**EEP100 Lecture 23 (Nov 17, 2009)**

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I have to talk about a lot of stuff today because I have to give you your homeworks. And if I don't get through it, then you're not going to know what you need to know to do your homework. So I hope you enjoyed that peer grading assignment. Hand it in there.

FYI I sent out this…I'm going to repeat what I said in the e-mail yesterday. Deadline, deadline, deadline, deadline. It's crunch time, unfortunately, in this class, and unfortunately, I know you guys have three or four other classes you're probably also facing crunch time? So this is about damage control at the moment. First thing is…you should be reading Schelling. I'm not going to talk…see there's this thing called rational expectations, which means you would have already planned when to read Schelling at the optimal moment given your class schedule, but most of you will be like, "Oh my god, I had no idea I was going to run out of time." Read Schelling before the final. That's the only advice I have.

Number 2: homework three, which I'm handing out, will be due in a week. it's fairly simple. It should take you 2 or 3 hours. It would take Fei an hour or 40 minutes if he wrote neatly. So you guys…if you're taking more than a long time, don't. And you can work in teams (I have no problem with that), but hand in your own work. It will be on the final. I'll also hand out briefing two. As you guys already know, briefing 2 is a rewrite of your blogpost. So I'll go over that at the end of the class.

My plan for the final exam is it's going to be very similar to the midterm. So some people were saying, "Oh my god, I have all these finals, and I have to memorize everything."

If you memorize stuff in this class, you have completely…I have failed. This is not a memorization class. So hopefully, in the course of paying attention throughout the semester, you will have learned things. And then you can study for a little while and then take the final. That's my idea. And I've taken plenty of finals in my life, and I think that…I'm trying to fit it into one of those "think smart, not memorize" finals. Okay, so hopefully when you're hitting finals week, it won't be an issue. The last class is on December 8th. The final is one week later on December 15th. There is no new material on December 8th. We will probably spend most of that time hanging out, talking about loose ends…if you like?

And anybody who wants to set up study groups for the final exam, please go ahead and use the forum on bSpace to do that.

Next time early people, can you sit in the middle, because now there's this pool of nothingness here. And the edges are full.

All right. That's some logistical stuff. There are no sections next week because it's Thanksgiving week. You'll be handing in the homework, but hopefully you'll be able to do your briefing before Thanksgiving. But some of you may not. I don't know.

Sorry about that, I know Thanksgiving homework sucks, but I had no choice. Are there any open questions on stuff?

*Section this week?*

Section this week, yes.

*Class Thursday?*

Class Thursday? Yes. I've already said what I think about striking. I'm here to help you guys. If I go on strike, I don't help you guys. Any other questions? No? Okay, good.

So, let's go back to where we were on Tuesday (a week ago) before Ties came in and told us about dykes. Let's see here.

So let's just revisit this sequential game, and…so you guys remember what we're talking about.

This is just your basic sequential game. And player one is going to move up or down, and player two is going to move up or down based on observing player one's move. I wrote this down on the board before, so those of you who had it in your last week notes…so the way to solve this game is to do what's called backwards induction. You basically look and see what player two would do given that player one had done either up or down. And then player one will say, "Oh, if player two is going to do that, then I should do this." So here's how it works. The payoff in the first one here is for player one, and the payoff here is for player two. This is very standard terminology that I will run into again. And let me make an overview comment about this type of game theory.

It is difficult to walk out into the world and use this kind of game theory to negotiate on buying a car or getting your first job. But it does get you aware of the idea of responding to other people's actions and thinking ahead, as in…if I do this, what will they do. If any of you have played chess or poker or any of those games, you'll be doing that kind of stuff. So this game theory can be useful, but you can't just take this out and stamp it down and make the world a better place.

You have to kind of apply the rules in general (the concepts) so if player 1 does up, and player 2 does up, the payoff to player 2 and 1 is zero for 1 and zero for player 2.

And over here, it's 2 and 1.

And what would player 2 do if player 1 does up? Down.

And what would player 2 do if player 1 does down? Up.

Okay…so then what player one says, "Aha, I understand that. And then you can actually just take the playoffs for player one and transport them over here. Given that essentially very simple logic. And then what would player one want to do? Up.

So the equilibrium in this game is going to be Up and Down. Which corresponds to the move of one and two. That's what I was talking about last week. Everybody got that?

Now let's do something…let's make it complicated. Let's just say that…

Let's do something called…we don't know what player one did. So that, in a sense, makes this into a simultaneous play game. Player 2 doesn't know what player 1 is going to do. Alternatively, one way you can actually say is that…instead of one, you actually have nature

moving. So you don't know what nature did. You're kind of walking in there going, "What should I do, given that nature could do those two things. Or given that player one could do those two things." So you have a problem of…this is no longer a complete information game. No. It is complete information. It's imperfect information because you haven't observed their moves (their prior moves).

So this starts to get really painful on the brain. But here's what you would do. So player two is sitting there going, "I don't know what player one is doing." But let's see it this way.

If I go down (I'm player 2). If I do down, I'm either going to get 1 or 1. I don't know what player 1 did. Does that make sense? I'm either going to get 1 or 1. So I know the payoff from going down is equal to 1. Okay, that's simple.

And if I go up, I'm either going to get zero or two. Let's put a prime here. Oh sorry. Zero OR two. Now we can't put a probability on any of these moves rights now. But we're going to get one of these two things. If you just say, naively, up or down, flip a coin, then the expected payoff…expected profit equals one. Let's just say. If it's 50/50. If you were playing a game, and you had a sure choice between a sure thing of 1 or a 50/50 chance of one…an expected payoff of one. 50% zero, 50% two, what would you want to do?

The sure thing. This is what comes out of the theory of risk aversion. And I'll talk a lot more about risk aversion on Thursday because I'm going to go into things like climate change and risk versus uncertainty, which is in the news, apparently. So if you have a choice between a sure thing, then you would take that.

Now unfortunately, that's not the end of this problem because if you are…if one is sitting there going, "He's going to go for that sure thing." I'm going to…so that means down. And down, as far as one is concerned…what is one looking at in terms of payoffs? Two or three, right? And… in a way…look at it this way. If one goes down, then it's either one or three or two or zero. So let's just say…if it's down and three, that's good. So maybe one wants to go down.

But if two is sitting there thinking about that, what would two want to do? Go up.

So, basically, what turns out is that...that is the (if we can) equilibrium. It's based on very weak logic. It's based on educated guesses. But you start off with down, and down is observed by one, and one would say…I'm going to go down. And two's like, "I'm going to go up." And one can't really do anything about that in either way, because it's a simultaneous game. And it's a best guess of what to do. And this is…I'm just going to…I'm not going to call it an equilibrium of very bleak.

I'm just giving it as a demonstration of the thinking. But you're not getting a black and white answer, which is annoying for people who want black and white answers. But that is what it's meant to do. It's meant to tease it out.

So it turns out in this…the equilibrium is down, up. Now…question

*I just have a question. So because the second player's optimal move is down, player one assumes that and then sees that his optimal payout is to go down if he goes down. But player two hasn't moved yet, so he goes up. Because he is…*

This is complete information. So everybody…they both know what's going on. They both can look at this board, here. I mean…think of it…if you're sitting there playing this with your friend or your enemy, and you're trying to figure out what to do, you would be going through this kind of logic. Well I should go down…and then it's not like other person's going to say, "Oh duh, okay fine." I know he wants to go down, but I'm not going to reply to that. Because if he goes down, and then you're like, "Oh, I'll go up," it's like…you're looking at a 2, maybe. But that doesn't pay off as well as going down on a down, which is a 3, right? So that's clearly dominant…to go down on a down. And then you're like…as player 2 you're like…whoa, he's going to go down on a down. Then I'll go up. And it's hard to get away from that particular set of moves. It's hard to find a better set of guesses, let's say. And as I said, it's not black and white. This is where you actually want to have a mixed strategy. But we have to play pure strategy. You have to play one move down or up. You can't play down 20% of the time, and up 50%...or 80% of the time.

Mixed strategy stuff is what I was talking about last week. There was a hand over here?

*I would assume that player one would always play up because he knows that player two would never play up.*

But player two doesn't know what player one is going to do.

*Why wouldn't he just play down? Because then he…*

Who play down?

*Player two.*

Well, player two might play down, but if he plays down and in case…and he looks at…so this first step is "down is a good idea". Number one understands that. Number one, therefore, will say, "Oh yeah, if he's going to go down, I definitely want to go down.

Number two understands that. Number two says, if he's going to go down, I'm going to go up.

*So where do you stop?*

You kind of stop around there. I'm saying that you stop around there. Try and go further than that, right? It's more or less stable. It is…I mean…theoretically…I don't even know if I would call it as equilibrium. This is like one of those…this is identified as an example where you get an equilibrium. But it's very shaky.

Because if the person's like…they don't think ahead…they failed at math, or whatever, you're doing this 50/50 probability stuff. There's all these assumptions that are rolled into it. And this is just an example of how this kind of…it's more uncertainty than risk. There's no probability assigned to either of these moves.

This is why it's actually appropriate to talk about nature. Is global warming happening or not? You don't know. It's not a 40% chance. So if you don't know, then you're like making a best guess. And that's what drives people crazy. They want certainty. But this is meant to describe a situation, but you can't get certainty the way it's been set up.

There was a hand in the back?

*What do you use the prime for? Do you assign the prime for the second move?*

The prime is to the second move or just because it's a label. This could be U1, and this could be U2. On your homework I say U2 for player 2. It doesn't mean anything except that's their move. Any other questions on this?

Okay, now let's look at that again, but let's assign some probabilities to it.

Oh yeah, okay.

We're going to have nature moving…and we'll just leave it player 2 just because. And let's say that nature has a 50/50 chance. Now we're talking about risk. It's not uncertainty. It's a 50/50 chance based on these payoffs that natures going to go up or down. Then you can actually collapse this game into just this one branch here. And what you're going to have…50% chance going up…if you go up, then it's going to be ½ times zero. Let's just look at your own payoffs if you're player two. ½ times zero plus…if you go up, it's 50% chance of down, ½ times two.

So nature's going to move. If you're moving up then you're either facing a 50% chance that nature went up or a 50% change that nature went down. Does that make sense? It's still part of that. You don't know which way nature went.

But your expected payoff for your up move is going to be half time zero one plus half times two, which is one. Your expected pay off for down is going to be ½ times 1 plus ½ times 1. 1. But this one is equal to ½ times 1 plus ½ times 1, and this is equal to one half times zero plus one half times two.

You are a risk aversive player. Which one will you choose? Up or down? Down, right? it's a sure thing in terms of expectations. That's given that we have that prior probability of ½ up or down.

*So if the top one was two, for example, instead of three. And the expected probability was 1.5, which is higher than one, but I have a higher risk.*

Then what you have to find out…I might actually do more talking about that so called…

It's like a risk premium…like how much you you're willing to pay to avoid risk. So here's the… when you talk about risk…you've got people who are either risk averse, neutral, or seeking. The guys from what's that show? Butt hole?

*Jackass?*

Jackass? These are risk-seeking guys. Let's go jump off a roof with a paper bag as a parachute. Those guys are risk-seeking. Their life expectancy is small.

That's what the Darwin awards are all about.

Risk neutral says you would look at a probabilistic payoff as if it was certain. If you were risk neutral, you would look at this payoff, 1 versus 1, and say, "I don't care. I am indifferent between those two." You are risk neutral. You do not care about the probability of not getting a

payoff. If you are risk averse, then you're going to have…you'll be more wary of a probabilistic one compared to a sure thing one.

The question is…well what if it was 1.5? Expected payoff of 1.5 against 1? Well then, maybe you would go for it. It depends on how risk averse you are. And that can be, in theory, it is quantifiable. Essentially the way insurance products work. But I might get into that later. Question?

*If the probabilities aren't ½ , ½ would you have to do these trees?*

Absolutely. No…you don't have to do these trees. You just find the expected payoffs. That's what I was going to do over here. So let's do that. Let's do that given that it's going to be… nature's going to move with the probability of ¼, ¾. So the branch, the up-branch, is going to be ¾ probability.

Your payoff for number two…you don't know what nature did, but your payoff for going up is going to be ¾. If you go up, you're going to get a payoff of 0 times ¾ plus ¼ times this payoff, which is 2.

It's a ½ expected payoff.

And if you go down, you're going to get a payoff of ¾ …I don't know if I did that right because my notes are wrong. We'll do it…you're right.

¾ times 2 plus ¼ times…no sorry I got it backwards. ¾ times 1, and then ¼ times 1. What did I do here that was wrong? Oh well, that doesn't matter. It's still fine.

So unfortunately, we have…I should've flipped that over and turned it the other way around. Can I do that without screwing everybody's notes up?

What did I do wrong? ¾ and ¼. Okay so sorry. ¼ times 0, ¾ times 2 is 3/2. So now you've got an expected payoff of 3/2, versus a sure thing of 1. If you are risk neutral, you will take the 3/2. You will go up. If you are mildly risk averse, then you'll still take the odds.

If you are very risk adverse, you might still go for the sure thing.

So is the issue, for example, global warming then? You have all the population, and some are risk averse and some are neutral and some are seeking.

*So some people would say, "No, let's do everything possible to avoid global warming even though they payoffs may be lower?*

The thing about global warming is it's not necessarily about risk aversion. I think the general population is about risk aversion. The question is what are the payoffs. So there's fear, uncertainty and doubt involved in what's going to happen and when is it going to happen

If we're all going to die tomorrow because of global warming, that means we should do something today.

But if it's maybe going to happen in 20 years, and maybe going to happen in 50 years, and really, kind of, maybe in a 100 years, then the future is so far away, that it's not necessarily going to affect us now if we're paying now.

So there's distance, which is about discount rates, then there's uncertainty, or risk. There's probability problems. It's actually more uncertainty than risk. Because we really don't know. If the ocean tips over in terms of the way that it's…the equilibrium, and everything dies in the ocean, that would be like…tragic fall of a cliff problem. So that's kind of…on the one hand that's like the science debate. But the other one is like…do we care about the future. Or the unborn.

Republicans care about some unborn, but not other unborn.

*Is another matter that the premium that would have to be paid to…*

Absolutely, it's a cost benefit question.

*But if that person, for example, the 1.5…only pays 0.2 to avert the risk, then, for example, it would still be worthwhile to avert the risk. But if it's more than that, then…*

So that's a good question. If you had to pay…if you're looking at this gamble here, and you're risk adverse. And you could pay ¼ to get certainty to know what nature was doing…what would you do? Would you pay ¼? And then you would do what?

*It's going to go up.*

Well actually it will be interesting, because you'll pay a ¼ but then you would know what nature did, and nature did go down. Or you would know if nature went up or down. But at least you would know whether or not it was worth taking this up move.

That's kind of insurance questions…information. The big topic…let's leave that for Thursday...let's roll along…any more questions about this stuff here? I'm going to switch to another model.

*Just clarifying the definitions here…if neutral is…I assume they see the benefit, and they don't care about the risk; they just go for the…does seeking mean they seek out risk, regardless of benefits? Or they'll choose the risk provided the benefits…*

If you're risk seeking, that means that expected payoff equals $1. And let's say that's equals to 1% times 100 plus 99% zero, then you would prefer this to a dollar. That's like crazy risk seeking. And even if you did 99 percent chance of a dollar, one, or whatever it would work out to. And a 1% chance of zero. Whatever it would average out to. One…you would still be risk seeking.

So if you'd rather have a gamble than a sure thing, based on the same expected payoff, then you are risk seeking. How much is a different question. Any other questions about this?

I'm going to get away from, I'm going to go into a different kind of game theory now, which is a Cournot competition. The French are very important today.

Let's say that we have two firms. Firm 1 and Firm 2.

They're in a market. They have marginal costs that are fixed, and we're trying to find their actions in competition with each other.

So let's say the market demand is such that price is equal to Q minus10. And firm 1 has a marginal cost of 2, and firm 2 has a marginal cost of 1. Just to be nice and confusing.

Now the profit function for firm one is going to be price times quantity minus cost. So it's going to be…10 minus q. The price, as far as this is concerned, is going to be 10 minus $q_1$ - $q_2$ x $q_1$, which is the quantity. This is going to be price times quantity. This is total revenue minus total cost. What's that going to be?

$2q_1$, right? Because it's the same marginal cost across the board. That's a nice, simplifying function. Profit for firm two is equal to the same thing. 10 minus $q_1$ - $q_2$ times $q_2$ - $q_1$.

*Where'd you get the total revenue from?*

Total revenue is just price times quantity. But because they have market power, it's a duopoly, right? So these guys are the market. So because they are affecting price in the market, so they're facing…together they're facing a downward sloping demand. That's why this is actually an interesting question.

*For the profits for[inaudible] is it q2?*

And take good notes because my 9s an my q's sometimes look the same. Okay. Now. Intuitively, which firm should be producing more in this example?

Two because why? Lower marginal cost right? Okay. So let's work out what they actually do produce. And what we're going to do is we're going to do what are called…we are going to find what are called reaction functions. Given that you're going to produce…I'm firm two. Given that firm one is going to produce X, Y, and Z, what should I do? And firm one is like… given that firm 2 is going to produce X, Y, and Z, what should I do? How should I respond? What's my reaction, right? That's why they're called reaction functions. So let's write out this profit function from firm 1, just so we can do the algebra easier. It's 10…we'll distribute that $q_1$. Minus $q_1$ squared, minus $q_1q_2$ minus $2q_1$, and that's equal to $8q_1$ minus $q_1$ squared minus $q_1q_2$. This is just step-by-step mathematics so that you see how the algebra works.

*Is that a seven?*

Probably not. 2. And likewise, we can rewrite profit 2. I'm just going to simplify…hopefully I can simplify this. There's only one here, so this will be 9 $q_2$ minus $q_2$ squared minus $q_1$ $q_2$.

So what are we going to do? The kings and queens of Lagrangians? First order conditions, yes. We are not going to use any Lagrangian. That was not meant…we're going to optimize. We're going to take a differential. So we're going to find change in profit one with a change in quantity one. Firm one only gets to choose how much quantity firm one is going to do, right? If we take that differential, the result that we get is going to be 8 minus $2q_1$ minus $q_2$. We're going to set it equal to zero.

So these guys are the market. So because they are affecting price in the market. Likewise, we're going to set that…for firm 2, the optimal first order condition that comes out is 9 - 2q2 – $q_1$ is set equal to zero. We're setting it equal to zero because we want to find a maximum. We want to have the maximum profit. Now we can simplify this, and solve…as far as firm 1 is concerned, we want to solve for $q_1$. So $q_1$* is going to be equal to…we've got to put this on one side and the other stuff on the other side, it's going to be 8-2 $q_2$/2.

For the profits, is it $q_2$? And $q_2$* is going to equal 9-$q_1$/2. Is all of that more or less straightforward now? This is a technique that will be helpful in about 46 minutes when you get your homework. That was a joke.

Now, what I want to do is I want to take… I can't lift this board up. Does everybody have this written down? I'm going to have to cover it up.

This is going to be kind of ugly because I would like to see that…maybe I'll just erase this.

What I want to write here are the reaction functions on a graph, so that you can see where the equilibrium is going to be. There they are.

If $q_2$ has a quantity…here's $q_1$…is going to go on 2q plus some constants, right? If $q_2$is zero, then what is $q_1$ going to be? $q_2$ is zero, and, likewise, when $q_1$ is zero, what is $q_2$?

4 ½, okay? I'm going to call this $r_2$ for reaction function two, and this is going to be r1.

Using your power of deduction, where on that graph is the important place? Where they cross, right? And what's the number going to be there? How convenient. Look, we've got two equations and two unknowns.

Let's solve that somewhere on the board. Let's solve that over here. Just plug it in. So I've got $q_1$ is equal to 8/2 (I'm just going to write that out) minus $q_2$ (I'm going to plug it in).

9/2 - $q_1$/2 times ½ . I'm just rewriting this. I'm plugging $q_2$* into $q_1$*. And I simplify that 4 - 9/4 - $q_1$/4. Minus and minus. Plus

And I'm going to move this over here, so I'm going to get…this will be your minus…so I get ¾ $q_1$ is equal to 16/4 -9. Is equal to 7/4 ¾ $q_1$ is equal to 7/4. I do 4/3, and then I get 7/3 equals $q_1$ *…7. Everybody see that? Step by step? I'm just trying to do the math. There's no theory.

$q_1$* is going to be 7/3, what's $q_2$* going to be? So I did all my math right?

So then we've got 10/3 $q_2$ equals 10/3, and $q_1$* is 7/3.

Okay, that's a bunch of numbers. But wait, does it match what we said at the start?

Who's going to produce more? Whatever I erased before. Who has the lower marginal cost? Two, right? Who's producing more?

*Two.*

Good. We didn't necessarily make a mistake. Or we made one, and it was not big enough to find. So that's how we find these values here. $q_2$ is 10/3, and $q_1$ is 7/3.

That is a Cournot equilibrium. A Cournot duopoly equilibrium. Whatever you want to call it. Both of the firms are looking at each other. They know each other's profit functions, and they're simultaneously deciding how much to produce, given that the other one is deciding how much to produce. And they get into an equilibrium, which means there's no point in deviating from there.

Any questions about this?

I'm going to alter this example with one small change. Now what we're going to do is player 1 gets to move first. This is called a Stackelberg equilibrium.

So if player one moves first, what's going to be happening? What's going on?

Player one is going to see what player two's profit function is. Going to see what player two's optimal response is. Is going to put that into his own profit function, then find out what's the thing to do. And then player 2 has to just take that as given. That's a fact on the ground, as they say. I was reading…the facts on the ground…this is an interesting…the Stackelberg leader model (Stackelberg leader kind of is redundant, but that's the way it actually means). It is actually something like…somebody moves first, and then you have to take that as given. And decide what you're going to do.

And I was thinking about all of the striking going on about reducing fees. And if I was at the office of the President, and I knew that the students were going to go on strike, and the professors and everything, and they were going to ask for a reduction in fees, there's two things that I can do. One is I can say, "Forget it. No reduction of fees." Or I could say, "Yeah, of course, I hear you, I'll reduce your fees."

Which one is more politically sensible?

*The latter.*

The latter, of course, to say yes, I'll reduce your fees. Now if you know that that's what you're going to do, if you're the UCOP president, what will you do in terms of the fee increase that you announce prior to the protests? Raise them even higher, right?

That's what happens with the so-called Christmas sale. All the prices in October go up by 20%. And they drop them by 20% right before Christmas. Ooh, it's a sale. So if I was at the UC, I'd be like…to cover the budget, we need to raise prices by 10%. The students are going to protest, because they always do. So what are we going to do? Let's raise it by 20%. We'll give them back half the raise, and everybody'll be happy. That's not complicated. And that's what…I'm going to predict that's what'll happen. And maybe it won't happen. Maybe they're just going to be assholes and say no. But if they want to be popular, they'll do that, and either way, you don't make any gain if you're student leaders. Or they don't know game theory and they screw up.

But in that case, if students knew that also and didn't protest, then the UC regents wouldn't have the incentive of dropping it again by 10%.

Then they'd get bonus. And they'd have extra holidays in Bermuda. Oh sorry. Staff retreats. I heard about it from a friend. They're called…anybody know a congressman? They're called Co-Dels. Congressional Delegations. And they go in and they investigate our situation overseas.

And somehow they never end up in North Korea or Mongolian winter…they end up in Cyprus, or in Egypt, where they diving is pretty good.

Let's go do an investigation in Australia. Let's find out what's going on down under.

So these Co-Dels (these congressional delegations)…they're all going out there and helping, serving us on the Barbie so to speak. This is another problem with strategic and behavior, right?

The other one's in the big health debate, which some of you might have heard of going on in the news. The drug companies are being told that they've been charging too much, and that the government is going screw down prices, and what are the drug companies doing?

*Raising prices.*

Right now, right? Prices are going up 9%...triple inflation right now in anticipation of a claw back from the government. So this is actually quite a useful little model.

So let's get back to…what's leader one going to do? Let's keep those things there; we're going to need those.

*So who's moving first in the situation?*

First mover is going to be player one. Now remember, player one is the inefficient one, right? But for some reason player one gets up earlier in the morning and goes out in the market and puts $q_1$ on sale. So player one knows that this is $q_2$. So player one's profit…we're going to rewrite, here. 10 - $q_1$ minus this here. 9 - $q_1/2$ $q_1$-2 $q_1$. Player one is a Stackelberg leader.

Let's simplify this mess. 10 $q_1$- $q_1^2$-9/2 $q_1$+ $q_1^2/2$-2 $q_1$. Equals ½ $q_1^2$.

Is that good?

*How did you cancel negative* $q_1^2$ *with the positive* $q_1$ *divided by 2?*

Well this is going to be 2 $q_1^2$ over 2. That's minus. So one minus two, right?

I did it wrong and then I did it right. There's a little minus sign there now.

*So you're saying that player 1 is going to produce based on what player 2 is going to produce?*

Player one knows player two's…

In the first example, player 1 and player 2 are looking at each other, they understand everything…complete information. And they simultaneously just move. In this one, player 1 get's out of bed earlier and says, "I know what player 2 is going to do. I'm going to move first."

And player 2 is going to have to take that as given. It's not even a credible threat. It is a fact. It is done.

That's our profit function. We'll take a derivative. Minus $q_1$ (then those two cancel out) plus 7/2 equals zero. We'll set that equal to zero. So $q_1$* equals 7/2.

Everybody see that? Yes?

What's $q_2$* going to be? 11/4. Just plugging that in. $q_2$ can't do different. $q_2$ is still going to choose optimal quantity, given that $q_1$ is not going to move…moved. It's still optimal. That's profit maximizing.

*I get all the math and stuff, but how does plugging $q_2$ up there…how does that represent the fact that for one it's…*

Oh, random. Daylight savings time and firm 1 got out of bed an hour earlier and then went…and firm 2 saw that as a fact. Because firm two (this is actually important). If firm two does not see that you moved first, firm one moved first, then firm one's strategy doesn't even matter.

*No, but I mean like…how does that math represent how…*

Because the math represents…because these are their optimal responses given each others' move in a period, right? The question, then, is…if one puts in two's response function, and it makes the move, this is no longer an unknown.

There is none of this up and down line stuff going on. What's going on is that $q_1$ is moving at 7/2, which was…7/2 is more. This is $q_2$'s move. This is $r_1$, but this is a fact. Here. Forget this $r_1$ stuff. So this is what's going to happen. And given that firm 1 is producing 7/2, firm 2 is going to produce that.

So the other example was…we're going back and forth, we're going back and forth. And you can actually see it…you can sit there and say, well, let's just kind of move along these lines here or move along these lines here, or whatever until we get to some point of equilibrium. But we're doing it simultaneously. But if you just say, "I've done 7/2, do what you want, firm 2." Then firm 2's going to be like, "I guess I'm going to produce 11/4.

*So is a Stackelberg leadership situation better for the consumer, in general, because…*

We'll get to that in a second.

Okay, now, for the sake of convenience, what I'm going to do here is I'm going to just show you the totals of quantities and prices side by side to compare these two situations, which is the question here, right?

So, if you've got Cournot versus Stackelberg. The price under Cournot is 4 and 1/3. This is just an example. But what we'll find is the signs of these magnitudes are actually…they're constant.

So price on Cournot is greater than the price on Stackelberg. The leader's producing more, the follower's producing less. And even if you did…remember firm 2 was more efficient? You made firm 2 the leader? Those signs…the signs would hold. The magnitudes might be a little bit different.

*What's the F?*

Stackelberg follower.

And then profits… the profits of the leader go up, and the profits of the follower fall.

Now, interestingly, total profit falls under the Stackelberg example, but the leader makes more money. If you're given the opportunity, and you're sitting in a Cournot situation, and you're given the opportunity to be a leader. What are you going to do? Are you going to take that or leave it?

*Take it.*

You're going to take it. If you get to be the leader, you're going to make more money, even though overall profits will fall.

But wait a second. If you're the government, should you allow…should you create a Stackelberg leadership situation? Who thinks the government should allow…not allow…facilitate…is that my word? Facilitate Stackelberg leaders? Yes they should? No they shouldn't? Yes they should?

A very small minority. Okay consumer surplus kids, which one should they do if you're the government. Consumer surplus is bigger. Price is lower. I suppose this is a good justification for political lobbying and corrupting, but I did not say that.

If rice is lower because consumer surplus is lower because the demand function is the same.

*Consumer surplus is higher.*

Sorry, what did I say?

*You said lower.*

Price is lower. Consumer surplus is HIGHER. Yes. That's what I'm imagining I said. It's on tape. It's all wrong.

Now the thing is…in terms of total social surplus, there could be a difference because the profits have fallen. But if you're worried only about consumers, then you would think lower prices are better. I've never actually thought about this. It would be a good question to look on the Department of Justice website on the FAQ on Stackelberg leaders, which I'm sure they have.

You know NASA has an FAQ on the end of the earth now? On 2012? Everybody thinks the world…oh my god the Mayans were right. And then NASAs like…no, they're not.

*So under Stackelberg, it's not just lower prices, it's more produced over all?*

No there's, I believe…well there is more produced. What's q? Total quantity is 6 ¼ versus… well no…total quantity is higher because this is just 10 minus the price. Total quantity is higher, price is lower.

*So Stackelberg's not only to get a cheaper price for the consumer, but also so more people would get…*

Yeah, they come together. They come as a team, right?

The problem is that…you have the…in this particular example, the low efficiency firm is producing more. From a social surplus perspective, because of the higher cost, this is not necessarily a good thing. So the profit is lower.

But if the low cost firm is actually given Stackelberg leadership, that would kind of be a gain game.

*So if the wrong firm gets a high marginal cost curve to lobby, then they may still end up being bad, so then…*

You answered my own question. That is what will happen. Stackelberg leaders are a good idea. Congress says yes, so the inefficient firm goes and gets that position. The consumers benefit. But society as a whole is worse off because we're using like…baby hearts instead of rice for manufacturing process.

Any other questions? Any other questions on Stackelberg?

So this is stuff…what kind of problems could we have with this model in terms of the assumptions? I'll just point this out. No, this is Bertrand, hold on. That's the end of Stackelberg.

Okay, so I'm going to go on to Bertrand. And it will take less than the rest of the time period.

I think I can just say this. So let's see here…

Bertrand competition has a bunch of assumptions. The first assumption is that…Bertrand competition is competing on price. The firms over here were competing on quantity. I set $q_1$, you set $q_2$, we set them simultaneously.

But what is you're competing on price? If you're competing on price, then you pay attention to marginal cost, or the cost of producing the good. Let's assume there's no fixed costs, let's assume that marginal cost is also fixed, and if firm 1 has $C_1=2$ and firm two has $C_2=1$, and we had unlimited production capacity at that marginal cost, and we're competing on price, what would the price go to?

So there's a suggestion, from the floor, of one. Who thinks it's going to go to 1? Who thinks it's going to go to 4? Give me a suggestion. I need another suggestion. 2. Who thinks the price is going to go to 2? Who has no idea?

We're learning. Okay.

*Is this a duopoly still?*

It's a duopoly. Only two firms. Now, let's look at one. If the price goes to 1, can firm 1 produce anything? They can't because they'll lose money.

But wait a second. If you're firm 2, would you lower your price to 1?

*No*

Where would you lower it to?

*1.99*

1.99, like the gas stations. And 9/10. This is going to be…if you want…this is the particular example from two different firms. Even worse, the typical assumption for Bertrand competition (this is where academics really get out of control) is they say...not only that marginal cost is fixed, but let's have two firms with the same marginal cost. What's the price going to be then?

*One.*

One, right?

Not 99 cents? Not a dollar, one.

And until you go all the way down to one. If I'm firm one, and I do $1.28, and you're firm two, what are you going to do?

*$1.27.*

$1.27…$1.26! Oh, what are you going to do?

*$1.25.*

And until you go all the way down to one. And they split the market, essentially, arbitrarily, half and half. 50/50.

*Why would you produce if you're not getting any profits if the price is at 1?*

Just because we love to produce. Remember, we're using economic profits. The economic profits of zero. You're still in business, you're paying a salary, but your economic profits are zero. And the Bertrand thing is like…it's got a whole bunch of assumptions. There's only 2 firms. There's no entry. Costs do not change. You could absorb the entire market.

Coca Cola would love to wipe Pepsi out, but they could not absorb the entire market. Let alone…Inca Cola would come in, or whatever. Inca Cola is like bubble gum. Who's had Inca Cola.

*So good.*

So good? Yeah. As long as it's different.

*It's the real thing.*

It's the real thing in Peru, yeah…Inca Cola. They had another one in Iran. It was called Mola Cola or something like that. What was it called? Who knows this, Iran?

*There's also…*

There's all these…yeah. All these anti globalization…drink our crap.

Assumptions. Okay. Now this result here is the same as what, in terms of what we started off the semester with? Firms are selling at marginal costs; profits are zero…perfect competition right? Maximize market expansion, surplus maximized…

So this is the theory behind…only two firms are necessary to get perfect competition.

As far as I can tell, it's never happened. The two firms to get to perfect competition? But on the other hand, you do see some pretty vicious price wars between, essentially, duopolies. Two firms that are competing against each other.

And that is…and they're competing, probably, on price. So there is some notion of truth here. It doesn't necessarily go all the way to the extremes. So in that sense, you should be learning from it, but not to the…from a religious perspective.

*But if they can foresee this outcome, wouldn't…like…say the first guy says, "Put up 2." Wouldn't the second guy just go, "Oh, well I'll just put up two." And then we split it.*

Right. So there's another huge assumption called…they don't coordinate. They don't form a cartel. Right? Assumption, assumption, assumption. Fall apart immediately, based on reality.

So as soon as you get into a Bertrand situation with your opponent, the first thing you do is schedule a business lunch. Actually there's…who's ever had those mini carrots? Who thinks they're born mini carrots? Baby carrots. Right? You know they're actually put on laves and shredded down in the south valley.

And there's two firms that dominate the baby carrot business, and they are across the street from each other. And I went down there…I was on this ag tour from Davis, and we were having a presentation from one guy who was from baby carrot factory number 1 or firm number 1. And I said, "So do you play golf with the guys across the street?"

And he didn't answer. Because the profits on those things are insane, right?

And people are like…whatever happens to all the waste? I think the waste goes into things like carrot cake and carrot juice and stuff like that. But that's a perfect example. Because those two firms dominate 90% of the baby carrot market, which didn't exist…we didn't know we needed baby carrots 10 years ago.

*Wouldn't that, in theory, be an open market, so somebody knows…*

No entry! Entry is not allowed. 2 firms! Don't talk to each other! Marginal costs identical! Don't change! There's assumptions all across the board.

*But in this particular case, where it's reality…* [the baby carrot market, yeah] *Why isn't a third firm opening up and not being part of the deal, lowering it just a cent…*

I think on one hand, a third firm will try and come in, and the baby carrot firms see that coming, what are they going to do? They're going to try and sign long-term supply contracts, they're going to create brand identity. Like…what is it called? Bunny Love. That's the brand, isn't it? Bunny Love or something like that? That's like a playboy spinoff or something like that. But they're going to try and keep entry from happening.

And in the end, they might have to…if it actually turns out that these two firms…say that it's firm 2 and 3, and they've got a marginal cost of one because they're actually quite competitive,

and someone comes in and can come in at two. But they're a cartel. Where are they going to set the price? 1.99. So now they act as one firm.

So that's kind of the way businesses would tend to take this situation and analyze it.

*So then the whole assumption that entry is easy is almost never true, then.*

No. The assumption that entry is impossible is not true. Entry is much easier than the Bertrand model suggests. If you have entry…I mean…this could be a form of entry. It's a threat of entry at the cost of two.

So…as long as you can keep out those guys, you'll set your price just below their marginal cost. But like…absorbing the whole market and stuff like that is kind of…crazy assumption.

Oh and there's also an issue of…another big assumption is that the marginal costs of these two products are identical, which means the marginal…the products are actually identical, themselves. Maybe baby carrots are commodities, but every firm on the planet is trying to differentiate their product from somebody else. They have…you can go into all the iterations. They give you a free card punch on your card, they'll make a 16 oz against the 15oz competition, they're going to have…whatever, whatever, whatever. The whole…Coca Cola versus Pepsi… it's like…they're different. Oh, no, they're the same. No, they're different! So they're always trying to make themselves different from each other, so that they can get that little bit of monopoly profits from dominating that difference. It also assumes no transactions cost. You can switch instantly between these two products if you're a consumer, and that's not necessarily easy to do either.

Any other questions about this?

I'm going to pass out stuff for you guys.

While this is coming back, I'm going to read over the briefing and the homework…not the homework…but the briefing. I'll say one quick thing about the homework. There's four questions on the homework. The first two questions are worth 1 point each. The last 2 questions are worth 1.5 points each. That's five points total.

Now, on Briefing 2, I'm going to read this out, so we hopefully reduce…we do not have anything close to the confusion we had over last time. I'll just read this.

As a Robert Frank fan, you want to be in his next book, *Amazing Things I Learned from Students*, a collection of articles that clearly explain the economic forces affecting topics of student interest. You have already chosen a topic (which is your blog post). Now you can rewrite it. And I want you to rewrite your blog post. Do not choose a new topic.

If you are one of the few that did not have a blogpost, then you can come up with a new topic.

So I want you to rewrite your blogpost to improve the prose: style and structure, grammar and spelling…that means…because your peer graders will be looking at the quality of your writing. Refine your economic analysis, especially in response to comments to your blogposts. Make it short and punchy. Short. One page. Like the other one. Right?

*Short as the other briefing.*

Short as the other briefing was.

*1-inch margins…12 point font..*

Same thing. One side of a page, 12 point type, single-spaced, one-inch margins. Put the last four numbers of the student ID. Identical Format. Style: concise and powerful rhetoric. Identical. If Frank or the grader gets bored or confused, you will not be famous, and you will get a bad grade.

Grading: you will be graded by three of your peers. This is single blind, okay?

Oh…I actually wrote…I did it; I screwed it up. Student ID. You can put your name on the top right corner on this. you can put your name on the top right corner.

*You can or you have to?*

You have to. If you're grading, I want you to go look at their blog post.

If you're writing one of these, and you're not basing it on a blog post because you actually did not write one, it's okay to make that note on the top. I didn't do a blog post. Check it out. Save them the effort of going to look for something that isn't there.

*What if your post…like…not a lot of people interested in it…no people comments on there…*

If nobody commented on your blog post, it was either amazing, or it wasn't interesting enough. Or it was a Saturday afternoon, and everybody's at the baseball game. The lack of commentary does not mean your blog post was perfect, and you should cut and paste it. but you will be the judge, and even worse, your peers will be the judge. So this will be…we'll call this enforced commentary.

*My post is long…can I choose just one section?*

Whatever you want—it's got to fit on the page. That's important. If your blog post is too long, it's got to fit on a page.

Also…this new note. Put references, if any, on the back of your page. This is to make sure that if you want to document stuff, you can.

If you quote somebody, you will document it and put it on the pack of the page, okay?

Only references. Not a footnote that has the other half of your blog post.

Can we stick with the same topic, but completely take a new angle?

Say it again?

Can we stick with the same topic, and take a totally new angle?

Yes. If you decide that you want to re-approach your topic from a different direction, that's fine. You might have learned something or changed your opinion or whatever.

Another question?  Don't go yet; we're not done.

Any other questions in the back there?

And it's due in two weeks.  Have a good Wednesday, I'll see you on Thursday.  Office hours now.

**Transcribed and checked for accuracy by Brynna Bunnag**