



Maureen L. Cropper

Annual Review of Resource Economics

A Conversation with
Maureen Cropper

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Annu. Rev. Resour. Econ. 2019. 11:1–18

First published as a Review in Advance on
May 17, 2019

The *Annual Review of Resource Economics* is online at
resource.annualreviews.org

<https://doi.org/10.1146/annurev-resource-100518-093858>

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JEL codes: Q50, Q51, Q53, Q54, Q58

Keywords

environmental economics, women in economics

Abstract

This article presents an interview with environmental economist Maureen L. Cropper. Maureen completed her Ph.D. at Cornell University and subsequently held positions at the University of California, Riverside, and the University of Southern California. At Riverside, she moved from monetary economics to environmental economics. She then landed at the University of Maryland, where she is still a professor. She has taken on leadership roles in numerous institutional settings, including the US National Academy of Sciences and the US Environmental Protection Agency (EPA) Science Advisory Board. Her contributions to environmental economics have been groundbreaking and extensive. Together with many collaborators—including former students and colleagues at the University of Maryland, World Bank, EPA, and Resources for the Future—Maureen has produced a body of work that spans theory, methods, and empirical applied economics. Her work covers the environment, energy, climate change, and transportation in both the United States and developing countries.

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INTRODUCTION

Maureen Cropper is an environmental economist whose career has spanned five decades. She has spent the majority of her career at the University of Maryland, but has also been a faculty member at the University of California, Riverside and the University of Southern California (USC). While at Maryland she has also served as a lead economist at the World Bank and as a Senior Fellow at Resources for the Future (RFF).

Maureen has made important contributions to several areas of environmental economics, including nonmarket valuation and the evaluation of environmental programs. She has also conducted pioneering studies on household transportation use and associated externalities. Although much of this research has been conducted in the United States, Maureen has published 20 articles on environmental issues in developing countries, including India, China, Thailand, and Ethiopia.

NONMARKET VALUATION

In the area of nonmarket valuation, Maureen's best-known work is on the valuation of health outcomes, especially premature mortality. A stated preference study to value reductions in risk of death among adults in Canada and the United States, which she developed with Anna Alberini, Alan Krupnick, and Nathalie Simon, was subsequently administered in other countries throughout the world (Krupnick et al. 2002, Alberini et al. 2004). The US and Canada studies have helped to determine the Organisation for Co-operation and Economic Development's (OECD) value of statistical life (VSL) (Lindhjem et al. 2010), and the Canada study formed the basis for Canada's VSL, which varies with age. Maureen's work with Alan Krupnick using risk-risk trade-offs to value chronic bronchitis risk (Krupnick & Cropper 1992) continues to form the basis of the US Environmental Protection Agency's (EPA's) valuation of cases of chronic bronchitis avoided by air pollution regulations.

In an international context, Maureen's study of the VSL in Delhi, India (Bhattacharya et al. 2006) is the first published stated preference study of the value of mortality risks for India. Her publications with Dale Whittington and others on valuing malaria in Ethiopia (Cropper et al. 2004) and respiratory morbidity in Taiwan (Alberini et al. 1997) were also among the first health valuation studies published for these countries.

In terms of revealed preference studies, Maureen and coauthors have helped to advance hedonic methods and the use of discrete location choice models to value local amenities. In a highly cited article with Leland Deck and Ted McConnell (Cropper et al. 1988), simulations of housing market equilibrium, using data for Baltimore, Maryland, were used to determine the impact of the form of hedonic price function on the accuracy of estimated marginal willingness to pay for housing characteristics. A follow-on article (Cropper et al. 1993) compared the ability of hedonic and discrete choice approaches to capture preferences for housing characteristics using simulated data.

More recent papers with Paramita Sinha and Martha Caulkins (Sinha et al. 2018) have used random utility models of residential location to value climate amenities in the United States—with an emphasis on taste sorting—and have contrasted results obtained using discrete choice and hedonic models.

EVALUATION OF ENVIRONMENTAL PROGRAMS

In a series of papers in the early 1990s Maureen and coauthors examined the factors explaining various EPA rules—the decision to ban or not ban a pesticide under the Federal Insecticide,

Fungicide, and Rodenticide Act (FIFRA) (Cropper et al. 1992b), the decision to use more permanent versus less permanent methods to clean up Superfund sites (Gupta et al. 1996), and decisions to ban various uses of asbestos under the Toxic Substances Control Act (TSCA) (Van Houtven & Cropper 1996). The goal was to examine the role of costs and benefits on the outcome of these decisions and to look at value per life saved implied by the EPA's decisions. The studies demonstrated that the EPA did in fact weigh benefits against costs—pesticides with lower costs of being banned and higher benefits were more likely to be cancelled; however, the implicit cost per life saved was very high: \$35 million (1986\$) to avoid a cancer case among pesticide applicators and \$49 million per cancer case (1989\$) in regulations issued under the TSCA.

This was followed by articles that examined the benefits of trading allowances to reduce sulfur dioxide (SO₂) emissions by electric utilities under the Acid Rain Program, rather than imposing a uniform performance standard on generating units (Carlson et al. 2000, Chan et al. 2018). These papers provide estimates of the benefits of trading, which suggest significant gains from trading allowances rather than relying on a uniform performance standard. Estimates of the gains from trade using ex post compliance data are smaller than what was predicted ex ante but still amount to about 20% of compliance costs.

In India, Maureen and coauthors have evaluated the impacts of reforms in the electricity sector on generation efficiency at coal-fired power plants and have evaluated the costs and benefits of retrofitting these plants with scrubbers to reduce SO₂ emissions. Unbundling generation from transmission and distribution at state-owned power plants prior to 2003 increased capacity utilization, especially at small units, and reduced forced outages by 25% (Malik et al. 2015). Retrofitting coal-fired power plants with flue gas desulfurization units to reduce fine particles and associated health effects appears on average to pass the benefit-cost test based solely on mortality benefits (Cropper et al. 2017); however, the benefit-cost ratio varies significantly across plants (Cropper et al. 2019).

TRANSPORTATION

Maureen has made important contributions to the literature that attempts to understand people's travel behavior and the relationship between commuting, housing location, and job choice. In the 1980s, in response to Bruce Hamilton's claim that observed commutes in Baltimore were 10 times what would be implied by a monocentric model of urban location (Hamilton 1982), she and Patrice Gordon (Cropper & Gordon 1991) estimated a model to explain the location choices of households in Baltimore as a function of housing and neighborhood characteristics and the commute distances of each household member. They determined that observed commuting distances were greater than minimum-required commutes, defined as the commutes that could be achieved by reallocating households to houses without reducing their baseline utility, but only by a factor of two. Much of the commuting characterized as "wasteful" was, in fact, the cost of achieving desired housing and neighborhood attributes.

To understand the trade-offs households are willing to make between commuting and housing characteristics in a developing-country context, Maureen and colleagues at the World Bank conducted a survey of 5,000 households in Mumbai in 2003–2004 (Baker et al. 2005). By estimating household utility as a function of the commute distances of household workers and housing and neighborhood characteristics, they were able to evaluate the welfare effects of slum relocation programs—programs to move households from centrally located slums with good job access to more distant slums with better housing (Takeuchi et al. 2008). Data on vehicle ownership and mode choice were also used to estimate the impact of measures to control vehicle pollution in Mumbai: a car licensing scheme, an increased tax on petrol, and a conversion of diesel buses to

compressed natural gas (CNG), which would raise bus fares (Takeuchi et al. 2007). Allowing for substitution across modes, converting diesel buses to CNG was judged the most effective means of controlling particulate emissions from transport, and (coincidentally) a significant fraction of buses in Mumbai were converted to CNG in 2007.

Maureen's other contributions to the economics of transportation and transportation-related externalities include a highly cited article on the impact of city shape on travel demand in the United States (Bento et al. 2005) and cross-country studies (with Elizabeth Kopits) of the relationship between traffic fatalities and economic growth (Kopits & Cropper 2005, 2008). More recently, Maureen and Randy Chugh (Chugh & Cropper 2017) estimated models of vehicle choice and miles driven in the Indian car market to estimate the welfare effects of alternative policies to encourage fuel conservation—raising the tax on diesel fuel, taxing diesel cars, and raising the tax on petrol. This represents the first application of a structural model of vehicle demand in a developing-country setting.

SERVICE AND TEACHING

Maureen's service to the profession includes heading the EPA's Science Advisory Board committee that reviewed EPA's first prospective study of the benefits and costs of the 1990 Clean Air Act Amendments and chairing the Agency's review of the arsenic standard for drinking water in 2001. She also chaired the Science Advisory Board's Environmental Economics Advisory Committee from 2002 to 2006.

Maureen was elected to the US National Academy of Sciences in 2008 and subsequently assumed an important role in two highly visible studies. She was vice chair of the National Research Council (NRC) committee that produced *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (NRC 2010), and she co-chaired the committee tasked with *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* (NRC 2017). She also served on the InterAcademy Council committee to evaluate the Intergovernmental Panel on Climate Change (IPCC) (InterAcad. Counc. 2010).

Maureen has been Treasurer and President of the Association of Environmental and Resource Economists (AERE) and Chair of the Department of Economics at the University of Maryland (2012–2019), and she has served on the National Academy of Sciences Finance Committee (2013–2018).

During her career Maureen has supervised dozens of Ph.D. dissertations (including ours) and has worked closely with both graduate and undergraduate students. In fact, 40 of her publications (out of 90) are coauthored with students. As impressive as these numbers are, they do not begin to convey the depth of her contributions to the lives of her students. To help readers better understand the level of that contribution, what follows is a personal reflection from Cathy.

Personal Reflection of Cathy Kling

Maureen was my major professor at the University Maryland. (I was incredibly fortunate to also work closely with Nancy Bockstael in the Department of Agricultural and Resource Economics (AREC); in retrospect I cannot believe how lucky I was to have two top environmental economists mentoring and supporting me through my early research endeavors.) When I arrived at Maryland to begin my graduate work, Maureen had been there only a few years, but she was well known among the graduate students as a brilliant wunderkind with a deep commitment to economics and the department. I vividly recall her walking around the fall graduate student–faculty meet and greet with a sign on her back advertising for students to enroll in the graduate resource economics class

to assure an adequate enrollment (it worked!) and being the hit of the department holiday party by singing a duet with Barbara Bergmann (another amazing female economist) about members of the department.

Initially, I found her quite intimidating, but once I enrolled in her graduate resource economics class, that quickly changed. She taught us control theory as if it were a simple exercise in algebra (for her I think it was!) and never doubted that each of us was fully capable of an equal level of mastery. Although my math training was barely sufficient, Maureen's excellent and intuitive instruction gave me the tools I needed to learn the material. More importantly, her instruction turned the mathematics behind key results (e.g., Hotelling's derivation of the optimal time path for resource extraction) into economic insight and intuition in ways I did not previously know were possible. When I was writing my dissertation, Maureen always promptly provided thorough, high-quality edits to my quite novice initial drafts; she effectively gave me a private course on how to write journal articles (be concise and add detail whenever you can!).

I knew I had been fortunate to have her as an advisor while still a student, but I did not begin to appreciate the breadth of her impact on my career and the profession until many years later. Her relentless work ethic and continuous production of compelling research on some of the most important and challenging environmental problems of our time are truly inspiring, as is the number of outstanding economists she has mentored through graduate education into careers spanning academia, government jobs, and private sector positions. Equally inspiring is her ability to deftly lead groups of otherwise disorganized individuals to consensus. And most inspiring of all are the professionalism and respect with which she treats all people, in all circumstances, at all times.

A CONVERSATION WITH MAUREEN CROPPER

Sussman: Maureen, can you tell us a little bit about your early life: Where were you raised, what led you to become an economist, and who were important influences on you?

Cropper: I was born in 1949 in Jersey City, New Jersey, and I lived there until 1959 when my family moved to Manhasset, Long Island. My father was a minister, and my mother was a minister's wife. I have a sister who's four years younger who became a lawyer and currently lives in Baltimore. In terms of deciding that I wanted to become an economist, I read Robert Heilbroner's *The Worldly Philosophers* when I was in high school. What economists did just seemed fascinating to me. But there was no course in economics in my high school back in the 1960s.

My first formal introduction to economics was in college. I entered Bryn Mawr College in 1966. I had great professors at Bryn Mawr: Philip W. Bell, Morton Baratz, and Richard DuBoff. I learned microeconomics by reading James Meade's *A Geometry of International Trade*—that's how we were taught microeconomics by Philip Bell. It was really a very good grounding in economics. I got married as I graduated from college to Stephen Cropper (hence my last name), and I went to Cornell University because Stephen was admitted to the Cornell Law School. I was admitted to the Department of Economics at Cornell.

Frankly, my interests at the time were really in monetary economics, so I took several courses at the Cornell Business School, including courses in portfolio theory. My dissertation was on bank portfolio selection with stochastic deposit flows. My dissertation advisor was S.C. Tsiang. Henry Wan and T.C. Liu were also on my committee. Henry was a fantastic mentor and advisor. I would write a chapter of my dissertation and put it in his mailbox; the next day he would have it covered with comments. He was just an amazing advisor and very, very engaged. At this time, I was not doing anything in environmental economics. In fact, my first job offer was from the NYU Business School.

The reason I went into environmental economics is that I met Russ Porter in graduate school. Russ later became the father of my children. We decided that we would go on the job market together and looked for a place that would hire two economists. We wound up at the University of California, Riverside, which at the time was the birthplace of the *Journal of Environmental Economics and Management* (*JEEM*). I was on the job market in 1973, just when this journal was launched. Ralph d'Arge was the chair of the department then. Tom Crocker also taught there, and Bill Schulze and Jim Wilen were students in the department.

It was going to UC Riverside that really caused me to switch fields and go into environmental economics. It was a very important decision, although I must say it was made partly for personal reasons. It's had a huge impact on my life. I was at UC Riverside from 1973 to 1978. Unfortunately for me, Ralph d'Arge and Tom Crocker went off to the University of Wyoming, where they established a great department. In 1978, Bill Schulze, who was then an Associate Professor in the Economics Department at USC, encouraged me to apply for a position there.

I joined USC as an assistant professor in 1978 and stayed there for two years. It was a wonderful environment, and I was able to continue working on environmental economics. Because my partner, Russ, did not receive tenure at UC Riverside, we decided in 1980 to move. Washington, DC was a natural a place to go. Russ got a job offer from the Federal Trade Commission, and I was fortunate enough to receive a job offer from the Department of Economics at the University of Maryland.

When I look back, I cannot imagine having a better life of an academic. I was very lucky that I received an offer from Maryland. I have been there for 39 years and hopefully will be there for many more. The people I have worked with at Maryland have been absolutely wonderful. This includes Wally Oates, who was, of course, a wonderful human being as well as a great economist.

Sussman: And a decent first baseman from what I heard.

Cropper: I didn't know about that!

Also, my colleagues in AREC, including Ted McConnell and Anna Alberini, have been fantastic coauthors. Bob Chambers, Richard Just, Rob Williams, and many other members of AREC have also been wonderful colleagues.

Because of moving from one place to another, I had my first sabbatical in 1986, which was as a Gilbert F. White Fellow at RFF. This was also a turning point in my career. My early work in environmental economics wasn't motivated much by policy. I had taught myself optimal control theory and wrote some papers using this technique. Coming to RFF was a real game changer. RFF is a place where people do very policy-oriented work and know what's going on in terms of environmental policy. I was able to interact with Paul Portney, Alan Krupnick, Dallas Burtraw, Karen Palmer, and many other RFF colleagues with whom I've coauthored over the years.

Being at RFF oriented me much more toward policy-relevant work, which was great. I was able to keep an office at RFF after my sabbatical—it is just down Route 1 from College Park, Maryland. I often think that, when I die, I will have my ashes scattered on Route 1! I've made so many trips from College Park to downtown Washington, DC. And, it's been great to maintain an affiliation with RFF.

In 1993, Nancy Birdsall was head of the Development Research Group (DECRG) at the World Bank. The research department was starting a group on energy and the environment, and Nancy suggested that I should take a leave of absence and visit the Bank. In 1993, I took a leave without pay from the university and spent a year at DECRG. Environmental problems in developing countries are still much more severe than they are in the United States, and that was certainly the case back in 1993. This was an exciting opportunity to work on problems that were, frankly, more pressing than many we face in the United States.

At the end of that year, I asked if I could be a part-time researcher at the Bank. From 1993 until 2006, I was a part-time senior economist, then a lead economist, at the World Bank, as well as being a faculty member at the University of Maryland. This was a great part of my career. Indeed, my heart is still in the World Bank, and much of my research agenda continues to be devoted to working on environmental problems in developing countries.

When I left the Bank, I came back to RFF as a Senior Fellow. It was more difficult to be in two places when I became chair of the Department of Economics at Maryland, but I have worked hard to maintain connections with both RFF and the World Bank. I think that summarizes how I got into environmental economics and where I am today.

Kling: That's outstanding. It's fascinating to hear about the different places and the interplay between your professional life and personal life. It's true for all of us in ways that I never understood when I was a student. Thanks so much for sharing that. Whom in your life do you view as the most important mentors or people that really supported your intellectual interests within economics?

Cropper: Well, I must say my parents were very, very encouraging about me getting a higher education. I think when I went to college that my father didn't realize I would become an economist. He thought after college I would come home and help him edit his sermons! I didn't do that. But my parents really had a huge impact on me. When I lived in Jersey City, I went to the Bergen School for Girls, which I think meant a lot of financial sacrifice for them. But it was a good school. And, frankly, we moved to Manhasset, Long Island because the public schools there were better than they were in Jersey City at the time. My parents were also very supportive of my going to Bryn Mawr.

Henry Wan had a huge impact on me because he was so dedicated as a professor. When I was doing my dissertation—I think S.C. Tsiang was actually on leave that year—Henry stepped in and was very supportive. It wasn't really his field that I was working in, but he was just a fantastic mentor. I think he deserves a lot of credit.

Another person who has had a huge impact on me is Paul Portney. Paul and I wrote a series of papers, beginning with an analysis of pesticide regulations issued by the EPA. We looked at the trade-offs EPA was implicitly making in banning pesticides. This led to a series of papers with other coauthors that looked at the benefit-cost trade-offs implied by other EPA regulations, including regulations issued under the TSCA and Superfund cleanup decisions. Paul and I also wrote a series of articles on discounting human lives: How do people view saving lives now versus in the future and saving the lives of persons of different ages (Cropper et al. 1991, 1992a, 1994)? These were all Paul's ideas. He had fantastic ideas but needed somebody to help execute them. I was fortunate that it was me!

One person I continue to enjoy working with is Alan Krupnick. We started to work on health valuation issues back in the late 1980s when I first came to RFF. And we continue to work together to this day, including working on the *Lancet* Commission on Pollution and Health (Landrigan et al. 2017). Alan has also had a big impact on me.

Kling: Fantastic. I think that's a great segue into a question I want to ask about the extensive variety of projects that you worked on at the World Bank and RFF. You've talked about a few of them. Can you share which projects—maybe those at the World Bank—that you really feel made significant contributions to the world? Perhaps you could tell us about some of those large projects because they are unique and interesting.

Cropper: Let me focus on some of my work in India, because there are a lot of different projects that I think illustrate different topics. When I first got to the World Bank I realized that, in India, there hadn't been any state-of-the-art studies on the impact of air pollution on mortality. This was

around 1995, the time when important cohort studies by Arden Pope and Douglas Dockery were coming out in the United States.

There is also literature looking at the impact of acute exposures to air pollution—daily time-series studies of the impact of air pollution on mortality. With the support of the Bank, I was able to get information in Delhi from air quality monitors—four years of daily data, although monitoring was not done every day. I was also able to obtain data on deaths by cause and age. I worked with Nathalie Simon and Anna Alberini to carry out a daily time-series study of the impact of air pollution on mortality. This is actually still cited (Cropper et al. 1997).

We had a hard time getting the study published in an epidemiological journal because economists write up their results differently than epidemiologists. But we did document significant effects of particulate matter on mortality. And, it was important to do something early on and convince people in India that this sort of work could be done. (There have been many subsequent studies.) It is also interesting that the results we obtained in Delhi were similar to results obtained in other time-series studies in the United States.

I also worked on transportation issues at the World Bank. In 2004, colleagues at the Bank and I conducted a survey of 5,000 households in Mumbai to study household travel patterns. The questionnaire gathered information about household employment, demographics, and use of transportation. Household members also filled out travel diaries. The study was advanced for its time: All the data were collected on PalmPilots, so we could do data checks in real time and obtain geocoded information.

We were able to do many things with the data, including characterizing housing cost and wage gradients in Mumbai, describing travel patterns and estimating models of mode choice. One of the results, which people in charge of public transportation in Mumbai didn't necessarily like, was that 40% of all commute trips were on foot: This is not surprising if you've been to Mumbai. We also looked at the trade-offs households were making between access to employment and the cost and quality of housing and used this information to evaluate the welfare effects of slum improvement programs in Mumbai—programs to move households from Dharavi, the world largest slum (which is centrally located)—to better housing in the eastern part of the city. The data were also used to estimate the welfare impacts of transit subsidies and to study the impacts of transport-related pollution control policies. We also made the data available to many other researchers.

To value programs that reduce risk of death—a frequent benefit of health and safety programs—Anna Alberini and Soma Bhattacharya, a student of mine from Maryland, conducted a stated preference study in Delhi in which we asked people in the context of traffic safety what they would pay to reduce their risk of dying. Soma, whose father was at the time the president of Jawaharlal Nehru University, actually stayed in Delhi when we did the study to supervise the interviewers and refine the questionnaire. We had to do a lot of work in terms of figuring out how to communicate risks and frame the questions in a way that was meaningful to people in Delhi. In other words, methods that worked in the United States didn't necessarily work in India.

There was also a series of papers with Maryland students about the Indian electricity sector: with Kabir Malik, who became a young professional at the World Bank, and with Alexander Limonov, who was an undergraduate at Maryland. We decided that we would put together a database of power plants in India going back to the early 1980s by digitizing documents from the Central Electricity Authority (CEA). We used the database to examine the impact of electricity sector reforms on the efficiency of generation at coal-fired power plants in India.

We were trying to illustrate what could be done in a developing-country context, not necessarily breaking ground methodologically, but doing a study that was careful and that had policy implications. Most recently—again with Kabir Malik, but also with other Maryland students, including an undergraduate, Zach Lazri—we looked at the costs and benefits of putting scrubbers

on coal-fired power plants in India. We did a bottom-up analysis to indicate where the benefits would be greatest and how you'd want to prioritize implementing pollution controls (Cropper et al. 2017, 2019).

The idea in all of these studies was to take work that could be—or had been—done in other countries and do it in the context of India, as an example of what other researchers could do, but also to provide policy insights.

Kling: I'm incredibly struck by your description of those activities and how socially valuable they obviously are. That was really your motivation. The next topic on the list was to note that your most-cited papers in the academic research world are your *Journal of Economic Literature* review (Cropper & Oates 1992), which was very valuable and influential in communicating the value of environmental economics to the broader profession. You also have a paper in the *American Economic Review's* American Economic Association Papers and Proceedings on population growth and environmental quality (Cropper & Griffiths 1994) and Policy Forums published in *Science* on the role of benefit-cost analysis and one on the discount rate (Arrow et al. 1996, 2013). Then we have your World Bank papers.

Those are the publications that come up with the most citations in the scholarly literature. But you also have a lot of work on the VSL and pesticide regulation. It's clear you think the related work in India is important, but those publications aren't on the highly cited list. What are your thoughts about that?

Cropper: You get a lot of citations if you make methodological advances, which I think is important. The work on the choice of functional form for hedonic price functions and comparing discrete choice and hedonic approaches, which I did with Ted McConnell, Leland Deck, and Nalin Kishor—who I believe is still at the World Bank—was more methodological, especially at the time (Cropper et al. 1993). It was done back in the early 1990s. I think that's perhaps why it's highly cited. The paper with Charlie Griffiths on population growth and environmental quality, which is really a contribution to the environmental Kuznets curve literature, may be cited because it appeared at the beginning of some of the empirical work on deforestation (Cropper & Griffiths 1994).

When I first went to the World Bank, I did some work with Maryland students, including Charlie Griffiths, Jyotsna Puri, and Muthukumara Mani on deforestation (Cropper et al. 1999, 2001). We actually used GIS data from Thailand to look at the impact of roads and population pressures on deforestation and then also the impact of protected areas on deforestation, although it was hard to instrument for their placement. (We tried!) When that came out, which was around the late 1990s, there wasn't a lot of empirical work in print. Empirical work by Alex Pfaff, Paul Ferraro, and other researchers was just beginning to appear.

In terms of citations, work that appears early in the literature is often cited, as are policy pieces (e.g., *Science* Policy Forums), even though they are not the same type of research contribution as a journal article, obviously. I think maybe that helps to answer your question.

The traffic fatality work that I did with Elizabeth Kopits, who's currently at the EPA and was one of my students at Maryland, has been well cited (Kopits & Cropper 2005, 2008). The issue of traffic accidents is a big one. What Elizabeth and I did was to digitize the International Road Federation Yearbooks going back many years. We also decided we would do the world a favor and put this on the World Bank's website so other people could use the data. We were reprimanded by the International Road Federation because they were selling the data that we had digitized. Of course, they eventually provided the data in machine-readable form. But what we did was to estimate Kuznets curves for fatalities per person and break this into Kuznets curves for vehicles per person and fatalities per vehicle. I think that work was popular with people who were interested in road traffic injuries, which is perhaps why it's highly cited.

Sussman: We're just really struck by the breadth of the topics—the geographical and sectoral breadth, the policy relevance, and the use of a wide variety of research tools. You've mentioned transportation, your work in India, and nonmarket valuation. Are there any other themes that tie your work together?

Cropper: I think that project evaluation is another theme. When people today talk about project evaluation and evaluating environmental programs, they usually refer to using quasi-experimental methods. These have advanced the literature and may be appropriate, depending on the problem you're looking at. I have conducted evaluations of environmental programs throughout my career, using different approaches. When I first came to RFF, Paul Portney thought it would be interesting to look at decisions that the EPA had issued with regard to pesticides to see what explained them and to calculate the implicit trade-off between the health benefits of the regulation, for example, the reduction in cancer cases associated with banning a pesticide and the cost of banning it.

Doing the evaluation meant collecting dozens of regulatory impact analyses (RIAs) and extracting data from them. In those days, this meant requesting RIAs in paper form, having students read through them, and making sure different students got the same answers to a set of questions. Constructing a data set that quantified the costs and benefits of several dozen regulations was a huge task.

There were follow-up studies to the EPA pesticide work that I did with George Van Houtven, who's now at RTI International, and Shreekanth Gupta, who's at the Delhi School of Economics. We did work on Superfund along those lines and also a piece in *JEEM* (Van Houtven & Cropper 1996), which again looked at the trade-offs implicit in EPA regulations.

The ex ante program evaluation of the SO₂ Allowance Program (with Curtis Carlson, Dallas Burtraw, and Karen Palmer) involved estimating marginal abatement cost curves for electricity-generating units affected by the program and then calculating the least-cost solution to achieving the allowance cap set under Title IV of the 1990 Clean Air Act Amendments (Carlson et al. 2000). We contrasted this with the cost of achieving the cap via a uniform emissions standard.

More recently, Andrew Chupp, Nick Muller, Ron Chan, and I conducted an ex post study of the gains from trade under the SO₂ Allowance Program (versus a uniform performance standard) using a structural approach to estimating compliance costs (Chan et al. 2018). This evaluation of programs doesn't fit into the mold of the very excellent work that has been done using quasi-experimental methods. It's a different approach. But, I would say it constitutes an evaluation of environmental programs.

Similarly, more recent work in India involves modeling, plant by plant, the impact of power plant emissions on ambient particulate matter. It considers what would happen if you actually installed pollution control equipment and then tried to assess the associated mortality benefits and compare them with pollution control costs. It's a benefit-cost analysis, which, I think, constitutes project evaluation.

Kling: Let's change topics a bit to focus on other issues. You've been in the profession for a while and you've seen the evolution of many things. I'd like to get your thoughts on a couple of issues. You've already mentioned reduced-form methods, which characterize the econometrics revolution. This has led to debates about those tools and methods versus more structural, theory-based approaches.

Can you share your thoughts about where the profession of environmental economics has gone, within the broader economics profession? And what kinds of things do current graduate students need to be good at? Is that different or the same as when Fran and I were students?

Cropper: Obviously, econometric methods have changed since I was in graduate school in the early 1970s and even since both of you were in graduate school. The emphasis is now on quasi-experimental methods and reduced-form approaches. I certainly think these do have their place. If you're trying to look at the impact of the NOx Budget Trading Program on ambient concentrations of NOx and ozone as Deschênes, Greenstone, and Shapiro have done (Deschênes et al. 2017), or the impact of the renewable fuel standard on ambient ozone (Auffhammer & Kellogg 2011), you need to use these approaches. They're really appropriate. They're important. And, graduate students need to learn these methods.

I think quasi-experimental econometrics are one of the things that graduate students really do learn nowadays. Graduate students are also learning structural approaches. If you want to estimate the welfare impacts of corporate average fuel economy (CAFE) standards on the new car market, you've got to use a structural model. You also have students who study empirical industrial organization, bringing those techniques to bear in environmental economics. In terms of the percentage of work that is done today that is more theoretically based, my impression is that theoretical research really has declined, in terms of the number of purely theoretical papers written or even papers that are using theoretical approaches.

The emphasis on theory has also changed during the time I have been teaching. When I was teaching a graduate class a few years ago, we were talking about discounting issues and, of course, the Ramsey formula. Students had heard of the Ramsey formula, but when I asked students if they knew who Frank Ramsey was, I was surprised to find that they didn't know. The fact is, I think there has been this shift. When I teach environmental economics, the preparation of students in terms of econometric techniques is really quite impressive. I've got to say that has really been ramped up.

That represents an important change in the profession, just as there's more of an emphasis on experimental economics, randomized controlled trials, and field studies than there was when both of you were in graduate school. Environmental economics is to some extent going to follow the trends in the profession.

Kling: It's a fascinating thing, and a lot of people are talking about those changes. It's very interesting for me. Welfare economics is a prime example of where these changes have a big impact. So I really find, too, that the graduate students don't have the same firm grounding in micro theory and utility maximization, but they have so many other strengths. It's just different.

Sussman: It sounds like we could have a whole other conversation on trends.

Cropper: I think you're right.

Sussman: Looking back at your career and your current efforts, in addition to the research that you've done, you've also on a number of occasions taken on leadership roles. These roles were in professional organizations such as the AERE, as the department chair at the University of Maryland from 2012 to 2019, and on various committees such as the Committee on the Status of Women in the Economics Profession (CSWEP). Then there's all the work you've done on the EPA Science Advisory Board committees that you've chaired or been part of. What would you like to tell us about that?

Cropper: There are two sets of activities. One is chairing committees that produce reports, and another is chairing the Department of Economics, which is different. But in terms of chairing committees, I learned so much in my time serving on the EPA Science Advisory Board. I actually began there in the 1990s when the retrospective analysis of the Clean Air Act—the first Section 812 study—was being written. Dick Schmalensee was the head of that committee. I actually chaired

the review of the first prospective 812 study of the benefits and costs of the 1990 Clean Air Act Amendments.

I also preceded you, Cathy, as the head of the Environmental Economics Advisory Committee at EPA. I learned a lot being on these EPA committees. In terms of the 812 studies, you've got a subcommittee that's dealing with the health impacts: epidemiologists and toxicologists. You have air quality modelers and people who are exposure measurement experts. And of course, you also have economists. It's a fantastic opportunity to be exposed to all parts of the analysis. If you are concerned about air pollution policy, which is what I've worked on the most, you need to get the perspective of all of these different disciplines. I think that being in this position and getting to work with these people was really a fantastic opportunity.

I really enjoyed chairing the review of the first prospective 812 study, which I think was remarkably well done by the EPA. No figure in the study is presented to more than two significant digits (that was Dale Hattis's contribution), and the study characterizes the uncertainty in benefit-cost ratios. We encouraged the Agency to present its analysis clearly, without overstating the case. Overall, the Clean Air Act Amendments really have yielded significant net benefits, and the methods used to estimate these benefits are explained clearly in the study.

I also chaired the review of the arsenic standard for drinking water in 2000–2001. That was also fascinating. It involved working with a very different group of experts to determine whether the evidence supported tightening the standard. We had to determine how long it would be, after reducing exposure to arsenic in drinking water, before the health benefits of reduced exposure occurred. The term cessation lag—the lag between reduction in exposure and reduction in risk—came out of that study. I don't know if I'm correct in saying that Kirk Smith coined that term, but he was one of many researchers (primarily not economists) with whom I had the pleasure of working.

This was a valuable experience, as were studies that I've been involved in with the National Academy of Sciences. I particularly enjoyed working with the committee that produced the *Hidden Costs of Energy* (NRC 2010), on which I served as vice chair (Jerry Cohen chaired the study). I also enjoyed co-chairing the study on the social cost of carbon with Richard Newell, another interdisciplinary study (NRC 2017). Both cases were a wonderful opportunity to learn about the subject matter.

Kling: To be an ambassador for economics.

Cropper: Well, that's true, too. Actually, there was one study where I really did have to be an ambassador for economics. After I was elected to the National Academy of Sciences, I was asked to be on a committee to evaluate the IPCC. This was an InterAcademy Council study. People from different national academies across the world were involved: Harold Shapiro was the chair of the study. Harold was once the chairman of the Department of Economics at University of Michigan, then the president there and, subsequently, the president of Princeton. He and I are both economists, whereas everybody else on the committee was not.

There were people like Mario Molina, the Nobel Prize-winning chemist, and Syukuro (Suki) Manabe, who developed one of the first general circulation models (GCMs); these people are really outstanding in their field, but they aren't economists. I had the task of making presentations to explain what economists had contributed to the IPCC. There were committee members who thought that Working Group 1, which evaluates the science of climate change, produced reports that were far superior to the reports of Working Groups 2 and 3, which evaluate climate impacts and the costs of mitigation. Explaining what people were doing in Working Groups 2 and 3, and what economists contribute to these efforts, was a big task, but an important one.

I actually wound up writing a chapter of the InterAcademy report with Mario Molina and Suki Manabe. We described how uncertainties should be characterized by the IPCC. The three of us

got along just fine. But, that was definitely a case where it was necessary to explain what economists do and do not do, and that they're not just there to make policy.

I think when you're on the EPA Science Advisory Board, it's a somewhat different situation because the epidemiologists, air quality modelers, and others are more used to working with people from other disciplines.

Sussman: Economists don't always agree with each other either. What was your experience with the discounting conference at RFF and your work on it?

Cropper: The experience was wonderful. I was really no expert on discounting, and the EPA wanted to have a conference that looked at discounting in an intergenerational context. They assembled 12 of the leading experts on the topic. These included Marty Weitzman, Ben Groom, Bill Nordhaus, Christian Gollier, Thomas Sterner, Richard Newell, and Billy Pizer. Also Geoff Heal, Bob Pindyck, Paul Portney, and Richard Tol. Ken Arrow, of course, was also on that committee. Some of these experts approached discounting from the descriptive approach, linking discount rates to market interest rates. Others, including Ken, approached discounting from the normative approach (e.g., the Ramsey formula).

These are two very different approaches, but we had to come to some sort of consensus. It's not exactly like a consensus study at the National Academy of Sciences, but there had to be some messages that everybody agreed on. We did agree on circumstances under which certainty-equivalent discount rates should decline. There are rationales for this, both from the descriptive and prescriptive (normative) approaches. But it was a matter of trying to get everybody to agree on the wording of two papers that came out of that conference. That's a challenge, although I think people worked together very well.

I must say, I also had to have back surgery, which I didn't expect, right after the conference. I think my surgery encouraged people to agree when they otherwise might not have, but that's fine. We actually did wind up with two papers—a *Science Policy Forum* (Arrow et al. 2013) and an article in the *Review of Environmental Economics and Policy* (Arrow et al. 2014). My colleagues were coming at the topic from different perspectives, with different views on how you would really justify selecting a schedule of intergenerational discount rates. It was an interesting experience.

Kling: I can't help myself from commenting about all these experiences. I knew you as a graduate student. You were an incredibly detailed, careful economist. And now, as I reflect on your career and hear you tell these stories, it's clear that you've been incredibly effective in bringing people together, for example, as department chair at the University of Maryland. I had the pleasure of seeing you run the NRC *Hidden Costs of Energy* study as vice chair and saw all the different people you worked with and your ability to bring together their individual strengths. You've done that over and over again at the World Bank.

It's so striking to me how unusual it is for an economist to be able to do that. Was this intentional? Have you worked on these skills?

Cropper: You have to listen to the viewpoints of different people and be able to get along with people. In terms of being chair of the department—I served seven years in that role—it is a matter of getting people who are coming to the department with different perspectives to work together and cooperate. I must say, it is challenging. Maybe this is not the right thing to say, but I think in many ways, it's easier for a woman to do this.

Sometimes you receive rather exacting demands from members of your faculty and from students, or the parents of students. You just have to react calmly, try to work out a solution, and not let yourself get emotionally involved. Maybe I'm wrong in saying this is easier for women, but I think it perhaps is. I've never really found it particularly difficult to work in these situations. I

mean, there are always people with conflicting views; that's actually true on every committee. Of course, in the context of the National Academy of Sciences committees, everyone does have to agree because they're doing consensus studies.

I think things can be worked out. And I must say, I've never really dealt with people who have been absolutely unwilling to compromise, which is a good thing. Getting people to cooperate is similar to getting one's own children to cooperate. So, women are used to doing that in other contexts. I've certainly enjoyed participating in diverse committees. In terms of the university, I've been in the department since 1980, so it was absolutely time for me to become chair. And I've tried to help the department.

It's tough being in a public university because money doesn't flow as readily as it does at some private universities. You have to think of ways to be entrepreneurial; it's been a challenge. I've tried to do that in the context of being department chair. In the fall of 2018 I got together the first group of alumni—an Economics Leadership Council—to act as a board of advisors for our department. Many departments at public universities have them, for example, the University of Michigan and UCLA. I think it's essential to have a board for both alumni outreach and also fundraising. And it was important to start one at Maryland. So, there are challenges to being a department chair at a public university. But it's important to try and help, especially if you've been there for many years—you really do owe people.

Sussman: You mentioned that perhaps women have some skills that help them do some of the things that you try to do. When you started at Maryland, was Barbara Bergmann the only other woman in the department?

Cropper: There had certainly been female faculty at Maryland when I joined the department. It's hard to remember the names of everyone at this point since we're going back to 1980. Barbara was there when I arrived, and she may have been the first woman in the department at Maryland. Now one-third of tenure-track faculty are women, which is high for an economics department. Things have changed over the years. And actually, they've changed perhaps more at Maryland than in economics departments elsewhere, which is great. In 2018 we officially had 31.5 tenure-track faculty, of which 10.5 were women. Yes, we have a large female representation. We've just hired really good people!

Sussman: How has being a woman over the course of your career affected your career? What challenges has it raised for you and what advice do you have?

Cropper: I initially signed all of my papers M.L. Cropper instead of Maureen Cropper. That probably goes back to the first 10 years or so of my career. It was probably good just to be M.L. and not Maureen, although I must say that I never felt discriminated against because I was a woman. But obviously, the fact that I signed the papers M.L. indicates that, back in the 1970s, there were fewer women in the profession. So, I thought that was the appropriate thing to do.

In certain ways, I've been really encouraged professionally. I remember when I was on an EPA Science Advisory Board committee; it was the first time I ever had to serve as chair. This was a long time ago, and I was uncertain what I should do. I remember that the people on the committee, including Mort Lippmann, a toxicologist, were wonderful and applauded after I chaired the first meeting. They were really encouraging.

Kling: Let me probe a little bit further because there's a lot of research in the last few years inside and outside of economics that relates to implicit bias. Some carefully done and carefully controlled studies suggest that, instead of signing Maureen, using M.L. could very well have been a smart move—what's hard about all of this is there's no way to ever know whether using your full

name, which would indicate your gender, would have mattered. I wonder if you have any thoughts about implicit bias towards women in economics. And, bias towards other subgroups too, people of color, people with disabilities. These things are getting a lot of discussion at public and private universities. Do you feel like that discussion is healthy?

Are we moving in good directions? I have some colleagues who feel like this is all a waste of time. They (some colleagues) don't believe the studies of implicit bias. Or, they don't find that these are useful discussions. But to me, the discussion is a big change from 30 years ago.

Sussman: Nobody was even asking these questions 30 years ago.

Cropper: That's true. I'm also aware of the literature about how students react to the same lecture presented by a man versus a woman. I think there probably is some bias. As I say, maybe I'm just fortunate that I haven't really experienced it personally, but it does seem healthy to talk about this.

I know from experiences shared by other people, including faculty at Maryland, the issues surrounding the Economics Job Market Rumors website. I must say I had never looked at the website until I heard from people who had been maligned on it. There clearly is a definite problem that needs to be addressed. The American Economic Association does seem to be trying to address it, which is great.

Sussman: But you didn't experience overt bias.

Cropper: Since I don't read Economics Job Market Rumors, I have not seen anything that might have been written there about me. We do encourage students in the department to ignore these forums. I must say we also discuss this issue much more openly than before. For example, during our incoming doctoral student orientation, we discuss implicit bias and also the fact that it is not professional to participate in rumor sites like this. It's actually pretty remarkable that one-third of our tenure-track faculty is female and that 36% of our Ph.D. and Professional Master's students are women. Twenty-six percent of our undergraduate students are women.

If you think about women making it in the economics profession, my impression is that those statistics have been pretty constant for a long time, especially at the entry levels. This may have to do with training—for example, receiving adequate training in mathematics. But, I think it has a lot of causes.

Sussman: We haven't yet asked you about your students and the enormous impact you had. Cathy and I and your other students benefited greatly from your knowledge and enthusiasm and from the incredible amounts of time and support you gave us.

Cropper: In truth, it is I who have benefited more from my interactions with students. I have enjoyed enormously working with students—especially one-on-one. I remember the theoretical work that we did on the VSL, Fran (Cropper & Sussman 1990), and all of the interactions that we have subsequently had about discounting. Cathy and I have never coauthored a paper, but we've worked closely on NRC and Science Advisory Board committees. The fact is that, without students, I would never have engaged in (or completed!) most of my research. Almost half of my publications (and over half of the substantial ones) were coauthored with students. The role that they have played is often not obvious, due to the profession's rule that we list coauthors alphabetically, and the fact that Cropper begins with C. But the students with whom I have worked have been an inspiration to me—and interactions with them a pleasure.

Kling: I think we've mostly been through our list of questions. Are we missing anything?

Sussman: Is there a fun story you want to tell?

Cropper: I hadn't really thought about funny stories to tell. But you also asked about Wally Oates. Wally was a fantastic person who cared very much about his fellow faculty. If I tell this story, I'll start to cry. When Wally was very near death, he sent me an email asking if I would help get a fellow faculty member elected as a distinguished university professor. I couldn't believe this; I just burst into tears. That was Wally to a T. Here is somebody near the end, who knows it, and this is what he writes the day before he dies. I'm sorry this is not a humorous story, but it's one I will never forget. It really is touching. Wally was a fantastic person.

Kling: Is there anything you'd do differently when you think back on your career? It sounds like serendipity, hard work, responsibility, and brains played roles.

Cropper: I would say that a lot of my career does have to do with luck. I owe a tremendous amount to Nancy Birdsall for contacting me about joining the World Bank. I had never even been inside any of the World Bank buildings before she contacted me! In the case of the Gilbert F. White Fellowship, I did apply for that, but there was no guarantee of being selected. There are moments when I wonder what would've happened if I had gone to the NYU Business School instead of UC Riverside.

There are many situations when it is, to some extent, a matter of chance how things will unfold. Would I do anything differently? No, I don't think so, not really.

Kling: A life well lived.

Cropper: I don't have any regrets at all, it's been a full life. I also have four children and two grandchildren. It's not over. There's no time when I think: oh, my gosh, I really should have done this, or, I really made a mistake.

Kling: Environmental economics has been deeply enriched by you. And I know Fran and I have been deeply enriched by you.

Cropper: Thank you very much. I've enjoyed this. It's hard to imagine a better life than being an academic because you can do so many things at the same time, so to speak. And, you can always work on a different problem. That's what makes it so interesting.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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