

University of Delhi
Department of Economics
M.A. Economics
Winter Semester 2017 (Jan 2 – April 27)

Course 609 Climate Change Economics

Wed, Thurs 1:50-3:00 pm
Professor Shreekant Gupta
Email: sgupta@econdse.org

Description

This course focuses on climate change from an economic perspective. The problem is characterised as one of regulating a global stock externality in an intertemporal setting and in the presence of uncertainty and irreversibility.

Topics covered include economic impacts of climate change, climate policy with regard to mitigation and adaptation and international cooperation.

Tools of analysis include dynamic optimisation, econometrics and game theory. Our approach will be analytical and empirical.

[Aside: Although climate change is commonly known as *global warming* in popular literature the former is the scientifically correct term: an increase in the concentration of heat trapping gases in the atmosphere (mainly CO₂ but also methane, etc.) causes significant adverse effects in addition to warming of the earth and oceans. These include (but are not limited to) sea level rise, glacier melt, and greater frequency of extreme weather events such as floods, droughts and cyclones.]

Requirements

Basic knowledge of micro, macro, maths, statistics and game theory as taught in the compulsory courses in first year.

Pedagogy

The course will be taught in an interactive format. Descriptive background readings on the science and politics of climate change and of general interest will be assigned. These will not be covered in class but will be part of the evaluation. Students are expected to read them on their own. Other readings will be placed in the course folder. Students are required to read them before coming to class. Hands on computer exercises for IAMs (see below) will be assigned.

Evaluation

Evaluation will be through an end-semester exam, two class tests and (if class size is small) a short paper.

Outline

1. Overview: Main issues in the economics of climate change and basics of climate science.
2. Climate modeling: various modelling approaches to analyse climate-economy interactions; how dynamic models can be applied to integrated assessment of economic and environmental processes; an examination of various approaches to regulating climate change within IAMs (Integrated Assessment Models); precursors of IAMs – energy-emissions models
3. The choice of discount rate for climate change policy: theoretical underpinning of IAMs; single (or finite) agent models with an infinite time horizon Ramsey growth model and its extension the Ramsey-Koopmans-Cass model; role of (and justification for) a pure rate of time preference; social rate of time preference (aka discount rate); role of discounting for climate change policy; declining discount rate (DDR).
4. Integrated Assessment Models (IAMs) and the value of carbon: determinants of the shadow price of carbon in integrated climate-economy models (SCC, social cost of carbon).
5. Uncertainty
6. Stern Review on the economics of climate change: analytical foundations; findings and policy implications; balanced growth equivalent (BGE); critique of Stern Review.
7. 'Tipping points' or non-linearities in the climate system and their role in formulating climate policy: fat tail probability distributions and the Weitzman Dismal Theorem
8. Technical change and fossil energy consumption: responses to climate change in an endogenous growth model with clean and dirty technologies; implications of a transition to clean technologies in an IAM.
9. Mitigation (tradable permits and carbon taxes)
10. Impacts and Adaptation: economic impacts of climate change (focus on agriculture in developing countries); adaptation.
11. Green paradox and carbon leakage
12. Environmental treaties: applying non-cooperative (Nash) and co-operative games.

Readings (indicative)

1. Overview

- Aldy, Joseph et al. (2010). "Designing Climate Mitigation Policy," *Journal of Economic Literature* 48(4):903-934.
- Pindyck, Robert. (2013). "The Climate Policy Dilemma," *Review of Environmental Economics and Policy* 7(2): 219-237.
- Frank J. Convery and Gernot Wagner (2015). "Reflections—Managing Uncertain Climates: Some Guidance for Policy Makers and Researchers," *Review of Environmental Economics and Policy* 9 (2): 304-320.
- Heal and Millner (2013) *REEP*.
- Wagner and Zeckhauser (2012). *Climatic Change*.
- Ackerman, Frank and E. Stanton (2013). *Climate Economics: State of the Art*. Routledge.

2. Climate Modeling

- Weyant, John et al. (1996). "Integrated Assessment of Climate Change," Chapter 10, in IPCC Second Assessment, *Economics* (1996).
- Nordhaus, William D. (2011). "Integrated Economic and Climate Modeling," Cowles Foundation Discussion Paper No. 1839. <http://ssrn.com/abstract=1970295>
- Nordhaus, William D. (2008). *A Question of Balance*. Yale University Press.
- Nordhaus, William D. (2010). "Economic aspects of global warming in a post-Copenhagen environment," *PNAS (Proceedings of National Academy of Sciences)*, 107(26):11721-11726, June 29 (and Supporting Information).
- Pindyck, Robert. (2013). "Climate Change Policy: What Do the Models Tell Us?" *Journal of Economic Literature* 51(3):860–872.
- Pindyck, Robert. (2015). "The use and misuse of models for climate policy." Available at: <http://web.mit.edu/rpindyck/www/Papers/PindyckClimateModels2015.pdf>
- Ackerman, Frank et al. (2009). "Limitations of integrated assessment models of climate change," *Climatic Change*.
- Ackerman, Frank et al. (2010). "The Need for a Fresh Approach to Climate Change Economics." Available at: <http://www.pewclimate.org/events/2009/benefitsworkshop>.

3. The choice of discount rate for climate change policy

Ramsey, Frank P. (1928). "A Mathematical Theory of Saving," *Economic Journal* 38(152): 543–559.

Cass, David (1965). "Optimum Growth in an Aggregative Model of Capital Accumulation." *Review of Economic Studies* 32(3): 233–240.

Koopmans, T. C. (1965). "On the Concept of Optimal Economic Growth." *The Economic Approach to Development Planning*. Chicago: Rand McNally. pp. 225–287.

Arrow, Kenneth J. et al. (1995). "Intertemporal equity, discounting, and economic efficiency," in *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, pp. 125–44.

Frederick, S., G. Loewenstein and T. O'Donoghue (2002). "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature*, XL vol. 40(351-401).

Portney, Paul R. and John P. Weyant, Eds. (1999). *Discounting and Intergenerational Equity*, Washington, Resources for the Future, 1999.

Creedy, John and Ross Guest (2008). "Discounting and the Time Preference Rate," *Economic Record*, 84(264): 109-127 (March).

Conceicao, Zhang, Bandura (August 2007). "Brief on discounting in the context of climate change economics" UNDP.

4. Uncertainty

5. Integrated Assessment Models (IAMs) and the value of carbon

US Working Group (2010). Interagency Working Group on Social Cost of Carbon, United States Government, "Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," available at <http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf>

6. Stern Review and its critique

Stern Review (The Economics of Climate Change) (2007).

Stern, Nicholas (2008). "The economics of climate change" (Richard T. Ely Lecture), *American Economic Review* 98(2):1-37.

Nordhaus, William D. (2007). "A review of the *Stern Review on the economics of climate change*," *Journal of Economic Literature* 45(3):686-702.

Weitzman, Martin L. (2007). "A review of the *Stern Review on the economics of climate change*," *Journal of Economic Literature* 45(3):703-724.

Anthoff, David and Richard Tol (2009). "The impact of climate change on the balanced growth equivalent," *Environment and Resource Economics*.

Tol, Richard and Gary Yohe (2009). "The Stern Review: a deconstruction" *Energy Policy*.

7. 'Tipping points' or non-linearities in the climate system and their role in formulating climate policy

John A. Robb (2008). Fat tail distribution; financial fat tail distribution.

Bailey: "Wagging the "Fat Tail" of Climate Catastrophe"

Leiss: "Fat Tails and Climate Change: Catastrophic Failures in Risk Management"

REEP Symposium on "*Fat Tails and the Economics of Climate Change*" (also see abstracts):

Nordhaus: "The Economics of Tail Events with an Application to Climate Change"

Pindyck: "Fat Tails, Thin Tails, and Climate Change Policy"

Weitzman: "Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change."

Nordhaus (2012). "Economic policy in the face of severe tail events," *Journal of Public Economic Theory*.

Weitzman REStud

8. Technical change and fossil energy consumption

Popp, David (2002). "Induced innovation and energy prices," *American Economic Review*, 92(1):160-180.

Popp, David (2004). "ENTICE: endogenous technological change in the DICE model of global warming," *Journal of Environmental Economics and Management*, (48): 742-68.

Daron Acemoglu, Philippe Aghion, Leonardo Bursztyn, and David Hemous (2012), "The Environment and Directed Technical Change", *American Economic Review*, 102(1): 131-166.

Acemoglu (JPE).

9. Mitigation (emissions trading and carbon taxes)

Pizer, William A. 1999. "The Optimal Choice of Climate Change Policy in the Presence of Uncertainty." *Resource and Energy Economics* 21 (3-4): 255-87.

Newell and Pizer JEEM (2003)

Bertram, I. Geoffrey (1996). "Tradable Emission Quotas, Technical Progress and Climate Change", *Environment and Development Economics* 1(4), 465-87.

Ellerman, A.Denny and Barbara Boucher. 2007. "The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results," *Review of Environmental Economics and Policy (REEP)* 1(1): 66-87.

Convery, Frank J. and Luke Redmond. 2007. "Market and Price Developments in the European Union Emissions Trading Scheme," *REEP* 1(1): 88-111.

Kruger, Joseph, W.E. Oates and W.A. Pizer. 2007. "Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy," *REEP* 1(1): 112-133.

Weitzman. 2014. "an Negotiating a Uniform Carbon Price Help to Internalize the Global Warming Externality?" JAERE 2014.

10. Impacts and Adaptation

Mendelsohn, Dinar, Williams (2006). "The distributional impact of climate change on rich and poor countries," *Environment and Development Economics*.

Deschênes, Olivier, and Michael Greenstone (2007), "The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather", *American Economic Review*, 97(1): 354-385

Gupta, Shreekanth, Partha Sen and Suchita Srivasan (2014). Impact of Climate Change on the Indian Economy: Evidence from Foodgrain Yields," *Climate Change Economics* 5(2).

Special Issue on "Adaptation to Climate Change in Developing Countries," *Climate Change Economics*, 3(2) May 2012.

Survey in *The Economist*, November 27th, 2010.

11. Green paradox and carbon leakage

Eichner, Thomas and Rüdiger Pethig. 2011. "Carbon leakage, the green paradox, and perfect future markets." *International Economic Review*, 52(3): 767-805.

Sen, Partha. 2015. "Unilateral emission cuts and carbon leakages in a dynamic North-South trade model." *Environmental and Resource Economics*, 1-22.

Sinn, Hans Werner. 2015. "The Green Paradox: a supply side view of the climate problem." *Review of Environmental Economics and Policy*, 9(2): 239-245.

Jensen, S., Kristina Mohlin, Karen Pittel and Thomas Sterner. 2015. "An introduction to the Green Paradox: the unintended consequences of climate policies." *Review of Environmental Economics and Policy*, 9(2): 246-265.

Long, Ngo Van. 2015. "The Green Paradox in open economies: lessons from static and dynamic models." *Review of Environmental Economics and Policy*, 9(2): 266-284.

Ploeg, Frederick Van Der and Cees Withagen. 2015. Global warming and the Green Paradox: a review of adverse effects of climate policies." *Review of Environmental Economics and Policy*, 9(2): 285-303.

12. Environmental Treaties

Barrett, Scott (1994). "Self-enforcing international environmental agreements," *Oxford Economic Papers* (46): 878-894.

Barrett, Scott (2003). *Environment and Statecraft: The Strategy of Environmental Treaty-Making*. Oxford: Oxford University Press.

Chander, P. and Tulkens, H. (1995). "A core-theoretical solution for the design of cooperative agreements on trans-frontier pollution," *International Tax and Public Finance*, (2): 279-294.

Nordhaus, William D. (2015). "Climate Clubs," *American Economic Review*.

Lecture outline

- The science (combine my slides with Ackerman + Hassler + Nordhaus)
- Stuff on temp projections and stabilization and mitigation scenarios (Perman + other)
- Economic modeling including IAMs (combine my slides with Ackerman/Karta + N'haus
Cowles paper + Sheri Markose + Hansel-Quaas)