Concordia University
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School of Business
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Analysis of Markets

CLASS NOTES

COMM 220

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About these notes

These are draft class notes for the topics that we will be discussing in Analysis of Markets. Neo-classical economics is emphasized. We will deal with behavioural economics in class. You can merge the two in your own notes.

Gregory Lypny

Monday, January 6, 2014

NOTE 1

Building Economic Models

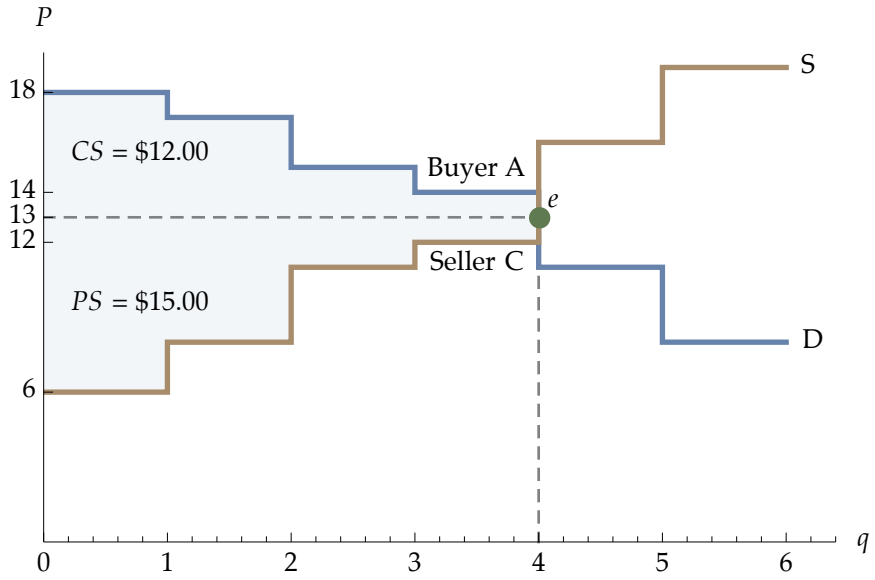
Twelve students take part in an experiment. Each is randomly assigned to be a buyer or a seller of an otherwise worthless metal token. Buyers are told that if they buy a token, they can turn it in at the end of the experiment and be paid its redemption value. The redemption value is different for each buyer, and is known only to the buyer. Sellers are given one token each, called an endowment, and told that if they sell their token, they can keep the sale price less the token's cost. The cost is different for each seller, and is known only to the seller.

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

The buyers and sellers trade by submitting their offers privately to Raymond, a skinny, bearded guy wearing Buddy Holly glasses and a Keep on Truckin' t-shirt that he bought in 1968. Raymond sorts the buyers' bids from highest to lowest and the sellers' asks from lowest to highest, and if there is a price for which the number of tokens that would be bought is equal to the number that would be sold, Raymond will call out that price as the *equilibrium* or market-clearing price. This type of market is called a *call market* because all of the offers are batched. All buyers who bid the market clearing at least the market-clearing price will receive a token supplied by the sellers who asked no more than the market-clearing price. What is your hypothesis for the equilibrium price and quantity in this market?

I think not more than four tokens will be traded at a price of about $13. It may not happen the very first session of the experiment because the subjects may need some time to learn, especially since redemption values and costs are private information. I do know that it would be strange if the number of tokens traded were greater than four (can you say why?). Four tokens

at about $13 should be what we observe on average. Draw supply and demand schedules like Raymond would.



If buyers want to earn some cash, they will bid less than their redemption values. I don't know how much lower; too low, and there is a risk of slipping to the right of the equilibrium and earning nothing. If sellers are greedy too, they will ask more than cost, but not too much more. So, it looks like greed is necessary to put us in the neighbourhood of *e*.

The $13 equilibrium price needs a word or two because it is, after all, being announced by Raymond. It isn't the only possible equilibrium price. You can see from the graph that Buyer A and Seller C, at the margin, determine the equilibrium. Buyer A will buy a token as long as the price no higher than $14, and Seller C will give one up as long as the price is no less than $12. So that fourth token would trade at any price from $12 to $14. The equilibrium price is not unique. But Raymond's job as auctioneer is to call out one equilibrium price, if it exists, so he had to have a rule to deal with multiple equilibrium prices, and his rule, which he announced to everyone at the beginning of the experiment, is to use the mid-point of the marginal bid and ask. It didn't have to be split down the middle; that's just the way Raymond's head works.

Of models and assumptions

The world is a complicated place. There's a lot going on all of the time. Economic models, like all scientific theories, are simplified versions of some small bit of reality. A theory sets out the conditions or variables that are necessary to answer the question being asked. *What should be the equilibrium in a call market when information about cost and redemption value are private?* Simple is usually best: being able to explain or predict something with just two variables is better than needing three. A theory is not intended to duplicate reality but capture enough of we want to

explain or predict. When a variable important to a theory cannot be measured because it is unobservable, an assumption has to be made about it. What assumptions were made to arrive at the hypotheses in the tokens experiment? Greed is one: people prefer having more to less. Another is that people place offers without thinking that their offers could somehow influence the equilibrium. They behave as if they are price-takers. The tokens experiment has been done many times, and the hypothesis is strongly supported. That's a brownie point for economics because, in this simple market, goods flow from the people who value them least (the lowest cost sellers) to those who value them most (the buyers with the biggest redemption values). The value of trade to the people in this market is reflected in the consumers' and producers' surpluses shown as CS and PS in the graph. They are better off than they would be without trade.

Something to think about

What if each the sellers were endowed with an I-Love-Concordia coffee mug, and everyone knew that the mugs was selling for $13.89 in the university bookstore?

Review

ask

assumption

bid

call market

consumer surplus

endowment

equilibrium

greed (self-interest, selfish, prefer more to less)

hypothesis

price-taker

private information

producer surplus

theory

NOTE 2

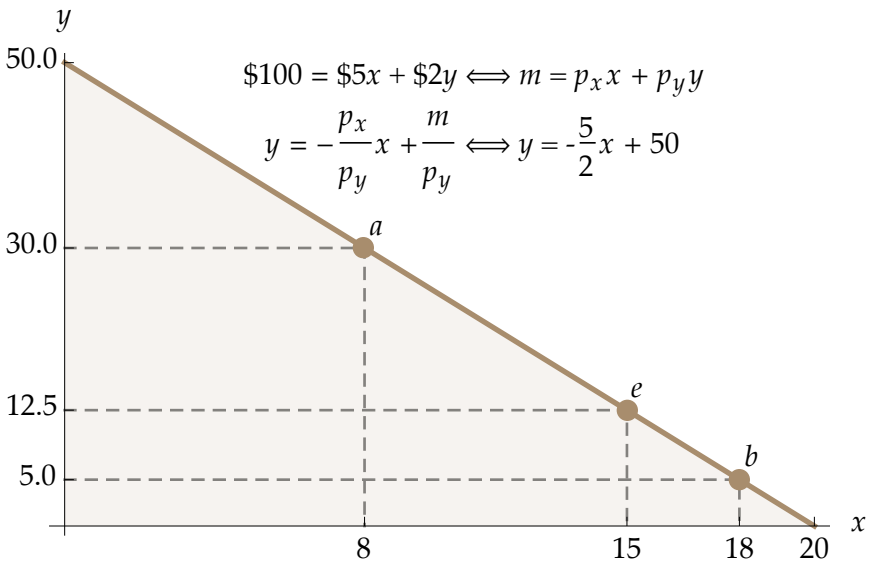
Utility Theory

Do I want to keep the I-Love-Concordia coffee mug that I had been given as a seller in the experiment in Note 1. Or should I sell it? Would I want to buy one if I were assigned the role as buyer? Economics is all about choices, and it assumes that we make choices that are best for us, that gives us the greatest satisfaction. The tokens version of the experiment was designed so that greed would motivate the decision to buy or sell and the offers to be made. The design, of course, stemmed from the assumption that people are greedy. Assuming greed seems like a pretty safe bet, but then there's philanthropy, altruism, and self-destructive behaviour, which do not fit so neatly in the best-for-me mould. The assumption of greed is not enough to form a hypothesis about equilibrium price and quantity, or whether there would any trade at all, in the mugs version of the experiment because everyone was told the price of the mug in the university bookstore, and everyone knew that the price was public information. A slightly broader assumption had to be made: people have different preferences or tastes for mugs. Some sellers might offer theirs for sale because they prefer cash, and some buyers might one. We can get a rough idea about someone's tastes and whether they are greedy after the fact, that is, by observing the actual choices they make. But it is much harder to do before the fact; tastes and greed are *unobservable* in that sense.[1] Utility theory uses mathematical functions represent tastes and greed in an economically meaningful way and to avoid having to measure them. Choices as well as responses to changes in prices and income can then be predicted.

[1] In science lingo, *ex ante* means before the fact or looking ahead, and *ex post* means after the fact or looking back at the past. You can also think of greed as the one aspect of our tastes that is the same for everyone.

Income, wealth, and budgets

Consuming the things that you have chosen is what gives you satisfaction. Call these things x and y. x and y are *flows* of goods, services, or any activity that is consumed.[2] Groceries per week, haircuts per year, and time spent listening to the blues are all consumption flows; combinations of these are sometimes called consumption bundles. Your *income* is a flow too. Income together with the prices of goods defines your budget, which determines how much you can consume. Suppose your weekly income is \$100, the price of x is \$5, the price of y is \$2, and you don't happen to own any x or y. You could consume 20 units of x per week if you spent all of your income on x, 50 units of y if you spent all of it on y, or any combination of the two that



doesn't cost more than \$100. All of the bundles whose cost equals your income lie on a budget line.[3] Bundles a, b, and e are just some of the many bundles that are affordable, and you would chose the one that you preferred to all others on the line. The slope of the budget line is $-2\frac{1}{2} = -\frac{\$5}{\$2} = -\frac{p_x}{p_y}$ because x is two and half times more expensive than y. An x is worth 2½ y's.

The *price ratio*, $\frac{p_x}{p_y}$, and not the individual prices, is what is important in making choices. That the price of x is \$5 or \$5,000 doesn't mean much unless you know the market prices of other

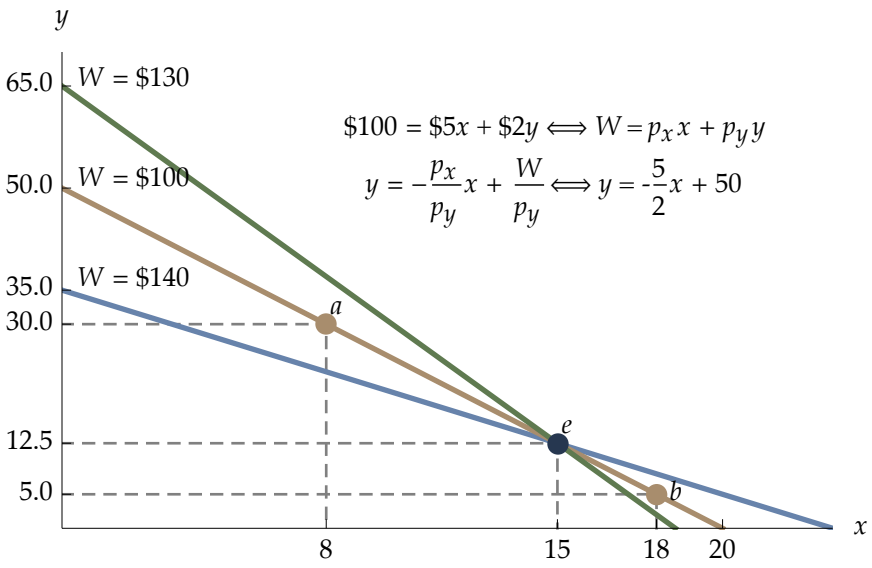
[2] To keep it short, I'll use goods to mean goods, services, or activities.

[3] It is a line if there are only two goods or only two are being considered. It is more generally called a budget constraint or income constraint.

things that might be consumed along with x or instead of x. (I'll leave it to you to review how the budget line changes position if one or both prices or income changes. You've done it before.)

If you have no income but are endowed with 15 x and 12½ y then your *wealth* is the value of your *endowment* at market prices—whatever you own or whatever you're entitled to—and that's \$100 (\$60 worth of x and \$40 of y). Your wealth is \$100 everywhere along the budget line or wealth constraint, so long as prices stay the same. Wealth, unlike income, is a *stock*; it is a value at a point in time.[4] A warehouse inventory, a firm's total assets, the number of bottles of beer in your fridge, my collection of Beatles records, and my daughter's 43 Beanie Babies are all stocks.

The budget line looks exactly the same whether you have an income (but no endowment) and are deciding how to spend it, or you have an endowment of goods (but no income) and are deciding whether to trade off some of one good to get more of the other. The only difference is that both the x and y intercepts of the wealth line change even when only one of the prices has



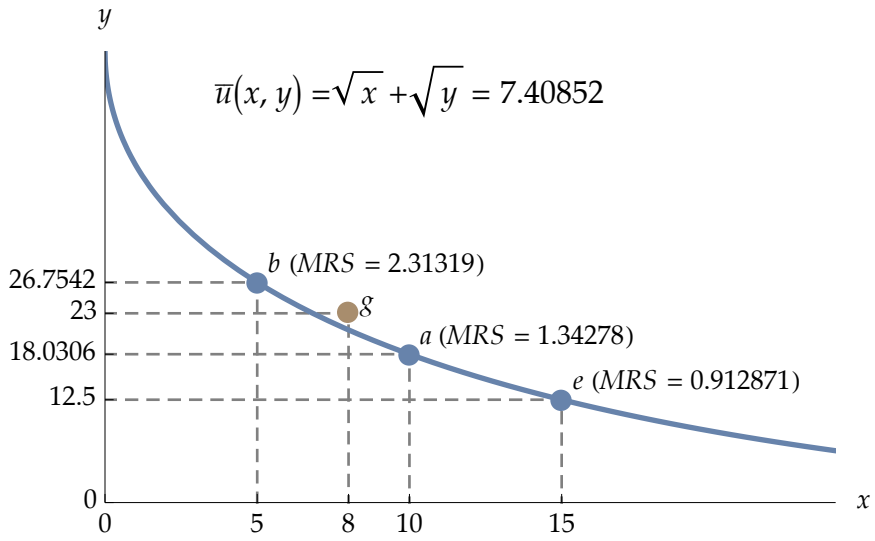
changed. This is because the wealth line always passes through the endowment point. This makes sense because, no matter how much the price of goods changes, you can always afford what is already yours. Can you say how prices must have changed for the initial wealth line (\$100) for it to become the wealth line at \$140 or \$130?

Utility functions and indifference curves

Your budget fixes the choices that you can *afford* to make. Your tastes set out the choices that you *want to* or are *willing* to make. Imagine listing all of the bundles of x and y that give you

[4] I flunked accounting class seven times.

exactly the same satisfaction as your endowment of 15 x and 12½ y. This set of bundles is called an *indifference curve*, and it is how tastes are modelled in economics. Maybe your tastes for x and y can be represented by indifference curve shown in the figure. The value of the function at e is about 7.40852. This number is called *utility* and can be taken as a measure of how satisfied you



are with 15 x's and 12½ y's.[5] All of the other points on the indifference curve are bundles that yield utility of 7.40852.

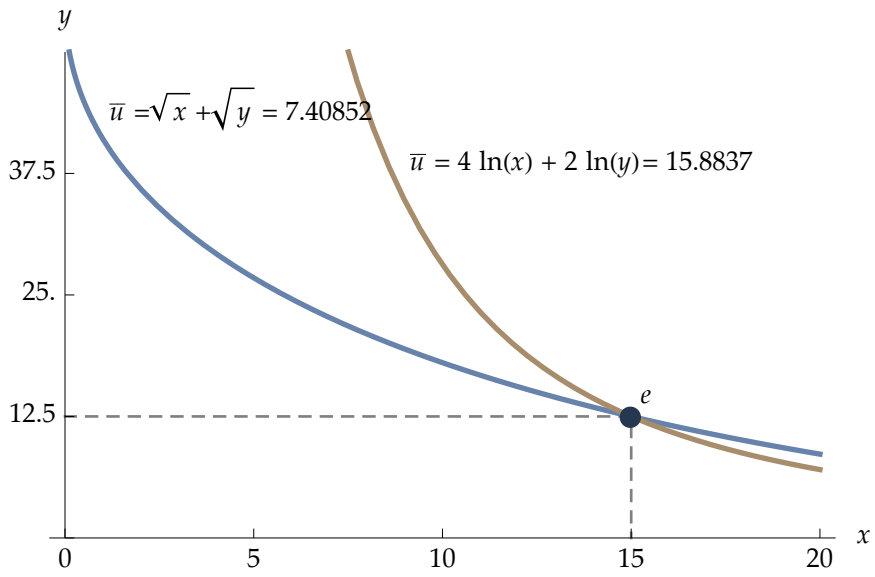
Bundles that a person prefers must lie on higher indifference curves. If someone offered you bundle g in return for e, you would take it. The utility of g is higher (I'll let you do the math), but it's not like you had a higher numerical value of utility in mind when you made the trade. You simply prefer g to e. Utility is not a real, physical, measurable thing like temperature, gravity, or the number of hairs on your head. It is just a ranking that is implied by the choices we make. But actual tastes are difficult to measure before a choice is made or if a choice is not observed. I don't think that many people believe that our tastes can truly be captured by mathematical functions, but if the functions are chosen carefully, they have plausible economic interpretations. A person like you with square root utility would choose g over e. Someone else with tastes represented by another function might not.

So what economic meaning is in the shape of indifference curves? They slope downward because they represent the tradeoff between two goods that a person is willing to make. Take away some of my x, and you'll have to give me a certain amount of y in return to leave me as well off as I was before. The tradeoff always exists if both goods are "good" in sense that more is preferred to less. It is not the case if one of the goods is a "bad" like secondhand cigarette smoke or construction noise. The steepness, ignoring the negative sign, is what really defines a per-

[5] Utility means satisfaction, happiness, welfare, or wellbeing. Better off is an increase in utility and worse off, a decrease.

son's tastes because it is the most y that a person is willing to give up in order to gain one more x or the least y they demand in return for giving up one x. The absolute value of the slope is called the *marginal rate of substitution*. Think of it as a personal price ratio defined by personality or tastes. The marginal rate of substitution at e for the square root utility function is about 0.91: one more or one less x is worth 0.91 y you if you currently have 15 x and 12½ y. The marginal rate of substitution at a is about 1.3 and at b, 2.3. Why does a unit of x increase in personal value moving from right to left along an indifference curve? Relative scarcity. You have less x compared to y at b than you have at a than at e. It makes sense that we value something more highly as it becomes scarcer relative to other stuff. Economics handles this by using convex functions for indifference curves. The functions chosen for indifference curves are also those that never flatten out completely because that would imply that there comes a point when you have so many x's that you are unwilling to pay anything for one more (MRS is zero). That wouldn't sit well with greed assumption. If you prefer more to less, then one more slice of pizza always provides you with some positive utility, no matter how small, and it does not matter that you have just finished your 17th slice.

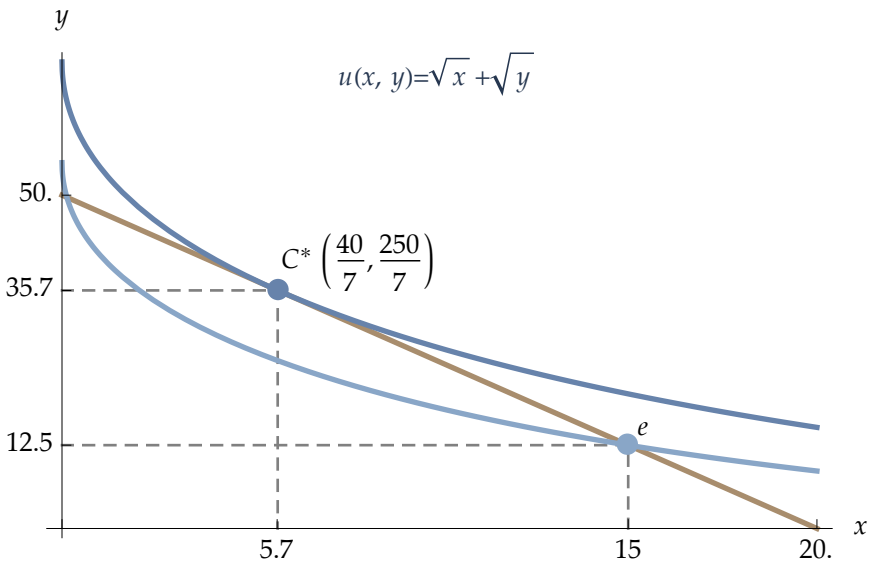
We have different tastes. I wish that high-waisted, pleated pants would come back in style. I bet that you do not. The marginal rate of substitution is the only way to tell one person from another. The next figure shows one of my indifference curves along with yours. I'm the log utili-



ty guy. We both have the same endowment. Who places a bigger value on the next unit of x?

Consumption optimum

Utility theory brings together budgets and utility functions in a simple mathematical optimization: *people make choices that maximize their utility subject to their budgets*. English translation: people make the best choices for themselves that they can afford. As a person whose tastes are represented by a square root utility function, you would choose bundle C^*, about 5.7 x and



35.7 y, because this brings you the highest utility. I'll let you check that utility at the optimum is 8.3666. There is no other bundle on the budget line that gives higher utility because the indifference curve that passes through C^* is tangent to the budget line; it touches the line at just that one point. Moving the indifference curve any higher would place it above the budget line, and those bundles are not affordable. Because the optimum is a tangency, it is determined by equating the slope of the indifference curve to the slope of the budget line. Because the negative signs of the slopes cancel when they are set equal to one another, C* is chosen so that the marginal rate of substitution is equal to the price ratio, which is constant at 2½.

$$C^* : MRS = \frac{p_x}{p_y} = \frac{\$5}{\$2}$$

The marginal rate of substitution is the rate at which you are willing to trade x for y, and the price ratio is the rate at which the market is willing to trade them. You cannot make yourself better off when you reached the point where the value you place on the next unit of x is the same value that the market places on it. How did you get there? If utility theory says that people maximize utility, they are always at C^*. Why would anyone be anywhere else? If there was a change in prices or income or some other event that moved them away from C^*, they would quickly do whatever was necessary (like trade) to get back to C^*. That implies that we really

wouldn't find people at *e* for any appreciable length of time unless, of course, *e* and *C** were one and the same. But not many would understand utility theory if they were told that *C** simple *is because it is*, so the explanation almost always includes a story of how the person trades from their endowment to move up along the budget line until they reach *C**. At *e*, your marginal rate of substitution is less than the price ratio, which means that you value the next unit of *x* less than the market does. So you sell some of your *x*'s in return for 2½ y's each. As you climb up the budget line, your marginal rate of substitution increases because *x* is becoming relatively scarcer to you. The bliss point is reached at C* when your marginal rate of substitution is exactly equal to the price ratio, and you stop selling.

Things to think about

Bundles that lie below the line. Affordable? Would a person choose one?

What is the difference between a utility function and an indifference curve?

What is the utility of bundle *g*?

Why can't your indifference curves cross one another?

Wealth versus welfare?

There is something wrong about using the square root utility function for modelling utility. What is it?

How would you draw an indifference curve if one of the goods was a "bad," like second-hand cigarette smoke or construction noise?

Review

consumption optimum

endowment

flow vs. stock

income vs. wealth

income constraint vs. wealth constraint

marginal rate of substitution

price ratio

relative scarcity

utility (a.k.a welfare)

NOTE 3

Welfare and Exchange

What can be said about the welfare of society as a whole if, as economic theory assumes, each of us looks out for number 1? Go to school or not, get married or not, get a job or live in your parents' basement for the rest of your life. All of these me-first decisions inevitably involve us interacting with each other, affecting each other, and while not always apparent, take in place in countless different markets.

What then does it mean for a society to be as well off as can be? One gauge of best welfare is a Pareto improvement. An allocation is Pareto optimal if it is impossible to make someone better off without making others worse off. You can also say that an equilibrium is Pareto efficient or allocationally efficient. The table shows some other ways of identifying a Pareto optimal allocation. How do we get there?

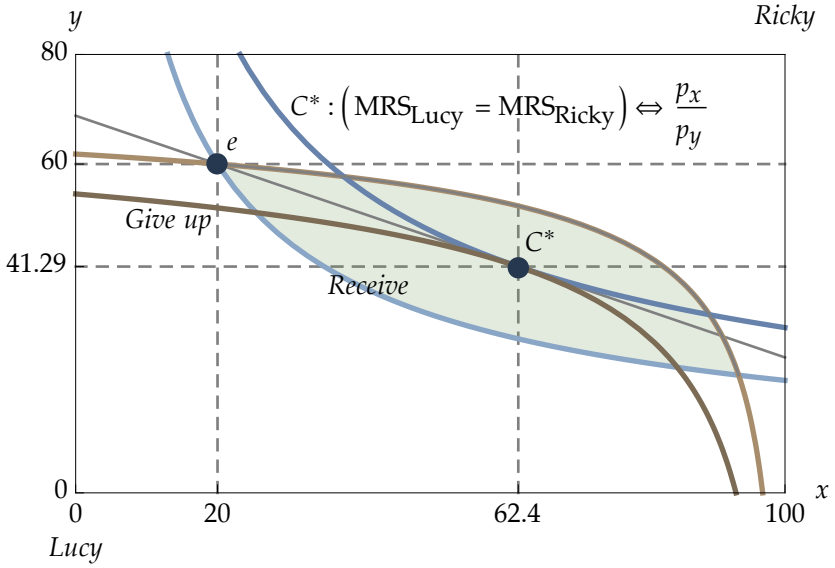
An allocation is Pareto optimal if there is no way to…
make everyone better off.
to make one person better off without making at least one other person worse off
gain from trade without someone else losing from trade

Here is how to draw a Pareto optimum. Pretend that the economy is inhabited by just two people, Lucy and Ricky, and both have log utility functions of the form

$$u = a\ln(x) + (1-a)\ln(y)$$

where $a = 0.4$ for Lucy and 0.6 for Ricky. Lucy is endowed with 20 x and 60 y. Ricky is endowed with 80 x and 20 y. This means that the aggregate endowment or supply of x and y in the economy is 100 x and 80 y. The economy can be represented as a rectangle, called an Edgeworth exchange box, with the width equal to the aggregate endowment of x and the height equal to y. Lucy's origin is the lower-left corner and Ricky's the upper-right. Lucy has some level of utility associated with her endowment, with an indifference curve passing through it (the light blue one), and so must Ricky with his (the light brown one). Point e represents their endowments, read from Lucy's perspective. Lucy increases her utility if she can obtain a bundle that lies above her initial indifference curve. For Ricky, down is up because his origin is the top-right

corner of the Edgeworth box. He increases his utility by moving down towards Lucy's origin. The green lens-shaped area formed by the intersection of their initial indifference curves, in-



cluding the boundary, is the area of Pareto improvement. A reallocation to any point in the green area from e would make both better off, or at least one better off without hurting the either. Neither would object to such a reallocation.

	Lucy	Ricky
Taste parameter a	0.4	0.3
Endowment e	{20,60}	{80,20}
Optimum C^*	{62.4,41.2941}	{37.6,38.7059}
MRS(e)	2	0.107143
MRS(C^*) = price ratio	0.441176	0.441176
Utility(e)	3.6549	3.41162
Utility(C^*)	3.88586	3.6473

The allocation C^* is the Pareto optimum. At this point neither Lucy nor Ricky can be made better off without making the other worse off. If Lucy were to move to a higher indifference curve, Ricky would have to pull back to a lower one. The same goes for Ricky. To get to C^*, Lucy bought some x from Ricky in return for some y. It makes sense that Lucy would buy x from Ricky since her marginal rate of substitution at e is bigger than his (can you see that?). At the Pareto optimum, Lucy and Ricky place the same value on the next unit of x in terms of y, so there are no mutually advantageous trades left. Mathematically, their indifference curves are

tangent to one another (the grey line passing through e and C^*), which means that their marginal rates of substitution are equal. It is the condition that defines the equilibrium.

Their common marginal rate of substitution at the Pareto optimum must also be the equilibrium price ratio. If money were to take the place of barter, the dollar prices of x and y, whatever they might be, would have to be in the ratio 0.441176 (see table or, again, the tangent line passing through e and C^* in the graph). Notice that the price ratio is not given but is, in fact, determined jointly with the optimal allocation C^*, and is called a *general equilibrium*—the values of all important variables, such as consumption and the price ratio, are determined jointly. You are not expected to be able to compute the Pareto optimum in this course (take my FINA 385 for punishment), but you should be able to look at the figure or table above and interpret them.

When a market is allocationally efficient, the allocation of goods and services and the price ratio together reflect an aggregation of everyone's tastes. If production had also been included in the economy, the allocation and price ratio would also be driven by producers, which could be Lucy and Ricky, each choosing the mix of x and y to manufacture so as to maximize profits.[6] You can think of an allocationally efficient market as one in which each person derives the most benefit—utility for consumers and profit, which in turn becomes utility too, for producers—at the same time that everyone else is doing the same. It is an equilibrium in the sense that there is no incentive for anyone to change: Ricky is happiest with his consumption bundle (37.6, 38.7) at C^*, and Lucy hers (62.4, 41.3), in light of the price ratio, 0.441176, and the price ratio is literally what it is because Lucy and Ricky are holding bundles for which their marginal rates of substitution are equal. I know what you are thinking: this whole general equilibrium looks like a tautology. Well, it is, but that is a problem of the economic paradigm that we'll have to leave for another day.

Arrow's Impossibility Theorem meets The First Welfare Theorem of Economics

Goodness, that's a long heading. It looks like trade is one way for an economy to reach a Pareto optimum, although it isn't clear what kind of trade, or whether the optimum is unique or exits at all. But are there other ways? Could a government or benevolent dictator come up with a formula to reallocate the endowments of its citizens to a Pareto optimum—doing what is best for the people? Does a democratic system of majority vote do the trick? Lotteries? Rankings? No such luck. Professor Kenneth Arrow figured out that there is no social decision rule that can guarantee a Pareto optimum (that's why it's called Arrow's Impossibility Theorem). The reason is pretty simple: governments, rulers, or anyone on the outside, cannot know people's tastes, so

[6] The economy described here is sometimes called a *pure exchange economy* because there is trade but no production.

it would be a fluke if any social decision rule they created could pick off a Pareto optimum. Makes you wonder how the millions of shareholders in modern corporations agree to anything!

Trade saves the day though. But only one kind of trade or market guarantees a Pareto optimum, and that is pure competition. This is not competition as in destroy-my-competitors-no-matter-what kind of competition but the kind we read about in textbooks where everyone is taken to behave as if they were price-takers. This means that when Lucy is thinking about how many y's she'd be willing to pay Ricky for so many x's, she does not think that her demand for x could somehow influence its price in the bigger scheme of things. The same goes for Ricky. Of course, the demand and supply of the millions of people like Lucy and Ricky, taken all together, do influence prices and quantities. But individually, each person must act as if they were inconsequential, tiny fish in a big sea.

If Lucy and Ricky set out to maximize their utility and do so by trading as price takers, they will arrive at a competitive equilibrium. The *First Welfare Theorem of Economics* tells us (we won't prove it) that competitive equilibria are Pareto optimal. So, if you know that a market is in equilibrium in a supply-equals-demand sense *and* that it is a purely competitive—something harder to do—then you also can conclude that it is also Pareto optimal. You don't need to know anything about people's individual tastes or motives. It is underlies Adam Smith's idea of the invisible hand at work: everyone acting in their own self interest makes for the best outcome for society as a whole. The implication of The First Welfare Theorem of Economics is profound because it suggests that free markets and economic freedom in general—private property and protection of property rights, reasonably low taxes, rights to trade and do business—should be the default path for improving societal welfare. What does that say about centralized economies?

Review

pure exchange economy

general equilibrium

Pareto improvement and optimum

Arrow's Impossibility Theorem

The First Welfare Theorem of Economics

price-taker

pure competition

NOTE 4

Information

In the previous note, one x is valued at 0.441176 y's in (general) equilibrium. Everything about the economy is packed into that price ratio. When the price ratio changes, it signals change, although what change is not always clear: technology, weather, demography, tastes, health. Take a step back from the price ratio to the information about those things that might cause the price ratio to change. Firms have to buy or rent their factors of production. For this they need financing from investors in the form of equity and loans. While the relative prices of goods and services are a signal to firms to allocate their factors of production profitably, existing and potential investors also rely on signals from the prices of financial securities to help them know whether this is being done; otherwise, investment capital wouldn't necessarily flow to the firms earning the highest return for a given level of risk. If we are greedy, wouldn't we be monitoring all kinds of information, trying to figure out its effect on the prices of goods and services, and in turn, the effect on the prices of stocks and bonds of the companies that put out those goods and services? You bet. Good news about the future cash flow of a firm should translate into a rise in the price of its securities and bad news a fall because greedy investors act on the news. How big a rise or fall? The *present value* or *discounted value* of the change in future cash flow, such as dividends, that investors expect to receive.[7] The level of and change in security prices presumably acts to discipline firms to produce efficiently.

How quickly should security prices adjust to new information? If enough of us jump up to buy or sell a financial security when there is news, its price should change quickly, so quickly in fact, that a stock that is underpriced at the moment of good news is never underpriced long enough for anyone to profit from buying it. It is never really underpriced to begin with because new information would be incorporated into the price instantly! (That's economics channeling physics.) That blindingly fast change in price should equal the present value of the expected changes in future cash flow. Some investment companies locate their operations as close as possible to the stock exchange so that they can minimize the length of wire runs from their computers to the stock exchange's servers. Enough said. The price is always right, in theory at least.

[7] You'll get to do some present value calculations and other time value of money calculations in the quizzes.

A capital market is said to be *informationally efficient* if the price of its securities reflects all relevant information about future cash flow. This is also called the *efficient markets hypothesis*. Nowhere is there greater attention paid to the relationship between prices and information than in capital markets, where investors, analysts, alchemists, and clairvoyants try to decipher the effect of all sorts of information on the value of securities. (I remember watching a TV show on PBS about corporations and capitalism in America, and a commentator said something to the effect that if it is reported that a woman dies of breast cancer in America, the price of biotech stocks will go up. I thought it was Noam Chomsky who made the remark, but when I emailed Professor Chomsky about it, he replied that he did not recall.) Informational efficiency is to capital markets what allocational efficiency is to the markets for goods, services, and factors of production. In an informationally efficient capital market, you can't make yourself wealthier trading securities in the same way that Lucy and Ricky do not make themselves wealthier trading x and y in a pure exchange economy. To get rich trading financial securities—and that does not mean hitting the jackpot now and again because anyone can get lucky—you'd have to have valuable information that most others do not have or have a better understanding of the available information than everyone else.

Rational expectations

The assumption that people are soaking up and responding to information continuously also includes each of us taking into account how we think everyone else is motivated and responds to information. A long time ago, an insightful little story about this appeared on the back cover of *Journal of Political Economy*. A group of young people who, while taking a walk on a well-traveled country road, come across a peach tree laden with ripe fruit. When one of them suggests that they stop to pick some peaches, another quickly responds that they shouldn't bother because if the peaches were any good they would've already been picked. That's *rational expectations*. I like peaches, and all the better if they are free. But wait, don't most other people like free peaches? And wouldn't they pick them if they were free? Then why are those beautiful peaches still on the tree?

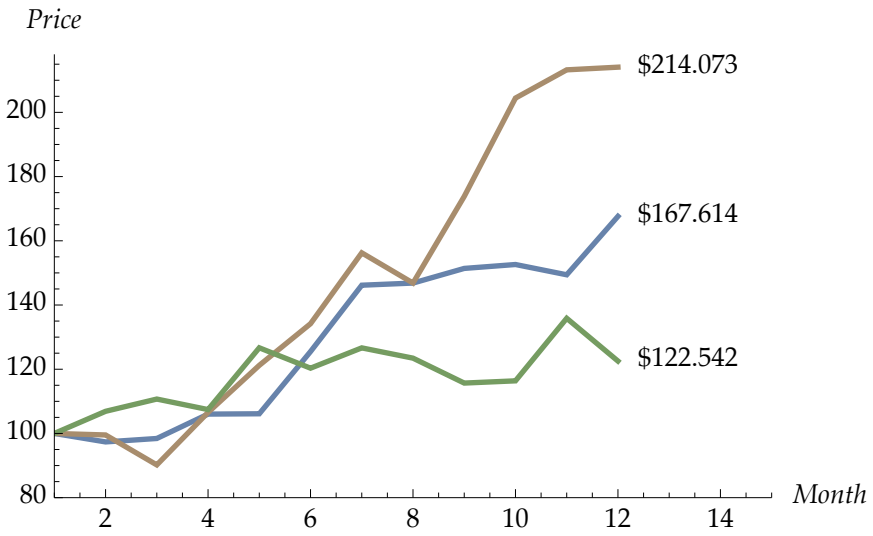
In utility theory, tastes are modelled by utility functions because tastes are unobservable. In the same way, individual decision processes are unobservable, so it is assumed that people behave *as if* they take into account every available scrap of information in making any decision, and that they are frighteningly logical about it. Rational expectations takes this individual logic one step further in assuming that we consider the effect of our choices on everyone else and everyone else's choices on us. The peaches never get picked. Assuming rational expectations to avoid having to include a specification of individual decision processes in economic models implies that people are assumed to behave as if they know the true model, that is, the economist's model of the economy (how convenient for economists), and that they behave as if everyone

else knows the true model of the economy (I know that you know that I know…). An implication of rational expectations is that monetary policy is ineffective. A government that pursues an inflationary monetary policy by printing money will be undone by unions who anticipate the inflation and, in turn, demand wage increases to compensate for the erosion of real wages.

Take a random walk

An implication of the efficient markets hypothesis is that you can't use the past to predict the future: markets have no memory. That's because news isn't really news unless it is, itself, a surprise. If news cannot be predicted, then our reaction to it must result in price changes that cannot be predicted. If you used past changes in price as your information or news, and identified a pattern in those prices that could predict the future ups and downs of prices, then there are probably other clever people who have found the same pattern.[8] Everyone would exploit the pattern, buying when it signals a rise in price and selling when it signals a decline. The buying and selling would cause the pattern to self-destruct, taking down trading gains along with it. That's why it is sometimes said that price changes in an informationally efficient market should resemble a *random walk*, and markets where the past cannot be used to predict future is said to be *weak-form efficient*.

Here are three stocks, each of which happened to be worth $100 at the beginning of month 1. Twelve months later there are big differences in their prices. Some people will look at a price chart like this and see patterns or trends. Some might say that the price of the brown stock has



reached its peak and will soon start to fall. Others might say that the blue stock is trending upwards. What would they think about the green stock? Those who didn't flunk their intro stats

[8] Don't think that you are the only smart cookie out there.

course might compute the correlation of the month-to-month price changes of each stock, despite the fact that they have only 11 price changes to work with (or they might go further back in time to increase their sample size). They might find that one or two of them display *positive serial correlation*: a rise in price is more likely to be followed by another rise than a fall. They might find that one of the stock's price changes is not serially correlated or may be negatively serially correlated (what does that mean?).

If it were now the end of month 12, would you base your decision to buy one of the three stocks on a pattern that you see? It wouldn't matter because there are no patterns. They all follow random walks, where each month there is an equal chance that price rises by 20 per cent or falls by 10 per cent. The monthly changes are completely unpredictable. The only thing that can be predicted is that if you buy any one of them and hold it long enough, your average return will be five per cent over the long run.[9]

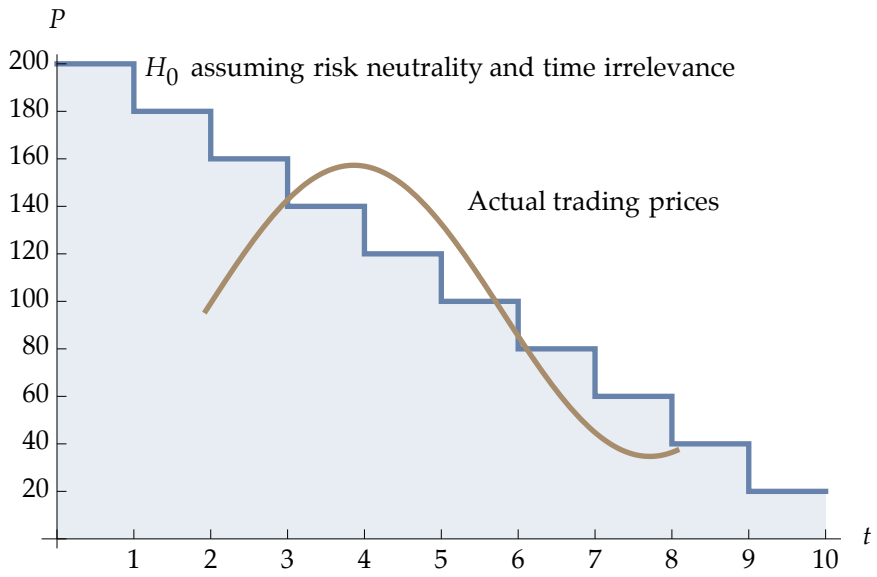
Bubbles and crashes

If people have rational expectations and information about a company's future dividends is widely available, the price of the company's stock should equal the present value of its expected (future) dividends. Professor Vernon Smith ran a series of clever experiments that demonstrated that a stock market bubble and crash could be created in a laboratory under controlled conditions, and that the rational expectations hypothesis is violated (for shame).

Subjects took part in an oral double auction market, trading a stock with a ten-period life. At the end of each period, a coin toss determined whether the stock paid a dividend of $15 or $25, and all participants knew this. The rational expectations price each period, that is, the equilibrium price implied by the efficient markets hypothesis, is simply the sum of expected dividends. Since the expected dividend each period is $20, the predicted price for period 1 is $200 ($20 x 10 periods), $180 for period 2 ($20 x 9 periods), and so on down the blue steps in the figure. In real life, the predicted equilibrium prices would be less than the sum of expected dividends because the market would discount them at some positive interest rate to compensate for the time value of money and the fact that the dividends are risky. But in an experimental market it is reasonable to take the interest rate as zero because each period is short, say, 20 minutes, as opposed to months, quarters, or years, and subjects face little risk since they do not have to put up any of their own money to trade. Subjects are effectively assumed to treat the time between dividend payments as irrelevant and ignore risk. Someone who does not care about risk is said to be *risk neutral* as opposed to *risk averse,* which is natural for real life situations. Risk neutrality implies that subjects care only about the expected dividend and not how risky it is: they see no difference between a fifty-fifty chance of receiving $15 or $25 or a fifty-fifty chance of $5 or $35.

[9] Since we are looking ahead, we can also say that the *expected* return is five per cent, a probability-weighted average, 0.5 x 20% + 0.5 x (-10%) = 5%. Probability-weighted averages are called *expected values*.

The actual average trading prices (brown line) sketch a classic stock market bubble and crash,



where at some point the price might be so high that even if all of the remaining dividends were $25, it would not be enough to recoup the purchase price!

Professor Robert Shiller's surveys of investors who experienced the stock market crash of 1987 and the boom and bust real estate markets of the mid to late 1980s are provocative. He finds there is a marked tendency for investors to focus most closely on recent price changes as their primary source of information about the future, resulting in herd behaviour. If everyone is watching price changes in order to guess what everyone else is thinking, who's looking at economic fundamentals? This is hinted at in Professor Smith's bubbles and crashes experiment in the comments of subjects who reported that they were aware that the stock was overpriced but bought anyway (or did not sell) because they were afraid of missing out on further possible price rises.

> Anyone taken as an individual is tolerably sensible and reasonable — as a member of a crowd, he at once becomes a blockhead.
>
> —Friedrich Von Schiller, as quoted by Bernard Baruch

Is private information reflected in prices?

Suppose you took part in an experiment that had you trading shares of a stock in a continuous, double oral auction market. The shares pay dividends in each of two periods, A and B. The dividends are certain, so you know exactly what you will earn, but yours won't necessarily be the same as those paid to other investors (types I, II, or III). Information about dividends is also private. You do not know what others will earn, and they do not know what you earn, and everyone knows that.

Investor	Period A	Period B	Total
I	$60	$40	$100
II	$90	$50	$140
III	$40	$70	$110

What does economic theory have to say about the equilibrium price in period A and B? If a price is an equilibrium price, there are no gains from trading at that price, and so there would be no point in trading. Start in period B and work back to period A. The equilibrium price in B must be $70 because, at a price of $70, type III investors are indifferent to buying and selling because that is exactly the dividend they will earn. At any price below $70, type III would gladly buy from I or II and pocket the difference between the purchase price and $70, and at any price above $70, III would gladly sell, although neither I or II would buy. Because B is the last period, the equilibrium price is equal to the highest dividend *anyone* might receive, and that happens to be the dividend paid to type III investors. Now slide back in time to period A. The price in A must be at least $140 because type II investors can earn $140 simply by sitting back and collecting dividends. But all investors can trade, and that means that those earning lower dividends can gain by selling to those earning higher dividends, who can of course gain too. The equilibrium price in A must then be $160 because the most that anyone (type II) can earn in A is $90 and the most that anyone (type III) can earn in B is $70. The right to trade means that price reflects the biggest benefit—cash flow in this case—that can be received at every point in time, but it does not matter who receives it. You can also think of the value of the right to trade as being $20 in this experiment, the difference between the equilibrium price of $160 and $140, the biggest total cash flow that any one investor type could earn from dividends alone. That's neat because the right to trade is a legal construct or freedom, and we've just demonstrated that is has value; it results in a Pareto improvement. A right has non-negative value.

It may be hard at first to wrap your head around this result because you can't help but think of real people, such as yourself, trading. How can the price be $160 in A if no one, not even investor III, knows that the biggest dividend to be paid in period B is $70? That's where the finessing assumption of rational expectations comes in. Economic theory assumes that, even though dividends are private information, investors behave *as if* they do know each others' dividends (I act like I know even though I really don't know). Without the rational expectations assumption, the equilibrium price cannot be predicted. And with the assumption, the equilibrium price in each period appears instantaneously. The moment the bell rings to start trading in period A, the bid and ask prices must be $160; the market is in equilibrium from the get-go and no trade occurs. The same goes for B. A market that is so informationally efficient that its prices even reflect private information is said to be strong-form informationally efficient. If real-world markets were strong-form efficient, insiders would not be able to enrich themselves at the ex-

pense of others, and investment advisors and hedge funds would not do better than the rest of us (which, in fact, they generally do not).

That is the theory. For experimental sessions, we wouldn't be quite so demanding. As a subject in the experiment, you are only human after all, and you cannot read the minds of other subjects. We'd expect trade to occur and hypothesize that the average trading price in A is $160 and the average in B $70, and that the trading prices should converge to these hypothesized values quickly rather than slowly. It turns out that in actual sessions the price in period B moves to $70 pretty quickly in the first run, but the period A price hangs around $140. If the experiment is repeated a number of times, subjects learn through the feedback of repetition that the stock is worth $70 in B and then incorporate this information into the period A price in subsequent runs, driving up the price to $160. It takes time to learn just as Bill Murray did in the 1993 movie Groundhog Day. In class, we'll discuss how the addition of a forward market can make the prices in this experimental market move more quickly to their efficient levels.

Review

informational efficiency or efficient markets hypothesis

rational expectations

weak-form informational efficiency

semi-strong form informational efficiency

strong-form informational efficiency

risk aversion and risk neutrality

Keynes beauty contest (look it up and see where it applies to this note)