Overview of current research

Rodney Beard
University of Glasgow
UK
Rodney.M.Beard@gmail.com
http://rbeard.sdf.org

What I work on

I work on shared resources. Examples of shared resources include local and global commons, collective production systems, Shared markets (oligopoly), institutions. The problem of sharing arises due to traditional customary property rights (rather than their absence although that too), spillovers such as externalities (pollution and disease) but possibly other types of spillovers, collective production systems, international treaties and agreements. Sharing entails determining how to share which involves ethical principles drawn from philosophy. These may be analyzed using either philosophical tools or the tools of welfare economics and social choice. The economic properties of shared resources usually require analysis using game theory. Game theory is largely a mathematical discipline so I use mathematics and computational tools as a tool of analysis. Many of the examples I use come from agricultural and resource economics so there is a lot of overlap with biological and ecological problems.

Examples of shared resources

- Local commons (traditional (customary) property rights)
- Global commons (Global climate, Oceans, Immunity/Resistance
- Shared Markets
- Institutions and organizations

Game theory

- Compromise solutions (dynamic stability of compromises)
- How to define characteristic function?
- Welfare economics (Benthamite or other?)

Examples

- Compromise agreements in sharing water resources (dynamically stable?)
- Shared markets (How to generalize existing theory)

Applied Game Theory

Applications

- Shared fish stocks
- Economic epidemiology (disease and behaviour)
- Water resources
- Common grazing

Main research areas

	General	Environment and Resources	Agriculture
Microeconomic theory	Demand theory, Oligopoly theory, Welfare Economics	Property rights	Animal Welfare Economics
Game theory (cooperative and non-cooperative)	Dynamic games & Computational methods	Fisheries, Energy, Economic Epidemiology, Property rights	Non-point source pollution & Grazing management
Optimal control (continuous and discrete-time)	Impulse control problems	Economic Epidemiology	Plant breeding and seed saving
Behavioural (Neuro-economics,Geno-economics)	Risk preferences and Genetics, Microarray Games		
Applied Econometrics	Panel data, Duration, Hazard analyses, Structural econometrics	Fisheries, climate change & Trade and livestock diseases	

Applied Game theory

- Applications of dynamic games to environmental and resource economics

Applied Game theory

- Applications of dynamic games to environmental and resource economics
    1) Differential games applied primarily to bioeconomic modelling (combining optimal control theory and ecological population dynamics)

Applied Game theory

- Applications of dynamic games to environmental and resource economics
  1) Differential games applied primarily to bioeconomic modelling (combining optimal control theory and ecological population dynamics)
  2) Structural econometric modelling of differential games

Applied Game theory

- Applications of dynamic games to environmental and resource economics
  1) Differential games applied primarily to bioeconomic modelling (combining optimal control theory and ecological population dynamics)
  2) Structural econometric modelling of differential games
- Applications of cooperative games to water resources and climate change

Applied Game theory

- Applications of dynamic games to environmental and resource economics
  1) Differential games applied primarily to bioeconomic modelling (combining optimal control theory and ecological population dynamics)
  2) Structural econometric modelling of differential games
- Applications of cooperative games to water resources and climate change
- Computational game theory using techniques from algebraic geometry (Gröbner bases)

Microeconomic theory

- Game theory and ethics

Microeconomic theory

- Game theory and ethics
- The Law of Demand and it's consequences

Microeconomic theory

- Game theory and ethics
- The Law of Demand and it's consequences
- Implications of the law of demand for elasticities (beyond obvious sign consequences).

Microeconomic theory

- Game theory and ethics
- The Law of Demand and it's consequences
- Implications of the law of demand for elasticities (beyond obvious sign consequences).
- General iso-elastic demand in different market settings (one paper published, 2015).

Microeconomic theory

- Game theory and ethics
- The Law of Demand and it's consequences
- Implications of the law of demand for elasticities (beyond obvious sign consequences).
- General iso-elastic demand in different market settings (one paper published, 2015).
- Welfare economics. Bridging consequentialist and deontological approaches to welfare and ethics.

Agricultural economics

- Common property and range management (pasture and herd dynamics) (PhD thesis)
- Non-point source pollution in particular nutrient run-off into waterways and eutrophication (series of papers mostly political economy models)
- Plant breeding royalties and seed saving (discrete-time optimal control model)
- Economic epidemiology of livestock diseases (Computational and Econometric Modelling)
- Welfare economics applied to animal welfare
- Fair sharing of water resources (published: Beard and McDonald 2007)

Climate change

- International environmental agreements using partition function form games (paper examines stability of the γ)-core in the presence of thresholds)

Climate change

- International environmental agreements using partition function form games (paper examines stability of the γ)-core in the presence of thresholds)
- Empirical research on the impact of climate change on fisheries

Climate change

- International environmental agreements using partition function form games (paper examines stability of the γ)-core in the presence of thresholds)
- Empirical research on the impact of climate change on fisheries
- Empirical research of impact of climate change on agriculture

Differential games-Current projects

Collaboration with Linda Nostbakken University of Alberta

Many resources are shared between different countries and management relies on international agreements. We develop a model of a shared resource for which there exists an international agreement that determines each country's share. Each government is responsible for the enforcement of national quotas. Countries can cheat on the agreement by reducing enforcement efforts and thereby inducing firms to exceed quotas. We analyze the effects of this in a differential game framework and characterize the long-run equilibrium. We find that the extent of enforcement can be influenced by both domestic and international policy instruments.

Dynamic games and bio-economic modelling of sheep-scab

Joint work with Louise Matthews

We develop a dynamic bio-economic model using differential game theory of the parasitic livestock disease sheep-scab. The model consists of a two-patch meta-population model to model the transmission of the disease within and between farms and farmers objectives are to maximise the discounted profit from sheep farming by choosing to adopt a diagnostic test to detect the presence of sheep-scab. Diagnostic test adoption reveals information about the underlying state of the system. Consequently the model is one involving costly information acquisition in an incomplete information setting. We solve the model numerically using the shooting method for two point boundary value problems. The model is solved for a number of different types of Scottish sheep-farms and the implications for disease spread as well as the economic impact are compared. The results provide information about the timing of adoption by different types of farms.

Hotelling model with network externalities

Collaboration with Ujjayant Chakravorty, Tufts University

The paper examines the transition from a fossil fuel economy to a renewable energy economy with network externalities as a game between the policymaker who determines the extent of extraction of fossil fuels and consumers who choose between a fossil fuel network and a renewable energy network in response to network externalities in consumption. Two cases are considered one with two immature industries both characterised by network externalities and one with a mature fossil energy sector in which network externalities are absent and an immature renewable sector that is characterised by network externalities. The key results demonstrate that network effects are a key barrier when the fossil industry is mature whereas if both industries are immature then the impact depends on the remaining lifetime of the fossil energy source. The results have implications for policy in particular it is suggested that barriers to the transition to renewable energy are a more appropriate target for policy than attempting to reduce the costs of capturing renewable energy as the latter is likely to strengthen the marginal impact of network externalities on resource extraction thereby slowing the transition to renewable energy.

Cooperative games

Threshold effects and international environmental agreements, Joint work with Thilak Mallawaraachi, ABARE and the University of Queensland

In this paper we present a model of international environmental agreements in the presence of threshold effects. The model is in the tradition of models of international environmental agreements formulated as games in partition function form. Games in partition function form allow the incorporation of external effects between players. The model is applied to global climate change agreements. Benefits to emissions abatement are subject to a threshold. Consequently, we model climate as a global threshold public good. This allows a mechanism to explore incentives and disincentives for signing agreements consequent to a critical number of other players committing to an agreement.

Cooperative games

Microarray games

Using cooperative game theory to analyze gene expression data for animals and humans o identify genes associated with disease resistance. Collaborative work with Simon Babayan.

- Using Shapley value to calculate the contribution of individual genes to overexpression
- Aim is to identify which genes contribute to disease and disease resistance.
- Programming in R using GameTheory package.

Empirical analyses of climate change

The potential impact of climate change on industry is frequently speculated about, but the actual historical impact of climate change on industry is rarely studied. Studies of the impact of climate change on fisheries have been largely simulation based or speculative and rarely use historical data. No studies of climate change test to see whether economic factors or physical and biological factors have a greater impact on the fishing industry. If policymakers are to make informed climate policy decisions environmental economists need to forecast the likely consequences of climate change on industry and be able to judge whether these consequences are large or small compared with changes due to other causes. In this paper, the impact of climate change on Irish fisheries is examined using a panel data set of 506 observations, consisting of 46 cross-sectional units and 11 longitudinal units. A comparison is made of the impact of economic factors and the impact of climate change on fisheries catch. It is concluded that climate change has had a considerable impact on the Irish fishing industry. An attempt is made to quantify the monetary impact of climate change on Irish fisheries and the loss to specific Irish fishing ports.

Trade models and livestock disease

A structural gravity model of UK livestock trade is developed and employed to assess the risk of possible disease incursions into the UK. Gravity models have been employed for a number of years in the econometric literature on international trade with considerable success. Structural gravity models differ slightly from the naive gravity model by developing a structural econometric model from an explicit theoretical model of consumer decision-making and this then results in the incorporation of multilateral trade resistance terms into the gravity equation. Gravity models have also been developed by epidemiologists to model the spatial spread of diseases between different populations. In this paper I develop a model that combines these two different approaches by using a combined panel dataset of livestock trade and disease incidence for the UK. Epidemiological variables are built into a theoretical model of individual consumer and producer decision-making and the corresponding structural gravity equation is derived. This is then estimated econometrically.

Thanks for listening!

Contact: Rodney.M.Beard@gmail.com
http://rbeard.sdf.org
Institute for Biodiversity, Animal Health and Comparative Medicine
University of Glasgow