THE BROOKINGS INSTITUTION

FALK AUDITORIUM

HOW CAN CLIMATE RISKS BE INCLUDED IN REAL ESTATE VALUES?

Washington, D.C.

Thursday, May 14, 2026

WELCOME and MODERATOR:

SANJAY PATNAIK
Bernard L. Schwartz Chair in Economic Policy Development, Senior Fellow, and Director, Center on Regulation and Markets, The Brookings Institution

KEYNOTE AND FIRESIDE CHAT:

DARYL FAIRWEATHER
Chief Economist, Redfin

PANELISTS:

JESSE KEENAN
Favrot II Professor of Sustainable Real Estate and Urban Planning, Tulane University

MARGARET A. WALLS
Senior Fellow and Director, Climate Risks and Resilience Program, Resources for the Future

* * * * *

PATNAIK: Good afternoon, everyone. Thank you so much for coming today. My name is Sanjay Patnaik, and I'm the director of the Center on Regulation of Markets here at Brookings. And so, today's event will be really focused on climate risks and how we can include climate risk in real estate markets. As there has been increasing interest in trying to find different ways to reflect growing climate risks in real estate valuations and in real estate markets. But one of these, one of the challenges we face here is that it's very difficult to do so in a rigorous and empirically sound manner because a lot of the climate risk models that we have produce different outcomes. So, you might have one property that under one model has a much different risk score, for instance, for flood risk than under another model.

So, what do we do with this, and how can we kinda like address this in a way, that is fair to market participants and still reflects the risk. Because if you think about it, let's we got a couple of audience questions actually on this. Let's say you have a pensioner, a retiree, all the value em- embodied in the asset they own, which is a house usually, and let's say that one of the climate risks says that there is a big flood risk and that score might be very different from another one, but it could be reflected in the value of the property, and in, in the value of the property when it goes on the market.

And so today we're gonna talk about these really important issues. We're gonna start off with a fireside chat with Daryl Fairweather, who is the chief economist at Redfin. And then we have two panelists that are very distinguished in this space. We have Jesse Keenan who is a professor of sustainable real estate and urban planning at Tulane University, and we have Margaret Walls, who is a senior fellow and director of the Climate Risk and Resilience Program at RFF. And we'll have audience questions for the panel, so please, if you have any questions, you can wave down my staff members, and they will give you flashcards to write them down. Okay? With this, I'm gonna welcome Daryl on the screen. Let's move into this.

FAIRWEATHER: I can hear you.

PATNAIK: Perfect. Thank you so much, Daryl. I really appreciate you taking the time to be with us today. I know you're super busy. Thanks for being here.

FAIRWEATHER: Yeah, thank you for having me.

PATNAIK: So, let's dive right in because, you are right at the center of all this. You are the chief economist at Redfin, and so you have a front row seat to millions of real estate transactions, right? To what extent do you see climate risk already being priced into home values, a- and where is the market still getting it wrong?

FAIRWEATHER: It's a bit tough to see that climate risk is being priced in unless you really zoom in at a micro level. When you look at macro trends, like which areas are going up in value or down in value, you don't really see m- much of climate change playing a role. But we were able to do an experiment when we launched risk factors for climate on our Redfin website and app back in 2020. We put flood scores on the app for the f- in the app and website for the first time, and we did a randomized trial where half of our users saw flood scores from First Street and half of them did not.

And we looked back at the data to see what happened to the people who saw the flood risk scores. They did decide to buy homes with less risk. The people that were previously searching for homes with severe or extreme flood risk went on to buy homes with about half as much risk compared to the control group. So, when we can really zoom in and measure things experimentally, we do see that people are responding to climate risks like flood. But when you look at migration trends, people are leaving areas that tend to be safer and moving into areas that tend to be more dangerous, that have higher heat risk, higher flood risk, higher storm risk, like in the Gulf area and in Florida. I think climate risk plays a role, but the thing that people really pay attention to is price and cost, and that is what motivates most moves.

PATNAIK: Oh, that's actually super interesting, especially that you guys were able to do this experiment because you don't have too many settings where you can actually do that. All right. Are you still here? Sorry, the screen went out.

FAIRWEATHER: Yes.

PATNAIK: Okay.

FAIRWEATHER: Yes, I'm here.

PATNAIK: So, one question I had is which a lot... we have been thinking a lot about is when you look at the risk, as you mentioned First Street, right? And they use a s- a specific model for this. These risk models can produce very different scores, and so even the same property for the same risk factor, let's take flooding or fire hazard, could have very different scores. And so how do you think you can reconcile those different scores and still provide meaningful and accurate information to market participants? Because let's say I have a house, I want to sell it, right? And then one score tells market participants that I have a huge flood risk, so people are less likely to buy it. But then actually another score says that the flood risk is negligible. And so, my value gets affected by the choice of model that is being used for this. So how can this be reconciled?

FAIRWEATHER: Yes, it is a challenge because any forward-looking climate score is going to be unfalsifiable, meaning that you're never gonna be able to say that one score is better than the other. Even if there is a storm and one model predicts it with a higher probability, you don't know if that was just a fluke or if that model was actually better. So, we display data from First Street on our website and app. That's our data partner. We really just chose them because they had a viable product before anyone else, and they had reputable climate scientists working on these models.

But it's not the only model that exists out there, and it's not the only piece of information that people should consider. Hopefully, what's happening is that when people see that a particular home has a high or low risk score, that's just the beginning of them researching what that really means. if they notice that a home has a higher flood risk, they might go actually look at the home and see what the reasons are. Like maybe it's because it's close to a waterfront, or maybe it's because of the elevation of that home, and they can decide for themselves whether that is something they can mitigate against, whether that's something they would want to insure against, or whether the data on the website or the score doesn't really match with what they're seeing in person.

So, I don't think it should be the end of the research. It should really just be the beginning of it. And hopefully pe- It gets people thinking about it so that they can make more informed decisions. And also, hopefully they ask about flood insurance and how much that costs because that, I think, is what

really will drive it, is what is the cost of that insurance. And the insurance companies are using the same model that... Or they are relying on First Street as well. They are a data supplier for many of the major home insurers.

PATNAIK: So, it's really not very similar to I don't know, a walking score or a school score because that is really more kind of standardized. It's really something to start the conversation and start the research. Is that correct?

FAIRWEATHER: The school scores are very problematic. Okay. Just as, they're just as pro- yeah, they have their problems as well, and it is a difficult decision. Do we display these school scores- Yeah ... that might represent just the income of the area or might represent the education of the parents in that area rather than how well that school is doing? But it's something that people care about and they check for. Yeah. So, on a consumer level, they obviously want that information.

PATNAIK: No, that's actually super helpful. And so, when you... From your perspective, when different climate models disagree on the same property who usually bears the cost of that uncertainty? Is it the buyer? Is it the seller? Is it the lender? Is it the taxpayer through disaster relief if something happens?

FAIRWEATHER: That's a good question. The sellers would say that if there's a score that isn't accurate, that they are the ones who suffer the consequences of the score not being what they think it is. For Redfin, if the seller does complain about the score, we will withhold it from the listing because that listing is something that is supposed to be an advertisement for them selling the home, and we believe- Got you ... that they should have some control over it, but they can't control their neighbor's score.And if people see that an entire region has high flood risk and one score on a particular home is missing, then they can, infer what the score of that might be. But at the same time, the buyers, I think, want this information. They deserve this information, especially when we know what the consequences of climate change will be in the future and how insurance costs could rise. There isn't, I think, a perfect source of information. There's going to be uncertainty no matter what, but I think that uncertainty is better than having an absence of information.

PATNAIK: So at least it provides some value to the potential buyer. Okay.

FAIRWEATHER: Yeah.

PATNAIK: One thing that I like to turn to is what you have done in the past. You've written about how climate disasters can turn homeowners into renters, which is quite interesting, right? Can you walk us through the dynamic a little bit and what it tells us about how buyers are actually processing long-term climate risk?

FAIRWEATHER: Yeah. So, it used to be that when you bought a home, you were doing it because it meant that your housing costs would be fixed into the future. You get a fixed rate mortgage, you know your mortgage payment isn't going to go up, but you have these other costs, like insurance costs and maintenance costs, that I think in the past were probably more predictable than they are right now. So, because those other elements of what your monthly housing payment is going to be are becoming more uncertain, more risky, the benefit of becoming a homeowner, I think, is diminished because you're not able to lock into that certainty of this is what my housing payment is going to be every single month.

So, if you're becoming a homeowner because you want to insulate yourself from those, the volatility in housing costs or in rental costs, then I think that is diminished. Also, I think investors are better positioned to continue to own homes relative to individuals in the face of climate change because they have more resources if there is a disaster to rebuild, they have multiple properties that they can spread across different geographies so that they can hedge against risk. And because investors have that advantage over an individual homeowner, you're probably going to see more investors in the market renting out to renters who see the benefit in renting that they can just, leave an area behind if there's a disaster versus those homes going to homeowners. But this is predicated on what happens at a government level, whether the government steps in to reduce the risks of individual home ownership because they see there being a benefit to that over investor-owned homes.

PATNAIK: That's actually really interesting because this could fundamentally change some real estate markets in certain parts of the country, right? And also, what it means how to build assets, how to build wealth, which in for most people is in, is tied up in the home.

FAIRWEATHER: Yeah, that's right. I think about Florida Florida's housing market has been faltering a bit, but it's always been pretty volatile. But if people in Florida don't wanna be homeowners anymore, but they still wanna live in Florida because of the weather, because of the lifestyle that it offers, maybe they're retirees and they're not really thinking about the long term anyway, the people who want to live in Florida are going to be pushing up the rents. Like, when demand shifts from home ownership to renting, then rents go up, and then that in and of itself becomes a benefit to investors who want to get in the market and counteracts that risk that they face by buying those homes. So yeah, you can have different distributions happen in markets as the risks rises.

PATNAIK: Great. Thank you. One, one challenge with a lot of these climate risk models is that they are backward-looking, right? They look at historic data. I think it's the same when you look at most of the flood maps. The problem is that when, with climate change, that's really upending all of this, right? And you'll suddenly see floods in areas where you never had floods or you would get, I don't know, five one in 100-year events within six years. And so, this really changes the way how you can assess risk. So how do you think about that? How can we make it- more forward-looking and try to incorporate that into climate risk assessments.

FAIRWEATHER: Yeah. I'm not a climate scientist. I'm not exactly sure how you would do that. But w- from what I understand is that these climate scientists are trying to use some assumptions about how much temperatures are going to rise, how much sea levels are going to rise in order to build models that are forward-looking, but they do hinge on a lot of assumptions that are not guaranteed. But one thing that I think is important to point out is that it's not just about which areas have more flood risk or more heat, it's also about which areas are prepared to withstand those changes. Because homes are inherently built for the environment that existed at the time that they were built.

So, in Los Angeles, for example, homes are traditionally not built with air conditioning. Air conditioning is a newer thing in homes in Los Angeles because there are more and more heat waves, so you have

to do these modifications to the older homes, and they're not built to withstand torrential rains. If you have one bad rainstorm, you can get a lot of flooding in an area because the homes weren't designed for that. But if a home has always been designed for that, like in Florida, you might not have as much additional maintenance because they were prepared for that kind of disaster. So- it's not just about, like, where the risks are rising, but whether or not the environment... the homes were built to withstand that risk in the first place.

PATNAIK: That's a truly important point, and I think also how maybe coding regulations, code regulations can keep up with that and change over time, right? And adapt to the new reality.

FAIRWEATHER: Yes, which is difficult because we already have a housing affordability crisis, and any added regulation adds to that. Yeah. But we have to deal with these crises at the same time.

PATNAIK: No, totally. That's a convergence of factors that is not in the favor of people being able to afford homes. You've mentioned Florida and California in two different contexts. We have seen in both of those markets some major insurers already withdrawing from the market, or at least from parts of the market. Do you think that insurance repricing will do more to correct climate risk mispricing in real estate than any other disclosure regime could? What role do you think, insurers play here?

FAIRWEATHER: I think that when people buy a home, what they care about first of all is how much it's go- is it going to cost them on a monthly basis. That's what determines whether they get approved for the loan, because that's what their lender is looking at, and it also just impacts whether they can afford the home in the first place. So, if the climate risk is translated into higher insurance costs, that is going to motivate people much more than seeing the risk score on its own. But you need an insurance market that is allowed to price that in. Yeah. In California, for example, you have more government intervention in insurance markets that keeps insurance costs low in places that do have rising risks, whereas in Florida, you don't have that same kind of regulated market, but they have created...

they are exploring ways to reduce insurance costs by making it so that people don't have to get as much insurance as they might actually need. Like- ... they have... The one thing that's been floated is

having insurance just for the mortgage and not for the homeowner, so if there's a disaster, the mortgage is paid off, but the owner just is left on their own to figure out what to do next. And I think if that's the default, you're gonna have a lot of people who opt into lower insurance costs and take on that risk themselves and just roll the dice on whether-

PATNAIK: Wow ...

FAIRWEATHER: their home actually is destroyed or not.

PATNAIK: Oh, that, that's crazy to think about. That would be very different type of market arrangement. Another question I have is, like when you look at climate risk you have two different categories almost. You have the very slow chronic climate risk, like rising sea levels like we see in the Outer Banks, for instance, or more heat days in Arizona, but then you have acute risk of extreme weather events, like hurricanes and wildfires that increase in severity. Do you think that markets are starting to price these two types differently? Or should they do it if they don't?

FAIRWEATHER: Yeah, it's, it, there, when you have a fire, for example, the entire home can be destroyed just in an instant, but a- if you survive the fire, if you're one of the homes that doesn't get hit, I think it's easy for people to forget about that risk, because it comes fast and furious, but then goes away, and then you forget about it, whereas something like heat, it's something that people have to endure every single day. But then the other side of that is that you have the frog boiling in a pot effect- ... where every year people get a little bit more ac- acclimated to that rising heat, learn to live with it, learn to adapt to it, and that might keep them there as well. Another thing I'd like to point out is that there are all types of risks that people don't ever think about with their homes that I don't think are getting priced in at all.

Like where I live in Wisconsin, we have a lot of radon risk- Oh, okay ... which is the second leading cause of lung cancer after smoking. But so many homes don't have radon mitigation, the homeowners don't test to see if there's radon there, and it doesn't get priced in. And in Seattle, for example, there's a 100-year risk of there being a devastating earthquake that causes a tsunami that could be, like, totally devastating to that area, but people don't think about it because people... I think its behavioral

psychology is just people don't think about these low risks and they don't think about risks that happen long into the future. So, we already, even without climate change, people don't think as much as they should, I think, about these types of environmental risks.

PATNAIK: That's actually a really good point. And I think it's in, in the human nature, as you mentioned. But o- one, one thing that relates to this is when you think about climate risks, they're incredibly local, right? Climate risks mean something very different to someone in Phoenix in Arizona or someone in Miami that who is worried about flooding. How should we think about communicating that, that climate risk? Because oftentimes we talk about it in very generic terms. Should it be something that is really localized also in terms of communication, in terms of, like, how this is being, like, presented?

FAIRWEATHER: Yeah. I think, I... and ideally there should be community-level action for climate change. It shouldn't just be on individuals to decide which homes to buy or where to live, because a lot of mitigation can be done at a community level. If you can design waterways that divert water away from homes and into retaining ponds, and that can help protect a whole community of homes, or if you have community-level forest management, that can reduce the risks to homes as well. So, I think it, it is on these local communities to figure out what risks are the most concerning for the people who live there and band together to figure out how to mitigate against them.

PATNAIK: That's actually really interesting. Like a localized collective action. Yes. That's interesting. So, let's talk a little bit about kinda like the regulatory environment. So, if you could advise a federal regulator on an intervention that could lead to better incorporation of climate risk, what would it be? What are some of the measures that you think could be really useful and helpful in that regard?

FAIRWEATHER: Like I pointed out before, I think it's a bad idea to intervene in insurance markets to keep insurance costs artificially low. If anything, I think we should be raising awareness of what insurance cost is for different types of homes. If you're searching for a home on Redfin or any other app, there's no way to see what the insurance costs will be for one home compared to another. In fact, most people don't find out how much their insurance is going to cost until after they've already put in an offer on the home.

They do it during the escrow period. They go shop around for insurance, and that can cause deals to fall apart. We're seeing that happen in Florida, where a home buyer doesn't realize they can't get insurance until they replace the roof, and the roof is going to cost $50,000. Wow. And neither the buyer or the seller wants to pay for it, and the insurance falls apart, or the deal falls apart. So, I think moving up that information earlier in the buying process can help people make better decisions. And then at a more collective level, I think it would make sense if, the federal government gave grants to communities that are doing community-level mitigation- ... against climate change, whether that's making their areas be more resilient to climate change or helping areas that are probably just too risky entirely relocate.

There have been towns in, South Carolina, even where I live in Wisconsin, that have been entirely relocated because of environmental risk. Wow. It's a tough decision to know where, which communities get the money to, to adapt and which communities are told to move away, but that's going to be the reality, I know, in future decades.

PATNAIK: It's all about trade-offs, right? A- another role when you look at the American real estate market Fannie Mae and Freddie Mac, they back a huge share of US mortgages, right? I- in your view, should they be required to incorporate climate risk into the underwriting standards? Would that help? A- and what would it do to, to markets, especially for housing affordability?

FAIRWEATHER: I don't know if it's directly the climate aspect, but I think that they should be aware of whether the home's insurance is sufficient ... to address the risks that are in that area. I think it makes more sense to go through the insurance markets rather than through Fannie and Freddie, and I know that, post-2008 crisis, there were restrictions put on Fannie and Freddie that they couldn't discriminate against zip codes because- there was so much blight in certain zip codes. They didn't want certain zip codes not to be able to get financing at all because there were so many foreclosures there. Yeah. So, I think that there... And if anything, that's a real concern that's probably going to continue. With climate change, though, if there's a disaster where there's a bunch of foreclosures in one area, maybe it doesn't mean that entire area shouldn't be able to get mortgage financing through the government in the future. But yeah, I think the proper channel would probably be more through insurance. Insurance, yeah.

PATNAIK: And you touched on a really important aspect, which is we have a big tension here, right? We a lot of people are talking about housing affordability, which is a big problem in this country and if you look across the pond in Europe as well. So, on the one hand, if you start pricing in climate risk more accurately, that will probably mean that some areas will be uninsurable or uninhabitable because they will be just too expensive to live in. So how can you balance that with being transparent about climate risk, be- making sure that we incorporate that somehow, but then also not leaving a lot of people out in the cold?

FAIRWEATHER: One way to m- to address that is through land value taxation- ... which we don't have in this country, but I've been talking about and advocating for it- ... a lot because climate change will change the value of land. As you said- Yeah ... some land will go up in value and some land will go down in value, and if you are taxing that value of the land, that means that certain people will get a tax cut if their land goes down in value through no action of their own, and some people will have to pay more in tax if their land becomes more valuable through no action of their own.

And that money could be used to address the harms of climate change that, people didn't sign up for themselves, that they are having to deal with on their own. So, I think that's one model for doing it. That's interesting. And if you can't do a perfect land value tax, I think that's still the logic that I would use, that these areas that are the winners of climate change should be taxed at a higher rate than the areas that are losers.

PATNAIK: So how would the land value taxation work as compared to regular property tax? Is it liking the change in value that you would tax? To some degree we have that with property tax valuations every year for each county, right? But I'm curious how that would work.

FAIRWEATHER: Yeah, so the problem with the way that property taxes work right now is that you are taxing the building. Your tax by taxing the building, you are discouraging building. And what we actually want is that- Okay ... when land values go up, we want more building in that area, not less. And when land values go down, you would want less building in that area. So, if you're taxing just the land and instead of the property, then you can get a lot more development in the areas that are going

up in value because instead of just holding that land vacant, you have an incentive to build, and also it removes the incentive to speculate.

People are already buying up land in areas that they think are going to be going up in value, and they're not developing it necessarily. They're just holding onto it- ... until it does go up in value so they can profit. It's rent-seeking, rent, rent- Yeah ... seeking behavior. So, if you taxed away that, that land value, then that would discourage that kind of rent-seeking with climate change.

PATNAIK: That's actually super interesting. Do you know of any countries that have implemented that to some degree or are thinking about it?

FAIRWEATHER: South Korea is thinking about it. Okay, cool. And I think Norway as well. Center for Land Economics does a lot of research about this, so they would be the best people to ask.

PATNAIK: Great, thank you. Another question relates to kinda like real estate agents and their role, right? They have been traditionally been very reluctant to disclose or volunteer negative information about properties. Makes sense, right? They're trying to make a sale here. What role should they play in trying c- to communicate climate risk? And how does the agent compensation that we had, like we, we've been restructured recently because of a court decision, how could that structure affect the dynamic in terms of how real estate agents get their commissions?

FAIRWEATHER: So, the agents at Redfin, what I've heard from them, the ones that are working in these riskier areas is they try to have these conversations really early on. Okay. Especially about insurance costs. You need to learn that... You need to... They tell their clients "If you buy a home in this area, the insurance cost is gonna be way more than if you buy a home in the other area." And they encourage their clients to talk to insurance agents early on in the process, so they know exactly what they're getting into.

So, they can just be I think, good communicators for doing that kind of research and helping explain what these climate scores mean and how they might translate to higher costs. On the commission side, since the lawsuit, we haven't really seen a change in commission structures. Okay. The real estate industry is just really set in its ways, that even though there are these new opportunities for, I

think experimentation with commission, people really aren't exploring that because I think they're just used to... I think they just don't wanna take a risk for this decision that they really only do one time in their lives. They just kinda wanna go with the status quo. So far, we haven't seen much of a difference there, but it's possible we might see more innovation in commissions in the future.

PATNAIK: Oh, that's very interesting. Another point I wanted to touch on is some economists have argued that w- there is already some kind of migration away from high-risk areas. It's kinda like a slow-moving climate migration. I'm curious, have you guys looked at that in your data? Do we actually see if this is real, or are there not any really trends that might be deviating from the regular fluctuations that we see?

FAIRWEATHER: So right now, some of the hottest or most in-demand real estate markets are in the Midwest and- The- Okay ... like inland Northeast, like Buffalo Pittsburgh, those post-industrial cities, I don't think that this is related to climate change. I think it's more about affordability. During the pandemic the prices went up dramatically on the coast and in the South, and the only place that didn't go up dramatically in value was the Midwest and those- more affordable Northeast cities. So, I think the reason those are going up in value now is because people... those are the places where people can still afford to buy on a middle-class salary. But they're also places where the insurance costs have been more stable, and people who are thinking about buying in Florida or Texas, they are up against these higher insurance costs, so the affordability premium of moving there is less than it was- pre-pandemic. Okay. So yeah, I think affordability is always the major reason why people move, but as that gets more incorporated into insurance, then climate change does play a role as well.

PATNAIK: And so, when you think about 10 years from now, do you think this kind of climate risk will be routinely incorporated, or do you think we're gonna have the same conversations? What's the most likely path you think that we see some change here?

FAIRWEATHER: Yeah, I think 10 years from now people are going to be just as focused on the cost of insurance and property taxes as they are on that monthly mortgage payment. I say property taxes as well because- ... communities that do a better job of, mitigating against climate change and are preparing for it are going to have inevitably lower property taxes. The communities that don't prepare

are going to have to raise their taxes in order to fund the after effects of these disasters. So yeah, I think 10 years from now, people aren't just gonna be thinking about the price of the home. They're gonna be thinking about the taxes and the insurance costs because those will be more significant and vary more by region.

PATNAIK: That's actually super interesting. Anything else that you wanna make as a final point before we conclude the fireside? Anything we haven't covered?

FAIRWEATHER: Yeah, I guess I'll just say one more time that we're already in this housing affordability crisis. The White House said that we're short 10 million homes. Freddie Mac's estimate from a couple of years ago was four million homes. Yeah. So, we have... And some of the homes that exist right now are not going to be as livable or will need a lot of maintenance in order to withstand climate change. So, it just makes it even more important that we build more housing, and we build it in places that are- Resilience to climate change. Right now, a lot of new construction gets built in areas that are less resilient, in flood plains, like in wetlands and in for- in forested areas because those are the places that are left to build in. And that's because we don't have multi-family zoning or allow for dense housing in the place, in, in the city center.

So, in California, for example, we should be building more housing in the Bay Area because that has a naturally temperate climate and it's hilly so it's not as vulnerable to sea level rise. Instead of having people move further and further into Central California where you have much higher wildfire risks. So, we need to change our zoning laws to address the housing shortage and to address the upcoming climate challenges.

PATNAIK: This has been super interesting. Thank you so much. This has been fantastic. Great to have you here today. Thank you.

FAIRWEATHER: Thank you for having me.

PATNAIK: Thank you. Margaret, can I ask you up on the stage, please? If I can ask you up to the stage. Thank you. Hey, Jesse, can you hear us?

KEENAN: Yes. Yes. Good afternoon.

PATNAIK: Hey, good afternoon.

WALLS: I thought Daryl was gonna get some questions. No questions for her, huh?

PATNAIK: All right. It's great to have both of you here, Jesse and Margaret. You have been working on this space for a very long time. And so, I wanna start off with a similar question I had asked Daryl, which is I think a lot of people underappreciate how different these different climate risk assessments can be for the same property because they use different models, different assumptions. How do you think about reconciling those different risk scores and still being able to provide meaningful and accurate information to market participants? Jesse, you wanna start on this?

KEENAN: Yeah. I think over time what we're gonna see is a shaking out of the third-party providers and their underlying technology. And the, and we see varying degrees to which external scientific validation is helping us refine that. Ultimately what I foresee is something we see in cat risk modeling today where, one of the major challenges we have a lot of proprietary models and providers, and the level of transparency is really just for many of them just not there. But by analog what we see, for instance, in insurance and property insurance as it relates to catastrophic risk is this proposition where regulators behind closed doors are given the opportunity to test and otherwise stress test or explore these models in the interest of consumers ultimately.

I tend to think that we're gonna go in that direction. But right now, we're easily five to 10 years away, I think, to having consumer friendly forward-looking climate analytics. And Dr. Fairweather set up a very important point to that end, which is that ultimately where we stand now it may, I think, cue consumers to take the next step to visit the property, talk to neighbors even call local town planning officials who manage flood plains or fire risk or whatever it may be. It's just gonna necessitate that that consumers take that extra step. And indeed, this is a role that relating to your previous question about brokers and agents, can help facilitate that consumer literacy. So, I, it's just gonna, I think first, a number of years require consumers to be more engaged.

PATNAIK: Margaret, what do you think about that? The different models.

WALLS: Yeah. There are indeed a lot of, and a growing number of these models out there. I- Yeah. The First Street one is the most consumer-facing. Yeah. So, there are, most of these models are sold to insurance companies, financial institutions, and so forth, and they do different things. I think people need to appreciate the challenges of doing this kind of modeling and scoring at a national scale. So, in my research projects, I've worked with flood modelers. It's complicated. It's very complicated. The, we use property level work with these flood modelers and do analysis.

But to actually take that to a market where somebody's choosing to buy one home versus another, it's no surprise to me that there was pushback in California- Yeah, and Zillow dropped the First Street from their listings and so forth. It's just a really hard thing to do. The data inputs you need are not available in many locations. Storm water infrastructure data is not available, and that's really important.

And so, we're just talking about even today's world, much less projections with climate change which is a whole nother level. So, it's just very challenging to do it at a property level. So, I'm not... The other thing is, what's provided, for example, for, by First Street, and I'm really glad Daryl brought this up, is that this is just a first step a consumer should take, is that you're given a one to 10 score I don't really know how to evaluate that. I don't really know. Maybe one's an eight and one's a 10, but what does that really mean? I don't really know. So, there are a lot of issues I feel like, but I do agree, more information is better than less. Usually. And probably Jesse's right, we're gonna move to some more standard approaches or get more... But I feel like it's a big hurdle to do this nationally.

PATNAIK: No, I think you raise a really important point, which is like the distinction between consumer-facing and maybe some companies using it. Is it even meaningful at this point in time when we don't have a standardization that consumers have these scores? Because frankly speaking, most people will not start doing deep research on this. They're gonna look at the score and then make a decision based on that, right?

WALLS: I think we're gonna talk in this session about what information we should be giving people. Yeah. Personally, I don't think the score is the way to go. Okay. I think there's other information that would be better and maybe we'll just get into that in a minute. Yeah.

PATNAIK: Great. Jesse, how about you? Do you think it's useful to have this information consumer-facing right now, or should it be mostly used at the back end in B2B transactions?

KEENAN: I think you're building market share. You're building the idea that there's some heuristic there that begins the conversation. Right now, I don't think there's a tremendous amount of evidence that these scores are shaping the scores themselves and the incremental distinctions between the ratings are shaping any kind of decisions. I think what we've seen in the preliminary evidence is that people certainly look at the scores after big events, right? So, there's a kind of response or intuitive response to say, "Hey, there was just a wasn't there just a big flood or fire?" And then at that point in time, it cues consumers to begin that process.

But at this point in time, it, I think consumers struggle to interpret this data and it almost becomes green read in binary in that sense. And in the long term that, that's probably okay as we begin to communicate not just certainty, but uncertainty in these measures. And so, I think in many ways it's a challenge of interface design as much as it is the underlying scientific analytics and how we communicate.

PATNAIK: I think key is really the uncertainty here, right? And that it's really important to communicate that uncertainty and the, those confidence intervals because it's all based on assumptions, it's based on modeling. It's not like a pure certainty here, right?

WALLS: And I just wanna bring up something. Margaret made a great point, which is that, across different impacts and hazards, the spatial scale really matters. And so, in some areas the resolution of the analytics is quite good, but it may be at a regional scale. It's not necessarily at a lot-by-lot basis, and that actually independently does have value. I think when we create a kind of false precision associated with a lot-by-lot, one side of the neighborhood or one side of the block to another, then we begin to I think, raise more questions than answers.

PATNAIK: No, that's a great point. Margaret when you look at climate risk, right? This really is at the intersection of science, finance, regulation, behavior. Where do you think kinda are the biggest bottlenecks? Is it a data problem? Is it a policy problem? A psychology problem?

WALLS: That's a big question, Sanjay. It is partly a science problem. Okay. Not problem, but science is complicated. That's... I'm just repeating myself now, but I think the underlying... Again, going back to the flood modeling and figuring out, spatially resolved estimates of flood risks is a challenge in that you need a lot of underlying data, you need sophisticated models you need validation of those models. And all of that is a hurdle, I think, to what you're talking about. The other hurdle is in people's understanding of these concepts. So, you're talking about confidence spans and uncertainty, and somebody goes to buy a home, they're probably just looking at the granite countertops.

They're not thinking about confidence spans on flood risks. On climate risks. Yeah. We're gonna have to say this in this session that the FEMA flood maps, which are the 100-year flood plain, is a very misunderstood concept, right? People don't know what that means. I'm in the 100-year flood plain, what does that mean? It means you have a 1% chance of having a flood in a given year. What kind of a flood? How much water? It doesn't tell you anything about that. It's just the probability, and the pro- the flood plain in one community is not the same as the flood plain in another community. It's more water in one than the other. People don't know this. It's a very limited concept. What it tells you is you have to buy a flood insurance policy.

That's all it was ever intended to do, was to say, "If you have a federally backed mortgage, you have to buy a flood insurance policy in that location." But it gets interpreted a certain way, right? Like we all think that tells me where it's risky, and it does tell you to a certain extent- ... what, that it's risky there versus not. But just inside or just outside the line, it's probably virtually the same. So, you know, same problem with those scores, right? You don't really know what the differences are. So, I think what information, back to your question, it is partly a how people make decisions question. How do people understand risk? People studied this for a long time, and it's a big question.

PATNAIK: How about you, Jesse? What are your thoughts on this one?

KEENAN: Yeah, one thing that comes up is we tend to focus on the idea that we're communicating exposure of assets and of course, huge variation there. But really there's another dimension here which is prior historical experience and disclosures, and this really reinforces the value, particularly

the state level laws on disclosures and prior events which have become more and more robust and have in fact been quite bipartisan in nature.

The other part of it is asset sensitivity, so not just the exposure, but what happens when you do have varying levels of, let's say, flood or a windstorm or whatever it may be. And we see this now of course from the insurance point of view. So, insurance and underlying risk analytics is looking at using drones and satellite data to look at the sensitivity of, for instance, a roof and the different construction and material typologies associated with buildings. And in fact, a better example is actually a hailstorm, right? So, we currently, almost 50% of property casualty losses in this country are hail. It's much bigger mess in many ways than flood. And we can quite easily now understand the type of construction, the type of shingles et cetera, et cetera.

That level of sensitivity to exposure is also something that consumers can be engaged in because now, I'm sitting here now in New Orleans, and there's preliminary data here in New Orleans. New Orleans housing market's been tanking. And there's been a little bit of bright side here as insurance markets stabilize a hair. But really what we see are those with class three and four shingle roofs and those with fortified roofs, right? So, the national standard for fortified roofs, they've actually been holding their value for several years now. So that becomes a measure of sensitivity from which there is disclosure and the market is diffusing that information, and it is shaping value.

PATNAIK: That's actually super interesting. Let's talk a little bit about the role of the federal government here, right? In the US we have a lot of different kind of like agencies that touch on this like FEMA, the GSEs, SEC, banking regulators, disaster relief Are these agencies kinda like coherent in their approach to climate risk? Is it a patchwork? Who should be leading this actually? Margaret, maybe we'll start with you.

WALLS: It is a patchwork. That's a good word to use. I think the federal government as a whole is not focused on our real estate markets reflecting disaster risk or climate risk. So that's one thing. So, it's not going in a systematic way across agencies. Again, to go to the flood situation, FEMA plays a very big role because they provide the, you can only, pretty much, only get flood insurance through FEMA,

through the National Flood Insurance Program, and they do the mapping of floodplains. So those are big things, and they do it across the country.

So, they play a big role. They also handle disaster... Most of the disaster relief goes through FEMA, so that's a big part of it. So, I, I put FEMA up near the top when it comes to disasters in general, and also anything to do with floods and flood risk as capitalized in home prices. But what you left off is the states and, the states play a big role because insurance is regulated at the state level, so there's no federal role that's really played on- homeowners insurance. It's all state level, and the states, there's 50 different ways it gets done. And also, when it comes to wildfire risks, which are growing, there's no federal mapping of that. That's only done at the state level and only in a couple of states. It's not even done that well.

So, California leads the charge there. And so, I think it depends on which of these kinds of problems we're talking about. I think on the wildfire space, there's nothing really at the federal level. The GSEs play a role, of course, in that again, back to flood insurance, you have to have flood insurance to get a federally backed mortgage.

PATNAIK: Yeah.

WALLS: The GSEs play a role in that they're the bearer of the risk really for defaults and so forth for m- for most mortgages. Are they doing anything proactively? It's not really- ... to, to address this problem. But maybe Jesse has some thoughts on this.

PATNAIK: Jesse.

KEENAN: There's a lot of different roles here depending on where we are in the value chain of real estate and housing. In the context of housing, we can think about sub-systematic risk within from the OCC or the Federal Reserve's point of view, the extent to which we have concentrations of collateral in banks and the extent to which Hazzard specific regions of the country, for instance, s- here in, in Louisiana represent, some measure of systematic or sub-systematic risk within the financial economy in terms of relative to credit and constraints and the like.

But when we look at the more specifically from a transactional point of view in the federal government, a number of years ago, FHFA actually at the very tail end of the first Trump administration did make a big pivot to take on climate. They had a request for information. There was a lot of outreaches. They came, ultimately, this is my interpretation, I think they ultimately came to the conclusion that we just, the science hasn't caught up to support a transactional system. So that those that are buying the agency paper are taking on their relative pools or constructing pools don't have a mechanism.

A qualitative mechanism. There's a geo- there's a concentration of geographic risk, so if there's a, in a RNBS pool, there's a lot of concentration in a certain part of Southwest Florida or whatever it may be. Yeah, that's one way to look at risk, but really, we just don't have the scientific mechanisms to support the underwriting all the way through and up to the capital markets. And so ultimately, they more or less kick that task on to FEMA and others that were developing, national risk index and things like that. But at the end of the day, those were incomplete measures that were not able to support a transactional economy. Might that be different in a number of years?

Yeah, probably, because I tend to think that the capital markets and really global investors in agency paper are increasingly sensitive to physical risk in their portfolios. Certainly, if you're coming from the EU that's an obligation. In Japan, many other places around the world are heading in that direction, so we'll need that transparency. And there, and we already see some very minor pricing in the capital markets in terms of housing, but nothing that would impact the cost of the life of the loan for the consumer really at the end of the day. So yes, there's a role because yes, there's a number of different challenges that have arisen, but without a coordinated federal leadership we, we're stuck in a hole.

PATNAIK: That that's very interesting, from the analysis. When you look at, like how we could remedy this, have you seen- Any innovative market approaches that could incorporate climate risk more meaningfully into real estate markets? Maybe even market approaches in public or private partnerships.

KEENAN: Yeah, I think what which is really quite interesting is that there's most certainly risk a reallocation of risk. You see it in construction contracts you see it in mortgage covenants you see it in

title insurance. The entire transactional economy behind housing, in very subtle ways, is thinking about who bears the risk and who bears the consequence of a million things going wrong. Literally, land washing away not caught in a survey. The quality of who bears the malpractice risk for engineers and architects. So, on a really fundamental level, we have seen a contractual shifting of risk and a reallocation, and risk coverage products have begun to mature in that regard.

But I want to point, yes, it this is important conversation to have in the context of consumers, but I think Daryl Fairweather was very correctly concerned with from the let's say the point of view of municipalities and fiscal tax base and fiscal viability going forward. Because here's the bottom line. We have had a tax cap, right? And with the great tax revolt, we've put in tax caps. We've not adequately been taxing ourselves at the property level for a generation now. And the bills are coming due. And those bills for hazard mitigation, flood protection, revamping infrastructure, things that we need to do to de-risk the tax base are becoming more and more immediate in the demands.

And so, what I think we're beginning to see is more fiscal stress at the municipality level. And in some areas, there has been innovation. So, we've seen coverage of property tax base. Or, so for instance, in California, a number of municipalities, if some portion of their tax base burns to the ground they can have some coverage for that for general obligation or revenue bonds. So, there's a lot of innovation here, but I think it, it doesn't... I think it's really adaptations of what we see in a general transactional sense.

PATNAIK: Margaret, same question to you, but I want to add something which is on the policymaker side. What are some of the misconceptions, or what do policymakers underappreciate when it comes to climate risk?

WALLS: What do they underappreciate when it comes to climate risk? I think in perhaps, let me see. A couple of things. One is, I think the interconnectedness of so many different things. So- Without a doubt, risks affect home prices. We can talk about whether or not people have full information, how much they affect it, is it the risk fully priced in, but they do like anything, like any amenity or disamenity. In a community, your flood risks are gonna affect a house price.

PATNAIK: Yeah.

WALLS: So, they start with that. It affects your insurance costs, which affects your, and it affects property taxes in the community. That means that it affects the community's ability to build adaptation infrastructure to mitigate the problem, and it affects their bond ratings. There are studies that are showing that, so they can't even borrow the money to invest in the infrastructure. So maybe what's un- one thing I think is unappreciated, there's probably many things, is the ripple effects and interconnectedness- ... of all of these things, and that it's not as simple as one problem or another.

Everything is linked. Yeah. And what people worry about is whether this, these sort of factors that I laid out, which are all financial in nature, will lead to bigger systemic problems in the financial system. And I think that's an unanswered question. The federal government, the Federal Reserve Board was starting to dig into this a little bit with the banks, but that's all been scaled back in this administration, so we're not really investigating it too much. But I think these ripples effects are a big deal.

PATNAIK: I think this is a really good point. I think people often forget that climate is really a risk multiplier, climate change. And so, it has a lot of kind of it basically makes existing risk even worse, right? In some areas. Jesse, I wanna turn to you. You've written in your book, a recent one, North: The Future of Post-Climate America, about the geography of risk a- and especially on the uneven spatial distribution of climate risk in the US. How should we think about correctly pricing those climate risks that are pretty uneven into property values, and who wins and lose, and who loses when we start doing that, and when we start seeing actually markets reflecting that risk properly?

KEENAN: Yeah. It's interesting. In the previous conversation the idea associated with taxing and land tax I thought was pretty controversial and quite bold there. And in fact, land taxes exist in countries. Brazil has done this widely. That, that's a very interesting but perhaps, something that will come in the future in terms of taxing the associated land that tends to benefit not the pr- not the real estate or the building but really taxing the land. That, that's interesting. But I think ultimately, when we're talking winners and losers we do see a shakedown in the rental market, and we do see responses in the rental market. And just to give your idea of how that's playing out, in really high-risk areas investors

are coming in and they're basically underwriting on a cash flow basis the value of the multifamily rentals that they're purchasing with a zero-exit value.

So, they're basically saying, "We're only gonna value this for its cash flow. We are just going to assume that this building will not be here at some point in time- Wow ... as a net present value function." And that shapes then a greater sensitivity in how they pass on volatility in insurance through r- and other carrying costs through rents. The rental market and the investor side of the rental market, particularly when we're talking about housing renovations and things that are critical to maintaining affordability, it is really creating a lot of, I think, fundamental challenges in these markets, particularly as single family. We see an exodus in some high-risk markets, es- essentially where single-family homes are being turned over to short-term rentals.

It's just not worth it for people to bear the long-term operating and carrying costs. That, of course, has gross impacts on total rents and relative to supply as we see more and more constraints. The other part of this too is ultimately a l- a function of land use. And the biggest, we talk a lot about the role of the federal government, but ultimately much of this responsibility is on really local governments to adjudicate risk within land use and zoning. And in theory, as we see more and more constraint on housing development in very high-risk areas, and we certainly see this in California relative to wildfires and there's more and more discipline that's being imposed on them relative by credit rating agencies, for instance but also by the mortgage markets, and we can talk about that.

The it's creating constraints in terms of scarcity and land scarcity relative to new production and new supply. So, there's a lot of different mechanisms here in terms of the geography of risk. But in the short term, it's really the renters that, that bear the emergence of this cost and shifting of capital in and out of, from one market to another.

PATNAIK: That's actually really interesting. I think I haven't seen too much on the data before. Margaret I wanna talk to you about you're an environmental economist, right? And from a, from an environmental economics perspective, what does the literature tell us about how well markets should price tail end risk, like flooding or wildfire? And how does the empirical evidence stack up to this? That's a huge question.

WALLS: Let's not go down the theory path too much. But I think, in general, theory will say that asset prices should reflect those, in general, expected average annual losses from these events. When you have a situation with tail risks, and not just tail risks. So, by tail risks, we mean, there are maybe fat tails where big catastrophic losses can happen, and then simultaneously you have spatial correlation in those risks. So, if a neighborhood is hitting a flood, everybody's hurt. If it's hitting a fire- ... everybody's hurt. You have all those calls on insurance for one thing, or you have a big loss in property value all in a big area.

And some of those added factors that climate change brings in, and then deep uncertainty. Deep uncertainty factors into these models as well. Then it-- the question is whether you can show theoretically that asset value should include not just those average annual expected losses, but also an added piece for these tail problems and the uncertainty. Do markets the evidence on whether markets capture all of that I would say is no, it doesn't. There's, there are studies, I think we're gonna maybe talk more about them, and some I've done myself, that shows that risks are capitalized into home prices where there's disclosure of those risks.

Okay. So, I've done a study in the wildfire space. Yeah. There's been a few studies that have looked at, if you're on the floodplain, is that capitalized into home prices? And generally, if you're using the right methods to tease that out, statistically you do find effects. But that's probably not what you're talking about. You're talking about the added sort of catastrophic fat tail risk, and I think the evidence is that no, those are not currently priced. That's my view anyway. Yeah.

PATNAIK: Great. So, let's stay a little bit on the disclosure, which I think is super interesting. And obviously we know it from other markets that disclosure can be one policy lever, right? Like, where you can bring information into the market more transparency. When you look at like the real estate, markets and mandatory disclosure regulations, does, how does it change buyer behavioral market prices? What have you found in your research?

WALLS: In this wildfire study which was California... So, in California, if you are in a high fire hazard severity zone, and you're in certain parts of the state, that has to be disclosed if you're gonna sell your house. And they have-- California has a new law that took effect last summer that also in high fire

hazard areas, you have to disclose any mitigation measures you've done on your house, or you have to disclose all the features of your house, like the roof, the window.

Are they double pane windows? Are your vents closed? Are... And your defensible space, all those things- That affect your propensity to burn down have to be now disclosed as of last summer. So that's a new thing they're doing. But in our study, we looked at that original disclosure law which took place in 2008 in certain areas of the state, and to see if where it's disclosed are wildfire risks, what is the capitalization and the home prices. And we found on average about a 4% average annual drop in home prices in those areas. But disclosure was key. You had to have the disclosure, otherwise- Yeah,that's, people don't know. And there's, a couple of other studies like that. Not too many, but there's a couple of others.

There's one in the flood space as well. But disclosure varies a lot, so California's the only one that has it for the wildfire that I know of. I think Colorado might be doing it. In the flood case, it varies widely across states in what has to be disclosed and when. The when question is not talked about enough. The problem in California, I think it's a problem, is when do you get that disclosure on the wildfire thing, and it's all hazards, it's not just wildfire. It's just that wildfire's a big one there. You don't get it till you're in escrow. So, you've already put an offer in on the house. You need to get that information earlier. So, I don't know the rules in every state, but in North Carolina, which has some new flood disclosure laws that are pretty good you, it's disclosed to you earlier. Okay. So, it it's not in the list, not put in the MLS listing or whatever, but the real estate agent has to disclose it before you make an offer.

That's interesting to me. I think that's important. But what's disclosed, we looked at a new law that passed in Florida last year I think, or year before. Think it was last year. And what you have to disclose in Florida is has the property ever filed a flood insurance claim? Have you ever received disaster assistance? I think there was another one, but not whether you're in the FEMA flood plain. That was not part of it, so you don't know that. I see. And I guess my problem with some of these sort of piecemeal things is very few people have flood insurance. So, if you haven't, if you don't have flood insurance, you haven't filed a claim.

And if you haven't lived in your house very long, you haven't filed a claim. So, it doesn't give you that much information in my opinion. Very few people get disaster aid. Number one, it has to be a federally declared disaster, so you're not getting any aid unless it's a federal, a, an actual disaster. Most people don't apply for disaster aid. Even if you apply, you don't get it. It's, so like, it's not, that's also not all that informative in my view if you think that you're comparing property A to property B.

PATNAIK: Yeah.

WALLS: And in fact, it could mislead you. Oh, that one they filed, they got disaster assistance, and that one they didn't. But in fact, they're the same risk, maybe. So, it just illustrates how hard it is really,

PATNAIK: I think this really like just highlights how, h- how important trade-offs here are, like the-

WALLS: Can I say something else about this?

PATNAIK: Yeah, please.

WALLS: In because you asked about innovative approaches. So, in North Carolina, they... And this is separate from what I was talking about before, but they have something called the Flood Risk Information System, and it's very detailed. And you can go to your individual property you might be considering buying, or your own property you live in, and click on it, and you will get way more information than you could probably use, but really good information.

Are you in the FEMA floodplain? What's the expected flood depth if you get a certain kind of storm, 5% storm, a 10%, 100%... the 100-year storm. What is the flood depth expected at the property? Now, is it ex- perfectly accurate? Probably not perfectly, but you can dig further. And something I think is really interesting that they do is they provide the do- expected annual dollar damage. I am really curious if we gave people financial information, this is what the damage costs, expected damage costs are. Maybe we'd need the confidence bands too. But would dollar information move the needle? That's interesting. And flood depth information move the needle? Those are a couple pieces of information I would like to see more. Final thing in the, in the North Carolina system is you can click, and you can see whether any flood studies have been done for the area, and you can download that

study and look at it. You can dive deep if you want to. That's a great... Yeah. And I find that interesting.

PATNAIK: Jesse, do you…

KEENAN: That relates to my perfectly relates to my prior commentary on asset level sensitivity. Because I think we can... We do analytically have the capacity to scale a present value a loss associated or let's say damage, potential damage claims based on base floor elevation, for instance, and the material typology or construction of the building. So, in that regard I think analytically w- we could probably get there pretty easily a- across the country, at least for select hazards.

PATNAIK: Let me stay with you, Jesse, because you have talked in your previous work about managed relocation, right? And there was just a very recent article, I think in the Wall Street Journal that talked about the outer banks in North Carolina where a lot of houses are literally falling into the sea and people are moving entire houses back to get them away. And so, we are seeing some of these planned relocations of high-risk communities. Does real estate start pricing these things in? Do you see that, this potential relocation or that managed relocation that will have to take place in some areas? And what signals should we look for?

KEENAN: Right now, at this point in time as it relates to, let's say, public driven or signals coming from public policy, whether it relates to future development or let's say buyouts on if we draw the line in geographic terms between sending zones and receiving zones, there's not a lot of response there in sending zones. There's a little bit, there's been some reported responses on building permits and development activity. It's somewhat dependent on belief systems locally as another sort of way to slice and dice it in terms of social science. But in there has been reasonably emergent empirical evidence associated with receiving zones.

So certain areas that are perceived and may even have some market recognition of being lower comparative risk o- often in proximity to high-risk areas, those risk area, those associated properties have seen some benefit in the sense that they've amenitized their relative position. But otherwise, the it's very much an emergent area in the literature.

PATNAIK: Yeah, that's, and I hope we can contribute to that a little bit- ... with our work.

KEENAN: Actually, there's a paper that just came out yesterday actually that looks- Yeah ... at this in the context of telework. And it's really interesting because the paper says that in terms of remote working has allowed people to move into relatively high-risk areas. Or at least high-risk areas have seen in-migration among those that are doing teleworking because they're moving there for non-climatic reasons, generally the amenitization of being on the water or in a, beautiful environment or view or whatever it may be, but what's really interesting in this paper is that it found a negative relationship between telework and extreme heat.

Which really actually makes a lot of sense because it's not the episodic dimension, it's the stress dimension. And if you're gonna be working online in the house in air conditioning all day, and there's not a great opportunity to get out and enjoy amenities in the context of regularized extreme heat then, what's the point? And that, to me, that's a really in- insightful finding that shapes the flip side of our conversation, which is consumer preferences. And the extent to which consumer preferences, particularly as we see this emerging and developing among age cohorts and income, but really age cohorts as well, is shaping not those that are just moving, but maybe those that didn't move, right?

That didn't move to Arizona, that side or reside in place for whatever reason. There's a lot of complexity there, but that reorientation of preferences, particularly in the context of an aging society, for instance in the context of extreme heat becoming more acutely aware of the implications of that, both physically, physiologically, but also socially in the context of extreme heat it matters. And these things are certainly coming up not just in the empirical literature, but in real estate marketing data as well.

PATNAIK: That's actually super interesting, that paper. Thanks for pointing that out. I wanna get back to you, Margaret, on the National Flood Insurance Program, which is widely seen as distorting like the market by subsidizing flood risk. How significant is that distortion suppressing accurate climate risk pricing? And what would a well-designed insurance framework look like for flood risk?

WALLS: Oh, goodness.

PATNAIK: Small question, right? I know it's a hard question.

WALLS: I don't know the s- the magnitude of the subsidy in aggregate, but yes, the National Flood Insurance Program, as it was set up, was grandfathered properties in and so forth. And over the years, many people in high-risk areas are paying less than actual- actuarially fair premiums, so lower than they should pay based on just the risk as it would be priced by an actuary. Nonetheless, not very many people buy flood insurance. So, one of the big problems is we have the, don't have enough uptake of flood insurance, and so people are under-covered.

So even at low subsidized prices, we have that problem. But yes, especially after hurricanes- Katrina and Rita in 2005, the National Flood Insurance Program had a solvency problem, in-insolvency problem, and has main- had an ongoing debt to the federal government because claims are not making up enough claims are over, they're paying too much relative to the premiums they take in, and that's because of the subsidies. As you probably know, they rolled out risk rating 2.0 to correct that problem a few years ago. And many places are now paying much higher premiums that are closer to actuarially fair.

And what has happened in light of that? Many states and local governments have sued FEMA over them, number one. Secondly s- there's a very good study that finds that take-up has fallen dramatically, interesting, in these places where the rates have risen. So, it's a tension. It's a voluntary purchase. You don't have to buy flood insurance, and people that are cash-strapped or wanna put their heads in the sand, or for a whole variety of reasons, may be very wealthy and can self-insure, but I don't think that's really what the case is. I think it's just people are ca- you know have a lot of other things in their lives they have to pay money for. And they just don't wanna pay for flood insurance.

PATNAIK: I think you touched on a really important aspect, which is cl- the tension between climate risk and affordability. I want to talk a little bit about that because obviously there's a big tension between wanting accurate and forward-looking climate risk pricing, but that might be that some of the land might be taken off the market, right? Or it might be so expensive that people can't afford it, and that scarcity probably would exacerbate some of the housing supply issues that we already have.

How do you navigate the tension of still being able to protect people, because it doesn't, it's not good for them either- ... if their house floods every two years, right? But if it's their only asset, if it's like maybe someone elderly with a fixed income, what are the options here?

WALLS: Daryl talked about this. Yeah. And I think, we have to figure out a way to build more in the safe places and less in the risky places, and that means a change in our zoning properties. I'm a huge fan of transfer of development rights programs, and I think we ought to use those more where we can shift, protect land in some areas and shift people to other places. That doesn't get at the problem that we already have a lot of housing in risky areas and people living there.

And one point I want to make about all this disclosure stuff that we're talking about, while d- disclosure versus really important 'cause we want the markets to reflect things accurately, somebody's gonna live in these houses. And so, it's what you asked Jesse, which is, who is exposed to the risk? If we suddenly do something like increase disclosure or change insurance policy or whatever- And we just shift people around from house to house, all it does is change who's at risk. It doesn't, you know- And who pays it ... we still have the house there. So, you're unless we do buyouts which is costly, and we can do them and should do them in the most risky places, but they're very costly. Yeah, I think, the housing affordability thing in light of these challenges is a real issue. We just need to figure out how to build more, set our policies up so we build more in the safe places and less in the risky places.

PATNAIK: That's my view. Jesse, quest, same question to you. How do you navigate that challenge?

KEENAN: It's, we can buy people out, of course. We can use life estates for those that are in high-risk areas, so essentially it rolls back over, r- reverts back to the state ownership upon death. There are ways to gradually move people out of the highest risk areas. But ultimately shifting a tax base, whether it's through t- transferable development rights up zoning and down zoning but fundamentally really just sending signals to the market about the predictability, and that can often just...

The predictability of where you can develop and where you shouldn't be building, and that can be done in a lot of different ways, including capital planning associated with where you're putting the infrastructure or where you're renovating the infrastructure. So, it's a combination of investment and

disinvestment, and when we look at places like Miami-Dade County they're sending very clear signals about where they're going to be providing service in the future which is, which by the way has a kind of spine in terms of elevation and where they're- ... gonna be disinvested in other areas where the OPEX and the CapEx just doesn't make sense, and they don't want to take on long-term liabilities. And we see this in energy distribution. We see basically among public utilities and or local utilities are beginning to do this out of necessity.

So, I think the from a local government's point of view, coordinating with utilities, coordinating with infrastructure providers to send clear signals about where we're moving, even just very locally, we're not talking about drastic moves, this is intra-county moves goes a lot is a major step forward because then we're not just talking about water and wastewater and energy, we're also talking about transportation, roads. It's a full spectrum of s- infrastructure services that need to be coordinated to make this happen. So, it's that... These are important tools, but these are tools that we already have. And in many ways, we're already doing it. But it just isn't often explicitly advanced in the name of climate change- it's advanced at broader realm of growth management.

PATNAIK: So then when you look at like the potential solutions for this Jesse, do you see a scenario where market-driven climate risk pricing can lead to a better outcome than regulatory mandates? Or is the nature of the problem such as that we really need strong government intervention?

KEENAN: I think when you're talking about local land use it's both. I'm not sure it's either/or, but right now I think it's worth acknowledging that the market is adapting much faster than local institutions can keep up. You see this particularly in the context of mortgage and insurance. And insurance companies do look at the fiscal bottom line of tax revenue at counties and local governments. They are looking to evaluate whether these local jurisdictions have the capacity to put in risk mitigation infrastructure or simply even respond in a post-disaster.

They're not just looking at pre-disaster hazard mitigation. I think right now we are certainly on a trajectory where market adaptations are shaping our options and our pathways moving forward. It's hard to imagine that given the politics of local land use and patronage of local land use, that's gonna fundamentally change anytime soon. But at the end of the day, as we see risk pricing in the Muni

bond market in particular as one of many adaptations of the market it's just, it's the hand of the market right now that's doing most of the heavy lifting.

PATNAIK: Margaret what do you think about the trade-off between market and regulatory intervention?

WALLS: Jesse's right. The markets are, building this in. It's happening, and you can't set up regulations and policy to push it to stymie that I feel is an important thing. Daryl talked about the limits on insurance pricing in California and that has been something that's been identified in studies and that, what did that lead to? It led to the non-renewal problem that they have out there where insurers are just dropping people. Interesting. You, there's always these effects that we know as economists unintended consequences. So, I think you have to let the markets work and set things up to let the markets work, but policy is required.

We talked about how these spatially correlated risks, the long, the fat tails of deep uncertainty sort of things that make it challenging for markets to handle all of that on their own, and also the sort of externalities from the spatial externalities, property to property, but other things where your actions affect my outcomes and things like that need to be considered as well. And finally, the big equity-issue, which is who is being exposed and people's ability to financially handle some of the problems that they're faced with is some, often a role for government that we need to, take care of the people that are the most vulnerable.

PATNAIK: Yeah. So, we got some really excellent audience question. I wanna turn to those a little bit. This is a really interesting one because when you look at it, we have 30-year mortgages in many cases. And insurance policies are written for one year. So, the question is, what would it take to incentivize insurance providers to consider multi-year contracts? Margaret, you wanna start and then Jesse-

WALLS: I've asked this question of...

PATNAIK: it's a good question ...

WALLS: people in the insurance industry or related to the insurance industry, and it is a question that has come up before and apparently, it's a no-go. And just that the industry, for a variety of reasons, is not willing to write multi-year contracts. I, personally feel that it's, there must be some incentive that they would. But what I've heard so far, and haven't done a deep dive to kind of- No ... tease out all the reasons, is that this has come up for them and they're like, no for things changing year to year and different other factors, they're not gonna write multi-year contracts. So maybe Jesse can talk about it.

KEENAN: Yeah, ultimately the insurance companies have to get reinsurance. So, you know, the reinsurance is the stickiest point here in terms of timing. But I'm not sure a multi-year policy would solve a problem because then you set up a price shock, right? Let's say we write a five-year policy. We've got an awful lot that happens in five years. It feels like a trend, maybe it's not. Either way, that gets priced as a price shock that's cumulative an- in terms of annualized year to year differences that are cumulative in year five or year six.

That shock may be worse than if we incrementalism it, particularly from a state regulated market that has usually statutory limits on annualized increases in policies, in increases for policies, and that's done very importantly to maintain that they are sound fiscally in their capacity to pay claims. So, it actually, multi-year contracts could create more problems particularly from a cash management or a fiscal solvency point of view where these massive shocks result in capital outflows that really exacerbate underlying problems.

PATNAIK: That's a great point.

WALLS: But just to follow up on that, it is a big deal for people who are faced every year with a worry that they're- I know ... not gonna have insurance the next year. Yeah. I know people- ... in California veer- my... relatives who are really concerned about this, who got dropped, weren't even in a high fire risk area, and then as soon as they finally found somebody, she was, my sister-in-law was like, "I'm worried next year they're gonna drop me again." Yeah. So, I think they wait on you for not, because you have to have you really want, got to mortgage them for anything. Yeah. You have to have your mortgage- There, there is and you have to have coverage, yeah. So, I think that sort of factor is a big deal, yeah.

PATNAIK: No, I agree.

KEENAN: There is a, there is an insurance company out there currently that will basically, they basically say, "We'll cover..." Th- you're basically making a bet with them, and the bet is that if your insurance goes above some threshold, they will trigger, it will trigger a payout from them to pay the difference in what you're paying them versus what your primary carrier is charging you. So, there are, there is consumer-facing insurance companies now that do offer these products that does provide more predictability. Now, you're paying a higher rate, but you're basically hedging. It's a hedging mechanism, yeah, that annualized inflation will be under some threshold. So, it's the same way we can think about energy, energy pricing. It's basically you're investing in the hedge. Yeah. So that does... I think that is meaningful, and that is likely to scale in the future.

PATNAIK: That's super interesting. Yeah. Thank you. Jesse, question for you. What, if anything, has the New Orleans real estate market learned from Katrina?

KEENAN: Yeah. There's a, I think an awful lot there in terms of Katrina. We see variation and price appreciation by risk zone, different types of flood risk zones and inundation zones relative to elevation. But at the end of the day windstorm is I think it's not just New Orleans, but it's Louisiana, and I think what Louisiana learned is that and this is a lesson that Florida's learning the hard way, and I hope we can have an opportunity to talk about Margaret's wonderful paper that just came out on insurance.

It's a, it's a critical contribution. But what Louisiana learned is that, and after a big event like Katrina, you have an outflow and an exodus of insurers. They basically subsidize small, fly-by-night, under-capitalized insurers to come into the marketplace, but that just creates a whole other set of problems if those insurers are not adequately regulated. We saw over a dozen insurers after 2022, 2023 leave the state, and really leave the state insurer of last resort, also, by the way, called Citizens, with an enormous problem, and without an ability to depopulate in the way that Florida can do at scale So we've created an, I think a set of incentives, that have not fully addressed the idea of market competitiveness in the ins- in the windstorm market in particular.

Florida is beginning to understand this as their depopulation policies have focused in on bringing in a lot of small insurers that really haven't, that represent a risk that's not fully appreciated by consumers. And certainly, there's been some empirical literature that shows that, these insurers, in the areas where these insurers have market coverage, is driving higher foreclosures, for instance, after events. It's a real challenge. And Louisiana has learned that maybe that wasn't necessarily the right thing to do.

PATNAIK: Margaret, do you wanna talk a little bit about the new paper that Jesse just mentioned?

WALLS: You mean the one I sent you all a link to? Oh, that study just came out today in our magazine. You can find it on the RFF website. We took the zip code level insurance data that the Treasury... I don't know if anybody saw that study from 2025. It's not available on the website anymore. The Treasury Federal Insurance Office collected data on insurance, various insurance things, nonrenewal premiums, polis- maybe policy counts. I can't remember what they were, but five things, I think. And loss ratios too. So that's claims over premiums.

And they made that data avail, publicly available, so we took it and matched it with some data we'd pulled together on events, storm events. Not just disasters, but all kinds of storm events of every type, to look to see if dynamically there's a link between when an event happens with those insurance outcomes. So of course there's correlation. That's in the Treasury report. The riskiest areas have the highest premiums and things like that. But what we were looking at specifically is when an event happens, what are the ripple effects in insurance markets? And indeed, nonrenewal rates go up in the very next year.

So back to whoever asked the question about one year insurance policies relative to 30-year mortgages, there you go. When an event happens, you do see these outcomes. So yeah, it's, and premiums go up, premiums and nonrenewal. And we look at where in the country these problems are, and in some places it's both things happen, in others it's nonrenewal go up and premiums go down, in others it's vice versa. So, there is just this response mechanism. And in the following year it goes back to normal. So, it was a one-year thing. We did a sort of spatial lag model to look at the effects

over time. And so, it's just an added piece of information about what's going on in insurance markets, I think how they react.

PATNAIK: Jesse, a question for you. So, you mentioned the importance of external scientific validation of cat vendor models Where do you see these developments coming from? Is it the validation, is it coming from the federal government, startups, AI labs, universities? Where do you see most movement here?

KEENAN: Yeah. It's not the cat models. The cat models and the climate impact models and are two ontologically distinct realms of analysis. The cat models are extremely well developed and very mature for generations now. It's the climate dimension to that. And, this goes back to our conversation on insurance. California didn't want these climate models incorporated in dialogue with the cat models, which w- admittedly was quite experimental. Many consumer groups felt like consumers would be paying the price for that experimental integration.

And of course, we saw the non-renewal problem and insurers basically talked their way in by allowing the California Insurance Commission to allow them to use these forward-looking models. And but they did so with the provision that the state would regulate and supervise that. So, I, I return to the proposition that validation mechanisms will utilize expertise in the private sector, but at, university level expertise as well to work with state regulators to help validate this. There has been or there was at one point some bipartisan movement on this in t- in terms of the federal government's role.

What if we had some kind of certification mechanism? But I ultimately f- found that to be somewhat limiting because it would require... this stuff changes year to year. The rate of change in technology and the underlying data and foundation is so dynamic, any kind of certification by, let's say, the federal government's stability of something is gonna reinforce some stationarity somewhere along the way analytically. How do we keep up with the rate of change? That requires a more regularized evaluation, as is the case with windstorm and cat models.

PATNAIK: Margaret, a question for you that I'm curious. So, the current presidential administration had discussed potentially shifting some of the burden for disaster response and recovery to the

states. Do you see some states being more proactive about it and in anticipation of this trying to dis-disclose and mitigate risks as like a potential preparation?

WALLS: There's two pieces there. So, one is kind, the question whether states can do, handle that. The capacity and who's positioned to handle that. And then the second, I think the question is, are states doing more hazard mitigation- Yeah ... to prepare and/or just emergency preparedness. Yeah. Those are two different things. To lessen the burden if and when a disaster happens. And I can't say that I know the differences across states that well to be able to point to somebody.

I, I've traveled I've had this conversation. I was in Kentucky and I talked to their emergency manager, and there's a, bunch of things I could share from that. I think ultimately, it's state... I have two things to say. One is, of course it's, this is obvious, but the states that are better resourced and larger and have faced these problems in the past are more better positioned to take this on. Florida, California. When states get hit by a hurricane Helene way far from the coast, and they have to, you know, they're kinda caught unawares, and that happened in North, in the Eastern Appalachians. So, I think there's that, which is somewhat of an obvious thing. And then I think the states that are proactively doing adaptation to, and really taking on the challenge of climate change, they're few and far between anyway. My feeling is most of what's going on in that space is planning and not a lot of implementation. I don't know if Jesse agrees with that, but…

KEENAN: Yeah, absolutely. Absolutely

WALLS: You probably have some views on this if you think there's some states you could hold up as examples.

PATNAIK: Jesse, any thoughts on this?

KEENAN: I know we're running out of time here. Yeah. I'll be brief. Yeah, most states really can't afford this, even California. On a per capita basis associated with individual assistance, much less hazard mitigation this is, it's beyond the capacity of even the big states to fully handle this. With the recent council report, yeah, there's this ambition, but, states have always been in control. They've always determined the path of where these resources go, and there are limitations on how we spend

public assistance dollars in particular. And that has often been driven by the Republican Party, interestingly enough to prevent waste and maybe even rightfully but any kind of streamlining we've had been streamlining through generations of experience on how we most efficiently and effectively get the money out. And things like Section 428 public assistance where we're not just rebuilding what we had, but we're trying to rebuild better, if you will. W- we, there are innovations.

At the end of the day, states are already in control. This is a big con- this is a big pipe dream that's gonna sit in Congress's lap. And unfortunately, that's a, it's a non-issue. States can't afford it, and that's the bottom line.

PATNAIK: I have one last question that we got online, which I think is really in- interesting. As climate risk is priced into real estate values, how do we protect elderly homeowners that have their house as their main asset and a fixed income in many cases? Jesse, you wanna go first?

KEENAN: This is an I don't know. I'd be curious to know the movement when the burst reverse mortgage entered the equation. I have heard anecdotally that the reverse mortgage market has been extremely sensitive to wildfire risk and potentially even flood risk. But it's way too early to know, but I think that's a really important potential area because I can understand why the life of those loans are shorter and there's, you're working in negative equity in that sense. So, I can understand why that may be a potential challenge moving forward.

PATNAIK: Margaret, last final thoughts.

WALLS: On that question? I think this just highlights what I said a minute ago is that who is exposed and who is at risk is as big a question as this w- premise we have for this session, which is our climate risks priced into home prices. And I think to a certain extent, this gets to the problem that we have in many areas where you made an investment 30 years ago and now, you're in a bad way, right? Yeah. Y'all, I made that decision. I didn't know, and that's fair enough, and that's what happened with the flood insurance program. So, they charged everybody really low rates in those areas, because, oh, they already lived there.

Now we're gonna make them pay. So, but when we do that, we just exacerbate a problem for down the road. So, I think, it is a challenge when people have invested, and that's wrapped up in their, that's they’re asset, and their understand what they're leaving to their heirs. But we have to be careful how we address that problem.

PATNAIK: Great. Thank you so much. Please join me in giving a big round of applause to our panelists. Thank you so much, Jesse. It was great to have you.

KEENAN: Thank you so much for having me.