

Curriculum Vitae, April 2016

**TERRY BARKER**

- 2013- **Honorary Professor**, School of Environmental Sciences, Faculty of Science, **University of East Anglia**, from August 2013
- 2011- **Senior Department Fellow, 4CMR**, Cambridge Centre for Climate Change Research, Department of Land Economy, University of Cambridge
- 2009 Contributor to the **IPCC's Scoping Meeting** for the Fifth Assessment Report, held in Venice, 13-17 July, 2009.  
Member of the **Scientific Committee of the Climate Change Congress**, Copenhagen, organised by the International Alliance of Research Universities, March 2009, and member of the Writing Team of the Synthesis Report of the Congress
- 2009- Member, **Scientific Advisory Board of the World Wide Views on Global Warming** ([www.wwviews.org](http://www.wwviews.org)).
- 2008 **Royal Society of Chemistry**, Environmental Chemistry Group, **Distinguished Guest Lecturer Medal for 2008**
- 2008- Member of the Editorial Boards of the *International Journal of Climate Strategies and Management* and of the *International Journal of Global Warming*.
- 2007 Contributor to the award of the **Nobel Peace Prize** to the IPCC (as a leading author in the IPCC's Third and Fourth Assessment Reports)
- 2006-2011 **Founder and Director of 4CMR, Cambridge Centre for Climate Change Mitigation Research**, Department of Land Economy, University of Cambridge and **Leader of the Tyndall Centre's** Integrated Modelling programme of research in Phase 2 of the Centre's funding.
- 2005- **Founder, the Cambridge Trust for New Thinking in Economics**
- 2004-2007 CLA, **IPCC Working Group III** for the Fourth Assessment Report 2007; Co-chair of WGIII Crosscutting Group on costs of mitigation
- 2002 Member of **The Royal Society** working group on economic instruments
- 1998-2001 **Coordinating Lead Author (CLA), Intergovernmental Panel on Climate Change (IPCC) Working Group III** for the Third Assessment Report *Climate Change 2001*; **Member of the Core Writing Team** of the *Synthesis Report of Climate Change 2001*
- 1993- Member of Editorial Board, *Economic Systems Research*
- 1976-87 **Director of the Cambridge Growth Project (CGP)**
- 1978-1983; 1985- **Chairman of Cambridge Econometrics Limited**
- 1977-1978 Director of Studies in Economics, Downing College, Cambridge
- 1976 Visitor, **Economic Council of Canada**, Ottawa, Canada
- 1974-1975 Assistant Editor of the *Economic Journal*
- 1974 Research Fellow, Institute for International Economic Studies, **University of Stockholm**
- 1965- University of Cambridge**
- 2005-2011 Senior Research Associate, Department of Land Economy
- 1973 **Ph.D. (Cantab.):** The major determinants of British visible imports
- 1972-2005 **Senior Research Officer**, DAE
- 1966-1977 Fellowship at **Downing College**, Cambridge
- 1969-1972 **Research Officer**, DAE
- 1966 **M.A. (Cantab.)**
- 1965-1969 **Junior Research Officer**, Department of Applied Economics (DAE)
- 1961-1965 **University of Edinburgh**
- First Class merit certificates in Political Economy, Mathematics and Fine Art.  
Class medal (top of class) in Economic Science final year and awarded M.A.(Hons)(Economic Science) II.I, and other distinctions, awards and prizes
- 1963 **London College of Music**

Awarded the Diploma of Associateship for **Speech**, with the right to use the letters  
**A.L.C.M.**

**Invited Keynote Lectures and other Presentations 2006-2016**

- 15 April 2016: “Scientific Economics: new economics vs. old economics”, given at the University of Piraeus, Greece.
- 13 May 2013: “The costs of stringent climate policy: what are the costs? and were the IPCC AR4 estimates biased in being too low?”, Invited Guest Lecture presented to the BEEER 2013 conference, organized by The Norwegian School of Economics, Department of Business and Management Science, Bergen, Norway.
- 23 April 2013: “Neoclassical economics as a pseudoscience”, presented in the Adam Smith Building to the School of Social and Political Sciences, University of Glasgow as a public lecture.
- 6 March 2013: “How neoclassical economic thinking has led to ecological disaster”, presented to the Big Picture Seminar Series, University of Greenwich, London.
- 31 January 2013: “The financial crisis and the world economy: when can we expect a return to normal?” presented to Leeds University Business School (LUBS) Economics Seminar, Leeds, and also to the St Catharine's Political Economy Seminar in the series on the Economics of Austerity, Cambridge (on 6 February 2013).
- 22 September 2011: “The global macroeconomic rebound effect of energy efficiency policies: an analysis 2012-2030 using E3MG” presented to Institute of Mechanical Engineers annual conference on “Future climate 2 – the challenge continues”, London.
- 4 May 2011: “The ‘whole systems’ approach in ecological economics”, presented to a conference on “The Political Economy of the Environment”, Oxford.
- 14 April 2011: “A new economics approach to modelling policies for climate change mitigation” presented to a conference on “Economic policies of the new thinking in economics”, Cambridge.
- 26 October 2010: “Modelling co-benefits of climate change mitigation with an application to Mexico”, presented to a seminar at the Sustainability Research Institute, School of Earth and Environment, University of Leeds.
- 6 October 2010: “Modelling for Climate Change Mitigation in 4CMR”, presented to a meeting held at the Department of Energy and Climate Change, London.
- 25 August 2010: “Technological change and economies of specialisation and scale in economic models of climate change mitigation” presented at the panel on “The new economics of climate change” in the ISEE Conference on ‘Advancing Sustainability in a Time of Crisis’, Oldenburg, Germany.
- 2 July 2010: “Proposed theoretical foundations of ‘New Economics’: values, resources, money, growth and policy”, presented to the Special Session on “The New Economics as Mainstream Economics” in the 7th International Conference on Developments in Economic Theory and Policy, University of the Basque Country, Bilbao, Spain.
- 27 May 2010: “Achieving the 2°C target in the Copenhagen Accord: an assessment using a global model E3MG”, presented at the Chinese Academy of Science, Beijing, China.
- 25 May 2010: “Economic impacts of climate change and climate policies”, presented to the Workshop organised as a contribution to the China Guangyuan Low-carbon Reconstruction Project funded by UK Dfid’s Facility for Post-Disaster Emergency Response, Guangyuan, Sichuan Province, China..
- 9 March 2010: “Achieving the 2°C target in the Copenhagen Accord: an assessment using a global model E3MG”, presented to the Institute for Sustainable Energy and the Environment (I-SEE), the University of Bath, UK.
- 25 February 2010: “Energy-environment-economy (E3) modelling of climate policies illustrated by environmental tax reform for Europe”, presented to an international workshop at the European Bank for Reconstruction and Development (EBRD), on “The economics of climate change in the EBRD region” organised by the EBRD, London.
- 28 January 2010: “Proposed theoretical foundations of ‘New Economics’: values, resources, money, growth and policy”, presented to a conference on “The New Economics as ‘Mainstream’ Economics”, Murray Edwards College, Cambridge.

- 16 December 2009: “400ppmv by 2100: A combination of policies for carbon pricing and regulation for energy and carbon efficiency. Results from the E3MG model”, presented at the COP 15, Copenhagen, December 2009, side-event “The economics of climate change – Research from different evidence lines from global to European analysis” organized by the European Commission.
- 26 November 2009: “Climate Change and EU labour markets” presented to the Conference on “Employment in Europe 2009”, organized by DG EMPL- D1 “Employment Analysis”, Brussels.
- 6 November 2009: “Climate Policy: Burden or Opportunity?” presented to the conference on “Beyond the Financial Crisis: Globalization at the Crossroads”, organized by the European Climate Foundation, November 5-6 2009, Berlin, Germany.
- 31 October 2009: “Assessment of the risks of depression and deflation after the 2008 “Big Crunch”: a “New Economics” modelling perspective”, presented to “The World Economy in Crisis – The Return of Keynesianism?”, 13th Conference of the Research Network Macroeconomics and Macroeconomic Policies (FMM) 30–31 October 2009, Berlin, Germany.
- 26 October 2009: Chair, DG Regio Seminar on Cohesion Policy and Climate Change, Expert Group meeting in Brussels.
- 20 October 2009: “Achieving greenhouse gas mitigation targets through carbon-price policies”, presented to the course for Chinese Leaders organized by the Cambridge University Programme for Sustainable Leadership, held in the Moeller Centre, Churchill College, Cambridge, October 2009.
- 15 October 2009: “The global macroeconomic rebound effect of energy efficiency policies: an analysis 2012-2030 using E3MG” presented to the UK Department for Energy and Climate Change, London.
- 9 October 2009: “The Copenhagen Scientific Congress 2009 and IPCC AR4 WG3 2007: achievements, revealed gaps and opportunities”, presented to the ITERREG Conference on Climate Change: Mitigation and Adaptation”, Rotterdam, October 8-9, 2009
- 8 October 2009: “The Financial and Climate Crises: the same causes and the same solution”, presented to npower, Worcester, UK.
- 28 September 2009: “Cutting the cost: the economic benefits from collaborative climate action”, presented in a webinar organised by The Climate Group in the series “Breaking the Climate Deadlock”.
- 26 September 2009: Panel member on a global webinar on climate change, adaptation and mitigation organized by the World Wide Views on Global Warming ([www.wwviews.org](http://www.wwviews.org))
- 19 September 2009: “Resolving the financial, climate and energy crises by bankrupting the bad banks etc.” Briefing for Friends of Le Monde Diplomatique seminar “The Energy Crisis: Facts and Remedies”, London.
- 20 July 2009: “The Energy-Environment-Economy (E3) econometric Model at the Global level, E3MG, in CIAS” presented to the UK Department for Energy and Climate Change, London.
- 11 July 2009: “The future of the world economy: projections using E3MG” Panel Session 4, Association for Heterodox Economics 11th Annual Conference, Kingston University, London, July 9-13.
- 7 July 2009: “Resolving the financial and climate crises by a global investment plan”, Keynote address to the Global Conference on Global Warming 2009, July 5-9, Grand Cevahir Hotel, Istanbul, Turkey.
- 2 July 2009: “Endogenous money in 21st century Keynesian economics”, the session on “21st Century Keynesian Economics” of the 6th International Conference Developments in Economic Theory and Policy, Bilbao, Spain.
- 30 June 2009: “Forecasting and resolving the global financial crisis with projections using E3MG”, to be presented to the “Conference on the Financial and Economic Crisis”, Boadilla del Monte, Madrid, Spain.
- 8 June 2009: “Climate change, climate policy and the financial crisis”, presented to the PETROSAM

- Seminar, Holmen Fjordhotell, Asker, Norway.
- 22 May 2009: “DECarbonising International Transport” (with Annela Anger) presented to the “Post-2012 Policies for Shipping” workshop, Madingley Hall, Cambridge. (Tyndall)
- 19 May 2009: “The financial crisis and low-carbon pathways”, for the introduction to session 1 titled ‘Current Futures’ to the conference on “Pathway toward low carbon society and global sustainability”, UEA, Norwich.
- 14 May 2009: “The global macroeconomic rebound effect of energy-efficiency policies: an analysis 2012-2030 using E3MG”, presented to the Cambridge Energy Forum and 4CMR Seminar on “On the rebound: could energy efficiency improvements backfire”, Cambridge.
- 8 May 2009: “Endogenous money in the global economic system”, presented to the conference on “21st Century Keynesian Economics”, SOAS, University of London.
- 24 April 2009: “The Financial and Climate Crises: the same causes and the same solution”, public lecture for the Department de Architecture Universidad Iberoamericana, Mexico (cancelled due to flu epidemic).
- 17 April 2009: “New economics”, climate control and air pollution: decarbonising scenarios for Mexico to 2050”, presented to the IXVIII Conferencia Internacional on “Políticas heterodoxas para desarrollo y la paz en América Latina”, UNAM, Mexico City.
- 14 April 2009: “Effects of climate control on air pollution in decarbonising scenarios for Mexico to 2050: coupling of an energy-environment-economy (E3MG) and atmospheric chemistry model (p-TOMCAT)”, “International Conference on Water, Environment and Health Sciences: The Challenges of Climate Change” (ICWEHS), Cholula, Mexico.
- 13 April 2009: “The Effect of Climate Control on Air Pollution: an economist’s perspective”, invited Keynote Speaker for ICWEHS, Cholula, Mexico. (Tyndall)
- 25 March 2009: “The new research agenda for climate modelling: towards AR5 and after the ‘21C Greater Depression’” presented to the conference on “How can climate policy models shape real decisions? From the best use of state-of-the-art to a new research agenda” IDDRI and CIRED, Paris. (Tyndall and ADAM)
- 24 March 2009: “Modelling the 2008 global depression: after the Big Crunch 2009-2020 using E3MG-UK”, presented to a Department of Land Economy workshop, Cambridge University, Cambridge.
- 16 March 2009: “The IPCC WG3 process and findings and the “new economics” of climate change, and the implications of the financial crisis”, presented to Chevening Fellowship Programme: Economics of Climate Change, Wolfson College.
- 10 March 2009: “IPCC WG3 2007: achievements, revealed gaps and opportunities”, presented to a special session, Copenhagen Scientific Congress on Climate Change organized by 4CMR and the Royal Society on “Mitigation of Climate Change: filling the knowledge gaps revealed by AR4”.
- 26 February 2009: “Projections of the “return to normal” of the global economy 2009-2010”, presented to the St Catherine’s Political Economy Seminar in the series: “The Financial Crisis: causes and Impacts”, Cambridge University, Cambridge.
- 24 February 2009: “Projections of the effects of a “Housing Action Plan”: construction, CO<sub>2</sub> emissions and the UK economy after the Big Crunch 2009-2020 using E3MG-UK” presented to a Homes and Communities Agency and Cambridge Econometrics Conference on “Retro-fit for Purpose” held at the Royal Society of Arts and Manufactures, London.
- 12 February 2009: “The global financial crisis and implications for climate policy”, presented at a research seminar, Environmental Institute, University of East Anglia.
- 13 December 2008: “The Financial and Climate Catastrophes: the same causes and the same solution” Presentation to the Franco-British Student Alliance Summit, Cambridge.
- 11 December 2008: “Including Aviation in the EU ETS versus a Global Emissions Trading Scheme for international transport” Presentation to Omega workshop, Department for Transport, London (with Annela Anger)
- 28 November 2008: “The Global Deal: treating anthropogenic climate change as an economic

- internality”, Presentation to the research seminar on “Complexity Economics for Sustainability” supported by the UK ESRC and the Environment Agency, Oxford, 27-28 November 2008.
- 21 November 2008: “Causes, consequences and solutions to the global financial crisis” given to the Conference on “The Big Crunch and the Big Bang: how to get out of the global financial mess”, Murray Edwards Hall, Cambridge.
- 14 November 2008: “Energy-environment-economy (E3) modelling of climate policies from the IPCC TAR to the AR4: why we need more “new economics” models” webinar presentation in “Towards the next generation of climate policy models” Potsdam Institute for Climate Impact Research (PIK).
- 13 November 2008: “Re-booting the global financial system by bankrupting the bad banks”, seminar given to the Queens’ College series, Cambridge 2008.
- 17 October 2008: Policies for reducing personal carbon: introduction to the CRASSH Climate Change Conference “Representing Climate Change: Ecology, Media and the Arts”, Cambridge.
- 8 October 2008: Verbal evidence to the House of Lords Select Committee on European Affairs on the “EU emissions trading system”, London.
- 1 October 2008: “The Big Crunch and The Big Bang in Global Financial Markets”, Environment Agency, London.
- 22 September 2008: “Economics of a Zero-Carbon Society: *transitional climate policies after the “big crunch”*”, invited Keynote Speaker at the First International Summit on Policy, Technology and Investment: Entrepreneurship for a Zero Carbon Society, University of Cambridge, UK. Also given in the Webinar Presentation for “macroeconomic briefing”, The Climate Group 9 October 2009 and for the Cambridge MPhil, Architecture, 17 October 2008.
- 15 July 2008: “Decarbonising transportation”, Defra, London.
- 10 July 2008: “Avoiding dangerous climate change: the role of input-output in modelling a zero-carbon global economy”, presented to “Economic Futures: A Session in Honor of Emilio Fontela (1938-2007)” 2008 International Input-Output Meeting Input-Output & Environment, Seville.
- 7 July 2008: “Global and Sectoral Mitigation Potentials to 2030 and the Carbon Price: towards decarbonising the global economy”, First Keynote address to the First Global Conference on Global Warming 2008, July 6-10, Dedeman Hotel, Istanbul.
- 27 June 2008: “A Global Emissions Trading Scheme for international transport” invited presentation to “Aviation: post Kyoto control structures, 947th Wilton Park Conference”, in partnership with OMEGA and support from Defra, BERR and DfT (with Annela Anger-Kraavi) (also to UK Defra)
- 6 June 2008: “Achieving the 2°C target through ecotax reform and carbon trading: implications for the EU and its Member States”, invited keynote presentation given to a seminar organized by the Netherlands Ministry of Finance in cooperation with the National Academy for Finance and Economics on ‘Towards an optimal tax structure, shifting to indirect taxation?’, Rijksacademie, Den Haag (also presented to UK Defra, 15 July, 2008 and N-Power, 8 September 2008)
- 5 June 2008: “Climate change mitigation and oil prices”, invited external expert presentation given to a meeting on “The impact of high oil prices in Europe”, Final HOP! Conference, Brussels.
- 22 May 2008: “Competitiveness and the EU’s 2°C target: Implications of recent scientific findings”, presented to the European Forum for Science and Technology, Prague “Efficiency of the European Science and its Global Competitiveness”, Prague, Czech Republic.
- 16 May 2008: Chair with introduction for the Workshop on “Policies to reduce personal carbon”, 4CMR and Cambridge Energy Forum, Pitt Building, Cambridge.
- 9 May 2008: “Economic costs and benefits of climate change, adaptation and mitigation: Implications for global climate policy of recent scientific findings”, presented to workshop of EU climate negotiators, held at Lake Bled, Slovenia.
- 7 May 2008: “Technological change and technological policies” presented to the International Expert Meeting on “Bottom-up Based Analysis on Mitigation Potential ~ Interaction among modelers,

- sectoral stakeholders, and policy analyst”, Novotel Paris Tour Eiffel, Paris, France. Organised by MOEJ and NIES, Japan.
- 22 April 2008: Chair, First International Scientific and Business Congress on Protecting the Climate, A World Joint Strategy, Frankfurt City Hall, Germany. “Economic costs and benefits of climate change, adaptation and mitigation: implications for business of recent scientific evidence” and “Reforming the global financial System to support decarbonisation”.
- 17 April 2008: “Costs and benefits of a zero-carbon economy by 2050”, Plenary speaker in the opening session, ECT2008 Energy-Climate-Technology: Bringing Solutions to Big Challenges, Bergen.
- 12 March 2008: “Achieving the 2°C target through carbon trading”, Royal Society of Chemistry, Distinguished Guest Lecture at the Environmental Chemistry Group Symposium on “The Science of Carbon Trading”, Burlington House, London, with medal. Also given in The Smith School, Oxford, 27 November 2008.
- 8 February 2008: “Modelling the costs of mitigation” Defra, London.
- 6 February 2008: “The economics of avoiding dangerous climate change”, The Global Student Forum Regional Conference, Stephen Perse Sixth Form College – Perse School for Girls, Cambridge.
- 31 January – 1 February: Chair, IEA-OECD Joint Transport Research Centre Roundtable on “The costs and effectiveness of policies to reduce vehicle emissions”, IEA, Paris.
- 30 January 2008: “Scenarios, modelling and meta-analysis: what can we learn from the Stern Review and the IPCC?”, UKERC Annual Energy Modelling Conference on “Scenarios”, Oxford.
- 20 November 2007: “The economics of avoiding dangerous climate change”, Corporate Leaders Group, Trinity Hall, Cambridge
- 18 October 2007: “The contribution of Environmental Tax Reform (ETR) to EU growth and employment: ex post evidence from ETRs in 6 EU Member States 1995-2010”, Keynote speech at the opening plenary session of the 8th Annual Global Conference on Environmental Taxation, Munich, Germany.
- 12 October 2007: “The economics of avoiding dangerous climate change”, given at the Second William Pitt Seminar, on Climate Change: approaches to its consequences and challenges”, Pembroke College, Cambridge.
- 12 September 2007: “The economic costs and benefits of avoiding dangerous climate change” given at the International Conference on Climate changes Spatial Planning, The Hague, The Netherlands, also given at HEEDnet Seminar, Office for Climate Change, London, 21 June, 2007, and at the conference on “Climate Change – what is known and how should we act?”, The Norwegian Academy of Science and Letters, Oslo 17 April, 2007.
- 26 June 2007: “IPCC WG3 2007: Global and Sectoral Mitigation Potentials, Technology, and the Costs of Climate Stabilization”, The International Energy Agency/Energy Modeling Forum/ Resources for the Future, International Energy Workshop, Stanford, California.
- 13 June 2007: oral evidence given to the Joint Parliamentary Committee on the Draft Climate Change Bill, London, on behalf of the Royal Society.
- 12 June 2007: “Macro-economic costs and benefits of climate stabilization” given at a conference organized by DG Environment during “Green Week”, Brussels DG Environment, Brussels.
- 21 March 2007: “Avoiding dangerous climate change through environmental tax reform” Keynote presentation given to the Workshop on Competitiveness and Environmental Tax Reform in Europe (COMETR), Brussels.
- 19 February 2007: “Financing the Stern global mitigation target: sources, scale and choice of incentives” given at the Tyndall Stakeholder Conference on “Financing international investment in low-carbon technologies”, Insurance Hall, London
- 14 February 2007: “After Stern: the Economics of Avoiding Dangerous Climate Change” given at the Federal Ministry of Economics and Technology Conference on “Time to Adapt – Climate Change and the European Water Dimension”, Berlin.

- 15 December 2006: “Avoiding dangerous climate change: policy interventions that could make a difference” given to HRH Prince of Wales Programme on Leadership for Business and the Environment, London
- 6 December 2006: “Top-Down & Bottom-Up linkages in a global E3 econometric model, E3MG”, to the Annual Energy Modelling Conference of the UKERC “Quantifying Energy Scenarios of a Low Carbon Society” (joint UK-Japan meeting on energy modelling), Oxford
- 25 September 2006: Presentations at DTI on “Macroeconomic Rebound Effect of Energy Efficiency Policies” and “The Macroeconomic Costs of Avoiding ‘Dangerous Climate Change’”
- 27 July 2006: Presentations at Defra on “Macroeconomic Rebound Effect of Energy Efficiency Policies” and “The Macroeconomic Costs of Avoiding ‘Dangerous Climate Change’”
- 26 July 2006: “Macroeconomic Rebound Effect of Energy Efficiency Policies” presentation to Environment Agency, London
- 16 June 2006: “A Meta-analysis of the Literature on Costs of Mitigating GHG 2000-2100” presentation to The Stern Review Team, HM Treasury, London
- 24 April 2006: “Macroeconomic Rebound Effect of Energy Efficiency Policies” presentation at Defra, London with Tim Foxon
- 11 April 2006: “UK leadership on climate policy: Potential impact on economic growth and competitiveness” given to Prince of Wales’ Business and Environment Programme Business Leaders’ Forum, London
- 28 March 2006: “Economics and Timing of CO<sub>2</sub> Mitigation” presentation at Imperial College Course on “Climate Change: Science, Impacts and Responses”:
- 2 March 2006: “Modelling induced technological progress in climate stabilization scenarios” presentation to the Workshop on “Understanding transatlantic differences”, Resources for the Future, Washington DC
- 20 February 2006: “Modelling Climate Change Mitigation through Accelerated Technological Change in E3MG: Why the Global and Chinese Economies may Benefit?” presentation to a Conference organized by The Chinese Academy of Social Sciences, Beijing.

## ***Research Interests***

### *Greenhouse gas mitigation*

When the potential problem of climate change became evident in the late 1980s, I shifted the focus of my research from more general economic modelling wholly to energy-environment-economy modelling and climate change mitigation using economic instruments. The main areas of applied work here are the empirical assessment of the ‘double dividend’, the effects of environmental policies on international competitiveness, and the effects on equity. This research has been and is carried out via E3 models at the UK, the European and global levels, as projects in 4CMR in the Department of Land Economy and previously in the Department of Applied Economics in the University of Cambridge. The development of the UK MDM-E3 was funded by the ESRC Global Environmental Change Programme; that of the E3 Model for Europe (E3ME), a comparable model of the EU Member States, was funded by the European Commission; and more recently the global model E3MG, was funded by Research Councils, UK, via the Tyndall Centre, and by Cambridge Econometrics. All these models are state-of-the-art in terms of their use of data, coverage of macro economies in detail, and sophistication of the modelling of policy options and effects, for example in the estimation of ancillary benefits of GHG mitigation for the EU. The models have been and are used extensively in policy studies funded by governments.

### *Economic systems*

My interest in economic system research started in the Cambridge Growth Project (CGP) when I took responsibility for the overall design of the model. This was to lead to the development of the multisectoral dynamic model (MDM) beginning in 1976. The original CGP idea was to have two models, one static and the other dynamic. However, there was a problem in that the static model had



no satisfactory empirical basis. How do we know if an economy is in static equilibrium at any time? The merging of the two models into one solved this problem by replacing the idea of an equilibrium solution with one of a long-run solution that is a characteristic of the model rather than any specific year's data and that is not necessarily in equilibrium. I came to the conclusion at this time that the concept of equilibrium was over-worked and misleading in the understanding of economic behaviour. My interest in systems was complemented by one in the applied econometrics of aggregation, another aspect of my PhD thesis. I am now working on the problems of solution stability in this class of simulation models, focused on annual projections 2013 to 2050 using the global model E3MG and scenarios for a reference case, a decarbonisation case and a low-growth case.

### *Energy modelling*

Interest in energy modelling was sparked by the oil price crises of the 1970s and the effects on the economy of exploitation of the UK's North Sea oil. From 1984, this interest was focussed on the reconstruction of OPEC's World Energy Model (OWEM) as an econometric energy-economy model. OWEM had originally been built mainly as an 'energy engineering' bottom-up model of energy demand and supply by team led by E.L. Dougherty, a petroleum engineer from the University of Southern California. But it failed to produce sensible or usable results. The value of the econometric approach is demonstrated by the fact that the reconstructed OWEM has continued to be developed and used by the Secretariat and the Organisation ever since. OWEM was, and to my mind still is, one of the most advanced global energy-environment models ever developed. For example, by 1989 it had a fully endogenous and dynamic solution for the world oil price 1970-2010, and it could also be solved over the past to provide *ex post* forecasting errors for world energy demand by fuel and fuel user and for world GDP. This makes it comparable in method, although not in terms of complexity or size, to the Hadley Centre models of climate change, which can also simulate the past e.g. historical changes in global mean temperatures. The world model E3MG is a successor to this work.

### *Economic policy*

My interest in economics started at Edinburgh University, inspired by lectures by Alan Peacock on economic policy, instruments and targets in 1961. This interest has continued throughout my professional career. As part of my final year in 1965, I studied the development of the National Plan for faster economic growth, published in 1964 by the UK Department of Economic Affairs. The research underlying the Plan was partly based on the economic growth model of the Cambridge Growth Project (CGP) in the Department of Applied Economics (DAE), University of Cambridge. The DAE had an international reputation as one of the leading centres for applied economics and econometrics. The CGP, had been founded by Richard Stone and Alan Brown in 1959, and was a team of 6-8 economists developing a large-scale econometric model of the British economy for economic research, forecasting and policy-making. I joined the project in 1965 to work with Richard Stone, who had been the first Director of the DAE and who had worked under John Maynard Keynes during the war. I continue to work on policy, but this is now oriented towards environmental policies and policies to resolve the financial crisis.

### *International trade*

When I joined the CGP I was assigned to work with Richard Lecomber on the foreign trade side of the model, which had proved problematic. The National Plan became discredited as a result of balance of payments crises partly due to increases in imports, which were not anticipated in the official and CGP results; sterling was devalued in 1967. The work on imports became my thesis topic, with Richard Stone as my supervisor. One aspect of the research was the development of a new theory of international trade. The variety hypothesis sets aside the orthodox explanation of trade as a special and partial case and lays the foundation for an alternative view of economic behaviour based on economies of scale and specialisation, indivisibilities and heterogeneity in production, in consumption and amongst people and social groups. The hypothesis was first published in 1970 in the Programme

for Growth series, number 10, co-authored with Richard Stone, and embodied as a central part of my thesis (examined by James Ball and David Champerknowne), which was accepted for my PhD in 1973. The full hypothesis was presented in a paper given at the Institute for International Economic Studies, Stockholm in 1974, eventually published in 1977 in the *Cambridge Journal of Economics*. The theories underlying these ideas have more recently been extended to the economic system in general in my book *Space-Time Economics* published as a limited edition in 1996. I am now working on a second edition.

*The role of money in the financial crisis 2007-*

One aspect of my book *Space-Time Economics*, 1996, concerned the central role of money in all modern economies, further developed in the paper 'Endogenous money in 21 Century Keynesian economics' published in 2010 (see below). This gives a perspective on the causes and solutions to the financial crisis and its aftermath. My conclusion was that the bad banks should have gone bankrupt and much of the debt (to be interpreted as the consequence of a collapse in the quantity of money in the system) extinguished. Instead the banks were bailed out and the state took on much of the debt and the risk. The outcome has been, predictably, a slow-growth economy, with banks holding very large but unrecognized "bad money" in the form of various derivatives and other financial assets based on falling values of property. The system continues to be at high risk of countries and banks defaulting, but the outcome of more state debt seems implausible. I am working on the various policy regimes that may emerge from the next crisis, which may be very different from the last one.

## ***Research Leadership and Management***

*The International Panel on Climate Change (IPCC)*

The IPCC represents the largest and most sustained scientific endeavour the world has ever seen in numbers of disciplines involved, time and resources spent, and weight of advice to governments. I was chosen for my economic expertise by the UK government to join the other experts from across the world in all disciplines. At the meeting of experts to start the 2001 process, I proposed that a new chapter (i.e. one that was not in the Second Assessment Report) on the global sectoral costs of mitigation (i.e. the costs for the world's oil and coal industries) be included in the Working Group III Report. This was accepted by the meeting and I was appointed by a peer-review process to be one of the two Co-ordinating Leading Authors for Chapter (Sector Costs and Ancillary Benefits of Mitigation). I instigated an IPCC Expert Workshop to stimulate research and publications. The proceedings were published and the new knowledge was taken on board in the various meetings. I led the writing team for Question 9 of the Synthesis Report (chaired by Bob Watson, Chief Scientist of the World Bank): 'What are the most robust findings and key uncertainties regarding the attribution of climate change and regarding model projections of: Future emissions of GHGs and aerosols, Future concentrations of GHGs and aerosols, Future changes in regional and global climate, Regional and global impacts of climate change and Costs and benefits of mitigation and adaptation options?'. I was active in the many meetings and negotiations in developing the answer and resolving issues with governments when the Policymakers' Summary was discussed. I also played a leading part in the debate in the multidisciplinary writing team on the representation of climate change, adaptation and mitigation (*Global Environmental Change*, 2003).

I was an active participant in two major international meetings, involving hundreds of delegates in Accra, February-March 2001, and London, Wembley, September 2001. I represented (on the platform and in side meetings) the expertise of the scientific community in explaining the assessment of mitigation costs to governments. I subsequently addressed major conferences on the economic findings of the IPCC in 2002 in Bonn (organised by the UNFCCC), in London (organised by The Royal Society) and in Beijing (organised by the IPCC outreach programme). As an impartial, unbiased academic expert, I was involved in the highly politically charged discussions on text for the Policymakers' Summary between representatives of the UK, Australia, Saudi Arabia and the US. In

2004 I was appointed to be the Coordinating Lead Author for Chapter 11 ‘Mitigation from a cross-sectoral perspective’ of the IPCC Fourth Assessment Report, published in 2007. This chapter covers the macroeconomic and sectoral costs and benefits of mitigation, including environmental co-benefits.

#### *Teams in the European Union*

Over the period 1993-2000, I led and co-ordinated an international consortium from EU Member States, building and applying the large-scale E3 regional model, E3ME, mentioned above, covering the (then) 12 member states of the EU and designed to explore efficient, effective and equitable ways of reducing greenhouse gas emissions. The model is based on a regionalised version of the CGP MDM for the UK and is in effect a continuation and development of the earlier DAE modelling work in this area. The team building and applying the model is an international European one. The work involved research activities across nationalities and disciplines and produced a successful conclusion, no small achievement in the European research context.

#### *The CGP*

My experience and skills in research leadership and management were developed during my membership of the CGP and inspired by Richard Stone. By 1972 I had become the effective research manager of the CGP with responsibility for arranging the funding (which continued until the project ended in 1987) and becoming the Director in 1983. This was one of the largest and sustained research efforts in econometric modelling in the UK, with a substantial output of papers in books and refereed journals, international conference presentations and software. Over 1976-78 I led the CGP team that created Cambridge Econometrics and its forecasting and analysis service, becoming Chairman of the company (see below). This has become one of the leading consultancies of its kind in Europe, with a current staff of 25. In 1989-95 I led a smaller team in the DAE developing the UK MDM-E3 system. The project was completed in 1993 and the research results were given the highest grade – ‘outstanding contribution to knowledge’ - by the ESRC's independent assessors.

#### *4CMR (Cambridge Centre for Climate Change Mitigation)*

Understanding the complexities of the climate problem and solution requires interdisciplinary research, and an approach which recognizes that the evidence is overwhelming that a long-run stable equilibrium is unlikely for the climate or the economy. We know from chaos theory and observations of the natural and human systems that change is intrinsic and stability can be short-lived. It became clear in 2004 and 2005 that the Faculty of Economics and Politics, as it was then, no longer regarded applied economics or indeed non-orthodox thinking as appropriate in a Faculty of Economics, so the DAE was merged into the rest of the Faculty and the name was reduced to simply the Faculty of Economics. At the same time, the requirements of student and graduate entry into the Faculty were tightened to require the use of specialist mathematics for economics (calculus, rather than the more appropriate measure theory - see Arnold M. Faden, *Economics of Space and Time : the measure-theoretic foundations of social science*, Iowa State University Press, 1977), so excluding many of those who were qualified in energy engineering and other disciplines relevant to studying whole-systems problems, such as climate change and its mitigation. This requires interdisciplinary research. Traditional neoclassical economists have until recently assumed that technological change (like, for some, the banking crisis) comes from outside the economic system. The benefits of technological change are “like manna from heaven” to these economists; on the other side, energy engineers (with models such as MARKAL) have assumed that the economy is not affected by their technologies.

I had therefore to leave the Faculty to undertake multidisciplinary research, so I looked around and found that the Department of Land Economy was a centre in Cambridge not only for Ecological Economics but also for Post Keynesian Economics, so it was a natural home for me and my research team. 4CMR was founded at the end of 2005 with a research programme to link micro-engineering studies with the macro-economy in studies: (1) of the UK household, transportation and electricity

systems for the UK Energy Research Centre; and (2) of how different global policy regimes can be designed, not only for efficiency and fairness, but also to improve economic performance. We began with partners in the UK Energy Research Centre and the Tyndall Centre, working together on projects and cooperating in proposals for research. Our funding came from the UK Research Councils, the Government and the European Commission, through various research initiatives.

The Centre is focused on computer modelling of mitigation, or slowing down, of climate change. It would be better to stop the change, but that is impossible. But hopefully future generations are not yet committed to *catastrophic* change. The science suggests that there is an increasing chance that they will be, unless we cut and eventually eliminate greenhouse gas emissions from burning fossil fuels and tropical forests. In one way the problem and solutions are simple to understand. Add more heat to the atmosphere and it becomes more agitated. Make emissions more costly and alternatives to burning coal, oil and gas will emerge. Powerful economic forces, un-noticed and pervasive, provide incentives for new technologies and new ways of doing things, adding to the more immediate responses of saving energy. But for mitigation to happen we as societies must agree with each other to act. Cooperation must replace competition between nations in areas such as pricing of oil seen as critical to economic welfare and success. There are precedents – the Montreal Protocol on fluorocarbons is proving a success – but the mitigation problem faces stronger opposition from vested interests with deep pockets.

#### *Teams in Mexico, OPEC and Botswana*

Other experience in leading research teams has been in the building of large-scale econometric models of economies in other countries. Over the period 1976-82, I worked with Vladimiro Brailovsky in leading a government in-house team building an economy-energy model for national planning in Mexico, a big oil and gas producer. This was my first hands-on experience of understanding a developing economy. In the reconstruction of OWEM, mentioned above, I led the in-house team in Vienna over the period 1984-87 as an external consultant during leave from the DAE. I also led the team, funded by the Commonwealth Secretariat, to extend the model used by the Botswana Ministry of Finance for planning (MEMBOT) 1987-89, and to convert it for use on personal computers.

#### ***Teaching***

I am organizing and contributing to the University of Cambridge Land Economy M Phil course on climate change, adaptation and mitigation 2006-07 and 2007-08. I have supervised and examined many PhD theses. Previously I have contributed lectures to the Economics and Politics M Phil course on economics and the environment and have given several lecture courses: first on ‘Balance of Payments Adjustment’ (final-year Economics Tripos); second on ‘International Trade Theory’ (second-year Economics Tripos); third on ‘International Economic Integration’ (with Dr G. Palma and Dr J. Wells for final-year and M.Phil students); and fourth (2001-2002) on ‘Environmental Economics’ (final-year Economics Tripos). I have also organised a course of 16 lectures on Economic Modelling for the M. Phil. post-graduate course, and given classes in Statistics for final year undergraduates. When I was a Fellow of Downing College, I supervised students in each year of the Economics Tripos and those reading special subjects in the final year.

#### ***Cambridge Econometrics***

In 1977 and 1978, at the instigation of the official sponsors of the CGP (the SSRC, H.M. Treasury and the Department of Industry), members of the project founded a company, Cambridge Econometrics, to provide a commercial service using the model of the British economy developed by the project (MDM). I was Chairman of the company 1978-83 and editor of the forecasts 1981-83. The company was re-launched as Cambridge Econometrics (1985) Ltd. in 1985 under my Chairmanship. The company has published 2 to 4 long-term UK industrial forecasts a year since 1978. Following the closure of the CGP, the company took over responsibility for maintaining and

updating the CGP model. I have also acted as Joint Editor of some reports. The company is highly successful with a staff of some 30 people and has become one of the leading consultancies in its field in Europe. See [www.camecon.com](http://www.camecon.com)

### ***Other Work***

Over the past 25 years, I have acted as a consultant to the Governments of Mexico and Norway on questions of economic and industrial planning, given evidence to the UK House of Commons Select Committees on Public Expenditure and Energy, and reviewed World and European economic and energy modelling systems for the EEC, the OECD, OPEC and the Commonwealth Secretariat.

### ***Comments on***

**‘The economics of avoiding dangerous climate change. An editorial essay on The Stern Review’, *Climatic Change* (2008) 89:173-194. doi: 10.1007/s10584-008-9433-x**

*"Your editorial is excellent! I have no immediate comments, except that I am impressed by its breadth, and that I agree entirely with your assessment. But I would like to read it again more carefully, and may then come up with some comments."*

**Professor Klaus Hasselmann**, Vice President, European Climate Forum

*"It is an excellent, and much needed, paper. I hope it is widely read and discussed. .. Again it is a terrific paper. Pls send me the final copy as I would like to circulate it to a number of people."*

**Eric Beinhocker**, author of "The Origins of Wealth"

*"Thanks very much for sending me the editorial. I like it very much. It's important to stand up for Stern's method, and I'm glad you're doing it in such a forceful way."*

**Professor John Broome**, University of Oxford

*"The editorial makes some pretty good points, but ...In general, the special issue looks very good and I think will be a valuable contribution"*

**Professor John Quiggin**, Australian Research Council Federation Fellow

*"I've now read your editorial and can offer some comments. I found it very enjoyable and 'panoramic'."*

**Dr Simon Dietz**, LSE, Houghton Street, London, WC2A 2AE, UK

*"Your article makes an astonishing number of the points I would make on this subject, I'm delighted to see it will be coming out."*

**Dr Frank Ackerman**, Tufts

*"I have read your Editorial, I think it reads extremely well and you have managed to explain the economic issues so that they are understandable to a wider audience."*

**Dr Rachel Warren**, Tyndall Centre, University of East Anglia

*"I have had a quick read through the article. It looks excellent and clarifies a number of issues for me."*

**Professor Andrew Watkinson**, Director, UK Tyndall Centre for Climate Change Research

## ***Selected Research Funding***

**Three Guineas Trust (one of the Sainsbury Family Trusts), Modelling policies for accelerated decarbonisation of the global economy.** This is a major project “to fulfill the design specifications of the E3MG model of the global E3 system, funding £2.5m over 3 years 2008-2011.

**European Commission, FP6 Integrated Project on Adaptation and Mitigation strategies for Europe (ADAM).** I contributed to the successful proposal and raised funding for 4CMR. Involved in Mitigation Research at a European and Global level (M1 and M2), 1st March 2006 - 28th February 2009. Project Funding £358,552.63

**Tyndall Centre phase 2.** In 2005, I became the Leader of the innovation theme for the successful proposal for Phase 2 of the Centre’s funding 2006-2009 to 3 UK Research Councils.

**UK ERC.** In 2004, the UK Energy Research Centre was founded with Jim Skea as Director. I was one of the successful proposers (with Paul Ekins) of the theme concerned with the modelling of the UK energy system.

**Tyndall Centre phase 1.** In 2000, I was a member of the consortium that was awarded the UK Climate Change Centre (the Tyndall Centre) in a bid organised from the University of East Anglia, with the funding from 3 UK Research Councils.

**Applications of E3ME: Industrial Benefits and Costs of GHG Abatement Strategies** EC DG XII Fourth Framework Programme 1998-99 JOS3-CT97-0019 €1,360K (with Paul Zagamé)  
**Environmental Fiscal Reform** 1994-96 (European Commission DG XII project)

**E3ME An energy-environment-economy model for Europe** EC DG XII Fourth Framework Programme 1992-95 J0U2-CT92-0203 €806K

**Completion and Extension of E3ME** EC DG XII Fourth Framework Programme 1995-97 JOS3-CT95-0011 €1,108K (with Paul Zagamé)

**Greenhouse Gas Abatement through Fiscal Policy in the European Union** (European Commission (DG XII) project PL932358, amount to DAE €67K)

**Greenhouse Gas Abatement through Fiscal Policy** (ESRC project L320253107) 1993-95 (also with Paul Ekins as joint Principal Investigator)

**Policy Options for Sustainable Energy Use in a General Model of the UK Economy** (ESRC project Y320253012) 1987-93 (with Paul Ekins as joint Principal Investigator)

**Growth and Fluctuations of the British Economy** (the CGP) 1972-1987 (SSRC/ESRC, HM Treasury, UK Department of Industry) (with Richard Stone as Principal Investigator until 1983)

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### **Research Students Supervised:**

- 1979: David Vines  
 Rogelio Ramirez de la O  
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- 1980: Maria del Rosario Patron, Darwin
- 1981-2: Frank Vanderbroucke, now MP in Belgium  
 Marcel Villena  
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### **Students Supervised (among others):**

- 1983: Cornelius Antony Casey – teacher
- 1971: Peter Lawson Agar
- 1975-78: David Willson
- 1978: Martin John Callaghan  
 Brian Lawson  
 Robert John Ashcroft  
 Robert James Dinwiddy