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EDUCATION

1997, *PhD in Industrial Economics*, Massachusetts Institute of Technology (MIT)
1996, *Master of Science in Economics*, MIT
1994, *Master of Science in Technology and Public Policy*, MIT
1991, *Master of Science in Hydraulic Engineering*, Pontificia Universidad Católica de Chile (PUCChile)
1990, *Civil Engineering*, PUC-Chile

ACADEMIC/PROFESSIONAL EXPERIENCE

2012-present, *Professor of Economics*, Department of Economics, PUC-Chile
2015-present, *Member of Expert Panel on Public Transport*, Ministry of Transportation
2014, *Visiting Tinker Professor*, Stanford University, January-March
2012, *Visiting E3 Scholar*, Bren School, UC Santa Barbara, February
2004-2011, *Associate Professor of Economics*, Department of Economics, PUC-Chile
2010-present, *Research Associate*, Economics for Energy, Vigo, Spain.
2010-present, *Research Associate*, Center for Global Change, PUC-Chile
2007-present, *Key Researcher*, Instituto Milenio/Basal Complex Engineering Systems (ISCI)
1997-present, *Research Associate*, Center for Energy and Environmental Policy Research, MIT
2005-2006, *Visiting Repsol YPF-KSG Scholar*, Kennedy School of Government, Harvard
2002-2004, *Assistant Professor of Economics*, Department of Economics, PUC-Chile
2001-2002, *Visiting Professor of Applied Economics*, Sloan School of Management, MIT
1997-2001, *Assistant Professor of Industrial Economics*, Dept. Industrial Engineering, PUCChile
2000, *Lecturer*, Department of Economics, PUC-Chile, August-December
1994, *Summer Internship*, The World Bank, June-August
1991-1992, *Lecturer*, Department of Hydraulic Engineering, PUC-Chile.

COURSES TAUGHT

- Microeconomic Theory I (Graduate, PUC-Chile)
- Microeconomic Theory II (Graduate, PUC-Chile)
- Environmental Economics (Graduate, PUC-Chile)
- Applied Econometrics (Graduate, PUC-Chile)
- Microeconomics (Undergraduate, PUC-Chile)
- Economics (Undergraduate, PUC-Chile)
- Economic Analysis for Business Decisions (Graduate, MIT)
- Industrial Organization (Graduate, PUC-Chile)
- Industrial Organization (Undergraduate, PUC Chile), Energy Markets (Graduate, Stanford)
- Short Advanced Course in Environmental Economics (Graduate, Carlos III-Madrid)
- Short Advanced Course in Environmental Economics and IO (Graduate, Ecole Polytechnique)

PROFESSIONAL SERVICES AND ASSOCIATIONS

- Editorial Board, Journal of Environmental Economics and Management, 2014-present
- Associate Editor, Journal of Economic Behaviour and Organization, 2012-2017
 - Lead Author, IPCC Working Group III Fifth Assessment Report, Chapter 15, 2012-2014.
 - CRESSE Associate (Competition and Regulation European Summer School and Conference), 2011-present
- Editorial Board, Environment and Development Economics, 2008-2013
- Editorial Board, Journal Economía, 2008-2009
- Editorial Board, Review of Environmental Economics and Policy, 2006-present
- Editorial Board, International Review of Environmental and Resource Economics, 2006-present
- Editorial Board, International Yearbook of Environmental and Resource Economics, 2004-2005
- Editorial Board, Journal of Applied Economics, 2001-present
- Editorial Board, Cuadernos de Economía, 2001-2003
- Co-Editor, Cuadernos de Economía, 2003-2008
- Panel, Journal Economía, 2006-2007
- Member American Economic Association (AEA)

OTHER PROFESSIONAL ACTIVITIES

Consulting in topics of industrial organization, environmental and resource economics for agencies in the Government of Chile such as Ministry of the Economy, the Ministry of the Environment, the Ministry of Foreign Affairs, the Competition Authority (Fiscalía Nacional Económica); private corporations in Chile and international organizations such as the World

Bank and the U.S. Environmental Protection Agency (more details on consulting work available upon request).

REFEREEING

American Economic Review, Annals of Operations Research, The BE Journals in Economic Analysis and Policy, Contemporary Economics Policy, Ecological Economics, Econometrica, The Energy Journal, European Economic Review, International Economic Review, International Journal of Industrial Organization, International Tax and Public Finance, Journal of Applied Economics, Journal of Economic Theory, Journal of Economics Behavior and Organization, Journal of Environmental Economics and Management, J Econ and Management Strategy, Journal of Industrial Economics, Journal of the European Economic Association, Journal of Law Economics and Organization, Journal of Political Economy, Journal of Public Economics, Journal of Public Economics Theory, Journal of Regulatory Economics, Operations Research, Production and Operations Management, RAND Journal of Economics, Resources and Energy Economics, Resource and Environmental Economics, Review of Economic Studies, Science, Cambridge University Press, Resources for the Future Press, Fondo Estudio Políticas Públicas U. Chile, Fondecyt-Chile, Perspectivas, Estudios de Economía, Ingeniería del Agua, Cuadernos de Economía, NSF, PNAS

SEMINAR PRESENTATIONS

2019: Univ. of Miami, INRA-Paris, CREST-Paris, CEPR-Madrid, Toulouse Climate and Energy Economics Workshop (keynote speaker)

2018: AARES-Adelaide (invited speaker), Univ of Florida, OECD/KPC Competition Economics Workshop-Seoul (invited speaker), Univ of Vigo (invited speaker), EAERE-Gothenburg (World Congress), CRESSE, Toronto, Ecole Polytechnique, TOI-Chile.

2017: Economics for Energy Workshop - Madrid, PUC-Rio, Aalto University, Bergen-BEEER Conference (keynote speaker), Toulouse Climate and Energy Economics Workshop, UBC Summer Competition Policy Workshop, Chile's Economic Society Meeting (keynote speaker), Cornell, RIDGE-Montevideo, LAMES-Buenos Aires.

2016: Economics for Energy Workshop - Madrid, McGill University, IIOC, Columbia, Paris School of Economics, Ecole Polytechnique, Univ of Vigo, CRESSE-Rhodes, Colombia's Economic Society Meeting (keynote speaker), Georgetown University, Notre Dame University, RIDGE-Montevideo (invited speaker).

2015: Univ. of Vigo, Univ of Miami, Harvard, Univ of Michigan, LSE, Ecole Polytechnique, CRESSE, IIOC (International IO Conference), EAERE, Universidad de Montevideo, ITAMPUC Chile Conference in Law and Economics, Brasil's Economic Society Meeting (invited speaker), TOI -Chile (IO Workshop)

2014: UC Berkeley, Stanford, MIT, Paris School of Economics, Toulouse School of Economics, IIOC, Economics for Energy Workshop, Université d' Auvergne Clermont-Ferrand (keynote speaker), Aalto University-Helsinki School of Economics.



Previous years: MIT, Harvard, Columbia, Yale, Stanford, UC Berkeley, Maryland University, Texas A&M University, Univ. Massachusetts-Amherst, UC Santa Barbara, University of Miami, UC Davis, Helsinki School of Economics, Catholic University of Louvain/CORE, University of Vigo, University College London, Toulouse School of Economics, University of Zaragoza, Center for Advanced Studies-Oslo, Universidad Carlos III, Università Bocconi, Ecole Polytechnique, University of Iceland, Paris School of Economics, CEMFI, St Andrews University, Universitat de Barcelona, PUC-Chile, University of Chile, University of Concepción, Universidad, Universidad Alberto Hurtado, CEMA University, Universidad EAFIT, Universidad de Montevideo, Universidad de los Andes-Colombia, NBER, ASSA-AEA, Econometric Society Meetings, EAERE Meetings, IIOC, LACEA, World Bank-Global Development Network Annual Meetings, CRESSE, TOI-Chile.

AWARDS/SCHOLARSHIPS/GRANTS

- 2017 COFECE (Mexico's Federal Economic Competition Commission) Research Award for the paper "Discount as a Barrier to Entry" (AER 2016, joint with E Ide and N Figueroa)
- 2016-2018 Fondecyt-Chile Grant #116-1802 (principal investigator; topic: "Discount contracts and exclusionary practices")
- 2017 Who'sWho Lifetime Achievement Award, Antitrust Economics
- 2013-2015 Fondecyt-Chile Grant #113-0998 (principal investigator; topic: "Correcting Externalities: Theory and Evidence")
- 2011 Simonsen Lecture, Latin American Meeting of the Econometric Society
- 2009-2011 Fondecyt-Chile Grant #109-5209 (principal investigator; topic: "On collusion")
- 2008 Campbell Watkins Award for best paper published in The Energy Journal in 2007
- 2008 Second Place in Research Medal Award of the Global Development Network (sponsored by the World Bank) with the paper "A simple auction mechanism for the optimal allocation of the commons"
- 2007 Appointed as main investigator, Instituto Milenio, Complex Engineering Systems (5 years appointment)
- 2007-2008 Fondecyt-Chile Grant #107-0982 (principal investigator; topic: "Auctions for protecting the commons")
- 2007 Chilean Economist of the Year (awarded by El Mercurio —Chile's main newspaper— based on a poll to 400 Chilean economists)
- 2007 Public Policy Grant, awarded by PUC Chile and the Ministerio Secretaría General de la Presidencia (Presidency General Secretariat Ministry)
- 2005-2006 Repsol YPF-KSG Research Fellowship at Harvard's Kennedy School of Government
- 2005-2006 BBVA Foundation Grant/Award (co- investigator)
- 2005-2006 Fondecyt-Chile Grant #105-1008 (principal investigator)
- 2003 First Place in Research Medal Award of the Global Development Network (sponsored by the World Bank) held in Cairo-Egypt.
- 2003-2004 Fondecyt-Chile Grant #103-0961 (principal investigator)
- 2000-2002 Fondecyt-Chile Grant #100- 0517 (co-investigator)
- 1999-2001 Fondecyt-Chile Grant #199-0100 (principal investigator)
- 1998-1999 Ford Foundation Grant for Studies in Public Policy (principal investigator)
- 1997-1999 Fondecyt-Chile Grant #197-1291 (principal investigator)
- 1995-1997 Presidente de la República de Chile Scholarship
- 1993 National Award of the Chilean Hydraulic Engineering Society
- 1992-1994 Fulbright Scholarship
- 1992-1994 Enciclopedia Britannica Scholarship
- 1990-1991 Shell Inc. Scholarship to the best graduate student in the School of Engineering, PUC.
- 1990 Best student, Hydraulic Engineering Department, PUC-Chile

PUBLICATIONS

Books

Markets for Clean Air: The US Acid Rain Experience (with A.D. Ellerman, P. Joskow, R. Schmalensee, and E. M. Bailey), Cambridge University Press, Cambridge, UK (2000)

Emissions Trading under the US Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance (with A.D. Ellerman, R. Schmalensee, P. Joskow, and E. M. Bailey), Center for Energy and Environmental Policy Research, MIT (1997).

Journal Articles and Book Chapters

Vintage-specific driving restrictions (with Nano Barahona and Francisco Gallego), forthcoming in the Review of Economic Studies.



Una restricción vehicular inteligente para la congestión y contaminación de Santiago (with Leonardo Basso, Felipe Sepúlveda, Luis Cifuentes, Pablo Valenzuela and Sebastián Vicuña). In: Centro Políticas Públicas UC, eds., *Propuestas para Chile. Concurso Políticas Públicas 2018*, Ch. 3, 79-113, PUC Chile editores, Santiago (2019).

Output-based allocations in pollution markets with uncertainty and self-selection (with Guy Meunier and Jean-Pierre Ponssard), *Journal of Environmental Economics and Management* 92, 832-851 (2018).

Using output-based allocations to manage volatility and leakage in pollution markets (with Guy Meunier and Jean-Pierre Ponssard), *Energy Economics* 57, 57-65 (2017).

Discounts as a barrier to entry (with Enrique Ide and Nicolás Figueroa), *American Economic Review* 106, 1849-77 (2016).

[Distinguished with Mexico's Federal Economic Competition Commission (COFECE) Research Award for best research on Competition Policy in 2016] Cartel sales dynamics when monitoring for compliance is more frequent than punishment for non-compliance (with Joseph E. Harrington). In: Martin Peitz and Yossi Spiegel, eds., *Analysis of Competition Policy and Sectoral Regulation*, now publishers Inc., Boston-Delft (2014)

Forward trading in exhaustible-resource oligopoly (with Matti Liski), *Resource and Energy Economics* 37, 122-146 (2014).

The effect of transport policies on car use: Evidence from Latin American cities (with Francisco Gallego and Christian Salas), *Journal of Public Economics* 107, 47-62 (2013).

The effect of transport policies on car use: A bundling model with applications (with Francisco Gallego and Christian Salas), *Energy Economics* 40, S85-S97 (2013).

En Busca de la Eficiencia y la Efectividad en el Transporte Urbano (with Francisco Gallego). In: Grupo Res Pública Chile, editors, *95 Propuestas para un Chile Mejor*. Santiago, Chile: Grupo Res Pública Chile (2013).

Cuotas de pesca y libre competencia: Consideraciones para la nueva ley de pesca, *Estudios Públicos* 127, 1-51 (2012).

A note on environmental policy and innovation when governments cannot commit, *Energy Economics* 33, S13-S19 (2011).

Market power in an exhaustible-resource market: The case of storable pollution permits (with Matti Liski), *The Economic Journal* 121, 116-144 (2011).

Output-expanding collusion in the presence of a competitive fringe (with Juan Ignacio Guzmán), *Journal of Industrial Economics* 58, 106-126 (2010).

Market power in pollution permit markets, *The Energy Journal* 30, 115-142 (2009).

A simple auction mechanism for the optimal allocation of the commons, *American Economic Review* 98, 496-518 (2008).

The Efficiency and Robustness of Allowance Banking in the U.S. Acid Rain Program (with Denny Ellerman), *The Energy Journal* 28, 47-71 (2007) [Distinguished with the Campbell Watkins Award for best paper in *The Energy Journal* in 2007]

An Auction Mechanism in a Climate Change Architecture. In R. Stavins and J. Aldy, eds., *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World*. Cambridge University Press (2007).

Tradable Permits with Incomplete Monitoring: Evidence from Santiago's Particulate Permits Program. In J. Freeman and C. Kolstad, eds., *Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience*. Oxford University Press (2007)

An auction mechanism for the commons: Some extensions, *Cuadernos de Economía* 44, 133-40 (2007)

Forward trading and collusion in oligopoly (with Matti Liski), *Journal of Economic Theory* 131, 212-230 (2006).

On pollution permit banking and market power (with Matti Liski), *Journal of Regulatory Economics* 29, 283-302 (2006).

Pollution markets with imperfectly observed emissions, *RAND Journal of Economics* 36, 645-660 (2005). [Reprinted in *Economics of Environmental Law*, edited by Richard Brooks, Nathaniel O. Keohane, and Douglas A. Kysar, Edward Elgar, Cheltenham, UK, 2008]

A model of final-offer arbitration in regulation, *Journal of Regulatory Economics* 28, 23-46 (2005).

A note on market power in an emission permits market with banking (with Matti Liski), *Environmental and Resource Economics* 31, 159-173 (2005).

Notas para una regulación eficiente de la transmisión eléctrica (with Salvador Valdés), *Cuadernos de Economía* 41, 255-283 (2004).

Markets for environmental protection: Design and performance, *Estudios de Economía* 31, 79-99 (2004).

Is it possible to move the copper market? (with Matti Liski), *Cuadernos de Economía* 40, 559-565 (2003).

Second-generation electricity reforms in Latin America and the California paradigm (with Hugh Rudnick), *Journal of Industry, Competition and Trade* 2, 159-172 (2002).

Market structure and environmental innovation, *Journal of Applied Economics* 5, 293-325 (2002).

Permits, standards, and technology innovation, *Journal of Environmental Economics and Management* 44, 23-44 (2002). [Reprinted in Kathelen Segerson (ed.), *The Economics of Pollution Control*, Edward Elgar Publishing, UK, 2011]

Prices vs. quantities with incomplete enforcement, *Journal of Public Economics* 85, 435-454 (2002). [Reprinted in Michael Hoel (ed.), *Recent Developments in Environmental Economics*, Edward Elgar Publishing, UK, 2004]

A market-based environmental policy experiment in Chile (with J.M Sánchez and R. Katz), *Journal of Law and Economics* 45, 267-287 (2002).

Multipollutant markets, *RAND Journal of Economics* 32, 762-774 (2001).

Crisis eléctrica en California: Algunas lecciones para Chile (con J.M. Sánchez), Estudios Públicos 83, 139-162 (2001).

Análisis de los Mercados de Derecho de Aprovechamiento de Agua en las Cuencas del Maipo y el Sistema Paloma en Chile: Efectos de la Variabilidad en la Oferta Hídrica y de los Costos de Transacción (con Guillermo Donoso y Sebastián Vicuña), Revista De Derecho Administrativo Económico De Recursos Naturales 3(2), 368-387 (2001).

Policies, measures and instruments (with Peter Bohn, Robert Stavins et al), in Climate Change 2001: Mitigation, Cambridge University Press, Cambridge, UK, Chapter 6, 399-450 (2001)

Precios eléctricos flexibles (with Hugh Rudnick), Cuadernos de Economía 38, 91-109 (2001).

Análisis del mercado de material particulado en Santiago (with J.M Sánchez and R. Katz), Estudios Públicos 81, 177-203 (2001).

Participación voluntaria en políticas internacionales de cambio climático: Implicancias para Chile (with L. Cifuentes and F. Soto), Estudios de Economía 27, 69-93 (2000).

Optimal design of a phase-in emissions trading program, Journal of Public Economics 75, 273-291 (2000).

Voluntary compliance with market-based environmental policy: Evidence from the US Acid 8 Rain Program, Journal of Political Economy 107, 998-1033 (1999). [Reprinted in Economics of Environmental Law, edited by Richard Brooks, Nathaniel O. Keohane, and Douglas A. Kysar, Edward Elgar, Cheltenham, UK, 2008]

Summary evaluation of the US SO₂ Emissions Trading Program as implemented in 1995 (with A.D. Ellerman, R. Schmalensee, P. Joskow, and E.M. Bailey), in S. Sorrell and J. Skea (eds.), Pollution for Sale: Emissions Trading and Joint Implementation, Edward Elgar, Cheltenham, UK (1999).

Optimal opt-in "climate" contracts, Journal of Applied Economics 1, 363-384 (1998).

The declining trend in sulfur dioxide emissions: Implications for allowance prices (with A.D. Ellerman), Journal of Environmental Economics and Management 36, 26-45 (1998).

An Interim Evaluation of Sulfur Dioxide Emissions Trading (with R. Schmalensee, P. Joskow, A. D. Ellerman, and E.M. Bailey), Journal of Economic Perspectives 12, 53-68 (1998).

[Reprinted in R.N. Stavins (ed.), Economics of the Environment: Selected Readings, 4th Edition, W.W. Norton's, 2000].

Marketable pollution permits with uncertainty and transaction costs, Resource and Energy Economics 20, 27-49 (1998).

A solute transport model for the acid leaching of copper in soil columns (with J.F. Muñoz, R. Abeliuk and M. Vauclin), Soil Science Society of America Journal 58, 678-686 (1994).

WORKING PAPERS AND WORK IN PROGRESS (AVAILABLE ON MY WEB SITE)

A theory of must have (with Enrique Ide; working draft coming soon)

Prices vs. quantities with multiple technologies (with Natalia Fabra, work in progress)

Quality Choice and Price Discrimination in Markets with Search Frictions (with Natalia Fabra; working paper, May 2019)

Efficiency and distributional implications of combining road pricing and driving restrictions (with Leo Basso and Felipe Sepúlveda, working draft coming soon)

Competing for certificates: The case of smog checks (with Barahona, Gallego et al; work in progress)

Multimarket contact, price discrimination, and collusive behavior (with Esperanza Johnson; working paper, June 2013)

On the exhaustible-resource monopsony (with Matti Liski; working paper, July 2012)

SOME OTHER PUBLICATIONS (RECENT ONES AVAILABLE IN MY WEB SITE)

National and Sub-National Policies and Institutions (with Larry Goulder and many others). This corresponds to Chapter 15 of the IPCC (Intergovernmental Panel on Climate Change) Working Group III Fifth Assessment Report. The full report can be found in <http://www.ipcc.ch/index.htm>. February 2014.

La Competencia en el Mercado Eléctrico Mayorista en Chile (with Natalia Fabra and Mar Reguant). This report, which provides an analysis of the competition in Chile's wholesale electricity market, was requested by the Competition Authority (FNE). January 2014.

Roadmap for Implementing a Greenhouse Gas Emissions Trading System in Chile (with Suzi Kerr and many others). Report to the World Bank on Partnership for Carbon Market Readiness. November 2012.

Colusión en Mercados de Minerales, Administración y Economía UC 58, 7-11 (2005)

Tradeable permits with imperfect monitoring, CESifo Forum 4 (1), 23-27 (2003).

Algunas lecciones para la ley de bonos de descontaminación (con José Miguel Sánchez), Administración y Economía UC 42, 24-26 (2002).

Explaining low sulfur dioxide allowance prices: The effect of expectation errors and irreversibility (with A.D. Ellerman) Working paper 98-011, Center for Energy and Environmental Policy Research, MIT, 1998.

Privatización y Regulación de Empresas Sanitarias: Implicancias para Chile (con Manuel Madrid-Aris), Jornadas de Hidráulica 1998, Universidad Católica de Chile, Octubre 1998.

Environmental Regulation and Technological Change, Revista Apuntes de Ingeniería (Junio 1997).