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Fields of Concentration:

Environmental and Resource Economics
Industrial Organization
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Desired Teaching:

Environmental and Resource Economics
Industrial Organization
Public Finance
Applied Econometrics

Comprehensive Examinations Completed:

October 2003 (Oral) Public Finance (*with distinction*)
May 2003 (Oral) Industrial Organization
May 2002 (Written) Microeconomic and Macroeconomic Theory

Dissertation Title: *Empirical Analyses of International Environmental Problems*

Committee:

Professor Patrick Bayer (Chair)
Professor Steven Berry
Professor Christopher Timmins

Degrees:

Ph.D., Economics, Yale University, December 2006
M.Phil., Economics, Yale University, May 2004
M.A., Economics, Yale University, December 2002
Diplom, Economics (*sehr gut 1.3*), University of Kiel (Germany), July 2001
Vordiplom, Economics, University of Hamburg (Germany), June 1998
Visiting Ph.D. Student, CEMFI Madrid (Spain), Summer 2004
Exchange Student, Economics, University of Paris I Panthéon-Sorbonne (France), Spring 1998

Fellowships, Honors, and Awards:

ESRC Grant “The Effects of the Climate Change Levy and Climate Change Agreements on Businesses in the United Kingdom: Evidence from Microdata” (with Ralf Martin), 2007-08
Earth Institute Fellowship, Columbia University, 2006-08
Joseph L. Fisher Dissertation Fellowship, Resources for the Future, 2005-06
John F. Enders Fund Award, Yale University, 2005
Leitner Award in International and Comparative Political Economy, Yale University, 2005
European Recovery Program Fellowship, German Ministry of Economics and Labour 2003-05
Doctoral Fellowship, Yale University, 2001-06
Economics Departmental Award, Yale University, 2001-05
Godin Guitars Scholarship, Berklee College of Music, Summer 2004
Holsteiner Studienpreis for academic merit (university wide), University of Kiel, 2001
Erich Schneider Award for highest GPA in graduating class, University of Kiel, 2001
Erich Schneider Award for best *Diplom* thesis, University of Kiel, 2000
German National Academic Foundation fellowship 1996-2001, 2003-05
ERASMUS scholarship by the European Union for studies in Paris, 1998

Teaching Experience:

Teaching Fellow (all Yale University):

Economics of Natural Resource Management (Masters), Professor Sheila Olmstead, Spring 2005
Economics of Natural Resources (undergraduate/PhD), Professor Robert Mendelsohn, Fall 2003
Certificate, Fundamentals of Teaching in the Social Sciences, September 2004

Current Positions:

Postdoctoral Research Fellow, The Earth Institute, Columbia University, September 2006-
Visiting Fellow, Centre for Economic Performance, London School of Economics, June 2007-

Previous Positions:

Research Assistant:

Professor Ernesto Zedillo, Yale Center for the Study of Globalization, 2004-06
Professor Oona Hathaway, Yale Law School, 2004-05
Professor Gernot Klepper, Kiel Institute for the World Economy, 1998-2001

Consultant:

The World Bank, Mexico Air Quality Management Team, 2002-03
The World Bank Latin America and Caribbean Environment Department, Summer 2002

Other:

Rurtalwerkstätten gmbH Düren. Conscientious objector to military service, 1995-96

Papers:

“The Design of Stable International Environmental Agreements: Economic Theory and Political Economy”, *Journal of Economic Surveys* vol. 15(3): 377-411, July 2001.
Reprinted as Chapter 5 of “Current Issues in Environmental Economics”, Nick Hanley and Colin J. Roberts (eds.), Blackwell Publishing, 2002.

“The Voluntary Provision of a Pure Public Good? Another Look at CFC Emissions and the Montreal Protocol”, *mimeo*, Columbia University, 2007. Accepted for publication in *Oxford Economic Papers*

“Agglomeration Effects in Foreign Direct Investment and the Pollution Haven Hypothesis”, (with Christopher Timmins), *mimeo*, Columbia University, 2007. Revision requested for *Environmental and Resource Economics*

“Estimating Strategic Complementarities in a Dynamic Game of Timing: The Case of the Montreal Protocol”, *mimeo*, Columbia University, 2007. [**Job Market Paper**]

“Looking Beyond Kyoto: Opportunities for Transformation”, (with Ernesto Zedillo), *mimeo*, Yale University, 2006.

“The Effects of the Climate Change Levy and Climate Change Levy Agreements on UK Businesses: Evidence from Microdata”, (with Ralf Martin), *work in progress*.

Conference and Seminar Presentations:

Columbia University, Development/Environmental Economics Seminar, December 2007
North American Summer Meeting of the Econometric Society, June 2007, Duke University
Coalition for Rainforest Nations, Economic Seminar, January 2007, Columbia GSB
NBER Summer Institute Public Policy and the Environment (research sketch), July 2005
Yale University, Environmental Economics Seminar, 2003, 2004, 2006, 2007
NAREA/CAES annual meetings, June 2004, Halifax, Canada
AERNA first conference, June 2004, Vigo, Spain
Kiel Institute for the World Economy, Staff Seminar, January 2004
NBER Summer Institute Public Policy and the Environment (research sketch), July 2003

Workshop Participation:

NBER Summer Institute. Public Policy and the Environment Workshops 2003-05
Panel Data Econometrics (Manuel Arellano), CEMFI, September 2003
Environmental Economics (Scott Barrett), Kiel Institute for the World Economy, 1999

Referee Service:

Environmental and Resource Economics, European Journal of Operational Research, Global Environmental Change, International Economic Review, Journal of Environmental Economics and Management, Journal of the European Economic Association, Oxford Economic Papers

Languages:

German (native), English and Spanish (fluent), French (proficient), Portuguese (intermediate)

References:

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Dissertation Abstract

The emergence of environmental problems that are global in scope has given rise to a set of challenging new questions in environmental economics: Why do some international agreements succeed in the provision of global environmental goods whereas others fail? What drives countries to engage in global environmental protection in spite of the incentive to free-ride? Which other interaction effects – strategic or not – are at work at the intergovernmental level when it comes to ratifying an international environmental agreement? Can a self-enforcing agreement achieve pollution abatement beyond voluntary levels? Finally, in the absence of an agreement, are domestic environmental regulations effective at curbing global pollution levels or do they merely shift pollution emissions abroad?

My dissertation analyzes individual and strategic incentives arising in the mitigation of international environmental problems. While theoretical research has routinely used game theory to study these questions, little attention has been given to strategic behavior in empirical work so far. The first two chapters of my dissertation bridge this gap by developing a new method for estimating strategic interaction in the timing of public good provision and applying it to the ratification of the Montreal Protocol, a major international environmental agreement. The third chapter revisits the evidence on abatement behavior before the treaty went into force and uncovers major limitations of a frequently used emission data set. The fourth chapter proposes a novel approach to studying the effect of environmental regulation on industrial location choice, which takes due account of externalities associated with industrial agglomeration.

Chapters I and II: Estimating Strategic Complementarities in a Dynamic Game of Timing: The Case of the Montreal Protocol [Job Market Paper]

The Montreal Protocol on Substances that Deplete the Ozone Layer was opened for signature two decades ago and has since been ratified by 191 countries. By controlling the stock of stratospheric pollutants that ultimately increase the prevalence of skin cancer, this international environmental agreement has overcome countries' incentive to free-ride and accomplished the provision of a pure public good at the global scale. This paper argues that cooperation under the Montreal Protocol is enhanced by government interaction effects that render ratification a strategic complement, in the sense that ratification by one country makes ratification more valuable to others. For example, the government of a non-member state may incur a reputation cost that increases with the number of member states. Similarly, the treaty's ban of trade in controlled substances between signatories and non-signatories reinforces the incentive to ratify once participation in the treaty reaches a critical size (Barrett 1997).

Since the ratification process is not observed repeatedly, I exploit the variation in ratification dates to empirically assess the extent of strategic interaction. To this end, I first develop a general theoretical model of the timing of public good provision. I study a binary voluntary provision game among asymmetric players which is repeated infinitely often. Private net benefits of cooperation are assumed to increase monotonically over time, reflecting exogenous changes in the provision cost and in the valuation of the public good. Strategic complementarities arise if the payoff difference between cooperation and defection increases with the number of players who cooperate. I solve for the unique strongly renegotiation-proof Nash equilibrium of the game and show that strategic complementarities bring forward public good provision in time, although provision remains slower than socially optimal. If time periods are sufficiently small, the model predicts that clustering of provision decisions in time can only occur in the presence of strategic complementarities.

This prediction helps to identify strategic complementarities in a structural model of ratification of the Montreal Protocol. While the timing of ratification by individual countries traces out the distribution of

the private net cost, the frequency of multiple countries ratifying on the same day reveals the strength of strategic complementarities. Using the method of simulated moments, I estimate both these components of the payoff function and find that strategic complementarities reduced the average time to ratification by 35 weeks. What determines the strength of strategic complementarities? I find that ratification by country A is more likely to trigger ratification by country B if both countries have ratified pre-existing international treaties, or if country A has a large share in global emissions of ozone-depleting substances. I interpret the former as indicating concern about reputation and the latter as reflecting a preference for equity. By contrast, I do not find evidence that bilateral trade flows affected the strength of strategic complementarities.

Chapter III: The Voluntary Provision of a Pure Public Good? Another Look at CFC Emissions and the Montreal Protocol

Based on their finding of a positive and nearly linear relationship between absolute reductions of chlorofluorocarbon (CFC) emissions and GNP across countries, Murdoch and Sandler (1997) have argued that abatement in the run-up to the Montreal Protocol was more consistent with a model of voluntary contributions than with cooperative behavior. Their article has been widely cited as evidence that the initial version of the Montreal Protocol did not prescribe abatement in excess of voluntary levels. This paper documents that this evidence relies on largely imputed emission data that drastically overstate emission reductions compared to emission data that countries reported to the United Nations Environment Program (UNEP). The imputation procedure appears to induce a spurious positive correlation between income and CFC reductions. In a replication of the econometric analysis using UNEP data, no robust relationship between income and emission reductions is found, and the hypothesis of linearity is rejected. Moreover, a simple example is given to demonstrate that the regression-based test cannot discriminate between cooperative and non-cooperative abatement choices. These findings call for a more cautious interpretation of the emission targets set by the Montreal Protocol and alert researchers to important limitations of a data set that has been widely used in empirical studies of this treaty.

Chapter IV: Agglomeration Effects in Foreign Direct Investment and the Pollution Haven Hypothesis (joint with Christopher Timmins)

Do countries with lax environmental standards attract polluting firms? This paper extends the literature on environmental regulation and industrial location choice by explicitly accounting for externalities associated with industrial agglomeration. Using panel data on outward foreign direct investment (FDI) flows of six industries in German manufacturing, we regress FDI on a survey measure of environmental regulatory stringency and other characteristics of the destination country. The investment equation also includes the total stock of inward FDI to proxy for agglomeration externalities that, if omitted, cause bias in the coefficient estimates. We use Arellano and Bond's (1991) GMM estimator to consistently estimate the coefficients on (potentially endogenous) time-varying country characteristics while controlling for serial correlation in FDI flows. Next, we compute the fixed component of FDI in each country and regress it on time-constant country attributes, including environmental stringency and the stock of FDI. This step is implemented in a difference regression where the least pollution-intensive industry is used to control for unobserved heterogeneity. The results show that omitting the stock of FDI causes substantial bias in the coefficient estimates and masks the pollution haven effect for the chemical industry. When controlling for agglomeration, we find a statistically and economically significant effect of environmental stringency on FDI inflows from Germany. Our estimates indicate that a one standard deviation reduction in environmental regulatory stringency leads to an increase in FDI in the chemical industry by 0.47 standard deviations.