

**LaSalle Street: Financial Markets Insights  
The Podcast of the Financial Markets Group  
at the Federal Reserve Bank of Chicago  
Episode 8 Transcript**

**Alessandro Cocco:** Does climate change have an impact on housing market values? And if so, could climate change have an effect on systemic stability?

Welcome to *LaSalle Street*, the podcast of the Federal Reserve Bank of Chicago. I'm Alessandro Cocco, vice president and head of the Chicago Fed's Financial Markets Group.

Financial market participants are increasingly aware of climate risk, but a comprehensive system to manage it hasn't been developed yet. So, here on *LaSalle Street* we are planning to dedicate some of our episodes to exploring different aspects of assessing the systemic impact of climate change risk.

Today we start with the possible impact of climate change on housing market values. We'll look into the potential effects of physical and transition risk on the housing market—and how that risk flows into financial markets.

Climate-related risks could flow into financial markets through the exposure of banks to their borrowers; the exposure of investors to mortgage-backed securities; or the exposure of insurance companies to claims from climate-related events, such as flooding.

The global financial crisis of 2007 and 2008 originated with a crisis in the mortgage markets. Can climate change risk trigger a systemic crisis?

Joining me today for this conversation is David Rodziewicz, economic specialist from the Federal Reserve Bank of Kansas City. Hi, David.

**David Rodziewicz:** Hello, Alessandro. Happy to be here.

**Alessandro Cocco:** I'm also joined by Eric Hogue, risk specialist, also from the Federal Reserve Bank of Kansas City. Hello, Eric.

**Eric Hogue:** Hi, Alessandro. Happy to be here as well.

**Alessandro Cocco:** I'm also joined by Jesse Keenan, associate professor of real estate at Tulane University in New Orleans. Jesse was also the editor of the report of the Climate-Related Market Risk Subcommittee, within the Market Risk Advisory Committee of the CFTC. Hello, Jesse.

**Jesse Keenan:** Thank you so much for having me.

**Alessandro Cocco:** Thanks, everyone, for being here. And detailed bios for each of our guests are on the webpage that accompanies this podcast. First, let's start by asking each of our panelists, what got you interested in climate risk work? I'll start with David.

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**David Rodziewicz:** Alessandro, I have a bit of a unique background: So I started my career in financial services in Chicago as a stock analyst. And then I found myself working for the National Oceanic and Atmospheric Administration, doing fisheries and oceanography work in, in the Bering Sea. And finally, I did my grad degree in energy economics.

So those combination of sort of my historical background converges into doing research in climate risk. And I'm really grateful to be a part of the transitions that are taking place in the financial sector and the economics world, as folks in those, those sectors begin to take notice and start to take some of these climate challenges on board.

**Alessandro Cocco:** Thank you, David. And now the same question for Eric. Eric, what got you interested in climate risk work?

**Eric Hogue:** Yeah, so I think from a personal standpoint—not to date myself—but I am of the Captain Planet generation, so climate has always been an instrumental part of my life. My family actually is, uh, from Houston, so, you know, when Hurricane Harvey impacted our area, just kind of seeing firsthand the impact it can have on a community, really got me interested in, you know, transitioning that to my professional work.

And so, being a supervisory—a risk specialist—we've seemed to notice that, you know, beyond just the impact it has on people's personal lives, it also has a major impact on the communities in regard to financial institutions and whatnot. So that's essentially what got me interested in climate risk.

**Alessandro Cocco:** Thank you, Eric. That's fascinating. And then finally, Jesse, tell us about your relationship with climate risk work.

**Jesse Keenan:** Well, I grew up with the benefit of a father who had been very concerned about climate change from the 1970s going forward. And we always had a certain set of family values to respect the environment and environmental stewardship. You can think of my dad as a kind of hippie in a way—a, a scientist hippie.

And, later on in professional terms, as I practiced law and urban development, real estate, capital markets, and the like, I developed, among other specialties of globalization in the financial markets and real estate asset classes—and essentially, helping build cities around the world for the past two decades—I developed a certain interest in specialization in post-disaster recovery, redevelopment, and the like.

From a research point of view, as a sort of emerging scholar, I would later go on to do my PhD in real estate and climate change. That transition from—like a lot of people, I started out in disaster risk reduction and thinking about the world in episodic terms in matters of shock. But it was really the interaction of shock and stress that began to have some firm attribution—at least in my mind—empirically to climate change itself a little more than a decade ago, I think, helped me transition to understanding not just asset-level impacts, but the systematic and broader implications of the evolution and the adaptation of financial markets themselves.

**Alessandro Cocco:** Thank you, Jesse. It's wonderful to have this diversity of views and experiences on the podcast.

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Next, I'd like to turn to David. David, you did some research on housing market value impairment from future sea-level rise inundation. What do the data tell us about the impact of climate change on housing market values?

**David Rodziewicz:** One of the main challenges that the climate risk space currently faces is matching climate risks to the associated economic data.

So in our project, we match housing data along with publicly available geographic and climate data—most notably, NOAA's Sea Level Rise Viewer shapefiles, as well as digital elevation models—to local measures of sea-level rise over the next hundred years.

So our analysis provides a local estimate at an individual house or parcel level, for coastal inundation risks, sea-level rise risk; and then we add that up to the metro levels.

Some of the key takeaways that you can get from our project are relative risks between metros. So we analyze primarily four or five metros in the main paper. And then we provide some supplemental [information] as well. And we give a risk profile for a city—or the single-family home properties within a city—over the next hundred years. And then we give some scenario analysis, as well as providing some uncertainty of when those properties are likely to go underwater.

So there's big—as mentioned, there's big differences across those cities. For example, in the median greenhouse gas concentration scenario, Miami—in our sample—has little less than 1 percent of its housing stock that goes underwater in the next a hundred years, whereas a place like Galveston has roughly 16 percent.

So our hope is with this project, we can identify that hyper-local risk and also the uncertainty within a climate change scenario.

**Alessandro Cocco:** Thank you, David. Now let's turn to Jesse. Jesse, you wrote about regional mortgage markets in the U.S., and you coined a new expression: "blue-lining." What does that mean?

**Jesse Keenan:** Blue-lining. For a number of years I had gotten somewhat, well, entirely qualitative, but somewhat anecdotal, evidence that banks were indeed making decisions in the participation of what is being originated in the forward flow of mortgages, uh, to accommodate different measures of environmental risks.

And I used the idea of blue-lining—this idea that banks are quite literally in some cases drawing lines around high-risk geographies from which they have a different calculus.

So there's many challenges that are both technical and scientific challenges, but also one of—that are unresolved in terms of risk management and operations as well.

And so what I'm trying to describe in this idea, or the theory of blue-lining, is the extent to which some people in very high-risk areas are not included in this zone of risk—or actionable risk.

And then there's, of course, people who may be grouped in, let's say, by a high-risk zip code, but otherwise their properties are otherwise not at risk in terms of collateral at risk in terms of mortgages.

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And they may just be grouped into a high-risk category, undeservingly so. So there's a certain friction there, analytically, in terms of the operations of lenders, originators, and the like that is indeed emergent and is indeed unevenly distributed by different types of banks in particular.

There's nothing universal to any of this, but it begins to describe what is, I would say, a kind of early-stage learning and experimentation about how to translate the science and the technology to their own transactional infrastructure and their own processes for evaluating and managing climate risk.

**Alessandro Cocco:** Thank you, Jesse. Let's stay with the exposure of banks to climate change risk.

Now turning to Eric. Eric, you are part of a team that builds electronic dashboards using flood risk to predict the exposure of local banks. Without revealing any confidential supervisory information, what can you tell us about the dashboard you're building?

**Eric Hogue:** Sure. So what we're doing in my area is utilizing both past data, as well as predictive models—either from internal sources, such as David's research, or external sources, such as NOAA—to highlight both the realized risk and potential risk to our regional bank lending portfolio. We utilize Tableau as a visual platform to communicate the risk to our supervisory staff. We have geographical matching tools with the flood risk to particular geographical areas within our region—as well as aggregate statistical measures to kind of highlight the risk both over time previously, as well as predicting into the future

**Alessandro Cocco:** Thank you, Eric.

Ah, David, there's a lot of debate on how to calculate discount rates. So how do discount rates factor into your analysis for housing market risk from sea-level rise?

**David Rodziewicz:** That's a great question, Alessandro.

So, so discount rates basically dampen the estimates of future losses, so no difference than—no different than a net present value calculation.

You know, future cash flows are discounted in terms of estimated value relative to more recent cash flows. So, for example, if a loss were taken or property were inundated by sea-level rise next year, so that estimated loss would be measured much more highly than, let's say, a loss or an inundated property that was affected a hundred years from now.

So, in sort of summary, higher discount rates result in a dampening of longer-term losses. So in our analysis, we did a sensitivity analysis in the back of the paper that sort of identifies at high discount rates, losses are dampened or compressed because of those outer years and at low discount rates, those estimates of losses or potential loss are, are quite a bit higher.

And the literature on long-term discount rates and real estate markets—which is probably something that Jesse's well familiar with—those estimates for long-term discount rates are in that—on the low single digits.

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**Jesse Keenan:** I mean, it's—you know, discount rates and real estate ... you know, it's a questionable exercise on some level. I mean, this is a certainly a challenge in not just economics, but philosophy, and particularly discounting—discount rates associated with climate change in general.

I mean, when you start to think about the interaction between real estate values and supporting public infrastructure and public finance markets, and you begin to, you know, internalize dimensions associated with long-term allocation of public resources that essentially, on some level, subsidize those, at least the land or econ-, the, some utility value of that real estate, you know, there's arguments for negative discount rate. And I think discounting, in a way, often stands in the way unnecessarily from having a more resolute understanding often in nonprobabilistic terms.

I mean, in thinking about dashboards and things like that, I mean, we have to draw some knowledge from associated challenges in climate analytics, and climate modeling, and global-change modeling, where we have to be disciplined and where we end our probabilistic analysis with degrees of confidence, and move forward with nonprobabilistic modes of analysis, particularly as it relates, for instance, to scenario planning. Which, by the way, is now an important methodological frame for many in not only the banking world—and I'm preaching to the choir on that front—but certainly among the GSEs and elsewhere, when trying to think about the truly dynamic interaction among many variables from which climate change connects, whether we recognize it or not.

**David Rodziewicz:** So I'll take it one step further on your statement of scenario analysis: So that's absolutely true. And within each climate scenario, each carbon concentration pathway over the next hundred, or 200 years, there's also uncertainty within each. So for our analysis for local sea-level rise risk, we also include those uncertainty bands.

So I think there's, there's a lot that needs to be done in the practitioner and the financial world around both scenario analysis, but also understanding uncertainty within climate risk. Not just picking a median line across a carbon concentration—or a greenhouse gas concentration pathway.

**Alessandro Cocco:** So you touched on it a little bit already, Jesse, but let's talk in a little bit more detail about information asymmetries, and the impact that these asymmetries could have on the broader financial markets.

**Jesse Keenan:** Yeah, so a number of years ago, I think it's maybe best memorialized in a paper that I published in *Science* on the climate intelligence arms race. And what's happening in the financial services world is the emergence of climate services technology. And these technologies are part interface design, or user design, they're part data management, and in some more advanced circumstances, they are trying to resolve or find some productive resolution in the relationship between global change modeling and catastrophe modeling—for instance, as used by the insurance and reinsurance world.

And there's a slew of intermediaries and, let's say, entrepreneurial and even tech startup ventures that sort of fill in the gaps on a lot of different things

But across this range of climate service technology firms is a deeper investment. We see this by Moody's, S&P, a number of low-hanging fruit—firms who are there to adjudicate and provide support and climate services on some level, or just, let's say, financial services on some level. But across the financial services sector, we see massive investments. And I think that those investments are an arms

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race, in a way, to see who has the superior technology to stress-test some of the experimental nature of this—the experimental nature of much of this science and technology—as in translation to investment support and decision-making and the like. It indeed is quite experimental. And that's complicated by the fact that there's proprietary technology that's not always subject to the highest standards of external peer review.

**Alessandro Cocco:** A lot of the debate on climate change is also focused on the importance of reliable data. And some of the work that Eric is doing helps us look into just one perspective on acquiring data.

So, Eric, what are some of the practical applications of the dashboard that you are building?

**Eric Hogue:** So the dashboard that we have available within our region kind of gives our staff the ability to see the impact of climate-related events in real time, as well as being able to project them out within the near short term, as those tend to have the most pertinent, you know, effects within our district.

So I'll give a quick example: In 2019 there was quite a few flooding events within our region. Prior to the implementation of the dashboard, we really didn't have a way of quantifying these events so that our supervisory staffs could have a holistic view of what the risk was related to our banking portfolio.

And so, with the dashboard, we now have the ability not only to geographically map where these flooding events are to identify where potential risks are within the institutions in our area, but also look at the historical relationship within certain events over time, as well as predicting into the future. And so, this has enabled our examiners to have materials to be able to take to their various stakeholders to communicate this risk as they see fit in a more digestible format.

**Alessandro Cocco:** Thank you, Eric. Now let's turn to David. David, how is your research useful for financial market participants? What information and insight can they glean from your sea-level rise analysis?

**David Rodziewicz:** So, Alessandro, the—again, the main challenge that I, I think the financial world and the economics world is facing right now in climate-risk analysis is matching climate risk to economic units of interest—could be asset markets, could be houses, could be mortgages.

So there's three things that I think a reader of our paper or other practitioners or financial market participants can, can glean.

Firstly, we developed a methodology that uses freely available geographic and climate data to match, in this case, single family homes to a timing of inundation, or when they might be affected by sea-level rise.

That methodology could be applied across markets. So, in our case, we used housing markets 'cause they're geographically diverse, readily available in coastal areas, but same could be applied to sort of any asset market that has a latitude and longitude. So hopefully that points to the publicly available data that others could use outside of private companies that are providing some of this type of analysis.

Additionally, our analysis gives a good sense of relative risk between locations, on a metro level. So, we provide impairment profiles for places like New York or Miami or Galveston. And it points to this idea of hyper-local effects. So when you think about a place like Houston, that might be affected by hurricanes

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and other forms of flooding relative to a Galveston—when we look at the potential impairments or the potential risk for Galveston’s housing market from sea-level rise specifically, there’s noticeable differences relative to another city that’s in the same region and nearby. And that has to do with the location of the houses, the relatively flat topography—for example, to get a Galveston or an Atlantic City is on a barrier island, a lot of houses near the coast, where, let’s say, Houston is a little bit more inland and maybe a little less prone to that type of risk.

And lastly, I think, maybe most importantly, is this idea of uncertainty. So, our analysis is indicative of this idea of asymmetry of risk. So when we looked at individual cities, and we looked at, let’s say, tenth to 90th percentiles within a climate scenario, we found that there was greater uncertainty within individual climate scenarios than there were across climate scenarios. So it, it sort of speaks to this idea that maybe the financial sector needs to move away from scenario-specific analysis or making these estimates of risk at the average—and really thinking about tail risks and asymmetry of risks.

**Alessandro Cocco:** Thank you, David.

Jesse, similar question: What is the practical impact of your research? And in particular, the CFTC MRAC Climate Subcommittee Report refers to sub-systematic risk. Can you tell us a little bit more about that?

**Jesse Keenan:** There’s a number things. But I think one of the things that comes to mind is this idea of sub-systematic risk, in the sense that if you look at the totality of exposed assets and you look at risk associate-, let’s just say housing assets for a second. And we’ll use this as an example. And we look at the totality of that relative to assets under management, total equity within households as a percentage of household net wealth, et cetera, et cetera—you know, the numbers, just with sea-level rise alone, you know, they’re large, but they’re not devastating on the order of a global financial crisis.

They’re going to be more problematic, but in, in discrete terms, they are ostensibly manageable in, in—by virtue of our capacity to adapt. Doesn’t mean there aren’t winners and losers. It doesn’t mean some people truly get left behind and lose everything. But the scale of the challenge just in these particular relationships—sea-level rise, Gulf Coast, East Coast of the United States, for the most part—it’s a, it’s a limited range of, of exposure over a certain time horizon.

But I think what you begin to understand as you dive deeper into it, that it’s not just about the risk of mortgages in collateral devaluation, it’s al-, not, you know, grandma can’t get her reverse mortgage because it’s, you know, that equity cushion isn’t there, it’s also about, of course, pr-, pre-payment risk and default risk altogether.

But those are known dimensions in the mortgage market associated with hurricanes and extreme events anyway. And in many ways, many mortgage investors aren’t terribly worried about that. But what becomes more problematic is when you think about the range of, uh, originators, but also mortgage investors, including small to regional and even larger, but let’s just say small and regional banks, who have a disproportionate amount of mortgages on the books—that is, they haven’t passed it off to the capital markets. And they’re on the books for a number of different reasons associated with, um, for a lot of different reasons. They have different constructions of mortgage portfolios.

And in a scenario where there is a higher concentration geographically in their portfolios, they don’t benefit from geographic dispersion or distribution, spatial distribution, rather. In the event that these more regional or smaller banks have a—are highly concentrated measures of risk. And so when we think

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about, you know, systematic risks, this idea of sub-systematic risk is that we have more localized essentially geographies of risks that translate to limit and impair economic participation among households, investors, borrowers, and ultimately banks themselves.

**Alessandro Cocco:** Thank you, Jesse.

So, thinking about the very interesting research we've covered today, I'd like to see if we can draw some conclusions. So, is there a scenario where real estate value impairment due to climate change could reach a systemic dimension?

So I'll start with David, then Eric, and then Jesse. David?

**David Rodziewicz:** Alessandro, that's, that's the multi-trillion dollar question. And I believe it's a little bit too early to tell.

So local factors matter. Based off of literature and sort of what researchers are doing, we're starting to see some repricing in certain local areas around the coast in terms of housing prices and real estate markets.

But it's not clear exactly whether or not those estimates of discounts or that repricing is the right price. So there's, there's some uncertainty as to whether or not, you know, markets have truly taken on board all the risks and what that sort of right risk-calculus is.

Additionally markets can adapt. There can be mitigation that can play a role in sort of stemming some of the systemic risks that folks are pretty, pretty concerned about. But I will say just the conversation that we're having today is sort of buoying and inspiring.

You know, as, as market participants begin to have these conversations—discuss these types of climate risks—it actually decreases the likelihood of any major broader-based systemic risk, because that awareness rises; some of that information gets embodied within markets either locally, regionally, or nationally; and it reduces the probability of, of those systemic risks. So.

**Alessandro Cocco:** Yeah, definitely, I, I agree. It's important to talk about these risks and start seeing whether we can approach a uh—designing a risk-management model that addresses some of these risks. And I think that the research of all the guests here today is helping us get closer to that.

So then I'll turn to Eric. Eric, what do you think?

**Eric Hogue:** That's, you know, like David said, it's a multi-trillion dollar question.

It is, it's hard to say with such precision as to whether or not it could rise to a level of systemic risks. I think there's very much a localized risk of certain regions that is very hard to quantify. And, you know, when you look at, you know, ag concentration in the Midwest or real estate concentration on the East Coast, uh, there's certainly substantial risks there. Would it rise to the risk levels that we saw in the Great Financial Crisis? That is—I guess I would say, beyond my, my scope of expertise, but I do think that having the discussions will help [mitigate] even the large, localized risk to various regions. And I think that it can definitely help, looking at a localized level, you know, keep people, you know, from either having very high downside risks—whether or not, you know, having the appropriate amount of



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insurance to help cover their homes. From the banking standpoint, being able to have the appropriate, you know, levels of capital to mitigate those risks as well.

Very, very hard to say if we'll be seeing anything close to what we saw in, you know, '08, '07 related to any particular climate-related event.

**Alessandro Cocco:** Thank you, Eric. Jesse in your view, is there a scenario where real estate value impairment due to climate change could reach a systemic dimension?

**Jesse Keenan:** We really look at exposure. And we haven't even gotten into broader understandings associated with the sensitivity of assets, markets, investors in managing that exposure.

I'm not quite sure that we have the level of resolution in risk analysis that we think we necessarily have.

So you do this sea-level rise analysis or an exposure analysis of flooding, and you tend to think of these things as very binary elections of impairment—asset impairment. But there are gradations to the behavior and our response to these things. And it's, it's quite unknown.

And, and David's certainly correct that discounting behavior's happening in single family—it's happening in multifamily. Either way what they have found, for the most part—at least in the, in a coastal context—is that that discounting behavior is, is correlated with levels and degrees of education, education attainment. It's not correlated necessarily to ideology or political affiliation or in these other things that we tend to assume self-distribute activity and, and associated behaviors. And indeed in the multifamily market, there's greater discounting behavior among investors who look or are looking essentially at the cashflow and, and, more or less, disregarding the long-term residual exit value.

So, you know—and, for our listeners, this isn't just coastal, it isn't just sea-level rise, it is-, isn't just pluvial, fluvial, or other types of flooding. This is also forest fire. And in fact, there's some really wonderful economics literature looking at the impact of forest fires on the housing markets.

So I think we have a long way to go, but I think we're getting there increasingly so—through public and private sources of data; through private sector, venture capital investments, and R&D investments; and also with the public investments in data and associated transparency and accessibility of that data.

You know, one of the challenges that we all have, particularly when we're talking about whether we're dealing with investment managers or consumers, you know, how do we translate our analysis and the uncertainty of our analysis, so that people can begin to have a heuristic to lean on.

And there's different ways of doing that—there's advances in interface and design—but it's a big leap forward in the translation of science to policy to investment. And all of these things are happening at the same time, but there's really a lot of work ahead of us.

**Alessandro Cocco:** Thank you, Jesse, let's stay with our gaze firmly into the future. So, I'd like to ask each of our guests, what are you working on now?

So, I'll start with Eric, then David, then Jesse. So, Eric, what are you currently working on?

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**Eric Hogue:** So right now we're incorporating some more predictive models into our tool to kind of give our supervisory staff a little bit more confidence as to the potential risk, you know, further down the line.

Currently, we only have predictive risk up to the next three months provided by NOAA, and so I'm looking forward to working with David a little bit more as far as incorporating potentially more longer-term risk—um, additionally us-, utilizing first-rate data to kind of evaluate risk, you know, over the next 30 to 50 years.

**Alessandro Cocco:** Thank you, Eric. And same question for David: What are you working on at the moment?

**David Rodziewicz:** So in addition to our sea-level rise work that we, we did last year, we also did some work on drought and risk to the agricultural sector. Myself and my, my other co-authors are in the process of taking some of those insights both for sea-level rise and drought and matching and doing some analysis in other markets. In the case of sea-level rise, I'm thinking about, you know, matching to mortgages or other asset classes, kind of like, just like I mentioned previously. And then on the drought side, instead of looking at crops, we're looking at matching that to other areas of agricultural sector, such as range land or ranchers, and how that natural disaster or that natural hazard affects that component of the agricultural sector.

**Alessandro Cocco:** Now, turning to Jesse. What are you currently working on?

**Jesse Keenan:** We have tons of work, but the one thing I think might be of interest to you in this context is we've primarily looked at single family market, but we really haven't done a great deal looking at multifamily and looking at development patterns in the land markets. And so, I'm trying to move away from single family to understand the broader land economy associated with low-risk development patterns.

So we're starting to see some evidence—both in quantitative and qualitative terms—about shifting local settlement and investment patterns from areas of high risk to low risk. And we're getting, trying to understand, get a better sense of what that really means in terms of the underlying land economy.

And by the way, that's critically important for societal values like affordability. Because land is very often the ultimate economic determinant of relative affordability. So I, I'm very concerned about those that get left behind, including low-income renters and others who may be caught in this friction, as our economy begins to adapt to climate change.

**Alessandro Cocco:** I would like to thank my three guests for sharing their views with *LaSalle Street* and our listeners on this topic: David Rodziewicz, economic specialist, and Eric Hogue, risk specialist—both from the Kansas City Fed—and Jesse Keenan, associate professor of real estate at Tulane School of Architecture.

I'm delighted you could join me. *LaSalle Street* will be back next month with another deep-dive discussion of the intersection of financial markets and public policy.

I'm Alessandro Cocco, vice president and head of the Chicago Fed's Financial Markets Group. Thank you for listening.