Research Statement, July 2018
Joseph S. Shapiro, UC Berkeley

My research agenda investigates the efficiency and effectiveness of environmental and energy policy. This statement describes my two specific areas of research: pollution, regulation, and trade; and defenses against externalities. The research is empirical but has close ties to economic theory. My primary fields are environmental/energy and public finance, though some of my work involves trade.

1. Pollution, Regulation, and Trade

Commentators in the 1960s worried that U.S. cities would reach unbearable pollution levels by the year 2000. Many types of pollution have instead declined, though greenhouse gas emissions have not. My first area of research investigates the extent to which changes in environmental regulation and trade costs have contributed to these trends.

Some of these papers study the intersection of trade and the environment, and they depart from existing literature in that area in several ways—they build quantitative models and estimate them structurally; construct administrative or other comprehensive microdata linking pollution, abatement, productivity, and trade; assess how productivity, geography, and trade costs affect environmental outcomes; and carefully estimate key parameters using reduced-form regressions that then help identify key aspects of the models.

1A. Declines in Air and Water Pollution

In joint work with Reed Walker (UC Berkeley), **"Why is Pollution from U.S. Manufacturing Declining? The Roles of Environmental Regulation, Productivity, and Trade" (forthcoming, *American Economic Review*)** analyzes the causes of decreases in air pollution from U.S. manufacturing. Using confidential administrative data, we find most of the decrease in pollution is because firms are emitting less pollution to produce a given product, and little is because firms are producing different types of products. The paper then builds and quantitatively analyzes a general equilibrium model of heterogeneous firms with endogenous pollution abatement. The model-based analysis finds that the stringency of environmental regulation, measured by the shadow price of air pollution, more than doubled over the period 1990-2008. This change in regulation, rather than changes in trade costs or productivity, accounts for most of the decrease in pollution.

Standard data document trends in air pollution. By contrast, for water pollution, existing work fails to document even whether pollution is declining, let alone why. In joint work with Dave Keiser (Iowa State), **"Consequences of the Clean Water Act and the Demand for Water Quality" (forthcoming, *Quarterly Journal of Economics*)** uses the most comprehensive set of files ever compiled on water pollution and its determinants, including several datasets new to economic research, 50 million pollution readings from 170,000 monitoring sites, and a network model of all U.S. rivers. The paper finds that water pollution concentrations have fallen considerably since the 1972 Clean Water Act, though these trends slowed over time. It analyzes $680 billion in expenditure due to Clean Water Act grants the federal government gave cities to improve water pollution treatment. Triple-difference regressions comparing areas upstream and downstream of grant projects and over time show that the grants substantially decreased water pollution, though through these grants it cost around $1.5 million annually to make one river-mile safe for fishing. These grants' estimated effects on housing values are about a fourth of their costs. The paper uses the hedonic model to carefully assess welfare implications. This paper uses revealed preference to estimate the willingness-to-pay for water quality; most existing academic and government analyses use stated preference (contingent valuation) methods, but nonetheless estimate benefits of water quality regulation which are substantially smaller

than their costs (**"Does Water Quality Regulation Benefit the U.S.?" R&R,** ***Proceedings of the National Academy of Sciences***, with Cathy Kling (Cornell) and Dave Keiser (Iowa State)).

In these settings, it is straightforward to measure and regulate pollution. But for used vehicles, existing technology makes it infeasible to measure and tax air pollutants like carbon monoxide or nitrogen oxides directly. **"Optimal Corrective Taxes with Untaxable Externalities" (in preparation)**, joint with Mark Jacobsen (UC San Diego), Jim Sallee (UC Berkeley), and Arthur van Benthem (U Pennsylvania), shows that emissions of these air pollutants from new vehicles have fallen by more than 99 percent since regulation began in 1967. The paper shows that tailpipe standards for new vehicles have caused much of this decline, but are inefficient. The paper uses the envelope theorem to develop general methods to analyze efficient policy in such settings where an externality cannot be taxed directly. In related work with van Benthem, **"Leakage from Environmental Externalities" (in preparation)** studies the efficiency of smog check (also called inspection and maintenance) programs for regulating used vehicle emissions. To this end, the paper constructs county-to-county used vehicle trade flows by combining national vehicle-level registration records with tens of millions of smog check inspections. The paper exploits variation in inspection tests due to the 1990 Clean Air Act amendments to assess the extent to which these tests relocate pollution versus actually decreasing it.

1B. Lack of Declines in Climate Pollution

For air and water pollution, this work suggests that environmental regulation has played a large role in decreasing emissions, though has not always been efficient. For greenhouse gases, the key question is why the U.S. and most other countries have failed to implement stringent regulation. The global public good nature of climate change and free rider problem are the standard explanations, but my work highlights several other political economy explanations.

"Trade Costs, CO_2, and the Environment" (2016, ***American Economic Journal: Economic Policy*****)**, studies the regulation of CO_2 from shipping. To this end, the paper builds a general equilibrium model of trade and the environment, and estimates its key parameters – the elasticity of bilateral trade with respect to bilateral trade costs, separately by sector – using reduced-form, panel data regressions. The analysis finds that proposed EU or US regulation of the CO_2 emissions from shipping would increase global welfare, and would benefit the implementing region (EU or US). While this may create some national reason to pursue such policy, the paper also shows that such policies would harm most other countries, especially poor countries, and fear of retaliatory trade policy has created practical disincentives.

Few countries have explicitly tied trade policy to climate change. But **"The Environmental Bias of Trade Policy" (in preparation)** documents the startling new fact that most countries' trade policies implicitly subsidize greenhouse gas emissions. The paper shows that in most countries and years, import tariffs and non-tariff barriers are substantially lower on dirty than on clean industries, where "dirty" and "clean" are defined based on an industry's CO_2 emissions per dollar of output. Globally, this implies an implicit subsidy of about $30 per ton of carbon on internationally traded goods. The paper finds that countries impose higher tariff rates on more downstream industries, and this pattern leads trade policy to implicitly subsidize greenhouse gas emissions. A model of lobbying competition between upstream and downstream industries helps rationalize the results.

These papers highlight international obstacles to climate change policy, but domestic political economy challenges are arguably even greater. Work joint with Sharat Ganapati (Dartmouth) and Walker, **"The Incidence of Carbon Taxes in U.S. Manufacturing," (2016)** develops a simple formula for the incidence of taxes on commodities like energy in the presence of market power, then analyzes the incidence of such taxes for several homogeneous manufacturing industries. Most research

on the economy-wide incidence of environmental taxation assumes that consumers bear the entire tax burden, which would limit long-run reasons for firms to oppose climate change regulation. This paper estimates that at least in the short- to medium-run, welfare costs are roughly evenly shared between manufacturing producers and consumers, which may help explain strong opposition by some industries to change change policy. Additional work with these coauthors, **"Optimal Pigouvian Taxation in Concentrated Industries**," is extending these methods to estimate the level of efficient corrective taxes, accounting both for externalities and market power. This is important because many dirty industries (e.g., steel, cement, refining) are concentrated. Their emission of harmful pollutants implies that they produce more output than is socially optimal, but their use of market power to increase prices implies that they produce less output than is socially optimal. Efficient environmental taxes should account for both market failures.

Defenses against Environmental Externalities

My second research area focuses on the importance of defensive investments that people undertake to avoid negative externalities. A typical analysis of an environmental good like air pollution studies how it affects arguments of the utility function, like mortality. But many people engage in defenses to protect against negative externalities. Defenses are traditionally ignored in benefit-cost analysis. But theory suggests these defenses are important, since individuals should set the marginal utility of defenses equal to the marginal utility of avoiding the harm itself.

A paper joint with Olivier Deschenes (UC Santa Barbara) and Michael Greenstone (U Chicago), **"Defensive Investments and the Demand for Air Quality" (2017, *American Economic Review*)**, uses medication purchases like asthma inhalers as one measure of defenses against premature mortality. The paper shows that a large cap-and-trade market substantially decreased air pollution, medication expenditures, and mortality. Medication costs are almost as important as prevented premature mortality in accounting for the market's benefits.

A critical question for studying climate change involves the extent to which people will invest in defenses that help them adapt to changing climates. In joint work with Alan Barreca (Tulane), Karen Clay (Carnegie Mellon), Deschenes, and Greenstone, **"Adapting to Climate Change" (2016, *Journal of Political Economy*)** shows that the effect of extreme heat on mortality has sharply declined over the 20th century. The paper tests several explanations for this decline, and finds that the rollout of air conditioning accounts for most of it. A discrete-continuous model of the demand for energy services shows that mortality benefits account for an important share of the total willingness to pay for air conditioning. A separate paper with the same coauthors, **"Convergence in Adaptation to Climate Change" (2015, *American Economic Review Papers and Proceedings*)** shows that the effect of extreme heat on mortality is much smaller in states that often experience extreme heat, consistent with widespread adaptation to climate change.