

EEP100: Lecture 2

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Sorry about the technical difficulties and the late start. It turns out that there's no Internet connectivity in here. I guess we have a little over an hour for the class, and my understanding is that this is the very first class other than some administrative meeting that you had earlier. And that you guys are going basically going to be studying (I think) microeconomic theory as it applies to resource markets and environmental economics. So the style of this lecture will (I hope) be somewhat interactive.

You can stop me at any point and ask me any questions

I'll give you a little bit about my background personally, so that you know what sorts of questions I might be helpful in terms of answering.

I am actually assuming everybody here...this is a graduate class? Is that right? Or this is an undergraduate class?

It's an undergraduate class! Okay! I'm really glad that you guys told me that.

Because I was thinking...I wonder if you're about to all get ready to write a thesis, or if you're just sort of starting to get situated in economics.

So, I'll tell you my background is...when I was your age, I was in a similar class. I studied resource economics, did an engineering degree at University of Arizona, and then I recently completed a PhD at Stanford in the Management Science and Engineering Department. And all of my thesis work was related to resource management. I was in an economic and finance group there.

And what I ended up writing for my dissertation was a series of new pricing models for water. So turns out that you probably know a little bit more about water resources, and it's an area that has been very slow to reform. And there's a lot of complicated economic questions to do with...how we should manage and price water. So that's the area of expertise that I have. So if you questions, at some point, about water resources or the economics of water then hopefully we'll touch on that during the lecture...but you can kind of...feel free to jump in if you have specific questions.

It's okay if we go a little bit off track, because my objective for the lecture is to give you a sense of research level questions and how economics plays into making decision in real resource markets.

And then to give you kind of an opportunity to ask things that are on your mind. David is going to actually take you into the microeconomic theory, so you learn some of the foundational stuff you need for working in this area.

Just really quickly...what sort of majors are you guys? How many of you are engineering majors? Earth sciences? Biology? Okay, what are some of the other majors that I'm missing?

[Environmental economics and policy]

Economics and policy is a major...so econ/policy. Okay, I think...so maybe there's a lot of undeclared people who are in the room.

This isn't the exact lecture I'm going to give you, but I'll start with a more general view of what we think about when we think about resource markets

So one of the things that you're going to be studying a lot of over the next couple of months is the idea of the market. What comprises a market and why we have to care about markets. Why markets exist and why they don't exist.

So I guess the first concept is the idea of trade. So, what does it mean to have trade? And here there's basically a set of economic principles that determine when you get trade. You need two things for trade. This actually is important; I'll quiz you on it at the end. No, I won't quiz you. I'll ask you at the end.

So, which one of these can you see best? This one or this one? Or are they equally as bad for some people?

You guys can see this one really well. It's opposite. Okay, well bear with me, I'll tell you what I'm writing. And I'll probably erase things as I go along. Is there an eraser maybe?

So the first concept is definitely trade. This like the foundation of, the economic foundation...what we care about in resource markets and all markets. And turns out there's two conditions that are well established in economic literature that determine when you get trade.

The first one is that you have to have property rights.

The second one...does anybody know the second one? The second condition? You guys can participate if you want. If you're really shy, that's okay.

[Legal system]

Legal System? Umm...think about just between two people...whether or not there's a legal system. But, yeah, I'd say property rights come out of a legal system. You don't have one without the other usually. So that's true. You know, that's the reason trade breaks down and society and corruption and so forth. So those are very tightly coupled principles.

The second one that I'm thinking about is actually kind of the obvious one, which is you have to have a difference in value. So you might call it a delta. Two things, right?

So, I have a very large store of Easter candy, and you don't have any candy. So you're willing to trade me something for candy. There's a difference in value. Sort of... I want something that you have. And those two things are actually the tenants of trade. If anybody asks you in sort of an Econ 101 class what do I need for trade, they'll be looking for these two things.

And that all comes from what we would call the Coasian Doctrine, which was of course Ronald Coase.

Okay, so now, that's already just one complete concept, which is sort of foundational to what we're going to study: trade.

So that all seems pretty clear; I'm sure you've probably heard something about that before.

Now here's another conceptual question that moves into the discussion about markets.

Can you ever have 1 and 2, and still not get trade? Is there anything that might prevent trade? If I have a property right (so it's mine to sell) and you want it more than I want it so you're willing to pay me something for it. Is there a reason why trade might break down?

[Tariffs, or government interference?]

Yeah, that's excellent, that's brilliant. So everybody's got this right? Sorry, guys in the back: can you kind of see this?

I need like a foil to do the opposite note taking. I feel...okay how about this. I'll... really you just need to know...you need to have written down these two things here... property rights and then a difference in value. And then just to be fair, I'll switch boards at some point.

So now we've got trade. Now when does trade break down? This is what gets to markets. And that's what you just said. This is the formal economic term: it's when we have transaction costs.

Just a show of hands...I'm trying to gauge how familiar you are with these concepts. Is transaction costs something that people talk about a lot? That you are very aware of? Or is this new jargon for you?

Okay, if you're really aware of it. Okay...kind of...okay so maybe this is a new concept.

Okay so transaction costs; let's try to list a few things that are transaction costs, because these are really important.

One of them is tariffs. That's an excellent one. So basically some sort of tax. You can think of it as a sales tax, any sort of tax.

What else? Give me another example.

[Quotas]

Quotas. Okay...so what are you thinking there? You're saying that there's a regulation that sort of says...yeah that's true. Let's put that into a slightly separate category... well no. Let's put it here. Regulation.

A good example of a regulation might be: I want to trade some water. And if I want to trade water with you, it turns out that the government says: "you've got to do a full environmental review before you give water to her."

And the transaction cost is high because you're going to have to pay for an expensive environmental review. So that's a really good example to have regulation.

Okay, anything else come to mind?

[The physical cost of moving it?]

Yes. Perfect. That's great. Transport. And let's say transport and delivery, maybe. Sometimes there's a delivery cost.

Anything else anybody's thinking about? I'll just keep going till we run out of ideas.

[Communication barriers?]

Yes, now say more.

[A language barrier perhaps...expensive communications, like if you're in a remote village somewhere, you can't exactly sell your homemade baskets on the world market]

Yeah. So that has...perfect. Now we've hit...you're going to get a lot jargon today. Sort of like...first year med-students. They increase their vocabulary by some 12000 words.

Here's another piece of jargon, which is what we call, in economics...search costs.

And you kind of actually hit on two things. You hit on search costs and you hit on information costs. And they're really related. Economists use them with slightly different ideas.

But the search cost is...you want to sell me your water, and I want to buy your water, but you live in Wichita, and I live in Chicago, and we don't know each other. So how are we going to find each other? And it turns out when you go into the market, and you start looking for someone to trade with, it's expensive. It could take you days. Those days translate into lost wages, etc. There's a time value of money.

And so that...

And the information costs are...what additional information do you need to hunt for. And that information cost might include reputation. Are you going to trade with

someone who you think might come back and say, "Oh, I still own that"? Which ties back to the property rights issue.

Is that it? Is there anything else you can think of?

[Administrative costs?]

Yeah, administrative costs. Admin costs. And I think you guys might be able to come up with a few more good examples. The last one I have is "legal costs". That's sometimes related. But that's exactly it.

So what happens if all of those things add up to a really large amount? Then a lot of times markets break down, and you don't get trade. You don't get trade for really rational reasons, because if the transaction cost is higher than the value of trading in the first place, then clearly no one wants to trade anymore.

But the point I'm trying to get at here is that you start in this perfect environment where all you really need is the property right and a difference in value. And then the world around you imposes a huge laundry list of transaction costs that actually end up determining whether or not you ever get a functioning market.

So these three concepts. If you take this away from the lecture, then I've done more than I intended. Basically: starting with the idea of trade, understanding that there's transaction costs. And then, does everybody kind of have this list?

That will bring us to the next concept, which is markets.

And here I'm going to draw you a nice little diagram to show you how a market works.

So this is the third concept, which is a market. So we've gone from trade, which could literally be just two people and transaction costs, to the idea of a market. So when I say markets...there's a spectrum of markets.

You can either have a really, what we call, a liquid market, where people can trade very easily or we can have an illiquid market, in which case it is very difficult and there are very few transactions. So a very mundane example is the toothpaste market. Does anybody have trouble buying toothpaste? No. I mean, you can go ahead and buy toothpaste anywhere, anytime, and you know exactly what you're going to pay for.

On the other hand, what about resource markets, which interests all of us? If you want to buy timber, or you want to buy water, or you want to buy land to a degree, or some form of energy...those markets can be a lot more illiquid. And I'll explain, in part, the conceptual market behind that.

So here's the foundation of the market, which is already what we've discussed. It's basically property rights. And the assumption, if you have a market, is that there's some value to trade. So we start with property rights, which is what you pointed

out...it is also the legal system. So that's what you start with. Thankfully in the US we have a functioning legal system.

Then you come up here, and you really have two choices. I'm going to ask you for a couple examples. But you have basically, here, what I would call, Distribution Points.

And over here you have, what I would call, basically, a clearinghouse, which is an auction, which is sometimes called a central clearing house. Okay?

And then you come up here, and you basically need is transportation, and that's part of the cost. So, transportation and delivery.

Sorry, I don't have great handwriting, which is why I tend to do PowerPoint for you guys.

So...just to read what this says. So the foundational property rights (you know, trade).

Here, two choices of structure. One is a central clearinghouse and the other is a distribution point. These are the two different sorts of models when you build a market. So when I say this, I'm thinking about all of us as a government body, and we're going to help design a market that we think should exist.

So first we're going to make sure that people can trade. Then we're going to figure out what the mechanism is (what the physical way they connect to each other is). And again, this is dealing with search costs, right?

And then this is going to be transportation and delivery. So then, quick question then. What are some examples of the model, this model of the central clearinghouse or auction model?

So think about a marketplace that uses this model. It's an auction-based model.

[Would e-bay fall under that?]

Yeah, yeah. E-bay is a great example. E-bay is the best example. It's the biggest example. And a lot of times when I think of this (central clearinghouse auctions) I think of *online* auctions.

But in reality there's a lot of auctions that aren't online right? So foreclosed properties would be a good example. A bank holds an auction, and you physically go farm auctions.

There's lots of examples where people use the auction method. It's a good way to get people together, and they can bid the value of something.

The nice thing about online clearinghouses is that you can have sort of dual sided bidding...you can have sellers and buyers placing bids, which is an efficient way to clear a market.

So e-bays a good example in the resource domain.

Yeah go ahead.

[Would that be like a commodity exchange too?]

Yeah, commodity exchange is another good example of a central clearinghouse. There's a nuance to that. That's good to discuss. That relates with transportation and delivery. That's also a good example, yeah very good.

So we're familiar with that model. Commodities is good. Another good examples from the resource division is...actually, if you go Google tonight, you'll find they're actually online market places for timber, for instance, and it'll actually show up on Google or show up on a website, and enter into an auction to get a certain number on a lumber delivery. Same for some other resources...I guess that there are...I'm trying to think of some good land auctions sites. Maybe not that I'm aware of, but if you come across them, you can let me know.

The distribution point model is the one that we're much more familiar with. Does everyone just want to give a random example of a distribution model, I mean...

[Retail]

Yeah, retail. It's basically everything that falls under retail. So your Safeway, your gas stations, your Walgreens. Everything is the distribution point model.

That basically begs the question: why do you choose the clearinghouse model over a distribution point model? And that's kind of an open question; I'm not suggesting that there's a really firm answer. There are clearly two different ways, or at least two different ways, to build a market.

So how do you choose? If you're the government body and you've been told..."Set up a market. We really need a market to make this area efficient", how do you choose between doing a retail model, and saying "okay we're going to have retail points, we're going to sell this stuff." Or we're going to do an online clearinghouse. Is that...

[I think if you have more instability in the supply and demand you might [inaudible] just because that way they can be more reserved by...if there's less supply then you're going to have to pay more [inaudible] so it works in both directions]

Well, then, you don't have the overhead of having to store, right? You don't have the distribution point that you can't stock, yeah that's really good.

Okay?

[Maybe the purpose would be different. For example like, if you want to create more jobs for people perhaps? Then you would want to choose the distribution point so you can hire more people for retail versus the online thing, where it's just a ...if you want to

buy something you just go directly to it...there's no like functioning or operational cost included]

So you're saying that it might be...you might want to have a higher labor component to it...like the labor cost is higher...

[Like if that's your purpose, so then you would shift more to like, retail idea]

Or what if it's custom...like a person has to be there to show you how to use it...okay, so certain things are fit in the labor model. Or maybe if you want more labor, you want more of the distribution point model, okay that makes sense.

[What if? I keep thinking commodities...what if you're dealing on like a world scale with different currencies...locations...would it make more sense to do the clearinghouse?]

To do the clearinghouse versus the distribution point? I mean well, say more because you have like multinationals that distribute things to distribution points all over the place...

[I mean, with my exhibit, you kind of need to have one price...that's my understanding...so people need to get from all over the world and that may set a world price]

Yeah, yeah, yeah. So having the central clearinghouse allows you, basically, to facilitate global trade, right? As opposed to the distribution points—doesn't allow you to have global trade. So for things that you're moving large amounts of, like commodities, you want to be able to do the clearinghouse and have global...yeah that makes perfect sense, I agree with that.

[I guess for things that have set prices...like for the distribution point you have someone sets the price on something. You're not...you know...I'm going to go to the store and bid my...you know...my rights on it. So if you want...]

Yeah, so if you're the one who wants to have a fixed price model then you also want to...okay, yeah. So there's a price involved, right?

[I think that it would be...for a lot of daily necessities it would be very inefficient to have a central clearinghouse because it takes a lot of time. Say, for example, for a housewife who wants to go buy toothpaste, she doesn't want to spend ten minutes bidding with the housewife next to her for the toothpaste, so it's easier to just say it's fixed]

Yeah, that make's a lot of sense. That's a perfect example, right? So...anybody else want to...you can chime in late too...

So, sort of characterizing what we've said so far. For certain things, it's actually really intuitive to know which model works partly because we observe the world

around us. So, as you said, I would say distribution points...you know, basically looking at things that...the demand is somewhat more stable. Right?

Because you've got overhead wherever you have your distribution point. You've got warehouse overhead and you've got labor overhead. When you've got pretty stable demand, no one's going to stop buying toilet paper, no one's going to stop buying toothpaste. You know, it seems like video games are pretty robust. You know, if you have a really strong market then the distribution point is really appealing.

On the other hand, if you have the fluctuating demand or let's say a fluctuation supply, then perhaps you want a clearinghouse. Now someone help me get to the next part, I'm talking a weekly...another piece of jargon that would describe why you might want a distribution point versus a central clearinghouse?

So one of the big differences here is price stability, right? So how much does the price of toothpaste change? It changes a little bit; it doesn't change a lot.

And so I guess my point here is that the supply and demand aspect of each of these markets determines price and it also gives you an indicator as to which model you think is the best fit for that market. So one thing is going to be supply/demand.

You're going to think, if I own toothpaste manufacturing facility, demand is X thousand tubes from day one until year ten, and I have all the ingredients that I need and you have a model that fits very nicely into some sort of distribution point.

But if you have a commodities exchange where the amount of wheat you have available each year changes. And crop substitution happens. And you have to move large volumes. Then you basically have to have a more clearinghouse model. It turns out that for our purposes, in terms of thinking about environment and resources? Clearinghouse models are dominant in that environment resources space.

And then I want to get to this last piece of the picture which is the transportation/delivery component because of your point...you don't want to be paying...there's cost here. And so the method of transportation and delivery also determines...this is really two way...

So the transportation and delivery also determines whether or not you want a distribution point model over if you want a central clearinghouse model.

So I'm going to try to think of a good example here.

Well, I'll give you two different resource examples. And both of them use sort of a clearinghouse model. At least they should be using a clearinghouse model.

So on the one hand there are central auctions for timber--online auctions--so in which case if you win that option you just basically get a large semi-truck that delivers the timber to you.

And the transportation is, you know, it's fairly routine, and so the clearinghouse model is driven a lot by not wanting to...the cost of transportation...you don't want to pay to take timber to one destination if there's no demand for it there. So you do a clearinghouse model, and you ship it where it needs to go.

On the other hand water, which I'm going to talk about in more detail in the second half of the lecture, doesn't have an easy transport mechanism. You can't sort of truck it...well people do truck it but it's very, very costly. So what you end up depending on is infrastructure that's basically state-owned or federal owned infrastructure. In which, again, you have to use this central clearinghouse model but you actually end up having to factor in accessibility of transport.

So if you understand these three parts of your problem. If you want to sell out of a market of anything, if you want to sell anything whether it's some sort of basic commodity or some sort of environmental resource...if you can answer these three components...

If you can say: I've got well-defined property rights, I either want clearinghouse model or distribution model or retail model (this is definitely retail), and I can figure out how the transportation (which is you know, like everything else)...it is a big component of cost...

Then I can decide, I can basically design a market...

Okay, so that gives you different parts of a market.

So I'm going to call this market design one.

So far we've done trade, and we've understood that there's transaction costs that affect whether or not you even have trade. And then if you have trade, the transaction costs can be somehow low enough, perhaps, through building a market that you can get a fully-fledged operating market. So now we're going to transition, and talk about an example that I think I know a lot about after I spent several years studying it, which is the idea of water markets.

So I'm sure that in the course of this semester you'll actually learn a lot about different environmental and resource markets. Water markets are an area that is starting to develop in several parts of the world...in South America, Australia, and actually here in California. We're starting to see the emergence of water markets. So now I've given you very basic tools to think about how we could design a market or what it takes for a market to exist.

So I think, well, what would be helpful is to do sort of maybe a case study and so I'll pose...we'll do it in two parts. And the first part, we'll think about why water markets don't currently exist. So we'll do a little bit of investigative work to see...okay, why don't they exist?

Then the second part we'll sort of say, okay well what would it take for a market to exist? And the reason that this is sort of generally relevant is because when you go

out into the greater wide world, you're going to be faced with a lot of situations, especially if you work in the environmental resource policy, there's real market failures, and when they ask sort of...hey, well why is this failing more, or what could I do to fix it, and what am I going to need to take into account if I'm going to design a well-functioning market.

So, I call it Market Design One because the first part is...we've arrived on the scene and we're all in California. And how many of you are familiar with California's water "problems" or issues. Pretty rare?

Okay, so you tell me what do you sort of think is the problem, or what are some of the problems with water? Okay? Go ahead?

[We've been having a drought recently so...scarcity of water right now?]

Okay, so maybe...oh shoot I almost need two boards. Do you want to do problems over there? I know everybody can't quite see, but we'll make sure we read.

Okay, so we'll start with the problems and and then we'll say...why isn't there a market. Okay, so one problem is very short-term, it's the drought. So there's not enough water.

[So there's always been a shortage of water especially since the Central Valley during the 1940s, 1920s]

Okay, shortage of water. Okay maybe, sort of, there's increasing...there's more demand for water? Like there's increasing demand so then...yeah okay.

So I'd say demand greater than supply, maybe?

[Only service water is governable and ground water isn't]

So the legal issue. It's a legal issue that affects water resources, right? So we have really savvy stuff about what you can do with the water that we see, and the water that we can't see...no one's regulating it. Very, very important.

[So in California there's a larger population, but not a large enough natural water supply?]

Right, yeah, so there's...how do we describe that. That's, there's kind of a disconnect between where the water comes from, and where the water is needed. Correct. So So Cal has high demand but no water. The opposite is true in Northern California. And that has some political implications too, right?

[So we have established a baseline for how much water California has during the extremely wet period, over it's history. So what we've considered the baseline was actually really wet. So it's not a drought, it's more of the actual average. Over history...]

So that affects people's property rights. People think...okay so...

[We made rights for more water than what was actually available, and then you call it a drought because it's less than what we're having]

Yeah, that's a really important one. So I would call that over allocation in California. So, a lot of legal problems that we're touching on together. Okay so, anything else, sort of, come to mind?

[Transportation problems arise]

Yeah, so one thing we have to take into account as a society is that we have to take the cost of transporting water. So this relates back to your point—they're really close—that Southern California and Northern California.

There's also transport costs, and I think the transport part has some other dimensions because when you transport water there are some losses; some of it evaporates, some of it seeps out of the canals or the piping. So the transport of water, the costs, and the actual losses in the system are really concerning. Anything else?

[Clean water? So it's not contaminated]

Yeah, pollution...do you have anything specific in mind? Like chemical pollution?

[High nitrate concentration?]

Okay, so fertilizer runoff, high nitrate concentration in water. So ag-pollution is one. What about...so have you guys been reading a little bit about increases in sea level—we're getting salt water intrusion in aquifers. So places along the LA coast—there's now salt-water intrusion.

So if you used to have a well that you use to pump water, now you're pumping, instead of nice, clean, portable water, you're pumping salt water. So we should include salt-water intrusion in aquifers. There are a few other climate change ones. I don't know if people want to...

[You get a lot of leakage from, say, gas stations]

Yeah, so another pollution might be...well it's a good point. I don't know if we should distinguish between the two, but there's surface water pollution and then there's ground water pollution. And in general, we're just concerned about the quality of the water instead of multiple pollutants. Okay, anybody else?

[Does an interest conflict, for example between fisheries and agriculture...like people who want to grow food; they'll pump water out of the river. But then people who want to fish will want the water to stay in the river so that the fish population stays stable?]

Yeah, that's exactly right. So it's slightly legal and sort of a competing resource maybe? We should certainly note that one. And you're probably thinking of that one...it was about maybe four or five years ago, there was a *[inaudible]* bay...or

[inaudible] fish disaster with the farmers wanted to irrigate their crops. This is in *[inaudible]*, so up in the East, sort of Washington area. And they basically convinced the regulators to allow the water to flow to fields. There was a massive, massive death of fish. So all of the salmon died in that particular river. Do you remember the political coverage of about a couple years ago? People showed up in DC and put dead fish all over the white house lawn. There have been major, major scandals—big fish kill.

So yeah, competing resources. Some dispute over who actually has right to the water. There are a lot of legal issues that we're hitting on. Anything else you want to add to the list?

[It could be a legal issue of water subsidies for agriculture.]

Okay so, but why is that a problem? Let's say more.

[If they can pay a lot less, because they can [inaudible] or something like that, they can out-produce the other producers who have access to water]

Okay, yeah so you're hitting on an important issue, but I think it's sort of a pricing issue. They're not paying...people are not...they are getting cheap water, so they're probably using too much of it or not using it economically. Whereas if they were facing a real price... if they were paying more for their water do you think they might install drip irrigation and use it more efficiently maybe?

So there's some pricing issues and subsidies are definitely a problem, but they're a problem because they distort the price of water.

Okay I think that's a really good list. I'm trying to think of whether I want to add anymore. I mean, there's a couple of other climate change things that are going on that people who regulate water care about, so if you look at histograms of the probability of flow of different points in a year. You'll see that it quite a bit. So now our snowmelt occurs is moving a couple, up to a few weeks or a few months earlier than it used to. And you sort of think: "Oh well, what's the big deal?" But the way we manage our reservoirs is: we usually store that water and then we release it later in the summer. But if you get the water a lot earlier, you can't store as much. And this is a little bit of problem, but you can't store as much water because what if you have a big storm and there's a flood?

So you need to reserve room in your reservoir to capture extra storm water. So if you have a snowmelt later in the season, then you can actually store more of it. Whereas if you have it earlier, you have to worry about rain and storms, and you actually have to let more of it go downstream. So your reservoir level gets lower, and the cause of that is actually just climate change. It's cause of global warming which then melts the snow earlier. So that's another climate change impact that...although California's not getting less precipitation (we're not getting less water) right now, we are seeing an effect of the timing of the water we receive, and that's messing up the system slightly.

[I guess another problem I can think of is other environmental problems that you have to...like if you're in the water...if you're dealing with the cleaning of the water and distributing it and other stuff you could deal with...like...something my dad has to deal with...like killing...like infestation of mussels and stuff like that? Like the clogging the pipes. And I guess that would increase your transportation costs because you have to get rid of mussels...]

Yeah, so I think that we have a lot of stuff about the fish and farm tradeoffs. We have to put in invasive species that are changing the natural system...changes to the natural system are problematic. And then I think we should also include endangered species because it turns out endangered species really affect how we manage our water...that's another legal issue. So you can imagine now. I don't know if any of you are thinking about maybe...careers in water management, but this is a long list of really difficult problems that we have to solve. Okay no we have a...I don't think that it's exhausted but it's a pretty long list of problems.

So I'll put it back into a narrative form again. So ten years ago, when I was in University of Arizona...it's a desert, so lot's of water problems. As many, if not more problems than California has, although less people. And I was starting to think about...what are some of the solutions to all of those problems? And there's no one solution, of course. But there's different things that have been proposed in terms of ways you can help deal with the system.

So here, I'll present a couple of different positions that have been touted in the academic world as solutions to some of these problems. You can give me a little feedback if you want to on how appealing the different solutions are. And then there's one in particular that I like to talk about in more depth.

So the first solution is back to your point about pricing the water. There's a group of economists that have said, "Look, all of those things on that list over there...those problems/issues? All of those are externalities. They're all problems with using water. They're not priced."

So an externality, classically...is that a familiar term, by the way? Yeah, I figured this was a super familiar term. So all of those things are externalities—meaning they're not priced in the current market for water. So here's one example. Why don't we just look at the price of water and raise it significantly, so that some of the costs are accounted for. We can raise it in a couple of ways, but we can raise it so we can basically decrease demand. So we use less water. We can also raise the price of water and set aside some of the funds used to buy water to go and help some of these problems—to go and help with the fish and basically do some remediation... deal with the competing resource issues, etc.

So one of the views is...raise the price, and a lot of the problems will disappear.

Second group of economists say no. The price mechanism, externalities—they're really hard to price. We don't really exactly know how much the life of a fish is worth. We've got some studies that say fish are worth a lot, but there's not a big

consensus. So you cannot try and raise the price of water arbitrarily etcetera. What we should do is come up with a really complete regulatory framework. We should get the 100 best scientists in the country, and we should come up with new laws. We should regulate ground water. We should decide actually how much water stays in the environment, exactly how much those two existing property rights hold is. We should determine exactly the permissible pollution level is and we should fine everybody who pollutes, and we should monitor much more extensively. So we should do this entire regulatory approach. We're just going to completely overhaul the system.

[Are you saying that they're rationing the water to these persons or just...]

Well in the regulatory framework, it depends on how much water there is left after we impose all those restrictions, but there'd be some rationing.

Under the proposed regulatory solution we might end up taking or you might end up confiscating water. So I don't know if you want to think that it's necessarily for sure rationing, but one thing that's already happened, right, is that we've taken some water from the farmers in Central Valley, and we've put it towards environmental uses. So you can sort of think that under the new regulatory framework, maybe the farmers get a little less water, maybe the fish get a little more water. There's probably, any way you look at it, going to be enough water for humans, of course. But maybe we have to pay a little more for the water under the regulatory framework. But again, let's think of it more as a pure regulatory framework, so taking the whole amount of water we have at stake, and deciding scientifically what's the best way to allocate that water. And then your eyes are supposed to be getting big because you're thinking, "How is that...how would it ever be possible... and that's of course one of the problems."

[Wouldn't that be really hard to do because basically everyone exerts some sort of national security rights over water? Because I know you have some countries, like I had to do this study for another class...where Jordan, like 70 percent of the country of Jordan's water supply goes to farming, which is only two percent of it's actual GDP. But it's still considered vital to do that so that they are self-sufficient.]

Right, exactly. So they're food independent right?

[Yeah, so I know that they're using all their water for farming and even though they can get that food for a lower cost outside.]

That's a really good point. And so that's something that comes up a lot when people talk about how water should be allocated, and something actually that I changed my opinion about, in the process of doing my research, was the value of being able to maintain farming in California for instance, which does feed a substantial part of the US.

Anyway, with both the first solution (where you have to price everything) and the second solution (where you develop this massive regulatory framework), both of

those are, understandably, really ambitious and really difficult. And so a term that people often use here is they say its massive institutional resistance, and part of the transaction costs you have in either of those systems is very, very high because you are going to get a lot of political resistance to do neither of those systems. And that's the political, and you're going to get a high overhead in terms of amount of study and knowledge that you need, which we need anyway to understand the system. But just the additional knowledge that we need to be able to price things well makes it almost impossible to be at that level.

So one and two are both things that have been proposed, they're actually actively discussed. But they both sort of meet with some skepticism on the part of the really applied, really pragmatic economists or really pragmatic policy makers. They're just inherently problematic.

So then there's this third solution, which is not a complete solution, but has really been actively discussed which is the idea of "what about creating a market for water, so that we can just get more efficient trading between people who want to use water without having to...you know...the price will be increased, but we don't have to regulate it in quite the same way. And we don't have to confiscate property rights, which will face massive political resistance, but we can actually start to change the way it's allocated. So I think that third design, that third solution, seemed really appealing to a large group of ag-econ or agricultural economists and water economists and so forth.

So it turns out about 30 years ago, there was a big drought in the state of California and the mayor had a blue ribbon panel and they wrote the document. And they said "Let's establish a water market in California, it'll solve a lot of our problems." And that was 30 years ago. So no one in this room was born I'm sure. That was the predominant idea at the time.

So that leads us to the third part, which is, or the next part, which is my question to you. Now that we understand some the problems...well now let me phrase it in two parts. What are your reactions to the proposed solutions? Does anybody want to have a reaction at this point? A strong reaction? At this point, a strong reaction?

[It's not a strong reaction but...how would you create a market for water? Would you...]

Well that's something we should talk about. So the question is, well that's presented in a slightly biased way, right? Saying, pure-pricing is very hard. Pure-regulation is very hard. And doing a water market is doing a compromise, but it's taken 30 years and we still don't have a water market in California so my question to you is, why don't we have a water market in California?

[I guess if we had a water market would that exclude a lot of people? Like if you were to have a market for water wouldn't there be people that maybe couldn't afford it?]

So yeah, one of the things is definitely [inaudible]. Now to make it a little bit...I don't want to say simpler. But how is water distributed in California right now. Basically, think of the snowmelt or the sources of water—rivers or streams. Then underneath that, there's a band of what I would call intermediaries, and they're things like water districts. So there's a Sacramento water district and there's a Berkeley water district. There's the metropolitan water district, which supplies a lot of water to Southern California. So there's the natural source, then there's intermediaries, and then there's us, the residents. And we use water. We get the water from some water utility, right? It's just like an electricity utility. So don't think of (at least at this point of the discussion)...let's not talk about a water market where you or I go online, like the toothpaste lady, and actually try to buy water in the morning.

Think about it more as the water intermediaries being able to trade water. So think of it more of a district in the farming community could trade water with the urban district.

So that way you can get away from the problem of not having water, because everybody within the district is getting supplied. And just as a benchmark, there's (last time I checked) more than 300 water districts in California. So I'm talking about trade, but between a group of...it'll be like companies being able to trade.

[Just to back a little bit to get perspective. I'm curious that you said that these are the views of two groups of economists. Are there also free-market economists saying that we should do nothing? And where does that fit in? Like percentage wise...]

Well the free-market economists would be in favor of the market solution. I think we're going to get to that

[Well free-market meaning, let it just take care of itself. Don't create a market...?]

Well the free-market...neoclassical free market economics...they would be in favor of establishing markets and then having to limit regulation of the markets.

[Who would be the people that would be in favor of not doing anything?]

Well, people who would be in favor of not doing anything would be like [inaudible]

I mean, as in, there's a recognized problem. So I'm not sure if I've come across that in academic literature. There's not very much discussion of "well there's no problem" or "this doesn't exist".

[Not that I'm advocating, I'm just curious to know]

No, that's a good thing, are there people say that this thing is fine, that there's no problem? No, there aren't very many people who say that this thing is fine. But in terms of market design, the free market approach, which is actually being tried out in Chile, would be more the anti-regulation. And there'd be another branch of economists that would say, "Let's build a market, but let's really carefully regulate it."

And they would say that all markets are subject to market failure, and so that all markets require regulation at some point.

[Who has the property rights to water in California?]

So the property rights in California are what are called applied-appropriation rights. So there's two different doctrines of water rights or water law in the US. East coast, they're more of what's called vicarian rights. And a vicarian right is established by basically being in proximity to the stream and removing water from the stream. And so once you're removing a certain amount of water and if you own land that's on the stream, then you have the rights to that water. Does that make sense?

In the west, in California, we have applied-appropriation rights, which means they're first come first serve rights. First in time, first in right. Some people moved out here in the 1800s, gold-rush period, and farmers moved out here...they started using water and whoever started using it first had the right to it. So you can imagine that the way California is structured now...the water rights are held by...predominately by farmers and people who started using that water for agricultural purposes before there was LA, before there was San Diego. And the water rights that now belong to San Diego and LA and so forth are considered junior water rights. So everything is based in time. So if you have a drought, and you have an 1890 water right? There's no drought. There's always enough water to fill your right. 1910—always enough water. 1960—always enough water. 1980—you might get cut. So a lot of cities in the western US that have more junior water rights...so what economists noticed is that a lot of cities pay a lot for water, and they value water really highly. But they don't have rights for water, at least not older rights for water. So that's how we get to the idea of markets, right? Because what if you can change the allocation, or what if a city can now buy older rights?

[I just thought about a really bad situation. What if there was a drought and it was more profitable for farmers to sell all of their water rights to Southern California versus growing crops. Would that be a potential problem?]

To sell all their rights to Southern California? Yeah, so that would be a problem in terms of food prices or in terms of security?

So in terms of food shortages. So you had a water shortage, and now you have a food shortage. Absolutely. It definitely could be a problem, but bear in mind. The economist's answer to that would depend on how well food markets work but if you're a farmer and you're going to sell your water and it's a drought. I'm sorry is the food shortage anywhere else in the world? Or anywhere in the US? The time that you have between when you use that water and when you have a profit is about three months. Very short. So if the price of rice is very high because there is a food shortage, then you're going to grow rice.

So there's already an automatic price system that's built in to your decision. Because you know what the price of food is and you know what the price of water is. And the economist would say the water should go wherever the value is most highly. So if

the value of water is most high for food, then the price of food should reflect that because there's a shortage of food.

And you saw a really, really high rice prices during the food crisis in 2007. And no one was thinking about selling their water because they were using their water to grow rice. Which they should've been because there was a rice shortage.

On the other hand, if there's a drought in California, but there's no rice shortage globally then the price of rice might be low so then the farmer would decide to sell his water. But the theory of the system works. Now are there sometimes problems where the price signal doesn't get through? Yeah. And does there have to sometimes be intervention? Well free market economist would say no. But someone who believes more in the regulation and corrections markets would say yes, you might have to have some rules that say how much you can sell. Does that make sense? So any more questions or comments?

We're not going to complete this because it's an open-ended idea and open-ended discussion. But what I want to leave with is... I'll launch in to one of the solutions that have been posed recently, that I actually contributed to with my research work and then get some of your input on what you think it takes to design a really good water market. And we won't be able to answer the whole thing today.

So when I started studying this problem with a lot of economists at Stanford...what we noticed was the attempt in California to start a water market, which we actually thought was a good idea, because it turns out that the amount of water you need to trade when there's a drought, while it's significant, is not a very large percentage of total amount of the water that moves around the state, at least not so far.

And so if you could trade water in times of drought, you could actually alleviate shortages and avoid both environmental problems and, also, losses due to not having enough water in urban areas. So we kind of started to investigate the water market idea. And what we came up with as part of the answer for why water markets don't exist, even though really forward thinking researchers proposed them and policy makers proposed them thirty years ago. It's really two reasons.

Well, three actually.

The first is the focus so far has been on trading permanent water rights. So I was telling you farmers had a permanent right to water, and cities have more junior rights. So imagine that LA wants to buy a farmer's water right. If LA wants to buy a farmer's water right (and we've seen this) a couple of things happen.

They have to go through a huge environmental review first. Because they're about to transfer water that goes into a stream, and it has environmental impact, to a city. And of course the state says you must review all the impacts of that. And you also have to make sure you don't hurt your neighbors because they were usually getting some of the runoff. So first of all, expensive environmental review.

What's the second thing that happens? The community of farmers knows that you, farmer Bill, are going to sell your water. And the community doesn't get any of the proceeds that you receive from your sales. So they actually start to resist. So within farming communities if people know that there's going to be a sale of a water right, it threatens their livelihood. It would be sort of like...you work at Intel, and Intel's going to move their corporate office overseas, you might protest because you might be like, I'm going to lose my job if you move your facility to Indonesia. So the same thing exists in the farming communities.

So you're going to end up with very, very high transaction costs that are associated with trading permanent water rights. And again I want to emphasize that. It's a permanent right, so once they give it to you; all the water from here every year is yours.

Now, turns out you don't have to trade a permanent water right. In California in 2003, the Metropolitan Water District, which is the largest water [inaudible] in the United States, for the very first time, did something kind of innovative. And they signed an option contract with a farmer. So they didn't actually buy the permanent water right. And no one in the community objected. And they didn't have to go through a really, really complicated environmental review because they were just moving the water one time. They had to go through an environmental review, which they should have, but it wasn't a drawn out process. And there was a drought that year, and they called their water option. And they delivered water to several of the districts in southern California.

So it turns out that by just changing the structure of the market, from the focus that existed for about thirty years on—always trading permanent water rights that were very, very hard to trade—to just an options off water, they started to trade in a market that didn't exist before. And so I would propose to you that one of the elements of design that are important for a water market is the flexibility to do temporary transfers of water using a market system.

So I'll leave a couple of minutes open for questions at the end, but these are kind of the ideas that we came up with for the necessary components of a really good water market and then you can add your own ideas if you want. But the first one was: you have to be able to do temporary transfers. Why temporary transfers? Because that's the only way you can really lower the transaction costs and make a viable market. And our whole thesis was the reason the markets didn't work before was because the transaction costs were so high.

So temporary transfers equal low transaction costs. That's the first thing.

The second thing you need is (anybody remember the little model?). Property rights?

[Clearinghouse?]

Yes, the second thing you need is a central clearinghouse. So we could imagine that, without very much difficulty, we could have an online clearinghouse for water that would connect districts around the state, so they could essentially trade with each other during times of drought. Do you remember that kind of top level that we need for a market? We have property rights; we have a clearinghouse with the distribution at the top? Exactly, transportation.

So the third part we need is the transportation, and here I'll be a little more specific. We needed tradable rights to infrastructure.

[Excuse me, for number two, why don't we just have a distribution center?]

Okay, that's a good question. Explain what you mean by that.

[Why don't we just have the government do something? Since we already have all the infrastructures and all that ready in place? Why don't we just ask them to change up the rules and regulations? And that'll save up a lot of costs.]

Well this is a very classic debate that you have. You guys will have to argue amongst yourselves for years to come, which is a lot of people think that the cost of the government...you're essentially asking for central regulation, actually. And we know that there are centralized governments in the world, but not in the US. And the thought with water and with other areas is that...government often don't really know better than companies. They don't have all the information. So a government can't necessarily decide what the water is worth to another district because they don't have that information. And the cost of them getting that information is high, and they might get it wrong a lot of the time. So the idea is to give that back to the people that actually trade because it's impacting them directly. And, in theory, that's actually considered to be the more efficient way for people to trade. And that's sort of the thinking behind that. Whereas if the government just decides, they have to have perfect information to get it right, and that's hard to get.

Where as individuals know their own information so they don't have to get...so know one has to know it for trade to work efficiently. Does that make sense?

So, importantly, the central clearinghouse, this is where prices get set. This is where...well I have a district in San Bernardino, and I want to buy your water, how much do I have to pay for it?

And the third...the transportation, the tradable rights to infrastructure. This is because the way water moves in California is through a central aqua duct and a canal system. So you have to be able to, if you're going to buy water, you have to know you can move it.

At the moment, there's a priority rights system on the infrastructure. So you need to be able to buy accurate infrastructure. It's like being able to rent a u-haul. I mean to me, this is like "rent u-haul" but it involves the government being able to lend you that U-haul because the government owns the infrastructure.

It seems simpler than a 1-2-3 list, but its actually a little more complicated. But that's the high level version of what we came up with for a water market in California.

Okay I'll stop now. Are there any questions? I'm here if you want to stop and ask questions.

Transcribed and checked for accuracy by Brynna Bunnag