[SQUEAKING]

[RUSTLING]

[CLICKING]

JUAN PALACIOS: So last week, before Kevin, one of the things that we did was going through the whole four-quadrant model to understand how each space, each quadrant in-- any impact in each quadrant will have an implication for the whole market equilibrium and will affect the different parts of the real estate market.

Now that is one purpose of the four quadrant model. But still, there is a big question of what is actually the first trigger of climate change on the real estate industry. It's very different if the tenant is the one-- the tenants are the ones that are triggering the first response to climate change or is actually the investors and the owners and the financiers that are the ones that are triggering it. Because the responses from policymakers and the owners and the real estate investors are very different whether you want to actually compensate tenants or you want to reduce risk associated to an asset.

Also, when it comes to the valuation of assets, this has very different implications because it means either you adjust the numerator of a discounted cash flow of an asset down because the exposure to climate risk-- so then you actually expect that the rents are going to go down-- or do you adjust the denominator because you need to adjust the risk associated with that asset or the access to financing of that asset? So the way that you impute climate into the model and the valuations is very different. So how it is actually being-- at the moment, how the markets are actually being impacted at the moment is something that comes down to an empirical question and to empirical papers.

So one of the things that I brought here is actually seeing different papers that try to dig down into whether it is the numerator, the rental cash flows that are affected, or is actually the denominator, is actually the CapEx is the risk associated with the asset-- what is affected? So you actually understand how climate risk is actually being incorporated into markets, if at all.

So there are price discounts associated with climate risk. And we had, in the green cities lecture, a whole discussion about how you do this from the empirical perspective, apple-to-apple comparison, and so forth. The way that these people try to have an apple-to-apple comparison since if you look at properties that are next to the coastline versus properties that are inland will result in a very different comparison. Because if you have a sea view, if you have these condos next to the beach and so forth, you cannot easily compare the prices of those with properties that are in midtown or in the suburbs.

So the way that people are usually doing is trying to compare properties with the same level of risk, but that has a different saliency of that risk. So either properties that are having different information at the purchasing time, so they have different description in places like Zillow or Costar for commercial real estate into how the property is exposed to climate risk and how resilient it is the property because of the characteristics and so forth. So this is how they actually do this empirical work, comparing properties with the same exposure but different saliency of the risk so that you understand that when the purchase has been done, there is the property that has a more salient information about climate risk being more prone to discount those factors in the valuation in the purchase.

And what you see is actually when you compare the properties with more saliency to climate risk versus not that the risk, the changes in prices are there, so around minus 3% lower prices associated with being exposed to high flooding risk, sea level rise, but there is no change in rents, which means that when you really think about it, the formula to calculate property prices, it seems that it's not coming from the NOI. It's not coming from the rents. But it's actually coming from the cap rate.

That is also something that makes sense because a lot of the risk associated with being in a flood-prone area is something that is in a multi-decade horizon. It's something that is not going to happen within a lease of 5-10 years, but it's usually happening 50, 60, 70 years. That's where the risk starts to become more late and more salient.

So it makes sense from the conceptual side that if the property-- the prices are adjusting, it's not really coming from the NOI because there is no disruption in the business or the disruption in the amenities of those places. But it's actually the disruption into your expectations of risk associated with that down the road. You do know that, eventually, some of those properties will face some problems on destruction, and that will actually interfere the cash flow of the properties.

Similar story happened when you look at the actual disasters. This is New York before and after Sandy. And what you see here is the development of the different properties, the prices in the different properties, the ones that didn't have any damage. This a slight discount around 9% reduction in prices compared to the pre-Sandy levels. That is also something that the properties with major damages end up stabilizing and also the properties with minor damages.

So it seems that there is a discount there, and it's nothing related to the actual damage or the actual destruction in the property. But it's something, again, related to the update of beliefs of how those properties are going to be hit again in the future when you are making those purchases. And this is a simple graph just to illustrate, but, of course, they do all of this econometric analysis that is pressing the green cities lecture to make sure that it is nothing there that is confounding the effects.

But the story is that it seems that it is-- an update in beliefs is something that is an updating beliefs that comes via the cap rates and the risk associated with those properties. And that is something that will ultimately result in reduction in prices. It is nothing that is coming down at this specific moment through the leasing and through the rents and so forth.

So here, the key thing-- and that's what we are going to start talking with me, but also mainly with Siqi, is how do we actually understand better the role of those beliefs and the formation of those beliefs? Because that is the critical channels via which climate risk is actually being translated now into a specific actions as of today in the real estate market.

And that is why it's important not only understanding how everything unfolds in this four quadrant model, but also understand what type of quadrant is being affected because it's very different when it comes to understanding how to tackle climate risk, whether it is the numerator, is the range, or it's actually the denominator, and it's the cap rates and the discounts associated with that.

Now this is-- the discount rates are especially important when you also start thinking not only about the value of those assets, but also investment assessment in those assets. Because when you are thinking about investing in climate resiliency measures, what you are doing is, again, similar to the energy efficiency story, you are investing upfront to avoid future risk and avoid future penalties or future stranded asset problems.

So now the difference with-- a lot of the difference with climate risk is that it's even more important than discounting that with a lot of the energy efficiency and transition risk issues because with transition risk, with energy efficiency, we are looking at things like Local Law 97 that is happening next year and is going to have even more penalties over the next decade or two.

But climate risks-- we are talking about probabilities of bad stuff to happen in the next 50 years, in the next 100 years. So any minor change in the discount rate is going to have major differences into how the expected damages that are going to happen in the future are going to impact the valuation today because you are compounding things that are happening 10, 20, 30, 40, 50, 100 years from now. So any minor tweak there is going to bring these guys down a lot or up a lot.

So there is a lot of discussion about what will be the right discount rate. And I'm going to actually show you a very clear example. Around the corner, there is a report about how to think about resiliency investments at the district level in Boston seaport by the city of Boston. So if you see the numbers, you see that when-- for the different predictions of sea level rise by the different decades-- so you see that now, at the moment, there is no sea level rise. This is the baseline. Then you see it's expected to be 9 inches by 2030, 21 inches by 2050, 40 inches higher by 2070.

Those are the predictions of the city of Boston. And these are the damages that you have-- so different number of people that are affected, different number of buildings that are affected, and what is the value of those buildings, and what are the cost in terms of property damages and lives being disrupted? It goes up also as the sea level goes up. So if there is no resiliency interventions, this is what the damage will be-- will start around $140 million as of now, all the way to $8 billion in the future.

So now what we are going to do is actually thinking about all of these framework to assess whether it is worth investing in preventing those damages or not, given the predictions of the city of Boston. [INAUDIBLE]?

AUDIENCE: We saw a similar table yesterday in studio from-- a city official came in. I asked a similar question. He wasn't able to give me a direct answer. So this, the same study from 10 years ago, predicted 9 inches of sea level rise by 2030, which is only 7 years from now. So we're past the halfway point. Have we seen 4.5 inches of sea level rise? Is there actually $1.2 billion in damages that have been experienced or 50% of that, $600 million in damages that have been experienced to date? Or is this being updated with new projections to reflect what's happened over the last 10 years?

JUAN PALACIOS: Every report that you have there of this kind will be always using the latest prediction. And you saw the table of the beliefs of the IPCC, the United Nations regarding climate change. That is updated every four or five years. So especially in 2022, there was a big update around those projections of the damages.

Here, what you will see is these are the-- usually, what you're getting to get these numbers is actually the properties that are going to be exposed or the properties that are here in this blue area times the value of those properties, and that's how they calculate the $8 billion.

AUDIENCE: Right, but the study itself, though, is done-- this one dated 2013. The one we saw yesterday-- 2017. Both showed 9 inches of relative sea rise by 2030, which is 7 years from now. Have we experienced more than 50% of that increase to date? I was wondering what the prediction was 10 years ago-- has that actually come into fruition or is there a need for more conservative estimates as to what the damages actually will be by that year?

JUAN PALACIOS: Yeah, there are two things there. I don't know exactly the numbers of how much of these 9 inches have been already observed. There is some sea level rise that has been, of course, observed there. There is a risk of doing that type of logic. That is that you assume some of linear increase in sea level rise. Every year, I get more and more and more and more, and the same delta will apply every year. But actually, a lot of these things are not linear because if you get-- if you try to visualize how things in Greenland, for example, work when it comes to melting of ice, these are big chunks of ice that eventually will come into the seawater.

And those doesn't happen kind of the same chunk of ice happens-- actually, the worst that can happen in terms of sea level rise that there is this big parts of ice of places like Greenland that become-- all of the sudden detach from the big block of ice. So it can be that it is, like say here, you have 2 inch or 3 inches happening for the period of 5-6 years, and all of the sudden, there is such an event that they call tipping points, and then you go up to 7 inches. So I think that it is hard to back up a lot of these issues with empirical observations on a year-to-year basis because a lot of these observations happen via very thorough assessments of de-icing and different events that you know will end up happening, and that will end up having a consequence on the sea level rise.

AUDIENCE: [INAUDIBLE]

JUAN PALACIOS: Yeah?

AUDIENCE: Just, like, for background [INAUDIBLE] it has actually risen 8 inches over the past 10 years. And there's some data I find online that shows the actual numbers year by year. So yeah, I think it's based on historical data and projected data.

JUAN PALACIOS: Awesome. And here is the plan of the city to invest in a lot of protection mechanisms to avoid that these-- you see low battery. Everyone has low battery, including myself. So here it is, the-- let me see what I can get rid of it. No worries. It's low battery, but not that low. These are the costs associated with protecting sea port. You have Fort Point Channel. You have different waterfront, different city walls that you will put all over the area to make sure that there is no such thing as those damages that we were projected in the previous one to avoid that the properties and the people are exposed to that one.

And you see that it's quite a lot of money here. You have a total of around from $500 million to $1 billion, and going to $7 million to $15 million in maintenance because once you build that infrastructure, of course, you cannot stay there forever. You need to maintain it every year. So it's a significant investment that you have. And $1 billion, let's be pessimistic and conservative, you will have to invest $1 billion to protect the city against $8 billion expected damages.

So when what you see is that on damages that will happen all the way. to 2070. So again, what discount rate you will put will make this investment worth it or not because you need to start investing those things now. And these damages will only happen severely over the next decades. So yeah?

AUDIENCE: Are the damages [INAUDIBLE] present value?

JUAN PALACIOS: No, they are when they will happen. So here is what comes down to-- so if you think about investing $1 billion to protect the city for $8 billion of damages in 50 years, you see that any changes in the cash flow will actually make a big difference into the decision-making.

We have always, in this course, NPV positive and NPV negative. And anything that you have here from 7% to 1%, that is a lot of the discount rates that you end up seeing in the literature. You see that there will be a very different outcome. So anything that will be below 4 will actually make it that those damages will be counting enough at present and will actually make it big enough to make sure that this number is above $1 million and, therefore, make an NPV positive solution.

And that's where a lot of the discussion and a lot of the decisions need to be made when it comes to mitigation, resiliency, and so forth. This is not mitigation in terms of reducing CO2 emissions because that will be even an extra loop of complexity. But already just thinking about resiliency versus expected losses and getting hit, you see that the political decision is how much do we value those or how much do we believe in those things to happen. And then, ultimately, even if we have an assessment of the damages and we all agree in the room that those damages are there, then the next question is, how do we discount those to the present to make sure that we have a fair evaluation?

If you see the actual data, you have these papers now evaluating these very long discount rates. It's a very complex exercise, actually. They do it with housing market because you can actually use the differences in lease terms to actually see how people will value those cash flows in the very, very far future. So, for example, I think Singapore has leases of 90-100 years. You can compare those with perpetuity type of things to see how people will value the 100-year losses versus perpetual losses. And you see that the discount rate that is usually there is 2.6 in the literature. [INAUDIBLE]?

AUDIENCE: This discount rate is trying to capture how the end users of the property would value this because it's the government itself that's spending this money?

JUAN PALACIOS: Correct?

AUDIENCE: The government doesn't really require positive NPV [INAUDIBLE].

JUAN PALACIOS: Exactly. Exactly. But you want to the ultimate homeowners-- what will they value? Because even though you, as a government, one of your missions is to do NPV-negative investments there because, otherwise, it wouldn't happen. You want to have some alignment of what these people will value and so forth to avoid burning your political power. Julio.

AUDIENCE: I'm sorry, I'm just trying to get this right. So the $8 billion is the damages of the properties that are there right now.

JUAN PALACIOS: Yes.

AUDIENCE: But you could have more properties or taller buildings, so the building could actually be a lot more?

JUAN PALACIOS: In seaport I think not anymore. I think that everything is fairly developed already. This these for seaport.

AUDIENCE: Then 50--

SIQI ZHENG: [INAUDIBLE] vacant land.

JUAN PALACIOS: OK, so there might be a so there might be that even there might be some more damages because you develop more property and you put more capital there, yeah. So that will make it even worse because it will not be $8, but it will be $10 if you keep developing high rises in areas that will be eventually hit by--

AUDIENCE: [INAUDIBLE] more feasible.

JUAN PALACIOS: Yeah, exactly because then the $8 will become $10, so then everything will be-- and this is like a public good for the entire district. Doesn't matter whether there are, here, 5, 10, 20, 300 buildings. You are trying to protect the whole border and protect everyone inside. So actually, the emptier it is, the more difficult it's going to justify the investment because the less damages are going to be there.

And now we're going to keep going with all of these discounts and so forth with [INAUDIBLE] and how we are actually going to think about those beliefs in a more thorough way. Exactly 10 minutes.

SIQI ZHENG: Yes, good. We switch. I could [INAUDIBLE] the last question I think [INAUDIBLE] very interesting [INAUDIBLE] protection [INAUDIBLE] sea wall and all the things. And if the government invests a lot, then that will boost the confidence of the private sector. The private sector will say, oh, this is not a big problem. You can just [INAUDIBLE]. You can further develop. So now it's a debate. It's an endogenous thing.

If the government invests a lot of money to protect that area, then the developers, the individual investors, they feel more confident to further invest in that area, to build buildings like that. So that may lead to a misallocation of resources because the cities, the city mayors, they always want to protect their cities. And then those dangerous places, risky places, they got more and more private investors to build there.

Anyway, now, let me continue. So, basically, I think-- we are the first real estate program. I'm very proud of this, that we have this sustainable real estate as a core class. Maybe you like it. Maybe you don't like it. But we are the first real estate master's program that we have this sustainable real estate as a core. And also, I think we are the first that we have three sessions dedicated to climate because we know climate is so important. And last year, we had two and we couldn't finish. So this year, we have three. So we are not in a hurry. We're not in a hurry. We are going to enjoy the process of these three lectures all about climate. So, after the three sessions, you become expert on climate real estate. So that's the point.

So, today, I will continue. And then, next week, we will have another last session, and I'm going to invite our guest speaker. I don't want to stand here always talking-- too boring. Last week, last session, we have Moody's cabin. Then, next Tuesday, we will have a very important person who is a former head of the FHA, Federal Housing Authority. So that's a big federal housing administration, and also the senior leadership in the Fannie Mae and Freddie Mac for many, many years at [INAUDIBLE].

And he will come here. He is a senior lecturer at the Sloan School heading some housing research center there. And he will talk give a guest talk next Tuesday on climate and real estate and how, from this government perspective, this HUD and FHA and Fannie Mae, how they are thinking of this and whether they want to invest more money, public money, to help those places that got flooded. So that will be next Tuesday. But today, will be Juan and me. Now it's my turn.

So this is the second lecture on climate and real estate. So just now, I think I can continue just now the conversation because just now, we talk about discount climate risk, and then we know that climate risk is a future risk. So it's not today. It's not today. It's about future-- next 50 years, next 100 years. So where's the pointer?

JUAN PALACIOS: It's right here.

SIQI ZHENG: Oh, here. Because the real estate is a long-term thing-- it's not a one day-- a long-term thing, holding period, many, many years. So we all understand the analysis is about future. When we talk about climate risk, always about future things. That is this discount rate just now Juan mentioned that is so important. If you choose 2.6% or you choose 3% or you choose 5%, totally different and will yield different NPVs. So that's the point of this discount rate-- so important. So that's this IPCC, that's RCP, Representative Concentration Pathway. And RCP 8.5 is very serious global warming. And this one is, like, if the human beings can mitigate.

So then think about this hypothetically. You buy an asset 2020. Then, maybe you will just hold the asset for many, many years-- you sell. So now when you are evaluating the impact of climate risk, you are thinking like this way. You are thinking because the global warming becomes more and more serious-- now, maybe no problem. Just not when it shows the seaport. For now, no problem.

But then, little by little, more and more and more hurricanes and the sea level rise and all kinds of things happen. So conceptually, we say, OK, when me, as a buyer in 2020, I stand here at this moment to consider whether to buy or not and my bidding price. So I'm standing here. So my current bid for asset is the present value of the future cash flows-- and, for example, all other things-- and minus the present value of the expected climate damages. Who knows? All the scientists-- they publish so many papers, but they are all guessing. They're making all kinds of projections. So this expected loss so important.

And then you say, OK, from the scientific report, we also wrote many, many papers and we published, and so many climate scientists, they say, oh, cost of damages-- they say this-- every year, how many the likelihood of the hurricane? Then the thing is, you can-- two factors here. Discount rate just now we mentioned-- this is so important. 2%, 3%-- totally different. So Juan covered this.

Now we are looking at this. Scientists are saying so, but not all people will believe in. You know it's a climate belief. So when you buy the asset and we think about future, you are thinking whether later you can sell that to the second buyer, the later one who will buy this from you. So all this market, who knows, even if the scientist publish all these reports? And maybe half of the people, the buyers-- they believe in that. The other half-- they don't believe. And this one will definitely influence the buyers, future buyers, the market participants, which means we cannot just look at this numbers. We must look at the belief.

So, fortunately, we also have some scientific measures of belief. So there's a very famous saying-- you can Google this. And Yale University, they have a Yale Climate Opinion map. They have a research group. They already run for many, many years. And each year-- they have a lot of research funding-- I think they just did a huge large-scale survey, thousands of hundreds of US citizens. I think now they are only looking at the United States.

So that's basically this. And then you go to the county level. Now this is a county-level thing. You see the county and the metropolitan area stays aggregate. Then they go there. They interview, and they have a bunch of questions. And then you have this map. They provide indexes, and then we can always use these indexes for our own research. So then you say, OK, this is 100%. So the question-- they have many, many questions. This is one of the questions. For adults who think global warming is happening. Then for the thing is, for the entire United States, 72% of the adults of us-- we are adults-- we think global warming is happening. And the 14%, they don't think global warming is happening. And in the middle, they don't know. They are not very sure. So that's the entire United States. Of course, you understand why, here, we are darker. Here, we maybe have a higher share. And here, the darker and in the middle, maybe lighter. So that's a situation.

Which means if you hold a scientific report, like Siqi's paper, and if you go here, go here, you get a lot of supporters. Yes, that's true. If you go here, oh, don't trust someone to fake me. It's not true. I don't believe in that. Question?

AUDIENCE: I think it would be interesting to put this map in comparison to voting patterns?

SIQI ZHENG: Yes.

AUDIENCE: I'm sure they're correlated.

SIQI ZHENG: Yes.

AUDIENCE: And it goes back to what you're talking about with beliefs, and it just becomes so politicized. Even the word global warming versus climate change and how people use the wording and thinking about, OK, then how are we going to use discount rates because people who don't believe in it or don't think it's as severe are going to say, hey, we want a higher discount rate. And then it makes it really difficult to try and to try and act upon it.

SIQI ZHENG: Very good. This can be a research topic, like a thesis topic, if anyone you can-- actually, two years ago, we had a PPP student-- the other program. He did a thesis exactly on this kind of topic. He tracked these political votes and correlate with this climate belief and other political opinions.

OK, so that's a [INAUDIBLE]. And then this is Yale University's one. This is another thing I got from another research institute, and this is by country. This is by country. So Greece, number one-- 90% think global warming is a major challenge, and followed by South Korea, France, Spain. I don't know. So why South Korea? OK? Are you from South Korea? OK. Do you have any sense why South Korean people, they believe in climate risk so much?

AUDIENCE: [INAUDIBLE]

SIQI ZHENG: That's good. You should be proud of this.

AUDIENCE: That's because [INAUDIBLE] advertise about global warming, so people in Korea doesn't actually try to criticize them, but [INAUDIBLE] so I think people are trying to [INAUDIBLE]

SIQI ZHENG: Yeah, good. And I think, for those small islands because they really have the threat, then they have more sensitivity to climate. And also related to this education and public media and all this, and also politicians' agenda. So I think US is here. It was very low, and I don't know-- maybe they couldn't get into China to interview people, so no China here. So that's the point.

And then, let's see-- so as you know-- so let me do an interesting thing. Now for the entire United States adults, 72%. Let's do a small poll here in this classroom. This is not a representative sample. It's too biased a sample towards some very dark place. Who thinks global warming is happening, please raise your hands. You don't think so. OK, fine. We are not counting-- no pressure.

AUDIENCE: [INAUDIBLE] comments from the--

SIQI ZHENG: Yes. So I just want to show this. If we say United States, 72%, this 11.350-- that's our classroom. So [INAUDIBLE] here. So it's much higher than the national average. So I think that's a situation. You know it's heterogeneous. It's not the same. You have a comment?

AUDIENCE: I just wanted to comment-- I just see that Israel is last. I think the reason for that might be that-- I can attest for Israel that it's not that people don't believe in it, it's just that it doesn't take the place in the media. I mean, it's--

SIQI ZHENG: Too many other things. Yes, that's true. That's exactly the same as in China. I think many from China that you know that there are so many other bigger challenges over there. The climate is so remote to common people's daily life. So that's a very good explanation. And when you are so happy with all other things, you start to worry about climate, worry about your next generations.

AUDIENCE: I think it's a good point. And also, I'd be interested in knowing the correlation of that list of countries and beliefs versus impacts. Like, if you're living somewhere like right on the coast, if you live in Venice and you're actually feeling it, versus a landlocked country that maybe you're not experiencing the impacts as much. I know coming from California and experiencing those wildfires, it makes you believe--

SIQI ZHENG: That your house got burned-- yes.

AUDIENCE: [INAUDIBLE] happened. So I'd be interested to see the correlation between that.

SIQI ZHENG: Good. Yes, that's very good-- another research topic. And then, see, that's exactly-- this graph addresses your point just now. So climate change is a priority, but now it's more and more partisan than ever. So they have this table. They have these trends. So these tools still-- I think they're still United States.

And see, four priorities. Economic growth-- of course, always the first priority. Jobs-- people want employment. Environmental protection-- I mean, like all the environmental things-- and the global warming. So this is the percentage of Americans who say the issue should be a top priority for the president and the Congress.

So then, clearly, you can see a very interesting thing is they have cycles, not like they're flat all the time. Always when the economy is good, then people are happy with jobs and the wage and all other things, they have more brain space to worry about climate. When the economy is so bad, in a recession, we don't know whether tomorrow we will have lunch or not, and we are not going to worry about climate. We need to first secure a job and all the other things. So you will say this is a financial crisis-- 2009. After 2009, the priority-- people always thought its economic growth and the jobs and all other things. It's not about global warming. And when the economy is becoming better, then they go up.

And then there's Democrats and the Republicans-- you'll see the gap is huge gap. Partisan gap-- it's so big. So that's basically-- and then here is after COVID-19. This is the recent, 2022. I got this yesterday. So now it's a strengthening economy, number one, because now we are also like very important moment for the economic growth. The inflation is so high, so reducing health care costs or something like that. And let me see-- there is global warming. Yeah, here, it's very small, but global warming is here. So you can see it's not always a priority, and it changes over time. So that's dynamic.

What's the implication of that? What's the implication? I'm going to use this paper to illustrate, of course, we care about public opinions, especially for those who want to go to the public sector later, become a policymaker-- sure. Look at this and study it. But later, if you go to private sector, you are just one developer or one small investor, then you need to understand the big picture to seek good opportunities in this.

So here, of course, you know climate change is always on people's mind-- sometimes very important, sometimes less important-- in some areas, more important. Then how that will affect real estate prices? That's real. You need to understand, if you go into a market, you go to the map of the climate belief, check in your submarket what the belief index is. And you think about this will affect your business. That's so real-- will affect your business, will affect real surprise, later on will show will affect the housing developers' profit if you are going to build something on the coast.

So this paper is the following-- this is a very good journal. And, of course, they say flood risk is so big, and especially for Florida and Hawaii, like, later will be inundated-- 10% will be inundated. And then they started, OK, this is scientific fact. This is scientific report. Then this paper went into the market, really got a lot of real transactions from 1997 to 2017 and also detailed housing listings, whether you are in flood zone or not, if you are in flood zone, higher risk. And then that's in Florida. So underwater means it's a dummy variable that the home is in the flood zone.

Then they got into this Yale Climate Opinion Map 2016 data. They ran a hedonic model. We are all hedonic experts now after my apples-to-apples comparison lecture last time. Now we are all apple-to-apple experts. So we run hedonic-- we run hedonic. We regress log P-- that's a housing price-- on so many other things and all these characteristics. Then we have underwater. Underwater means in flood zone. Then this paper found out the very interesting result. Always beta is negative. If you are flood zone, you have a discount. That's always. However, the size of the beta varies a lot. The size of the beta, the discount of the beta, [? where ?] is allowed for those homes, for those believers, they call the believers the median.

So they have the Yale Map of the belief that the median value of the belief-- about belief, they call this community as believers. Under the mean value, median value, they call it deniers. So compare this to the believers community associated with 7% larger decrease in housing price. So that's the finding. This is very intuitive, which means for those for those two-- remember apple-to-apple-- if there are two communities-- this is the ocean. These two communities, both on the coast, the same climate objective risk.

Flooding risk is the same. These are all believers. They say this is real. These are deniers. The same physical risk-- however, it says this one's housing price decreases a lot. This one decreases a little. So that's what they found. Then, if you are businessman-- If you are businessman-- you are local businessman. You are going to build something in seaport, for example, or some Florida coastal area. And then you only have a few choices. You have constraint. You have these few choices-- very similar physical risk. And which community are you going to go to to build your houses?

AUDIENCE: People who don't agree.

SIQI ZHENG: You go to the deniers. And do you think for yourself as a businessman, yes, that's a rational choice. You get profit. But if we aggregate 1,000 of businessmen like you, all go there to build-- is there any problem for the society?

AUDIENCE: [INAUDIBLE]

SIQI ZHENG: Not sure. So if you are an individual business, of course, go here to build because you'll have higher price, you'll make profit, and then you have a lot of buyers. But if you have so many builders all go here and build, then we'll be more and more housing in riskier areas. Once there is a hurricane damage, the damage will be borne by whom? The damage will be-- because you build, you sell, and you leave. You go to another place to build. Who will bear the damage if a lot of buildings just build here because there are deniers? Any sons who will bear the cost. Who will cry?

AUDIENCE: Residents-- people who live there.

SIQI ZHENG: The residents will cry. And who else will cry?

AUDIENCE: Insurance companies.

SIQI ZHENG: Yes. And who else?

AUDIENCE: The deniers.

SIQI ZHENG: OK, they now understand. They learned. And also banks-- the banks because they buy these houses using mortgage and then all the people then get inundated, then they default. The households will default. Take over my house-- I default. Remember? Then banks will cry. And these are low-income household-- they couldn't leave. They have to leave there, and they will cry. So that's the social problem. So I just want to keep this open. And later, you can discuss it a lot. So basically, you can see all these interesting topics.

And then, of course, now we understand-- not so many people they know Yale-- that Yale University map-- before, I just mentioned, who of you know-- except our teaching people, we all know. Who knew this climate belief map existed? You've heard of that?

AUDIENCE: I kind of knew that that's where [INAUDIBLE] would believe it based on politics, like what [INAUDIBLE] said, Democrats more likely to believe that climate change exists.

SIQI ZHENG: Yes. So that means, at least, we cannot force people to believe something or not believe something. They have their freedom of belief in climate change or not. That's their freedom. But I think, as a private sector or the government, they should provide information. They should provide information for people to judge by themselves. Instead, they don't understand. They even don't know their houses are in flood zone. That's not good. So this disclosure is important.

This is very similar, but it's the opposite example of the green building certificate, remember? When I talk about green buildings, I talk about market failure. One market failure is information asymmetry. So people don't know whether they see a green building or not like that, and then LEED, Energy Star, and all those certificate-- of course, they have their own problems and limitations, but at least they made a big contribution to solve the information asymmetry problem. That is green building.

This is a negative thing. Climate risk-- also need the information. Provide information. So that's why now they have this Home Seller Disclosure Requirement-- mandate the sellers, no matter the individual sellers or developers, provide buyers with detailed information of the known material defects. It's not just about climate, but climate is a new item they require to put into that disclosure. At first, it's disclose all other things-- sewage and this and basement and building materials like that. Now they say, now it's time to add climate risk into that disclosure file. When you buy a house, you need to-- when the buyer buys the house, you need to tell them.

And then this mandate was implemented step by step, not immediately. It's very hard to get things immediately. Then some states started doing this, and some states lag behind. You can say this also correlation with that partisan or belief map. Here quickly, and this slowly-- but they are doing so.

And my lab's postdoc, [? Xinghong-- ?] some of you know [? Xinghong-- ?] [? Xinghong ?] is supposed to be my lab. He has a very good paper to study this disclosure's impact on housing market outcomes. And he said, OK, the home seller disclosure requirement, this better information helps. Then, he showed that in those states and counties with a disclosure implemented, then you see this place is losing people and higher housing vacancy. So when people know this place is risky, they start to leave, and then the market starts to decline. So that's the information channel. You just give information and let people judge by themselves.

OK, that's [? Xinghong's ?] research. And my lab has another research. We have a website-- search Google. We have a climate-- we have a global sentiment project. So this project is the following-- also linked to climate change. So we use natural language processing. That's a kind of machine learning-based way to extract information from social media. We started from Weibo, China's Twitter. Then we expand it to all Twitter, So all over the world-- now we have 100-- more than 100 countries. And this is machine learning, so we can process all kinds of languages. We don't rely on dictionary.

So then we use this NLP approach to extract information about people's sentiment. Twitter, Tweets-- whether you are happy or not. We have a sentiment score for each tweet, and then we aggregate. And then we link the sentiment to these extreme temperatures to show that when it's very hot or it's very cold, people are less happy. It seems very intuitive. But it's really heterogeneous. You can see different countries because they have different adaptation strategies. It's not all the countries are rich, as in the United States. You have air conditioning, you have heating. No, some countries-- very hard to adapt to extreme temperatures.

And then we have different countries. Then we quantify-- we call it emotional toll, the climate change's emotional toll on people. And basically, that's why you see the inverse U. So this is our paper. We will soon publish it. And then, of course, you can link that to all kinds of other outcomes. Actually, we already link to-- Juan and me and the [INAUDIBLE] paper will link to COVID the same sentiment and also air pollution and other negative shocks. So this is our website. Go there and take a look of our projects and the team if you want to use this index.

The third project for my lab-- related. And it's also the information belief matters. So this is an ongoing project by my PhD student, [INAUDIBLE]. And so, basically, this says-- this is very interesting-- we further explore Twitter, not just are they happy or not, but also their friendship. You know, on Twitter, you have followers and followees-- followers, and you follow others-- others follow you. We know that information.

So we create the friendship network, which means your friends-- not just here-- of course, here, all of us, we are friends. We are good friends. But you also have friends in Harvard and another state and another country like that. You have your social network. Then we say this-- like Hurricane Ida just hit Louisiana. In Louisiana, people suddenly got so unhappy because they lost homes and like this-- so unhappy. And then they chatted on Twitter. And this information not just in Louisiana-- more space got hit and also spread out.

So Louisiana first, and then Mississippi and Rhode island and California like that. So this is the response, which means the hurricane hit one place, and then, because of social network, that's a social learning. And then the friend here, here, here, here, they learned, oh, this is dangerous. And at first, they didn't know what hurricane mean because they never experienced it.

Then, suddenly, the pictures on Twitter shows my friend in Louisiana got hit and so bad, so miserable. Then they understand the risk. Then they adjust their belief and all the things. So that's basically our matrix of the information-- hurricane information networks, which say we have more friend with the other states and how this information flow. So that's another ongoing thing.

So these are all about beliefs, so it's very interesting. It's a very soft thing. It's not very concrete. But we can measure and we understand that really matters. And the soft thing will lead to tangible things of the new development. Now we are going to go move on. Belief is important.

Now let's see how to quantify how to quantify the impact of the climate risk on housing outcomes. So this paper is one of the first papers I think that's on your reading list. And this is a very good paper. It's a very good journal, a very good paper, one of the first several papers, and very easy to understand paper-- Hurricane Sandy and New York City housing market.

So I will use this, but I will expand. I will tell a big story in the methodology in this paper. And after you understand this paper, you will become expert. And then you can easily do yourself-- I know you are not looking at a seaport in your studio project. And that one is very high risk of the sea level rise. So you can use our data and this methodology to quantify the climate risk on your seaport project. I think that's something later we will need to do as our P set number 2 and some analysis in Carlos' class.

Now I'm going to enter the boring part, abstract part. So hedonic model on climate risks-- the thing is clearly, for example, Hurricane Sandy-- so, for example, there's a hurricane. The hurricane hit an area, a city. Then, of course, there's a flood zone. And outside the flood zone-- for now, we assume the flood zone is very accurately measured. Actually, it is not, but for now, we assume. This is a flood zone-- just get flooded. And the other zones, they are not flooded because the flood zone may be very low, elevation like that, and very close to the coastline.

Then we say, OK, we want to quantify this flood risk impact on housing prices. Now we have a very simple way to do so. We compare. We compare this "treated"-- we call the "treated" this one got flooded with this-- without flooding. Then we calculate the gap of the housing price between these two areas, and then we draw a conclusion. Is there any problem on this? [INAUDIBLE] here?

AUDIENCE: [INAUDIBLE] it's not [INAUDIBLE].

SIQI ZHENG: Good. Now we understand this is not apple-to-apple. So today, I don't have real apples and oranges. I didn't have time to go to Trader Joe's yesterday, but next time I will bring more. But now let's see-- just now. I already said we cannot just compare all these [INAUDIBLE] and calculate the price gap. That's too naive. Then it's all apples-to-oranges comparison. But could you elaborate a little bit more? What kind of things potentially are different between these two zones? We are talking about apple is not orange. That doesn't equal to an orange. What are potential differences?

AUDIENCE: [INAUDIBLE] properties on [INAUDIBLE] might be, like, [INAUDIBLE]

SIQI ZHENG: Why the control zone will be older? What's the rationale?

AUDIENCE: Maybe it's [INAUDIBLE] that have been developed for a long time and the treated zone is the [INAUDIBLE]

SIQI ZHENG: You are thinking about the Seaport, the control is like Boston downtown. And then they expand and then become the coastal area. OK, that's possible. Any others? What do you think is a systematic difference? We must look at the systematic, not random difference.

AUDIENCE: The one-- excuse me-- some of the ones that could be in the flood zone or affected by hurricane could have a premium on them because of preferred views or better location versus some control zone may be more inland commuter locations versus premier locations.

SIQI ZHENG: You are talking about-- actually, this treated ones may be very good will because ocean-- everyone likes ocean view. So if you like ocean view, you live in on beach, you're on the beach, you need to bear the risk of being flooded. So that's one difference. Any other things?

AUDIENCE: There could also be the flip side of that, like maybe inside the flood zone, it was a poorer neighborhood, and maybe there wasn't as much investment and red lining and different things like that, so it wasn't as protected as outside of the flood zone.

SIQI ZHENG: Good, yes. Maybe because the inside the flood zone already declining-- declining neighborhood and people understood that, then people left because we just showed paper, people left-- [INAUDIBLE] paper-- people left, and not enough property tax revenue, then very badly maintained-- so they're already bad. So these are all the different things. And another thing is flood insurance because it's required, although it's not very well-enforced. But it's required if you borrow mortgage from the bank, if you are in a flood zone, you need to buy flood insurance. So they are insured. And these are not insured. So that will be like, oh, I'm insured, so not-- no problem. Even if I get hit-- insured. So that is a difference.

Think about this. Last time, I used this to help you better understand-- in a very numerical way understand this. Let's look at this. Let's think about the problem of that apple-to-orange comparison. So, for example, there is a house, $1 million. Then we decompose that hedonic-- decompose. Three rooms, two busways, two subway stops, and a nice park and some trash can-- the trash can here. And now we have that inside flood zone-- now we know inside flood zone bad. Then, after a lot of data, crunching the data and the regression things, negative 0.1 million discount. So that's the hedonic model. Thus, we cannot compare no matter apple/orange you put together to compare.

Then this basically what we [INAUDIBLE] I think that our [INAUDIBLE] number two. Keep in mind this kind of thing-- we are interested in alpha 3. This is a trash can. That's why we have an R square, which is not 100%. It is 3%. So that's the idea. I think you have the intuition of this.

Now, clearly, we understand. The trash can is not that clean. It's not random. There are some things in the trash can which may be correlated with this flood zone location. So now I have one example-- to make this simple one example, which is ocean view. As we said, the ocean seaport is very easy that you are in a flood zone.

Now the trash can is not that clean. So if we can observe with a measure-- for example, we are so sophisticated we can measure exactly the ocean view's value. That's a hypothetical scenario. But anyway, if we can observe-- suppose it's $0.05 million. And then this will be the remaining trash can or something we really want to measure, like that. Then we are very confident. But if we cannot observe the ocean view and if, in the extreme case, that the ocean view means flood zone-- these two are the same thing-- then you have a trouble.

So, basically, you will see-- I think this is the-- let me say ocean view. So basically, you will say here-- so ocean view will go into here because ocean view and the flood zone is the same thing. So you naively run the regression. You don't know these two are different. You think that's the same. Then you get this. Then you underestimate the discount. You say, OK, in the flood zone, now it's not a big deal. In the flood zone, you only have a discount of $0.05 million, because in the flood zone, you also have a benefit of the ocean view.

Actually, if you can really split the ocean view out, actually, and the flood zone is so bad that's negative $0.1 million, then this one offset this bad thing, this negative amenity. This is a positive. If you can really measure, you get this right. If you cannot, you get it wrong. You underestimate. So that's the big challenge of this kind of research. We call it identification because it's identification challenge is this all kinds of things in the trash can get correlated with the thing you are mostly interested in.

Don't worry-- we have a way to handle this to make this to apple-to-apple. So this is called difference-in-difference, DID. So maybe you heard of this term. Anyway, I think [INAUDIBLE] last time you mentioned you know DID, right? Can you use a very simple language to explain to us what is the idea about?

AUDIENCE: I've got to think about that.

SIQI ZHENG: OK, you forgot. OK, no problem. Take your time.

AUDIENCE: It's more like. Instead of you directly try to find a relation shape between two [INAUDIBLE] stuff, you try to find like an intermediate as a vehicle in the middle. And you--

SIQI ZHENG: Oh, that's an instrumental variable.

AUDIENCE: Oh, OK

SIQI ZHENG: So anyway, now we are talking about different methodologies. Remember, last time, in my first apple-to-apple comparison, I taught a methodology called what? I hope you can remember the terminology.

AUDIENCE: Sorry, I actually don't, but I can list [INAUDIBLE] all of them.

SIQI ZHENG: Matching.

AUDIENCE: Matching.

SIQI ZHENG: Yes. The simple way is matching. Remember, last time, we talked about matching. So all kinds of ways for us to have apple-to-apple. Last time, we talked green building-- that's matching. Green-- nongreen-- very close by. Then we match green with nongreen. The same location, similar things, all similar-- we calculate the difference. This is called matching.

Now this is the first methodology I hope you can grasp. Now today, the second one is DID. DID I'm going to use a very intuitive way. I'm going to show so that you can understand. Now just now, we already said they are different animals-- one is apple, the other is orange. We cannot direct compare. That will lead to bias. We show bias.

Now we have a way-- fortunately, this is a over time thing. It's not like we only observe one time point. We observe over time. So we observe-- like Sandy, this hurricane-- before Sandy and after Sandy. So we take advantage of that. If you can only observe one time point, that's all, then you cannot do. If you observe all the time, you have this way to do.

Before Sandy is a smaller apple. I use this [INAUDIBLE] so always, the housing price go up-- in normal time, go up. So before Sandy, the apple is smaller. Then it grow larger naturally-- naturally grow larger. And can we just compare-- no question-- can we just compare this small apple and this big apple-- say, OK, I understand I cannot compare apple and orange. But now I'm going to change. I compare before Sandy, what's the price? After sandy, what's the price? Subtract. Then this is the impact of Sandy. Any problem of this or it's good? Go ahead.

AUDIENCE: I mean, something might have-- something else might have changed in the neighborhood.

SIQI ZHENG: For example?

AUDIENCE: I don't know-- like new retail in the area [INAUDIBLE] home prices up.

SIQI ZHENG: OK, good.

AUDIENCE: [INAUDIBLE] market appreciation. I mean, that also doesn't factor in here.

SIQI ZHENG: Like subway stops-- like something like that. Now it's naive. This direction-- naive. This direction-- naive. Now we have seen this control before-- small orange to big orange also grow over time. Now this is called difference-in-difference in the way. First, the steps-- first, measure the baseline difference. Baseline means before the treatment. That's the baseline. Measure the baseline difference between pre-apple and pre-orange. So we call it pretreatment. Actually, it's called pre-treatment. But I use this language called pre-apple and pre-orange. So there's small ones. So let's measure this baseline difference. They are different. So we get this.

Second, this is [INAUDIBLE]. This is-- they are different animals. Orange and apple-- totally different-- nutrition and all things different. Then subtract the baseline difference from the underline after treatment-- difference between this post-apple and post-orange to get the real treatment effect. So that's the point.

First, measure before anything has happened. What's the fundamental difference of the baseline? The two small orange and apple. Then we know they are different. We control for that. Now, after treatment, they become more different, and then we subtract. So that's the hurricane effect.

And another thing is to this. This is another way. It's the same. First, measure the baseline time trend from pre-orange to post-orange. This thing hurricane never happened in this neighborhood. No hurricane thing never happened. General trend-- general trend. Go from small to big-- measure this. Then subtract this natural growth from the treatment growth. Then you will find that this and this are the same, You just rearrange. You just rearrange. So each way is fine. Either way is fine. But you understand that you have four cells, and then you first get some difference, then subtract. That's why it's called difference-in-differences. This is the two differences-- difference. So that's the DID. It's a very intuitive. Any questions here? I need to pause a little bit. Are you fully comprehend?-- it's not that easy.

AUDIENCE: On the left side, how similar does the left side need to be? I mean, there's already a [INAUDIBLE].

SIQI ZHENG: Yes, that's a very good point. So basically, the thing is this fundamental-- I think you are asking a fundamental assumption of this methodology. To make sure this methodology holds, we have a fundamental assumption is except for the treatment we are interested in, which is Sandy, other natural things grows are similar between this and that. The only different thing is Hurricane Sandy. Besides Hurricane Sandy, all the macroeconomy and weather there is some booming of the city and other things are the same between this orange and apple.

So, actually, we are using this orange natural growth to infer-- this orange natural growth to infer for this treatment group if hurricane hadn't happened, what would have been for this treatment group? That's a counterfactual. We cannot know that. Nobody can know because it already happened. But we believe these treatment and control, in the absence of that treatment, will follow the same trend. So we use this trend to infer the trend of this in the absence of that treatment. So that's the counterfactual thing. This is the counterfactual here. So that's the assumption. We must test that assumption is true.

AUDIENCE: Everything else is called constant [INAUDIBLE] then if the building material is subpar on this side, and then it corrodes faster-- so do we still need to control characteristics?

SIQI ZHENG: Yeah, we can control. We can control as much as possible. But for the trash can, we assume they are similar.

AUDIENCE: Since they're controlling for characteristics so much, what's the difference between diff-in-diff and matching? How different is it?

SIQI ZHENG: Oh, they are used in different scenarios. So for this over time matching, you don't need over time [INAUDIBLE] if you only observe one cross-sectional thing, you can still do. This one, maybe you only have two areas, but you don't have so many together. Then you use this. They are not like one is much better than the other. It's totally data and all the context.

AUDIENCE: I would imagine that immediately after the hurricane, the growth in the apple would be a lot smaller. But say if you extended the study over a much longer period of time, say 6-7 years, maybe that difference would start to--

SIQI ZHENG: To diverge?

AUDIENCE: Yeah, it would not be so much--

SIQI ZHENG: Yes, yes.

AUDIENCE: I'm curious to know what the period of the study is?

SIQI ZHENG: Yes, that's a good point. It's a definite answer. That depends on the data and the study research question. But it's not like yesterday and today-- not like that. It's not so immediate change because all the-- housing markets gradually change, so years, like two years before, two years after, something like that. Yeah?

AUDIENCE: So the [INAUDIBLE] between the DID [INAUDIBLE] climate risk.

SIQI ZHENG: Yeah, that's the impact of the climate risk on the outcome. The outcome may be a housing price. That's why the treatment is the climate. OK, good. OK, now let's position. Now remember this. This is a framework that you don't need to memorize. If you grasp all this-- PhD graduate. So don't worry. I need to first make sure that you don't worry.

But the idea is, as I remember, as I said last time, we really hope you can grasp all of [INAUDIBLE] run regression and you have some more sophisticated specification. But you really want to do this-- you say, OK, now I understand. Causal inference is so important. We just don't want to draw naive conclusion, just a correlation. If you have that goal in your mind, you want to be more advanced, then we already talked matching. Matching, like geographically matching, like that, and more sophisticated called propensity score matching-- no need to really get into this unless you want to do a PhD.

And now, today, we are talking about DID. Difference-in-differences is DID. So that's the thing here. So now we have at least two. We grasp two out of four instrumental variables-- so sophisticated. RDD-- later, I will touch a little bit on this. And then you know the golden thing is the experiment. But not so everyone is lucky to run an experiment. But if you do an experiment, that's the best. So now you understand the big picture.

And then, to give you some algebra-- it's so easy. So this property inside the flood zone. This property outside the flood zone-- this. So that's over time. Now I [INAUDIBLE] this is economist bad-- so overall, this trend is going down, but many times, it's going up. But anyway, let's say the overall trend-- going down. Then we understand all other trends similar. Suddenly, there is a hurricane. Then, for the treatment, will get a bigger jump. So our focus, our goal is to get this treatment effect, which is this big gap right here. Then the orange thing is the algebra is like this-- treated control yt1, t2, c1, c2-- then you just have the first difference, then the second difference. So that's the expression of this.

And then just now we call it parallel trend is this-- before these two groups should have the similar trend? That's the assumption. If this assumption doesn't hold, then game over-- cannot use. So to do the DID [INAUDIBLE] the first test, the parallel trend is before anything has happened, these two have the similar trend. This is called parallel trend assumption. If they do not have this, you cannot use, but not at the end of word because we have other approaches. Oh, DID cannot be used-- then we go to other. That's econometricians-- they always daily dealing with these things.

Now I talk too much about methodology. Let's see some application. So I'm going to have this. I go back to that paper. That paper you will read. So Sandy, 2012, hit New York. And then they use it-- they say, OK, this is a perfect setting for DID because not all the communities got hit. Some got, some not-- then treatment and control. And then the question is Hurricane Sandy on New York City housing market. What's the impact of that? And then they say, OK, they collect all the data. They knew New York City is not that difficult to collect the housing transaction. It's very easy.

And then they geocode. And then also they got FEMA data on the damage. The good thing is they really have the damage. They have the damage data, the building-- they have several damage levels.

They find properties in flood zone has 8% persistent price penalty after Sandy. So remember, 8%, persistent-- not like after Sandy the next year, 8%-- the second year, people forgot about that and then recover, and then later fully recover. They said no, persistent. So that's your finding. But I need to let you know. Now this area of research-- a lot of papers, and they have different findings. They are inconsistent. Some papers, they found temporary and then recover. Some they found persistent. So then you cannot say you are wrong, you are right-- no, because they are looking at different hurricanes, the different data sets.

So algebra-- empirical specification-- DID. DID here is log p. And this is variable name is very complicated. You just look at this dummy. Treatment sales in the flood zone times post-- so here, maybe I need a little bit-- one-minute explanation of this because otherwise, when you look at paper, you got confused.

So the point is the following. You have log p. That's very clear-- hedonic. Then you have beta 1 [INAUDIBLE], all the controls, like number of rooms, like this school, subway. Then you have another beta times Treat-- Treat is some dummy of the-- yes, OK. Let's say alpha, beta 1 plus beta 2 times After plus beta 3. This is the interaction. So that's a specification.

So what do you mean by this? Well, we suddenly become so complicated-- actually, it's very intuitive. Think about this. Remember this matrix? This is a treated area, which is a flood zone. This is a control. This is before. This is after. The force sells. That's the key thing as we showed here.

Now when you look at the equation-- when you look at the equation, say the Treat flood zone before, then Treat is 1-- Treat is dummy 1. Then After is 0, and After is 0-- this is 1. So for this part, we only look at this part. The only coefficient can survive is beta 1, is that right, before because before After 0-- After is the dummy. Only After is 1. 0, 0, 0, 0, 0, beta 1. And then treat after-- this survives. This yes, this yes. So that's beta 1 plus beta 2 plus beta 3. Treat after three coefficients. Control-- before 0, 0, 0, 0. And After-- 0, 1, 0-- only beta 2.

Then you have all the parameters. And then you do, OK, now I understand that this difference-in-differences in what kind of thing is difference-- yes, difference, further difference. So the thing is this is a measurement. So when you run this regression, this thing is -8%. Is that clear? OK, if you got so confused, come to my table and think about my apple-to-oranges thing. This thing then, look, has a coefficient. Write on your paper you derive-- this is the coefficient.

AUDIENCE: So what's the thesis of this research? Is it-- is it that buyers attribute a lower value to houses that have the potential for flood risk?

SIQI ZHENG: Yes.

AUDIENCE: My issue with that is that this based on what we've been told, this research seems to ignore the effects of the increase in insurance premiums that are the result of post-storm damage. So you have to go in and rebuild the location, and then there's going to be a higher holding cost afterwards. So naturally, there should be some correction there that will ultimately revert to a mean?

But as far as buyer's preferences, generally, in the United States, buyers own homes for 5 to 8 years. So it's not like-- I don't understand why a rational buyer would say there was a 1-in-300-year storm that occurred and hit New York. Yes, there's significant damage, but I project that we're going to get another 1-in-300-year storm. Statistically, that's not a rational decision to make. So I don't think that they can attribute that to the effect of that massive storm. It's more the effect of the tail end of it, which is the insurance industry's response to a large--

SIQI ZHENG: Yes, yes. So basically, yes, you are right. So, for example, if the market is very efficient and the information-- very efficient, then even before this happens, they understand this place is riskier than this place if you look at the long run. Then they're already capitalizing into the place discount. So after additional shocks-- no change because they fully understand-- they fully capitalized those future things in now--

AUDIENCE: There should be a little bit of a change though because of the change in--

SIQI ZHENG: Yeah, temporary, like you need to repair and things like that. But later, you will just-- will become same. But always, this is not enough information. So those buyers, at first, they don't have the big capitalization effect. Then, after this shock, they understand more. Then the discount disappear-- discount appear more. So that's my explanation.

And there's other explanations. But what you said also makes true because in another paper, exactly the same data-- Sandy and the New York City, some of them they found recovered. And different neighborhoods are so totally different in terms of whether they have insurance and whether they have the capacity to repair and things like that. OK, technical thing, any question? You have a question?

AUDIENCE: [INAUDIBLE] beta 1 before the treat [INAUDIBLE].

SIQI ZHENG: Beta 1 before, yes, before treat-- treat is 1. Treat is always 1 for treated, no matter before or after. After is 0, and this is 0. 1 times 0 is 0. So you only have beta 1 there. So 1, 0, 1, 0. Yes, I think this, of course, will take time, too. At first, I didn't understand. I need to tell you that when I was a PhD student, I didn't learn this. At that time, they had not-- the econometrics field advanced very fast in the last 20 years. When I was a PhD student, no DID, no matching things, no. And then we didn't learn. And later, I saw the papers, all of you were using this. I got so confused. I didn't understand why this interaction term matters. I just do all my math, and now I understand. Good.

Then I will skip this because this I already told you-- this 8% persistent. And they also have three level of measures-- three levels of damage-- light damage, medium damage, very heavy damage. You see, it's different. The heavy damage-- 15% of the discount. And these are OK-- overall stabilized at 8%. For those, first drops a lot and later recovered a little bit and finally stable at 8%. So that's for housing. Remember, housing, housing, housing.

I think, today, I'm not going to have time to for commercial. But next week, we will talk commercial. Then there's a commercial real estate paper says, oh, commercial real estate. They crave data. They drop. After two years-- fully recover. That's a commercial real estate paper. But I don't understand why they fully recover. But anyway, there are so many different papers. But for this one, 8% in New York City after Sandy.

And also, you see there's other papers. This is another paper to look at change in the risk premium. And then you see this lending. At first, no price differential between flood zone and no flood zone. People may be deniers, I don't know. And they don't have knowledge like that. And unfortunately, this area got hit several times. And first, before, no differential, and then one hit. After this first hurricane, Fran, got discount. And then, unfortunately got hit again by the Floyd. And the further discount-- they learned and learned the-- to the extent that stable, now they understand, for this location, the future probability is what, and they fully capitalize that. But it still depends on belief. Maybe no matter how many times, I just don't believe-- you don't believe.

AUDIENCE: About this model, even in China, like one housing [INAUDIBLE] the developer [INAUDIBLE] repair. And after five years, if the house broken, the--

SIQI ZHENG: The developer is gone.

AUDIENCE: No, the property [INAUDIBLE] will repair. But if the climate risk, like flooding, the city government will repair it. So the treat and after the [INAUDIBLE]

SIQI ZHENG: Yes, that's something we need to discuss. Who is responsible to repair? If always the government responsible to repair, then they don't care. They still buy, and the builders still build. That's a moral hazard. We call it moral hazard if the thing that-- you don't bear the risk when you make the decision, moral hazard-- you just build, build, build. Yes. OK, thank you. And today is about housing. And because Juan eating my time, I cannot go through this. Next week, commercial and guest speaker. Thank you so much.