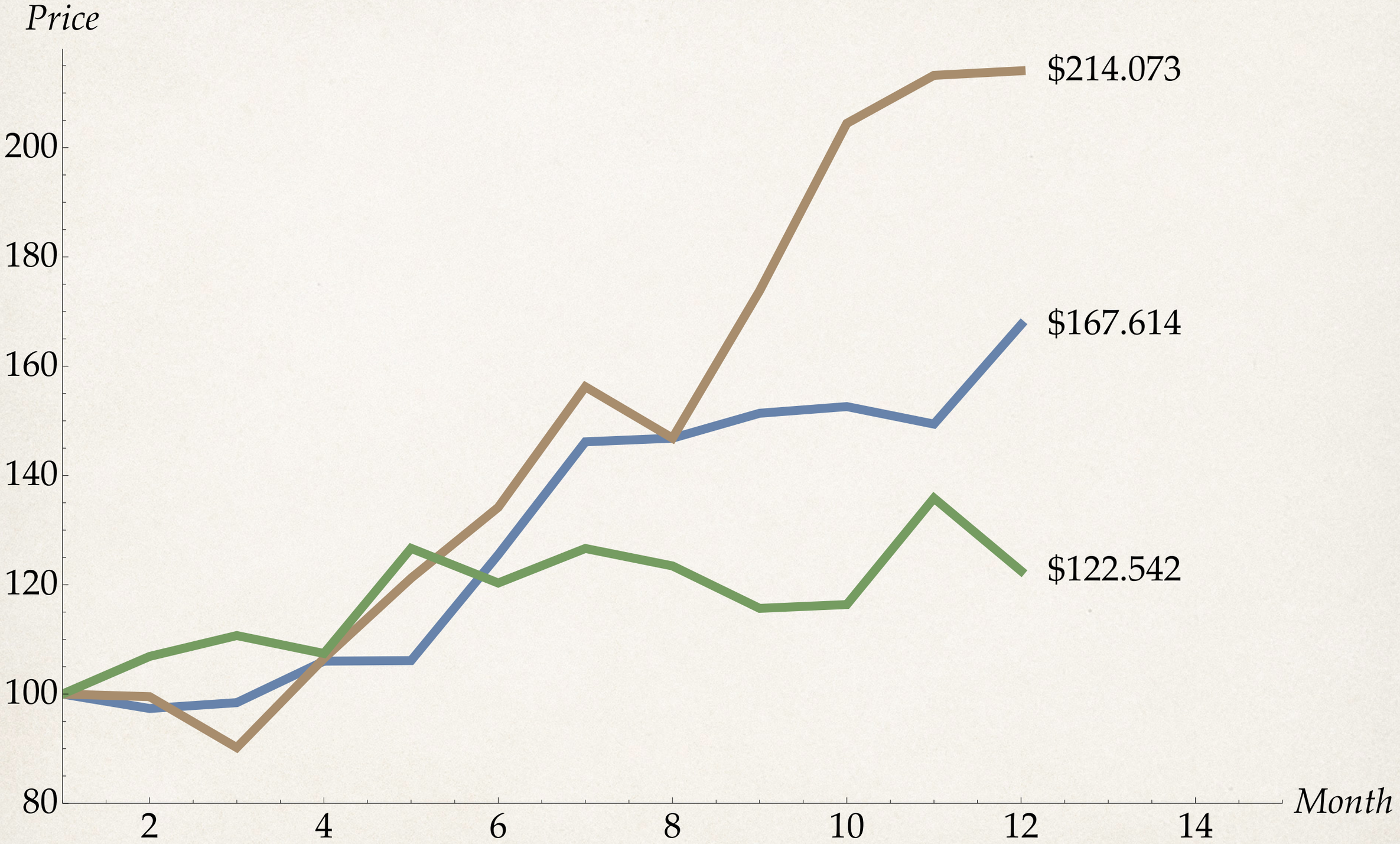
Topic 4

Efficient markets hypothesis

- Prices reflect all relevant information about future cash flow
- Price or value changes cannot be predicted, at least not profitably
- Weak-form, semi-strong, and strong-form informational efficiency

Random walk research and weak-form efficiency

De Bondt and Thaler, 1989, "Anomalies: A Mean-Reverting Walk Down Wall Street," *The Journal of Economic Perspectives*, 3(1): 189-202



Random walks

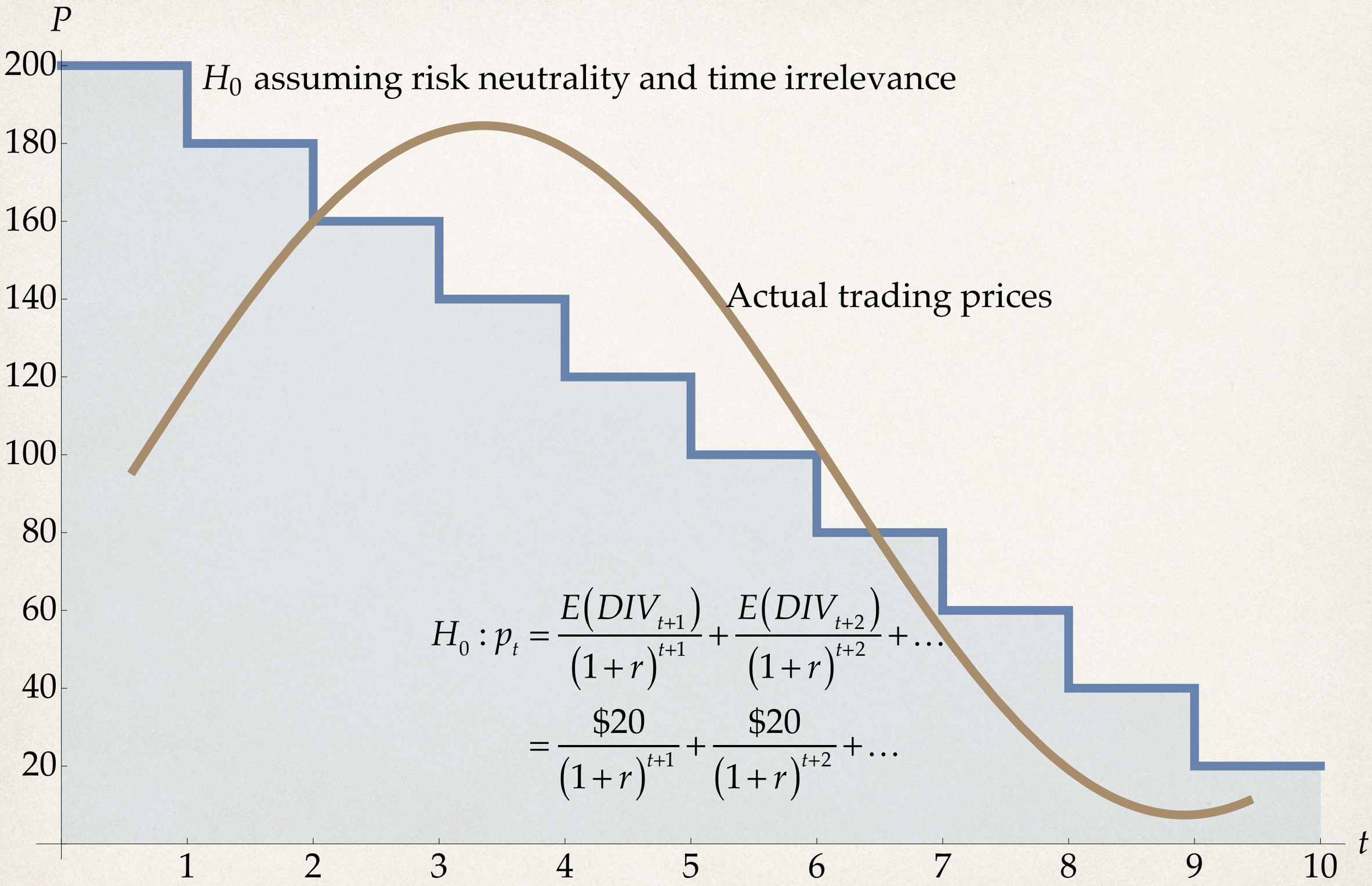
Protocol and results

Date	*Stock 1*	*Stock 2*	…	*Stock n*
1926-01 to 1930-12	*r*	*r*	*r*	*r*
…	…	…	…	…
…	…	…	…	…
1978-01 to 1982-12	*r*	*r*	*r*	*r*

Negative serial correlation: losers gain 30% and winners lose 10%

Bubbles, crashes, and semi-strong form efficiency

Smith, V.L., Suchanek, G.L., and A.W. Williams, 1988, "Bubbles, Crashes, and Endogenous Expectations in Experimental Spot Asset Markets," *Econometrica,* 56(5): 1119-1151.



Bubbles and crashes and semi-strong form efficiency

Galbraith on 1929

- Silence the kill joys
- Build your pyramid
- Ride the coaster up
- Find a Martha when it crashes
- Galbraith, J.K., "The 1929 Parallel," *The Atlantic Monthly*, January, 1987, 259(1): 62-66.

"From the mergers, acquisitions, and buy-backs, it is now reasonably well agreed, comes no increase at all in industrial competence. The young men who serve in the great investment houses render no service to investment decisions, product innovation, production, automation, or labour relations in the companies whose securities they shuffle." [Galbraith, page 66]

Keyne's beauty contest

- On advice from central banks, government, and other experts
  - They talk, and we try to read their messages
    - What if we stop looking for our own information and look only to them?
    - What happens when they're wrong? (The sub-prime loan crisis, for example.)
- "It's not always good to talk," *The Economist*, 24 July 2004, 372(8385): 76.

Private information and strong-form efficiency

Forsythe, Robert; T.R. Palfrey, and C.R. Plott, 1982, "Asset Valuation in an Experimental Market," *Econometrica*, Vol. 50, No. 3, 537-568.

Experiment, hypotheses, & results

Investor	Period A	Period B	∑
I	$60	$40	$100
II	$90	$50	$140
III	$40	$70	$110
	H_0: P_A = \$160 (not supported)	H_0: P_B = \$70 (supported)	Then add a forward market

Wealth management and strong-form efficiency

- Say there are 1,024 mutual funds in Canada, and you read in a newspaper that ten of them have beaten the market for the past five years in a row.

- Does this information help you choose a fund?

- "The law of averages," *The Economist*, 5 July 2003, 368(8331): 6-9.

Popular Models

Shiller, Robert, 1990, "Speculative Prices and Popular Models," *Journal of Economic Perspectives*, Vol. 4, No. 2, 55-65

Real estate booms

- California booming, Boston slumping, Milwaukee flat
- What's the popular model? **Economic**. Prices driven by interest rates
- California a good place to live
- Samuel Clemens and *shortage illusion*: Invest in land cause they ain't makin' any more of it

Crash of 1987

- What's the popular model? **Psychology**. Market mania
- Recent price changes as the primary source of information
- Seen it coming? Yes, of course, it was time for a correction
- And afterwards? Good time to invest because what goes down will come up again

IPOs

- Left to you

A digression on risk aversion

Gamble	π 1/3	(1 - π) 2/3	Expected Payoff	Standard Deviation	Spread
A	-$14,100	$9,000	$1,300	$10,889	$23,100
B	$8,400	-$2,400	$1,200	$5,091	$10,800
C	-$4,800	$4,200	$1,200	$4,243	$9,000

If two ventures offer the same expected return, a risk averse person chooses the safer one. If they do not, it's a matter of taste, as it is with A *versus* B.

Risk aversion

- Genetics—Identical twins have a stronger propensity to invest in shares than fraternal ones

- Upbringing and environment—The educated and rich are more willing to take financial risks

- Cultural norms—Teenage girls at single-sex schools are less risk-averse than those at co-ed schools

- Financial history—People who enjoy high stock returns early in life are more likely to report a higher tolerance for risk and to invest more in shares

- Financial turmoil and other trauma—Those exposed to an economic shock, such as unemployment, are less likely to own stocks a decade later; likewise for other trauma

  - Sources: www.economist.com/risk14

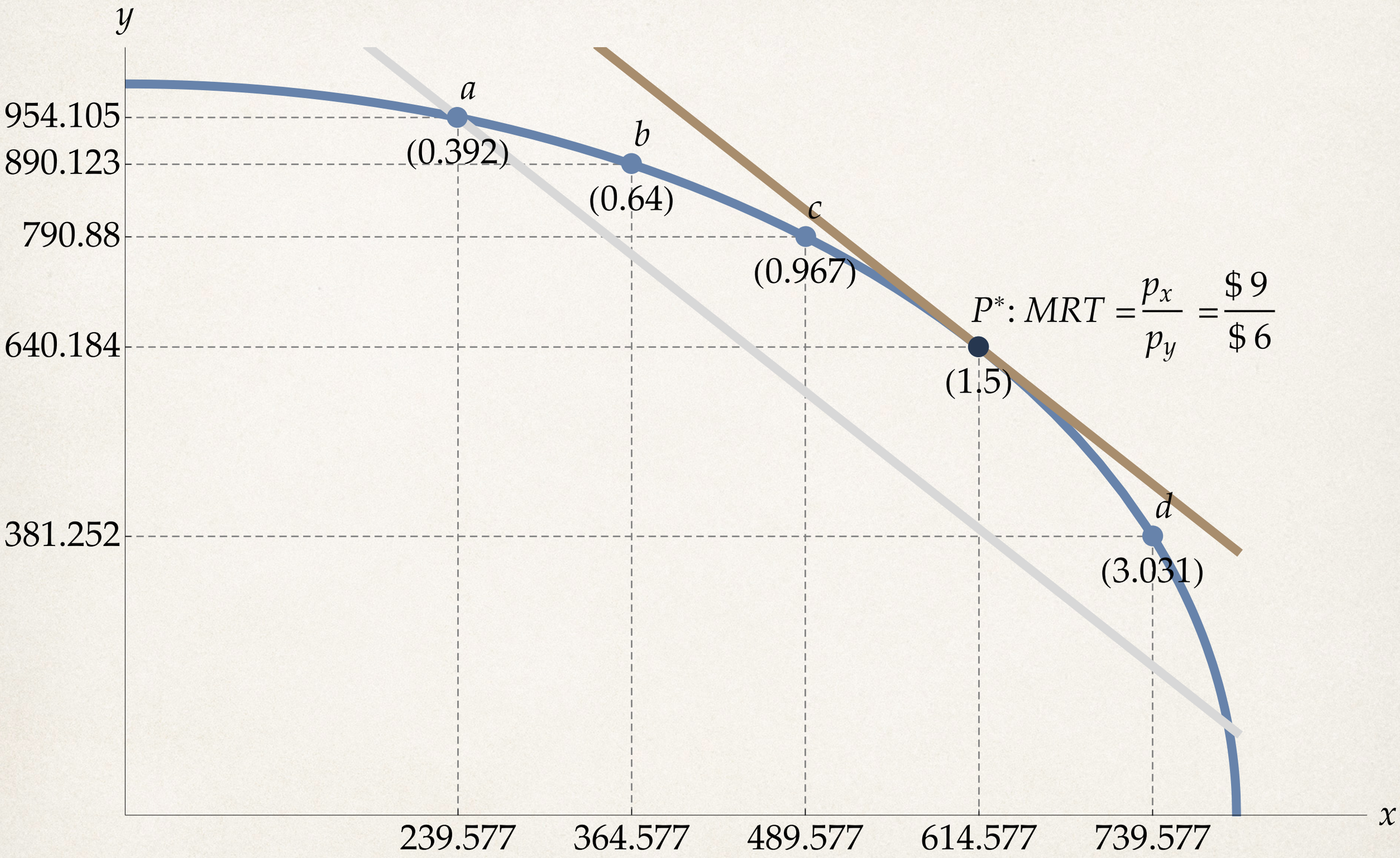
Production and Finance

Topic 5

We wanted flying cars, instead we got 140 characters.

–Peter Thiel, venture capitalist, founder of PayPal

Production Possibilities and Profit Maximization



Competition and Corporate Strategy

Lock-in

- Hard lock-in
  - Vacuum cleaner bags (hey, why not?)
  - Beta *versus* VHS (yes, it's an old one)
  - Blu-ray *versus* HD DVD formats
- Soft lock-in
  - Search engines
  - Productivity software

The convergence craze

	Inter-net	Broad-cast TV	Cable TV	Tele-coms	Film prod'n	TV prod'n	Music	Pub.	Theme parks	Radio
AOL Time Warner	X	X	X		X	X	X	X		X
Viacom		X	X		X	X		X	X	X
Vivendi	X		X	X	X	X	X	X	X	
News Corp.		X	X		X	X		X		
Disney		X	X		X	X		X	X	X
Bertels-mann		X				X	X	X		

Corporate diversification

- Cynthia Montgomery, 1994, "Corporate Diversification," *Journal of Economic Perspectives*, Vol. 8, No. 3, 163-178.

- What is corporate diversification?
  - It is not financial diversification
  - It is doing many things instead of just a few
  - It is diversification of services or production

Research questions

- 500 companies account for three-quarters or $3.7 trillion of US output
- Why this degree of diversification?
- Implications for profit maximization?
- Implications for allocational efficiency (read Pareto optimality)?

Three models of diversification

	Market Power	Agency	Resource
What it is	Grab bigger market share to get more market power	Managers looking out for themselves instead of us	Using excess capacity & technology for new things
Necessary conditions	Power in some markets	Separation of ownership & control	Excess capacity + factor indivisibility + technology with general uses
Economic outcome	Profit-maximizing but allocationally inefficient	Not profit-maximizing & allocationally inefficient	Profit-maximizing & allocationally efficient
Nature	Cross subsidization, mutual forebearance, reciprocal buying	Managers use free cash flow to build empires & hedging	Diversification to expand use of core resources
Hypothesis	+	-	+

Selected evidence

- Firms pursuing "related-constrained" diversification are more profitable
- Bidders often look for targets with negatively correlated cash flows
- Targets fair better in unrelated or conglomerate mergers

Is Google a Monopolist?

- "The search giant's pre-eminence in these fields is not related to a **proprietary technological lock-in** (internet users can easily switch between search engines); its **market share** falls far short of the 90% that Microsoft boasts in desktop operating-systems and office-productivity software; and it is not a convicted monopolist. So to call Google the new Microsoft is, in many ways, unfair. But it is undeniably the company that other technology firms and media giants are now most scared of—including Microsoft itself. Google's growing **market share in search**, and hence its clout in online advertising, make it look unstoppable." [emphasis added]

- *The Economist*, February 9, 2008, pages 13-14. And over 75 hits containing "Google" and "monopoly" at *The Economist* recently.

On Productivity and Innovation

The puzzle of Britain's 'high' employment and stagnant growth

- What if lags are the problem?
  - Takes time for hard-hit companies to shed labour and capital
  - Takes time for healthier sectors to absorb it
- What if people are mobile (at least domestically) but are working for companies that should not exist?
- Is credit easing a culprit in all of this because it allows weak firms to build up a capital war chest?
- *The Economist*, "Productivity: The job rich depression," Jan. 26, 2013.

Brains and productivity

- Glen Hodgson and Alan Arcand, "Brains alone can't boost productivity," *Financial Post*, August 21, 2012.

- Weak productivity growth in Canada for decades

- Theory:—A more educated labour force should lead to more investment in physical capital, which in turn, spurs growth

  - Educated labour is more expensive, so there is an incentive to substitute physical capital for labour (maybe; how easily?)

  - Skilled workers increase the return on physical capital

Brains and productivity (con't)

- Claim:—Canada could benefit from more PhD grads and grads in disciplines that spur innovation (I disagree)

- Claim:—The quality of Canadian labour has improved steadily (questionable)

Brains and productivity (con't)

- So why the poor productivity?
  - Weak dollar in 1990s and early 2000s meant those cost-saving machine produced in the US were too expensive
  - 1985 federal capital tax (since repealed)
  - Domestic and international tariff and non-tariff barriers
  - Under-investment in infrastructure, particularly roads and rail
  - An under-performing venture capital market

Have innovation and technology failed to drive growth

- *The Economist*, "Innovation pessimism: Has the ideas machine broken down?" Jan, 12, 2013.

- Stuck with growth that is *extensive* (adding more or better labour and capital) but subject to diminishing marginal returns

- When we want *intensive* (discovery of better ways)

- Can't beat indoor toilets, electricity, combustion engine, whose effects were widespread

- More knowledge workers, such as PhDs, don't make for more innovation

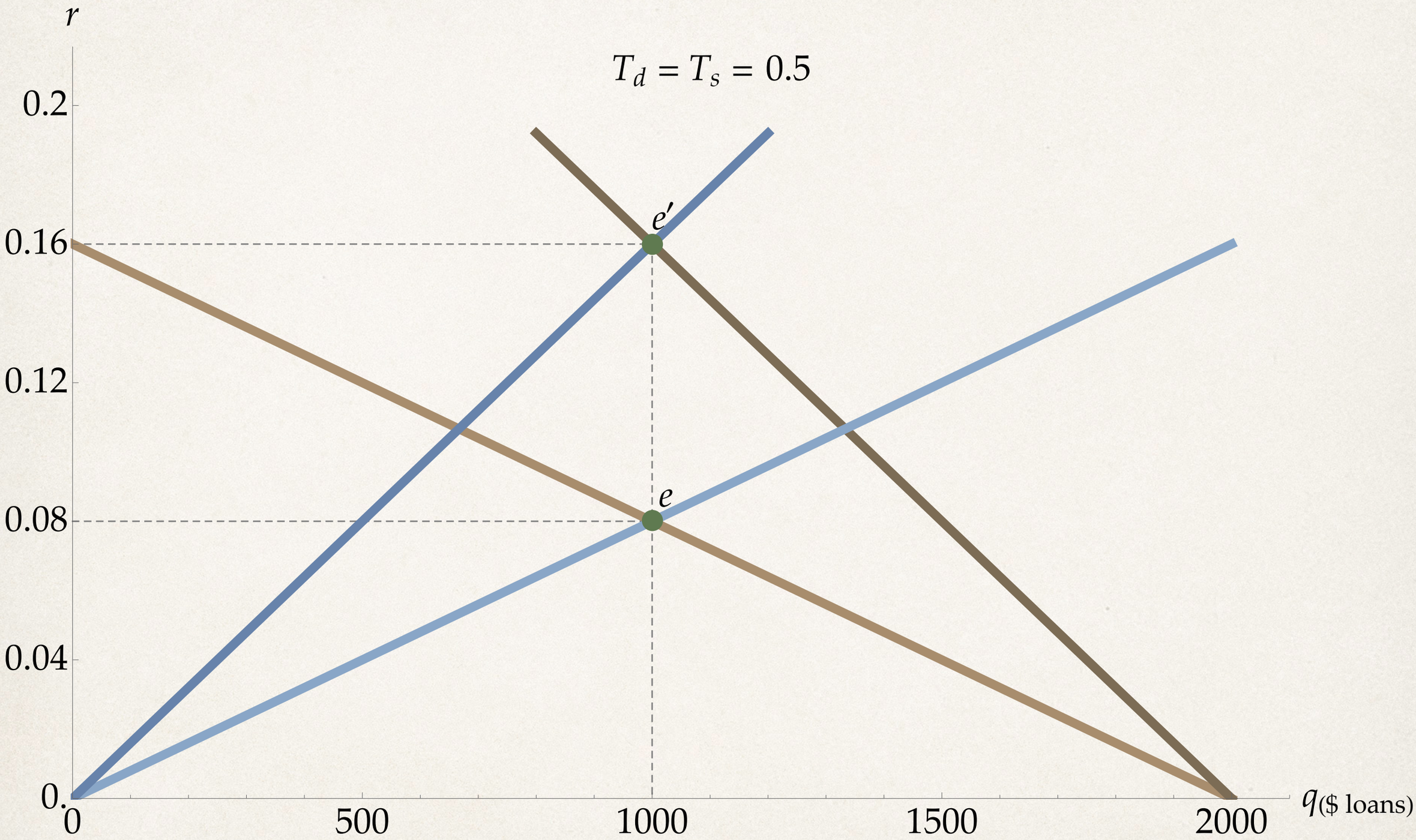
Government Intervention

Topic 6

Ways to intervene

- *Ad valorem* and quantity taxes and subsidies
- Price controls (ceilings)
- Price supports (floors)
- Countless other ways, limited only by your imagination

Taxes, subsidies, and business loans


$T_d = T_s = 0.5$
r
0.2
0.16
0.12
0.08
0.04
0.
e′
e
0
500
1000
1500
2000
q($ loans)

Neutral because tax rates the same

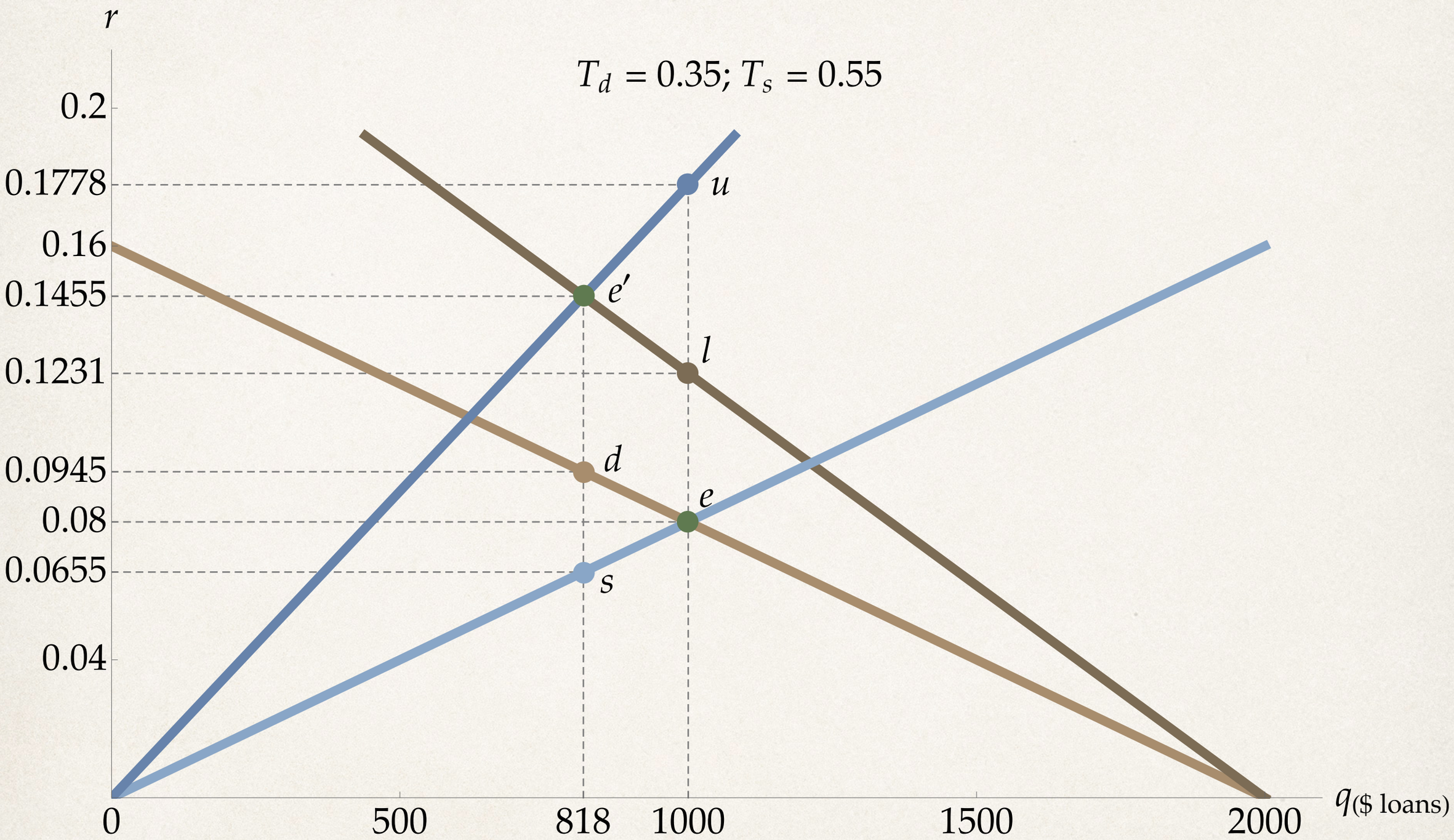
$$\text{After-tax cost of borrowing} = r'\left(1 - T_d\right) = .16\left(1 - .50\right) = .08$$

$$\text{After-tax return on lending} = r'\left(1 - T_s\right) = .16\left(1 - .50\right) = .08$$

$$\begin{aligned} TR &= \left(r' \times q'\right) \times T_s \\ &= \left(.16 \times \$1{,}000\right) \times .50 \\ &= \$160 \times .50 \\ &= \$80 \end{aligned}$$

$$\begin{aligned} TS &= \left(r' \times q'\right) \times T_d \\ &= \left(.16 \times \$1{,}000\right) \times .50 \\ &= \$160 \times .50 \\ &= \$80 \end{aligned}$$

$$\Delta_{gov't} = \left(r' \times q'\right) \times \left(T_s - T_d\right) = \$0$$


$T_d = 0.35; T_s = 0.55$
r
0.2
0.1778
0.16
0.1455
0.1231
0.0945
0.08
0.0655
0.04
u
e′
l
d
e
s
0
500
818
1000
1500
2000
q($ loans)

Non-neutral when tax rates differ

$$\text{After-tax cost of borrowing} = r'\left(1 - T_d\right) = .1455\left(1 - .35\right) = .0945$$

$$\text{After-tax return on lending} = r'\left(1 - T_s\right) = .1455\left(1 - .55\right) = .0655$$

$$\begin{aligned} TR &= \left(r' \times q'\right) \times T_s \\ &= \left(.1455 \times \$818\right) \times .55 \\ &= \$118.20 \times .55 \\ &= \$65.01 \end{aligned}$$

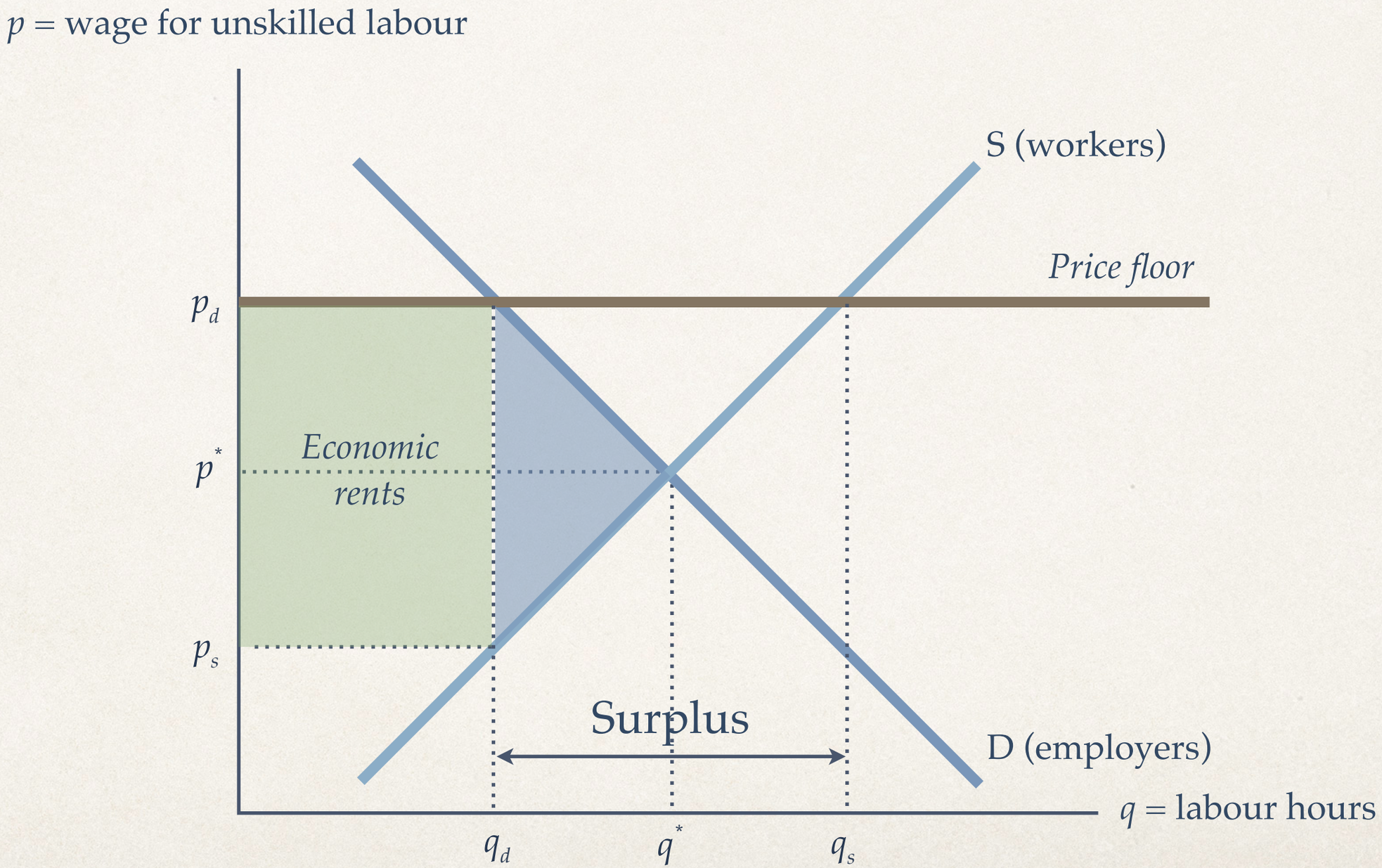
$$\begin{aligned} TS &= \left(r' \times q'\right) \times T_d \\ &= \left(.1445 \times \$818\right) \times .35 \\ &= \$118.20 \times .35 \\ &= \$41.37 \end{aligned}$$

$$\begin{aligned} \Delta_{gov't} &= \left(r' \times q'\right) \times \left(T_s - T_d\right) \\ &= \left(.1445 \times \$818\right) \times \left(.55 - .35\right) \\ &= \$118.20 \times .20 = \$23.64 \end{aligned}$$

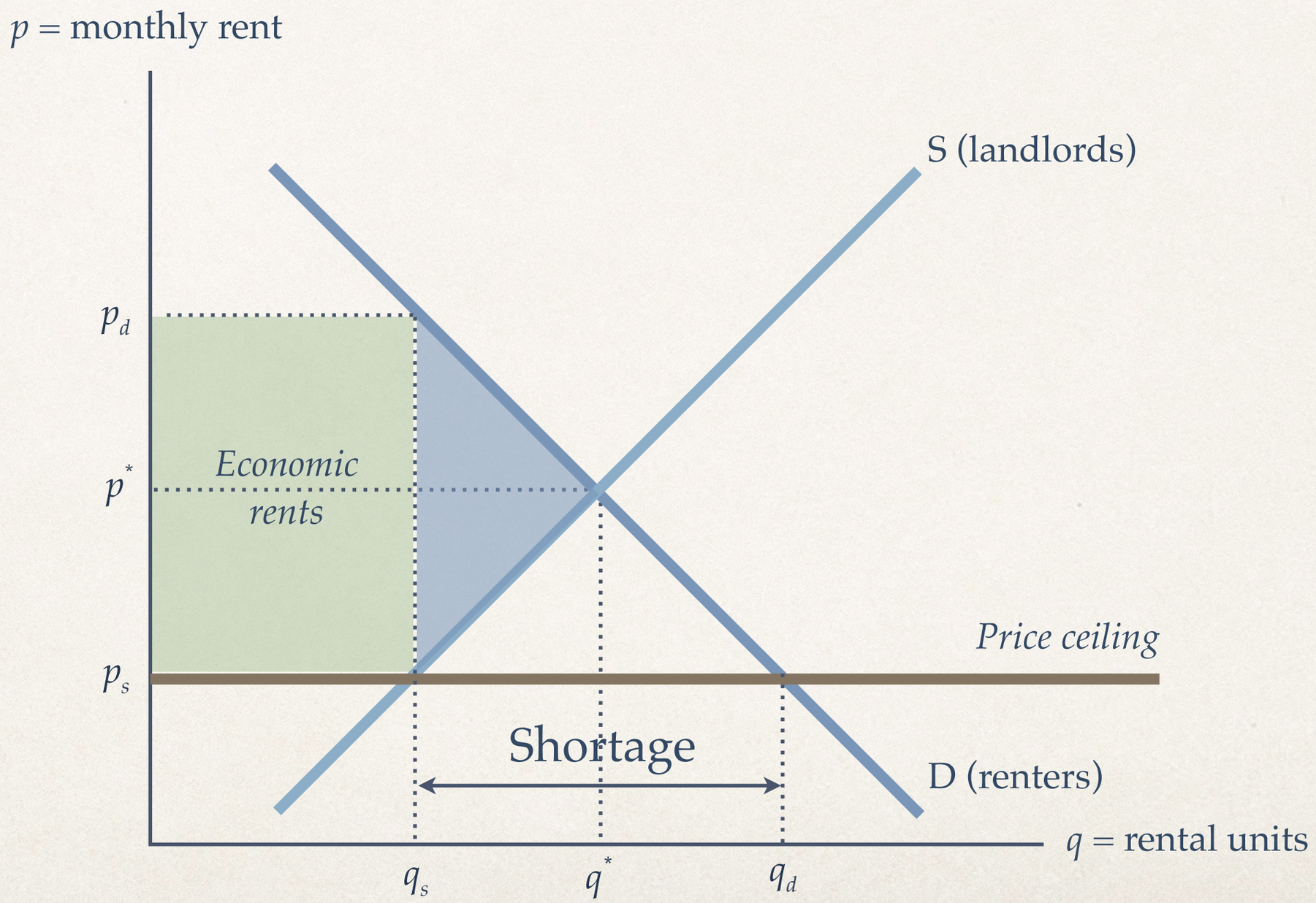
Price floors and ceilings

The floors are high and the ceilings low

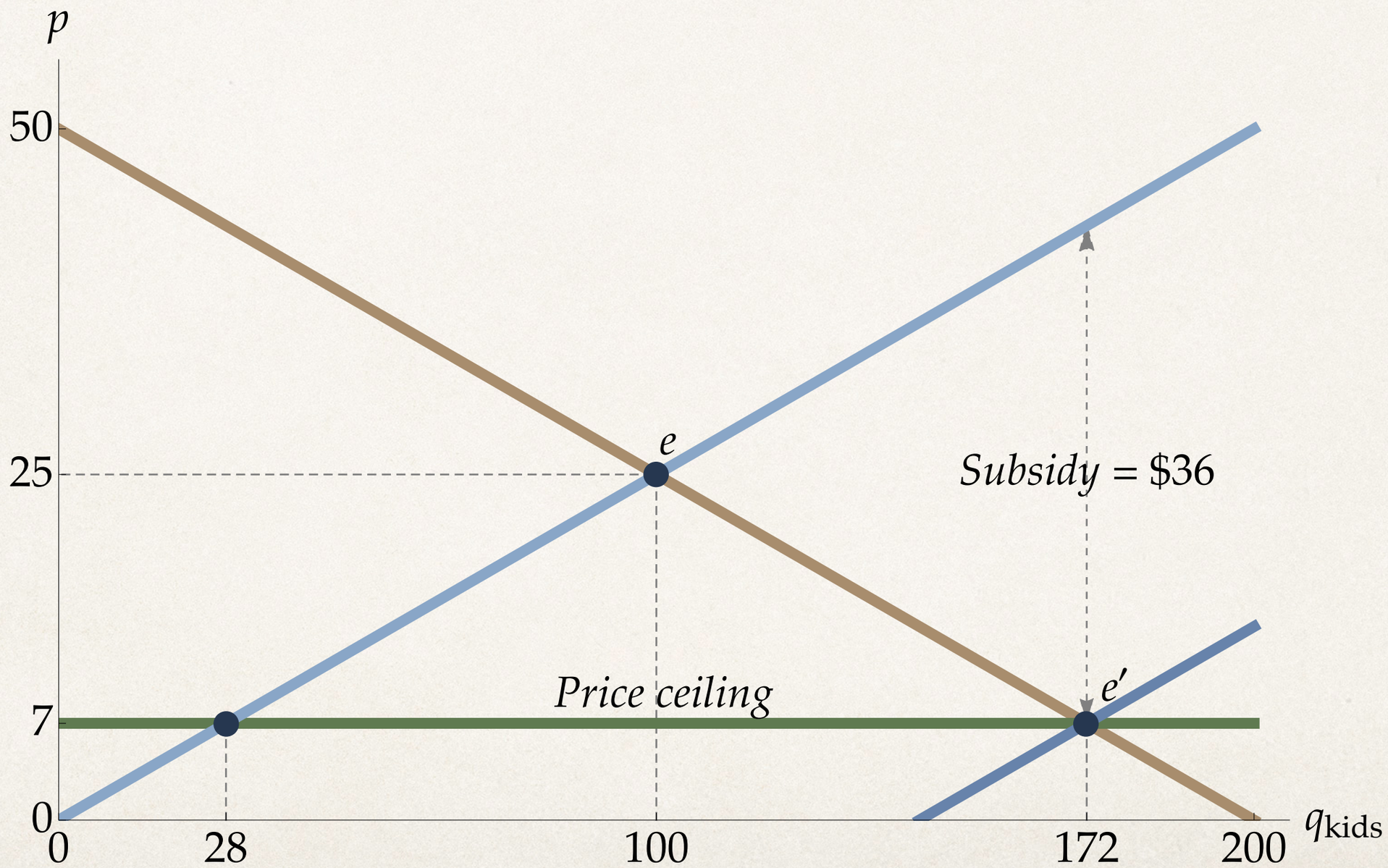
Price floors—the minimum wage



Price ceiling—rent controls



Seven dollar a day daycare



Tuition and the quality of university education

- "Sometimes I think students regard universities the way music fans regard Napster," he noted playfully in a 2001 address to SSMU. "They don't much care about the musical artists, they just want their music for free."

  - Bernard Shapiro quoted in *McGill News*, Winter 2002-2003

McGill is cutting back on arts courses {an update}

- *Montreal Gazette*, January 17, 2013

- McGill students in the Faculty of Arts will have 100 fewer courses to choose from next school year.

- [Christopher] Manfredi [Dean of the Faculty of Arts] said the decision was taken in order to respond to student interest in having more courses taught by full-time instructors.

- "We've always believed that the quality of teaching programs is better when they're taught by full-time, permanent teaching staff, as opposed to part-time, temporary teachers – that's well documented in the literature on the university pedagogy," Manfredi said.

Too Big to Fail

Bank failures & the Great Depression

- Kryzanowski, L. and G.S. Roberts, 1993, "Canadian Bank Solvency, 1922-1940," *Journal of Money, Credit and Banking*, 25(3) Part 1: 361-376.

- Was the depression less severe in Canada than the United States because the Canadian banks were better diversified through their national branch systems, resulting in fewer failures?

What really happened

- Twenty-seven bank failures in Canada between Confederation and 1940
- Our reputation comes from the absence of failures after 1923
- Kryzanowski and Roberts restate the assets of Canadian banks at market value and find most were insolvent between 1929 and 1940
  - Royal, Montreal, Commerce, Nova Scotia, Dominion, BC Nationale, Imperial, Toronto, Provinciale
- You can be insolvent but not failed

The implicit guarantee

- Archival evidence proves insightful
- The government implicitly guaranteed all deposits at par
  - Standing ready to lend to banks
  - Encouraging bigger banks to merge with smaller ones that were in immediate financial distress
- The bigger banks, wishing to expand, were willing participants

Market Failure

Topic 7

The First Welfare Theorem

- But read the fine print
  - Increasing returns to scale (market power—been there, done that)
  - Asymmetric information
  - Externalities & public goods
  - Inequality (darn important but not this time)

Asymmetric Information

What happens when we do not all have the same information?

Adverse selection happens

Example	Adversely selected	Costly signals
Lemons	good used cars	certification, guarantees
Careers	good workers	education, certification
Insurance	good risks	safety measures
Equity finance	profitable firms	R&D, advertising
Bond finance	equity	convertibles

Adverse selection defined

- Market prices don't reflect the true value of products or services because this information cannot be conveyed credibly
- So the bad drives out the good
- Credible signals are costly
- When is it worth sending a signal of good quality?

You sound pretty good, kid, but can your mom recognize you on the radio?
- Les Paul

Moral hazard happens

Example	Moral hazard	Response
Insurance	The insured have no incentive to take care	deductibles, incentives
Value of a firm	Shareholders rip off bondholders	bond covenants, convertibles
Banks	Banks in dire straits may go for broke	risk-adjusted deposit insurance
Sub-prime loans	No due diligence in credit assessment	regulation

Moral hazard defined

- The risk that someone is going to rip you off
- They have an information edge and can exercise some control over outcomes
- Rational markets recognize this and charge them for it up front
  - It is an *ex ante* agency cost

Externalities

What happens when what you do affects me or what I do affects you, and none of those affects are priced in markets?

Too much production or consumption happens

Example	Type	Symptom
Noise, pollution	Negative	Too much production
NIMBYS	Negative	Too much production
Fable of the bees	Positive	Internalization

Externalities defined

- Externalities (think *external*) are by-products or side effects of our production or consumption
- Externalities affect our utility directly
- The problem is that they are not priced in markets
- The producer of the externality is not charged for bad effects and not compensated for good

Fixing externality problems

- Specify clear property rights, then let people work it out in markets
- The Coase Theorem:—The efficient amount of a good involved in an externality is independent of the distribution of property rights
- Example: Kyoto, acid rain, and trading emissions credits

Cap and trade of pollution

- Legislate a reduction in emissions combined with an allocation of the transferrable emissions credits
  - Reductions exceeded
  - Volume of trade in credits increases
  - Bid-Ask spread of credits price decreases
- Stavins, R., 1998, "What Can We Learn from the Grand Policy Experiment?: Lessons from SO2 Allowance Trading," *The Journal of Economic Perspectives*, 12(3): 69-88.

Public Goods

Goods which are ostensibly free, so we overuse them, underproduce them, and free-ride

Example of free-access goods

- Roads, parks, fisheries, libraries, national defense, & etc.
- {Definition 1} Goods for which everyone can consume the same amount
- The problem is overuse
- *Tragedy of the Commons* (it's over-grazed)
- Solution—property rights and user fees

More ways to think about public goods

- {Definition 2} A good for which one person's consumption does not reduce another's
- {Definition 3} Or its marginal cost is tiny compared to its average cost and exclusion is expensive
- Attracts of *free riders* and results in *under-production*
- Intellectual property is a good example!

Scientific Research

- Intellectual property
- Patents as a way to balance public and private interests
- Patenting genes?
- Patenting everything!
- Check out www.bustpatents.com

Patenting genes

- October 1994, BRCA1 discovered and published in *Science*
- 1994, first BRCA1 U.S. patent was filed by the University of Utah, National Institute of Environmental Health Sciences (NIEHS) and Myriad Genetics
- 2003, talks between Myriad Genetics and Canadian officials break down after the company claimed intellectual property rights over the BRCA1 and BRCA2 genes
- March 2010, a New York federal court rules that the patents are invalid
- July 2011, a US federal appeals court overturns that decision, arguing that the company has the right to patent both genes because it is testing for specific mutated forms of the genes that have a different molecular structure than the naturally occurring genes
- June 2013, US Supreme Court rules unanimously that human genes cannot be patented. Justice Clarence Thomas wrote for the court that isolated DNA is a "product of nature and not patent eligible."

Scientific publishing

- 2,000 publishers publish 1.2 million articles a year in about 16,000 periodicals

- Positive feedback loop

- Cornell's library budget increases 149 per cent from 1986 to 2001 but the number of journals grows by only five per cent

- Elsevier's prices increase by over 10 per cent annually

Academic publishing activists

- In 2011, 24-year-old MIT student Aaron Schwartz hacks into MIT's computer network, downloads four million JSTOR articles, and posts them to the web

- Faces 35 years in prison and a $1 million fine

Boycotting Elsevier

- 2,700 researchers pledge not to submit articles to Elsevier
- Complaints that
  - Elsevier charges too much
  - Requires libraries to subscribe to bundles of journals
  - Supports legislation, such as the Research Works Act, that would forbid the government from requiring free access to publicly-funded research
- "The price of information," *The Economist*, February 4, 2012

Solutions for science publishing

- Change employment contracts so that copyright stays with the funding institutions

- Require publishers to make research available online free within a certain time

- Online pay-to-publish and open-access journals

- But the catch is still the lure of the reputation of print journals (from positive feedback) and the lack of reputation of online journals

Other examples

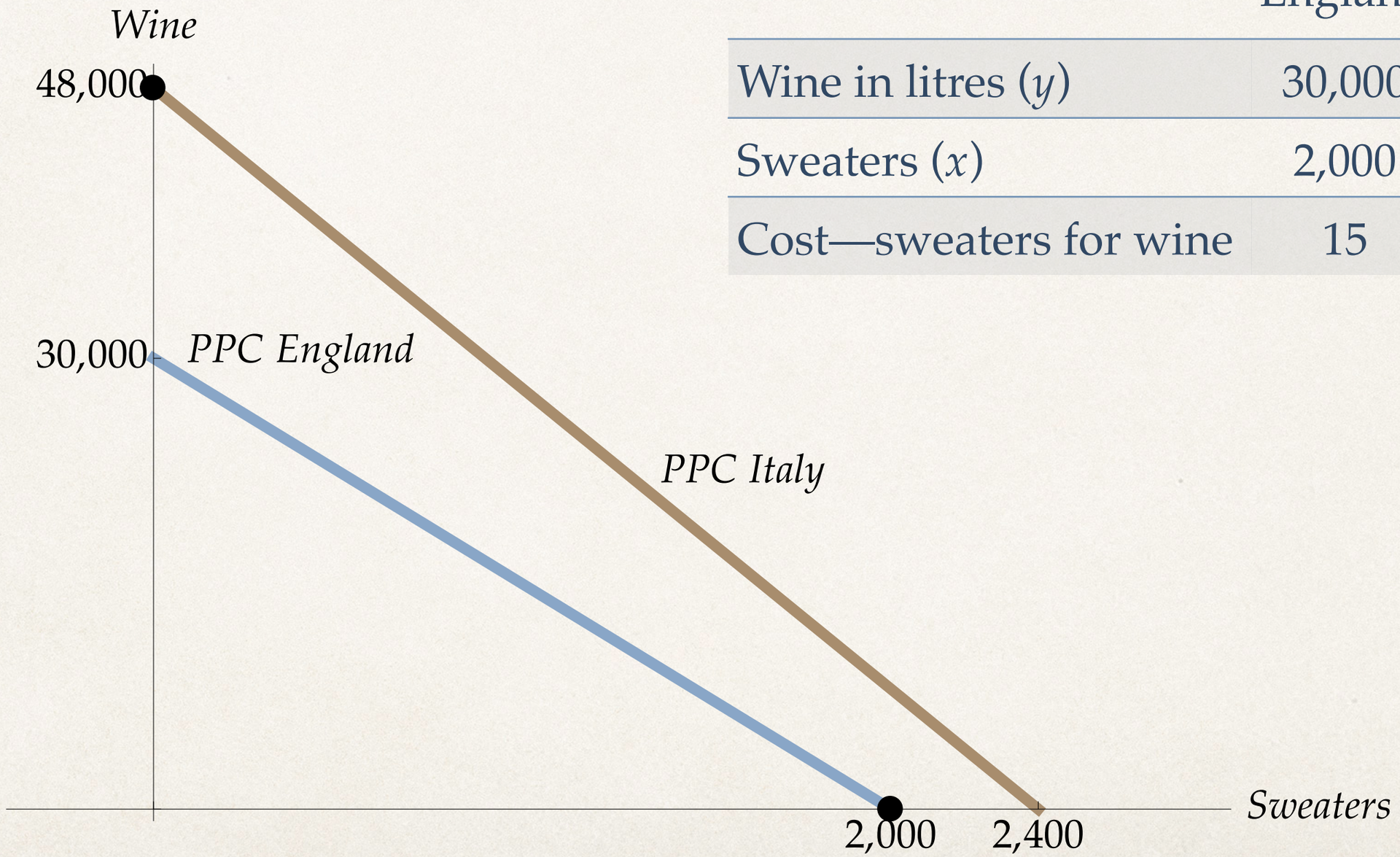
- Music downloads
  - In the news all the time
- SPAM
  - "Make'em pay," *The Economist*, 12 February 2004.
- Radio spectrum
  - "On the same wavelength," *The Economist*, 14 August 2004, pages 61-63.

International Markets

Topic 8

Specialization & Gains From Trade

Production possibilities & comparative advantage



	England	Italy
Wine in litres (y)	30,000	48,000
Sweaters (x)	2,000	2,400
Cost—sweaters for wine	15	20

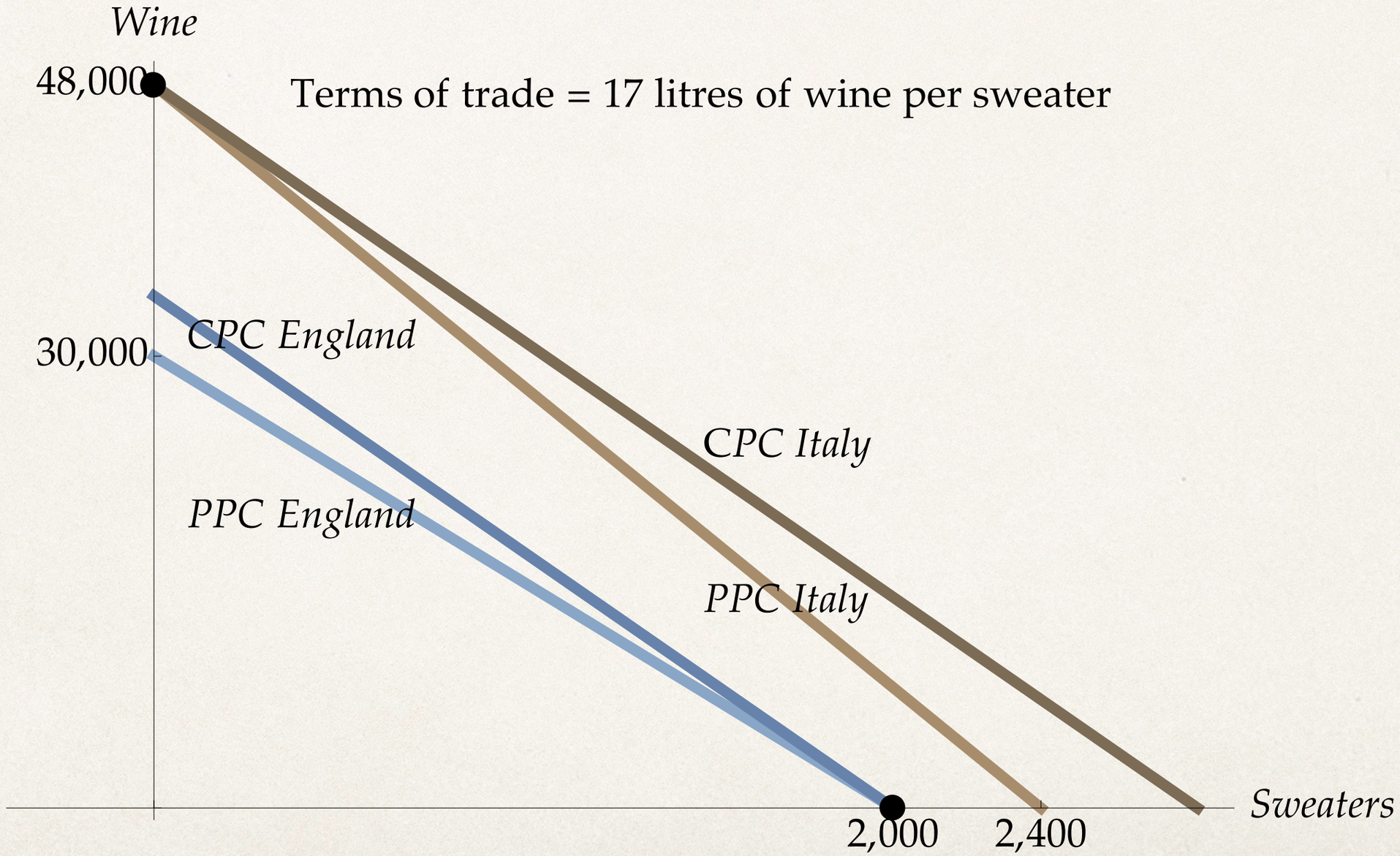
A little specialization

	England	Italy	Gain
ΔWine in litres	-1500	2000	500
ΔSweaters	100	-100	0
MRT (litres per sweater)	15	20	5

England sells 1,000 sweaters to Italy for 17 litres of wine each

Price ratio = 17	England	Italy	Total
Price ratio x 1,000	17000	-17000	0
MRT x 1,000	-15000	20000	5000
Gain (litres of wine)	2000	3000	5000
MRT (litres per sweater)	15	20	5

Consumption possibilities when the terms of trade are 17



The distribution of gains depends on the terms of trade

Price Ratio	Gains		
ΔWine/ΔSweaters	England	Italy	Total
14	-1,000	6,000	5,000
15	**0**	**5,000**	**5,000**
17	2,000	3,000	5,000
18	3,000	2,000	5,000
20	**5,000**	**0**	**5,000**
21	6,000	-1,000	5,000

Free trade agreements

- "But one of the tragedies of this campaign is that both Mr Obama and Mrs Clinton have decided to ignore Bill Clinton's message—that the only way that America can remain competitive is to prepare people for new jobs rather than cling on to old ones—and instead engage in a silly competition to see who can bash NAFTA hardest."
  - "Lexington: Obamaworld versus Hillaryland," *The Economist*, March 6, 2008
- Better to have many small, bilateral or trilateral agreements or one big one?

The politics of offshoring

- John Kerry and George Bush opposing and debating, during their race for the presidency, call centres moving to India or more exotic places like New Brunswick
  - "The new jobs migration," *The Economist*, February 19, 2004
  - "The great hollowing-out myth" in the same issue
- "A toll for the common man," *The Economist*, July 1, 2006

Interest Rate Parity

What is the relationship between the interest rates in two countries and their currency exchange rate?

Notation

rd	3%	Canada's interest rate (d for domestic)
rf	5%	France's interest rate (f is for foreign)
$p0$	\$1.3021	Spot price of the Euro
$p1$	unknown	Spot price of the Euro a year from now
$\hat{p}$	\$1.28	Your personal expectation or forecast for the value of the Euro one year from today
f	\$1.25	Today's actual one-year forward price of the Euro (may not be the equilibrium forward price)

Invest $1 million

Canada

$$\$1{,}000{,}000\left(1+r_d\right)$$

$$=\$1{,}000{,}000\times 1.03$$

$$=\$1{,}030{,}000$$

France

$$\frac{\$1{,}000{,}000}{p_0}\left(1+r_f\right)\times p_1$$

$$=\frac{\$1{,}000{,}000}{\$1.3021}\times 1.05\times p_1$$

$$=€767{,}990.17\times 1.05\times p_1$$

$$=€806{,}389.68\times p_1$$

Uncovered interest rate parity

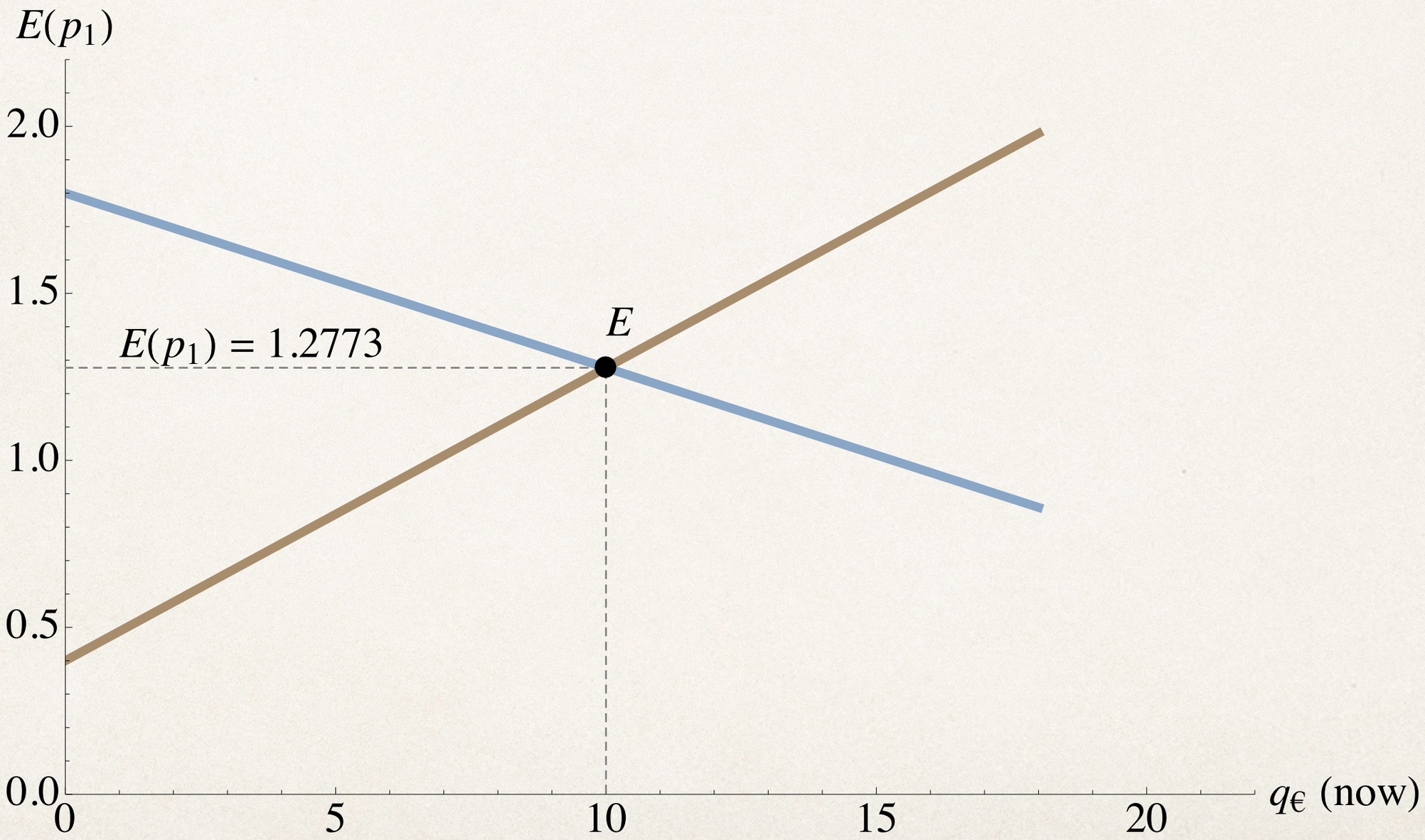
$$\left(1+r_d\right)=\frac{1}{p_0}\left(1+r_f\right)E\left(p_1\right) \quad \text{or} \quad \frac{1+r_d}{1+r_f}-1=\frac{E\left(p_1\right)}{p_0}-1$$

$$E\left(p_1\right)=\$1.2773$$

$$\frac{E\left(p_1\right)}{p_0}=\text{-}0.0190476$$

$$\approx r_d-r_f=-.02$$

Breaking even & equilibrium



How would you speculate?

Borrow in Canada, invest in France, buy Euros to pay off your loan

$$\$1\left(1+r_d\right) < \frac{\$1}{p_0}\left(1+r_f\right)\hat{p}_1$$

$$\$1\left(1.03\right) < \frac{\$1}{\$1.3021}\left(1.05\right)\$1.28$$

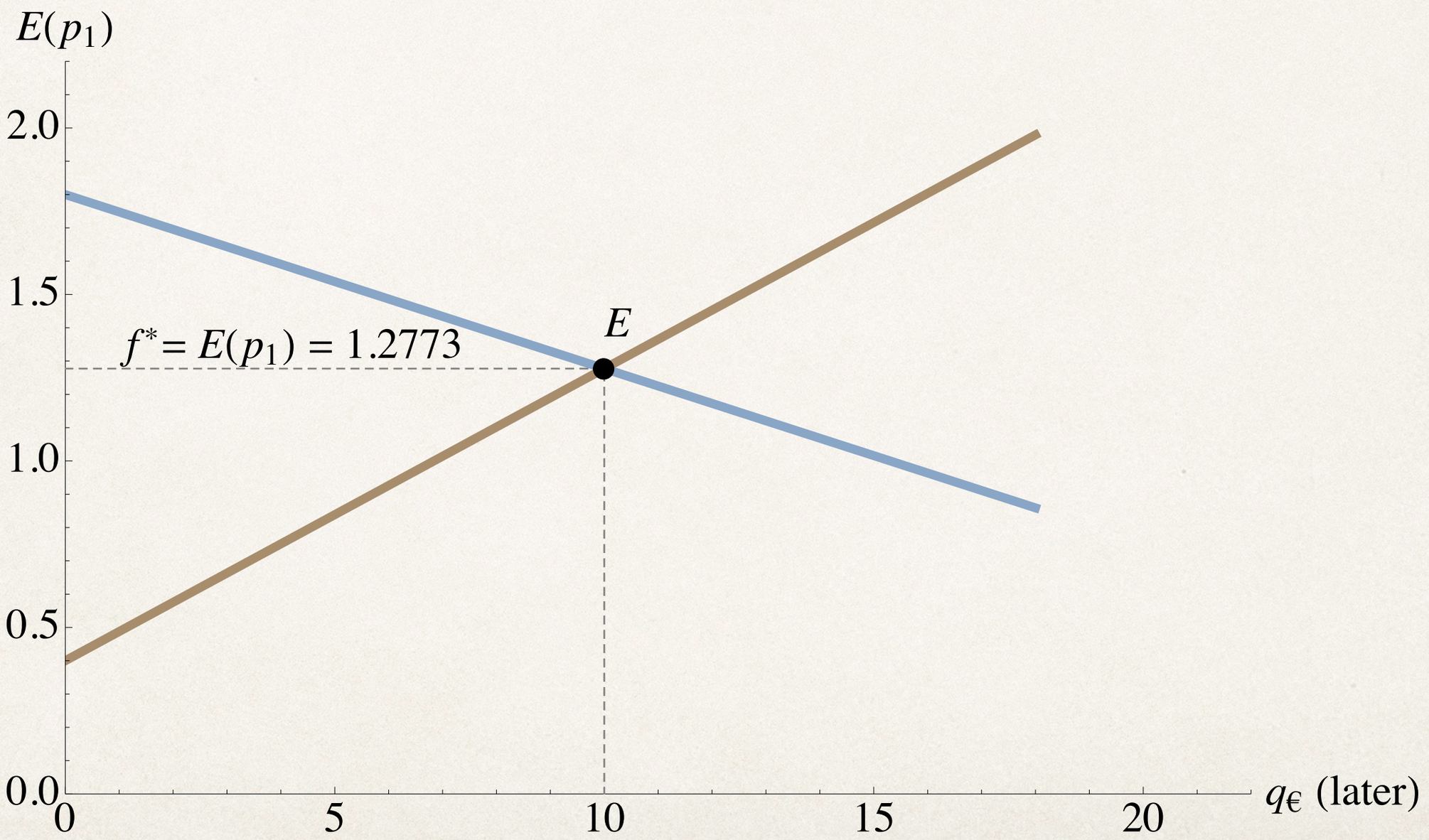
$$\$1.03 < €0.76799017\left(1.05\right)\$1.28$$

$$\$1.03 < €0.80638968 \times \$1.28$$

$$\$1.03 < \$1.03217879$$

$$E\left(profit\right) = \$0.00217879 = \$2{,}178.79 \text{ per } \$1\text{m}$$

Equilibrium in the forward market



Covered interest rate parity

$$f_0^* = E(p_1) = \$1.2773$$

$$(1+r_d) = \frac{1}{p_0}(1+r_f) \times f_0^* \quad or \quad \frac{1+r_d}{1+r_f} - 1 = \frac{f_0^*}{p_0} - 1$$

How would you arbitrage?

Borrow in France, invest in Canada, buy Euros forward

$$\$1\left(1+r_d\right) > \frac{\$1}{p_0}\left(1+r_f\right) f_0$$

$$\$1.03 > \frac{\$1}{\$1.3021} \times 1.05 \times \$1.25$$

$$\$1.03 > €0.767990 \times 1.05 \times \$1.25$$

$$\$1.03 > €0.80638968 \times \$1.25$$

$$\$1.03 > \$1.0079870978$$

$$profit = \$0.0220129 = \$22{,}012.90 \text{ per } \$1\text{m}$$

For discussion

- Speculation and arbitrage, good or bad?
- Are arbitrage opportunities too good to be true?
- Is there empirical support for uncovered interest rate parity?

Interpret

$$1\left(1+r_d\right)=\frac{1}{p_0}\left(1+r_f\right)E\left(p_1\right)$$

$$\left(1+r_d\right)=\left(1+r_f\right)\frac{E\left(p_1\right)}{p_0}$$

Intertemporal Markets

Topic 9

Start your engines

- Bond valuation
- Term structure (expectations, arbitrage)
- Consumption optimum in partial equilibrium
  - Exchange (borrowing and lending)
  - Investment and exchange
- General equilibrium (Pareto optimum)
- Permanent income hypothesis and anomalies

Bond Valuation

What determines the market value of debt?
What is the relationship between the price of a bond and its yield?
Does investing in financial securities make you wealthier?
Can the cash flow from bonds be chopped up and sold as separate financial securities?

Example

Par or face value	$1,000
Coupon rate (c)	5%
Coupon (C)	$50
Interest rate (r)	6.5%
Maturity (T years)	25
Compounding (m times a year)	2
Present value of coupons (PV(C))	**$613.79**
Present value of par (PV(F))	**$202.07**
Bond value (P)	**$815.86**

Do the math

$$P = \frac{C}{m}\left[\frac{1-\left(1+\frac{r}{m}\right)^{-mT}}{\frac{r}{m}}\right]+\frac{F}{\left(1+\frac{r}{m}\right)^{mT}}$$

$$= \frac{\$50}{2}\left[\frac{1-\left(1+\frac{.065}{2}\right)^{-2\times25}}{\frac{.065}{2}}\right]+\frac{\$1{,}000}{\left(1+\frac{.065}{2}\right)^{2\times25}}$$

$$= \$613.79 + \$202.07 = \$815.86$$

Explore

T	0%	2.5%	5%	6.5%	10%	15%	20%
0	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
5	$1,250	$1,117	$1,000	$937	$807	$657	$539
10	$1,500	$1,220	$1,000	$891	$688	$490	$361
25	$2,250	$1,463	$1,000	**$816**	$544	$351	$256
30	$2,500	$1,525	$1,000	$803	$527	$342	$252
1,000	$51,000	$2,000	$1,000	$769	$500	$333	$250

To infinity and beyond

$$P = \left(\frac{C}{m}\right)\left(\frac{1-\frac{1}{\left(1+\frac{r}{m}\right)^{m\times T}}}{\frac{r}{m}}\right)+\frac{F}{\left(1+\frac{r}{m}\right)^{m\times T}}$$

$$\text{If } T \to \infty,$$

$$P \to \frac{C}{r} = \$769.23$$

Pure discount bonds

- Present values should add up (why?)

$$P = \frac{F}{\left(1 + \frac{r}{m}\right)^{m \times T}}$$

- So you can strip apart bonds and create new securities

- A pure discount bond (why the name?) is one that pays a lump sum F at maturity but makes no coupon payments

- Those issued by the government determine our risk-free rates of interest and are called Treasury Bills

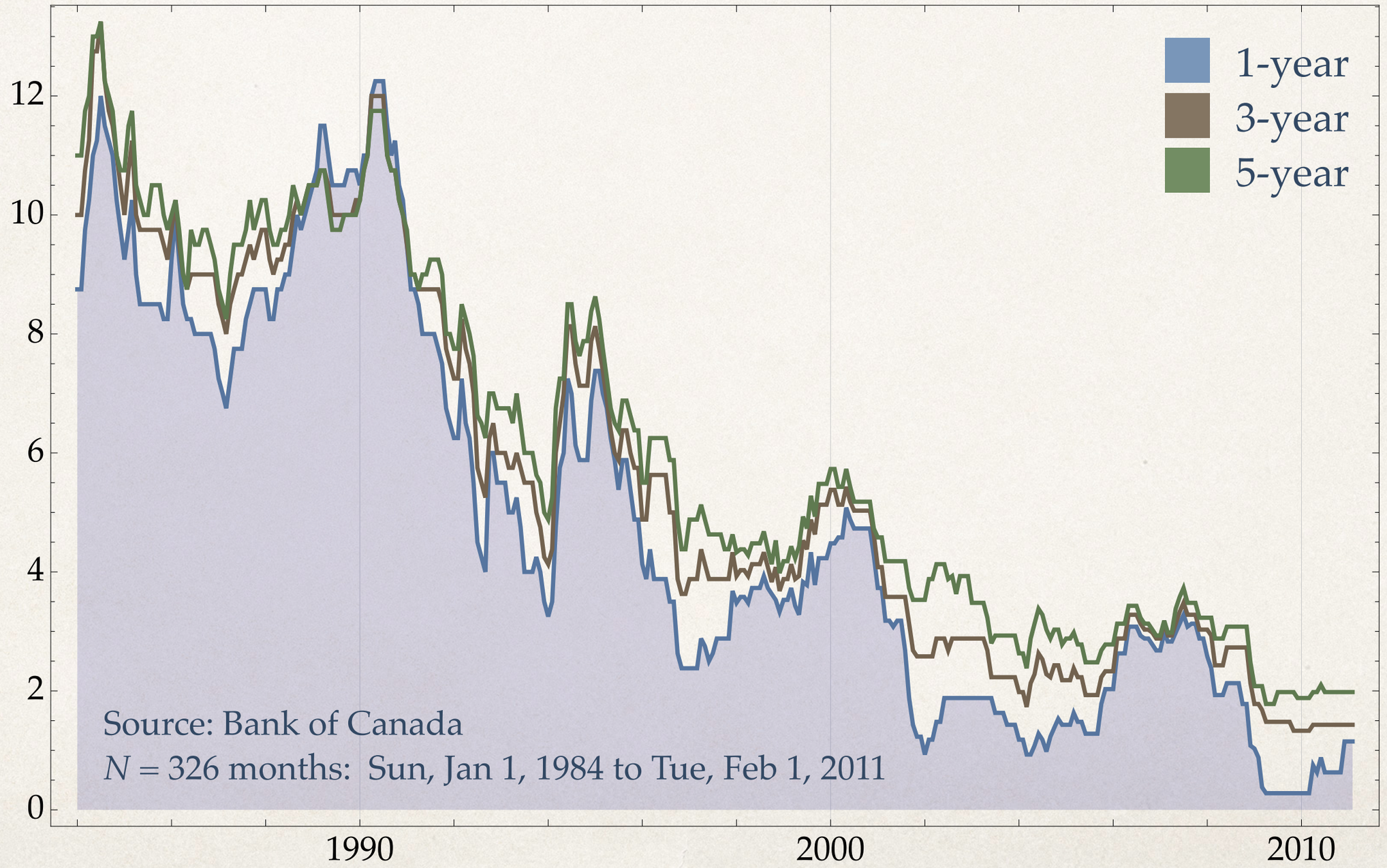
T-Bill	Price	r
1-month	$999.244	0.910%
3-month	$997.633	0.950%
6-month	$994.629	1.080%
1-year	$986.537	1.360%

Tuesday, February 1, 2011

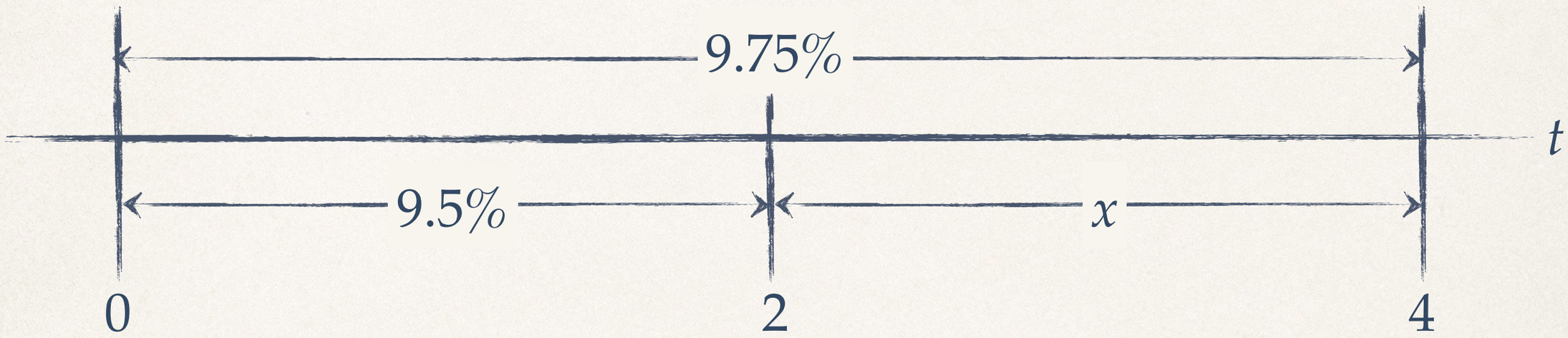
Term Structure of Interest Rates

Why is there a difference between short-term and long-term interest rates?

Example of interest rates on GICs



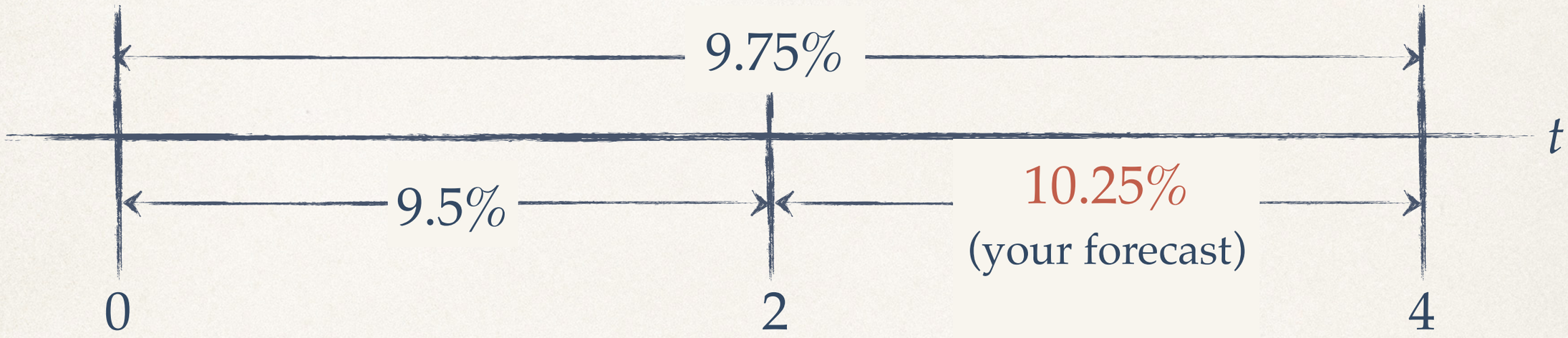
The expectations theorem



$$\left(1+\frac{0.095}{2}\right)^{2\times 2}\left(1+\frac{x}{2}\right)^{2\times 2}=\left(1+\frac{0.0975}{2}\right)^{2\times 4}\Rightarrow x=0.100003$$

The long-term rate is *above* than the short-term rate when the *market* expects the short-term rate to *increase* in the future

Speculate



$$\$1\left(1+\frac{0.095}{2}\right)^{2\times 2}\left(1+\frac{0.1025}{2}\right)^{2\times 2} > \$1\left(1+\frac{0.0975}{2}\right)^{2\times 4}$$

$$\$1.47042 > \$1.46344$$

$$E(profit) = \$0.00697287$$

Borrow long term, invest short term and roll over the investment

Arbitrage

$$\left(f = .099\right) \neq \left(f^{*} = x = 0.100003\right)$$

$$\$1\left(1+\frac{0.095}{2}\right)^{2\times 2}\left(1+\frac{f}{2}\right)^{2\times 2} < \$1\left(1+\frac{0.0975}{2}\right)^{2\times 4}$$

$$\$1.20397\left(1+\frac{0.099}{2}\right)^{2\times 2} < \$1\left(1+\frac{0.0975}{2}\right)^{2\times 4}$$

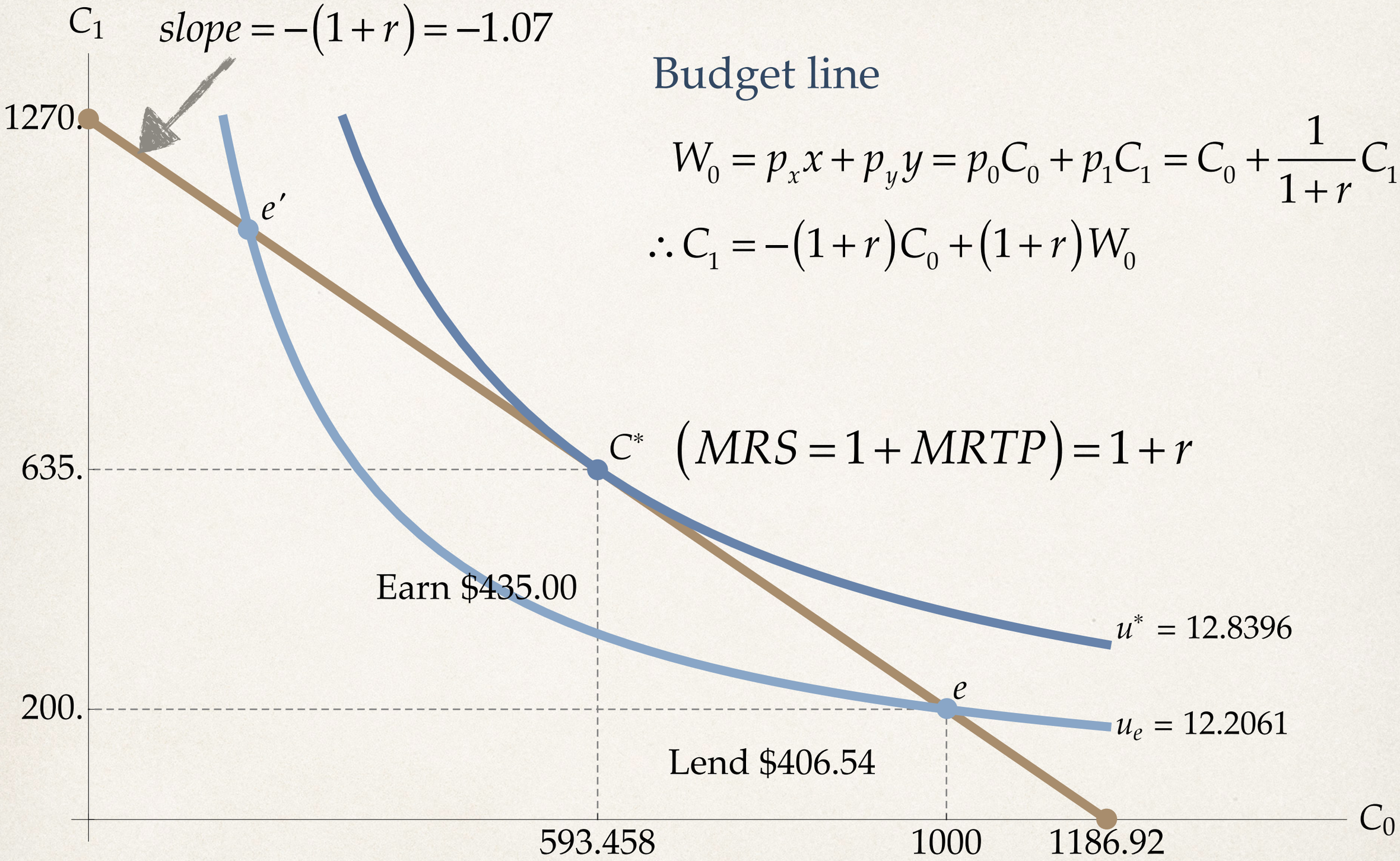
$$\$1.46065 < \$1.46344$$

$$profit = \$0.00279382$$

Borrow short term, borrow forward, invest long term

Consumption Optimum

How much will you consume today and how much next year?
What is consumption smoothing?
Do all of us use the same discount rate in making decisions?
How can I make myself richer?
Does how much I invest in real projects limit how much I can consume?



Budget line

$$W_0 = p_x x + p_y y = p_0 C_0 + p_1 C_1 = C_0 + \frac{1}{1+r} C_1$$

$$\therefore C_1 = -(1+r) C_0 + (1+r) W_0$$

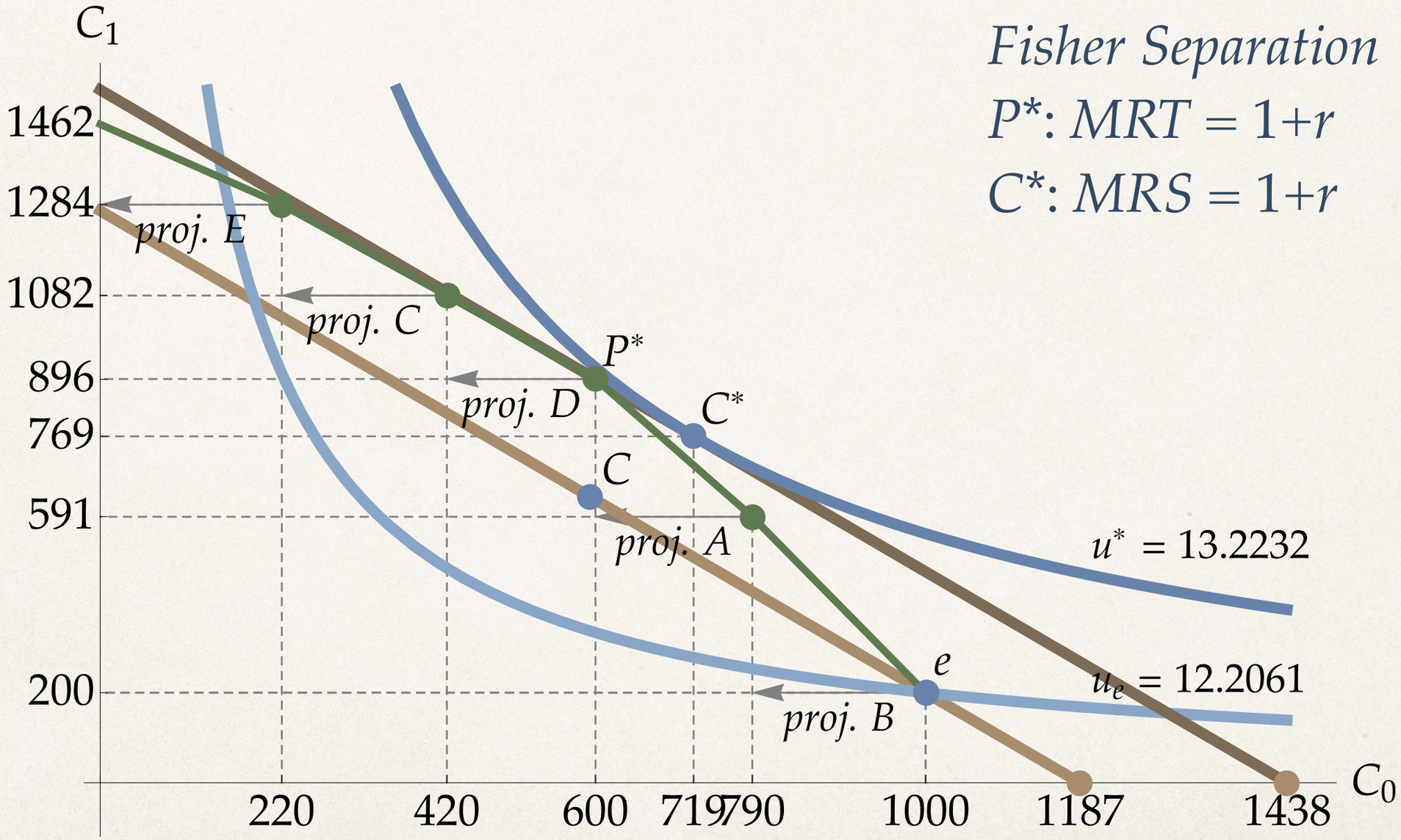
Does everyone use the same discount rate?

- Air conditioners
- Scholarships: $100,000 next week vs. $120,000 in a year and one week

Real investment and exchange

Project	Invest (now)	Earn (next year)	*ROI*	NPV at 7%
A	$190	$305.90	61%	$95.89
B	$210	$390.60	86%	$155.05
C	$200	$202.00	1%	-$11.22
D	$180	$185.40	3%	-$6.73
E	$220	$178.20	-19%	-$53.46
Optimal	$400	$697		**$251**
Wealth	$1,187			**$1,438**

Fisher Separation



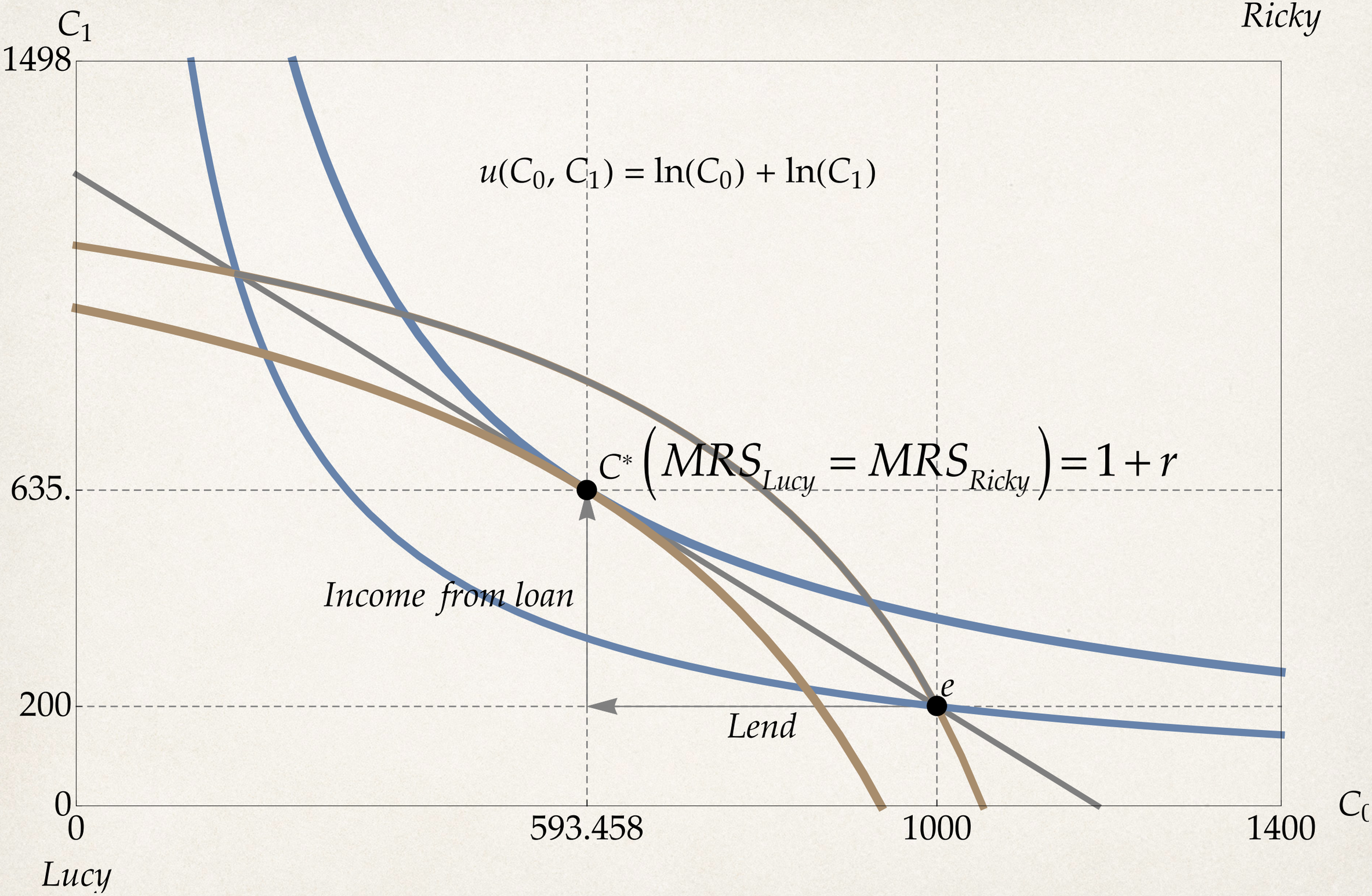
Fisher Separation

P^*: $MRT = 1+r$

C^*: $MRS = 1+r$

General Equilibrium

How are the interest rate and consumption determined together?



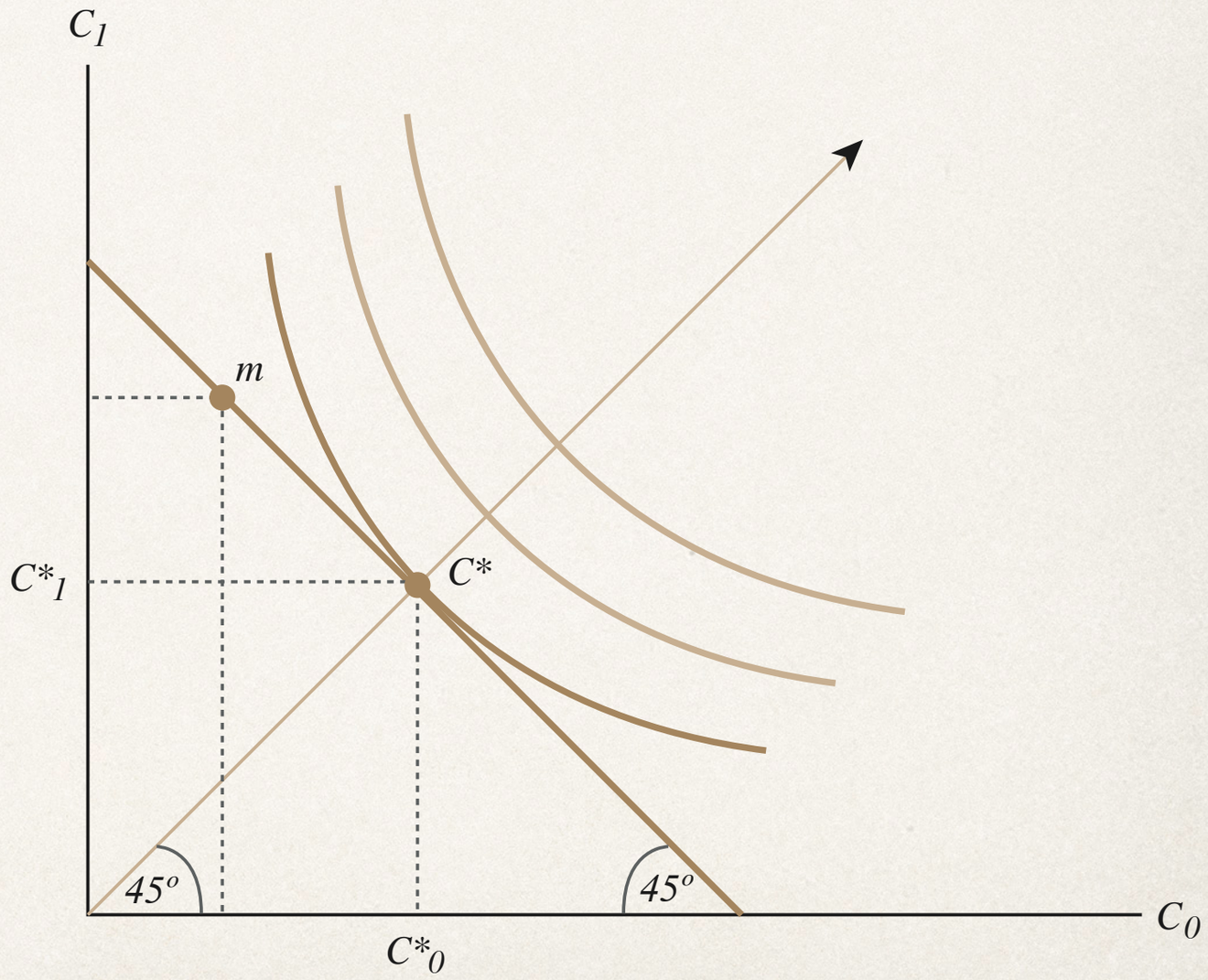
Where is the 7 per cent interest rate?

The Life Cycle Theory of Consumption and Savings

How do we decide to consume and save over our lifetimes?

Permanent income hypothesis

- Three simplifying assumptions
- The interest rate is zero
- Income is growing
- Indifference curves are *homothetic*



What's your permanent income?

Preferences	homothetic
Age now	20
Age at retirement	70
Age at death	88
Interest rate	0%
Annual income	$100,000
Growth rate of income	1.5%
Assets	$380,000

Do the calculation

$$PV\left(income\right)=\$100,000\left[\frac{\left(1.015\right)^{0}}{\left(1+r\right)^{1}}+\frac{\left(1.015\right)^{1}}{\left(1+r\right)^{2}}+\ldots+\frac{\left(1.015\right)^{N-1}}{\left(1+r\right)^{N}}\right]$$

$$=m\left[\frac{\left(1+g\right)^{0}}{\left(1+r\right)^{1}}+\frac{\left(1+g\right)^{1}}{\left(1+r\right)^{2}}+\ldots+\frac{\left(1+g\right)^{N-1}}{\left(1+r\right)^{N}}\right]=m\left[\frac{1-\left(\frac{1+g}{1+r}\right)^{N}}{r-g}\right]$$

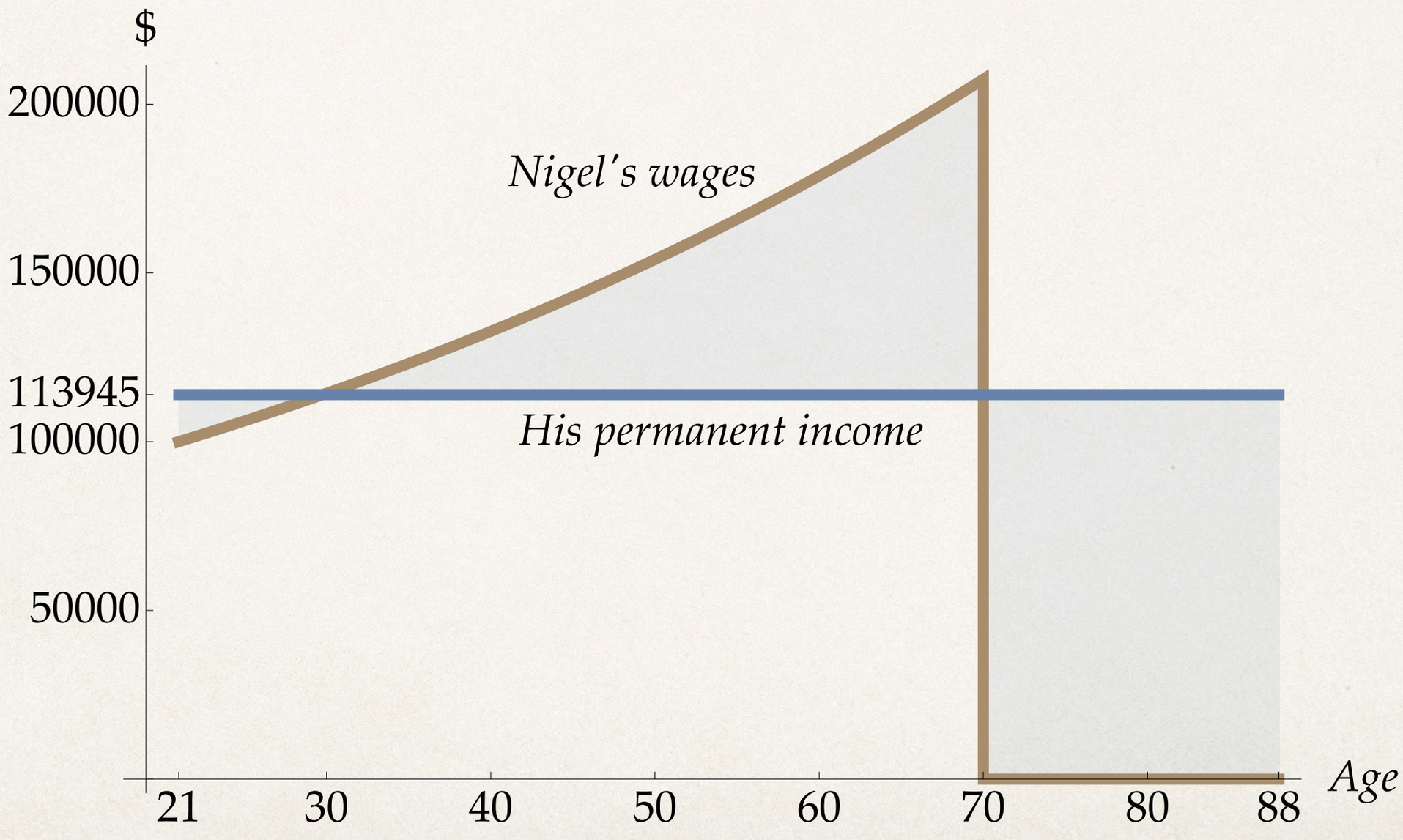
$$=m\frac{\left(1+g\right)^{N}-1}{g}$$

$$=\$100,000\frac{1.015^{50}-1}{0.015}=\$7,368,280$$

$$Wealth=Assets+PV\left(income\right)=\$380,000+\$7,368,280=\$7,748,280$$

$$Permanent\ income=\frac{\$7,748,280}{68}=\$113,945$$

The life cycle



Those darn anomalies

- Consumption tracking current income
  - Teachers' salaries
  - War restitution
  - Social security benefits
- Fungibilty
  - Pension wealth
  - Housing wealth

Tell a behavioural story

- Impatience and (lack of) self control
- Mental accounts and fungibility
  - Current account (MPC close to one)
  - Future account (MPC close to zero)
  - Asset account (MPC in between)
- See Thaler (1990) in your readings package

Markets for Risk

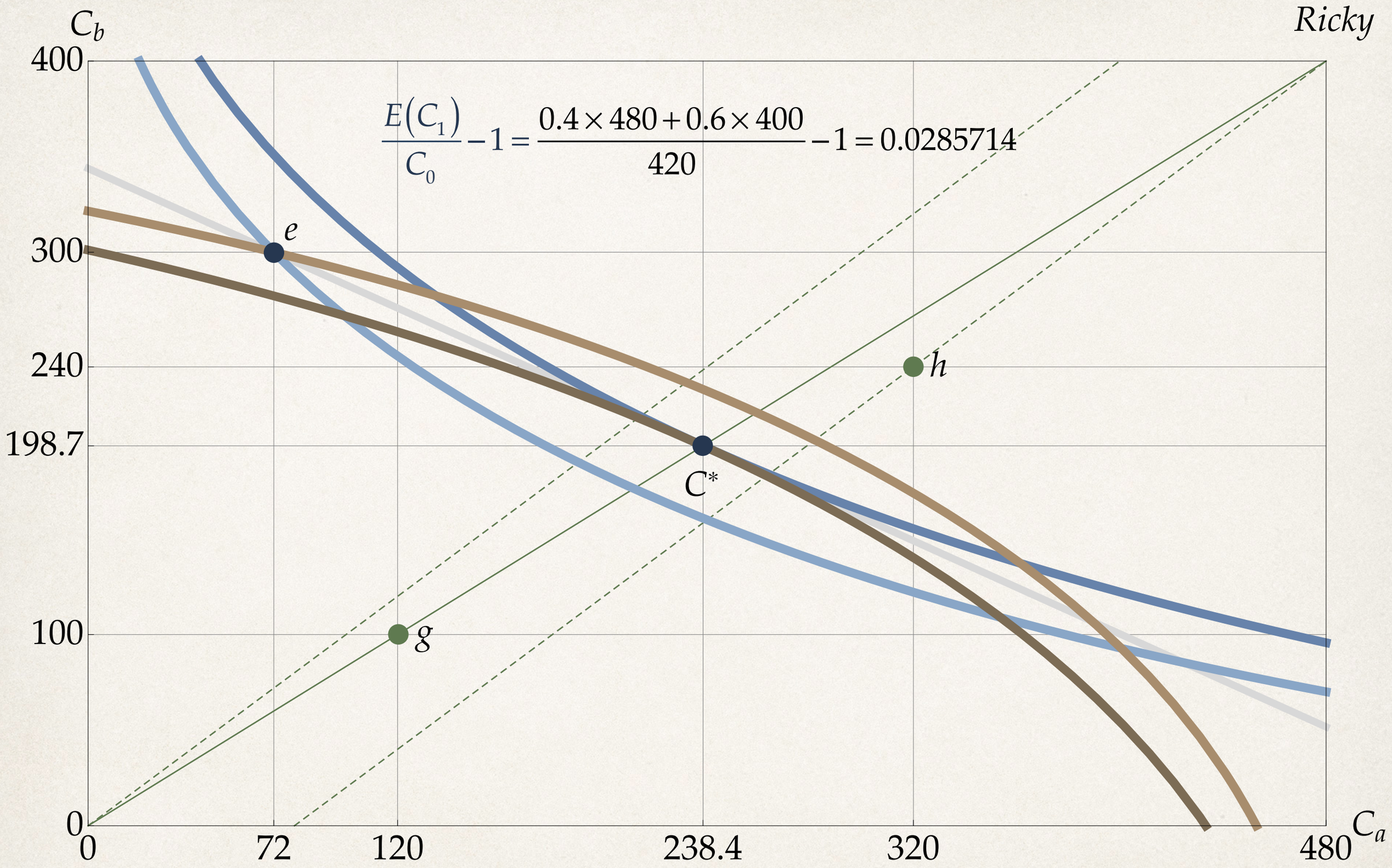
Topic 10

Time-State Preference

The future is uncertain. How can we model an economy as one in which risk is traded?

States a and b, and pure securities

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	\$168	\$252	\$420	Price ?	Price ?
1	***a***	**0.4**	**0.3742**	\$72	\$408	\$480	\$4.80	\$1.00
1	***b***	**0.6**	**0.6148**	\$300	\$100	\$400	\$4.00	\$1.00



$$C^* : MRS_{Lucy} = MRS_{Ricky} = \frac{p_a}{p_b} = \frac{0.374166}{0.614817} = 0.608581$$

Consumption optimum

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	\$168	\$252	\$420	Price ?	Price ?
1	a	0.4	**0.3742**	\$72	\$408	\$480	\$4.80	\$1.00
1	b	0.6	**0.6148**	\$300	\$100	\$400	\$4.00	\$1.00

$$C^* : MRS_{Lucy} = MRS_{Ricky} = \frac{p_a}{p_b} = \frac{0.374166}{0.614817} = 0.608581$$

Wealth

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	**$168**	$252	$420	Price ?	Price ?
1	a	0.4	**0.3742**	**$72**	$408	$480	$4.80	$1.00
1	b	0.6	**0.6148**	**$300**	$100	$400	$4.00	$1.00

$$W_0 = p_0 C_0 + p_a C_a + p_b C_b$$

$$W_{Lucy} = 1 \times \$168 + 0.374166 \times \$72 + 0.614817 \times \$300 = \$379.385$$

Price of risky stocks

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	\$168	\$252	\$420	Price ?	Price ?
1	a	0.4	**0.3742**	\$72	\$408	\$480	**\$4.80**	\$1.00
1	b	0.6	**0.6148**	\$300	\$100	\$400	**\$4.00**	\$1.00

$$P_M = p_a X_a + p_b X_b = 0.374166 \times \$4.80 + 0.614817 \times \$4 = \$4.25526$$

$$E(R_M) = \frac{E(X)}{P_M} - 1 = \frac{\pi_a X_a + \pi_b X_b}{P_M} - 1 = \frac{0.4 \times \$4.80 + 0.6 \times \$4}{\$4.25526} - 1 = \frac{\$4.32}{\$4.25526} - 1 = 0.0152132$$

Price of safe bonds

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	\$168	\$252	\$420	Price ?	Price ?
1	a	0.4	**0.3742**	\$72	\$408	\$480	**\$4.80**	\$1.00
1	b	0.6	**0.6148**	\$300	\$100	\$400	**\$4.00**	\$1.00

$$P_F = p_a X_a + p_b X_b = \left(p_a + p_b\right) X = 0.374166 \times \$1 + 0.614817 \times \$1 = \$0.988983$$

$$r_f = \frac{X}{P_f} - 1 = \frac{\$1}{\$0.988983} - 1 = 0.0111399$$

Portfolio composition

Contingencies				Endowments			Securities	
Date (t)	State (s)	Prob.	P	Lucy	Ricky	Canada	M	F
0	-	1	1	\$168	\$252	\$420	Price ?	Price ?
1	a	0.4	**0.3742**	\$72	\$408	\$480	\$4.80	\$1.00
1	b	0.6	**0.6148**	\$300	\$100	\$400	\$4.00	\$1.00

$$e_{Lucy}\begin{cases} C_a = 72 = 4.80 \cdot q_M + 1 \cdot q_F \\ C_b = 300 = 4 \cdot q_M + 1 \cdot q_F \end{cases} \rightarrow \quad q_M = -285,\ q_F = 1,440$$

Complete markets

- There are at least as many linearly independent or unique securities as there are states of nature
- Short selling is allowed
- Implications
  - Any distribution in the Edgeworth box is feasible
  - Opportunities for financial engineering

Which markets are complete?

	Market 1		Market 2		Market 3		Market 4		
	M	K	G	H	O	P	I	T	S
a	$4.80	$3	$8	$12	$1.5	$3.5	-$4	-$12	$3
b	$4	$1	$2	$3	$6	$1	$2	$6	$7

Create synthetic securities

	Market 1	
	M	K
a	$4.80	$3
b	$4	$1

How would you combine M and K to create a risk-free security that pays $2?

Interest Rate Swaps

Why exchange a stream of risky interest payments for a stream of safe payments?

Here's a swap

- The boss of company A meets the boss of company B at Java U for café latte
- They agree to swap interest payments on a pretend $1 million loan
  - A will pay B a floating rate equal to prime plus 1.75% every year
  - B will pay A a fixed rate of 7% every year
- Each takes a sip of their coffee; B orders a biscotto
- The swap is the difference in the two cash flows; it is a bet on the prime rate

Here are the swap's cash flow

Prime	A owes B	B owes A	Difference	This…	Goes to…
5.28%	7.03%	7%	0.030%	**$300**	B
3.56%	5.31%	7%	-1.690%	**$16,900**	A
5.4%	7.15%	7%	0.150%	**$1,500**	B
4.36%	6.11%	7%	-0.890%	**$8,900**	A
5.04%	6.79%	7%	-0.210%	**$2,100**	A
6.4%	8.15%	7%	1.150%	**$11,500**	B
7%	8.75%	7%	1.750%	**$17,500**	B

Looking for a loan

What the banks charge

	Co. A	Co. B	|Δ|	Swap
Fixed	6.0%	11.0%	5.0%	?
Floating	5.0%	8.0%	3.0%	?
|Δ|	1.0%	3.0%	2.0%	?

Comparative advantage in fixed rate borrowing

	Co. A	Co. B	|Δ|	Swap
Fixed	6.0%	11.0%	5.0%	?
Floating	5.0%	8.0%	3.0%	?
|Δ|	1.0%	3.0%	2.0%	?

How are the swap terms chosen?

	Co. A	Co. B	$\lvert\Delta\rvert$	Swap
Fixed	6.0%	11.0%	5.0%	7.00%
Floating	5.0%	8.0%	3.0%	5.75%
$\lvert\Delta\rvert$	1.0%	3.0%	2.0%	1.25%

Are the gains real?

	Co. A	Co. B	|Δ|	Swap
Fixed	6.0%	11.0%	5.0%	7.00%
Floating	5.0%	8.0%	3.0%	5.75%
|Δ|	1.0%	3.0%	2.0%	1.25%

"Gain" = Fixed rate flows + Floating rate flows

A's "gain" = (7% - 6%) + (5% - 5.75%) = 0.25%

NPV(A's gain) = ?

B's "gain" = (11% - 7%) + (5.75% - 8%) = 1.75%

NPV(B's gain) = ?