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Econ 812

Week 1: Efficiency and Probability

I. The Many Meanings of Efficiency
   A. The *Merriam-Webster College Dictionary* defines "efficiency" as "effective operation as measured by a comparison of production with cost (as in energy, time, and money)."
   B. Economists occasionally do use "efficiency" in the dictionary sense - ratio of the value of output to input or something similar.
   C. But normally they use it in quite different ways, and unfortunately often equivocate between the various usages.
   D. The two most common uses in economics are:
      1. Pareto efficiency
      2. Kaldor-Hicks (or cost-benefit) efficiency
   E. Since much of micro analyzes efficiency, it is important to understand these terms' precise meanings.

II. Pareto Efficiency, I
   A. Most of the famous theorems in welfare economics discuss Pareto efficiency.
   B. A situation is **Pareto efficient** iff the only way to make one person better off is to make another person worse off.
   C. Similarly, a **Pareto improvement** is any change that makes someone better off without making anyone else worse off.
   D. Slight variant - a situation is Pareto efficient if there is no way to make everyone better off. Note that in a perfectly continuous world, this is equivalent to the other definition. Why?
   E. In theory, it is quite possible that people will voice objections to Pareto improvements for *strategic reasons*. So it is <u>not</u> equivalent to a demonstrated preference standard.
   F. In a highly stylized theoretical setting, we will see that Pareto improvements are conceivable. Ex: If everyone has identical preferences and endowments.

III. Pareto Efficiency, II
   A. Even so, there is a strong argument that, in the real world:
      1. Everything is Pareto efficient.
      2. Pareto improvements are impossible.
   B. Why? Almost any change hurts someone, and it is highly unlikely in practice that literally everyone can be compensated, that absolutely no one will be missed.
   C. Ex: I buy your watch. How will we compensate everyone who might have asked you the time?

D. More fruitful variant: Analyze the Pareto efficiency of ex ante *rules* instead of ex post results. But even then, someone somewhere is sure to slip through the cracks.

IV. Kaldor-Hicks Efficiency, I

A. In practice, then, economists almost always switch to Kaldor-Hicks efficiency, aka "cost-benefit efficiency."

B. A situation is **Kaldor-Hicks efficient** iff the dollar value of social resources is maximized.

C. A **Kaldor-Hicks improvement** is any change that *raises* the dollar value of social resources.

D. Every Kaldor-Hicks efficient situation is Pareto efficient, but most Pareto efficient situations are NOT Kaldor-Hicks efficient.

E. Ex: You value a watch at $20, I value it at $30, the strangers you will encounter value your having the watch at $.10, the (different) strangers I will encounter value my having the watch at $.10.

1. If I have the watch, the situation is K-H and Pareto efficient.
2. If you have the watch, the situation is Pareto but not K-H efficient. Social value on the watch rises from $20.10 to $30.10, but your time-askers lose $.10.

F. Every Pareto improvement is a Kaldor-Hicks improvement, but most Kaldor-Hicks improvements are not Pareto improvements.

G. K-H efficiency is often described as "potentially Pareto efficient" because if the value of social resources rises, then (assuming perfect continuity), you *could* compensate all of the losers by sharing the gain in surplus.

H. But what exactly does this "could" mean? Essentially, you could if transactions costs of arranging compensation were zero.

I. This bothers many people - why shouldn't the transactions costs count just as much as other costs? Ultimately, though, this is just another way of saying that Kaldor-Hicks improvements don't have to be Pareto improvements. No one said ever said they were.

1. When you judge whether something is a K-H improvement, you do count the transactions costs for the move itself.

V. Kaldor-Hicks Efficiency, II

A. K-H efficiency naturally gives rise to another concept: deadweight costs. If the value of social resources is not maximized, deadweight costs exist.

B. Everyone knows that you can *transfer* resources from one person to another. That's obvious.

C. Economists' marginal product: It is far less obvious that resources can be destroyed, leaving *no one* better off.

D. Ex: Piracy. It is obvious that pirates transfer treasure from victims to themselves. The deadweight costs of piracy are far less obvious. What are they? Treasure that gets lost in the fight, damage to ships, lost lives on both sides, etc.

1. The point is **not** that pirates make themselves worse off by piracy. At least ex ante, they don't. The point is that the pirates only gain a fraction of what the non-pirates lose.
2. This assumes, of course, that people don't *directly enjoy* fighting, watching gold sink to the ocean floor, etc.

E. Now let's examine Landsburg's K-H analysis of drug legalization. Main insights:
1. Taxes raised are a transfer, not a "benefit."
2. Imprisonment and effort spent avoiding imprisonment is a deadweight cost.
3. Theft is a transfer, but resources (time, tools, etc.) used to steal are a deadweight cost.
4. Voluntary consumption is a benefit!
5. Internalized losses (like loss of productivity) are already counted in consumption decisions.

F. Economists often criticize non-economists for thinking in terms of a "fixed pie" of wealth. In this sense, economists are more optimistic than the public. However, a corollary is that the pie can also *shrink*! In this sense, economists are more pessimistic than the public. With a fixed pie of resources, conflict at least has to benefit SOMEONE.

G. Reducing deadweight costs is always a K-H improvement; if a situation is K-H efficient, deadweight costs are zero.

VI. Kaldor-Hicks Efficiency versus Utilitarianism

A. Kaldor-Hicks efficiency is based on dollar valuations, not utility or happiness.
1. You can know that I'm willing to pay $100 for something without having any idea about how much happiness it brings me.
2. Similarly, you can know that something makes me very happy even if I have a low willingness to pay for it.

B. Utilitarianism, in contrast, is precisely about maximizing happiness or pleasure. The main reason economists rarely officially use it is that it requires "interpersonal utility comparisons." Simply: How do you "add happiness"?

C. People often say that utilitarianism just factors in the marginal utility of wealth, unlike K-H. There is a point here, though it is not necessarily true: People might be willing to pay for things other than happiness.

D. Utilitarianism is often used to justify redistribution, but even on its own terms, this doesn't necessarily follow. The "utility monster" is the standard philosophers' counter-example.

VII. The Comparative Institutions Approach and "Second Best"

A. Demsetz famously complained about the "Nirvana fallacy" - doing (K-H) efficiency comparisons while selectively relaxing important constraints.

B. His target was old-style welfare economics, where the solution to any market shortcoming was government involvement. The shortcomings of government - and even its basic overhead - were almost never factored in.

C. Classic example: P>MC.
   1. Standard solution: Impose P=MC price control.
   2. Secondary problem: With fixed costs, firms now lose money.
   3. Standard solution: Subsidize them.
   4. Tertiary problem: How can the subsidies be funded?
   5. Standard solution: Taxes
   6. But what about the DW cost of the taxes?!

D. Demsetz's lesson is that economists should use a "comparative institutions approach." Nothing in the real world is perfectly efficient. What fails least badly?
   1. The Tale of the Emperor

E. When you add more constraints to a standard problem, the original optimum is usually no longer feasible. Economists frequently refer to the original optimum as a "first-best solution," and the new, worse optimum as a "second-best solution."

F. Example: Pricing subject to a P=AC constraint in a decreasing cost industry.

VIII. Moral Philosophy and Efficiency

A. Who cares about efficiency anyway? Does anyone seriously believe that the right action is always the one that does the most for K-H efficiency?

B. One popular reply: K-H efficiency combined with redistribution.
   1. That still seems highly inadequate to me. What about desert and entitlement?

C. More moderate view: Efficiency is probably ONE of many consequences worth thinking. Why then should economists concentrate on it? Because they have special training for distinguishing transfers from DW costs, but no special training in moral philosophy. Economic analysis thus becomes a potentially useful input into the moral thinking of others.

IX. Probability, Objective and Subjective

A. Probability language allows us to **quantify uncertainty**. There is more to say in an uncertain world than "I don't know."

B. Least controversial interpretation: *objective* probability. Even when you do not know what will happen, you can still talk about *relative frequencies* of various observed events in the past.

C. But objective probability is problematic in many ways. Most notably, it implies that you cannot talk about probability of unique events. If you take this idea seriously, moreover, you will realize that every event is, strictly speaking, unique, so you could never apply probability to the real world!

D. This leads us naturally to the broader but more contentious *subjective* interpretation of probability.
E. A subjective probability is simply a *degree of belief* that a person assigns to a proposition. Simple axioms of probability:
    1. Beliefs range from impossible (p=0) to certain (p=1).
    2. Since *something* is certain to happen, the sum of all probabilities about an event must equal 1.
F. Main objection to subjective probability: Realism. People rarely explicitly assign probabilities to events.
G. My reply: Even so, people almost always have some probabilities in the back of their minds. Probabilities is like willingness to pay.
H. Further objection: When people are asked difficult questions, they often say "I don't know."
I. But what if they HAD to guess? In real life you must.
J. Common sophism: "No one can 'know' X."
    1. If this means "No one can know X **with certainty**," then it's obvious but uninteresting.
    2. If this means "No one has any idea at all about X," then it is clearly false.
K. Does probability theory rule out "surprise"? Not at all. The occurrence of the improbable, extreme events is inherently surprising.
L. In practice, economists typically use the subjective interpretation of probability, but add assumptions that link subjective and objective probabilities. More on this later.

X. Conditional Probability and Bayes' Rule
A. Subjective probability theory puts no constraints on pre-evidential beliefs, but it does restrict the way that people can *update* their beliefs when new evidence comes in.
B. Conditional probability formula: P(A|B)=P(A&B)/P(B).
    1. Ex: P(2 heads|first flip is heads)=P(2 heads)/P(first flip is heads)=.25/.5=.5.
    2. Ex: P(child saw monster|says he saw monster)=P(child saw monster & monster)/P(says he saw monster). So if P(child saw a monster and monster)=10^{-9}, and P(says he saw monster)=.1, the conditional probability comes out to one-in-a-hundred-million.
    3. Note: Conjunction can never be more probable than either of the components!
C. A more advanced formula, known as Bayes' Rule, lets us link the P(A|B) and the P(B|A). Bayes' Rule states that P(A|B)=P(B|A)*p(A)/[P(B|A)*P(A)+P(B|~A)P(~A)].
D. Ex: P(child saw a monster|says he saw monster)=P(child says he saw monster|saw monster)*P(saw monster)/[P(child says he saw monster|saw monster)*P(saw monster)+P(child says he saw monster|did not see monster)*P(did not see monster). So if P(child

says he saw monster|saw monster)=1, P(child says he saw monster|did not see a monster)=.1, P(saw monster)=10^{-7}, and P(did not see monster)=1-10^{-7}, the conditional probability works out to $1*10^{-7}/[1*10^{-7}+.1*\{1-10^{-7}\}]=10^{-7}/[10^{-7}+.9999999]=9.999991*10^{-7}$.

E. Bayes' Rule provides a natural framework for scientists to relate hypotheses to evidence. Let A be your hypothesis and B be some evidence; then calculate P(A|B).

F. Ex: The P(minimum wage causes unemployment|Card/Krueger study's findings). Suppose P(CK findings|m.w. does cause unemployment)=.3, P(CK findings|m.w. does not cause unemployment)=.8, P(m.w. does cause unemployment)=.99, and P(m.w. does not cause unemployment)=.01. Then the conditional probability comes out to .3*.99/(.3*.99+.8*.01)=97.4%.

G. Do people update their beliefs "as if" they knew these formulae? Obviously, they do to some degree. We:
   1. ...run away when we appear to see a large fire
   2. ...meet reports of alien abduction with skepticism
   3. ...believe shocking disaster stories in the NYT, but not the Weekly World News.
   4. ...do not change our minds about the minimum wage when astronomers discover a new galaxy.

H. This is fortunate since game theory and information economics depend heavily on these formulae. After the midterm we will examine empirical evidence which points to some exceptions.

I. Application: What should you infer if you think you witness a 0-probability event?

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Week 2: General Equilibrium

I. Strategic Interaction Between Maximizers
   A. Economists usually think of individual agents as maximizing something, but rarely analyze individuals in isolation. For social scientists, interesting questions almost always involve more than one individual.
   B. Such interesting questions are however analytically challenging. When one person "plays against nature," the action is one-sided. You do not need to worry about how your "opponent" will change its behavior in response to your behavior. Once there is more than one person, you do.
      1. Even this is oversimplified, since animals can play strategically to some degree. But no one e.g. expects wolves and rabbits to form an alliance against hunters.
   C. Given the complexity of the problem, economists have focused a lot of time on a very easy case. Imagine that there are not just more than one agent, but *a lot* of agents. So many, in fact, that you do not have to worry about how other actors will strategically respond to your decisions.
      1. There are many examples of this kind of thinking. When you buy corn, you do not contemplate how corn farmers will respond to your purchase.
   D. Interesting result: Once you make the problem easy in this one way, you can make it extremely complex in other ways, and still get clear answers. Analysis of complex economies from this starting point is known as *general equilibrium theory*.

II. Examples of General Equilibrium
   A. Simple example: Suppose *I* consumers have identical preferences and endowments in a two-good economy. U=a ln x + b ln y; a+b=1. These agents make exchanges in markets where they know their personal behavior has no perceptible effect on prices.
   B. What happens? Intuitively, this situation is sustainable only if prices induce everyone to consume their own endowment!
   C. Formally: We can substitute out for y by noting that

$$y = \frac{Income - p_x x}{p_y}$$, and in a commodity economy,

$$Income = p_x \bar{x} + p_y \bar{y}$$, so agents maximize:

$$a \ln x + b \ln \left[\frac{p_x \bar{x} + p_y \bar{y} - p_x x}{p_y} \right]$$

D. Differentiating, we learn that: $x = \frac{a}{b}\frac{p_y}{p_x}y$. Since agents consume all of their income: $x = \frac{aIncome}{p_x}$, $y = \frac{bIncome}{p_y}$, the usual constant-income-fractions result.

E. Now simply find the prices that induce everyone to consume their initial endowments. Set $x = \bar{x}$, $y = \bar{y}$. Then you have $\bar{x} = \frac{a\left(p_x\bar{x} + p_y\bar{y}\right)}{p_x}$. Simplifying, we learn that: $\frac{p_x}{p_y} = \frac{a}{b}\frac{\bar{y}}{\bar{x}}$. The equilibrium price of x is directly proportional to the taste parameter for x and the initial endowment of y; the price of y is directly proportion to the taste parameter for y and the initial endowment of x.

F. What if we make things more interesting by allowing for taste and endowment differences? Specifically, each agent *i* has $U_i = a_i \ln x + b_i \ln y$, and endowments $\bar{x}_i$ and $\bar{y}_i$. Then what?

G. Now agents are actually going to make trades at equilibrium prices, instead of just noting that prices leave no incentive *to* trade. So we have to find the prices that induce aggregate consumption to equal aggregate endowments, taking the full interaction between prices and consumption into account.

H. Formally, add up *I* equations for individual consumption of x as a function of prices and initial endowments. Then impose the constraint that $\sum x_i = \sum \bar{x}_i$. This gives us: $p_x \sum \bar{x}_i = p_x \sum a_i \bar{x}_i + p_y \sum a_i \bar{y}_i$. Solving, we find that: $\frac{p_x}{p_y} = \frac{\sum a_i \bar{y}_i}{\sum b_i \bar{x}_i}$. Once again, we have solved for prices as a function of preferences and initial endowments.

1. Note: We would get the same result if we solved for y instead. Intuitively, if there are two markets and one clears, so does the other.

I. Worth noticing: Utility function implies that people will give up anything to have a finite quantity of each good. If half of the people had no x, and the rest had both, why couldn't the no-x-ers be induced to give up practically all of their y?

III. General Equilibrium in Pure Exchange Economies

A. General equilibrium problems can be analyzed in very general terms.

B. Formally, assume:

1. There are *I* consumers indexed *i*=1,...,*I.*
2. There are *K* commodities indexed *k*=1,...,*K.*
3. Commodity consumption must be non-negative.

4. Utility $U_i(x)$ is strictly increasing in all commodities (stronger than necessary, but simpler).
5. Consumers start with endowments of commodities; endowment of consumer *i* is e^i.
6. There is a continuous market price vector $p=(p_1,...,p_k)$ that agents treat as exogenous.

C. Then let us define *general equilibrium* to be a situation in which:
1. Consumer *i* maximizes U_i s.t. $px \leq pe^i$ for all *i*.
2. Aggregate consumption never exceeds aggregate endowments: $\sum_{i=1}^{I} x^i \leq \sum_{i=1}^{I} e^i$.

D. Intuition: Since endowments and utility functions are fixed, what varies to make an equilibrium possible? The consumption vectors, *x*. And what changes consumption vectors? Naturally, the price vector, *p*.

IV. Sufficient Conditions for Existence of General Equilibrium

A. Caveat: General equilibrium might still exist even though sufficient conditions not met!

B. First, note that the inequalities can be replaced with equalities because utility functions are strictly increasing.

C. Second, note that since this is an endowment economy, multiplying all prices through by a scalar λ changes nothing; if *p* is an equilibrium price vector, so is λp. So we can restrict attention to price equilibria where $\sum_{k=1}^{K} p_k = 1$.

D. Then the following assumptions guarantee the existence of general equilibrium.

E. **Assumption 1: $U_i(p)$ has a unique solution for all *i* and all *p*.**

F. **Assumption 2: Total demand for good *k* exceeds total endowment for a small enough p_k, and falls short of total endowment for a large enough p_k.**

G. **Assumption 3: The total demand function for *k* is continuous in p_k for $0<p_k<1$.**

H. In a 2-commodity world (*k*=2), you can prove the existence of general equilibrium using the Intermediate Value Theorem. If one market clears, the other has to clear, and if demand is continuous and can be too high or too low, it must at some point be just right.

I. In a *k*-commodity world, you can prove the existence of general equilibrium using Brouwer's Fixed Point Theorem. Basic idea of fixed point theorems: find conditions for functions such that there must be an f(x)=x. All of our assumptions together conveniently satisfy Brouwer's Fixed Point Theorem, so QED.

J. How do you get to these fixed points? GE theory usually focuses on the "Walrasian auctioneer" who adjusts price vectors to

eliminate excess demands. (Austrians tend to hate this). We will discuss alternatives later.

V. Counter-Examples
   A. When would a general equilibrium not exist? Each of the assumptions is made for a reason. Some of the more notable possible reasons for non-existence:
   B. Counter-example #1: Lexiocographic preferences, hence no utility function. No prices would induce people to give up the lexicographically preferred commodity.
   C. Counter-example #2: Discontinuity. If total demand for x is 90% of endowment at p=.7, and 110% of endowment at p=.7-ε.
   D. Counter-example #3: Demand not "well-behaved" at extreme prices. This might simply imply 0 prices for some goods, but there may be technical complications.
   E. Counter-example #4: Prices are discontinuous. If prices have to be in discrete 1-penny units, for example, general equilibrium may not exist.
   F. Remember: Standard theorems give sufficient conditions. G.E. might exist anyway. Ex: Linear utility functions, where U=x+y. What assumption does this violate? Can you describe the G.E. anyway? (Hint: What happens to demand for x if the price of x exceeds the price of y? Vice versa?)

VI. The Two Welfare Theorems
   A. Market-clearing prices in individual markets have familiar welfare properties. At the intersection of S&D, total surplus is maximized, so the allocation must be Pareto efficient.
   B. But can these results be generalized to multiple markets? General equilibrium theory can prove that the results from simple S&D cases generalize broadly.
   C. **First Welfare Theorem: Under the previous assumptions, the general equilibrium allocation is Pareto efficient.**
   D. There is a standard proof by contradiction. Suppose that x is an equilibrium allocation but x' is Pareto superior to x.
      1. Then since x' must be feasible, $\sum_{i=1}^{I} x_i' \leq e$.
      2. Then since prices are non-negative, $\sum_{i=1}^{I} px_i' \leq pe$.
      3. Since utility is strictly increasing in consumption, $\sum_{i=1}^{I} px_i = pe$.
      4. This implies that $\sum_{i=1}^{I} px_i' \leq \sum_{i=1}^{I} px_i$.
      5. BUT: By the definition of Pareto improvement, all consumers must weakly prefer x' to x, one must strictly prefer x' to x. Weak preference requires that x' not be *more* affordable than

x: $px_i' \geq px$. Strict preference requires that x' be not affordable for some *i*, so for at least one person, $px_i' > px$.

6. Summing up these weak and strong inequalities implies that: $\sum_{i=1}^{I} px_i' > \sum_{i=1}^{I} px_i$, contradicting (4).

E. Many economists find this welfare theorem less than compelling. After all, an allocation where one person owned everything is also Pareto efficient. But these economists often find hope in the second main result (some additional assumptions on utility functions are needed, and I omit the proof):

F. **Second Welfare Theorem: Any Pareto efficient allocation can be a general equilibrium given some initial endowments.**

G. Standard interpretation: Just by changing initial endowments ("redistributing") in the right way, you can make any Pareto efficient allocation self-sustaining.

H. Philosophical perspective: All distributive complaints against competitive markets can be answered with some form of lump-sum redistribution. Mere existence of the market does not make any efficient equilibrium unsustainable.

I. Possible contrast: Democracy.

VII. Arrow-Debreu Contingent Claims Markets

A. General equilibrium already seems rather general. But Arrow and Debreu noticed that it was much more general than anyone realized.

B. G.E. can handle intertemporal markets. Just think of good *k* at time *t* as a *different good* than *k* at time *t+1*. Instead of trading current goods, you can trade promises to deliver goods at any time.

C. Ex: I have an endowment of bananas in 2016 that I can trade just as if there were physical bananas in my hands.

D. More impressively, G.E. can handle an arbitrary level of uncertainty. Just think of good *k* if x happens to be a different good than *k* if not-x happens.

E. Ex: I have an endowment of bananas in 2016 *if* average temperature exceeded 80 degrees. I can trade this contingent claim just like I had some physical bananas right now.

1. Imagine taking an unconditional claim and ripping it into pieces, each of which specifies the conditions under which it pays off.

F. In both cases, the problem is isomorphic to the standard one, so all of the standard results go through.

G. Natural extension: Betting markets.

H. Particularly interesting: You can analyze contingent claims markets without specifically talking about time preference or probabilities.

VIII. Application: Intertemporal Consumption

A. Macroeconomists often analyze consumption over time. How can you move from individual (or small country) analysis to general equilibrium?

B. Once again, the trick is to find the prices that induce aggregate consumption to equal aggregate endowments. In intertemporal markets, such prices are usual known as interest rates.

C. So suppose the world is populated by identical infinitely-lived agents who maximize $\sum_{t=0}^{\infty} \beta^t \ln(c_t)$, and have a given endowment stream.

D. Standard result is that each individual sets $c_{t+1} = \beta(1+r)c_t$. If $\beta(1+r) < 1$, you consume less every period; if $\beta(1+r) > 1$, you consume more every period.

E. But what happens in general equilibrium? In general equilibrium, consumption must equal endowments in every period. Therefore, if endowments are constant and people have identical preferences, $(1+r) = 1/\beta$.

F. Similarly, if endowments are growing at a rate (1+*g*), people *want* to smooth consumption by borrowing against their future income. So interest rates in general equilibrium must rise high enough that people are content consuming their current endowment and no more. This happens when $(1+r) = (1+g)/\beta$. Expected growth raises interest rates today!

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Weeks 3-4: Intro to Game Theory

I. The Hard Case: When Strategy Matters
   A. You can go surprisingly far with general equilibrium theory, but ultimately many people find it unsatisfying. In the real world, people frequently stand in between the one-agent and the near-infinite-agent poles.
   B. Even when people start out in the near-infinite-agent case, they often ex post end up interacting with a few people.
      1. Ex: Marriage market
   C. Game theory tries to analyze situations where strategy does matter. It generally ends up with less determinate answers than GE, but is often arguably more realistic. ("I'd rather be vaguely right than clearly wrong.")

II. Extensive and Normal Forms
   A. Standard consumer choice provides the basic building blocks: game theory retains the standard assumption that people maximize utility functions. Slight change: Game theorists often talk about "payoffs" instead of utility. The concept is the same: Given a choice of payoffs, agents pick the largest.
      1. Payoffs are usually interpreted as von Neumann-Morgenstern utilities to sidestep issues of risk aversion.
   B. Any game can be represented in two different ways: *extensive* form and *normal* form.
   C. Extensive forms display every possible course of game events, turn by turn. They show how behavior branches out from "choice nodes," showing payoffs at the end of each branch as it ends. For this reason, extensive forms are often called "decision trees."
   D. Simple example: Your career game tree. At each node you can keep going to school, or get a job and get your payout.
   E. More interesting example: *The French Connection* subway game. Criminal decides whether to get on or off the subway; then Popeye decides whether to get on or off. From the first node, the tree spreads out into two branches; then each of those branches spreads out to two further branches; then the game ends. Payoffs for {Criminal, Popeye}: (on, on)=(0,10); (on, off)=(10,0); (off, on)=(10,0); (off,off)=(0,10).
   F. Complications:
      1. Nature as a random player.
      2. Information sets: simultaneous moves are equivalent to sequential moves with uncertainty.

3. If you learn something before you decide, node representing what is learned must precede node where decision is taken.

G. Normal forms (aka "strategic forms"), in contrast, display a complete grid of strategy profiles and payoffs. The grid has one dimension per player.

1. Important: Strategy profiles often contain irrelevant information about what you would have done in situations that did not in fact arise.

H. Normal form of your 1-player career game:

Drop out before H.S.	Finish H.S., stop	Finish B.A., stop	Finish Ph.D., stop	Finish 2 Ph.D.s, stop
10	15	20	30	0

I. Normal form of the *French Connection Game*:

	Popeye		
Criminal		On	Off
	On	0,10	10,0
	Off	10,0	0,10

J. Example from Kreps: Player 1 chooses A or D. If D, game ends. If A, then player 2 chooses α or δ. If δ, game ends. If α, player 1 chooses a or d, and either way, the game ends.

K. Normal form:

	α	δ
Aa	3,1	4,3
Ad	2,3	4,3
Da	1,2	1,2
Dd	1,2	1,2

L. Challenge: Write down the extensive form.

III. Strictly and Weakly Dominant Strategies

A. So what does game theory claim people do? It begins with some relatively weak assumptions, then gradually strengthens them until a plausible answer emerges.

B. Weakest assumption: People do not play strictly dominated strategies. If there is a strategy that is strictly worse for you *no matter what* your opponent does, you do not play it. If elimination of strictly dominated strategies leaves you with a single equilibrium, the game is *dominance solvable*.

C. Classic example: Prisoners' Dilemma.

D. If all players think this way, you can extend this idea to *successive strict dominance*. If your opponent would never play a strategy, you can cross out that row or column. This may in turn imply that some more of your strategies are strictly dominated, and so on.

1. Fun fact: Order of iteration does not matter.

E. A dominance solvable normal form from Kreps:

	t1	t2	t3
s1	4,3	2,7	0,4
s2	**5,5**	5,-1	-4,-2

F. Further refinement: If probabilistic combination of strategies strictly dominates another for any probability distribution, that too may be eliminated. Then this normal form from Kreps becomes dominance solvable:

	t1	t2	t3
s1	**4,10**	3,0	1,3
s2	0,0	2,10	10,3

G. It may happen that one strategy is sometimes strictly worse and never strictly better than another. Using the criterion of *weak dominance*, such strategies may also be eliminated. Unfortunately, with weak dominance, order of iteration may matter.

IV. Backwards Induction

A. In any game perfect information, each node marks the beginning of what can be seen as *another* game of perfect information.

B. Question: What happens if we apply the procedure of "backwards induction," i.e., repeatedly apply strict dominance to these "subgames"?

C. Intuition: Systematically reason "If we get to this point in the game, no one would even do such-and-such, so we can erase that part of the tree."

D. Modest Answer: We can eliminate more possibilities than before.

1. Consider extensive and normal forms from Kreps **(Figure 12.5)**.

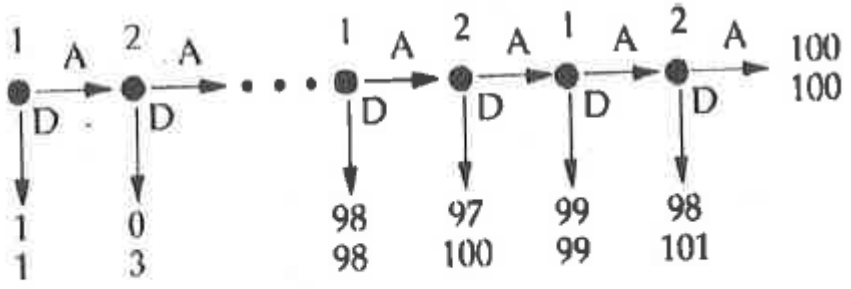

Figure 12.6. Rosenthal's centipede game.

E. Immodest Answer: Any finite game of complete and perfect information without ties becomes dominance solvable.

1. Chess example

F. Ex: The Centipede game **(Figure 12.6)**

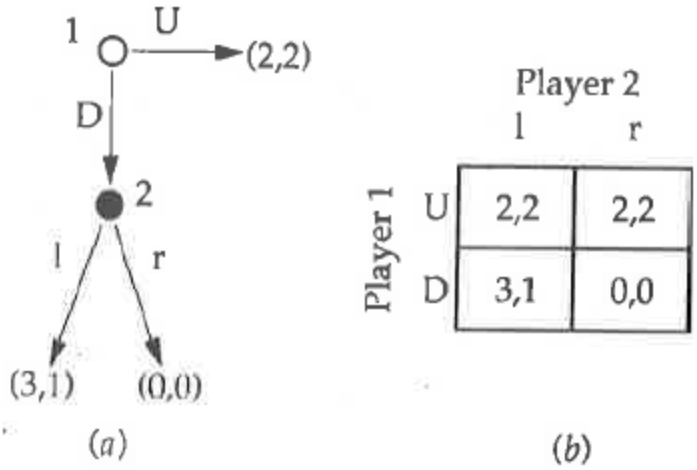

Figure 12.5. A simple extensive form game and its normal form counterpart.

V. Pure Strategy Nash Equilibrium

A. You can only get so far with strict dominance-type reasoning. Backwards induction seems impressive at first, but it only works for finite games of perfect and complete information. Very few interesting situations fit that description.

B. This leads us to a very different equilibrium concept, the *pure strategy Nash equilibrium*. A set of player strategies is a PSNE if and only if NO player could do *strictly* better by changing strategies, **holding all other players' strategies fixed**.

1. Imagine asking players *one-by-one* if they would like to do something different. If ALL of them answer **no**, you have a PSNE.
2. From the definition, it should be obvious that a game can have multiple PSNE or zero PSNE.

C. Example #1. Find the PSNE. How does this differ from strict dominance?

		Player 2	
Player 1		Left	Right
	Up	15,10	**8,15**
	Down	10,7	6,8

D. Example #2: Find the PSNE. How does this differ from strict dominance?

		Player 2	
Player 1		Left	Right
	Up	10,10	**0,15**
	Down	**15,0**	-5,-5

E. Example #3: Note the absence of any PSNE.

		Player 2	
Player 1		Left	Right
	Up	10,0	0,10
	Down	0,10	10,0

F. The PSNE concept is probably the most used in game theory and modern economics generally. It is somewhat paradoxical, however, because it seems to assume away strategic interaction, precisely what game theory was intended to address! A more strategic player might think "I'm not going to switch just because I would be better off holding my opponent's action constant. Maybe he'll *respond* in a way that makes me wish I hadn't changed in the first place."

VI. Mixed Strategy Nash Equilibrium

A. Talking about "pure strategy" NE strongly suggests a contrasting concept of "mixed strategy" NE. Instead of just asking whether any player has an incentive to change strategies, you could ask whether any player has an incentive to change his *probability* of playing various strategies.

B. How do you solve for MSNE? Each player has to play a mixture that leaves *all other* players indifferent.

C. Ex: Return to the game where:

		Player 2	
Player 1		Left	Right
	Up	8,10	1,15
	Down	12,0	-9,-5

D. When is player 2 indifferent between playing Left and playing Right? Let player 1's probability of playing Up be σ, and Down be (1-σ). Then player 2 is indifferent so long as: $10\sigma + 0(1-\sigma) = 15\sigma - 5(1-\sigma)$, which simplifies to: σ=.5.

E. When is player 1 indifferent between playing Up and playing Down? Let player 2's probability of playing Left be φ, and Right be (1-φ). Then player 1 is indifferent so long as: $8\varphi + 1(1-\varphi) = 12\varphi - 9(1-\varphi)$, which simplifies to φ=5/7.

F. So there is a MSNE of (σ,φ)=(.5, 5/7). When player 1 plays Up with probability .5, and player 2 players Left with probability 5/7, neither could do better by changing their mix. (They wouldn't do worse either, admittedly!).

G. Many people find the MSNE bizarre, but I maintain the opposite. The MSNE concept brilliantly accommodates the strategic complexity of real-world small-numbers interaction. Think of it this way: You make your opponents indifferent in order to *eliminate behavioral patterns they could exploit.*

1. Ex: Sports. You don't do the same thing all of the time because opponents will notice the pattern and play the most effective response. A predictable player is easy to beat. In

racquetball, for example, you play a mix of hard and soft serves, aiming at different locations on the court.

2. Ex: Strategy games. If you always attack the same place, your opponent will put all of his defensive strength there. In Diplomacy, for example, you randomize your attacks because a fully anticipated attack is easy to repel.
3. Ex: Rock, Paper, Scissors. You randomize to avoid being a sucker. Of course, if you play against someone who doesn't randomize, you don't want to randomize either; but maybe they are just tricking you into *thinking* they don't randomize!
4. Ex: Bargaining. If you are a hard bargainer, you get better but fewer deals. If you are a soft bargainer, you get worse but more deals. Which strategy works better? Neither!

H. MSNE cuts the Gordian knot of unlimited second-guessing, third-guessing, etc. All of these layers of thought can be reinterpreted as a randomizing device.

I. Solve the *French Connection* game. (Note the parallels to the Austrians' Sherlock Holmes example).

VII. Subgame Perfection

A. Suppose I threaten to fail any student who leaves early from any class. If you believe my threat, you will not leave early, and I will never have to impose my threat. This sounds like a Nash equilibrium - since I get what I want at no cost to me, and you prefer sitting in class to failing, neither wants to change.

B. But this sounds like an implausible prediction, because I probably would not want to carry out that threat. There would be a big fight, I would have to explain myself to the chairman, the dean, etc. How can a threat I would never carry out change your behavior?

C. In general terms, this is known as the problem of "out of equilibrium" play. I can optimally choose bizarre behavior in situations that I know will never happen. But knowing what I *would* do in situations that will never happen can affect your actual behavior in situations that routinely happen!

D. This gives rise to the Nash refinement of *subgame perfection*. Subgame perfection, in essence, requires Nash play in every subgame of a game.

E. To check for subgame perfection, you apply backwards induction as far as you are able. Thus in games of perfect and complete information, the result you get from backwards induction is always subgame perfect.

F. Standard example: Entry game. The two PSNE are (In, Accommodate) and (Out, Fight). But only the first is subgame perfect.

G. In games of imperfect information, though, you have to switch from strict dominance to Nash.

VIII. Prisoners' Dilemma

A. Surely the most analyzed game in economics is the Prisoners' Dilemma. Standard representation:

		Player 2	
		Coop	Don't
Player 1	Coop	5,5	0,6
	Don't	6,0	**1,1**

B. Natural solution concept: Strict dominance. Player 1 is better off not cooperating no matter what Player 2 does. Player 2 is better off not cooperating no matter what Player 1 does. So neither cooperates.

C. The Prisoners' Dilemma has many applications: public goods and externalities, collusion, voting, revolution... Others?

D. There is a lot of experimental literature on the PD. The extreme prediction is rarely borne out (people will cooperate even when defection is strictly dominant). But people do "leave money on the table," and there are a number of standard ways to reduce cooperation levels.

E. Moreover, no experiment that I know of has people play for, say, a year. I would strongly expect large-N, long-term play to closely match the game theoretic prediction.

IX. Coordination Games

A. Another game with a high profile in both theoretical and policy discussions is the Coordination game. Standard representation:

		Player 2	
		Left	Right
Player 1	Left	**3,3**	0,0
	Right	0,0	**5,5**

B. Natural solution concept: PSNE. If Player 1 plays Left, Player 2 is better off playing Left. If Player 1 plays Right, Player 2 is better off playing Right. And vice versa.

C. Coordination games underlie the whole path-dependence literature. Main idea: It is *possible* for people to be "locked-in" to Pareto inferior equilibria. (Of course, mere possibility is hardly proof!)

D. Problems like this naturally lead us to the notion of focal or "Schelling" points. Some coordination equilibrium are in some sense more obvious than others.

1. The classic NYC meeting example.

E. What would it take to actually get people into the Pareto-inferior NE? Most plausibly, at least a moderate number of players and gradual information dispersion.

F. Experimental evidence? Not too surprising.

X. Ultimatum Games

A. The Ultimatum Game is another game that has received a lot of academic attention. Standard set-up: Player 1 proposes one way to divide $10 between himself and Player 2. Player 2 accepts or

rejects the division. If he accepts, they get Player 1's proposal; if he rejects, they both get 0.

		Player 2	
Player 1		Accept	Reject
	t	(10-*t*),*t*	0,0

B. Natural solution concept: Subgame perfection. Player 2 will accept any amount greater than 0, so Player 1 offers $.01 and takes $9.99 for himself.

C. Experimentally, no one does this. Even splits are common, and people often reject "ungenerous" offers.

D. Is this motivated purely by spite? Parallel Dictator game proves otherwise.

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Week 5: Repeated Games, Competition, and Cooperation, I

I. Finitely-Repeated Games
   A. We frequently play with the same people over and over again.
   B. Question: If players condition their behavior in one game on your behavior in previous games, what happens?
   C. Answer: More equilibria may be sustainable.
   D. There are two main cases to consider: finitely-repeated games and infinitely-repeated games.
      1. Note: Games that *probabilistically* end, with no fixed upper bound to number of games, count as infinitely-repeated.
   E. Suppose two players first play a PD game, then a Coordination game, using last week's payoffs.
   F. Note: The "independent" equilibria of the two games remain equilibria.
   G. But a Pareto-superior outcome now becomes possible. Suppose that each player plays Left in the second game if either player failed to Cooperate in the first game, and Right otherwise. Then both players play Cooperate, Right, and this is a NE!
   H. How is this possible? If a player fails to Cooperate in the first game, he gets 6, but then only earns 3 in the second game, for a total payoff of 9. But equilibrium play has a payoff of 10.
   I. What happens if you reverse the order of the two games?

II. The Paradox of Backwards Induction
   A. Thus, even in finitely-repeated games, the set of Nash equilibria expands. But it expands much less than you would think.
   B. How so? Suppose two players play the PD game a hundred times. Couldn't they sustain Cooperation by threatening retaliation?
   C. No. In the last turn, both players will defect. Since they both defect in the last turn no matter what, *threatening* to defect if your opponent fails to cooperate in the *second-to-last* game is no deterrent at all. So people fail to cooperate then, too,
   D. Pushing this logic backwards all of the way to the first turn, cooperative play completely "unravels."
   E. How does this differ from the previous example? That combined a dominance-solvable game with a game with *two* Nash equilibria. So even in the last turn, a sort of "revenge" is possible. Not so if all of the games in the series are dominance solvable.
   F. Aside: In reality, of course, experiments confirm that people *do* cooperate in finitely-repeated games to a greater extent than 1-shot games. Some attempts have been made to theoretically model

this. Most are based on the premise that players assign a small probability of irrationality to their opponent.

III. Infinitely-Repeated Games

A. Few games literally last forever, but many games always have a *chance* to continue. As long as they have that chance, game theorists call them "infinitely repeated."

B. With infinite repetition, the previous unraveling logic no longer holds, making more equilibria sustainable. Now, the intuition of retaliation works.

C. Simple example: Repeated PDs. Suppose we both make the most extreme possible threat (aka "trigger strategy"): If you cheat me once, I'll **never** cooperate with you again. Suppose further that we both discount the future by β. (Alternately, that the game continues each turn with probability β). Is this a NE?

D. If you cooperate, you get $\sum_{t=0}^{\infty} \beta^t 5$. Recalling the formulae for infinite sums, this adds up to $\frac{5}{1-\beta}$.

E. If you defect, you get 6 immediately, but then only 1 forever afterwards. Mathematically: $6 + \sum_{t=1}^{\infty} \beta^t$, which adds up to: $6 + \frac{\beta}{1-\beta}$.

F. To check to see whether this is a NE, then, we see whether the Nash payoff weakly exceeds the defection payoff. Is $\frac{5}{1-\beta} \geq 6 + \frac{\beta}{1-\beta}$? It is, so long as $\beta \geq 1/5$.

1. Note: Without discounting, repeated games are a no-brainer. No finite gain from cheating would ever be worth infinite punishment.

G. Are other equilibria sustainable? Of course. You might not cooperate at all. You might only punish for one period, then return to cooperation. Intuition: The weaker the punishment, the higher β must be to make cooperation sustainable ($\beta \geq 1/4$ in the latter case).

H. The Folk Theorem shows that if cooperation is sustainable at all, there will normally be an infinite number of equilibria.

I. So what actually happens out of the endless possibilities? As in Coordination games, focal points probably matter a great deal, but are hard to formally model.

IV. Reputation

A. Economists frequently invoke reputation to explain seemingly money-losing behavior. Does this make sense?

B. Yes. The logic of repeated play often works even if there is some one-shot interaction. Suppose, for example, that a store owner decides to cheat or not cheat a customer, and one-time customers decide whether to buy or not.

	Buy	Don't
Cheat	10,-2	0,0
Don't	5,2	0,0

C. Using weak dominance, the store owner always cheats, so the customer never buys.

D. But suppose that customers know whether the store has cheated in the past, so they can play (Buy if no past Cheating, Don't otherwise).

E. Is this a NE? It is if $\frac{5}{1-\beta} \geq 10$.

F. The applications of reputational models are endless. Most obviously, reputation is the market alternative to regulation of product quality and the like.

1. Question: How does ease of detection affect reputational incentives?

G. Reputation probably matters for prices as well as quality. Stores may keep prices below daily profit-maximizing levels because they want a reputation for low prices.

H. Intuitively, we usually think that reputational incentives lead to Pareto superior outcomes. But reputational incentives could actually lead in the opposite direction. Outlaws might try to develop reputations for ferocity, or dictators for brutality.

I. How can the standard intuition be rationalized? Add on free entry and exit. Then people with bad reputations earn no advantage because they have no one to interact with.

1. The Tullock PD-with-partner-selection experiment.

V. Monopoly and Contestability

A. You have all seen the standard monopoly model. The monopolist maximizes PQ-TC, and sets MR=MC.

B. Does this make sense in game theoretic terms? Sure, this is *an* equilibrium. But there is also an equilibrium where consumers refuse to buy anything if P>MC, so the monopolist sets P=MC. And of course there are many other equilibria.

1. Question: What extra assumptions and/or solution concept underlie the standard account?

C. Still, the standard account intuitively seems right as far as it goes. The main problem is that it neglects *potential* competition.

D. Contestability models offer one of the most appealing ways to analyze potential competition. Basic setup: An incumbent firm sets its price. Then a potential entrant decides whether to enter and, if so, at what price. Consumers buy from the lower-priced firm.

E. Suppose TC=bQ. Then if P_i>b, the entrant enters and charges P_e= P_i -ε, leaving the incumbent with 0 profits. The only NE is where the incumbent charges P_i=b and the entrant stays out.

F. What if the entrant has higher costs than the incumbent? Then the incumbent prices just below the entrant's costs.

G. What if there are *fixed* costs, so TC=a+bQ? Then P=b is no longer an equilibrium, because that implies profits of -a<0. In that case, the incumbent prices at AC instead of MC.

H. What if there is a *sunk* cost of a, followed by pricing decisions? Then the first-mover acts like a monopolist, since if entry occurs, both firms will compete price down to b, and both lose money.

I. What about *simultaneous* decisions to incur sunk costs? Analyze the following normal form.

	In	Out
In	-a, -a	Π^m,0
Out	0, Π^m	0,0

VI. Allocative versus Productive Inefficiency

A. Most micro texts focus on the allocative inefficiency of monopoly.

A. Main intuition: Landsburg on "Why Taxes Are Bad." Units consumers buy anyway involve only a transfer; units that are no longer bought involve a deadweight loss.

B. Allocative inefficiencies are normally quite tiny, however, because they arise only on the marginal units, or DW loss "triangle."

C. Far less discussed: productive inefficiency. A situation is productively inefficient iff the AC of producing a given quantity is above the minimum AC.

D. Productive inefficiencies can easily be large, because they exist on ALL units produced, yielding a whole DW loss trapezoid.

E. With contestable monopoly and unequal costs, some allocative inefficiency persists, but no productive inefficiency.

F. In contrast, imagine an inefficient monopoly with a price cap at P=MC. There is no allocative inefficiency, but still productive inefficiency.

G. Government-created monopolies versus market monopolies: Both allow for allocative inefficiency, but the former have a strong potential for productive inefficiency as well.

VII. Predation, Entry Deterrence, and Mixed Strategies

A. "Predation" means many things to many people. What insight can game theory shed here?

B. Simplest model of predation: limit pricing. There are many potential producers with varying costs. The lowest-cost producer prices just below the costs of the second-lowest-cost producer, winning the whole market.

1. This probably happens frequently, with or without "predatory intent."

C. More interesting model: Incumbent prices high if no entry, low if entry; entrant decides whether to enter.

D. As discussed earlier, there are two NE: (Out, Fight) and (In, Accommodate). But (Out, Fight) is not subgame perfect. Once the entry happens, the incumbent is better off accommodating. The

threat to predate is not credible; the incumbent would be "cutting off his nose to spite his face."

1. Less formal literature emphasizes that predation is *especially* costly to the incumbent; the game theoretic point is simply that even if predation is cheap, it is more expensive than accommodation.

E. What if predation game is infinitely repeated? Then predation is potentially sustainable. It all depends on the short-term cost of predation versus the long-run monopoly profits. (Here the standard arguments come into their own).

F. Big question about predation: Why can't "two play at that game"? In other words, why can't entrants predate against incumbents just as well as incumbents predate against entrants?

G. Natural solution: Mixed strategy. Returning to the previous normal form, note that in addition to the two PSNE, there is also a MSNE. Potential monopoly profits balance out potential losses of "destructive competition."

H. I maintain that the MS solution makes a lot more sense. There is no way to credibly commit to be In no matter what. The bigger the conditional benefit of being a monopoly, the more willing firms will be to *try* to win monopoly status.

VIII. Bertrand and Cournot Competition

A. The previous arguments rely heavily on what is known as Bertrand competition (and, to some degree, constant MC). Firms propose prices; all customers buy from the firm that offers the lowest price, and randomize between equal prices.

B. In equilibrium, the most (productively) efficient firm takes the whole market, and charges just below the price of the second-most efficient firm. P=MC if at least two firms can produce in the most productively efficient way.

C. Bertrand competition strongly undermines the perfectly competitive benchmark. It shows that you can get perfectly competitive outcomes with just TWO firms.

D. Perhaps because of this result, many economists prefer the Cournot model of oligopoly. Cournot assumed that firms set quantities rather than prices. The price then independently adjusts to clear the market.

E. Formally, define Q as the sum of all N firms' q's, suppose P=a-bQ, and firms' MC=0. Bertrand competition predicts a price of 0 for all N. What does Cournot predict?

F. Each firm maximizes Pq_i-MCq_i=$\left(a - b\left[q_i + \sum_{j \neq i} q_j \right] \right) q_i$. So they set: $a - 2bq_i - b\sum_{j \neq i} q_j = 0$, which gives the optimal response of firm *i* given the behavior of all the other firms.

G. Natural solution: Look for the *symmetric* NE, where all firms produce the same q. Then $a - b(N+1)q = 0$, so $q = \frac{a}{b(N+1)}$, and $Q = \frac{aN}{b(N+1)}$.

H. Now Q goes to the perfectly competition level a/b as N goes to infinity. Q falls as N falls even though each firm thinks only of itself and makes no effort to collude.

I. Big weakness of Cournot: Firms would want to split! Under these assumptions, an infinite N would arise endogenously.

J. If you add a fixed cost for each firm, it can also be proven that Cournot competition with free entry is not even second-best. Imposing a zero-profit condition implies an inefficiently large number of firms.

K. Once again, though, if one firm could credibly commit to expand its output and take over the whole market, you would reach the second-best (P=AC) outcome.

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Week 6: Repeated Games, Competition, and Cooperation, II

I. Bertrand and Cournot Collusion

A. Assuming at least two firms can produce at the minimum MC, the one-shot Bertrand game (as well as the finitely-repeated Bertrand game) has a simple solution: P=MC for all N.

B. In the infinitely repeated Bertrand game, more equilibria are sustainable. What about a perfectly collusive outcome, where each firm produces a 1/N share of the monopoly level of output?

C. As usual, the "trigger strategy" tells us the highest sustainable level of collusion. If one defection leads to a permanent end of collusion, collusive is sustainable so long as a 1/N share of the monopoly profits forever is valued more than 100% of the monopoly profits once, followed by 0 profits thereafter.

D. Formally, the condition is $\frac{1}{N}\sum_{t=0}^{\infty}\beta^t\Pi_m \geq \Pi_m$. Simplifying: $\beta \geq \frac{N-1}{N}$. The more firms there are, the more each must care about the future for collusion to work.

E. What about Cournot collusion enforced by "Nash reversion" trigger strategies? There are two big differences:

1. Punishments cannot drive profits below the non-cooperative stage game profits. (Makes collusion harder)
2. The defector does not take the whole market. (Makes collusion easier).

F. Formally, the condition is $\frac{1}{N}\sum_{t=0}^{\infty}\beta^t\Pi_m \geq \Pi_d + \sum_{t=1}^{\infty}\beta^t\Pi_c$, where Π_d indicates defection profits and Π_c indicates ordinary Cournot profits. Using last week's functional forms: $\Pi_m=a^2/4b$ and $\Pi_c=a^2/b(N+1)^2$. But how do you calculate Π_d?

G. Answer: The collusive/monopoly output level is a/2b. So if all firms other than yourself produce the collusive output level, you simply play your best response to $\frac{N-1}{N}\frac{a}{2b}$. Thus, you maximize $\left(a - b\left[q_i + \frac{N-1}{N}\frac{a}{2b}\right]\right)q_i$.

H. Differentiating and simplifying: $q_i = \frac{a(N+1)}{4bN}$. Then $Q = \frac{a(N+1)}{4bN} + \frac{N-1}{N}\frac{a}{2b} = \frac{a(3N-1)}{4bN}$ and $P = \frac{a(N+1)}{4N}$.

I. Therefore Π_d=Pq= $\frac{a^2(N+1)^2}{16bN^2}$.

J. Collusion is therefore sustainable so long as:

$$\frac{1}{N(1-\beta)}\frac{a^2}{4b} \geq \frac{a^2(N+1)^2}{16bN^2} + \frac{\beta}{1-\beta}\frac{a^2}{b(N+1)^2}.$$

K. Solving for β, we learn that

$$\beta \geq \left[\frac{(N+1)^2}{16N^2} - \frac{1}{(N+1)^2}\right]^{-1}\left[\frac{(N+1)^2}{16N^2} - \frac{1}{4N}\right].$$

L. If N=2, for example, β*=.53.

M. Remember that these examples abstract from a great many problems with collusion - especially new entry.

II. Public Goods and Game Theory

A. I assume you are all familiar with the concepts of public goods and externalities. While many treatments also emphasize non-rivalry, non-excludability is the key.

A. The basic logic of selfishness:

1. There is no feasible way to exclude non-payers.
2. Since you do not *have to* pay to use it, selfish people *will not* pay to use it.
3. And if no one will pay for it, why would selfish producers provide it?

B. Diagramming external costs and benefits.

C. People often use "public goods/bads" and "positive/negative externalities" almost interchangeably. In practice, people tend to call something a public good if private benefits are near-zero, and a public bad if the social benefits are near-zero.

D. It has often been observed that collusion is a public good vis-a-vis the firms in an industry. All firms in the industry would be better off if they all raised prices, but holding the behavior of all other firms fixed, no firm wants to participate.

E. This suggests that provision of public goods can be analyzed using the tools we have already developed for competition and collusion.

F. For starters, we can analyze voluntary donations as a Cournot game. Suppose that individual utility depends on total contributions times personal consumption: $U_i=c_iD$, where D is the sum of all donations d_i, and c_i+d_i cannot exceed the initial endowment of 1.

G. Looking for the symmetric equilibrium, we learn that c=N/(N+1), whereas utility maximizing c=.5 for all N. Intuitively, as the number of individuals rises, contribution to public goods declines.

1. How come no one contributes to public goods in perfectly competitive settings?

H. This is of course the non-cooperative result. In a repeated game, punishment may sustain higher levels of donation, perhaps even

optimal ones. But this requires higher and higher discount levels as the number of players increases.

III. Coase Revisited

A. Coase ("The Problem of Social Cost") famously argued that public goods and externalities problems really boil down to transactions costs problems. With zero transactions costs, people would simply write a contract to get to the cooperative solution.

B. This gives another reason to suspect that degree cooperation declines in N. As the number of transactors rise, presumably so do transactions costs.

C. Still, enforceable contracts allow for cooperation when even trigger strategies are inadequate.

D. In experimental settings, cooperation seems greater than either repeated play or Coase would allow. Presumably this shows that at least some of the time human beings are less selfish than economists assume.

E. Insofar as cooperation arises out of desire to do good, socially harmful collusion seems likely to be less prevalent than socially beneficial cooperation, a point I build on in a paper with Stringham in the RAE.

IV. More on Coordination

A. Recall the simple coordination game:

		Player 2	
Player 1		Left	Right
	Left	**3,3**	0,0
	Right	0,0	**5,5**

B. In addition to the PSNE discussed earlier, note that there is also a MSNE. However, the MSNE is unstable. If you slip a little bit above or below it, you unravel to an end point.

C. There are many nice applications of Coordination games:

1. Language
2. Culture
3. Technology
4. Location

D. Under the guise of "path dependence," a number of economists have pointed to various forms of inefficient technology lock-in. QWERTY is the classic example.

E. Remember, however, that inefficient lock-in is merely *possible*. Another possibility is that the status quo is really fine and complaints are "special pleading." Still another possibility, plausible in the case of language, is that while we would be better off if a different language had been chosen long ago, it is not worth changing now.

F. The QWERTY example has been ably debunked in several papers by Margolis and Liebowitz.

G. Coordination problems seem particularly unlikely when the number of players is small, or if there are focal market leaders. Imagine what regulations would have developed if there were dozens of incompatible operating systems!

V. Bargaining

A. Consider this simple model of bargaining:

		Player 2	
		Hard	Soft
Player 1	Hard	0,0	5,1
	Soft	1,5	4,4

B. There are two PSNE, but it is the MSNE (.5,.5) that is really interesting. Note further that this MSNE *is* stable. If 51% of players bargain Hard, your payoff will be higher if you switch your strategy to Soft.

C. Intuition: In equilibrium, both strategies are equally good. As Landsburg says, "Don't mistake a *hard* bargainer for a *good* bargainer."

D. Outcome: Not first-best, but the worst outcome only occurs if both sides happen to play Hard (which happens only 25% of the time). As the bad outcome gets worse, fewer and fewer people take the risk of bargaining Hard (though the probability has to remain strictly positive).

E. Of course, people would like you to *think* they will play Hard. But since everyone wants to be perceived as a Hard bargainer, it is hard to convince anyone that you intend to play Hard.

F. This provides a simple explanation for why people sometimes "stupidly" fail to reach agreement. It could just be bad luck - two Hard bargainers happened to deal with each other.

VI. War and Peace

A. The above bargaining game is better known as the Chicken game or the Hawk/Dove game. It also provides some interesting insight into war and peace (not to mention animal behavior!).

		Player 2	
		War	Peace
Player 1	War	-10,-10	5,1
	Peace	1,5	4,4

B. Intuition: Universal peace may be mutually beneficial, but it may be unstable. If all countries are peace-loving, there is an incentive for one country to switch to aggressive bullying.

C. The more horrible warfare is, the less likely any country is to be aggressive, making it very unlikely that TWO countries will be aggressive.

D. Once again, this provides an alternative interpretation of the occurence of wars. The problem may be bad luck (both sides happened to play aggressively) rather than stupidity.

E. How does repeated play affect these results? Peace is certainly sustainable, but another possibility is that countries try to build up reputations for aggressiveness.

F. Hobbes and *Leviathan*: PD or Hawk/Dove game?

G. One reason why matters aren't worse: Territory/property. Suppose that people are more likely to fight if attacked on their *home territory*. This expectation makes the threat to fight if attacked more credible than the threat to fight if resisted.

VII. Rent-Seeking and Lobbying Inefficiency

H. We have already discussed allocative and productive inefficiency. A final form of inefficiency is known as lobbying or rent-seeking. inefficiency. It arises when people use resources to effect the transfer of other resources.

I. Simple example: grants of monopoly privilege. Firms pressure the government to become the sole legal producer. The more a firm spends, the better its chances.

J. This lobbying is a sort of "tug-of-war." Bigger prizes induce more effort to win the prize.

D. Gordon Tullock's deep insight: lobbying/rent-seeking is a competitive industry like any other. If lobbying earns a 10% rate of return, and the standard rate is 5%, this will induce "new entry" into the lobbying "business."

E. Note the analogy to mixed strategy reasoning: in equilibrium, the payoffs of production and redistribution must be equal.

F. Firms will keep entering this "arms race" until the *net profits* of the privilege are zero. This happens when the *total costs of lobbying equal the total value of the monopoly privilege*! This is known as "full rent dissipation."

1. Can you diagram the "Tullock rectangle"?

G. The government could award monopoly privileges by taking bids (or bribes) rather than listening to lobbyists. But then, Tullock pointed out, this intensifies *political* competition; if people can get rich in politics, they will pay more to win a seat.

H. This even works in a dictatorship or monarchy; if the dictator can get rich by awarding monopoly privileges, this strengthens the incentives of "upstarts" to try to seize the throne, stage a coup, etc.

I. Once again, repeat play could lead to a better equilibrium, but not necessarily. Firms might lobby extra hard in the hope of acquiring a reputation for toughness.

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Week 8: Symmetric Information

I. Expected Utility Theory
   A. How do people choose between gambles? In particular, what is the relationship between the value they put on having x with certainty versus having x with p<1?
   B. Simplest theory: Expected value maximization. People choose whatever option has the highest average monetary value.
      1. Ex: You will be indifferent between ($1000 with p=.01 and $1 with p=.99) and $10.99 with p=1.
   C. This is highly tractable, but also highly unsatisfactory. Would anyone here really prefer $1 billion with p=.001 to $1 million for sure?
   D. This suggests a richer theory of choice under uncertainty, known as *expected utility theory* (aka von Neumann-Morgenstern expected utility theory). Intuition: Instead of maximizing average wealth, let us suppose that people maximize expected utility.
   E. Three step procedure:
      1. Assign numerical weights to various outcomes.
      2. Linearly weight outcomes according to their probability.
      3. Choose whatever gamble has the highest linearly weight outcome.
   F. Example. Suppose I have utility of wealth given by $U=W^{.5}$. I can either have a 50% chance of $10,000 and a 50% chance of $0, or $2000 with certainty. So my expected utility of the first gamble is $.5*10{,}000^{.5}+.5*0^{.5}=50$; my expected utility of the second gamble is $1*2000^{.5}=44.72$. Given a choice, then, I would prefer the first option.
   G. Note: Simple utility functions are invariant to any monotonic transformation. Expected utility functions are not. (Aside: They *are* invariant to any affine transformation).
   H. Some implications:
      1. Compounding. Consumers are indifferent between a 50% chance of a 50% chance of x and a 25% chance of x.
      2. Linearity in probabilities. If you value a 1% chance of something at $10, you value a 100% chance at exactly $1000.
      3. This does NOT however mean that you value $1000 one hundred times at much as $10! It is only the probabilities that matter linearly.

II. Rational Expectations

A. As explained in week 1, there are two different interpretations of probability: objective and subjective.
B. Subjective probability is much more generally applicable than objective probability.
C. Problem: Subjective probabilities have no necessary connection to reality! This hardly seems satisfactory. There is clearly some connection between the real world and what people believe about it.
D. The leading theoretical effort to formalize the link between subjective probabilities and the real world is known as "rational expectations" or RE.
E. Simple characterization: A person has RE if judgments are *unbiased* (mean error is zero) and mistakes are uncorrelated with "available" information.
F. Deeper characterization: A person has RE if his subjective probability distribution is identical to the objective probability distribution.
G. Standard modeling technique: everyone is unbiased; information or lack thereof just changes estimates' *variance*.
H. RE in no way rules out error; it does not assume that information or cognition is free.
I. Example #1: Attending graduate school. No one knows for sure how they will do. But RE says that on average you correctly estimate how well you will do in the program and what completion will do for you.
J. Example #2: Renting a movie. Until you see it, there is no way to know for sure if you will like it. But RE says that on average your prospective ratings equal your retrospective ratings. The same goes for your rankings conditional on e.g. movie genre, stars, directors, etc.
K. Example #3: Wittman on pork barrel spending.

III. Application: Testing for RE of Economic Beliefs
A. RE made its first big splash in macro. In the 1970's, there were many empirical tests performed on e.g. inflation forecasts to check for RE.
B. How would you go about this? Try regressing inflation forecasts on a constant and actual inflation: $f = \alpha + \beta i$. RE implies that α=0 and β=1.
C. One particularly interesting area to me: RE of beliefs about economics. Most intro econ classes, it seems to me, try to correct students' pre-existing systematic misconceptions.
D. The Survey of Americans and Economists on the Economy asked economists and the general public identical questions about economics.
E. Natural test of RE: are the average beliefs of economists and the public identical? Run the regression $Belief = \alpha + \beta * Econ$, where

Econ is a dummy variable =1 for economists and 0 otherwise. Does β=0?

F. Of course, this only tests for the public's RE if economists themselves have RE! Many critics of the economics profession claim that it is the economists who are biased, either because of self-interest or ideology.

G. These claims are however testable using the SAEE. Simply re-run the regression $Belief = \alpha + \beta * Econ$ controlling for income, job security, ideology, etc, and see if β falls to 0. (It doesn't).

IV. Search Theory and Expectational Equilibria

M. The Arrow-Debreu interpretation of general equilibrium offers one way for economists to analyze economic uncertainty. But complete contingent claims markets do not seem very realistic.

N. Is there any other approach? Yes: there is an extremely general theory of economic action under uncertainty, known as "search theory."

O. Basic assumptions of search theory:
   1. More time and effort spent "searching" increase your probability of successful discovery.
   2. Searching ability differs between people.
   3. RE. (This can however be relaxed).

P. Main conclusion: People search so that the marginal cost of searching equals the <u>expected</u> marginal gain of searching.
   1. Qualification: You need to adjust for a searcher's degree of risk-aversion.

Q. The (endless) applications:
   1. Doing R&D.
   2. Hunting and fishing.
   3. Prospecting for gold.
   4. Looking for investment opportunities.
   5. Searching for a job.
   6. Dating.
   7. Rational amnesia.
   8. An economic theory of comedy.

R. What if people don't search much for a good price? Then sellers search for consumers.
   1. A tale of Istanbul.

S. Who is overpaid/underpaid? Look at who is investing more in search.
   1. Head-hunters vs. pavement-hitters.

T. Main conclusion: If the economics of perfect information doesn't make sense, try search theory. It explains almost everything else.

U. Some economists, especially Austrians, resist search theory. Why? As far as I can tell, it just comes back to objections to probability theory, especially claims that probability theory cannot capture "radical uncertainty" or something along those lines.

V. Measures of Risk-Aversion

A. The difference between expected value maximization and expected utility maximization boils down to taste for risk.

B. Suppose you choose between $x with p=1 and $x/q with p=q. Simplest taxonomy

1. If you are indifferent between the sure thing and the gamble, you are *risk-neutral*.
2. If you prefer the sure thing to the gamble, you are *risk-averse*.
3. If you prefer the gamble to the sure thing, you are *risk-preferring*.

C. Most economic models assume that actors are risk-averse (though *firms* are often modeled as risk-neutral).

D. Graphing: A risk-averse agent has a *concave* utility of wealth function. If you draw a line between any two points on the utility function, the utility function is always above that line. This indicates that a certain payoff of ax+(1-a)y is always preferred to the gamble (x with p=a, y with p=1-a).

E. Certainty equivalence: If you are indifferent between a gamble and x* with certainty, x* is that gamble's "certainty equivalent."

1. The risk premium, similarly, is the difference between a gamble's expected value and its certainty equivalent.

F. There are a number of different ways to quantify risk aversion. Probably the most common is with the *coefficient of absolute risk aversion*, which is equal to -u''/u'. The higher the coefficient, the more risk-averse you are.

G. Example: If $u=w^{.5}$, the coefficient of absolute risk aversion is $-\frac{-.25w^{-1.5}}{.5w^{-.5}} = .5w^{-1}$ In contrast, if u=w, the coefficient is $-\frac{0}{1} = 0$, indicating that the latter function is risk neutral.

H. Note that the coefficient of absolute risk aversion normally decreases with wealth. This captures the intuition that a millionaire worries less about betting $1 than someone on the edge of starvation.

VI. Demand for Insurance

A. A natural application of the preceding analysis is the demand for insurance.

B. Specifically, suppose a consumer with $EU=w^{.8}$ wants to insure his income, which is $1000 with probability .6 and $0 with probability .4. The insurance company offers *i* worth of insurance - which pays off if the client's uninsured income is $0 - at price .4*xi.* (If *x*=1, then the price is actuarially fair).

C. Then the consumer has an EU problem to solve, maximizing wrt *i.*:

$$\max_i .6(1000 - .4xi)^{.8} + .4(-.4xi + i)^{.8}$$

D. Simplify, differentiate and set equal to zero to solve:

$.6*.8*-.4x(1000-.4xi)^{-.2}+.4*.8*(1-.4x)((1-.4x)i)^{-.2}=0$

E. This simplifies to:

$(1000-.4xi)^{-.2}=\frac{5(1-.4x)}{3x}((1-.4x)i)^{-.2}$

F. Taking the -.2 root of both sides, defining $\theta=\left[\frac{5(1-.4x)}{3x}\right]^{-5}$. and solving: $i^*=\frac{1000}{\theta(1-.4x)+.4x}$

G. Interesting implications: If the insurance contract is actuarially fair, $\theta=1$, and *i**=$1000; consumers will fully insure. If the actuarially contract is less than fair, optimal *i**<$1000.

H. If the price of insurance is high enough, then even risk-averse agents want negative insurance.

VII. Efficiency Implications of Symmetric Imperfect Information

A. Many textbooks state that market outcomes are inefficient if there is "imperfect information." This is a gross over-statement. Market efficiency and imperfect information are often compatible.

B. This is particularly clear where there is *symmetric* imperfect information, where everyone is equally in the dark.

C. Suppose for example that I don't know how much I will enjoy my consumption bundle, so $U(x,y)=x^a y^{1-a}+\varepsilon$, where $\varepsilon \sim N(0,\sigma^2)$. My optimal decision is still to spend a*I on x and (1-a)*I on y.

D. Similarly, suppose I don't know my relative tastes for x and y, so $U(x,y)=x^a y^{1-a}$, where a=.5 with p=.6, and a=.9 with p=.4. Then I simply maximize $U(x,y)=.6[x^{.5}y^{.5}]+.4[x^{.9}y^{.1}]$.

E. General point: Just because you are ignorant does not mean you are stupid. If you are uncertain, you adopt more "general purpose" strategies that take account of all of the possible outcomes.

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Week 9: Asymmetric Information

I. Moral Hazard
   A. In the real world, everyone is not equally in the dark. In every situation, some people usually know more than others. Economists refer to this as *asymmetric information*. If information is not only imperfect but also asymmetric, inefficient outcomes *may* be the consequence.
   B. Simple case: moral hazard. It is efficient to insure risk-averse agents, but the insured normally knows more about the risks he undertakes than the insurer. Examples:
      1. Auto insurance
      2. Employment contracts (risk-averse workers want constant wage, but apply little effort without performance-based pay)
   C. Thus, once you insure a risk-averse agent, they may want to take additional risks. To cope with such opportunism, agents have to choose a mix of two sub-optimal outcomes:
      1. Less-than-full insurance
      2. Inefficient risk-taking
   D. Example: Insurance deductibles.
   E. Of course, you can often *infer* behavior from outcomes. If you can do so perfectly, then information asymmetries make little difference. But usually inferences from behavior to outcomes are less than perfect, so the moral hazard problem persists to some degree.
   F. Moral hazard is not, however, an efficiency problem if agents are risk-neutral. A risk-neutral CEO, for example, could simply buy all of the stock of his firm and become the sole proprietor. Then he would exert management effort if and only if the expected gain exceeded the expected effort cost.
   G. Furthermore, contractually arranged "punishments" may be able to mitigate or even eliminate moral hazard problems. In particular, if the less-informed can pay to observe the more-informed, then they can enforce good behavior at a low cost with random monitoring and threats of severe punishment.

II. Adverse Selection
   A. A more complex form of asymmetric information is known as adverse selection. Basic idea: You know your own characteristics, but others treat you based on the *average* characteristics of people who superficially resemble you.
   B. So if you are *above average*, you may decide that the market does not make participation worth your while. If enough above average people think this way, the whole market can "unravel"!

C. Simple example. Suppose that true company values are uniformly distributed from 0 to 100. Each company is worth 50% more in the hands of the buyer than it is in the hands of the seller. But sellers know their company's value, while buyers only know averages. What happens?

D. Suppose you, the buyer, bid 50. Then anyone whose company is worth between 0 and 50 sells. The average company sold, therefore, is worth 25*1.5=37.5 to you. You have to pay 50 to for an average payout of 37.5.

E. What happens in equilibrium? The market price falls to 0, and the whole market disappears.
   1. Note how different the outcome is with symmetric information.

F. Of course, the effect of adverse selection could be less severe. If the companies were worth twice at much to buyers as to sellers, there is no effect at all. If half the companies are worth 50 and half are worth 100, then the buyer offers 50, and half of the mutually beneficial potential deals work out.

G. The implications of adverse selection are often poorly understood. Take the used car market. The argument is *not* that asymmetric information allows car sellers to cheat or "take advantage of" car buyers. On average, buyers still benefit from whatever purchases they make. The efficiency problems stem from the exchanges that *don't* happen because buyers can't distinguish good cars from bad.

H. Adverse selection is probably economists' favorite argument for insurance regulation - most credibly, for regulations requiring everyone to buy insurance.

I. This is analogous in the previous example to forcing everyone to sell. Then buyers pay 50, sellers with value of 50 or less gain, and sellers with value of more than 50 lose. But the dollar losses of the last group will be much less than the dollar gains of the first two groups.

J. Economists rarely notice, however, that many insurance regulations are designed to make adverse selection worse! Many regulations specifically forbid insurers from conditioning premia on buyer characteristics. States often subsidize car insurance for reckless drivers, or force insurers to cover them at a loss. Medical insurers are often barred from denying coverage to customers with "pre-existing conditions."

K. A couple of recent empirical studies find little evidence of adverse selection. Two takes on this:
   1. Insurance companies actually know more about you than you do about yourself. They have the actuarial tables. You don't.
   2. More conscientious people both take fewer risks and are more likely to buy insurance.

3. A paper in the *Rand Journal* theoretically models "advantageous" (or "propitious") selection.

L. Free-market defense example.

III. Signaling, I

A. Some Puzzles

1. Why does non-job-related schooling still raise your income? ("What does this have to do with real life?")
2. Why won't people buy goods without a warrantee?
3. Why do you use nice paper on a job application?
4. Why do you (sometimes) have to wear a suit to work?
5. Why are wedding rings so expensive?
6. Why do countries have tons of weapons they never intend to use?
7. Why do male peacocks have such huge tails?

B. A popular way to resolve these paradoxes goes under the heading of "signaling." Basic assumptions:

C. Assumption #1: There are different "types" of people and firms: able and unable, smart and dumb, honest and dishonest, hard-working and lazy...

D. Assumption #2: It is difficult to observe "types" directly. (Asymmetric information).

E. Assumption #3: However: different types (may) have different costs (lower disutility) of performing the same *observable* activity.

1. Smart and hard-working people find it easier to do schoolwork.
2. Lazy people find it more costly to take extra effort with an application.
3. Honest firms find it cheap to provide warrantees.

F. Therefore: It may be in the interest of the type in higher demand to go to school, fill out an application with extra care, provide a warrantee, etc. - *even if the effort itself does NOTHING for buyer or seller!* People only want what the effort proves you already had in the first place.

IV. Signaling, II

A. Example. Suppose there are two kinds of workers, good and bad. Both types are equally numerous. Good workers are worth $100 k to me; bad workers are worth $25 k to me. It costs good workers $25 k to complete school, but $50 k for bad workers to do so. I can tell if a worker finished school, but cannot observe their quality directly. Workers can earn 50% of their value to me if they choose to be self-employed.

B. In any equilibrium:

1. I, the employer, must maximize profits.
2. Good workers must not want to look like bad workers.
3. Bad workers must not want to look like good workers.

C. What happens?

1. There are many obviously silly strategies, like paying all workers the same regardless of education.
2. In equilibrium, though, we should expect only good workers to be educated. So good workers have to be offered at least $75 k, and bad workers at least $12.5 k, or else they turn to self-employment.
3. But offering the lowest wages necessary to prevent self-employment can't be an equilibrium either, because at those wages, bad workers would want to be educated.
4. To deter them, I would have to raise uneducated wages up to $25 k. Can anyone propose a better strategy from my point of view than this one, where I make an average of $12.5 k per worker? If not, we have a NE.

D. Note the deadweight costs: Expected surplus per worker is $31.25 k, but realized surplus is only $18.75 k. The other $12.5 k is a deadweight cost of signaling.
1. Sometimes, though, a costless cash transfer - like a money-back guarantee - can be an effective signal. It is cheaper for an honest firm to give refunds than a dishonest firm.

E. Signaling models have been used to analyze a variety of real-world situations.
1. Education
2. Health care?
3. Funerals

F. Question: If signaling is a deadweight cost, could government action make matters more efficient?

G. Answer: Yes - government could *tax* the signal. Then everyone could get e.g. half as much education and still get the same job offers.

V. The Winner's Curse

A. Imagine there is a second-price auction with N participants. (In a second-price auction, the winner pays the bid of the second-highest bidder).

B. Every bidder has RE about the true value of the item being auctioned. Thus, each estimates its value at $V_i=V+\varepsilon_i$, where V is the true value and $\varepsilon_i \sim N(0,\sigma^2)$.

C. Since your estimate is unbiased, it seems sensible to simply bid your estimate. (Indeed, this seems like a weakly dominant strategy. Can you see why?)

D. In fact, though, this strategy is likely to be disastrous. Why? Even though the *average* estimation error equals 0, the average *winning* estimation error is positive. Conditional on winning, then, you can expect to have over-estimated the item's value.

E. This is known as the "winner's curse." The more serious your error, the more likely you are to win; if you win, you are likely to have made a serious error.

F. If the V_i's were all common knowledge, you could simply take the average to solve this problem.

G. Even when you only know your own V_i, however, there is an obvious solution: underbid! If the winner normally over-estimates the true value by 20%, bid only 80% of your estimate. Then if you win, you won't expect to be burned.

VI. Efficiency Implications of Asymmetric Imperfect Information

A. Symmetric imperfect information has no efficiency implications.

B. If all market agents are equally informed, but the government knows more, the government can simply *publicly reveal* what it knows. There is no need to do more.

C. Asymmetric information *sometimes* has efficiency implications, as we have seen.

D. Even when market outcomes are inefficient, government may be unable to improve matters.

1. Moral hazard

E. In many cases where government could improve matters, actual regulations do the opposite.

1. Limiting contractual punishment
2. Restricting risk-adjusted premiums
3. Subsidizing education

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Week 10: Behavioral Economics and Irrationality, I

I. The Behavioral Approach and Choice Theory
   A. Most economists never even think about empirically testing fundamental micro choice theory. Why?
   B. Elementary consumer theory almost seems true by definition.
   C. If however we assume that preferences are *stable* - as almost all economists do in empirical work - there are a lot of testable implications.
   D. Moreover, if we assume that preferences are selfish in the ordinary language sense of the word - another standard auxiliary assumption - there are a great many other testable implications.
   E. Once we move from basic consumer theory to expected utility theory, there are lots of testable implications.
   F. A rapidly expanding literature - often called "behavioral economics" - conducts precisely the empirical tests that most economists never think about running.
   G. The product of this literature is a long list of "anomalies" - robust evidence that people sometimes violate basic axioms of choice theory.
   H. These violations of choice theory are sometimes equated with "irrationality." Economists who earned their Ph.D.'s prior to the RE revolution are particularly likely to talk this way.
   I. Before surveying some of the main documented anomalies, it is worth pre-answering a few objections.
   J. Objection #1: "All theories are false. What matters is prediction."
      1. Reply: It is usually just as easy to provide evidence that the **predictions** of basic micro fail as it is to show that the assumptions are false.
   K. Objection #2: "Deviations cancel out."
      1. Reply: They don't! They are systematic.
   L. Objection #3: "Anomalies arise due to weak incentives."
      1. Reply: Stronger incentives often don't matter. And anomalies appear even in financial markets, where incentives would appear to be great.
   M. To some extent I will be playing devil's advocate. Most economists familiar with behavioral economics either dismiss it or see it as highly significant. I personally often take an intermediate position.

II. Preference Reversals
   A. For practical purposes, economists almost always assume that people have *constant* preferences over *outcomes*.

B. But behavioral economists have uncovered a number of what appear to be counter-examples. A single individual will prefer A to B or B to A for apparently irrelevant reasons. This is known as a "preference reversal."

C. Logically equivalent descriptions of the same choice problem elicit different choices: Doctors will select one form of surgery if you tell them it has a 90% chance of success, but make a different choice if you tell them it has a 10% chance of failure.

D. People sometimes select the choice they put less monetary value on: Given a choice of two bets (H: 8/9 chance of $4; L:1/9 chance of $40), most subjects choose H over L. But if they own the gamble and you want to buy it, most subjects demand more money to sell L than H.

E. Preference reversals have received an enormous amount of attention. But it is hard to me to see the real-world significance. True, if you aim to persuade others, you probably do better by saying "The glass is half full." But could you persuade a lot more people to play Russian roulette by saying "You have a 5/6 chance of surviving"?

F. Most preference reversal experiments focus on "close" choices. Could you induce a heavy metal fan to reverse his preference for Ozzy Osbourne over Bach? Even the choice of surgery may be fairly "close" - both routes look pretty bad, but the discrete structure of the problem masks this.

III. The Endowment Effect and Status Quo Bias

A. Another well-documented way that people deviate from basic choice theory is that their endowments somehow interact with their preferences.

B. Simplest anomaly: the endowment effect. People seem to put more value on objects merely because they are *their* objects. In a classic experiment, agents who were given a coffee cup had a markedly higher willingness to accept than willingness to pay. A few critics appealed to wealth effects, but that is a pretty lame objection.

C. Aside: This has some interesting implications for the Coase Theorem.

D. A more complex anomaly: status quo bias. People are somewhat reluctant to both buy AND sell. Alternatives become more popular purely by being designated as the status quo, even when transactions costs are negligible.

E. In the real world, it is easy to attribute apparent instances of the endowment effect and status quo bias to transactions costs or information costs. Usually the status quo option, for example, gets to be the status quo because most people prefer it that way. (Think toppings on a hamburger). And again, most experiments focus on

"close" choices. If you gave someone 100 coffee cups, I strongly suspect he would sell the vast majority without a premium.

IV. Selfishness and Cooperation
- A. While pure theorists rarely mention it, almost all real-world applications of economic theory assume that people are narrowly selfish.
  1. Slight variation: Inclusive fitness.
- B. Of course, perfectly selfish non-relatives can sustain cooperation through repeated play. So mere cooperation is hardly evidence against human selfishness.
- C. But: There is plenty of experimental evidence that people will cooperate even in one-shot games. Why? They care about strangers to some degree. (See General Zod in *Superman II*).
- D. Much of this evidence comes from public goods experiments. Even in one-shot games, agents contribute 40-60% of the socially optimal level.
- E. Cooperation declines with repeated play, but if you "re-start" a tournament with experienced players, cooperation initially jumps up again.
- F. There is plenty of extra-experimental evidence, too.
  1. Tipping
  2. Charity
  3. Voting
- G. Real-world significance? Clearly it is there to some degree. We offer and accept small favors from strangers all the time. We pass up and expect others to pass up small chances to take advantage. Still, people on average keep 98% of their income for themselves.

V. Fairness and Vindictiveness
- A. The opposite of selfishness is altruism - caring directly about the well-being of others. But empirically, interpersonal motivation seems richer than either.
- B. For one thing, treating other people better than selfishness recommends often seems to be motivated by concern for "fairness" rather than directly caring about others. We seem more concerned about how we treat people that we directly interact with, and pay more attention to whether we behaved "fairly" than the actual welfare of others.
- C. Thus, in ultimatum and dictator experiments, first-movers often offer splits with the second-mover, but rarely share their winnings with the next stranger they meet. Fairness suggests the first, but not the second.
- D. A second motive that operates in the ultimatum game, but not the dictator game, is "vindictiveness." Especially when we have been treated unfairly, we often put a *negative* weight on the welfare of another person.

E. Real-world significance? Again, it is easy to observe on some level. Even when there is no repeated interaction, we give up small personal benefits to do what fairness requires, and expect others to do the same. Prices and wages might be more volatile in the absence of fairness and vindictiveness motives. A few glaring shortages (concert tickets, for instance) would disappear. But how big is the overall effect?

VI. Preference Heterogeneity
- A. Many economists not only assume that preferences are constant over time; they also assume that they are identical across individuals. Stigler and Becker made this a standard methodological position, with the slogan "you can explain anything with preferences."
- B. There is ample empirical evidence, however, that this is simply not so. In my *JEBO* paper on personality and economics, I review a wealth of evidence from personality psychology indicating a high degree of preference heterogeneity.
- C. Methodological point: Preferences only "explain everything" if preferences are not independently measured.
- D. Applications.

VII. Expected Utility Anomalies
- A. Recall that expected utility theory puts definite restrictions on choice under uncertainty. Many of these have been experimentally falsified.
- B. People often seem risk-averse over utility, not just wealth.
- C. People often seem risk-averse relative to a "reference point." E.g., if a wealthy person plays a low-stakes game of poker, he is likely to play as if he had a large risk premium, even though he remains rich if he loses.
- D. Choice is not linear in probabilities, as EU theory predicts.
- E. The Allais paradox. Consider the following choices of gambles:
  1. $27,500 w/p=.33, $24,000 w/p=.66, $0 w/p=.01; $24,000 w/p=1.
  2. $27,500 w/p=.33, $0 w/p=.67; $24,000 w/p=.34, $0 w/p=.66.
- F. Most people take the second choice in the first case and the first choice in second case. EU theory says this is impossible. (Can you prove why?)

VIII. Loss Aversion and Prospect Theory
- A. One general lesson that behavioral economists attempt to draw from various findings is that people are "loss averse." In basic consumer theory, this makes no sense, because preferences and endowments are separate. The intuition behind "loss aversion," though, is that having something you currently possess taken from you is worse than never having had it at all.
- B. This insight gives rise to one of the major positive theoretical innovations of behavioral economics, known as "prospect theory."

Basic idea: replace EU w/risk aversion with an S-shaped curve that kinks at the current "reference point."

C. Such a curve indicates that people are risk-averse in gains but risk-seeking in losses. Given a choice of an extra $1000 or a gamble with the same expected value, they prefer the $1000. Given a choice of a loss of $1000 or a gamble with the same expected value, they prefer the gamble.

D. The simple version of prospect version raises as many problems as it solves. In particular, it seems to predict no one would want insurance against losses. In practice, almost all insurance works that way.

E. A more sophisticated version of prospect theory says that people are:
   1. Risk-averse in gains with high probabilities.
   2. Risk-seeking in gains with low probabilities.
   3. Risk-averse in losses with low probabilities.
   4. Risk-seeking in losses with high probabilities.

F. Many experts in behavioral economics find this highly illuminating, but obviously it has a lot of wiggle room: you can fiddle with the reference point as well as the cut-point between "high" and "low" probabilities.

IX. Intertemporal Anomalies

A. With perfect capital markets, basic micro says that everyone will discount future payments by the rate of interest. Even with imperfect capital markets, moreover, there are often definite predictions of intertemporal choice.

B. Behavioral economists have uncovered a variety of intertemporal anomalies. In many cases, consumers appear to have *negative* discount rates - choosing, for example, to be paid over 12 months rather than 9, or persistently receiving tax refunds.

C. In other cases, consumers appear to have discount rates far in excess of the interest rate. In buying major appliances, for example, they appear to put little weight on future energy cost savings.

D. Furthermore, consumers often appear to have different discount rates for gains versus losses.

E. Even more striking, discount rates often seem to vary with the total waiting time. They discount a benefit a year-and-a-day from now only slightly more than a benefit a year from now. But they discount a benefit tomorrow a great deal compared to a benefit today.

F. This implies "dynamic inconsistency." As time goes by, consumers actually regret previous decisions and want to change them.

G. It is natural to see this as a sort of "self-control" problem. A person may want to save for retirement, but face a constant urge to spend. Therefore, they might want to have money withheld from their

paycheck to overcome "temptation." Similarly, a person may want to lose weight, but at every particular moment they have an urge to eat. Therefore they might, for example, avoid having food in the house to avoid temptation.

H. It is widely assumed that the long-term plan is somehow better or more reflective of the agent's true preferences than the short-term plan, but is there any warrant for this assumption?

I. Many of these example are striking, but again, what do they mean in the real world? It hardly seems like there are abundant opportunities to loan money to people at 100% interest. And it is not at all clear that it would be worth my time at current interest rates if I investigated the energy efficiency of my appliances. It is somewhat interesting that people turn down free interest, but the dollar value does not seem that high.

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Week 11: Behavioral Economics and Irrationality, II

I. The Behavioral Approach and Belief Formation
   A. Last week we reviewed empirical evidence on choice theory. This week we pursue a parallel agenda on belief formation.
   B. Belief formation gets less attention than choice theory in basic micro, but nevertheless there are definite standard assumptions, and most work relies on these assumptions.
   C. Economists, especially those who earned their Ph.D.s after the RE revolution, frequently refer to the violation of these assumptions as "irrationality," as distinguish from ignorance. Intuitively, there are two quite different reasons you might make mistakes:
      1. Lack of information
      2. Irrationality/stupidity
   D. While the distinction is uncontroversial, in practice, economists are reluctant to blame errors on anything other than lack of information. However, claims about rationality are empirically testable.
   E. Weakest rationality assumption: Bayesianism. Even if you put no restrictions on agents' prior probabilities, there are testable empirical implications. Examples:
      1. $P(A\&B) \leq P(A)$.
      2. Bayes' Rule
   F. Stronger rationality assumption: RE. Almost all modern models explicitly rely on RE, and a great deal of earlier work implicitly relies on it. And RE has definite empirical implications:
      1. No systematic errors
      2. Errors uncorrelated with available info
   G. In what sense do earlier models implicitly rely on RE? Take a simple story about price controls. If suppliers systematically and persistently underestimate the price control, no shortage will arise. Suppliers will keep responding optimally to the market as they imagine it.
   H. A large empirical literature has uncovered a variety of deviations from not only RE, but elementary probability theory. Once again, I will partly be playing devil's advocate, but also indicating some reservations along the way.

II. Cognitive versus Motivational Biases
   A. Psychologists distinguish between two sorts of bias: cognitive and motivational.
   B. Motivational biases are biases where our *emotions* steer our intellectual faculties away from the sensible answer they would otherwise reach.

C. Cognitive biases are biases where our intellectual faculties give us mistaken answers in the absence of any emotional commitment.
D. Many psychologists - especially those who specialize in cognitive bias - maintain that *all* biases are, in fact, cognitive. These psychologists have been especially influential in economics.
E. As you might guess, other psychologists disagree. Their objections have received less attention from economists, but they have nevertheless had some influence.
F. People occasionally equate cognitive biases with "not sensitive to incentives" and motivational biases with "sensitive to incentives." But this is hardly clear. Incentives could work on diverse margins.

III. Belief Perseverance and Confirmatory Biases
A. The Bayesian framework is all about updating. Empirically, though, there are a number of experiments showing "belief perseverance." People stick with their initial view in spite of contrary evidence that comes to them.
B. What is particularly striking is that people can actually be more accurate with *less* information. Someone who views the complete history of a blurry image gradually coming into focus has more trouble identifying the image than another person who saw only the later part of the history.
C. Other experiments find an even stronger effect: Once people believe an hypothesis, they tend to grow *increasingly* confident. Why? They are more likely to notice confirming evidence, and to misinterpret ambiguous evidence as additional support. This is known as "confirmatory bias."
D. In one particularly interesting experiment on the death penalty, people were initially sorted into supporters and opponents. Both groups were shown the same evidence, and both groups became more confident in their judgments!
E. In more general terms, there is some evidence of systematic over-confidence. This can usually be found if you graph the probabilities that people assign to their beliefs against the fraction of those beliefs that are correct.
    1. However, people are more accurate when they give their average accuracy rate instead of rating their accuracy question-by-question.
F. Real world significance? The experiments demonstrate the existence of these problems, but what real-world mistakes can be attributed to them? Once you have a lot of evidence, it should take a lot of evidence to noticeably change your mind. And how often is it that people keep getting more and more certain of their views? There are few issues as emotional as the death penalty, so perhaps this evidence is not so impressive.

IV. Availability and Representativeness Biases

A. People often estimate probabilities according to the ease of thinking of examples. This is known as the "availability heuristic."
B. While this is sometimes a useful heuristic, it also predictably generates biased judgments. If examples of something are especially vivid or memorable, we tend to overestimate probabilities.
C. Example: Are there more words in the dictionary that (a) start with "a" or (b) have "i" as the third-to-last letter? It is easier to come up with examples of the former, and people normally conclude - falsely - that such words are more common. (Hint: How many words end in "ing"?)
D. Availability bias has often to used to explain why, e.g., people overestimate the risk of flying. Plane crashes are vivid and memorable, so people infer they are likely.
E. Another common technique for estimating probabilities is to compare particular cases to stereotypes, and go with the "better match." This is known as the "representativeness" heuristic.
    1. Example: Suppose someone asked you which was more likely: a Chinese professor teaches Chinese literature, or a Chinese professor teaches psychology. Your stereotype of Chinese literature professors is probably that they are almost all Chinese, while your stereotypical psych prof is not.
F. What is wrong with this? Oftentimes, nothing. However, many experiments have documented a tendency to ignore "base rates." If there are many more psych profs than Chinese lit profs, this must raise the probability that the Chinese prof is a psychologist. In practice, people often suffer from "representativeness bias," where they look only at the stereotype and ignore base rates.
G. Classic experiment: You walk into a joint engineer/psychologist convention. 70%[30%] of the attendees are engineers. You meet a guy with horn-rimmed glasses and a pocket protector. What is the probability he is an engineer?
    1. You generally get the same answer regardless of the whether the base rates are 70/30 or 30/70.
H. False positives. Suppose a medical test always detects an illness if it is present, but gives a false positive 5% of the time. One person in a thousand has the disease. What is the probability you have the disease conditional on testing positive? Our stereotypical sick person tests positive; our stereotypical well person does not. But the conditional probability of having the disease if you test positive is only 1.96%!
I. Real world significance?

V. Risk Misperceptions
A. The basic RE assumption is that actors' risk estimates are, on average, correct. A large empirical literature examines this question, and often concludes that this is not so.

B. A standard finding is that estimates of low-probability events are particularly biased. In particular, it seems as if people either:
   1. Treat low-probability events as if they had 0 probability.
   2. Or, treat low-probability events as if they were much more likely than they really are.

C. While advocates of paternalistic safety regulations often appeal to this literature, the policy link is tenuous. If you take this literature seriously and want to use policy to do something about it, you would obviously want to *reduce* the level of safety in a wide variety of areas.

VI. Systematically Biased Beliefs About Economics

A. Most intro econ classes try to correct students' pre-existing systematically biased beliefs about economics. Many famous historical economists operate from a similar perspective.

B. But almost all academic work in economics assumes that people's economic beliefs satisfy RE.

C. I have a series of empirical papers that examine this question. I find overwhelming evidence of systematic errors in the public's beliefs about the economy.

D. Data: The Survey of Americans and Economists on the Economy

E. Method: Estimating beliefs as a function of Econ dummy and control variables. RE says Econ dummies' coefficients should equal 0, at least after appropriate controls.

F. Why the controls? Many critics of the profession say it is the economists who are biased, not the public. Two main versions:
   1. Self-serving bias
   2. Ideological bias

G. Clusters of error:
   1. Anti-market bias
   2. Anti-foreign bias
   3. Make-work bias
   4. Pessimistic bias

H. Other findings: The public is heterogeneous. Neither income nor conservative ideology make people "think like economists," but the following do:
   1. Education
   2. Being male
   3. Job security
   4. Income growth

I. Real world implications? At least in my judgment, it is rather easy to link these biases to specific real-world outcomes. Most policies that economists think are foolish can be naturally linked to public's confused beliefs about economics.

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Week 12: Labor Economics

I. Human Capital Theory
   A. I assume you are all familiar with the calculation of present discounted values, or PDVs. Recall that the lower interest rates are, the more future benefits count.
   B. While PDVs are most-frequently calculated for businesses, the idea is completely general. You can calculate the PDV of adding insulation to your home.
   C. Similarly, you can calculate the PDV of attending school.
   D. This is the key intuition behind *human capital theory*. We can think about labor market decisions like any other investment.
   C. Ex: Should you get another year of school? Add up the PDV of your foregone earnings during school and the extra income you expect to get after you've completed the schooling.
      1. Note: Since you forego earnings first, and get a raise afterwards, education makes less and less sense as interest rates rise.
   D. What else can you do for your career, and how do you decide if they are good investments?
      1. Co-writing a paper with a faculty member
      2. Putting your cv on fancy paper
      3. A computer projector

II. The Return to Education
   A. An enormous empirical literature tries to estimate the return to education.
   B. Underlying motivation: Many economists see credit market imperfections as a serious problem, especially if there is no obvious collateral. An unusually high rate of return to education would confirm their suspicions.
   C. So how do you calculate the return to education? Basic estimates start with an assumption that makes analysis highly tractable: Foregone earnings are the ONLY cost of education.
   D. Then ignoring finite lifespan, a regression of log earnings on a constant and years of education gives you a rate of return estimate. Just look at the coefficient on education. A coefficient of .1 indicates that a year of education raises earnings by 10%. In other words, if you give up one year of income, you earn 10% extra every year thereafter - just like a consol.
   C. Using this approach on NLSY data, you get an estimated 12.6% real rate of return to education (controlling for no other factors).
   D. But this number is surely too high:

1. You do not reap the benefits of increased earnings forever. This is a slight effect, since the lost years are far in the future. Return drops to 12.56%
2. It costs resources to educate people. Counting these costs drastically reduces the rate of return. With annual tuition of $15,000, estimated return falls to 6.5%.
3. There is also a return to experience; you have the subtract this rate from the return to education to figure out how much extra you get if you go to school instead of work.
4. This is an estimate of the average, not the marginal rate of return. (The marginal rate would be lower. Can you explain why?)
5. The estimate tacitly assumes school completion probability is 100%, when it's actually far lower.
6. It does not control for intelligence, which is highly correlated with education.

III. Intelligence and Human Capital

A. We all have an intuitive notion of what is means to be "intelligent." Empirical research on intelligence is one of the best-developed areas of psychology.

B. In practical terms, researchers usually measure intelligence with IQ (Intelligence Quotient) or related tests. These tests have come under angry attack on a number of grounds. We'll briefly consider each in turn:
   1. Cultural bias
   2. "There is no one thing that constitutes 'intelligence.'"
   3. Imperfection

C. Complaint #1: "Cultural bias." There are large group differences in performance on IQ tests. Jews do about 1 SD better than average, blacks about 1 SD worse. Critics blame this on cultural bias - supposedly, the tests measure familiarity with middle-class lifestyles rather than ability. Unfortunately for this argument, it has been carefully tested and shown to be wrong. If you use IQ tests to predict performance on practical tasks – like ability to drive a tank through an obstacle course – IQ tests actually *over*state the performance of members of groups with low average IQs.

D. Complaint #2: "There is no one thing that constitutes 'intelligence.'" Everyone is good at some things and bad at others, or so the claim goes. Still, the fact is that for a wide range of mental problems, people who are good at some are usually (not always) good at all of them, and vice versa. Think about the SAT Verbal versus Math scores. There are some people who are great at Verbal and terrible at Math, but there are a lot more who are great at both or terrible at both.

E. Complaint #3: Imperfection. There are several varieties of this complaint. One is that the same person has received very different

test scores at different times. Another is that world-renowned geniuses (Feynman is a common example) got low IQ scores. All this may be true, but it's irrelevant. IQ scores are more reliable than anything else, and if you tested 100 geniuses their average score would be very high.

F. Intelligence is a lot like "strength." There is some ambiguity, but at root we know what we mean, we know there are real differences, and we know that people who are strong by one measure are usually strong by other measures, too.

G. There is a second debate about the extent to which IQ is hereditary or environmental. There is no time to resolve this here, but evidence from carefully-constructed twin and adoption studies finds that the variance is about 80% genetic. Unclear where the remaining 20% comes from - it doesn't seem to be family environment.

H. Why do I bring all this up? Because controlling for IQ sharply reduces the measured return to education to a mere 7.5%. (1 extra percentile of IQ bumps you up .7%; a year of education is thus worth about as much as 11 percentiles of IQ).

I. Estimated return with $15,000 tuition drops to 3%.

IV. Signaling and the Social Rate of Return

A. Main idea of credit market imperfections: social return exceeds private return.

B. The empirical case in the NLSY looks quite weak once you make a few obvious adjustments. (Of course, some might simply say that the case is weak precisely because governments already so heavily subsidize education).

C. All of these calculations assume, though, that education actually increases productivity and thereby raises social output. But recall that there is a competing hypothesis: signaling.

D. Insofar as education is signaling, when one worker becomes more educated, his wages go up. But at the same time, all other workers look relatively worse, and their wages go down. The effect on productivity of additional signaling is zero.

E. Implication: the previous estimates only show the *private* rate of return. The social return will be lower.

F. If 50% of education's effect is signaling, the estimated rate of return falls to -.3%! If it is 90% signaling, it falls to -5.5%.

G. Note that there is a simple policy government could use to improve the market's efficiency: *taxing* education. In the signaling model, education wastes real resources. Taxing education would preserve the relative ranking but use fewer resources.

H. In reality, of course, governments almost always massively *subsidize* education.

I. If education were unsubsidized, you might not be able to afford it; but then you probably wouldn't <u>need</u> it to get a good job either.

Firms would switch to apprenticing and other ways to find out your "type."

V. Nominal Rigidities

A. One unusual feature of labor markets that has often been discussed is nominal rigidities. Even though labor seems to satisfy the assumptions of perfect competition quite well, nominal wages rarely fall even in the face of surplus labor.

B. Neoclassical theory does not rule this out. Nominal rigidity could exist simply because of menu costs.

C. But menu costs seem pretty small relative to the value of the product. This has led behavioral economists to blame it on money illusion and/or fairness.

E. Evidence: Numerous psychological studies indicate that most people have money illusion to some degree.

F. Even when you make the point explicit, respondents evaluate employers' "fairness" partly in nominal terms. In one study, people were asked to evaluate two firms' behavior when both are making "small" profits.

Firms	**Unfair?**
Inf=0, Raise=-7%	62%
Inf=12%, Raise=+5%	22%

G. Who cares about fairness? There is also evidence that disgruntled workers' performance worsens. "Wage cuts hurt morale." Effort is partly about incentives and partly about trust.

H. Ask employers: How do workers respond to wage cuts versus layoffs?

1. The UC Berkeley pay cut.

I. Note: Nominal rigidities could *potentially* be corrected by simply inflating them away. In practice, of course, this is more easily said than done.

VI. Efficiency Wages

A. Unpleasant working conditions in an occupation decrease labor supply and raise wages. This wage premium is generally known as a "compensating differential."

B. With symmetric information, then, employers can induce workers to work harder by paying them more, and markets still clear.

C. However, with asymmetric information, matters are more complex. What happens if workers know more about their effort level than their employer does?

D. Employers might threaten to fire you if they catch you shirking, but in competitive markets, the fired worker can immediately get a job just as good as his last job.

E. So what might employers do? They might raise workers' pay above the market-clearing level in order to make the threat to fire them serious. That way, if they get fired, it will be hard for them to find a job that is just as good as the one they lost.

F. What happens if all employers think this way? Then everyone raises wages above the market-clearing level, and a permanent labor surplus emerges.

G. If you hire the unemployed workers at a lower wage, then given certain assumptions, their performance falls faster than the wage. This makes them unemployable, even though they are identical to the employed workers.

H. Note that this is a real model. Inflation raises the equilibrium nominal efficiency wage 1:1.

I. Some economists use the efficiency wage model to argue for industrial policy. You can increase total output by taxing the employed to subsidize jobs for the unemployed.

J. However, the efficiency wage problem can also be mitigated by simply making unemployment less pleasant. So it could just as easily be seen as an argument against unemployment insurance, welfare, etc.

	A	B	C	D	E	F	G	H
1	Age	Period	Net Flow	PDV		Net Flow	PDV	Dif
2	18	0	0	0	1.12559052	15000	15000	-15000
3	19	1	0	0		15000	13326.3383	-13326.34
4	20	2	0	0		15000	11839.4195	-11839.42
5	21	3	0	0		15000	10518.4072	-10518.41
6	22	4	24112.6433	15021.8395		15000	9344.7902	5677.049
7	23	5	24112.6433	13345.741		15000	8302.12235	5043.619
8	24	6	24112.6433	11856.6573		15000	7375.79272	4480.865
9	25	7	24112.6433	10533.7217		15000	6552.82059	3980.901
10	26	8	24112.6433	9358.3959		15000	5821.67359	3536.722
11	27	9	24112.6433	8314.20996		15000	5172.1061	3142.104
12	28	10	24112.6433	7386.53163		15000	4595.0157	2791.516
13	29	11	24112.6433	6562.36128		15000	4082.31557	2480.046
14	30	12	24112.6433	5830.14975		15000	3626.82122	2203.329
15	31	13	24112.6433	5179.63652		15000	3222.14976	1957.487
16	32	14	24112.6433	4601.70589		15000	2862.63051	1739.075
17	33	15	24112.6433	4088.25929		15000	2543.2255	1545.034
18	34	16	24112.6433	3632.10175		15000	2259.45889	1372.643
19	35	17	24112.6433	3226.8411		15000	2007.35423	1219.487
20	36	18	24112.6433	2866.79841		15000	1783.37877	1083.42
21	37	19	24112.6433	2546.92836		15000	1584.39392	962.5344
22	38	20	24112.6433	2262.74859		15000	1407.61129	855.1373
23	39	21	24112.6433	2010.27687		15000	1250.55361	759.7233
24	40	22	24112.6433	1785.97531		15000	1111.02003	674.9553
25	41	23	24112.6433	1586.70074		15000	987.05525	599.6455
26	42	24	24112.6433	1409.66072		15000	876.922144	532.7386
27	43	25	24112.6433	1252.37438		15000	779.077408	473.297
28	44	26	24112.6433	1112.63764		15000	692.149939	420.4877
29	45	27	24112.6433	988.492369		15000	614.921615	373.5708
30	46	28	24112.6433	878.198913		15000	546.31023	331.8887
31	47	29	24112.6433	780.211719		15000	485.354329	294.8574
32	48	30	24112.6433	693.157686		15000	431.199731	261.958
33	49	31	24112.6433	615.81692		15000	383.087565	232.7294
34	50	32	24112.6433	547.10564		15000	340.343632	206.762
35	51	33	24112.6433	486.060988		15000	302.368958	183.692
36	52	34	24112.6433	431.827543		15000	268.631401	163.1961
37	53	35	24112.6433	383.645328		15000	238.658195	144.9871
38	54	36	24112.6433	340.839161		15000	212.029323	128.8098
39	55	37	24112.6433	302.809197		15000	188.371632	114.4376
40	56	38	24112.6433	269.02252		15000	167.353606	101.6689
41	57	39	24112.6433	239.005673		15000	148.680717	90.32496
42	58	40	24112.6433	212.33803		15000	132.091302	80.24673
43	59	41	24112.6433	188.645895		15000	117.352892	71.293
44	60	42	24112.6433	167.597267		15000	104.258956	63.33831
45	61	43	24112.6433	148.897192		15000	92.6260074	56.27118
46	62	44	24112.6433	132.283623		15000	82.2910338	49.99259
47	63	45	24112.6433	117.523754		15000	73.1092102	44.41454
48	64	46	24112.6433	104.410753		15000	64.9518711	39.45888
49	65	47	24112.6433	92.7608677		15000	57.704707	35.05616
50	66	48	24112.6433	82.4108468		15000	51.2661631	31.14468
51	67	49	24112.6433	73.2156548		15000	45.5460154	27.66964
52	68	50	24112.6433	65.0464388		15000	40.4641072	24.58233
53	Total PDV			134113.577			134113.577	2.49E-07

	A	B	C	D	E	F	G	H
1	Age	Period	Net Flow	PDV		Net Flow	PDV	Dif
2	18	0	-15000	-15000	1.06537277	15000	15000	-30000
3	19	1	-15000	-14079.5789		15000	14079.5789	-28159.16
4	20	2	-15000	-13215.6361		15000	13215.6361	-26431.27
5	21	3	-15000	-12404.7061		15000	12404.7061	-24809.41
6	22	4	24112.6433	18717.0952		15000	11643.5359	7073.559
7	23	5	24112.6433	17568.5879		15000	10929.0722	6639.516
8	24	6	24112.6433	16490.5546		15000	10258.4489	6232.106
9	25	7	24112.6433	15478.671		15000	9628.97605	5849.695
10	26	8	24112.6433	14528.878		15000	9038.12854	5490.749
11	27	9	24112.6433	13637.3656		15000	8483.53626	5153.829
12	28	10	24112.6433	12800.5576		15000	7962.97454	4837.583
13	29	11	24112.6433	12015.0974		15000	7474.35522	4540.742
14	30	12	24112.6433	11277.8341		15000	7015.71827	4262.116
15	31	13	24112.6433	10585.8104		15000	6585.22393	4000.586
16	32	14	24112.6433	9936.25014		15000	6181.14532	3755.105
17	33	15	24112.6433	9326.54786		15000	5801.86155	3524.686
18	34	16	24112.6433	8754.25776		15000	5445.85116	3308.407
19	35	17	24112.6433	8217.08419		15000	5111.68608	3105.398
20	36	18	24112.6433	7712.87235		15000	4798.02583	2914.847
21	37	19	24112.6433	7239.59965		15000	4503.61221	2735.987
22	38	20	24112.6433	6795.36763		15000	4227.26423	2568.103
23	39	21	24112.6433	6378.39431		15000	3967.87335	2410.521
24	40	22	24112.6433	5987.00707		15000	3724.39906	2262.608
25	41	23	24112.6433	5619.63589		15000	3495.8647	2123.771
26	42	24	24112.6433	5274.80713		15000	3281.35352	1993.454
27	43	25	24112.6433	4951.13754		15000	3080.00505	1871.132
28	44	26	24112.6433	4647.32878		15000	2891.01161	1756.317
29	45	27	24112.6433	4362.16215		15000	2713.61507	1648.547
30	46	28	24112.6433	4094.49374		15000	2547.10383	1547.39
31	47	29	24112.6433	3843.24984		15000	2390.80996	1452.44
32	48	30	24112.6433	3607.42263		15000	2244.1065	1363.316
33	49	31	24112.6433	3386.0661		15000	2106.40497	1279.661
34	50	32	24112.6433	3178.29232		15000	1977.15299	1201.139
35	51	33	24112.6433	2983.26783		15000	1855.8321	1127.436
36	52	34	24112.6433	2800.21032		15000	1741.95564	1058.255
37	53	35	24112.6433	2628.38548		15000	1635.06679	993.3187
38	54	36	24112.6433	2467.10405		15000	1534.73679	932.3673
39	55	37	24112.6433	2315.71907		15000	1440.56318	875.1559
40	56	38	24112.6433	2173.62329		15000	1352.1682	821.4551
41	57	39	24112.6433	2040.24671		15000	1269.19726	771.0495
42	58	40	24112.6433	1915.0543		15000	1191.31753	723.7368
43	59	41	24112.6433	1797.54388		15000	1118.21661	679.3273
44	60	42	24112.6433	1687.24406		15000	1049.60126	637.6428
45	61	43	24112.6433	1583.71239		15000	985.196253	598.5161
46	62	44	24112.6433	1486.53357		15000	924.743225	561.7903
47	63	45	24112.6433	1395.31778		15000	867.99968	527.3181
48	64	46	24112.6433	1309.69911		15000	814.737999	494.9611
49	65	47	24112.6433	1229.33413		15000	764.744529	464.5896
50	66	48	24112.6433	1153.90046		15000	717.818729	436.0817
51	67	49	24112.6433	1083.09551		15000	673.772362	409.3231
52	68	50	24112.6433	1016.63524		15000	632.428742	384.2065
53	Total PDV			234779.135			234779.135	-1.14E-07

	A	B	C	D	E	F	G	H
1	Age	Period	Net Flow	PDV		Net Flow	PDV	Dif
2	18	0	-15000	-15000	1.03016849	15000	15000	-30000
3	19	1	-15000	-14560.7249		15000	14560.7249	-29121.45
4	20	2	-15000	-14134.314		15000	14134.314	-28268.63
5	21	3	-15000	-13720.3905		15000	13720.3905	-27440.78
6	22	4	20032.0371	17786.5644		15000	13318.5888	4467.976
7	23	5	20032.0371	17265.6847		15000	12928.5539	4337.131
8	24	6	20032.0371	16760.059		15000	12549.9411	4210.118
9	25	7	20032.0371	16269.2406		15000	12182.416	4086.825
10	26	8	20032.0371	15792.7958		15000	11825.6539	3967.142
11	27	9	20032.0371	15330.3037		15000	11479.3395	3850.964
12	28	10	20032.0371	14881.3557		15000	11143.167	3738.189
13	29	11	20032.0371	14445.5551		15000	10816.8393	3628.716
14	30	12	20032.0371	14022.5169		15000	10500.0681	3522.449
15	31	13	20032.0371	13611.8674		15000	10192.5735	3419.294
16	32	14	20032.0371	13213.2438		15000	9894.08395	3319.16
17	33	15	20032.0371	12826.2939		15000	9604.33565	3221.958
18	34	16	20032.0371	12450.6758		15000	9323.07262	3127.603
19	35	17	20032.0371	12086.0577		15000	9050.04639	3036.011
20	36	18	20032.0371	11732.1174		15000	8785.01572	2947.102
21	37	19	20032.0371	11388.5423		15000	8527.74649	2860.796
22	38	20	20032.0371	11055.0287		15000	8278.01138	2777.017
23	39	21	20032.0371	10731.2822		15000	8035.58977	2695.692
24	40	22	20032.0371	10417.0165		15000	7800.26748	2616.749
25	41	23	20032.0371	10111.9541		15000	7571.8366	2540.118
26	42	24	20032.0371	9815.82548		15000	7350.09532	2465.73
27	43	25	20032.0371	9528.36897		15000	7134.84773	2393.521
28	44	26	20032.0371	9249.33063		15000	6925.90368	2323.427
29	45	27	20032.0371	8978.46393		15000	6723.07855	2255.385
30	46	28	20032.0371	8715.52956		15000	6526.19315	2189.336
31	47	29	20032.0371	8460.29523		15000	6335.07355	2125.222
32	48	30	20032.0371	8212.53543		15000	6149.55088	2062.985
33	49	31	20032.0371	7972.03128		15000	5969.46125	2002.57
34	50	32	20032.0371	7738.5703		15000	5794.64554	1943.925
35	51	33	20032.0371	7511.94622		15000	5624.94931	1886.997
36	52	34	20032.0371	7291.95884		15000	5460.22264	1831.736
37	53	35	20032.0371	7078.41378		15000	5300.31999	1778.094
38	54	36	20032.0371	6871.12239		15000	5145.10009	1726.022
39	55	37	20032.0371	6669.90153		15000	4994.4258	1675.476
40	56	38	20032.0371	6474.57342		15000	4848.16401	1626.409
41	57	39	20032.0371	6284.9655		15000	4706.1855	1578.78
42	58	40	20032.0371	6100.91025		15000	4568.36483	1532.545
43	59	41	20032.0371	5922.24506		15000	4434.58024	1487.665
44	60	42	20032.0371	5748.81208		15000	4304.71353	1444.099
45	61	43	20032.0371	5580.45808		15000	4178.64997	1401.808
46	62	44	20032.0371	5417.03434		15000	4056.27818	1360.756
47	63	45	20032.0371	5258.39645		15000	3937.49005	1320.906
48	64	46	20032.0371	5104.40428		15000	3822.18063	1282.224
49	65	47	20032.0371	4954.92177		15000	3710.24805	1244.674
50	66	48	20032.0371	4809.81686		15000	3601.59341	1208.223
51	67	49	20032.0371	4668.96135		15000	3496.12073	1172.841
52	68	50	20032.0371	4532.23079		15000	3393.73681	1138.494
53	Total PDV			399714.75			399714.75	2.31E-06

	A	B	C	D	E	F	G	H
1	Age	Period	Net Flow	PDV		Net Flow	PDV	Dif
2	18	0	-15000	-15000	0.94485672	15000	15000	-30000
3	19	1	-15000	-15875.423		15000	15875.423	-31750.85
4	20	2	-15000	-16801.937		15000	16801.937	-33603.87
5	21	3	-15000	-17782.5237		15000	17782.5237	-35565.05
6	22	4	15455.0879	19391.3329		15000	18820.339	570.9939
7	23	5	15455.0879	20523.0407		15000	19918.7228	604.3179
8	24	6	15455.0879	21720.7968		15000	21081.21	639.5868
9	25	7	15455.0879	22988.4558		15000	22311.5417	676.9141
10	26	8	15455.0879	24330.0972		15000	23613.6774	716.4199
11	27	9	15455.0879	25750.039		15000	24991.8077	758.2312
12	28	10	15455.0879	27252.8507		15000	26450.3679	802.4828
13	29	11	15455.0879	28843.3687		15000	27994.0519	849.3169
14	30	12	15455.0879	30526.7119		15000	29627.8276	898.8843
15	31	13	15455.0879	32308.2975		15000	31356.953	951.3446
16	32	14	15455.0879	34193.8593		15000	33186.9927	1006.867
17	33	15	15455.0879	36189.4652		15000	35123.8365	1065.629
18	34	16	15455.0879	38301.5378		15000	37173.7173	1127.82
19	35	17	15455.0879	40536.8742		15000	39343.2324	1193.642
20	36	18	15455.0879	42902.6682		15000	41639.3636	1263.305
21	37	19	15455.0879	45406.5336		15000	44069.5006	1337.033
22	38	20	15455.0879	48056.5284		15000	46641.4642	1415.064
23	39	21	15455.0879	50861.181		15000	49363.5314	1497.65
24	40	22	15455.0879	53829.5174		15000	52244.4627	1585.055
25	41	23	15455.0879	56971.0904		15000	55293.5295	1677.561
26	42	24	15455.0879	60296.0105		15000	58520.5445	1775.466
27	43	25	15455.0879	63814.978		15000	61935.8931	1879.085
28	44	26	15455.0879	67539.3178		15000	65550.5666	1988.751
29	45	27	15455.0879	71481.0158		15000	69376.1981	2104.818
30	46	28	15455.0879	75652.7573		15000	73425.0992	2227.658
31	47	29	15455.0879	80067.968		15000	77710.3004	2357.668
32	48	30	15455.0879	84740.8572		15000	82245.5925	2495.265
33	49	31	15455.0879	89686.4633		15000	87045.5712	2640.892
34	50	32	15455.0879	94920.7026		15000	92125.6839	2795.019
35	51	33	15455.0879	100460.42		15000	97502.2799	2958.14
36	52	34	15455.0879	106323.444		15000	103192.662	3130.782
37	53	35	15455.0879	112528.643		15000	109215.144	3313.499
38	54	36	15455.0879	119095.987		15000	115589.107	3506.88
39	55	37	15455.0879	126046.611		15000	122335.064	3711.547
40	56	38	15455.0879	133402.884		15000	129474.726	3928.158
41	57	39	15455.0879	141188.481		15000	137031.069	4157.412
42	58	40	15455.0879	149428.457		15000	145028.412	4400.045
43	59	41	15455.0879	158149.33		15000	153492.492	4656.838
44	60	42	15455.0879	167379.167		15000	162450.549	4928.618
45	61	43	15455.0879	177147.672		15000	171931.412	5216.26
46	62	44	15455.0879	187486.281		15000	181965.592	5520.689
47	63	45	15455.0879	198428.267		15000	192585.383	5842.885
48	64	46	15455.0879	210008.845		15000	203824.96	6183.884
49	65	47	15455.0879	222265.282		15000	215720.497	6544.785
50	66	48	15455.0879	235237.024		15000	228310.276	6926.749
51	67	49	15455.0879	248965.817		15000	241634.813	7331.005
52	68	50	15455.0879	263495.844		15000	255736.99	7758.853
53	Total PDV			4380662.89			4380662.89	-0.000477

	A	B	C	D	E	F	G	H
1	Age	Period	Net Flow	PDV		Net Flow	PDV	Dif
2	18	0	-15000	-15000	0.9972718	15000	15000	-30000
3	19	1	-15000	-15041.035		15000	15041.035	-30082.07
4	20	2	-15000	-15082.1822		15000	15082.1822	-30164.36
5	21	3	-15000	-15123.442		15000	15123.442	-30246.88
6	22	4	17379.7562	17570.7188		15000	15164.8147	2405.904
7	23	5	17379.7562	17618.7864		15000	15206.3005	2412.486
8	24	6	17379.7562	17666.9855		15000	15247.8999	2419.086
9	25	7	17379.7562	17715.3165		15000	15289.613	2425.703
10	26	8	17379.7562	17763.7796		15000	15331.4403	2432.339
11	27	9	17379.7562	17812.3754		15000	15373.3819	2438.993
12	28	10	17379.7562	17861.1041		15000	15415.4384	2445.666
13	29	11	17379.7562	17909.9661		15000	15457.6098	2452.356
14	30	12	17379.7562	17958.9617		15000	15499.8967	2459.065
15	31	13	17379.7562	18008.0914		15000	15542.2992	2465.792
16	32	14	17379.7562	18057.3555		15000	15584.8177	2472.538
17	33	15	17379.7562	18106.7544		15000	15627.4526	2479.302
18	34	16	17379.7562	18156.2884		15000	15670.204	2486.084
19	35	17	17379.7562	18205.9579		15000	15713.0725	2492.885
20	36	18	17379.7562	18255.7633		15000	15756.0582	2499.705
21	37	19	17379.7562	18305.705		15000	15799.1615	2506.544
22	38	20	17379.7562	18355.7832		15000	15842.3827	2513.401
23	39	21	17379.7562	18405.9985		15000	15885.7221	2520.276
24	40	22	17379.7562	18456.3512		15000	15929.1801	2527.171
25	41	23	17379.7562	18506.8416		15000	15972.757	2534.085
26	42	24	17379.7562	18557.4701		15000	16016.4531	2541.017
27	43	25	17379.7562	18608.2371		15000	16060.2688	2547.968
28	44	26	17379.7562	18659.143		15000	16104.2043	2554.939
29	45	27	17379.7562	18710.1882		15000	16148.26	2561.928
30	46	28	17379.7562	18761.373		15000	16192.4362	2568.937
31	47	29	17379.7562	18812.6978		15000	16236.7333	2575.964
32	48	30	17379.7562	18864.163		15000	16281.1516	2583.011
33	49	31	17379.7562	18915.769		15000	16325.6913	2590.078
34	50	32	17379.7562	18967.5163		15000	16370.353	2597.163
35	51	33	17379.7562	19019.405		15000	16415.1368	2604.268
36	52	34	17379.7562	19071.4357		15000	16460.0431	2611.393
37	53	35	17379.7562	19123.6088		15000	16505.0722	2618.537
38	54	36	17379.7562	19175.9246		15000	16550.2246	2625.7
39	55	37	17379.7562	19228.3835		15000	16595.5004	2632.883
40	56	38	17379.7562	19280.9859		15000	16640.9002	2640.086
41	57	39	17379.7562	19333.7322		15000	16686.4241	2647.308
42	58	40	17379.7562	19386.6228		15000	16732.0726	2654.55
43	59	41	17379.7562	19439.6581		15000	16777.8459	2661.812
44	60	42	17379.7562	19492.8385		15000	16823.7445	2669.094
45	61	43	17379.7562	19546.1644		15000	16869.7686	2676.396
46	62	44	17379.7562	19599.6361		15000	16915.9186	2683.718
47	63	45	17379.7562	19653.2542		15000	16962.1949	2691.059
48	64	46	17379.7562	19707.0189		15000	17008.5978	2698.421
49	65	47	17379.7562	19760.9307		15000	17055.1276	2705.803
50	66	48	17379.7562	19814.99		15000	17101.7847	2713.205
51	67	49	17379.7562	19869.1972		15000	17148.5695	2720.628
52	68	50	17379.7562	19923.5526		15000	17195.4822	2728.07
53	Total PDV			819736.122			819736.122	0.00011

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Econ 812

Week 13: Finance and Portfolio Theory

I. Permanent Income Anomalies
   A. If you have diminishing marginal utility of consumption and access to intertemporal markets, tailoring your consumption to your *current* income makes little sense.
   B. Instead, the smart thing to do is base your consumption on your *permanent*, or expected long-run, income. This is one of the main insights that won Friedman his Nobel prize.
   C. Obviously there is a lot of truth in the PIH. Young people tend to build up a lot of debt, and pay it off as they age. Once they retire, they consume out of the assets they built up during their working years.
   D. Nevertheless, behavioral economists have assembled a long list of violations of the PIH. It does not seem to work perfectly.
   E. For one thing, consumption seems moderately sensitive to current income. Medical students go into debt, but their consumption levels predictably rise once they begin practicing. More formal statistical analysis confirms this impression: current income has a moderate ability to predict current consumption.
   F. In addition, consumption responses seem to vary with the nature of the income. Most people who get a windfall - like a one-time cash bonus - rarely use it to raise their consumption smoothly over their lifespan.
      1. Question: How do durable goods alter PIH predictions?
   G. Similarly, there is empirical evidence that people are reluctant to tap into both pensions and home equity to smooth their current income. Reverse mortgages are extremely unpopular, even for elderly people living very modesty in high-value homes.

II. Liquidity Constraints Versus Debt Aversion
   A. The standard neoclassical explanation for the partial failure of the PIH is liquidity constraints. A medical student can't borrow more than a small fraction of his future income stream; he lacks the necessary collateral.
   B. However, liquidity constraints only explain away anomalies where individuals are indeed liquidity constrained. Once people have significant home equity, liquidity constraints no longer bind. But many deviations from the PIH persist.
   C. Behavioral economists argue that there is a separate phenomenon of "debt aversion." People simply dislike being in debt, as such.
   D. Evidence? For one thing, most second mortgages are taken out for home improvements, not to smooth consumption.

E. We also see people pre-paying low home mortgage and student loans instead of investing surplus funds in the broader market.
F. Interesting: though a common theme in behavioral economics is that people are excessively impatient, the debt aversion evidence points in the opposite direction. People would be better off if they borrowed more to live better today.

III. PDV, Diversification, and Risk Premia
A. In a world of certainty, the price of every asset has to equal its PDV.
B. With risk-neutrality, this result holds under uncertainty as well. The only difference is that assets go for their *expected* PDV.
C. Once there are enough risk-averse agents, though, factors besides assets' PDVs begin to matter. In particular, we would expect assets to trade for their PDV minus some risk discount (equivalently, we would expect assets to earn a normal rate of return plus a risk premium).
D. But this is complicated by the fact that there are numerous risky assets. Basic probability tells us that the average riskiness of a bundle of different risks is less than the average riskiness of an equal dollar amount of the same risk.
E. Thus, to some degree, risk can be "diversified away." We should not expect diversifiable risk to earn a premium.
F. What you earn a premium for, then, is undiversifiable risk. Insofar as the return of an asset positively correlates with the "average market" return, you should expect a risk premium.
G. If you could actually find an asset that negatively correlates with the "average market" rate (these are hard to find!), it would actually be more valuable than a riskless asset.

IV. Mean-Variance Efficiency
A. A popular simplifying assumption in finance is that people care only about the *mean* and the *variance* of their consumption. The higher than mean and the lower the variance, the higher their utility.
B. This gives rise to the idea of *mean-variance efficiency*. This basically amounts to assuming that agents select portfolios on the mean-variance budget constraint. They want the highest mean given the variance, and the lowest variance given the mean.
C. Working through these assumptions implies the following equation for the expected return of an asset:

$$\overline{R_a} = R_0 + \frac{\sigma_{ae}}{\sigma_{ee}}\left(\overline{R_e} - R_0\right)$$

D. Translation: The expected return on asset a equals the risk-free rate, plus the difference between "average market" rate of return and the risk-free rate, times the ratio of the covariance of a's return with the average market return to the variance of the average market return.

E. The latter ratio is, in fact, the coefficient you would get if you regressed asset a's return on the average market return. For this reason, this ratio is often called asset a's β.

V. The Efficient Markets Hypothesis

A. Once you have a formula for the return on assets, it is pretty obvious what has to happen when new information arrives: Market prices must adjust, rising if there is good news and falling if there is bad news. Otherwise, the return equations would not be satisfied.

B. This becomes more surprising when you reflect on when it is that news "arrives." It often arrives long before anything actually changes! If you find out that a firm has to pay $1 M ten years from now, the price has to fall right away.

1. The same applies to probabilistic news. If it is suddenly revealed that something is more likely to happen than previously thought, asset prices must adjust.

C. Note further: The occurrence of any expected pattern is NOT news.

D. Surprising implication: Asset price *changes* should be completely unpredictable. More technically, asset prices should follow a *random walk*, such as $E(P_{t+1})=P_t$. This is known as the Efficient Markets Hypothesis, or EMH.

E. Even strong critics of the EMH acknowledge that it performs well in many respects. For example, asset prices often fall when profits are announced, and rise when losses are announced. The EMH explanation is simple: In the first case, profits were smaller than expected; in the second case, losses were smaller than expected.

F. Moreover, the EMH passes some surprising empirical tests. You cannot predict annual rates of return for the S&P using past rates of return. In spite of a whole industry of specialists debating whether "this is a good year" to invest, there are no obvious correlations of annual returns.

G. The great practical success of the EMH may be seen in the rise of index funds. Buying and holding diversified bundles of assets has at least the gross return of the average "expertly" managed fund.

1. When you look at net returns, the contest is even more uneven. In a way, though, this is itself anomalous. Search theory suggests that **net** returns should equalize.

VI. Calendar Effects

A. In spite of the logic of the EMH, behavioral economists have uncovered a variety of anomalies. Some of the best-publicized are so-called "calendar effects."

B. Best-known: the "January effect." Average NYSE monthly returns February-December are .5%; average January return is 3.5%. This seems to stem primarily from especially high returns for small firms in January.

C. January effects have been found in 15 out of 16 countries studied.

D. Another calendar anomaly: The weekend effect. If markets close on weekends, average Friday-Monday return should be three times the normal return. If you hold debt, you get three days worth of interest. Why not the same for stocks? In fact, though, Monday returns do not seem especially high.

E. Thaler acknowledges that most anomalies are hard to take advantage of due to transactions costs. But you should still expect people to alter the transactions they were going to make anyway to take advantage of these patterns.

VII. Mean Reversion

A. EMH tells us that returns are unpredictable. You cannot use past returns to forecast future returns.

B. A growing literature on "mean reversion" calls this view into question. It offers evidence that unusually high returns in the past predict unusually low returns in the future, and vice versa.

C. Thaler suggests that these patterns arise due to systematic overreaction by investors. Past returns negatively forecast future returns because too many people think that past returns positively forecast future returns.

VIII. Betting Market Anomalies

A. Betting markets are a special kind of asset market. The same empirical techniques applied to asset markets have been applied to betting markets.

B. Much about betting markets is as you would expect. There is a very high correlation between subjective and objective probabilities.

C. A large literature tests for anomalies in the price of bets. Once again, some have been found. Probably the best-known is the long-shot bias: Expected returns in horse-racing increase with the probability of the horse winning.

1. One explanation is that at the end of the day bettors switch to a long-shot in order to have a chance of breaking even.

D. Similar anomalies have been found in lottery betting. While conventional wisdom has it that lotteries are a "tax on stupidity," Thaler points to evidence that there are some positive expected sum bets. When you pick your numbers, you should pick unpopular numbers - like non-birthdays.

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Week 14: Economics of Politics

I. The Median Voter Theorem
- A. Assume that voters' preferences are "single-peaked." This means that voters have an "ideal point" (aka "bliss point"), and their utility declines monotonically as policy moves away from it.
- B. Suppose we have a two-party (or two-candidate) election. Voters care about and are perfectly informed about party positions on exactly one issue: liberalism versus conservatism.
- C. The electoral rule is "winner-takes-all" - whoever gets more votes wins.
  1. Assume ties are resolving by flipping a coin.
- D. Assumption about party/candidate motivation: They want to win, and care more about that than everything else put together.
- E. The two parties compete in exactly one way: By taking a stand on the issue.
- F. The electorate may be divided into three groups: those who definitely vote for the more liberal party, those who definitely vote for the more conservative party, and the people in the middle, who pick whichever party is closer to them.
- G. In equilibrium, parties' platforms cannot be different, because both parties gain votes by moving closer to each other. $P_D = P_R$.
- H. Thus, equilibrium platforms "converge." But to what?
- I. Could the equilibrium platform ever be one where both parties are above the median of the distribution of voter preferences? No. Why? Because one party would get more than 50% of the votes by moving a little closer to the median. So $P_i \leq P_{med}$.
- J. Could the equilibrium platform ever be one where both parties are below the median of the distribution of voter preferences? No, for the same reason. So $P_i \geq P_{med}$.
- K. Could the equilibrium platform *be* the median of the distribution? Yes! If both parties are at the median, then staying there gets you 50% of the votes, but moving a little to the left or right gets you *fewer* than 50%. Thus, we arrive at the famous **Median Voter Theorem**: $P_D = P_R = P_{med}$.

II. Rational Ignorance and Special Interests
- V. How much do voters know about politics? Search theory suggests that we look at the marginal cost and expected marginal gain of acquiring political knowledge.
- W. But the probability one vote changes an electoral outcome is approximately zero. So the expected marginal gain of info is 0.

X. With positive MC and 0 MB, what is the privately optimal quantity of political information to acquire? None. Hence the concept of **rational ignorance**. When knowledge gives you no practical benefit, and time is money, ignorance (the decision not to acquire knowledge) is rational.

Y. Empirically, this is not exactly true, but it is not far from the truth.

Z. The Median Voter Model makes no room for "special interests." Voters get what they want.

AA. Still, observers have frequently argued that "special interests" - small groups of activists "behind-the-scenes" - foil the majority's wishes. But how?

A. Simple idea: Special interests are well-informed because they have so much riding on the political outcome. Regular voters aren't informed because they have so little riding on it. "Concentrated benefits, diffuse costs."

III. The "Miracle of Aggregation"

A. A number of economists and political scientists have admitted the ignorance of individual voters, but still defend the quality of the **electorate's** decisions.

B. The argument:

1. Individual voters are poorly informed, and thus their votes are highly random.
2. But elections are based on *aggregate* opinions of millions of voters.
3. A basic principle of statistics is the Law of Large Numbers: random errors tend to "cancel each other out" (in percentage terms).
4. Thus, even if there is a large component of randomness in individual voting, the principle of aggregation ensures, for all practical purposes, that outcomes still make sense.

C. Suppose 90% of all voters are uninformed and vote randomly. The remaining 10% are perfectly informed. What happens? Whichever candidate wins the support of a majority of informed voters also wins the election.

D. This result has been named "the miracle of aggregation." It seems *miraculous* because it implies that a highly uninformed electorate may - at the aggregate level - act "as if" it were perfectly informed.

IV. Voter Ignorance, Principal-Agent Problems, and Optimal Punishment

A. The politician-voter relationship is easy to analyze as a principal-agent problem.

B. Simple model: politician does what voter wants iff: $B_v > B_s - pD$, where B_v are the benefits a politician gets from doing what voters want, B_s are the benefits of shirking, p is the probability of being caught shirking, and D is the punishment for shirking.

C. Many believe that rational ignorance allows politicians to shamelessly and repeatedly violate voter trust.

D. But as Becker observed, when information is available but costly, a natural way to align incentives is (as in the efficiency wage model) *random monitoring combined with harsh punishment*. Most obviously, set $D > \frac{(B_s - B_v)}{p}$.

E. Ex: If the media catches a politician taking a $1 bribe, voters could decide to never vote for him again, or even give him jail time.

F. Main point: Theoretically, even rationally ignorant voters remain able to control politicians. They could just massively punish all observed dishonesty.

V. Wittman's Challenge to Orthodox Public Choice

A. Critics of the economic approach to politics usually dislike its "economistic" assumptions and its anti-democratic conclusions.

B. Donald Wittman of UC Santa Cruz offers a radically different critique of public choice economics.

C. Wittman does **not** object to public choice's "economistic" approach.

D. Instead, Wittman complaint is that so much of public choice is simply bad economics.

E. He claims that standard public choice arguments generally depend upon extremely dubious assumptions:

4. "Extreme voter stupidity"
5. "Serious lack of competition"
6. "Excessively high negotiation/transfer costs"

F. Wittman's conclusion: The standard tools of microeconomic analysis show that political markets work just as well as economic markets. The political failures emphasized in public choice theory are largely imaginary.

VI. "Extreme Voter Stupidity"

A. Many public choice arguments, according to Wittman, assume "extreme voter stupidity."

B. Normally, of course, public choice economists talk about "ignorance" or "lack of information," rather than "*stupidity*." But Wittman argues that the assumption of voter stupidity is implicit.

B. Wittman's Principle #1: *Voter ignorance is not a serious problem*.

C. Why? **First**, the *amount of information held by voters has been underestimated*.

1. Party labels are "brand names" that drastically reduce information costs.
2. Politicians pay to inform voters by advertising, giving speeches, and so on; voters don't have to pay to inform themselves.

D. **Second**, *informed judgments can be made with little information*.

1. Voters have many "cognitive shortcuts." Voters can simply ask their preferred experts for information. If I like guns, I just vote the NRA line; if I don't like guns, I follow the advice of Citizens for Gun Control.

E. **Third**, *the deleterious effect of biased information has been overstated.*
   1. Ignorance does not mean *systematic* bias. The Miracle of Aggregation shows that even if people are highly ignorant, their random errors will cancel out.
   2. "To be uninformed about a policy does not imply that voters have biased estimates of its effects. For example, to be uninformed about the nature of pork-barrel projects in other congressional districts does not mean that voters tend to underestimate the effects of pork barrel - it is quite possible that the uninformed exaggerate both the extent and the negative consequences of pork-barrel projects."
   3. Voters can discount, or simply ignore, information from biased or questionable sources. If the media has a "liberal bias," then voters can easily adjust.

F. **Fourth**, *the effect of unresolved asymmetric information in politics is to make government inefficiently small, not inefficiently large.*
   1. Just as it is naive to think that asymmetric information helps used car dealers sell cars, it is naive to think that asymmetric information helps politicians create Big Government.

G. Wittman's bottom line: To reach their standard conclusions about political failure, then, ignorance is not enough. They need to assume that voters are "stupid" or **irrational** - that RE fails.

VII. "Serious Lack of Competition"

C. Wittman's Principle #2: *Politics, like the market, is competitive*.

D. Why? **First**, *reputation matters.*
   1. If politicians break promises, voters hold it against them. If they do a good job, they reward them. Even if politicians only stay in one office for a few years, they want to build up a good name in order to rise to higher offices.
   2. Remember the theory of optimal punishment: Voters can adjust for a small probability of detection with over-punishment. Politicians can destroy their whole reputation with one mistake.

E. **Second**, *political races are at least as competitive as markets.*
   1. Politics is full of "political entrepreneurs" who want to stage a successful "takeover" (gain power) by locating unpopular policies and campaigning to change them.
   2. High rates of reelection prove NOTHING. "The main reason for high rates of incumbent success is... They are the best. That is why they won in the first place and why they are likely to win again."
   3. Similarity of platforms also proves NOTHING. Similar prices are actually a sign of competition in markets; so are similar platforms in politics.

4. Alleged "barriers to entry" are usually minimal. Third parties can't win because voters don't like them, not because "the system" is against them.

F. **Third**, *empirical evidence shows a strong link between voter preferences and legislative behavior.*

G. Wittman's bottom line: In markets, economists are usually skeptical about collusion. Why are they less skeptical in politics? How is the grand electoral conspiracy maintained?

VIII. "Excessively High Negotiation/Transfer Costs"

A. Finally, public choice economists often argue that transactions costs prevent more efficient policies from replacing the status quo.

1. Ex: A special interest "blocks" changes harmful to its interests, and it is "too hard" to buy them off.

B. This brings us to Wittman's Principle #3: *Political bargaining can eliminate any remaining significant inefficiencies.*

C. Why? *Democracy is <u>designed</u> to have low transactions costs.*

1. Majority rule is cheaper than the unanimity required by markets.
2. Representative democracy (as opposed to direct democracy) drastically reduces transactions costs. Instead of 250 M Americans bargaining, we have a few hundred Congressmen and Senators bargaining. (The same logic holds for committees).
3. Log-rolling can turn efficient but unpopular policies into efficient AND popular policies.

IX. Rational Irrationality

A. What reasons are there to believe that the rational expectations assumption is true?

B. One of my main research ideas: Just as economists think of agents weighing the costs and benefits of *information*, so too can we think of agents weighing the costs and benefits of *rationality*. Just as it is sometimes rational to be *ignorant* (have little information), it may sometimes be rational to be *irrational* (deviate from full rationality).

C. In other words, we can think of irrationality as a normal good. Why does anyone want this "good"?

1. Big reason: People derive comfort, security, and sense of identity from their belief structure.
2. Moreover, rational thinking is often hard, painful, discouraging work.
3. Indirect reason: Other people you depend on may treat you differently depending on your beliefs.

D. What is the "price" of irrationality? It is the material success that you give up in order to retain systematically mistaken beliefs.

E. Writing down an individual's "demand for irrationality" curve for a given issue is easy. Just put quantity of irrationality on the x-axis, and the implicit price of irrationality on the y-axis.

F. When the price of irrationality is high - as it often will be - people consume less. Perhaps they consume none at all - on at least some issues, they might be fully rational.
G. When the price of irrationality is low, people consume more. When irrationality is completely free, people stick with whatever belief makes them most happy, however crazy.
H. Remember the probability of voter decisiveness?
I. Immediate implication: The expected price of voter irrationality is essentially zero, so we should not be surprised if voters hold highly irrational beliefs!
J. I take my work on systematically biased beliefs about economics as a natural implication of rational irrationality. We get stupid economic policies because voters have stupid beliefs about economics.

X. Irrationality as Political Pollution
A. Economists' efficiency calculations must count the consumption value of irrationality as a benefit. However, this hardly implies an efficient outcome.
B. Why? Voters enjoy the full benefit of their own irrationality, but pay only an infinitesimal fraction of the cost. Each voter subconsciously thinks "My irrationality makes no perceptible difference on policy, so I might as well believe whatever makes me feel best."
C. If enough voters rely on systematically biased beliefs to decide how to vote, disastrous policies may be adopted.
F. Just as all polluters can be better off if everyone polluted less, all voters can be better off if everyone consumed less irrationality.
G. Application: protectionism. Public choice economists have typically seen protectionism as a product of special interests taking advantage of the public's rational ignorance.
H. Big puzzle for this theory: Protectionism is popular!
I. My alternative theory: People hold rationally irrational beliefs about trade policy. Politicians offer protectionist policies to get their votes.
J. Empirical support: On the *SAEE*, the public is much more pessimistic about foreign trade than economists, controlling for everything else.
K. The real puzzle: Why isn't policy far more protectionist than it is?

XII. Caplan's Critique of Wittman
A. I say: Yes, public choice arguments frequently assume "extreme voter stupidity," as Wittman charges. But so what? Voters - even smart ones - *become* extremely stupid (“irrational”) when they deliberate on political/economic questions.
B. Voter irrationality is both:
1. Plausible in theory
2. Easy to detect empirically on a large scale

C. Key asymmetry between politics and markets: Incentives for rationality. In markets, ignorant actors do their best with what they know. In politics, they scarcely try.

D. Rational irrationality helps explain why politicians cater to voters' prejudices rather than trying to "educate" them. Voters like candidates who share their confusions, not pedants who lecture them.

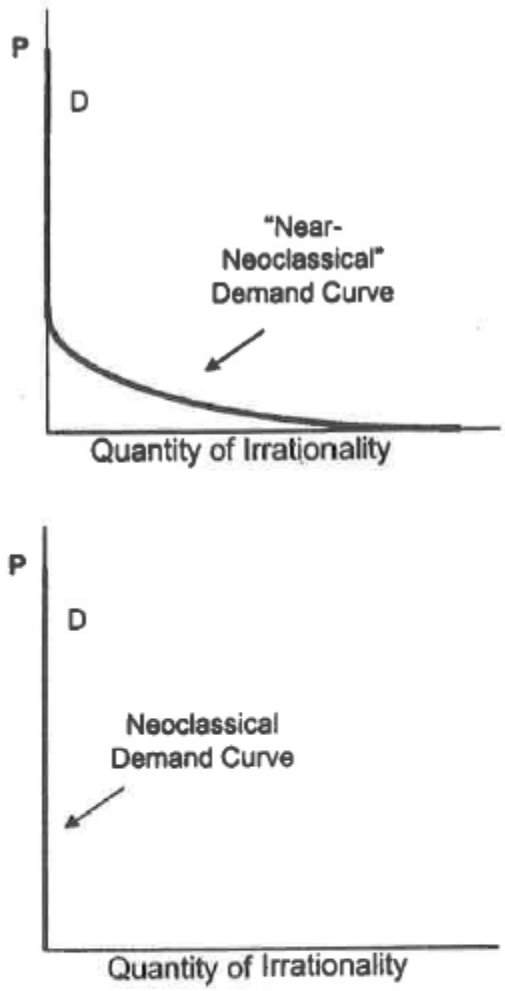

Diagram 2. Neoclassical vs. "near-neoclassical" demand for irrationality.

politics will have a negative impact on his wealth by leading him to vote against his own interests is no greater. However deluded one more person is, democratic outcomes will almost certainly not change (Akerlof, 1989). It is the *marginal* cost of systematic political error that must be considered: even though protectionist policies tend to reduce the wealth of protectionists, one cannot avoid paying a tariff by changing one's mind about the validity of the law of comparative advantage. The institutional structure of politics tends to peg the price of irrationality at zero. Note that this does *not* imply individuals consume an infinite quantity of irrationality: When the price of irrationality is zero, people adhere to their bliss belief, consuming irrationality until they are "satiated" (Diagram 3).

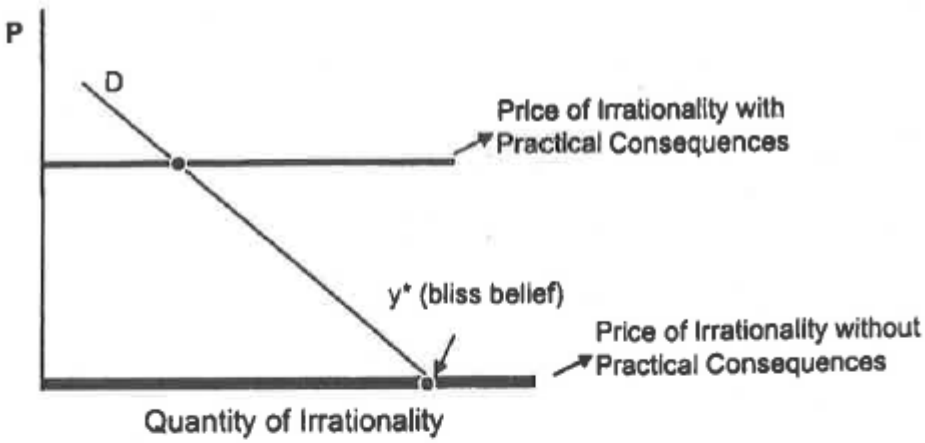

Diagram 3. Price-sensitivity of the demand for irrationality.

In contrast, systematic errors about non-political issues often have large private, marginal costs. Over-estimating your job performance while intoxicated makes you more likely to lose your job and ruin your career. Under-estimating the rate of inflation leads to poor portfolio choices. In cases like this, the price of irrationality is strictly positive: the expected wealth of an agent who becomes a little bit more irrational definitely falls. As Diagram 3 shows, this reduces the quantity of irrationality demanded. With near-neoclassical demand for irrationality, a moderate price is sufficient to induce rational expectations.

If people derive utility from holding irrational beliefs, what is the connection between irrationality and political failure? The problem is that for political irrationality, the private and social costs of irrationality are different. Even though the private cost of irrationality is zero, the social cost can be enormous. Just as the divergence between private and social cost of polluting leads a group of identical polluters to a suboptimal, high-pollution outcome, so too does the divergence between the private and social cost of irrationality lead to a suboptimal, high-irrationality outcome. Note further that while rationally ignorant individuals admit they are ignorant, rationally irrational individuals believe that they know the truth. The former admit they have a problem and can take steps to compensate for it; the latter, in contrast, make no effort to adjust for a problem they deny exists. For example, if voters are rationally ignorant about the specifics of trade policy, they can still support general procedures to curtail protectionist pressures. But such procedures would win no favor from voters who affirmatively favor protectionism due to their rationally irrational overestimates of the social benefits of protectionist policy.[3]