Alan S. Manne: Innovative Approaches to Climate Policy Design

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November 22, 2006

Abstract

Alan Manne was a pioneer in the adaptation of energy-economy models to climate policy issues. The talk will highlight aspects of these models which were pathbreaking and remain state of the art: putty-clay technology, stochastic equilibria, integrated treatments of climate and economic systems, and the solution of large-scale equilibrium models with tax distortions and public goods solved by use of iterative optimization.

Overview of Talk

1. Policy issues.

2. Model evolution

3. Innovations

Research Program

Produce models through which to *quantify* alternative ways of thinking about climate change.

Establish frameworks which are sufficiently flexible to explore divergent views on a wide range of contentious issues: costs of abatement, damages of climate change, valuation and discounting.

Provide analytic tools for general use within the analytic community:

`http://www.stanford.edu/group/MERGE`

Ten Policy Issues in Climate Policy

1. What is an appropriate framework for evaluating carbon emissions abatement policies (cost-effectiveness analysis)?

Buying Greenhouse Insurance - the Economic Costs of Carbon Dioxide Emission Limits, MIT Press book, Cambridge, MA, 1992. (with Richard Richels)

"Greenhouse Gas Abatement - toward Pareto-Optimal Decisions under Uncertainty", Annals of Operations Research, Baltzer Science Publishers, 68 (1996) 267-279. (with Timothy Olsen).

2. To what extent does international trade vitiate subglobal climate agreements?

“International Trade in Oil, Gas and Carbon Emission Rights: An Intertemporal General Equilibrium Model”, *The Energy Journal*, 15:1, 1994. (with T.F. Rutherford).

“International Carbon Agreements, EIS Trade and Leakage”, March 2000.

3. How can we frame climate policy design from a *cost-benefit* perspective, accounting for market and non-market damages and climate-economy interactions?

"MERGE - A Model for Evaluating Regional and Global Effects of GHG Reduction Policies", *Energy Policy*, vol. 23, no. 1, pp. 17-34, 1995. (with Robert Mendelson).

"The Greenhouse Debate: Economic Efficiency, Burden Sharing and Hedging Strategies", *The Energy Journal*, vol. 16, no. 4, pp. 1-37, 1995. (with Rich Richels).

4. How do equity and efficiency objectives affect the design of climate policy?

"Greenhouse Gas Abatement - toward Pareto-Optimality in Integrated Assessments", ch. 26 in Education in a Research University, edited by K.J. Arrow, R.W. Cottle, B.C. Eaves and I. Olkin, Stanford University Press, Stanford, CA, 1996.

"Equity, Efficiency and Discounting", ch. 12 in P.R. Portney and J.P. Weyant, Discounting and Intergenerational Equity, Resources for the Future, Washington, D.C., 1999.

5. What are the strengths and weaknesses of specific climate policy proposals?

"The Kyoto Protocol: A Cost-Effective Strategy for Meeting Environmental Objectives?", *The Energy Journal*, special issue, May 1999, pp. 1-23.

"On Stabilizing CO2 Concentrations - Cost-Effective Emission Reduction Strategies", *Environmental Modeling and Assessment*, 2 (1997) 251-265.

6. How should climate policy measures treat different greenhouse gases?

“An Alternative Approach to Establishing Trade-offs among Greenhouse Gases”, *Nature*, vol. 410 (2001), pp. 675-677.

7. How does learning-by-doing (endogenous technical change) affect the qualitative properties of efficient climate policy?

“Learning-by-doing and carbon cioxide abatement”, *Journal of Economic Dynamics and Control*, 2002. (with L. Barreto)

“The impact of learning-by-doing on the timing and costs of CO_2 abatement”, 2002.

8. How does the application of market exchange rates (as opposed to purchasing power-parity data) affect baseline emissions growth paths?

9. What role should *carbon sinks* play in greenhouse policy?

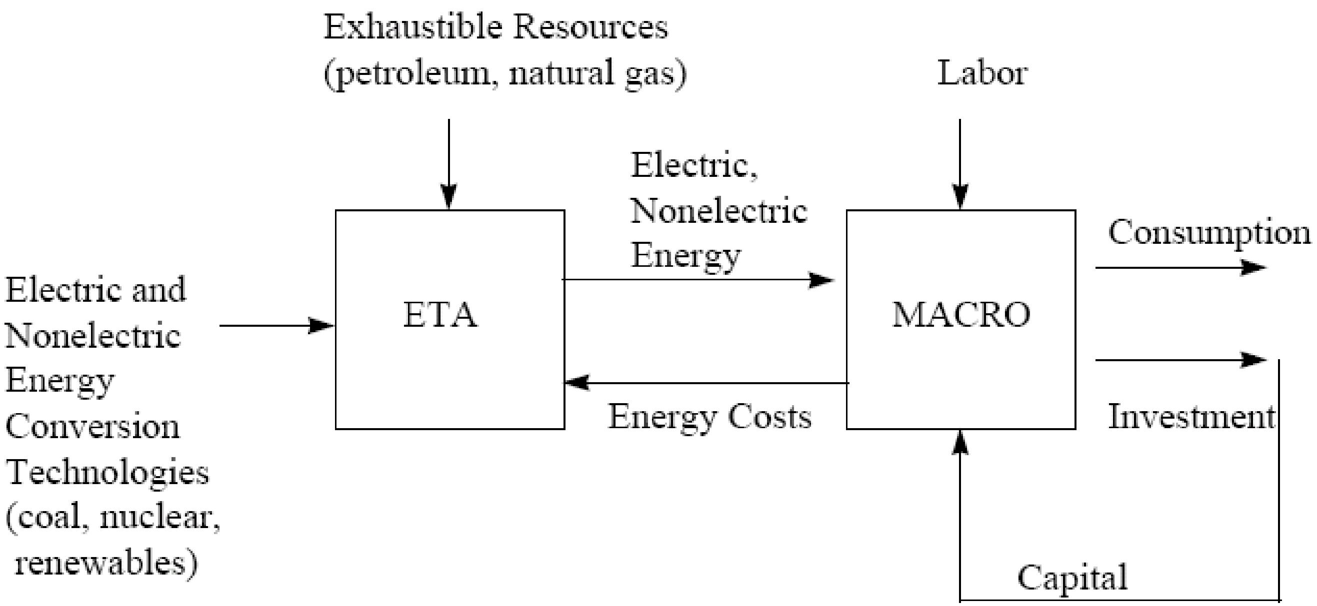
10. How do natural gas and petroleum resource exhaustion affect climate policy?

Model Evolution

1. The ETA-Macro Framework (1982)

   - Ramsey model of savings and investment
   - Putty-clay technology
   - Process model of electric and non-electric energy supply
   - Double exponential resource exhaustion model
   - AEEI (autonomous energy-enhancing improvements)

An Overview of ETA-MACRO



The Macro Model

Output Markets

Region r in period t:

$$Y_{rt} = C_{rt} + I_{rt} + EC_{rt} + X_{rt}$$

International Markets

$$\sum_r X_{rt} = 0$$

Capital Stock

$$K_{r,t+1} = (1 - \delta)K_{rt} + I_{rt}$$

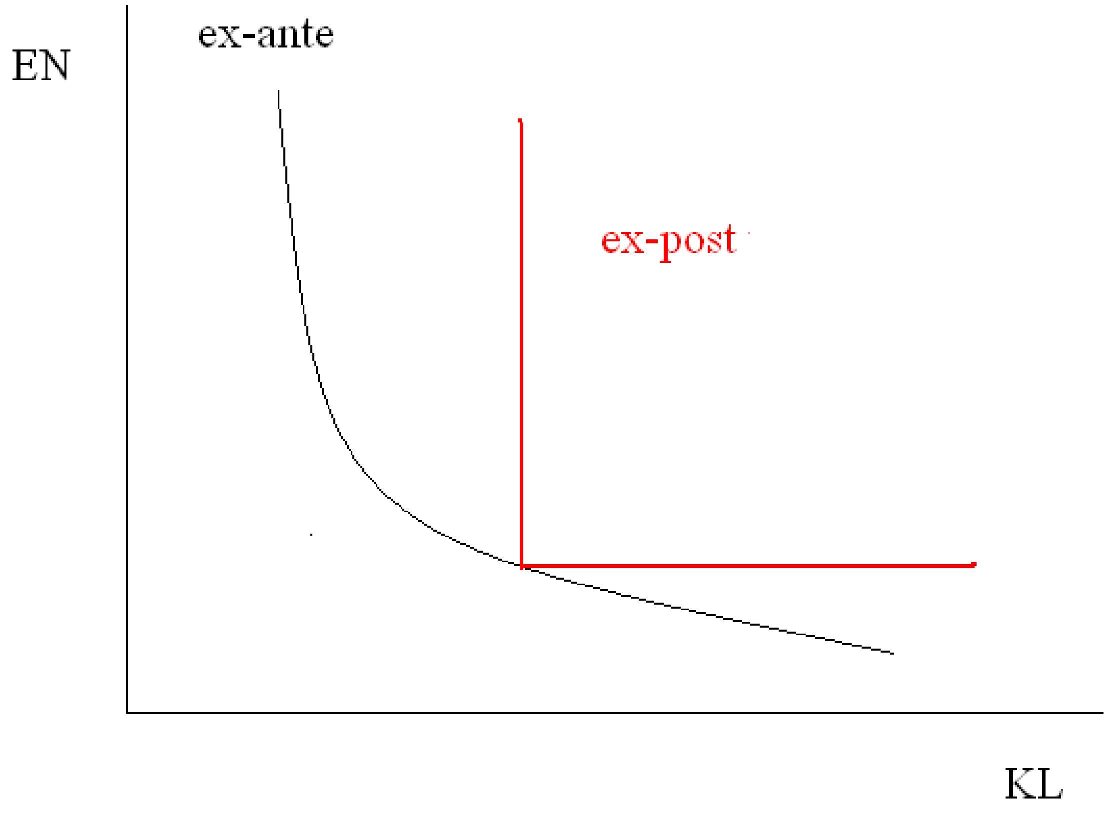
Ramsey Model

$$\max \sum_{t=0}^{\infty} \Delta_{rt} \log(C_{rt})$$

subject to

$$\sum_{t} p_{rt} C_{rt} = M_r$$

Putty-Clay Technology - Idea



Putty-Clay Technology - Implementation

$$Y_{rt} = (1 - \delta)Y_{r,t-1} + YN_{rt}$$

$$L_{rt} = (1 - \delta)L_{r,t-1} + LN_{rt}$$

$$E_{rt} = (1 - \delta)E_{r,t-1} + EN_{rt}$$

$$N_{rt} = (1 - \delta)N_{r,t-1} + NN_{rt}$$

$$KN_{rt} = I_{r,t-1}$$

$$YN_{rt} = f(KN_{rt}, LN_{rt}, EN_{rt}, NN_{rt})$$

Non-Electric Technologies

`oilnon`	Oil
`gasnon`	Natural Gas
`cldu`	Coal - direct use
`renew`	Renewables (low cost, limited quantity)
`nebak`	Non-electric backstop (high cost, unlimited quantity)

Electric Technologies

`hydro`	Oil
`gas-r, gas-n`	Natural Gas (remaining and new-vintage)
`coal-r, coal-n, coal-ccs`	Coal (remaining, new-vintage, carbon capture and storage)
`nuc-r, nuc-n`	Nuclear (remaining and new vintage)
`adv-lc,adv-hc`	“Advanced” (low cost and high cost)

Decision Variables and Logic

Energy supply by technology:

$$X_{irt} \geq 0$$

Expansion and contraction constraints:

$$(1 - \psi_i)X_{irt-1} \leq X_{irt} \leq (1 + \epsilon_i)X_{irt-1} + \bar{x}_{ir}$$

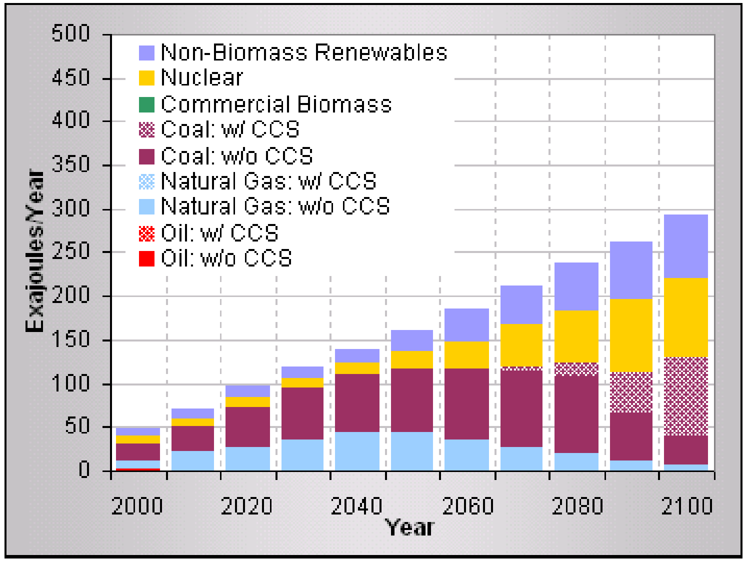
Energy costs:

$$EC_{rt} = \sum_i c_{irt} X_{irt}$$

Electric and non-electric supplies:

$$E_{rt} = \sum_{i \in \mathcal{E}} X_{irt}, \quad N_{rt} = \sum_{i \in \mathcal{N}} X_{irt}$$

Global Electric Energy Production

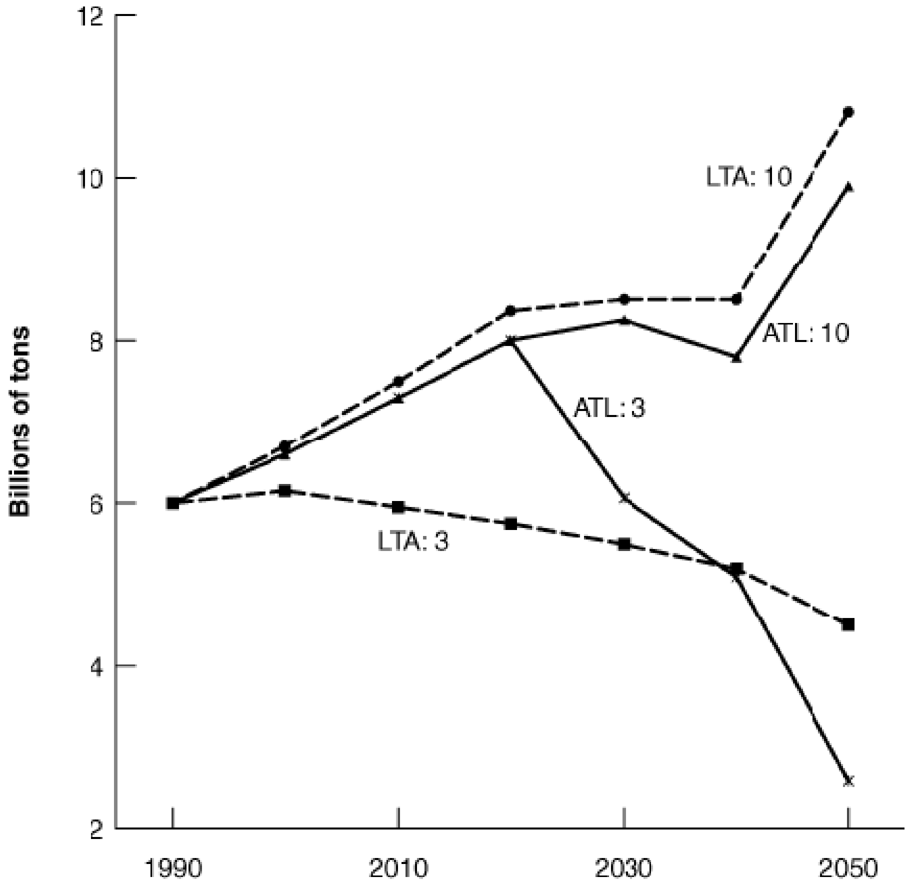


2. Global 2100 (1992)

- Multiple infinitely-lived representative agents (budget constraints and distributional analysis)
- Carbon emissions coefficients.
- Climate model
- Hedging decisions with stochastic programming (ATL versus LTA)
- Cost effectiveness analysis

Stochastic Progamming for Beginners

“Learn then act” versus “act then learn”.



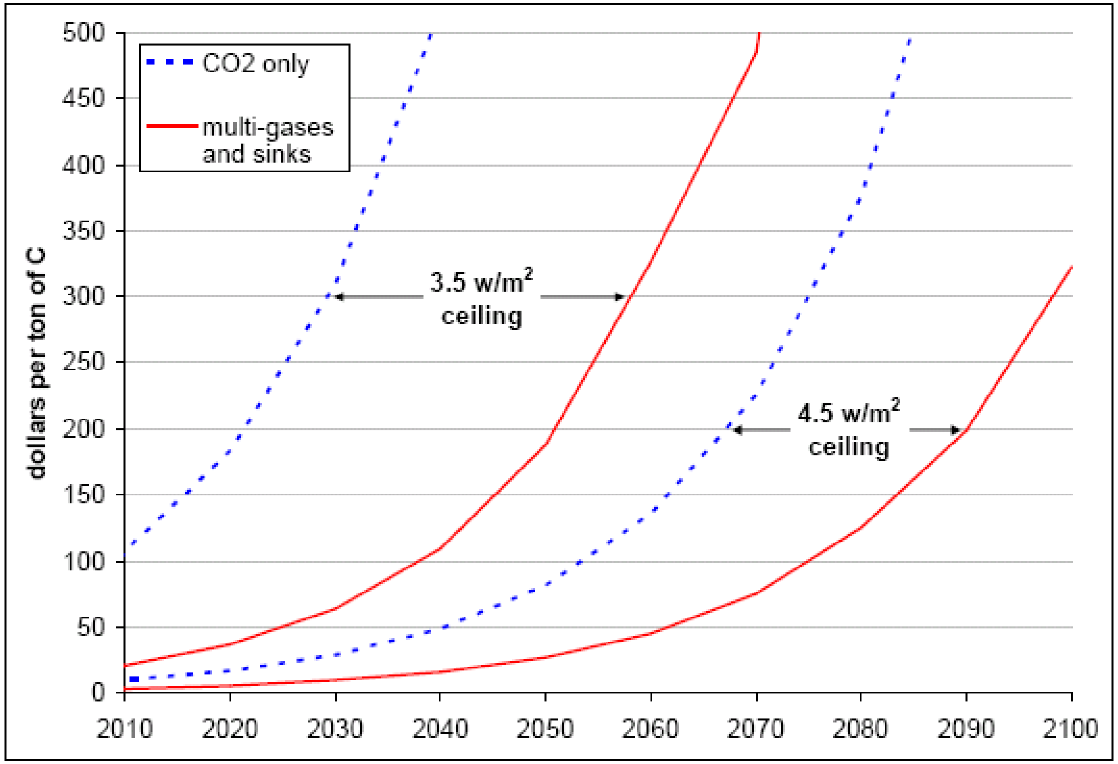
12
10
8
6
4
2
Billions of tons
LTA: 10
ATL: 10
ATL: 3
LTA: 3
1990
2010
2030
2050

3. MERGE (1995)

- Other greenhouse gases (methane, nitrogen oxides, HFCs)
- Market and non-market damages
- Integrated assessment

EMF21 Analysis of Multigas Issues (2005)

Figure 5. Comparison of Carbon Taxes



Alan's Legacy for My Own Work

- Strunk and White: required reading in Operations Research
- GAMS-MINOS: Three Examples
- Occam's Razor
- Virtues and existential pleasures of careful bean counting
- The fable of the tortoise and the hare.