

Resources

Celebrating the
People of RFF



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A Note from RFF's President

Celebrating the People of Resources for the Future

This year marks the 70th anniversary of Resources for the Future (RFF); naturally, we will take every opportunity to celebrate this milestone! The previous issue of *Resources* magazine, published in February, showcased some of RFF's landmark research from the past seven decades. The articles in this issue cover the high-impact work that RFF is doing right now, tackling the tough problems for which the world is currently navigating solutions—especially climate change. For instance, RFF Fellow Penny Liao describes recently published research on flood insurance, Fellow Hannah Druckenmiller previews work in progress about landscapes in transition, and Senior Fellow Maureen Cropper discusses timely work on the social cost of carbon—a topic that's been considered in recent court cases and discussed by legal scholars in this magazine, alongside Supreme Court cases that could substantially limit federal authority to regulate greenhouse gases.

In these pages, we celebrate the people of RFF. Our organization *is* its people—our scholars, staff, supporters, and affiliated colleagues—and the decisions we make professionally (and personally) in these moments. What we do now determines our future, and what we take to heart now helps measure the significance of our past. I hope it's apparent that, as a research organization seeking practical impact, we consciously cultivate what we do. I think our vice president for research and policy engagement, Billy Pizer, says it well in our "Day in the Life" episode of the *Resources Radio* podcast, which you can hear at [Resources.org](https://resources.org) and read on page 38: "The thing I really like about my role at RFF is helping the researchers do what they enjoy doing, which is doing research that's policy relevant. To the extent I can help them figure out how to do that better—that's incredibly gratifying."

I also know that our other scholars and staff at RFF approach their roles similarly, all in service of the mission of RFF, which is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. By helping each other, in alignment with our core values of balance, rigor, independence, respect, and results, we can achieve far more than we ever could alone.

We are part of the solution, advancing a healthy environment and thriving economy.

And we hope we can count you among us.



With good wishes,

Richard G. Newell
President and CEO, Resources for the Future

Resources

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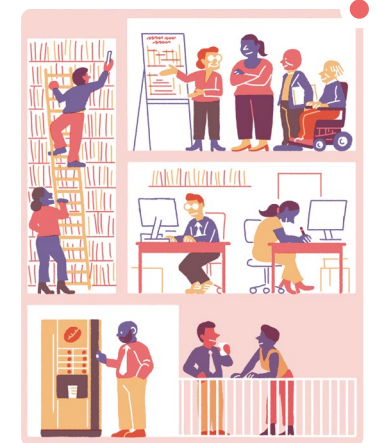
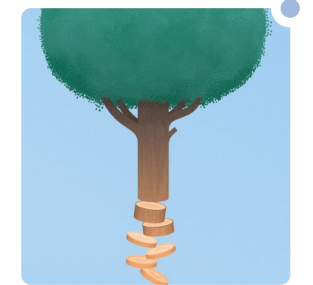
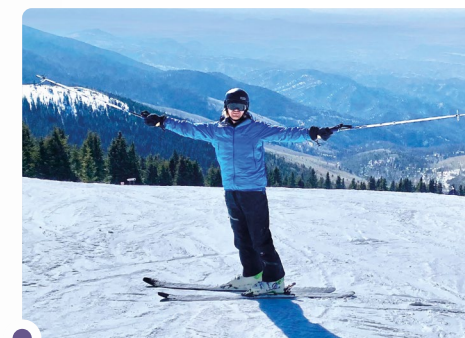
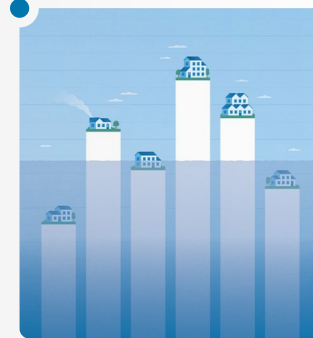
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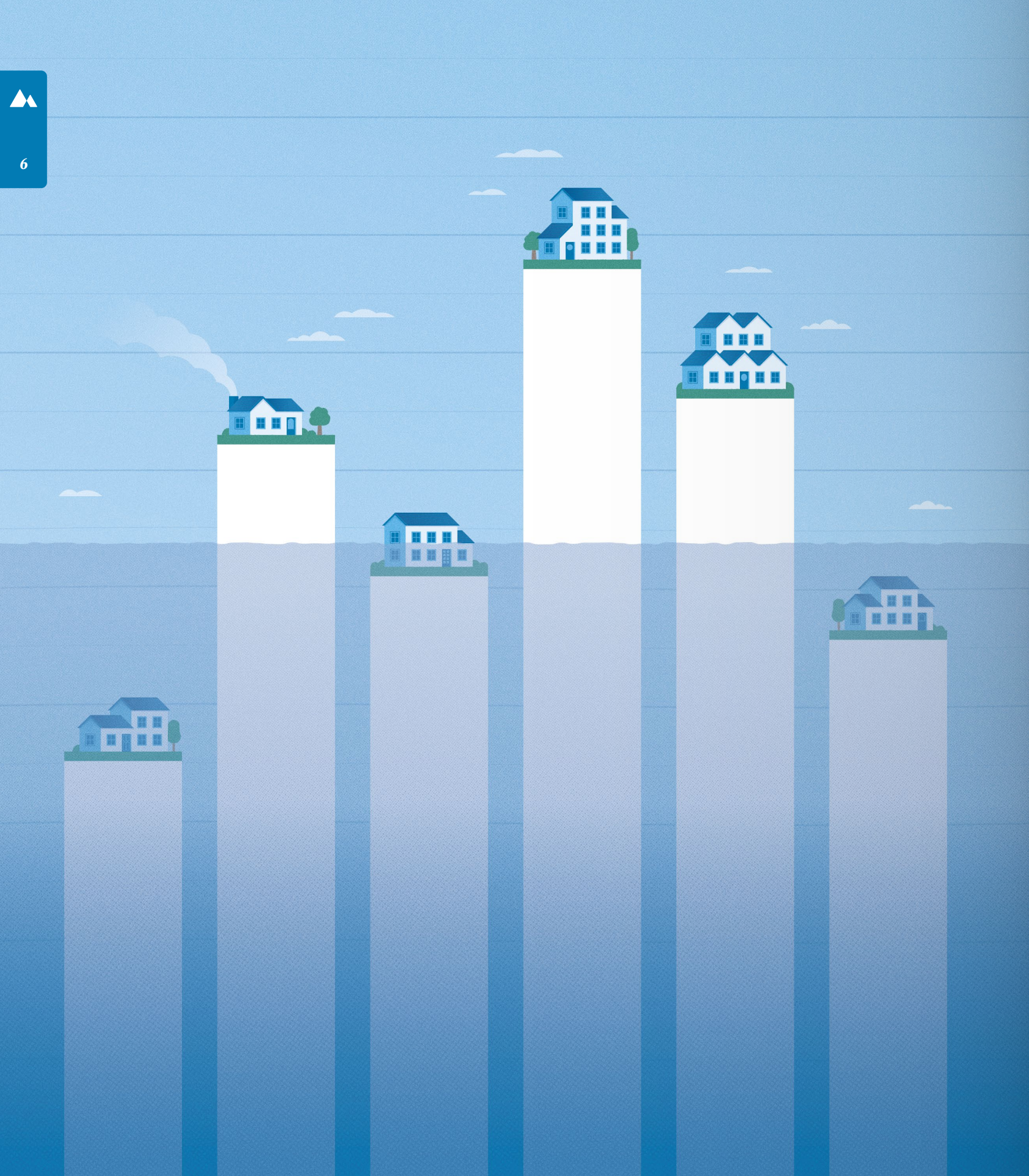
New

Fellows!

Interviews
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 James Round

Resources for the Future (RFF) is looking to grow its team of researchers, and our latest additions are Fellows Yanjun (Penny) Liao and Hannah Druckenmiller. These two scholars now have nearly a year under their belts at RFF —and one even has a new baby.

Both fellows spoke about their backgrounds and their latest research with podcast hosts Daniel Raimi and Kristin Hayes on *Resources Radio*, a weekly podcast produced by the *Resources* editorial team and RFF. These conversations with Penny and Hannah are transcribed here, serving as introductions to some of the more recent members of RFF's research team.



Risks and Rewards in Homeownership and Flood Insurance

Yanjun (Penny) Liao, a scholar of behavioral and market responses to environmental risk, joined Resources for the Future (RFF) as a fellow in August last year. On *Resources Radio*, Liao elaborated on her research about how a household decides to purchase flood insurance, finding that homeowners with more home equity are especially likely to purchase flood insurance because they have stronger incentive to avoid defaulting on their mortgage, while households with highly leveraged mortgages might not fully account for their flood risks.

Kristin Hayes: Can you tell our listeners about the path that brought you to this point?

Yanjun (Penny) Liao: I actually started on this path to be an environmental economist by chance. I was an undergraduate in economics at the University of Hong Kong, and nobody in my university studied environmental economics. The field does not exist there. But I happened to know an environmental economist teaching at another university in Hong Kong, named Professor Bill Barron, and he was incredibly passionate about the field. As soon as he learned that I was an undergrad in econ, he immediately recommended two papers for me to read.

Those are "The Tragedy of the Commons" by Garrett Hardin and "The Problem of Social Cost" by Ronald Coase, and these papers blew my mind. They're such seminal papers in the field,

and they laid out very profound and powerful ideas in a very accessible way that I—as a second-year undergrad—could understand. I remember being so fascinated by the idea that you can apply an economic lens to environmental problems. That appeals to me a lot, because growing up in China, I've seen the tension between economic development and environmental quality. And environmental economics seems to have this potential for confronting this tension and finding a path forward.

So, this fascination has stuck with me ever since. I started working for an environmental and urban policy think tank in Hong Kong called Civic Exchange. Then I went to the University of California, San Diego, to pursue a PhD in economics, specializing in environmental economics. When I completed my PhD, I was already working on climate and disaster impacts.

“ I remember being so fascinated by the idea that you can apply an economic lens to environmental problems. That appeals to me a lot, because growing up in China, I’ve seen the tension between economic development and environmental quality. ”



IN CONVERSATION
Kristin Hayes and Yanjun (Penny) Liao

ILLUSTRATION
James Round

This interview was broadcast in August 2021. The transcripts of these conversations have been edited for length and clarity. The episodes can be streamed online at [Resources.org](https://resources.org).

I then joined the Wharton Risk Center as a postdoctoral researcher. The Risk Center deals a lot with questions of risk—how people make decisions related to risks, how risks get diversified, and things like that. That’s when I started thinking about disaster risk management and adaptation more systematically.

I love the beginning of that anecdote, just because it reminds me how much of a difference an individual professor—or just a passionate person of any variety—can really make a difference in someone’s trajectory. But it sounds like you blazed your own path, in terms of following your passions and bringing things together in a way that wasn’t common.

I was definitely lucky to have such good mentors along the way. I think that, during your formative years, running into these people really helps.

Can you say more about why you chose to focus on disasters, risks, and adaptation? Why did that capture your imagination?

First of all, even without climate change, disaster risk is a very important and interesting topic to me. There are catastrophic events throughout human history that have destroyed the lives and livelihoods of so many people. We now have more advanced physical knowledge and modeling techniques than before, and we know that we can see this as a risk-management problem.

From a public policy point of view, I think it’s an important question: How do we build a robust system to reflect and diversify the risks, and to protect vulnerable populations from the realization of those risks? On top of that, we have climate change, which makes things much worse.

I think you spell it out really well in your question. The relative inaction on mitigation makes adaptation more important. That’s also the realization I’ve come to during graduate school, and I think there’s a lot of room for improvement when it comes to adaptation.

This summer, we’re seeing a record number of extreme weather events and disasters across the world. And it seems clear that the

infrastructure in many places is not really well defined to handle such events. There are a lot of opportunities right now for governments to take note and be more prepared for unexpected events like this. It’s not just the governments—individuals, businesses, and other entities can also take actions to be prepared. There are a lot of open questions about whether we have the right incentive structure in place, for these agents to take the necessary adaptation measures.

At RFF, we focus on policy—and the policy levers are incredibly important, but you’re right to point out that adaptation is going to happen across a wide range of jurisdictions, including everything from the homeowner, to the insurance company, to the local government, state government, all the way up to the federal government. So, the range of questions and players is very wide. It makes sense that there’d be a lot that we still need to figure out.

You mentioned that you got your undergraduate education in Hong Kong, before coming to the United States, and that you grew up in China. Can I ask, for a global perspective, how you see the conversation around mitigation—and perhaps adaptation in particular—being different in a place like Hong Kong, compared to the United States? Are there different policy levers available? How does the conversation look?

There are certainly both differences and similarities. First of all, in Hong Kong, climate change is not a politically charged issue, so I think the general public might not consider it a huge concern, compared to the economy, for example. But they do overwhelmingly support mitigating carbon emissions within Hong Kong. In terms of adaptation, Hong Kong is a predominantly urban environment: Most people live in an urban environment, and they have exposure to extreme heat and tropical cycles. The infrastructure there has more or less been adapted to such events, and management practices are trying to adapt to these risks.

But, going forward, it’s unclear whether the existing infrastructure is going to hold up in more extreme scenarios of heat and things like storm surges coming from sea level rise. I think

“**From a public policy point of view, I think it’s an important question: How do we build a robust system to reflect and diversify the risks, and to protect vulnerable populations from the realization of those risks?**”



“**Flooding is a very expensive type of disaster, both in aggregate and for individual homeowners. In aggregate, it cost about \$15 billion annually over the past decade.**”



that is actually universal to a lot of other places, as well, which are all facing uncertainty.

There is also a high level of inequality. I’m not sure I have seen enough discussion there about what this means, in terms of exposure to climate impacts by different groups. I think the equity concern is true both in Hong Kong and the United States. I think that there are definitely differences, but also a lot of similarities.

Interesting. Thank you for that context, with the trans-Pacific perspective there.

You’re wrapping up some work on flood insurance and home equity, and you and your authors look at how “mortgage default may be a form of implicit insurance against disaster risk for leveraged households.” Can you explain that hypothesis and ground us in what you’re looking at?

This paper is with Philip Mulder, who’s a graduate student at Wharton. In the paper, we’re interested in looking at flood insurance, but let me first give you some context.

Flooding is a very expensive type of disaster, both in aggregate and for individual homeowners. In aggregate, it cost about \$15 billion annually over the past decade. For individuals, when their home is flooded, the damage can easily be tens of thousands of dollars. For example, in 2019, the average flood insurance claim was \$52,000. In 2017, when there were particularly severe hurricanes, the average claim went to more than \$90,000. These are flood insurance claims in the United States. They’re very high numbers for a normal household if they don’t have insurance. In the past, we’ve seen that flooding leads to higher rates of mortgage defaults and foreclosures.

What that means is that some homeowners, instead of paying to repair the house out of pocket, would rather default on their mortgage and give up their home equity. This can be a rational choice when the homeowner has a low level of home equity but high flood damage. So, in this case, we can think of mortgage default as a kind of high-deductible insurance policy. The deductible is the home equity, but that’s all the homeowner’s going to lose when the flood damage goes beyond that.

The level of equity is the key here. If you have a lot of home equity, then you wouldn’t want to default, so you cannot rely on this implicit insurance. In that case, you would be better off buying formal flood insurance. So, the main prediction is that the more home equity you have, the more you’re willing to pay for flood insurance.

You took advantage of some previous fluctuations in housing market prices, to tease out this relationship between home equity and insurance uptake. Can you explain about the data sources that you used and how you found a moment in time when you felt like you’d be able to look at this question robustly?

The main relationship we want to test for is that higher home equity increases flood insurance demand. For flood insurance data, the main source we used comes from the National Flood Insurance Program. This is a public program operated by the Federal Emergency Management Agency (FEMA), and it provides around 95 percent of all flood insurance in the United States. We’re capturing the vast majority of the market because, historically, private insurance companies are not willing to provide flood insurance coverage.

FEMA has published policy-level data in its open FEMA website. It’s a great data source for researchers who are interested in studying flood insurance, and that’s the data we used. We collected other data to supplement it as controls.

The most tricky thing in this research is a challenge in the research design, because home equity is correlated with other important factors in flood insurance demand, such as income, education, or risk attitudes. To identify the causal relationship, we needed to find something that drives home equity but not these other things. For that, we used sudden changes in housing prices during the housing boom and bust in the early 2000s. Around this time, we observed that there was a sudden price acceleration in some housing markets, but not others. In these housing markets, the price first grows smoothly. Then, between around 2003 and 2005, there was a sudden acceleration, where the price of new houses started growing much faster. This



Taxpayer dollars are on the line, and this is an implicit cross-subsidy to homeowners exposed to flood risk.



variation is likely to be speculative, and it's independent from fundamental changes in economic and demographic conditions.

This drives large changes in home equity for many homeowners, but it does not change, for example, their underlying flood risk, or the expected cause of flooding for them, because they're still living in the same buildings. This gives us a good opportunity to identify the causal effect of home equity on flood insurance demand, while holding these other factors constant.

We looked at all the metropolitan statistical areas across the entire United States.

What relationships did you discover? And how do you and your coauthors explain what you found?

The first thing we see is that flood insurance take-up indeed increases more in high-boom markets when compared to low-boom markets. More importantly, we're able to estimate how flood insurance take-up changes over time, in response to that shock, and trace that out over time. We find that the trajectory of insurance take-up correlates really well with the trajectory of housing prices in response to the same housing-market shocks. This suggests strongly to us that there is a direct relationship between the two, so we're able to estimate this relationship directly. We find that a 1 percent increase in housing prices leads to a 0.3 percent increase in flood insurance demand. To put this in context, this is twice the effect of a 1 percent drop in insurance premium. That's a primary factor in insurance demand, so this suggests that there's quite a substantial relationship.

We also find other patterns that are very telling. For example, National Flood Insurance Program households that live in 100-year floodplains are mandated to buy flood insurance if they have a federally backed mortgage. But outside of the 100-year floodplains, there's no mandate whatsoever—so, the decision is completely voluntary. We find that this is largely driven by those households living outside of the 100-year floodplains. So, we're capturing this conscious decision: these are voluntary choices people are making.

To further establish that this is really driven by a mortgage default mechanism, we looked at how things were different across the metropolitan statistical areas with different foreclosure costs. By "foreclosure cost," we mean things like, "How soon will I be evicted from the house? Would I be charged a large fee by the lender if I did?" This could vary across states based on their foreclosure laws. Some states require all the foreclosures to go to court, and these are called judicial requirements. When there's a judicial requirement, it protects the borrower's interest. We find that, indeed, in these places, the relationship between home equity and insurance demand is much stronger than the places without the judicial requirement. That also supports the mechanism.

It sounds like you did a tremendous amount of digging around with the information you had, and thank you for sharing those findings. How do you see all this affecting future decisionmaking? In other words, what would you want policymakers and other decisionmakers to take away from what you've done, as they're designing future flood insurance programs or thinking about how to better protect homeowners in the future?

The first implication from the findings is that homeowners with a highly leveraged mortgage do not fully internalize their flood risk. Instead, part of the risk is transferred to the lenders, but ultimately, a lot of these loans are securitized by government-sponsored enterprises (GSEs), such as Fannie Mae and Freddie Mac. Taxpayer dollars are on the line, and this is an implicit cross-subsidy to homeowners exposed to flood risk.

It leads to the second implication, which is that the implicit subsidy here can distort incentives by these homeowners to insure, which we have shown in the paper. It was similarly a factor in people's incentive to take adaptation measures, such as floodproofing their homes.

We think that some possible solutions to address this problem of incentives is to focus on reflecting the risk in the mortgage system, especially for homes outside of the 100-year floodplains—as we find that's where the effect is. The GSEs, for example, could consider



pricing the risk they have taken on, such as charging a higher fee to securitize at-risk loans without insurance coverage. Alternatively, it's worth considering expanding the flood insurance mandate to beyond the 100-year floodplains, because that 1 percent risk cutoff is pretty artificial. Homes outside that zone also are exposed to quite substantial levels of risk.

I've also mentioned the incentive to take adaptation measures. It's also important for flood insurers to price in these risk-reduction measures as a way to encourage people to undertake them. These are things like receiving a discount when you have undertaken certain floodproofing measures.

Recently, we have seen some promising steps taken by different federal agencies, which I think are going in the right direction. For example, FEMA has come out with Risk Rating 2.0, which aims to provide more accurate risk-based pricing to insurers. The Federal Housing Finance Agency, which is the main regulator of the GSEs, issued a request

for input on climate and disaster risk in April, which reflects them giving this issue real attention. So, I think it will be very interesting to see where these efforts take us; they could even be future research topics.

Penny, thank you for explaining all of that so clearly and for grounding us in the work you're doing.

What do you hope to work on as you start at RFF, building on what you've been doing in the past, as well as issues that you've been talking about with colleagues on staff? Are there things that you're particularly excited about tackling in your ongoing research career?

Yeah, definitely. I'm going to continue this line of work, in general, thinking more about how we handle risk—especially as climate change is increasing those risks. I'm already starting to think of collaborating with RFF colleagues, looking at climate impacts on businesses and how they're able to handle that risk. ■

IMAGE (ABOVE)
Flooding is the costliest—and most common—natural disaster in the United States.

Vstock LLC / Getty Images



We think that some possible solutions to address this problem of incentives is to focus on reflecting the risk in the mortgage system, especially for homes outside of the 100-year floodplains—as we find that's where the effect is.



How Much Is a Tree Worth?

Hannah Druckenmiller, who studies the value of healthy ecosystems and the causes of long-run environmental changes, likewise joined RFF as a fellow in August last year. Elaborating on her various research projects on *Resources Radio*, Druckenmiller described the economic value of trees, based on how tree mortality shapes property values, air quality, wildfire risk, and more. She also described an ongoing project that uses twentieth-century photographs, taken by British aircraft, to approximate modern satellite imagery and estimate changes over time for environmental resources in Africa.

Daniel Raimi: Let's start by going all the way back to when you were a kid. When you were young and growing up, were you interested in environmental issues? Did you have experiences with the natural world that were important for you?

coral reefs, and then you come back into the classroom and talk about what you saw and how everything there was interacting.

It ended up being a formative experience for me. It exposed me to all sorts of environmental issues, especially regarding sustainability and how human and natural systems are interwoven, and I think that's probably the biggest reason why I decided to pursue those topics when I went to college and then to my PhD program.

There's two tracks that we often find environmental economists have taken. Some of them start with an interest in the environment and then choose economics as a tool to work on that issue. Some folks start by wanting to be an economist and then discovering environmental issues. Which led the way for you—was it the environmental angle or economics?

It was the environmental angle. In college, I started out as an environmental science major, and I had a focus on oceans, so I got to take

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I've always been interested in oceans. They are so unexplored and unexplained. It's a unique part of the earth that covers more than 70 percent of surface area, but we have very little idea of what's happening in most of it.

”



IN CONVERSATION

Daniel Raimi and Hannah Druckenmiller

ILLUSTRATION

James Round

This interview was broadcast in August 2021. The transcripts of these conversations have been edited for length and clarity. The episodes can be streamed online at Resources.org.



all these amazing classes in marine biology and ocean chemistry—things like the physics of waves—but I also took some courses in marine resource management, and I got pretty interested in fisheries. I've always been interested in oceans. They are so unexplored and unexplained. It's a unique part of the earth that covers more than 70 percent of surface area, but we have very little idea of what's happening in most of it.

One of the things I liked the most was that it was at the intersection of a bunch of different disciplines, so you had to understand the underlying biology—but you also had to understand social and political factors to manage these resources effectively. I took a class called World Food Economy at Stanford, which is taught by Roz Naylor. She just so powerfully conveyed to me what a useful tool economics is for understanding how systems work and for effecting change in those systems. That really led me down this path.

One question I want to ask sounds like a really simple question, but it's really fascinating: How much is a tree worth?

That question is motivated by estimating the social and economic value of healthy forests. A lot of my work is motivated by the idea that we need to be able to quantify the value of natural resources so we can know how to manage them, and so we can weigh the benefits they provide against the costs of environmental protection. I decided to focus on forests because they're one of our largest sources of natural capital. That's true in the United States and around the world. We think that forests provide a whole array of ecosystem services, but we don't have a really good idea of how much they're worth in terms of dollar value.

Unfortunately, we've seen large declines in forest health around the world over the last several decades. Tree mortality rates have doubled in the last 20 years. My paper tries to understand the consequences of those declines in forest health for human well-being.

I think, in general, the challenge with valuing natural resources is that many environmental goods and services—including trees—don't have a clear price in the market. We could go out there

and try to estimate the value of a tree by looking at how much timber costs, and that would give us part of the picture—but we know that trees also provide other benefits. They provide aesthetic value and air purification, and healthy trees protect us against floods and fires. We want to capture all those benefits—which in economics, we call nonmarket benefits—when we're thinking about the total value of a tree. That's what I try to do in the paper. I try to take into account both the market value of trees and their nonmarket value, so that when we're thinking about how to manage forests, we can weigh that dollar-value benefit against the cost of investments and forest health.

We're not going to get into all the details of the methods, but can you give us a thumbnail sketch about how you estimate some of those market and nonmarket benefits?

I can provide a sense of how I measure forest health, which is not straightforward; how I measure economic value; and how I try to create a causal link between those two things.

For forest health, I basically use tree mortality as a summary statistic. I do so for a couple reasons: The first is that we have pretty good data in the United States on tree mortality over time. The Forest Service runs a pretty cool survey where they fly planes over almost all forested areas in the western United States, and they circle areas where they observe dead trees. So, we have these nice annual maps of where tree mortality is occurring and how severe it is. I also chose to focus on tree mortality because it's a pretty stark indicator of forest health, and it's been increasing a lot over the last several decades, so it's something that scientists are interested in understanding the consequences of.

To get at the economic value of trees—again, I'm really focused on capturing both market value and nonmarket benefits. Market value is pretty straightforward, because we can just go out there and see what price people and firms are willing to pay for timber tracts. Nonmarket benefits are more challenging. Luckily, the field of environmental economics has spent a lot of time developing methods to estimate nonmarket benefits, and one of the most popular approaches is called "hedonics," which is based on the idea that environmental goods and services should capitalize into property values.

You can think of this as the idea that I would probably be more willing to pay more money for a home in an area with lower levels of air pollution, because I value my air quality—similarly, the concept that I would be willing to pay more money for a home in a healthy forest than one in a degraded forest, because I think that healthy trees provide me and my family with some sort of benefits. What we can do is look at the price premium that homeowners are willing to pay for a higher-quality environment, and that's the dollar value we assign to that resource. That's what I do in the paper to get at those two different types of benefits.

The last step is to establish a causal link between forest health and the value that we place on trees.

And here comes the beetle.

Yes. We really want that link to be causal, because we're using this information hopefully to guide policy decisions—we don't just want a correlation. Which means that we need some sort of random variation in forest health. What I do is I rely on a natural experiment that's based on bark beetles.

If you're not familiar with beetles, they're the leading cause of tree mortality in the American West. They're these tiny bugs that burrow in the bark of trees, and when they breed, they can cause mortality events.

Something that's really neat about beetles is that their survival is heavily dependent on temperature. In particular, there are temperature thresholds at very low temperatures, where we see mass mortality rates in bark beetles because their tissue freezes. We can look at years that had days just above and below these thresholds—those years are pretty comparable in terms of the rest of the weather distribution—but just one additional day below the thresholds causes large differences in beetle survival and therefore tree mortality. That gives us a way to compare forests that should be similar along many dimensions—but one has very high rates of tree mortality, and one has very low rates of tree mortality.

That's such a clever way to look at it. What are some of the key results?

Unsurprisingly, I find that beetle population sizes are sensitive to cold temperatures and that tree mortality is very sensitive to beetle survival, so there's the strong link between very cold days and tree mortality the following summer. I think that's interesting in its own right, because with climate change, we're expecting increases in winter temperatures, which would lead to higher rates of beetle survival and higher rates of tree mortality. This is just another thing we need to think about when we're thinking about managing forests in a changing climate.

The bulk of the paper focuses on understanding the consequences of tree mortality for human well-being. I find that tree mortality greatly reduces the value of timber tracts (the market value of forests), and it also has pretty big impacts on local property values—which, again, are intended to capture some of these nonmarket benefits.

To give you a sense of magnitude, I find that a pretty significant mortality event (you can think of that as like 10 percent of trees in a forest dying) would reduce local property values by 1 to 2 percent and would reduce the value of timber tracts by about \$2,500 per acre. These are economically meaningful effects.

I'm also able to look directly at the effect of tree mortality on some specific environmental services. I look at what happens to air quality, wildfire risk, and flood damages when we see mortality events, and I find that tree mortality is actually a strong driver of all three of those natural hazards. This gives us some intuition for why people are willing to pay more for a home in an area with healthier trees, because we have a sense that healthy trees not only provide us with aesthetic value but also might provide us with hazard protection.

When you add all those things together, I estimate that a tree in my sample is worth about \$40—to get at your original question—but it's worth noting that there's huge variety in this value across space. As you might expect, there's much higher value for trees that are located in timber-producing regions and for trees that are in areas with high population densities, because more people are exposed to the benefits that those trees provide.

I want to ask you now about another one of your research projects: This one is all about using millions of photographs, taken from aircraft in the middle of the twentieth century of what were then 60 different British colonies, mostly in sub-Saharan Africa. What are you doing with all these pictures taken from airplanes? What information are you trying to gather?

This is a big project that's a collaboration with researchers at Stockholm University; the University of California, Berkeley; and the National Collection of Aerial Photography in the United Kingdom. The main goal is to extend our understanding of where people were located, where infrastructure was, and where resources were, back in time before data were collected at a large scale or in a systematic way.

Part of the motivation is that the research community has benefited from access to satellite imagery. Starting around 2000, really high-resolution imagery became widely available, and we were able to take that imagery and make it into maps of human development, environmental resources—things that we care about at a global scale. We can look at how deforestation rates have changed over time, or what happens when you add a road to an area, or whether natural resources decline.

This has transformed our understanding of global change. But a big limitation of these data is that they date back only a couple of decades. A lot of the questions that researchers are interested in studying span a longer time period than that. The idea of this project is to try and take advantage of these large archives of aerial photography that were taken over the course of the twentieth century to essentially extend the satellite timeline backward, to the 1940s or '50s. We like to think of it as providing a window back in time to let us see what was happening on the ground before we had good data collection in a lot of these developing countries.

What we're doing in the project specifically is we have this archive of photos that were taken during the process of mapping the British Empire. The British wanted to understand where people were located, where resources were located, and how these things were changing over time. What we're doing is taking

“**When you add all those things together, I estimate that a tree in my sample is worth about \$40 ... but it's worth noting that there's huge variety in this value across space.**”



Bridgetown, Barbados, 1950



Bridgetown, Barbados, 2017

all the old images and using them to generate data products that map out the location of natural and built capital.

One of the really cool things about the archive is that the countries are visited not only once, but multiple times between 1940 and 1990, so we can create data sets that span different decades and understand how the locations of people and resources were changing over this time period.

It has turned out to be a big undertaking. The photos are in boxes, in the United Kingdom, as physical prints. The first thing we need to do is get them onto our computer—so our partners at the National Collection of Aerial Photography have set up a state-of-the-art scanning operation using robots to digitize the archive at scale. Then, the pictures come to us as black-and-white prints of a location in space—but, unlike a satellite image that you might download, they don't have any information

embedded as to where that image is located in geographic space. That's something we have to learn from the information contained in the image. We've created this whole machine-learning pipeline that essentially takes these millions of individual images and stitches them together into seamless maps—something like you might see if you opened Google Maps and looked at the satellite layer.

The last step is that we want these images to be helpful to researchers; so instead of just handing them a picture of Kenya in 1950, we want to give them data that they can actually use in their analysis—we need to extract structured information from the imagery. We're applying out-of-the-box machine-learning tools, like convolutional neural networks, that input the images and output data on road networks or building footprints. We're making maps of land use, so we can measure forest cover, croplands, and urban extent. These are data sets that we're lucky enough to currently have access to from

IMAGE Hannah Druckenmiller and her collaborators are comparing historical aerial photographs taken from airplanes with modern images taken by satellites.

TOP National Collection of Aerial Photography

BOTTOM © Mapbox

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We're applying out-of-the-box machine-learning tools, like convolutional neural networks, that input the images and output data on road networks or building footprints.
 ”

“
That's the intuition of what the computer is doing in this case. It builds us a mosaic of the whole country—and then a person has to place it in geographic space.
 ”

about 2000 to 2020, but we think the research community will really benefit from having access to them going much further back in time.

It's astonishing that you can develop an algorithm to learn where photos were taken without any of that kind of metadata or contextual information. Is it possible to describe how the machine-learning algorithm can ultimately figure out where in space the photo was taken?

There's still some human input, and we do have some information about where the images are located. What we get is a box full of images—they might be hundreds of images if you're looking at a small country like Barbados, or thousands of images if you're looking at a larger country like Kenya. Along with these images, we get a hand-drawn map of where the plane flew. You can think of this as a map of Kenya with a bunch of lines across it that show where the plane was flying—so, we know the order of the images. That allows us to use algorithms that can take two images that have overlap and identify common points between them. It's more complicated than this with computer vision, but intuitively, it's like if the computer sees the same road intersection in two adjacent photos, it's going to align those images so that intersection is overlapping. We do this for every pair of images in the sample.

But unfortunately, it's not as easy as that—because if you just lay down one image and then sequentially add images on top of that, these small errors in matching propagate to make something that looks unrecognizable. Our team developed a procedure that essentially optimizes the location of all images jointly, so you can kind of think of this as a person that's trying to align multiple images into a mosaic on their desk, and you have to shift each image a little bit. When you shift one, you have to shift another so that it matches, and you do that enough times that, finally, you get something that you're happy with.

That's the intuition of what the computer is doing in this case. It builds us a mosaic of the whole country—and then a person has to place it in geographic space. They identify points that haven't changed over time; for example, a coastline or a major highway

intersection. By finding just a few of those points, we're able to locate the entire image on a modern map.

You've already hinted at some of the research questions that you or others could answer using these data. But do you have particular applications in mind?

We do hope that the data will be used across a wide range of disciplines; but personally, I'm most interested in understanding the long-term impact of climate shocks. A nice thing about these data is they allow us to look at how impacts persist over time—not just in the next five or ten years, but over half a century. The data also allow us to look at climatic events that happened before we had good information on social and economic outcomes.

One event that I'm really interested in studying is the effect of the Sahel droughts on human migration in Africa. These were decade-long droughts, very severe, that happened between the late 1960s and early 1980s. It's widely believed that they caused massive famine and displacement of people; but unfortunately, we haven't been able to study their impact because we haven't had good data on where people were located during that period.

Climate scientists often think that the Sahel droughts will be a very close analog for the types of droughts that we'll see under climate change. It would be useful to understand how they affected migrations, so we can use the historical knowledge to inform what we think might happen in the future. But again, we just haven't had the data to be able to see what it did to populations on the ground.

One thing we can see in these images is human settlement. We plan to pair data on the droughts with newly created data on where people were located and how land was used to try and understand some of the social implications that these droughts had in the 1960s and 1970s.

That's so cool. Thank you so much, Hannah, for coming on the show and introducing us to some of your research. Really looking forward to getting to know it in more detail as we get to work with you in the months and years ahead. ■

The Global Climate Policy Partnership

This year, Resources for the Future (RFF) and the RFF-CMCC European Institute on Economics and the Environment in Italy have launched the new Global Climate Policy Partnership (GCPP)—a global expert working group proposing innovative policy solutions to meet our climate challenge.

In the context of rapidly evolving and often overlapping proposals, policy evaluation becomes critical to help design effective and fair decarbonization strategies. The GCPP establishes an international network of leading economic and policy research institutes to evaluate global climate policies and propose actionable policy solutions to help the major world economies achieve the climate transition efficiently and inclusively. Working to understand the needs of country-level and international policymakers, the GCPP will establish and execute an agenda of new analysis and policy research.

Members of the GCPP are well-positioned to introduce the results of these examinations directly into country-level and international policymaking. The intent is to grow the GCPP over time, adding new international research and policy analysis institutions as well as individual research and thought leaders drawn from the global community. This map illustrates the current network of partners within the GCPP.

SAN FRANCISCO, USA
Climate Policy Initiative

WASHINGTON, DC, USA
Resources for the Future
Environmental Defense Fund

CAMBRIDGE, USA
Harvard Environmental Economics Program

MEXICO CITY, MEXICO
Instituto Tecnológico Autónomo de México (ITAM)

RIO DE JANEIRO, BRAZIL
Climate Policy Initiative
Coppe of the Federal University of Rio de Janeiro
International Institute for Sustainability

POTSDAM, GERMANY
Potsdam Institute for Climate Impact Research

BERLIN, GERMANY
Mercator Research Institute on Global Commons and Climate Change

FLORENCE, ITALY
School of Transnational Governance at the European University Institute

MILAN, ITALY
RFF-CMCC European Institute on Economics and the Environment

OXFORD, UK
Oxford Net Zero

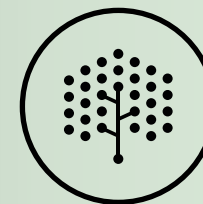
DAEJEON, SOUTH KOREA
Korea Advanced Institute of Science and Technology

BEIJING, CHINA
Energy Foundation China

NEW DELHI, INDIA
The Energy and Resources Institute
Centre for Policy Research

SHANGHAI, CHINA
Duke Kunshan University

NARA, JAPAN
Research Institute of Innovative Technology for the Earth



The GCPP is a global working group of experts that will propose innovative policy solutions to meet our climate challenge.

The latest updates on GCPP membership and news are available at rff.org/gcpp.

Senior Fellow Status Update

Environmental Insights is a podcast hosted by Robert Stavins, a professor at the Harvard Kennedy School and a university fellow and co-vice chair of the board of directors at Resources for the Future (RFF). The podcast features interviews with insightful members of research institutions, government, nonprofit organizations, and the private sector who speak to the intersection of economics and environmental policy.

The conversations often cover topics related to market-based approaches to environmental preservation. Transcribed here is one recent episode, in which Stavins talks with economist Maureen L. Cropper about her career in environmental economics, the social cost of carbon, the future of climate policy, climate activism, and more.

Robert Stavins: You studied economics at Bryn Mawr College as an undergraduate. At that point, were you already thinking of the environment? Or did that part of your research interests come later—perhaps in graduate school?

Maureen Cropper: Actually, the environment didn't come to my attention until my first academic appointment, which was at the University of California, Riverside. I majored in economics when I was in college, and when I was at Cornell for graduate school, I was really doing more monetary theory. My dissertation was on bank portfolio selection with stochastic deposit flows. I got a job offer from the New York University business school, but I wound up going to UC Riverside because it was a joint job search with me and my partner at the time. I arrived at UC

Riverside in 1973, and that's when I became an environmental economist. Around this time, in 1974, the *Journal of Environmental Economics and Management* was started.

My partner did not get tenure at UC Riverside, so we went on the job market together. And luckily for me, I received an offer from Maryland; I have been here for more than 40 years.

You've been an assistant, associate, and full professor—and now, on top of all that, you're a university distinguished professor. Along the way, at some point, you spent a substantial period of time as lead economist in the research department of the World Bank. Can you talk about that? How did that come about, and what was the experience like?

I should say that, when I was at Maryland, I also began an affiliation with Resources for the



IN CONVERSATION

Robert Stavins and Maureen L. Cropper

The transcript of this conversation has been edited for length and clarity.

“As time has gone by, a lot more attention has been given to the use of big data to evaluate environmental programs. I think that has been a quite remarkable and good trend—the use of empirical data is appropriate for answering certain questions.”



Future (RFF), which actually happened before I went to the World Bank. I was a Gilbert F. White Distinguished Visiting Fellow at RFF, which had a huge effect on my career.

In 1993, Nancy Birdsall asked if I would join the research department at the World Bank, which was a wonderful opportunity. I took a year off from the University of Maryland and joined the Development Research Group at the World Bank. After that year, I was a part-time economist at the World Bank and had an academic appointment at the University of Maryland.

Can you talk about the tremendous changes that have taken place in the scholarly world of environmental economics? Do any particular changes or trends stand out to you?

One thing that's clearly happened in environmental economics is a move toward empirical work and adopting what I would say are the quasi-experimental methods that have been championed and advanced by economists. If we think about the balance, let's say, for economists and environmental economists doing what's considered theoretical work versus empirical work, I would say the balance really has shifted. As time has gone by, a lot more attention has been given to the use of big data to evaluate environmental programs. I think that has been a quite remarkable and good trend—the use of empirical data is appropriate for answering certain questions.

It's certainly the case that methodologies and ways of thinking have spilled over from environmental economics to other areas of economics. And other spillovers, such as randomized control trials, are now used in environmental economics—particularly for studying environmental issues in developing countries.

Yes, that's definitely true. Together with Joseph E. Aldy, Maximilian Auffhammer, Richard Morgenstern, and Arthur Fraas, I coauthored a review piece that came out in the *Journal of Economic Literature*, which looked at the Clean Air Act after 50 years. In that article, we focus on reviewing published research that evaluates the benefits and costs of the

Clean Air Act by applying quasi-experimental methods, ex post studies, newly available data sources, and even randomized control trials in some cases. But if you think about the state of environmental economics in the past several decades, it's hard to imagine that these types of studies could have been written back in 1980. I think the fact that we have this large body of literature attests to the way that environmental economics has evolved with the profession.

What's your assessment of the current US administration's environmental and resource policy? Any aspects of it that you're particularly following?

As you know, the area that I pay the most attention to is the social cost of carbon. Overall, we've seen momentum to further the cause of estimating and using the social cost of carbon. After all, on President Joe Biden's first day, he reinstated the Interagency Working Group, which had been disbanded by former President Donald Trump and announced the intent to make progress in revising the social cost of carbon. I do think a lot has been done along those lines. But of course, the progress we see and how the social cost of carbon ultimately is used will likely be affected by recent rulings.

For those who may not be familiar with the social cost of carbon: It's a number that essentially refers to the present discounted value of the future stream of health and environmental damages from carbon emissions that are released in the atmosphere. The estimate may increase if the new Interagency Working Group lowers the discount rate from three percent to two percent and makes other changes. These updates would increase the current interim value, which I believe is \$51 a ton.

Yes, the new estimate of the social cost of carbon certainly could come out to be more than that. If you take the analysis that was done before Trump took office, and you change the discount rate from three percent to two percent, then the social cost of carbon would increase from \$51 to something like \$120.

And if you make other changes in the modeling of emissions based on temperature, damage functions, and other impacts on climate, then you'll certainly see an increase in the social cost of carbon. A Brookings paper by colleagues at RFF about the social cost of carbon updates certain components of the analysis and comes up with a value of \$171 per ton, based on a current discount rate of 2 percent. I think it's very likely that a revised value could approach \$200—and in any case, the new estimate would be much larger than \$51.

Speaking of the social cost of carbon, which obviously is associated with global climate change, can you tell me where you are along the spectrum of optimism to pessimism about progress on climate change policy in the United States?

From a great distance, I'm not very optimistic about the rate at which greenhouse gas emissions are being reduced.

As we wrap up our conversation, I want to ask for your personal reaction about some big changes in recent history: youth movements of climate activism. They were striking for the first time in the United States and Europe in 2019; took a bit of a hiatus during the pandemic; and then came to the fore again, particularly in Glasgow at COP26 in 2021. What's your personal reaction—as an economist, a mother, an individual, or however you'd like to respond? What's your reaction to these youth movements of climate activism that we see today?

I think it's wonderful to see people—full stop—but especially young people interested in doing something and getting behind solutions to climate change. One hopes that, as the next generation grows up and matures, they will indeed have different attitudes. I have four children, a stepchild, and three grandchildren. I do see their attitudes, which really are very encouraging to me in terms of what's happening in the country as a whole. It does seem like a very good indicator or bellwether, one hopes, of things to come. All I can say is I really hope that, going forward, these young people will continue to have the attitudes that they do now. ■

Climate Change and the Supreme Court

IN CONVERSATION

Lisa Heinzerling, Jonathan Wiener, and Susan F. Tierney

ILLUSTRATIONS

Daria Kirpach

In 2022, the US court system could largely determine the future of US climate policy and environmental regulation. Acting on two specific doctrines in recent cases, the Supreme Court may end up substantially limiting regulations on carbon pollution.



Three recent Supreme Court cases could have a substantial influence on future federal climate policy and environmental regulation.

First, earlier this year, the Supreme Court's decision in *National Federation of Independent Business v. Department of Labor, Occupational Safety and Health Administration (NFIB v. OSHA)*, elevated the "major questions doctrine." The major questions doctrine holds that federal agencies should have strict limits on their ability to issue regulations of "major importance" unless Congress has given the agency clear legislative authority to do so.

Second, last month, the court heard oral arguments for *West Virginia v. US Environmental Protection Agency (EPA)*, which focused on the major questions doctrine while touching on another key legal principle: the "nondelegation doctrine." This doctrine limits the ability of Congress to delegate its own legislative authorities to another branch of government—in the case of *West Virginia v. EPA*, an executive branch agency. In this ongoing case, application of the major questions doctrine, the nondelegation doctrine, or both could greatly affect EPA's authority to regulate carbon emissions.

And third, legal disputes are continuing around the federal government's use of the social cost of carbon (or the social cost of other greenhouse gases), a number that's critical for assessing the benefits of putting regulations in place that are designed to reduce carbon emissions. In the case of *Louisiana v. Biden*, a federal district court in Louisiana issued a preliminary injunction against EPA's use of the interim social cost of carbon. That decision (which has since been put on hold, at least temporarily, by the US Court of Appeals for the Fifth Circuit) has been hindering the Biden administration's efforts to issue an

updated social cost of carbon value and make policy decisions based on these estimates.

These three cases may have big implications for the future of US climate policy and environmental regulation. A recent event hosted by Resources for the Future (RFF) brought together two legal experts to discuss exactly what's happening in the Supreme Court right now, along with the potential consequences of the court cases.

Professor Lisa Heinzerling joined from the Georgetown University Law Center. She previously served as Senior Climate Policy Counsel to the Administrator of EPA, as well as Associate Administrator of EPA's Office of Policy. Heinzerling was the lead author of the winning key briefs in the monumental *Massachusetts v. EPA* case of 2007, in which the Supreme Court held that the Clean Air Act gives EPA the authority to regulate greenhouse gases.

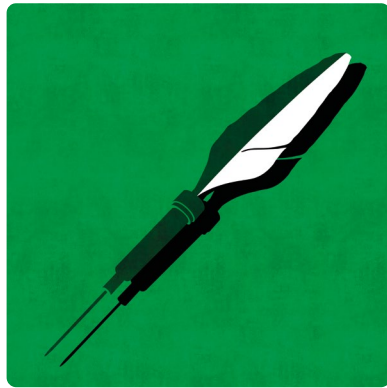
Professor Jonathan Wiener joined from Duke University; he's also a university fellow at RFF. He previously served at the White House Council of Economic Advisers, the Office of Science and Technology Policy, and the US Department of Justice during the first Bush and Clinton administrations. Wiener also helped negotiate the United Nations Framework Convention on Climate Change.

Susan F. Tierney moderated the conversation. Tierney is the chair of the board of directors at RFF, a senior advisor at Analysis Group, and an expert in energy economics, environmental regulation, and many other topics covered by RFF research. Previously, she was the Assistant Secretary for Policy at the US Department of Energy and served on the US Secretary of Energy advisory board. ■

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A recent event hosted by Resources for the Future brought together two legal experts to discuss exactly what's happening in the Supreme Court right now, along with the potential consequences of the court cases.
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The transcript of this discussion has been edited for length and clarity. The event was held on March 22, 2022.





Lisa Heinzerling

West *Virginia v. EPA* is pending in the Supreme Court right now. It's a complicated case with lots of intricacies, and a lot is at stake. The case concerns the scope of EPA's authority to regulate greenhouse gases under the Clean Air Act, Section 111. However, the outcome and reasoning of the ultimate decision may have a dampening effect on ambitious regulatory programs far beyond Section 111—and far beyond even the Clean Air Act itself.

Section 111 requires EPA to regulate categories of stationary sources that the agency has found to significantly contribute to air pollution that endangers public health and welfare. EPA regulates these sources by establishing standards of performance for them. The key statutory phrase describing EPA's obligation of setting standards for performance directs EPA to apply "the best system of emission reduction" that has been adequately demonstrated. States are responsible for meeting these standards of performance, and states have flexibility in figuring out how to do that.

EPA has long regulated fossil fuel-fired power plants under Section 111. But in 2015, with a rule called the Clean Power Plan, EPA for the first time set limits on carbon dioxide emissions from power plants. In setting those limits, EPA considered a variety of pollution-control measures, including some that went "beyond the fence line," as they say, of particular power plants by shifting generation from coal-fired plants to gas-fired plants or to renewable sources like wind and solar. That feature of the rule is front and center in *West Virginia v. EPA*.

However, the Supreme Court stayed the Clean Power Plan before the rule was ever implemented and before any lower court ever reviewed it. Then, the Trump administration repealed the Clean Power Plan and replaced it with a much weaker rule. And then, the US Court of Appeals for the DC Circuit vacated the repeal of the Clean Power Plan and the replacement rule that followed it. The DC Circuit held that EPA was mistaken in believing that the Clean Air Act

unambiguously precluded the agency from incorporating into its standards under Section 111 any measures that could not be put into operation at a particular facility, at a particular physical location. The very next day after the DC Circuit issued that decision, President Joe Biden was inaugurated. And at EPA's request soon after, the DC Circuit stayed its vacatur of the repeal of the Clean Power Plan—which wiped out the vacating of the repeal. EPA had explained to the court that the Clean Power Plan was no longer up to date and that EPA was working on a whole new rule to address power plants under Section 111. So, the DC Circuit stayed the vacatur of the Trump administration repeal of the Clean Power Plan. What this means right now is that there's no rule in effect that governs greenhouse gas emissions from power plants under Section 111—not the Clean Power Plan, and not the replacement rule.

Despite the apparent lack of any current effect on or injury from any existing EPA regulation, the Supreme Court took up the challenge to EPA's authority under Section 111. And at oral argument, the conservative justices showed no sign that they're contemplating ditching the case because of the lack of a current injury from a regulation in place right now. I think it's reasonable to expect the court to decide the case on the merits.

Two legal doctrines may loom large in the court's decision. The first is the nondelegation doctrine; this one is constitutional. The second is the major questions doctrine; this one is statutory.

Nondelegation Doctrine

The nondelegation doctrine holds that it's unconstitutional for Congress to delegate its legislative authority to any other person or institution, including administrative agencies like EPA. Only twice in its history, however, has the court actually struck down a federal statute on the ground that it violated the nondelegation doctrine—and both were in 1935.

The justices came to understand the profound difficulty of distinguishing permissible from impermissible delegations of legislative power. They worried that, without a neutral and predictable test for distinguishing the permissible from the impermissible, a vitalized nondelegation doctrine would simply seize power from Congress and hand it over to the courts.

Today's conservative justices don't appear to be worrying about this problem anymore. Although the current court hasn't struck down a statute based on nondelegation, five of the six current conservative justices have served notice that they're prepared to be more aggressive in policing delegations of authority by Congress to administrative agencies. And they all appear to agree on at least one possible test for identifying illegitimate delegations: A delegation is improper, they've suggested, when Congress hands off an important policy issue to the executive branch for decision, and the executive uses that delegated power to control private conduct. This proposed new test is hopelessly subjective and skewed against ambitious regulatory programs.

It's also true, however, that in *West Virginia v. EPA*, no party has asked the court to invalidate Section 111 of the Clean Air Act on nondelegation grounds. And I didn't see any indications at oral argument that the court would take this route. But there's every reason to think that the case may ultimately turn on a principle of statutory interpretation that lately has become closely associated with the nondelegation principle: the major questions doctrine.

Major Questions Doctrine

It's quite new, as canons of statutory interpretation go. Yet even in its brief life, the major questions doctrine has mutated—from being a relatively minor observation about why a particular statute should be interpreted to not give an agency a particular kind of power, into being a handy, all-purpose tool for disempowering agencies from taking on important problems. The most up-to-date description of the doctrine, I think, comes from the court's recent opinions that reject the moratorium on evictions from the

Centers for Disease Control and Prevention (CDC), and which reject OSHA's COVID shot or test mandate. The court in those cases said, "We expect Congress to speak clearly when authorizing an agency to exercise powers of vast economic and political significance." For this court, ambiguity and generality as to major questions will not do.

So, I'm hoping you can see the danger that this doctrine might pose for issues related to climate change. The conservative justices have been quick in several prior cases already to conclude that regulatory issues related to climate change raise questions of great economic and political significance.

Moreover, the relevant statutes tend to speak in broad terms about the power of agencies. This broad-strokes approach requires the agencies to tackle new environmental risks as those risks emerge, without specifying the risks in detail in advance. The point of this legislation is to empower agencies to tackle risks that Congress either doesn't foresee or didn't know enough about at the time the statutes were passed.

I think the court's major questions idea threatens to undo these statutory judgments. And in these recent cases that we're discussing, the conservative justices have intertwined the major questions idea with the nondelegation idea—thus perhaps transforming a principle of statutory interpretation into a principle of quasi-constitutional significance. To return to *West Virginia v. EPA*: the challengers to EPA's authority argue that, given the policy importance of what they characterize as a restructuring of the energy sector, Congress needed to speak more clearly if it wanted to give EPA the authority that EPA claimed in the Clean Power Plan.

Consequences of Court Cases

It's always perilous to make predictions about what the Supreme Court might do. But let me just say: I'm worried. I'm worried that the Supreme Court will deploy the major questions doctrine to limit EPA's authority as easily, and even as casually, as it did in the cases involving the CDC's eviction moratorium and OSHA's test or shot rule for workplaces. ■

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Lisa Heinzerling is a professor at the Georgetown University Law Center.



Jonathan Wiener

In considering the role of the major questions doctrine in *West Virginia v. EPA*, it's interesting and somewhat arresting for us to notice the interplay between what's happening now and an older doctrine—the *Chevron* doctrine, which dates back to 1984 with a Supreme Court decision about EPA's interpretation of the word "source" in the Clean Air Act.

Essentially, the doctrine says that if Congress has delegated authority over a statute to an agency, and if that statute is not clear or has an ambiguity, then the court will look to the agency's interpretation of that ambiguity in what the statute means and how the agency proposes that the interpretation should be resolved—at least as a first pass. If the court finds that the agency's interpretation of the ambiguity is reasonable, then it will allow the agency's interpretation. The *Chevron* doctrine gives latitude to executive agencies to operate and interpret ambiguous statutory language.

The *Chevron* doctrine has been used in a wide variety of cases, including the interpretation of the word "source" in the Clean Air Act in the *Chevron* case itself. More recently, in 2009, the Supreme Court in an opinion by Justice Antonin Scalia in *Entergy Corp. v. Riverkeeper* upheld EPA's interpretation of a provision of the Clean Water Act—Section 316, to regulate cooling water intake structures—allowing EPA to use cost-benefit analysis under EPA's interpretation of the word "best" in the Clean Water Act provision.

Interestingly, the major questions doctrine seemed, at one time, to be a kind of exception to the *Chevron* doctrine, saying that when there really are major questions, then the agency would not get deference for its interpretation, and the court itself would interpret the ambiguous statute. But the major questions doctrine has evolved over time, seemingly to stand apart from the *Chevron* doctrine, and even to operate in cases where that whole *Chevron* multi-step analysis doesn't even enter into the case. In *West Virginia v. EPA*, for example, there was no discussion of *Chevron* deference in the oral argument. And in the *NFIB v. OSHA* case in January, the opinions did not rely on *Chevron* deference.

“The *Chevron* doctrine has been used in a wide variety of cases, including the interpretation of the word ‘source’ in the Clean Air Act in the *Chevron* case itself.”

This independence of the recent cases from the *Chevron* doctrine suggests (as others have commented) that the major questions doctrine is being treated (at least by its advocates) as a distinct limitation on the delegations that Congress can make to agencies. The major question doctrine seems to have become not just an exception to the idea of deference to agencies when statutes are ambiguous, but perhaps a limitation on agency authority even when the statute is clear. For example, in the *NFIB v. OSHA* vaccination and testing rule case, the statute said that OSHA has the authority to regulate occupational risks, new dangers, and grave threats. But the majority of six justices—and especially a concurring opinion by Justice Neil Gorsuch for three justices—wrote that the agency needed to go back to Congress, seemingly because OSHA covers occupational risks at the workplace but not public health risks outside the workplace, or because OSHA covers occupational risks but the law did not name a pandemic or COVID as such a risk.

Where does all this bring us in *West Virginia v. EPA*? Clean Air Act Section 111 clearly authorizes EPA to regulate air pollutants by setting a standard based on the “best system of emission reduction,” taking into account several other factors such as cost, non-air quality impacts, energy requirements, and that the “best system” is adequately demonstrated. All of that is relevant to the interpretation of Section 111. And the Supreme Court already has held that the term “air pollutant” includes greenhouse gases, in *Massachusetts v. EPA* back in 2007. But even so, the Supreme Court majority nonetheless might still invoke the major questions doctrine to say that climate change is such a major issue—or that the regulation of the electricity system is such a major issue—that Congress must say so more clearly to delegate that authority.

Invoking the Major Questions Doctrine

What can trigger an invocation of the major questions doctrine? During the oral argument of *West Virginia v. EPA*, I thought Justice Elena Kagan put it well when at one point, she asked one of the lawyers, “How

big does a question have to be, or how do you know when it's big enough?” The answer seems quite unclear at this point.

We can look to some past cases as examples. For instance, in *Food and Drug Administration (FDA) v. Brown & Williamson Tobacco Corporation* in the year 2000, the Supreme Court said that the FDA did not have authority to regulate tobacco, even though the agency has authority to regulate drugs, because tobacco was not mentioned in the statute (and based on other factors in the history of what Congress may have intended). That case often is cited as one of the major milestones in the major questions doctrine. So, I think it's an important and difficult issue to watch in the current case of *West Virginia v. EPA*.

A second point here is the way the major questions doctrine is being deployed to restrict agency authority to deal with major risks—and especially new major risks—which is evident in the *NFIB v. OSHA* case about COVID vaccination and testing from January, along with other cases. I think that suggests a kind of irony: Congress delegates authority to an agency to use its expertise to address a set of risks that Congress knows will evolve over time, but the major questions doctrine is being used to say that the agency has to go back to Congress for new authority each time a major new risk arises. That obviously poses a timing problem.

In addition to the distinction that Lisa mentioned about action versus inaction, invoking the major questions doctrine like this also poses an irony about which types of risk the courts are willing to allow executive action to address first. In these health and environmental cases—like *NFIB v. OSHA*, *Alabama Association of Realtors v. Department of Health and Human Services*, and possibly *West Virginia v. EPA*—the major questions doctrine is being deployed to say that if it's not extremely clear in the statute, then the agency has to go back to Congress for new authority. But for national security risks, the typical posture is the opposite: the executive branch has latitude to act first, and then Congress could restrict that executive action. And if the point of the major questions doctrine—or even the nondelegation doctrine—is to force Congress to take democratic accountability for major decisions, then it seems possible to work either way. That is, it could be that Congress has to act

first; but it could also be that the executive gets to act first, and then Congress can, by statute, condition or restrain—or limit the duration of—the executive action.

There's a risk-selection asymmetry here, to the extent that health and environmental risks are being sent back to Congress, but the executive gets more latitude to act in response to national security risks. One might say that this asymmetry may derive from the executive's greater authority over military, national security, and foreign policy issues under Article II of the US Constitution, but one could then recognize that climate change and pandemic disease also are national security risks and foreign policy issues. This asymmetry at least needs to be addressed as a risk management problem—and as a legal question.

Social Cost of Carbon

And I'd just like to mention briefly the *Louisiana v. Biden* case about the social cost of carbon. This was a decision by a lower court—the US District Court in the Western District of Louisiana—quite recently. In a case brought by the attorneys general of Louisiana and several other states, the court enjoined the reinstatement of the Interagency Working Group to estimate the social cost of carbon; its interim estimates, which were adopted in February 2021; and Executive Order 13990, issued by President Biden—on the ground that these directives threatened harm to the plaintiffs and exceeded the authority of the executive branch.

But then, the US Court of Appeals for the Fifth Circuit stayed that district court injunction (at least temporarily) on the ground that the plaintiffs had not pointed to an existing rule that could cause them harm; hence, the plaintiffs lacked standing to sue where they couldn't show a concrete injury. But that case still may get a full appellate hearing in the future. And even after the appeals court rules, the case may get sent back to the same district court, which might have further proceedings.

The *Louisiana v. Biden* case is interesting and important because it relates to the ability of the executive branch to think through and estimate the impacts of policy decisions. It's an important case to watch. ■

“There's a risk-selection asymmetry here, to the extent that health and environmental risks are being sent back to Congress, but the executive gets more latitude to act in response to national security risks.”



Jonathan Wiener is a university fellow at Resources for the Future and a professor at Duke University.

Judging the Cases

Susan Tierney In many of these environmental regulatory and public health issues, the technical, scientific, and evidentiary considerations for the construction of public policy is very dense. We couldn't expect every congressperson to be expert across so many different complicated domains as to be able to provide detailed statutory instructions to agencies that cover the variety of circumstances that may affect regulation across the many states. And we also can't expect bills and laws to anticipate, cover, and address all the technical permutations that could exist in, let's say, regulating power plant emissions—if that were true, we'd see 3,000-page decisions.

Please speak to this tension between the ability of policymakers in Congress to actually make decisions on 3,000-page laws with the fulsome consideration of all of these questions, versus drafting general instructions that deliberately delegate to more technical experts the job of figuring out how to execute on that policy.

Lisa Heinzerling One of the basic reasons that Congress delegates authority to agencies is because people in Congress don't have the expertise or the time to handle all these problems. We've seen pervasive delegations of authority to administrative agencies since early on in this country's history. What we're really talking about is a fight between the power of the court and the power of Congress.

To the extent that these decisions shift from an approach that grants or withdraws deference to agencies, to an approach that says, "Congress, you need to speak more clearly if you want to do this," the Supreme Court is taking direct aim at the power of Congress to delegate authority to whomever Congress wishes. This shift is a threat to that choice of handing the decision over to others.

And it's hard to predict at this point how clear the court will insist Congress should be—especially given that statutory ambiguity

is inevitable, at least to some degree, and especially on big problems that already require hundreds of pages of bills. There's going to be ambiguity, but the court essentially is saying, "You can't do that." These are cases in which Congress has not failed to act—Congress *has* acted and passed a statute—but the court can't or won't hear what Congress has said.

Jonathan Wiener I'd like to make three quick points—about timing, sticking up for the executive branch, and limiting principles.

The Pace of Congress

Jonathan Wiener We can point to some situations in which Congress has written an extremely long bill with lots of detail, yet the court says, "Even so, the agency does not have the authority, so it's back to Congress." An example is *FDA v. Brown & Williamson Tobacco Corporation* in 2000, in which the Supreme Court said, "No, FDA does not have the authority to regulate tobacco." Congress responded by enacting a new statute to give the authority more clearly to the agency—but it was still nine years later that Congress enacted the Family Smoking Prevention and Tobacco Control Act in 2009.

A more recent example is a little bit different. The DC Circuit held in 2017, in an opinion by then-Judge Brett Kavanaugh (when he sat on the circuit court), that EPA lacked the authority to regulate hydrofluorocarbons under Section 612 of the Clean Air Act—declining to defer to EPA's statutory interpretation under the *Chevron* doctrine. Congress then enacted new authority in the American Innovation and Manufacturing Act in late 2020, just about three years after the DC Circuit decision.

So, things can take a long time—Congress can be slow, and in some cases, new authority may never be enacted. This slow pace could result in the court sending "major questions" back to Congress as a blank slate, which can result in gridlock and inaction. That's why I mentioned earlier



Susan F. Tierney is the chair of the board of directors at Resources for the Future and a senior advisor at Analysis Group.

“What we're really talking about is a fight between the power of the court and the power of Congress.”

“What this means right now is that there's no rule in effect that governs greenhouse gas emissions from power plants under Section 111—not the Clean Power Plan, and not the replacement rule.”

the possibility of the presumption going the other way—as in the national security arena—in which the executive can act first, but then Congress can still exercise its role by ratifying or restraining that executive action. In that case, Congress has a policy to respond to, rather than dealing with a blank slate of no policy.

Executive Branch, Checks, and Balances

Jonathan Wiener In addition to the courts and Congress, we also have the executive branch—for good reason. Yes, Congress should be democratically accountable for passing laws, and the executive branch should take care that those laws are faithfully executed, as the US Constitution says. But the executive branch also performs the executive function of thinking through problems and making difficult policy decisions. I'm reminded here of Alexander Hamilton's advice in Federalist Paper 71, in which he says that a key reason we have an executive branch is that we don't want the government to reflect only the immediate "inclinations" of the general public—some complicated problems need to be thought through with "cool and sedate reflection," involving expertise and executive decisionmaking. So Hamilton says that, while the people "commonly intend the public good," they don't always know how best to do so—and we need the executive branch to think carefully, and at times to "save the people from the very fatal consequences of their own mistakes." I think all this is quite applicable here: neglecting pandemic disease or climate change, or designing policies with adverse effects, can be fatal mistakes.

That's not to say the executive can act without any authority. But if Congress already has delegated to OSHA explicitly in the statute the regulation of occupational risks, grave dangers, and new hazards, then OSHA could apply its expertise to a new hazard where its risk is heightened by workplace conditions—and Congress can then act to restrain OSHA—rather than the court disabling OSHA from regulating at all. And likewise, potentially, in *West Virginia v. EPA*.

Limiting Principles

Jonathan Wiener The nondelegation doctrine used to be understood as saying it's okay for Congress to delegate if Congress provides intelligible principles to the agency. A 3,000-page statute, as we've mentioned, would have lots of limits and conditions on what the agency can do—lots of instructions. In *NFIB v. OSHA*, Justice Gorsuch seemed especially displeased with OSHA's remark in its rule that OSHA has "almost unlimited discretion" to regulate occupational risks. The courts look for limits on authority delegated to agencies, in order to avoid excessive delegations (as in the Benzene case back in 1980).

During the oral argument in *West Virginia v. EPA*, it was noteworthy that US Solicitor General Elizabeth Prelogar specifically pointed out the limiting principles in Clean Air Act Section 111, such as the "best system of emission reduction," costs, non-air quality impacts, energy requirements, and the "adequately demonstrated" clause. And the word "best" in "best system of emission reduction" could include benefit-cost analysis, analogizing from the Supreme Court in 2009 in *Entergy Corp. v. Riverkeeper*.

Limiting principles might satisfy a court that sufficient constraints limit executive action, to ensure that the executive is being faithful to the legislation and is not going too far afield.

Endangerment Finding

Susan Tierney Can we read anything in the tea leaves about this Supreme Court with regard to the "Endangerment Finding"?

Lisa Heinzerling There's a strange and frustrating thing about the court's recent turn toward looking for major questions and, upon finding them, looking for extreme statutory clarity: Once the court has done so, it doesn't have to do anything else. It just says, "This is a big question. Congress didn't answer it clearly enough to our satisfaction. We're done here." So, the extensive scientific and technical bases for policies that we mentioned before become irrelevant, almost with a single sentence. Those cases on the



CDC’s eviction moratorium and on OSHA’s shot or test rule were incredibly brief. The Supreme Court got in, saw a major question, and got out.

I don’t think the court has to do anything with the Endangerment Finding in order to cut way back on authority to regulate greenhouse gases in an ambitious way. The reason is that the court is operating on a whole different plane. Justices may have their own views about climate change and the science behind it, but those views are not even relevant in these cases, because the court is operating at such a high level of generality and looking only at legal principles—not at scientific findings or even environmental risks.

I mentioned before that I think the court applies the major questions doctrine in a skewed way, by applying the major questions doctrine against regulatory programs that are ambitious, rather than against failures to regulate. Thus, in looking for a major question, they’ve always been looking at what the effect is on the regulated industry—and they don’t take into account the effect on the environment or on humans of denying regulatory authority. So, it’s even worse than you might have supposed: It’s not that the Supreme Court is going to undo the Endangerment Finding; I just don’t see that happening. What’s going on is the Endangerment Finding is irrelevant to the court in thinking through the statutory questions.

Reigning Supreme

Susan Tierney About the nondelegation doctrine: A limit constrains Congress in its ability to delegate power, when that power is applied to control the actions of private actors. Lisa, I’m intrigued by your comment just now about considering the effects on private actors versus effects on the environment or humans or the public interest more broadly—can you talk more about this focus on private action? And are the actions of individuals as citizens implicated under the umbrella of private action, or are we mainly talking about corporations and other organizations?

Lisa Heinzerling Based on my reading of things, the court recently has been quite careful

to talk about its worries about regulation—not its worries about nonregulation, nor weak regulation—that addresses significant problems and has significant economic and political consequences.

That’s where the nondelegation and the major questions doctrines start to look alike—both have a skew in the current court. And what the conservative justices seem to be worried about is the intrusion on liberty posed by government regulation. What I think they are *not* worried about is the intrusion on liberty posed by private people acting in ways that hurt other people, which the government might be able to step in and address.

Susan Tierney The United States has three equal branches of government. But from what I’m hearing you both say, the Supreme Court is “acting supreme,” in some sense. Do you have thoughts on that?

Lisa Heinzerling I think your question cuts to the heart of the fear that many of us feel about the Supreme Court. In a sense, the court is “acting supreme,” but the harder the Supreme Court makes it for Congress to pass legislation that the court is satisfied with, then the more the Supreme Court appears to be its own “supreme” entity within the government. And the court has gotten very aggressive recently—we’ve seen this with its shadow docket, and we’re now seeing this with its regular docket. The court has been very aggressive about taking cases, keeping cases that might not have an injury to support justiciability, and pushing back on the power of Congress. Congress under the US Constitution is supposed to be the first and main branch, right? These are decisions that strike at the power of Congress.

Jonathan Wiener I’ll just note that RFF University Fellow Nathan Richardson wrote a detailed historical article with a powerful critical argument, called “Antideference,” about exactly this point. He describes the history and reasons for the evolution of the major questions doctrine, in the way the doctrine has been deployed during the last year in the CDC eviction moratorium case, the OSHA vaccination and testing case, and perhaps in *West Virginia v. EPA* about the

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The United States has three equal branches of government. But from what I’m hearing you both say, the Supreme Court is ‘acting supreme,’ in some sense.
”

[The social cost of carbon] ... has the power, potentially, to change the direction of the agency regulatory proceedings—or at least the magnitude of the regulation that the agency embraces.

Clean Air Act. He argues that this evolution of the doctrine speaks more and more to a kind of judicial supremacy or judicial activism.

In *NFIB v. OSHA*, it's interesting to see how, even though Justice Gorsuch concurs with the denial of OSHA authority, and Justice Stephen Breyer speaks for the dissenters who would have recognized the authority in OSHA, they both conclude on exactly the same point. Justice Gorsuch said, “The question before us is not how to respond to the pandemic, but who holds the power to do so. The answer is clear ... that power rests with the states and Congress, not OSHA.” By contrast, Justice Breyer concluded his dissent, “Underlying everything else in this dispute is a single, simple question: Who decides how much protection, and of what kind?”

But then Justice Breyer goes on to say that the methods we use to address a pandemic should be a choice between the expertise of the agency authorized by Congress, versus the court and the judges. And Breyer cites a previous opinion by Chief Justice John Roberts when he says, “And then, there is this court. Its members are elected by, and accountable to, no one. And we ‘lack the background, competence, and expertise to assess’” these complex risks. And Breyer goes on to say, when we (the court) are wise, we know when to defer to experts. “Today, we are not wise.”

I think in that question about the judicial branch versus Congress, the majority seems to be saying, “Congress has to make these decisions. Force Congress to be democratically accountable.” But the near-term result is to disable the executive, and Justice Breyer would have recognized the authority in the executive.

Catch-22 for Congress in Court Cases

Susan Tierney I want to call everyone's attention to Nathan Richardson's question in the audience. He essentially asks whether all of this is setting up a catch-22 situation: The court is saying that Congress has to be very clear—but any delegation that's clear enough to satisfy the major questions doctrine could

be a violation of nondelegation criteria. Do you think the Supreme Court's requirement for a clear statement from Congress in the major questions cases is something Congress could realistically satisfy? Or is any delegation that's clear enough to satisfy the major questions doctrine itself a violation?

Jonathan Wiener In *NFIB v. OSHA*, Justice Gorsuch's concurring opinion has a sentence in it that says, “This lone statutory subsection does not clearly authorize OSHA's mandate”—meaning that the delegation of authority is not clear enough, so under the major questions doctrine, the question has to go back to Congress.

But even if the delegation *were* clear, he hints that it would be excessive delegation. As Gorsuch wrote: “On the one hand, OSHA claims the power to issue a nationwide mandate on a major question but cannot trace its authority to do so to any clear congressional mandate. On the other hand, if the statutory subsection the agency cites really *did* endow OSHA with the power it asserts, that law would likely constitute an unconstitutional delegation of legislative authority.” And in the climate change context, what would that look like? What kind of law could Congress write to satisfy at least this one point of view on the court?

Hypothetically, if the Supreme Court majority in *West Virginia v. EPA* were to decide that Clean Air Act Section 111 has to be interpreted narrowly, such as inside the fence line, and if they go further to decide that Congress did not clearly delegate the control of greenhouse gas emissions to EPA, because that's such a major question (which would, by the way, be overturning the *Massachusetts v. EPA* case that Lisa won)—then what? Could Congress write a new law, which might run into the same catch-22 we're mentioning? Or is there a way that Congress could regulate greenhouse gases without delegating to an agency—such as by enacting a carbon tax directly in the statute? (In the oral argument in *West Virginia v. EPA*, Justice Kavanaugh alluded to Congress having enacted the acid rain trading program directly in the 1990 statute.) I don't know how to estimate the likelihood of that

kind of law, but I'd be curious to know what Lisa thinks.

Lisa Heinzerling I think there are two separate questions. One: Is there any clarity that's good enough for the Supreme Court, regardless of whether there's a catch-22? I really don't know. Because if you look at the OSHA statute, it feels like it fits the pandemic really well. And there's no doubt that the standard applied only to workplaces. The notion that it wasn't clear enough in allowing workplace standards during the pandemic strikes me as signaling that the court isn't really hearing what Congress is trying to say.

On the catch-22 question: If Congress speaks clearly and says, “We see the following major decision that needs to be made, and we are going to hand it over to the agency with complete crystal clarity,” then Congress could get into trouble for being so clear in handing the decision over. I think the opinions in nondelegation cases that haven't yet matured into a holding from the majority suggest that Congress needs to be clear—not just in handing over power to the agency, but actually in making the major decisions itself.

Susan Tierney Listening to you in this conversation is giving me pause as I think about the new proposed regulations from the US Securities and Exchange Commission on climate disclosures.

Social Cost of Carbon Holding Court

Susan Tierney Is the social cost of carbon likely to come up in a case before the Supreme Court? If so, what do you anticipate would be the result, given the makeup of this court?

Jonathan Wiener I would have thought that it would depend on the statute and the specific posture in which the case comes to the court. I think the decision by the Louisiana court was premature, because there was not a rule under a specific statute yet that might cause harm to the plaintiffs and for the court to review—and that's effectively what the US Court of Appeals for the Fifth Circuit said.

The case in Louisiana, at least in the first round, was based in part on whether the global social cost of carbon can be used by federal agencies, as opposed to a domestic-only social cost of carbon. The court cited the initial section of the Clean Air Act, which refers to its purpose of protecting “the nation”—so, some people have argued that means EPA can consider only impacts in the United States. But on the other hand, other provisions of the Clean Air Act speak more broadly and apply to international and global environmental impacts. We could have a debate about what the Clean Air Act says. The National Environmental Policy Act, in Section 102(2)(F), tells all federal agencies to consider “worldwide” impacts and “international cooperation.”

The court also looked to OMB Circular A-4, which gives guidelines to federal agencies on how to do benefit-cost analysis. Issued in 2003 and still in force today (but possibly soon to be revised), OMB Circular A-4 contains two sentences about domestic versus global impact—but those sentences don't say to focus only on domestic impacts; they say to focus on domestic impacts *and* to report impacts outside the United States. And a recent op-ed by RFF Visiting Fellow Arthur Fraas—alongside John Graham, Randall Lutter, and Jason Shogren—says the federal government should look at both domestic and global impacts of the social cost of carbon.

All of this poses an interesting question for those at RFF and elsewhere, who estimate the social cost of carbon: Can a global *and* domestic set of impacts be readily estimated in the social cost of carbon calculations?

One might have thought—under the Administrative Procedure Act of 1946 and a whole series of cases that goes back to at least 1983 in a case about automobile airbag rules called *Motor Vehicle Manufacturers Association of the United States, Inc. v. State Farm Mutual Automobile Insurance Company*—that agencies would be obligated to consider the full impacts of their decisions, and it would be arbitrary to omit an important impact. And indeed, just two years ago, regarding the citizenship question in the census case of *Department of Commerce v. New York*, Justice Breyer wrote an opinion

saying that, in his view, it's arbitrary under the Administrative Procedure Act to omit an important impact. So, it would be curious for the Supreme Court to say that the agency has to neglect an important impact as a general matter of agency regulation. From this point of view, an effort to estimate an important impact, like the damages from climate change, ought to be in—not out.

Lisa Heinzerling The Louisiana district court decision is a little bonkers on the social cost of carbon, for a variety of reasons. There's something a little crazy about saying that there's justiciability now, talking about OMB Circulars as if they can't be undone by later interagency documents that address the same questions, and for all sorts of other reasons. But there's a nub of sense, which I worry about going forward. It is the kind of case that the justices might be interested in, but we're a long way from any real controversy over the social cost of carbon and its injuries to people.

The estimate of the social cost of carbon is a weird kind of decision. It's supposed to be used in all rulemaking proceedings, and it has the power, potentially, to change the direction of the agency regulatory proceedings—or at least the magnitude of the regulation that the agency embraces. And in that case, I do think the government would be well advised to take administrative procedures seriously and to effectively treat this as a rule by going through notice and asking for comments.

Jonathan Wiener I'll just quickly corroborate what Lisa just said, by adding that the Trump administration lost many cases in court—a much higher percentage than other administrations—often because they skipped steps in the administrative process. And courts may well be watchful for that now as well.

Susan Tierney Thank you, Lisa and Jonathan, for sharing your expertise. This is a time of huge uncertainty. As a student of federal policy, state public policy, and regulation in this area, I feel as though we're gravitating toward a place we've often been—where states do their own form of regulation in a patchwork of approaches that may cause the regulated industries to ask for regulation nationally. ■



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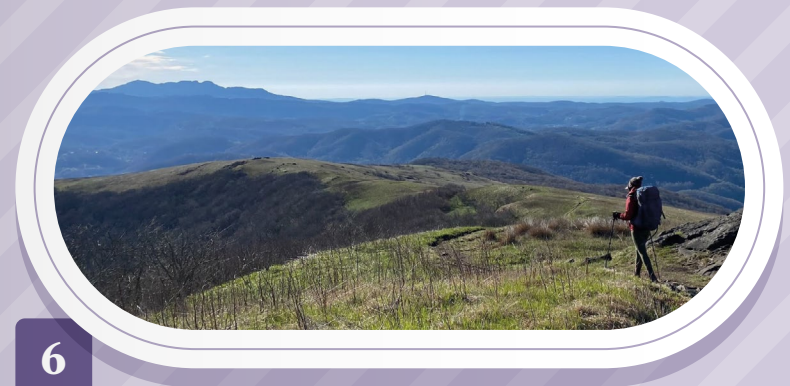
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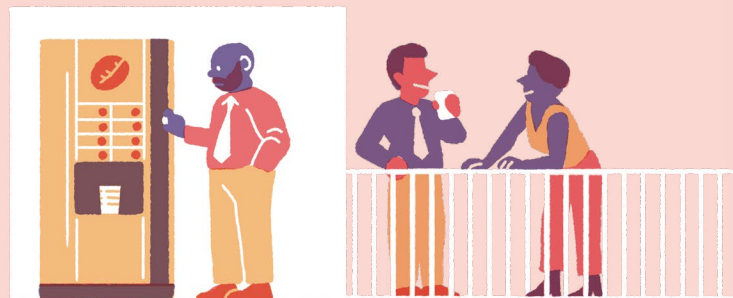
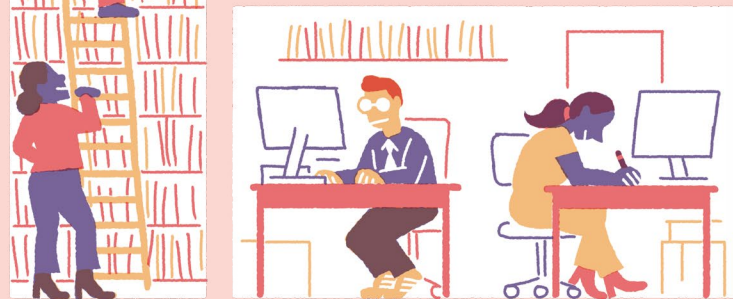
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Making Memories with #MyResources

Resources magazine is possible because of Resources for the Future (RFF) researchers and staff—and pets that keep scholars and staff cuddled. Also very important: the children of RFF, who help drive the organization's mission, as their parents are working hard to help ensure a healthy environment and thriving economy for the next generation.

- 1 Filson shows off the new signage at RFF headquarters.
- 2 Nico patiently explains an admittedly complex chart to his papa, RFF Postdoctoral Fellow Luis Fernández Intriago.
- 3 Carolyn Mollen, RFF's VP for finance and administration, hikes with her daughter, Penny, at Antelope Island State Park in Utah.
- 4 Crosby—son of Shannon Wulf Tregar, RFF's VP for development and institutional strategy—is one of RFF's most enthusiastic supporters.
- 5 RFF Fellow Marc Hafstead thinks about environmental economics while he slides down ski slopes.
- 6 Annie McDarris, RFF media relations associate, makes sure that the environment features heavily in her work and play.
- 7 Rudy nose that Resources Fur the Future makes much joy pawsible for his two-legged friend, RFF Unifursity Fellow Robert Stavins.
- 8 Archie purr-uses an issue of Resources magazine.



A Day in the Life at Resources for the Future

Resources for the Future (RFF) first and foremost is a research organization—which means that it’s typically the researchers who are the focus of the work and attention at RFF. But on one fateful day, *Resources Radio* podcast hosts Kristin Hayes and Daniel Raimi did something pretty different from their usual podcast routine: they gave listeners a flavor of what RFF looks like today, across the spectrum of the organization.

A lot happens behind the scenes at RFF, and many fantastic contributors help get the work done. This quite spontaneous episode involved wandering from office to office, tapping people on the shoulder to hear their thoughts, with precious little advance notice. Read on to hear from a collection of voices about how many different people help make RFF work.

INTERVIEWS Daniel Raimi and Kristin Hayes

ILLUSTRATIONS Vincent Sorel



Resources Radio, a podcast launched in late 2018 and produced by the *Resources* editorial team, releases new episodes weekly with hosts Daniel Raimi and Kristin Hayes. Each episode features a special guest who talks about a new or interesting idea in environmental and energy policy.

These interviews were recorded in February 2022 and broadcast in May 2022. The transcripts of these conversations have been edited for length and clarity. Interviews by cohosts Daniel Raimi (DR) and Kristin Hayes (KH) are indicated in the text.



“ I love that I get to talk to people, and I especially love the HR aspects and some of the work we’ve been doing to try to help RFF become an organization where everybody will want to work. ”



Carolyn Mollen

Hi there! I’m the vice president for finance and administration at RFF.

I have been working here for just over two years. I started in December of 2019 and was here for a whole three months before we went fully remote thanks to COVID.

KH: I’m sure that was a very “fun” time in which to figure out everything about the IT infrastructure, human infrastructure, and policies! We’re grateful that you led us through this very challenging time. Can you talk about your role here and what you’re responsible for?

I oversee the internal operations at RFF. We own our building, so everything dealing with the building, tenants, and our own office space; human resources and everything that comes under that; IT; and, of course, finance and accounting and all the budget and financial reports. It’s a lot!

Of all the things you work on—and there are many—would you say there’s something that you find particularly enjoyable about your role? Maybe something that stands out

to you, or something particularly interesting about your work?

I really love the “people” aspect of my job. I’m a Certified Public Accountant—and while accountants tend to be introverts, I’m an extrovert. I love that I get to talk to people, and I especially love the HR aspects and some of the work we’ve been doing to try to help RFF become an organization where everybody will want to work.

The theme of our podcast episode today is “a day in the life.” What are you working on today, given the millions of things that it sounds like you could be working on?

Today is actually a funny day. I spent my morning switching offices because one of the things we’ve been working on is getting the office ready for everyone to come back. And that means assigning offices to all the people who have joined us in the last two years. So, I got to move, and this is my first day in my new office. ■



Anagha Komaragiri

Hi, I'm a communications associate at RFF.

I mostly focus on RFF's publications and make sure that our research is condensed and conveyed in the most effective way possible. That involves playing with new visual formats, new structures, and new styles of publications that we want people to read. It's been exciting to brainstorm new ideas for publications.

KH: What have you been up to today?

I've mostly been big-picture planning for the next month of publications at RFF. I've also been thinking about how to get RFF's annual report, which we've just wrapped up, on our website and designing the webpage—just thinking through how to present it creatively. On top of that, I've also been designing some figures for a handful of reports that we're about to release in the near future—actually getting into the weeds on some graphs and charts here and there.

Tell me one thing about your job that you've found particularly fun, interesting, or surprising in your first six months here at RFF.

I would say that something I've been surprised by is how much creative agency I have in this role. I've really liked having the opportunity to come up with ideas, and I feel like I'm playing a pretty important role on our team and making decisions for how RFF's content is displayed to the world. ■



Aline Philpott

Hello, I'm a desktop support associate at RFF.

KH: How long have you been with us at RFF?

I've been working here since April 2021. Basically, a year.

So, you have experienced RFF largely during the pandemic?

Yes. I've been coming to the office often since I started here—at least a couple days a week. So, I've pretty much met everybody because I work for IT, and I handle the laptops for the new people.

It's somewhat rare during the pandemic to have met so many folks. That shows how central the IT team is to the operations of the organization.

Yeah, thank you. It's been great working at RFF. I enjoy it very much. And, hopefully, now that the office is going to open soon, it'll be more fun to interact with more coworkers. ■



Mun Ho

Hi there, I am a visiting scholar at RFF.

I work with the Harvard-China Project, but I live in Washington. So, I come to this office to work with colleagues.

KH: How long have you been associated with RFF?

I've been here since 1999, except for four years when I was abroad.

Can you talk about the scope of your research and what's of interest to you?

I've been doing a lot of work on US energy and carbon policies, and I've also been doing the same thing for China. My current research is focused on Chinese issues—Chinese electricity policy and carbon policies.

So, the big question of the day is: What are you working on today?

Today, I'm trying to debug a computer programming problem with my China model. I've been sweating—quite literally sweating—because I've been struggling for the past three days with a bug in the model! ■



Matthew Wibbenmeyer

Hello, I'm a fellow at RFF.

KH: Research fellows, of course, are the backbone of everything that happens here. How would you characterize the role of a fellow at RFF?

We work on environmental economics and policy-related questions that are intended to make an impact on policy and decisionmaking. I think what I like the most about working at RFF is just how varied the job is. In a given week, I may be working on four or five different projects, writing, doing analysis, and having meetings with other researchers or policymakers or funders.

What have you been working on today?

I attended our climate resilience impacts and adaptation meeting in the morning. And then I had a couple of research meetings this afternoon, looking at environmental justice issues related to the allocation of fuel treatments for wildfire risk reduction—and another project that's looking at household residential location decisions across wildfire-risk areas.

How do you decide what's going to be your next big undertaking?

In the case of one of the projects I mentioned, we were approached about an extension to a previous project that we had been working on, for a presentation at an academic conference. That's how that project got started. ■



Andreea Culian

Hi, I'm the director of corporate engagement at RFF.

I get to sit at the intersection of our corporate donors, partners, and RFF's work. So, I have my ears perked up to what RFF is doing, our latest research, and the emerging issues that we're thinking about—because RFF really sits at the cutting edge of the future, and companies are part of what we're working on. We don't just work in a bubble or in a lab by ourselves—we work together with the marketplace, and companies are part of where we need to move forward, advance, and make progress.

Just yesterday, I was in a call with one of our donors and Joshua Linn, a senior fellow in RFF's Transportation Program. And they were geeking out on one of the data tools that they developed and going very deep into the analysis. It was such an honest discussion that, at the end of the meeting, the donor basically said, "We appreciate this conversation, because you all at RFF are really trying to ask the right questions." I hear that over and over, every single day, which is inspiring.

And it's good to see that our corporate partners understand that RFF's research is independent. We accept funds to support our work, and we are very clear that that cannot influence the outcome of the research—the research is what it is. And that's something we put up front in the conversations, so there's no confusion. There's great appreciation around that.

DR: Andreea, as we burst into your office and interrupt your day, what are you working on right now?

Every day is different, which is what makes the job so exciting. Right now, I'm working on preparing RFF's president, Richard Newell, for his upcoming trip to CERAWEEK, which is the largest conference of energy professionals.

Yeah, it's like the Energy Super Bowl.

Exactly! So, I'm working on preparing meetings and connections for Richard to make while he's there, which is challenging—it's a sea of people attending the event, so we have to be strategic. ■

“**We work on environmental economics and policy-related questions that are intended to make an impact on policy and decisionmaking.**”

”



Billy Pizer

Hello there, I'm the vice president for research and policy engagement at RFF.

KH: How long have you been at RFF?

I originally came to RFF in the fall of 1996, right after I finished graduate school with my PhD in economics. I started again at RFF in May 2021. So, this is my second time around. And I assumed the role of vice president for research and policy engagement in September 2021.

I know this is going to be a tricky question, because you have a wide set of responsibilities, but tell our listeners about your role.

The main thing about my role here is trying to help the research staff formulate and execute a research agenda that is intellectually interesting, relevant for policymaking and decisionmakers, and can be presented in ways that reach our audience so they can assimilate the information. It's really working with the research staff to formulate the strategy for research at RFF.

I'm spending a lot of time, right now, trying to recruit new people to RFF, because we really want to expand the research staff. And then there's lots of little bits and pieces about trying to make the organization run more smoothly, efficiently, and effectively.

What, of those many things, are you working on today?

All of them. Seriously—my day has been all over the place. I had a morning meeting where I heard about new research that Margaret Walls and Penny Liao are doing, looking at the impacts in coastal regions of rising sea levels and how that's affecting businesses. So, I got to hear about new research. I got to explain prospective research to funders. We also had a policy conversation about making our models open source, which I think is a great idea but has complications. So, lots of little pieces. I think one of the reasons I really like the job is because it jumps around a lot. I'm never bored.

I think the thing I really like about my role at RFF is helping the researchers do what they enjoy doing, which is doing research that's policy relevant. To the extent I can help them figure out how to do that better—that's incredibly gratifying. I think the other thing that's kind of cool (and I was actually just thinking about this the other day) is that I get to learn about a lot of things. I have my little areas of research that I've focused on for 25 years, and I know a lot about that stuff, but I don't know that much about sea level rise and employment on the coast, or wildfires, or electricity modeling—and I get to learn about all that stuff and try to be a little bit knowledgeable about all of it through this job. ■

An interview at home with Billy Pizer's 12-year-old son, Micah Pizer.

Billy Pizer: Okay, I'm going to make sure this recorder works by interviewing you. What's your favorite musical instrument?

Electric guitar.

Really? How long have you been playing the electric guitar?

A month or two.

Do you find that having braces now interferes with your ability to play the electric guitar? Does it make you play better or worse?

No.

No effect whatsoever. Okay, have you noticed any other consequences of wearing braces?

Yeah; my teeth are aching a lot, and it's really uncomfortable.

Okay. We'll have to work on that. Thank you so much. This has been a great interview.



Luis Fernández Intriago

Hello, I'm a postdoctoral fellow at RFF.

DR: We're basically barging in on people and asking them what they're doing—like, right now. What are you working on today?

We're giving some consultancy to New York State. We're tweaking a model and getting it ready to replicate—the best that we can in the actual state of the economy—so we can give the best policy advice to them.

Where did you grow up? How did you get interested in environmental issues?

I grew up in Mexico City. It's well known that it's really polluted. But I started working on environmental issues later in my PhD. I started out as a labor economist, more focused on understanding the macro effects on labor markets and things like that. I took a really interesting class on environmental economics during my PhD—and that was basically what changed my life. I already understood that we need policies to make the environment better, to have clean energy, and all these things that we are discussing right now—but at the same time, these policies may come at a cost for some workers and industries. I wanted to understand how we can find a balance; ease the transition; and help get a little bit of what, in economics, we call a “double dividend”—to try to see if there's any way to leverage economic tools to make the environment better while hurting the smallest number of people possible.

What's something about your job at RFF that you enjoy?

The thing I like most about my job is using my tools and training to try to influence policy and better decisionmaking. I remember, when starting my undergrad, that I wanted a profession in which I could have the most impact. And when I chose to be an economist, I was worried that I wouldn't be able to have a big impact. When I decided to be an economist, I told my father—who is a surgeon—that I was worried about the impact that I could achieve, and I stressed the fact that I wanted to affect policymaking. He told me something that was really reassuring: he said that, by being an economist and by working in policymaking, I could potentially affect many more people with a single good policy than all the patients he could treat in his whole career.

So, working here at RFF, being able to advise federal and state governments, helping design policies that balance environmental and economic improvements, and all these things—I think it's incredible. Using my tools and everything that I've learned to influence policymaking—I think that's the best part of my job. ■



Sarah Tung

Hi, I'm the communications and events manager at RFF.

DR: You are a woman of many hats. When we stepped in to bother you, what were you working on?

I just stepped out of a meeting with one of our researchers, who's working on putting together a private workshop. We were just chatting about the list of potential speakers for that, so that's top of mind for me today. I'm also working on getting our annual report printed and mailed to RFF's supporters.

How did you end up coordinating events here at RFF?

I joined as part of the marketing and events team; my primary background is in communications. But in this new role that I stepped into late last year, I've been taking more of a guiding and strategic role with putting on events. I think something I enjoy about working on the comms team is—like you said, I wear many hats on the job, and that's something that can be really fun.

In addition to the fact that I feel like I'm learning a lot from the research that we put out, I also feel that, similarly, I get to learn a lot on the job because I wear so many hats. It's always different, every day, depending on what we have going on. One time, I got to help with putting together an infographic; another time, I got to help with drafting a press release. Every day is always a new day. ■

I'm digging through all the literature I have stored on my computer, and googling around, trying to find exactly the right publications to cite for these statistics.



Margaret Walls

Hello, I'm a senior fellow at RFF.

DR: We're just popping in today to see what you're up to. What are you doing right now?

We're working on a couple of explainers (which are popular RFF publications) on flooding. So, I've been going back and forth with Donnie Peterson (RFF's communications and events associate) about flooding trends in the United States over the past couple of decades. I'm digging through all the literature I have stored on my computer, and googling around, trying to find exactly the right publications to cite for these statistics.

What kinds of metrics can we use to understand who might be more vulnerable and more exposed to different risks?

When we think about flooding or any kind of disaster impacts, we talk about "risk" as the hazard itself—the likelihood of an event happening, the exposure in the area that's at risk, and the vulnerability of the population. Vulnerability is your ability to "weather the storm," and poorer people tend to live in flood-prone areas—that is a fact—and they tend to

be less likely to have flood insurance. Study after study shows that flood insurance is really important for recovering from these events. And these folks also might have underlying health conditions and so forth that make them at risk. Where are those places in the country? Some are coastal; some are riverine areas, where there's river flooding. We map the floodplains in the country. We know something about where those flood risks are, and we tend to find more vulnerable people in most of these locations (setting aside those right-on-the-coast, high-end properties, which also are at risk).

What are the key things you want people to take away from the flooding explainers?

The explainers are going to describe what flooding is, where it comes from, what the trends are, how climate change is changing it, and what the impacts are. There will be two explainers. One will be a fact-based description of what kind of flooding there is and what the impacts are, and the second one will be about the policies that can address the problem. ■



Maya Domeshek

Hi there, I'm a senior research analyst at RFF.

KH: You've been here for several years. Tell me what a senior research analyst role entails.

Research analysts tend to do the coding and grunt work of the research that occurs at RFF. I work on two different models that we use for our research, and my job is mostly maintaining those models.

Maya, I'm just going to go ahead and say that I think you've dramatically undersold yourself in that introduction. I know for a fact that you are an incredible contributor to the research, and you also spend a fair bit of time discussing that research with policymakers! What are you working on today?

One of the things that I work on is an electricity model called Haiku, which represents the US electricity sector at an aggregate level. It's a long-term planning model that helps us think about how the electricity sector might change over time. Today, I'm working on calibrating that model and making sure that we represent projections of renewable electricity usage correctly.

What's one thing that you would highlight as something that's particularly enjoyable or interesting about your job here at RFF?

I particularly enjoy coming up with new projects. I haven't been here quite long enough to come up with a lot of projects, but I have been around for the start of some projects, when we were able to frame some of the questions—in one case, about the relationship between climate policy and public health. For instance: What's a useful takeaway? What questions are worth asking? ■

Podcast host Daniel Raimi becomes the interview subject.

Sarah Tung: Maybe we should flip the script, and I should ask you some questions.

All right—bring it.

Using only sounds from your mouth, can you recreate the Resources Radio theme song?

[Wild mouth sounds.]

For the music nerds out there, that opening is called a "hemiola"—which means that the musical phrase sounds like it's in a different time signature than it's actually in. It sounds like the song is in the time signature of three-four, when it's actually in four-four time.

But yeah, I worked for about three years writing music for films and TV shows before I went to grad school and studied energy policy.



Combating Climate Change with Economic Incentives

Resources magazine recently spoke with Resources for the Future (RFF) Board Member Bob Litterman, who over the course of his career has worked as a researcher at the Federal Reserve Bank of Minneapolis, an economics professor at MIT, an executive at Goldman Sachs, and founding partner of global asset management firm Kepos Capital. Below are excerpts from the conversation, which covered the role of incentives in motivating climate policy, environmental justice concerns, and more.

What drives your interest in applying economics to environmental challenges, such as reducing emissions and tackling climate change?

When I went into economics, my motivation was to understand human behavior. If you want to understand human behavior, you need to understand incentives. With the right incentives, eight billion economic agents make the right decisions, given the prices that they see. But if you have the wrong incentives, then you have eight billion people making the wrong decisions, creating too much pollution and destroying the welfare of future generations.

Globally, we are not creating appropriate incentives to reduce emissions. The United States, I would argue, is by far the worst agent here, because we are a wealthy society that can afford to do better, and we haven’t done anything. That’s what gets me so passionate about this issue.

What originally brought you to RFF?

It was Larry Linden who pulled me in. Larry was head of operations at Goldman Sachs, and I was head of risk management, so he and I worked closely together and became good friends. It was Larry (then an RFF board member) who



Supporter Spotlight

In this RFF Supporter Spotlight feature, we hear directly from donors about their commitment to issues in climate, energy, and the environment; how they make a difference; and why they support Resources for the Future—all in their own words.

“**To this day, if I have questions about economics of the environment—in particular, climate—RFF is the place to go.**”



IMAGE
Jake Armour for Minneapolis Fed

one day in 2006 or 2007 asked, “Bob, are you interested in the environment?” I remember saying, “I’m very concerned about climate risk, and the reason is that we’re not pricing the risk. It’s obvious that greenhouse gases are creating pollution. But we’re not putting a price on those, and therefore, we’re creating too much.” Larry’s response was, “The problem is that none of the economists know where to price emissions.”

I took that as a challenge. I started reading the literature and applying the mathematics. Larry told me about RFF, the role it plays, and all the good economists there. He basically told me it’s the best economic think tank on the environment in the world. Naturally, I thought I should talk to them; they know what’s going on. Larry then introduced me to various folks working on climate at RFF.

Do any issues stand out to you today as being particularly challenging, and which RFF is especially poised to help address?

RFF has done a lot of work on flood insurance and federal subsidies of flood insurance. The economic reality is that if you don’t price risk, more people are going to live in risk-prone areas,

and then you’re going to have more damage. Now, with climate change, we’re going to see more flooding, more wildfires, more disasters. The poor people who live in some of those disaster-prone places didn’t cause this problem, but they can’t afford to live there anymore. Insurance rates are going up, so what does that mean? It’s a big issue for society as a whole.

Recognizing your generous support of RFF, do you have a “philanthropic philosophy”? How does RFF fit into it?

Some people worry about whether you should focus your philanthropy very narrowly. For me, it was a little bit opportunistic. When Larry brought me to RFF, I found it very rewarding. I was learning a lot, and I felt it was my responsibility to give back financially and by joining the board.

What do you think sets the RFF community apart?

RFF is by far the leading economic research institute on the environment—and when I say that, I’m talking about the people. For me, engaging with RFF is a way to learn and to interact with people. And to this day, if I have questions about economics of the environment—in particular, climate—RFF is the place to go. ■

Four Ways You Can Support RFF



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3 Give through a donor-advised fund

Donate through a DAF account at a community foundation or financial institution to support RFF while receiving favorable tax benefits.



4 Give through a will, trust, or gift plan

Include RFF in your estate plans to provide meaningful, long-lasting support.

Discover other ways to give at rff.org/waystogive or contact Tommy Wrenn at twrenn@rff.org



What's at the Top of Your Stack?

A recurring segment on *Resources Radio* is "Top of the Stack," when podcast hosts Daniel Raimi and Kristin Hayes ask each guest what is on the top of their literal or metaphorical reading stack. Here's a selection that gives an idea of what folks at Resources for the Future are reading and enjoying.

"I've been poring through this book about California agriculture. The 1902 Reclamation Act provided federal funding for water development in California, with the promise of land for small family farmers—but that promise was never fully realized. Wave after wave of immigrants from China, Japan, the Philippines, and Mexico—and then Depression-era migrants from Middle America—came into the state and were played against each other. This book looks at the role of scholarship in critiquing and engaging California industrial agribusiness and the effect of the conglomeration of landholdings on communities and workers. Two of the eight scholars covered in the book, Isao Fujimoto and Don Villarejo, influenced me as mentors when I was an undergraduate at the University of California, Davis. It's a great story that illustrates how research can stay engaged with the values that brought us into this field of work in the first place."

Dallas Burtraw
Darius Gaskins Senior Fellow



The Splendid and the Vile by Erik Larson

"This book is about Winston Churchill and the Blitz in Britain. It's an extraordinary story of leadership at a time of crisis. It gives you hope for democratic processes and leadership."

Susan F. Tierney
Chair of the RFF
Board of Directors

In The Struggle by Daniel J. O'Connell and Scott J. Peters

"*The Biggest Little Farm* is a documentary about sustainable agriculture. It portrays the saga of a family that starts an organic farm by converting an old farm north of Los Angeles into a farm that has livestock, fruits, and vegetables. You see a lot about the vulnerabilities of farms and the resilience of sustainable farms to weather. And there's a lot of interesting lessons about integrated pest management, the virtues of crop diversity, and the role of ground cover. It's an inspiring story."

Karen Palmer
Senior Fellow

The Biggest Little Farm Dir. John Chester



The Cure for Catastrophe by Robert Muir-Wood

"The book is full of lovely, illuminating stories. I'll share one anecdote: A girl was in Thailand on vacation with her parents when a large tsunami came. They were out walking on a beach, and she looked at the ocean—she had just taken a disaster education curriculum—and said to her parents, 'I think a tsunami's coming; the ocean's not supposed to look like that.'"

To calm her down, her dad took her into the hotel. A Japanese gentleman looked out at the ocean and said, "That is absolutely a tsunami coming. You have to clear the beach immediately." It was one of the only places in the country where no one died. I think that is such a profound story for how important it is to raise awareness about these issues, even starting at the young age of children—and maybe also a story about trusting our kids and their knowledge."

Carolyn Kousky
University Fellow



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“
It's a great story that illustrates how research can stay engaged with the values that brought us into this field of work in the first place.
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