Lectures' Outlines and Reading Lists

Prof. Santiago RUBIO, University of Valencia, Spain (School Coordinator).
Topic: Dynamic models of international environmental agreements: a differential game approach.

The lecture is organized in three parts covering the following items:

a) The Basic Model: A Differential Game of International Pollution Control
   - Description of the game
   - The Full-Cooperation
   - The Non-Cooperative Equilibria:
   - The open-loop Nash equilibrium
   - The stationary Markovian Nash equilibrium

b) Self-Enforcing International Environmental Agreements with a Stock Pollutant and a Fixed Membership
   - The agreement formation game with a fixed membership
   - The open-loop Nash equilibrium of the emission game
   - The stability conditions

c) Self-Enforcing International Environmental Agreements with a Stock Pollutant and a Variable Membership
   - A difference game of international pollution control: description of the game
   - The agreement formation game with a variable membership
   - The stationary Markovian Nash equilibrium of the emission game
   - Approximating the value function

Reading list:

Rubio, Santiago J. and Begoña Casino (2001). "International Cooperation in Pollution Control." Working paper AD 2001-21, Instituto Valenciano de Investigaciones Económicas.

Rubio, Santiago J. and Begoña Casino (2005). "Self-Enforcing International Environmental Agreements with a Stock Pollutant." *Spanish Economic Review*, 7(2), 89-109.

Rubio, Santiago J. and Alistair Ulph (2007). "An Infinite-Horizon Model of Dynamic Membership of International Environmental Agreements." *Journal of Environmental Economics and Management*, 54(3), 296-310.

A very useful book for consultation is:

Dockner, Engelbert, Steffen Jorgensen, Ngo Van Long and Gerhard Sorger (2000). *Differential Games in Economics and Management Science*. Cambridge University Press.

Other approaches have been developed recently by:

Breton, Michèle, Lucia Sbragia and Georges Zaccour (2010). "A Dynamic Model for International Environmental Agreements." *Environmental and Resource Economics*, 45(1), 25-48.

de Zeeuw, Aart (2008). "Dynamic Effect on the Stability of International Environmental Agreements." *Journal of Environmental Economics and Management*, 55, 163-174.

Germain, Marc, Henry Tulkens and Alphonse Magnus (2010). "Dynamic Core-Theoretic Cooperation in a Two-Dimensional International Environmental Model." *Mathematical Social Sciences*, 59(2), 208-226.

Prof. Scott BARRETT, Columbia University, USA
Topic: Climate treaties

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1. CLIMATE TREATIES: TECHNOLOGIES
Cooperation and the design of an international environmental agreement can depend on the nature of the technology options.

READINGS:

Barrett, S. (2006). "Climate Treaties and 'Breakthrough' Technologies." *American Economic Review* (*Papers and Proceedings*), **96**(2): 22-25.

Barrett, S. (2010). "Climate Treaties and Backstop Technologies," CESifo Working Paper No. 3003.
http://www.cesifo-group.de/pls/guestci/download/CESifo%20Working%20Papers%202010/CESifo%20Working%20Papers%20March%202010/cesifo1_wp3003.pdf.

OPTIONAL BACKGROUND READING:

Barrett, S. (2009). "The Coming Global Climate-Technology Revolution," *Journal of Economic Perspectives*, **23**(2): 53-75.

2. CLIMATE TREATIES: UNCERTAINTY
Does the prospect of uncertain catastrophe change the prospects of international cooperation, or the design of climate treaties?

READINGS:

Milinksi, Manfred, Ralf D. Sommerfeld, Hans-Jürgen Krambeck, Floyd A. Reed, and Jochem Marotzke (2008). "The Collective-Risk Social Dilemma and the Prevention of Simulated Dangerous Climate Change." *Proceedings of the National Academy of Sciences* 105(7): 2291-2294.

Barrett, S. (2010). "Climate Treaties and Approaching Catastrophes." In preparation.

OPTIONAL BACKGROUND READINGS:

*Weitzman, Martin L. (2009a). "On Modeling and Interpreting the Economics of Catastrophic Climate Change," *Review of Economics and Statistics*, 91(1): 1-19.

*Nordhaus, William (2009). "An Analysis of the Dismal Theorem," Yale University. http://nordhaus.econ.yale.edu/documents/weitz_011609.pdf.

Prof. Carlo CARRARO, Ca' Foscari University of Venice and Fondazione Eni Enrico Mattei, Italy
Topic: The incentives to participate in and the stability of international climate coalitions: a game-theoretic analysis using the WITCH model

The lecture will be divided in two parts. In the first parts key concepts of cooperative and non-cooperative coalition theory will be introduced. A particular focus will be given to the analysis of key concepts as *profitability, stability, potential environmental effectiveness*. The possibility to make profitable coalitions stable by means of transfers will be carefully examined.
In the second part of the lecture the key concepts introduced in the first part will be examined using recent applied work on coalitions profitability, stability and environmental effectiveness with the WITCH model.

Preliminary outline of the lecture:

1. Introduction: Game Theory and Climate Change
2. The Cooperative Approach
3. Non-cooperative Coalition Theory
4. Profitability, Stability and the γ-game
   a. Profitability and stability as necessary conditions for existence of coalitions
   b. The γ-game: from characteristic functions to partition functions
5. Environmentally effective coalitions
   a. The concept of PECs (Potentially effective coalitions)
6. Equilibrium structures and the rules of the game
   a. Simultaneous games
   b. Sequential games
   c. Bargaining on the rules of the game
7. The Enlargement of Coalitions
   a. Superadditivity
   b. Coalition rationality
   c. Commitment
8. Transfers
   a. Ex-ante transfer schemes
   b. Ex-post transfer schemes
9. Issue Linkage
10. An applied analysis with the WITCH model
    a. A game-theoretic introduction to the WITCH model
    b. An applied analysis of the incentives to participate in and the stability of international climate coalitions

References

The lecture will be largely based on the following working paper:

Bosetti, V., C. Carraro, E. De Cian, R. Duval, E. Massetti and M. Tavoni. 2009. “The Incentives to Participate in and the Stability of International Climate Coalitions: a Game Theoretic Approach Using the WITCH Model” OECD Economics Department Working Papers No. 702, June 2009.

Other suggested readings are:

- Barrett, S. (1994). “Self-enforcing International Environmental Agreements.” Oxford Economic Papers, 46, pp. 878–894.
- Barrett, S. (1997), "Towards a Theory of International Cooperation" in C. Carraro and D. Siniscalco, eds., New Directions in the Economic Theory of the Environment, Cambridge University Press, Cambridge.

- Bosetti, V., C. Carraro, M. Galeotti, E. Massetti and M. Tavoni (2006), "WITCH: A World Induced Technical Change Hybrid Model" The Energy Journal, Special Issue. Hybrid Modelling of Energy-Environment Policies: Reconciling Bottom-up and Top-down, December 2006: 13-38.
- Bosetti, V., E. Massetti and M. Tavoni, 2008. "The WITCH Model. Structure, Baseline, Solutions" FEEM Nota di Lavoro No 10.2007, January 2007.
- Botteon, M. and C. Carraro (1997). "Burden-Sharing and Coalition Stability in Environmental Negotiations with Asymmetric Countries." In International Environmental Agreements: Strategic Policy Issues, edited by C. Carraro, Cheltenham: E. Elgar.
- Carlo Carraro (1997). "Modelling International Policy Games: Lessons from European Monetary Coordination." Empirica 24: 163–177, 1997. 163.
- Carlo Carraro and Carmen Marchiori (2003). "Stable Coalitions", in C. Carraro, ed., The Endogenous Formation of Economic Coalitions, E. Elgar: Cheltenham.
- Carraro Carlo and Domenico Siniscalco (1993). "Strategies for the international protection of the environment." Journal of Public Economics 52 (1993) 309-328. North-Holland.
- Carraro, C. and D. Siniscalco (1995), "Policy Coordination for Sustainability: Commitments, Transfers, and Linked Negotiations", in I. Goldin and A. Winters, eds., The Economics of Sustainable Development, Cambridge University Press, Cambridge.
- Chander, P. and Henry Tulkens (1997). "The Core of an Economy with Multilateral Environmental Externalities." International Journal of Game Theory (1997) 26:379-401.
- Eyckmans, J. and H. Tulkens (2003). "Simulating coalitionally stable burden sharing agreements for the climate change problem." Resource and Energy Economics 25 (2003) 299–327.
- Finus, M., E. van Ierland and Rob Dellink (2003). "Stability of Climate in Coalitions in a Cartel Formation Game." FEEM Nota di Lavoro 61.2003.

Prof. Rob DELLINK, Wageningen University, The Netherlands
Topic: Drivers of stability of climate coalitions: simulations with the STACO model

This lecture deals with the formation and stability of international climate agreements from an applied perspective. The STACO model is used to project costs and benefits of an international agreement on climate change mitigation activities. First, the key building blocks of the model are described. Essentially, STACO is a hybrid between an Integrated Assessment model that describes how climate change and economic activity are linked and a game-theoretic model that describes the formation and stability of an international climate coalition.
Next, the issue of calibration, that is so important for numerical analysis, is discussed.
The STACO model is then used to investigate which drivers affect the formation and stability of international climate agreements (ICAs). Different financial transfer schemes are compared, and different specifications of the game rules.
Throughout the lecture, the emphasis will be on clearly explaining how applied modellers can specify their modelling framework to provide numerical insights that go beyond the stylized theoretical findings.

Lecture material:

M. Finus, E.C. van Ierland and R.B. Dellink, 2006, "Stability of climate coalitions in a cartel formation game", *Economics of Governance* 7, pp. 271-291.

R.B. Dellink, 2010, "Drivers of stability of climate coalitions in the STACO model", unpublished manuscript, Wageningen University.

Prof. Michael FINUS, University of Exeter Business School, UK
Topic: Coalition formation under uncertainty and risk: the success of international environmental agreements.

The two lectures deal with the formation of international climate agreements, considering uncertainty and learning. The lectures comprise three parts. 1) risk neutrality, 2) risk aversion and 3) possible interesting extensions. The lecture notes will be available shortly before the summer school. The reading list comprises a selection of references which may be useful for following the lecture and for further reading. Obviously, choices by students will depend on individual preferences and time constraints. Therefore, I indicate below only a very small selection of references with an asterisk which are immediately related to the lectures, not implying that the other references are not important or not interesting. The indicated papers will be made available in their most recent version.

Reading List:

Barrett, S. (1994), Self-enforcing International Environmental Agreements. *Oxford Economic Papers*, **46**: 878-894. **Comment:** The beginning of the IEA-literature, important background paper; no uncertainty.

Boucher, V. and Y. Bramoullé (2009), Providing Global Public Goods under Uncertainty. Mimeo. **Comment:** Paper immediately related to lecture, risk-aversion.*****

Bramoullé, Y. and N. Treich (2009), Can Uncertainty Alleviate the Commons Problem? *Journal of the European Economic Association*, **7**: 1042-1067. **Comment:** Analysis of risk aversion on non- and fully cooperative strategies, though no coalition formation.

Carraro, C. and D. Siniscalco (1993), Strategies for the International Protection of the Environment. *Journal of Public Economics*, **52**: 309-328. **Comment:** The beginning of the IEA-literature, important background paper; no uncertainty.

Dellink, R. and M. Finus (2009), Uncertainty and Climate Treaties: Does Ignorance Pay? Stirling Economics Discussion Paper No. 2009-16, UK. **Comment:** Analysis uses the climate simulation model STACO.

Dellink, R., M. Finus and N. Olieman (2008), The Stability Likelihood of an International Climate Agreement. *Environmental and Resource Economics*, **39**: 357-377. **Comment:** Analysis uses the climate simulation model STACO.

Endres, A. and C. Ohl (2000), Taxes versus Quotas to Limit Global Environmental Risks: New Insights in an Old Affair. "Environmental Economics and Policy Studies", vol. 3, pp. 399-423. **Comment:** Analysis of uncertainty and risk in a simple two player prisoners' dilemma framework.*****

Endres, A. and C. Ohl (2003), International Environmental Cooperation with Risk aversion. *International Journal of Sustainable Development*, **6**: 378-392. **Comment:** Analysis of uncertainty and risk in a simple two player prisoners' dilemma framework.*****

Eyckmans, J. and M. Finus (2009), An Almost Ideal Sharing Scheme for Coalition Games with Externalities. Stirling Economics Discussion Paper No. 2009-10, UK, 2009. **Comment:** Proposes an optimal transfer scheme in coalition games. *****

Finus, M. (2001), *Game Theory and International Environmental Cooperation*. Edward Elgar, Cheltenham, UK. **Comment:** Reference on the game-theoretic and formal analysis of IEAs; no uncertainty.

Finus, M. (2003), Stability and Design of International Environmental Agreements: the Case of Global and Transboundary Pollution. In: Folmer, H. and T. Tietenberg (eds.), *International Yearbook of Environmental and Resource Economics 2003/4*. Edward Elgar, Cheltenham, UK, ch. 3, 82-158. **Comment:** Non-technical overview article on the state of the art of the literature on IEAs; no uncertainty.

Finus, M. and P. Pintassilgo (2010), International Environmental Agreements under Uncertainty: Does the Veil of Uncertainty Help? Economics Department Discussion Paper Series, 10/03, 2010, University of Exeter, UK. **Comment:** Paper immediately related to lecture, risk-neutrality. *****

Finus, M., P. Pintassilgo and A. Ulph (2009), International Environmental Agreements with Uncertainty, Learning and Risk Aversion. Mimeo, University of Stirling, UK, 2009. **Comment:** Paper immediately related to lecture. *****

Kolstad, C. (2007), Systematic Uncertainty in Self-enforcing International Environmental Agreements. *Journal of Environmental Economics and Management*, **53**: 68-79. **Comment:** Paper immediately related to lecture, risk-neutrality. *****

Kolstad, C. and A. Ulph (2008), Learning and International Environmental Agreements. *Climatic Change*, **89**: 125-141. **Comment:** Paper immediately related to lecture, risk-neutrality. *****

Kolstad, C. and A. Ulph (2009), Uncertainty, Learning and Heterogeneity in International Environmental Agreements. Mimeo. **Comment:** Paper immediately related to lecture, risk-neutrality.

Na, S.-L. and H.S. Shin (1998), International Environmental Agreements under Uncertainty. *Oxford Economic Papers*, **50**: 173-185. **Comment:** Paper immediately related to lecture, risk-neutrality. *****

Ulph, A. (2004), Stable International Environmental Agreements with a Stock Pollutant, Uncertainty and Learning. *Journal of Risk and Uncertainty*, **29**: 53-73. **Comment:** Paper immediately related to lecture, risk-neutrality.

Prof. Andreas LANGE, University of Maryland, USA
Topic: Equity preferences and the formation of coalitions to provide public goods - experimental evidence from the lab.

This lecture links the problem of forming international agreements to the question of voluntary provision of private goods. Just as countries, individuals have incentives to free-ride on each others provision of the public good. The lecture discusses recent literature on the private provision of public goods and relates this to coalition formation problems. This lecture draws on insights from experimental and behavioral economics. In the first part, we discuss how equity considerations may influence the provision efforts of public goods and the stability of coalitions. In the second part, we discuss findings from experiments that provide a direct test of theories on coalition formation.

Why should you care?
Negotiations frequently involve references to equity and fairness. For example, negotiators in international climate negotiations often refer to relate to the polluter-pays principle, to equal per capita emissions, or to percentage reduction of emissions. Similarly, at the individual level, many experiments have shown that individuals do not necessarily maximize their payoff only, but may take inequality and fairness aspects into account when making their decisions. As a consequence, standard economic theory has been adjusted to account for such behavioral economics insights. It can thereby inform institutional decisions at different levels.

We can therefore study how equity considerations may impact the formation of coalitions, both theoretically and empirically. Furthermore, economic experiments provide a wonderful testing ground for how well existing theories on coalition formation actually succeed in explaining actual behavior.

What should you expect?
The first lecture approaches the role of equity in international negotiations from two different, but related perspectives: (i) based on recent behavioral models, we discuss what effects equity considerations may theoretically have on cooperation, i.e. on the stability of coalitions. (ii) we discuss empirical evidence on the role of equity in international negotiations.
In the second lecture, we discuss experiments that test the theory of coalition formation. We relate this to the very vibrant economic literature on voluntary provision of public goods.

List of suggested background readings:

- Shogren, J. and L. Taylor, 2008, On Behavioral-Environmental Economics, Review of Environmental Economics and Policy 2008 2(1):26-44.
- Smith, Vernon, 2008, Experimental Economics, The New Palgrave Dictionary of Economics, Second Edition. (available online: http://www.dictionaryofeconomics.com/article?id=pde2008_E000277)
- Fehr, E. and K. Schmidt (1999), "A Theory of Fairness, Competition, and Cooperation," Quarterly Journal of Economics 114, 817-868.
- Bolton, G. and A. Ockenfels, Self-centered Fairness in Games with More Than Two Players, Handbook of Experimental Economics Results, Volume 1, 2008, Pages 531-540
- Murnighan, J.K. (2008), Fairness in Ultimatum Bargaining, Handbook of Experimental Economics Results, Volume 1, 2008, Pages 436-453.

Readings on equity and coalition formation:

- Lange, Andreas and Carsten Vogt, "Cooperation in International Environmental Negotiations due to a Preference for Equity", *Journal of Public Economics* 87, 2003, 2049-2067.
- Lange, Andreas, Carsten Vogt and Andreas Ziegler, "On the Importance of Equity in International Climate Policy: An Empirical Analysis", *Energy Economics* 29(3), 2007, 545-562.
- Lange, Andreas, Andreas Löschel, Carsten Vogt and Andreas Ziegler (2010), "On the Self-Serving Use of Equity Principles in International Climate Negotiations", *European Economic Review*, 54 (3), p.359-375

Readings on experimental evidence on coalition formation

- Dannenberg, Astrid, Lange, Andreas, and Bodo Sturm (2010), "On the Formation of Coalitions to Provide Public Goods - Experimental Evidence from the Lab", NBER Working Paper w15967.
- Burger, N. and Kolstad, C.D. (2009): *Voluntary Public Goods Provision, Coalition Formation, and Uncertainty*, NBER Working Papers 15543.
- Kosfeld, M., Okada, A., and Riedl, A. (2009): Institution Formation in Public Goods Games, *American Economic Review* 99: 1335-1355.

Dr. Leonardo MASSAI, TMC Asser Institute, The Netherlands
Topic: Before and after the Copenhagen Accord: stocktaking pros and cons of the new legal architecture of the climate change regime.

The Copenhagen Summit of 7-18 December 2009 (COP15 and CMP5) gathered together almost 115 Heads of State and government and 40.000 individuals, including representation of academia, the business sector, media, non-governmental organizations (NGOs) and international organizations with the aim to provide legal certainty and political guidance to the future of the international climate regime after 2012 in accordance with the Bali Roadmap.

At the end, the Summit did not conclude the two years negotiation process initiated by the international community in Bali in 2007. Ten official meetings among Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol were not sufficient to reach a conclusion on the future of the international climate change regime after 2012.

This lecture is aimed at shedding some light on the process, results and follow-up of COP15 and CMP5 from a legal perspective. To this aim, the following issues will be addressed:

- History and development of the negotiations on climate change:
    - Negotiations groups and practices under the UNFCCC
    - Foundations of the post-2012 climate change talks
    - The original sin: Bali Road Map
    - The road to Copenhagen in 2009: Bonn (III), Bangkok and Barcelona
- The Copenhagen Accord:
    - The failure of the UNFCCC process
    - Procedural irregularities
    - Pros and cons
    - Legal aspects and effects
- The future of the UNFCCC after Copenhagen:
    - Voting or consensus?
    - The 'legally binding' question: international treaties, customary law, decisions of international organizations, decision by Conference of the Parties
    - Unresolved issues for COP16 (amendment to the KP and Convention, new Protocol) and beyond
    - Options for the future

SUGGESTED READINGS

T. Akanle *et al*., 'Summary of the Copenhagen Climate Change conference: 7–19 December 2009' 12:459 *Earth Negotiations Bulletin* (22 December 2009)

D. Bodansky, 'The Copenhagen Climate Change Conference: a Post-Mortem', *University of Georgia School of Law* (12 February 2010);

L. Massai, "The long way to the Copenhagen Accord: climate change negotiations in 2009", *Review of European Community and International Environmental Law* (2010) RECIEL (19)1, Wiley-Blackwell, p. 102-119

B. Müller, 'Copenhagen 2009 – Failure or Final Wake-up Call for Our Leaders?', *Oxford Institute for Energy Studies EV 49* (February 2010

L. Rajamani, 'Neither Fish nor Fowl',*Seminar 606* (February 2010)

W. Sterk *et al.*, 'Something was rotten in the State of Denmark – Cop-out in Copenhagen

Copenhagen Accord of 18 December 2009, decision 2/CP.15 UNFCCC

UNDP Environment and Energy Group, 'The Bali Road Map: key issues under negotiation', 2008.