Towards a New Complexity Economics for Sustainability

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Outline

- Introduction
- What is ‘complexity economics’?
- Key tools, techniques and ideas
- Compatibility of economics growth and sustainability
- Conclusions and policy implications

Introduction

- ESRC research seminar series 2008-2010
  - University of Oxford, 27-28 November 2008
  - Free University of Bozen-Bolzano, 30-31 March 2009
  - University of Leeds, 23-24 June 2009
  - University of Cambridge, 3-4 December 2009
- To examine a range of new economic ideas and their implications for policy to address environmental and sustainability challenges
  - e.g. climate change mitigation, food systems, sustainable production and consumption systems
- Presentations and discussions from previous seminars available at http://www.see.leeds.ac.uk/research/sri/projects/esrc-research-seminar-series.htm

What is ‘complexity economics’?

- Coined by Brian Arthur, Santa Fe Institute, 1999
- Drawing together a range of approaches:
  - Complex systems thinking
  - Evolutionary and institutional economics
  - Ecological economics
  - Social and psychological understanding of behaviour
  - Socio-technical transitions theory
- Used by Eric Beinhocker to explain the ‘origin of wealth’ in industrialised countries, through a process of co-evolution of physical technologies, social technologies and business plans

Complexity economics: sources

- Complex systems thinking
  - Individual and firms lack perfect foresight, but can learn and adapt over time, and interact through networks
- Evolutionary and institutional economics
  - Individuals' habits and firms' routines evolve through a process of variation, retention and selection
  - Institutions (social rule systems) enable and constrain choices
  - Gives rise to path dependency and lock-in ('history matters')
- Ecological economics
  - Situate economic systems within environmental systems providing resources, waste assimilation and ecosystem services
- Social and pyschological understanding of human behaviour
  - Multiple (not only economic) motivations, influenced by social structures
- Socio-technical transitions theory
  - Systems change through interactions between social and technological elements at multiple levels

Economies as complex adaptive systems

- *Dynamics*:
  - economies are open, dynamic systems, far from equilibrium
- *Agents*:
  - made up of heteorogeneous agents, lacking perfect foresight, but able to learn and adapt over time
- *Networks*:
  - agents interact through various networks
- *Emergence*:
  - macro patterns emerge from micro behaviours and interactions
- *Evolution*:
  - evolutionary processes create novelty and growing order and complexity over time

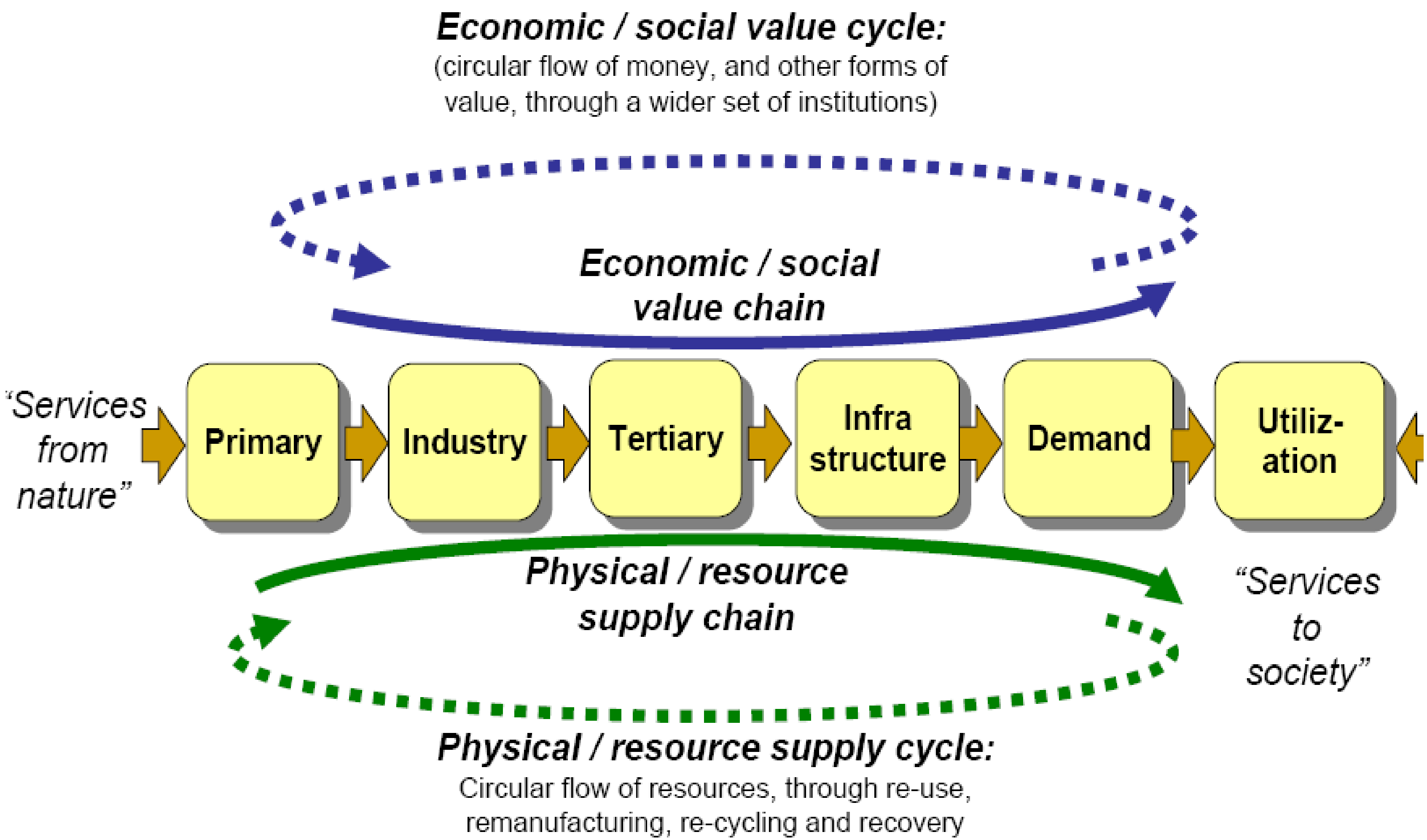
Addressing environmental and sustainability challenges

- What are the implications of these ideas for the mix of incentives needed to promote more sustainable patterns of behaviour by consumers and businesses?
- How to promote technological and social innovation for sustainability, overcoming inertia and lock-in of current technologies and institutions?
- Can a transition to more sustainable patterns of production and consumption be achieved in ways which are compatible with ensuring continuing spread of economic prosperity in both developed and developing countries?

Key tools, techniques and ideas (1)

- Systems analysis
  - Systems transform energy inputs, e.g. fossil fuels and calories from agricultural production, into useful goods and services, whilst creating wastes, heat and greenhouse gases
  - Relate physical supply chains to economic and social value chains in which they are embedded (Ravetz)
  - Examine sustainability and resilience of systems under transient shocks and enduring stresses (Stirling)
  - Investigate socio-economic factors influencing how drought events affect crop failures (Fraser)

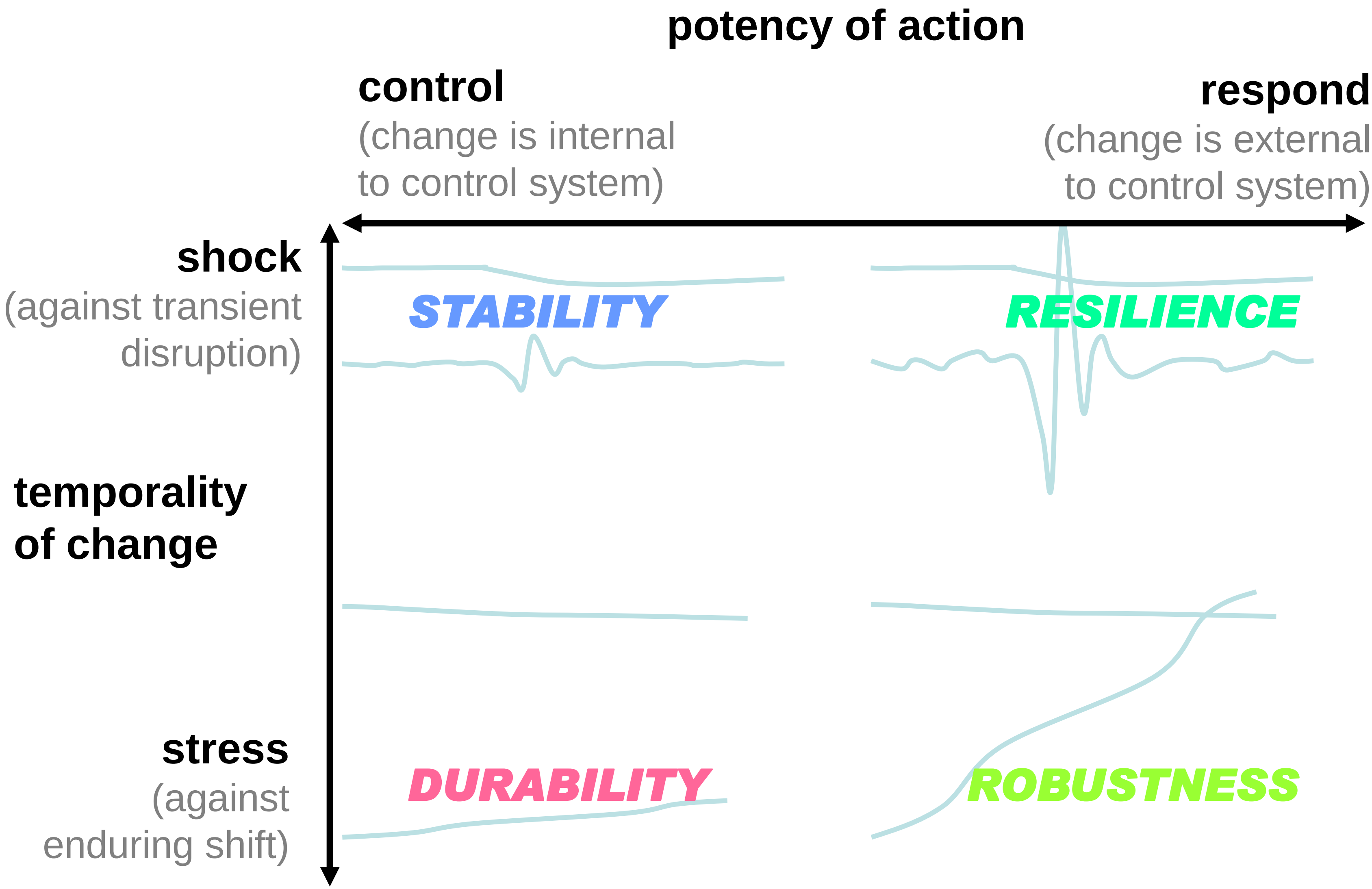
Linking physical and economic cycles



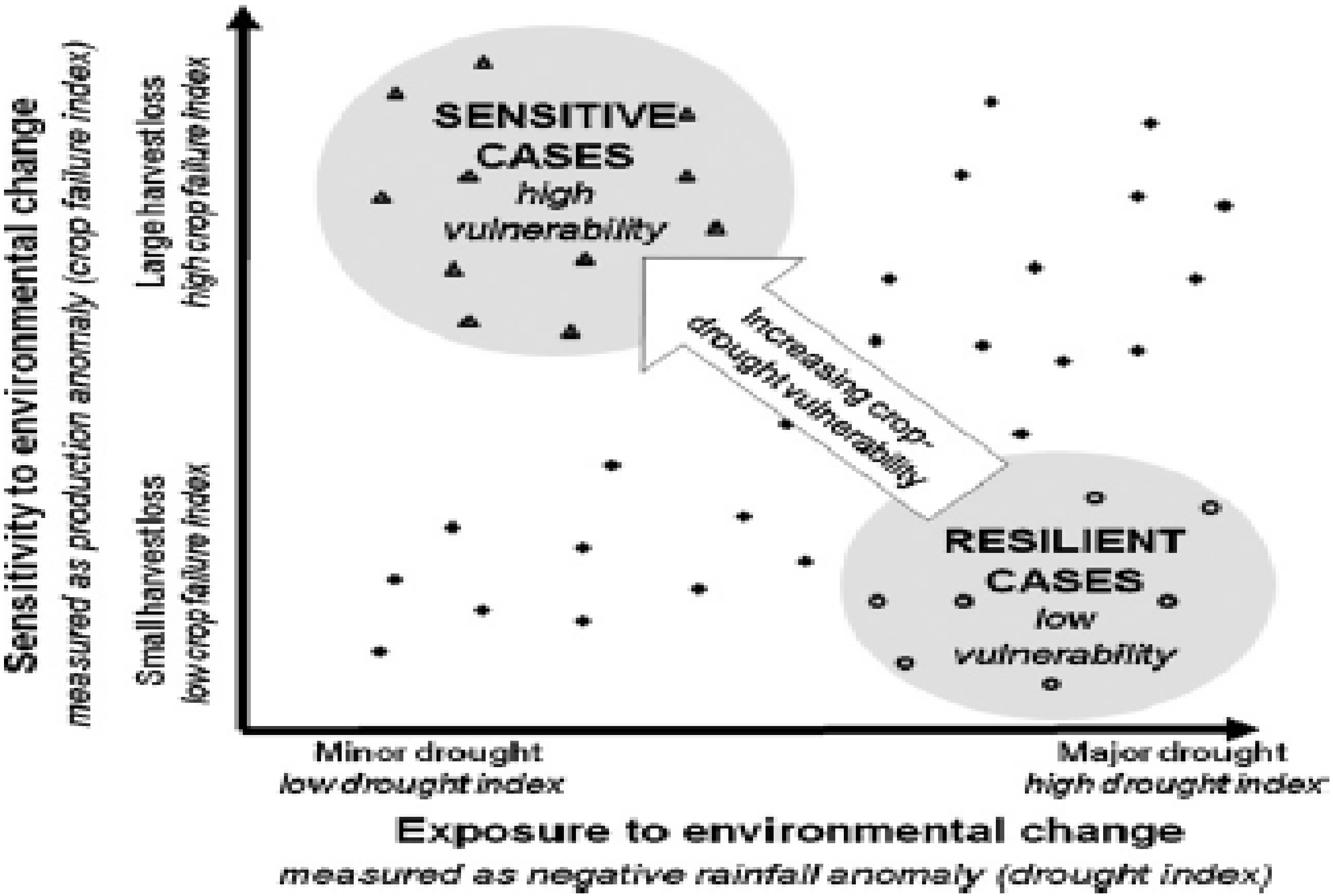
Source: Ravetz (2009)

Distinguishing Dynamics (Stirling, 2009)

A heuristic framework



Increasing crop-drought vulnerability in China

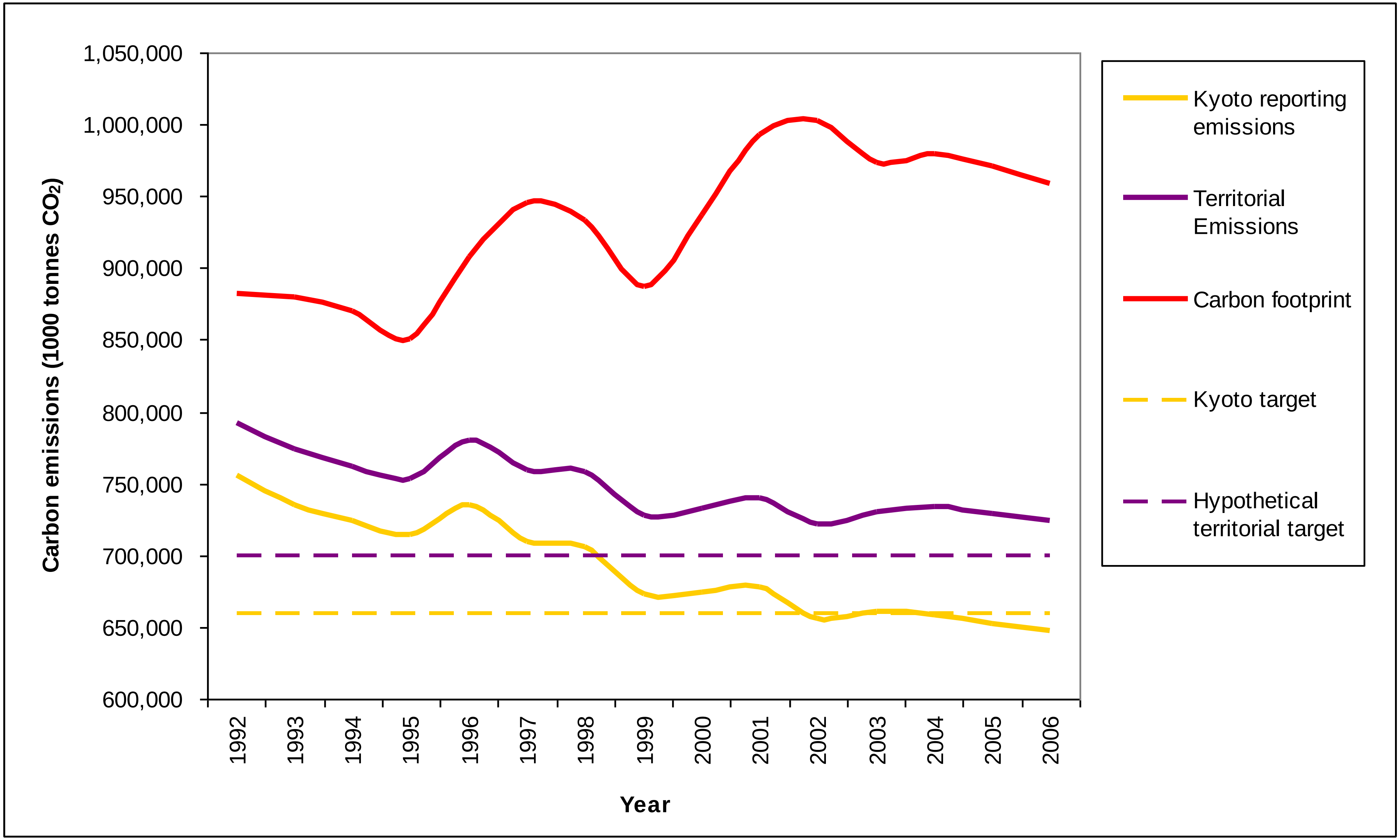


Source: Simelton, E, Fraser, E, Termansen, M., Forster, P and Dougill, A (2009), *Environmental Science and Policy*

Key tools, techniques and ideas (2)

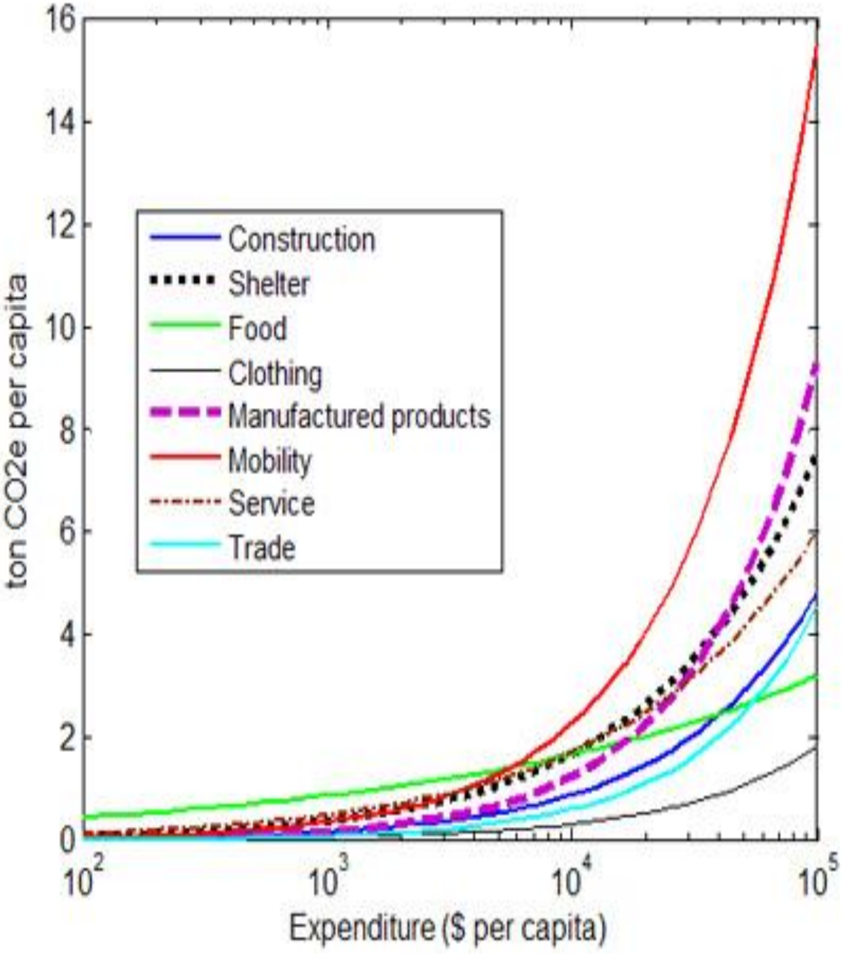
- Input-output analysis
  - Combining ‘top-down’ input-output analysis at the country level with ‘bottom-up’ life cycle analysis (Hubacek)
  - CO_2 emissions on a consumption basis
  - Effects of international trade (Barrett)
- Social network analysis
  - Analysis of social network relating to firm entry and exit (Reed-Tsochas)
  - Growth of technological or market niches (Köhler)

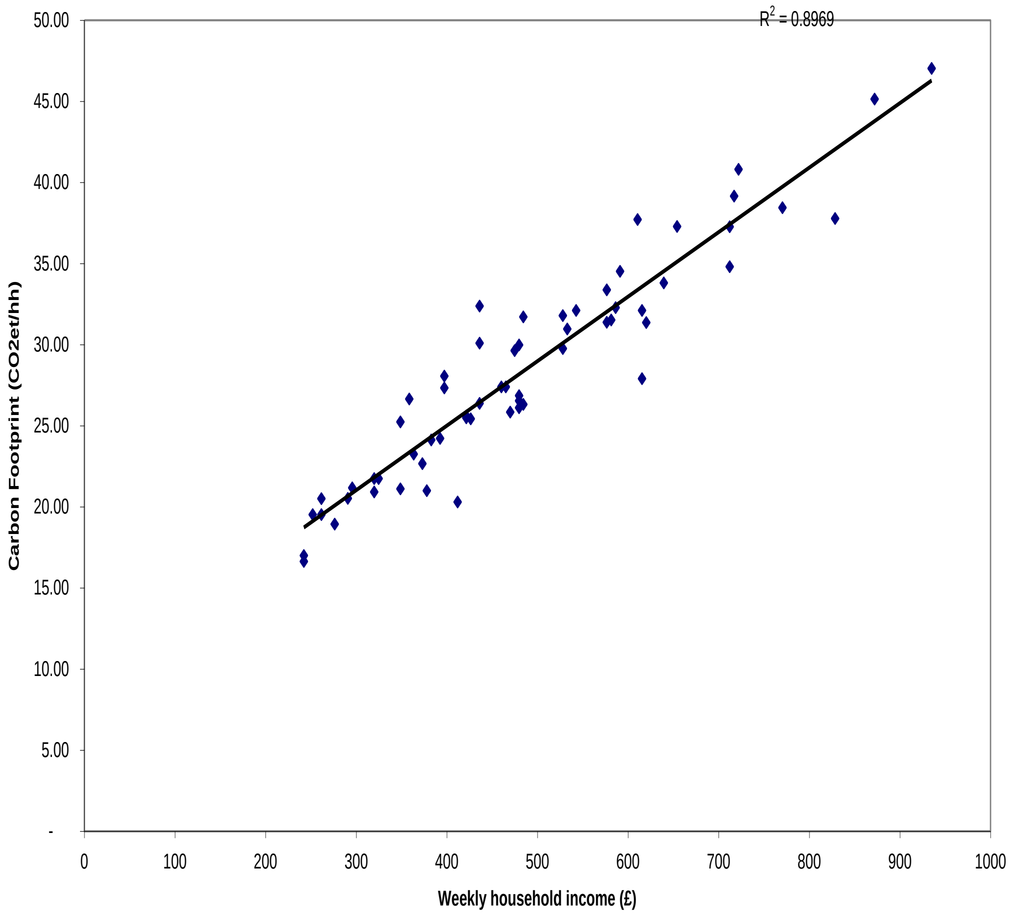
Development of UK GHG emissions from 1992 to 2004



Source: Stockholm Environment Institute

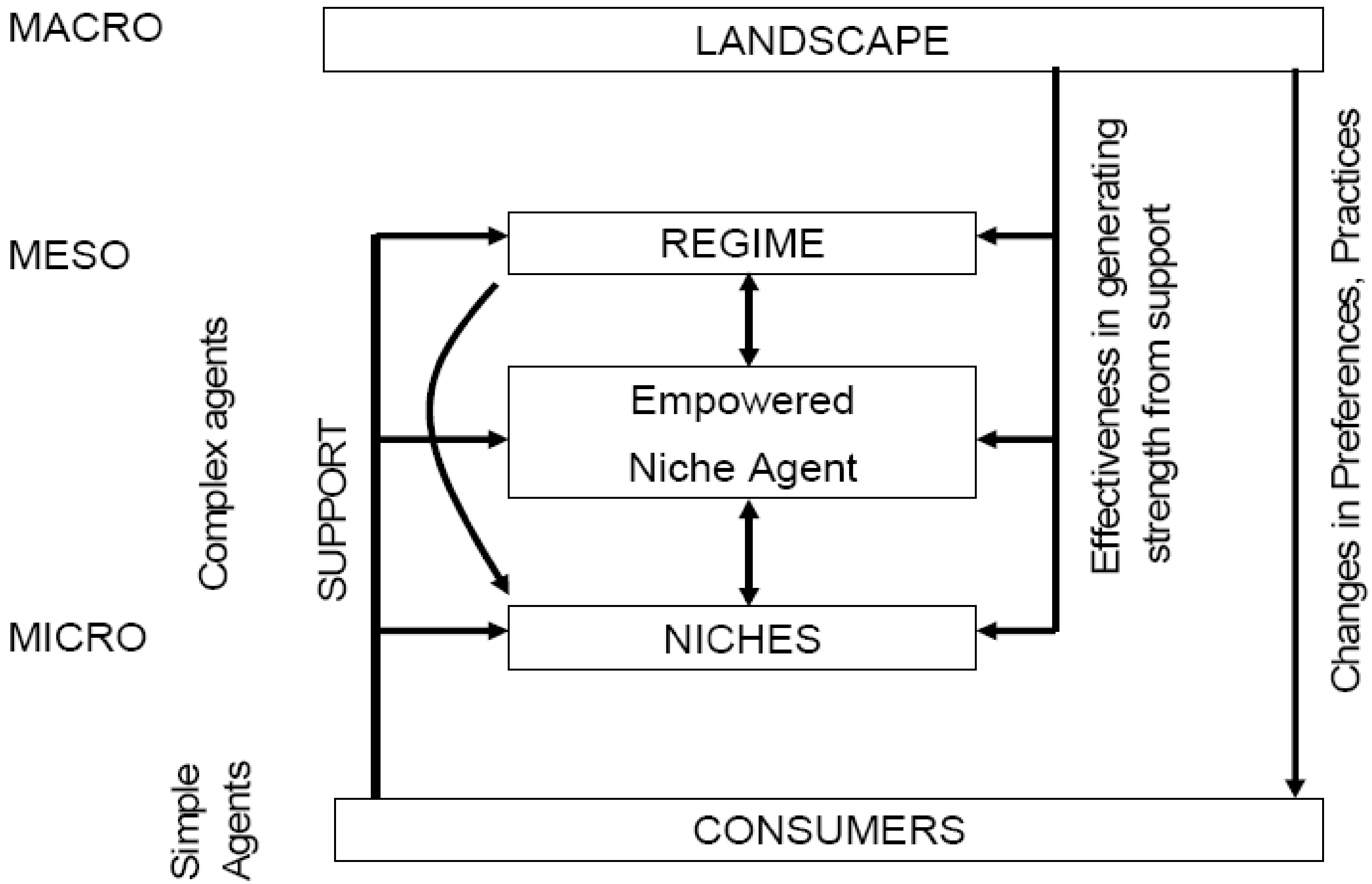
Relationship between Economic Growth and GHG Emissions





Source: Hertwich and Peters, *Environmental Science and Technology*, 2009

Modelling the interactions of agents contributing to a systems transition (Köhler)

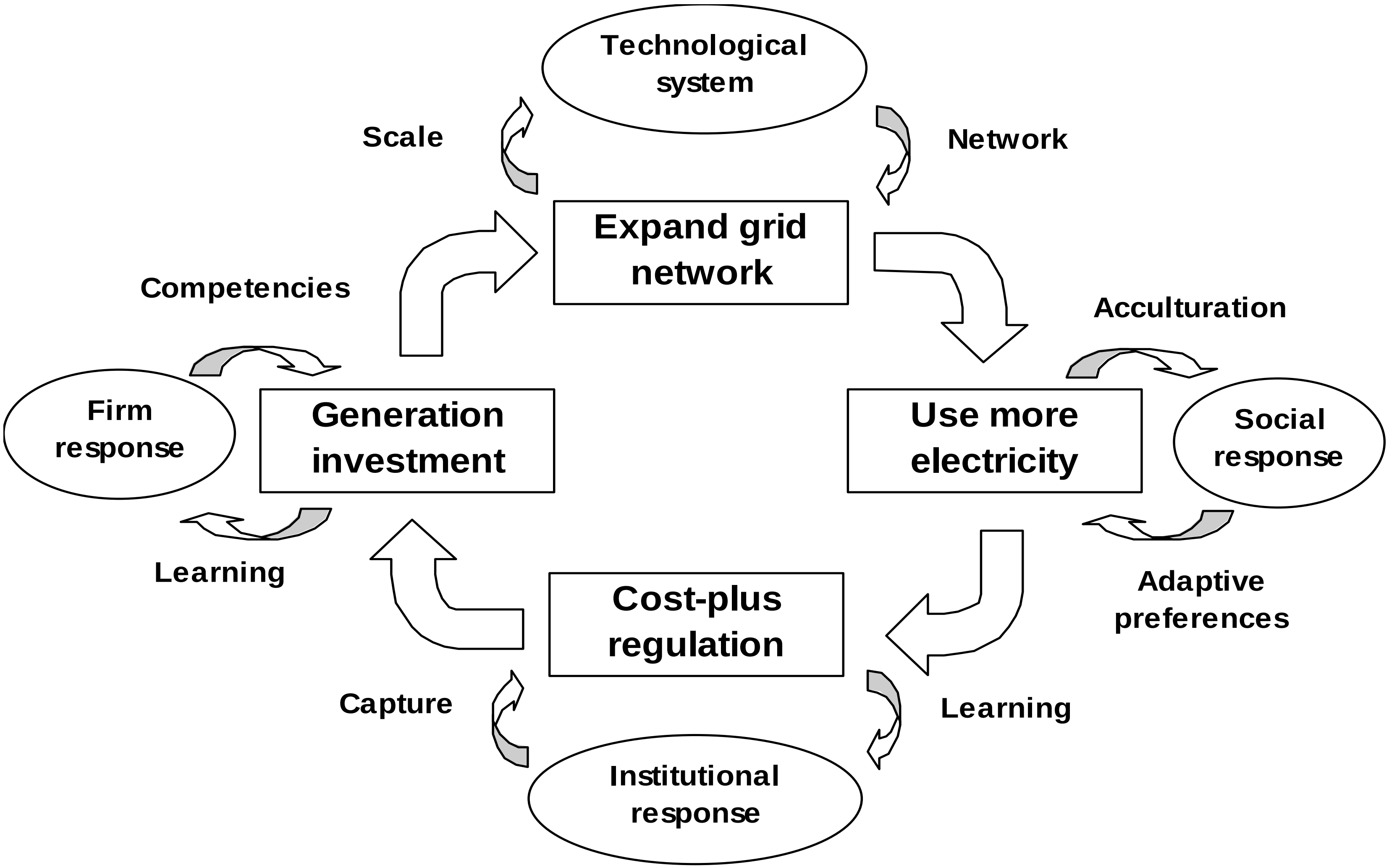


Source: MATISSE project

Key tools, techniques and ideas (3)

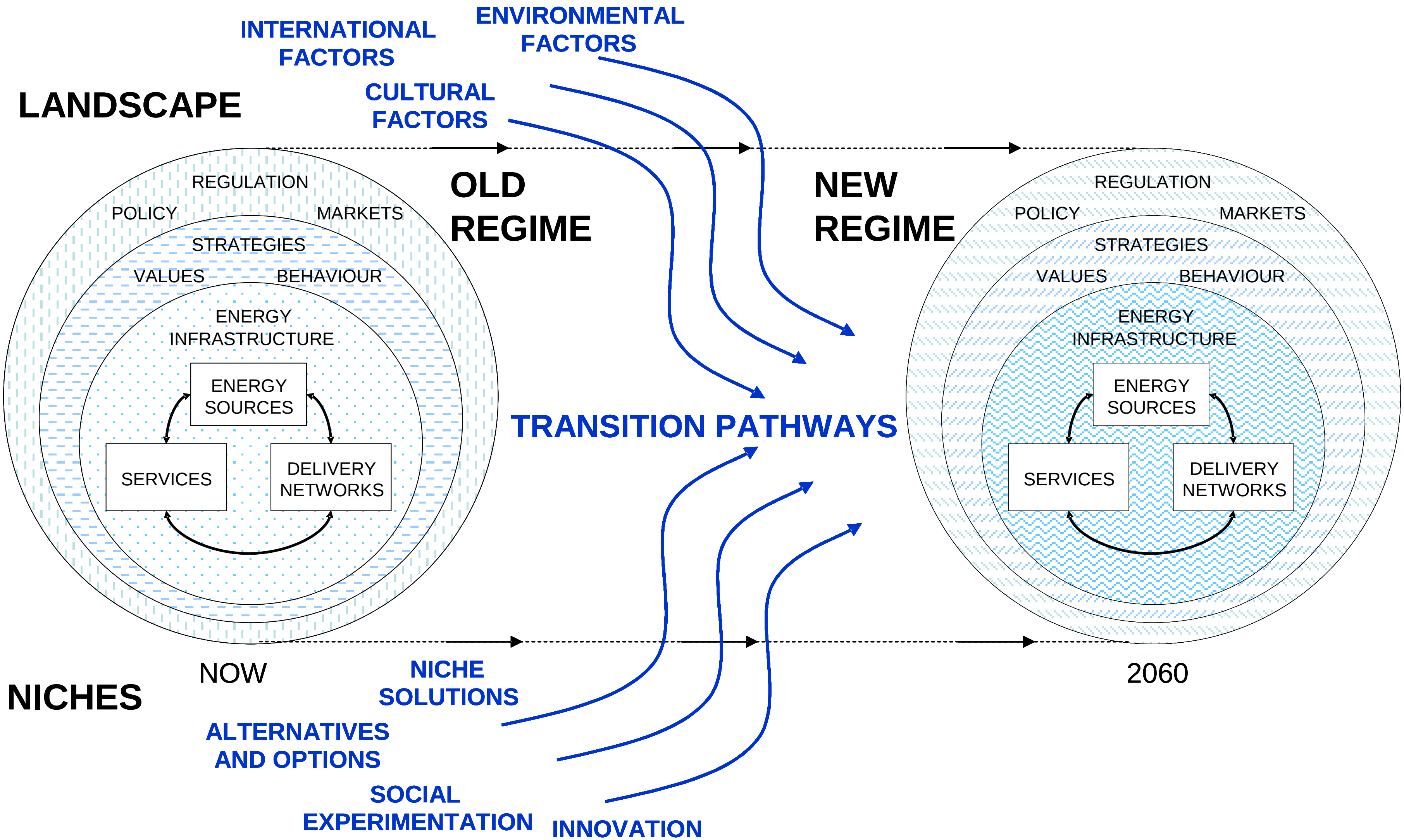
- Co-evolutionary approaches
  - ‘Carbon lock-in’ of high carbon energy systems through co-evolution of technologies and institutions, driven by path-dependent increasing returns to adoption (Unruh)
  - ‘Origin of wealth’ through co-evolution of technologies, social technologies and business plans (Beinhocker)
  - Transition pathways to a low carbon energy system through co-evolution of technologies, institutions, business strategies and user practices (Foxon et al.)

Co-evolution of technologies and institutions for electricity system



Source: Unruh, *Energy Policy* 2000

Develoing and analysing transition pathways



Source: Foxon et al., *Tech Forecasting and Social Change* 2010

New economic thinking (Barker)

- All economic activities are specific to a place and a time (representative agent assumption is not just wrong but misleading)
- The presumption is that all people and social groups are different (different location, different history)
- Econometrics is about averaging & finding tendencies
- Ecological "whole systems" economics replaces individual utility-maximising rational economic man (based on 19thC energetics-based general equilibrium)

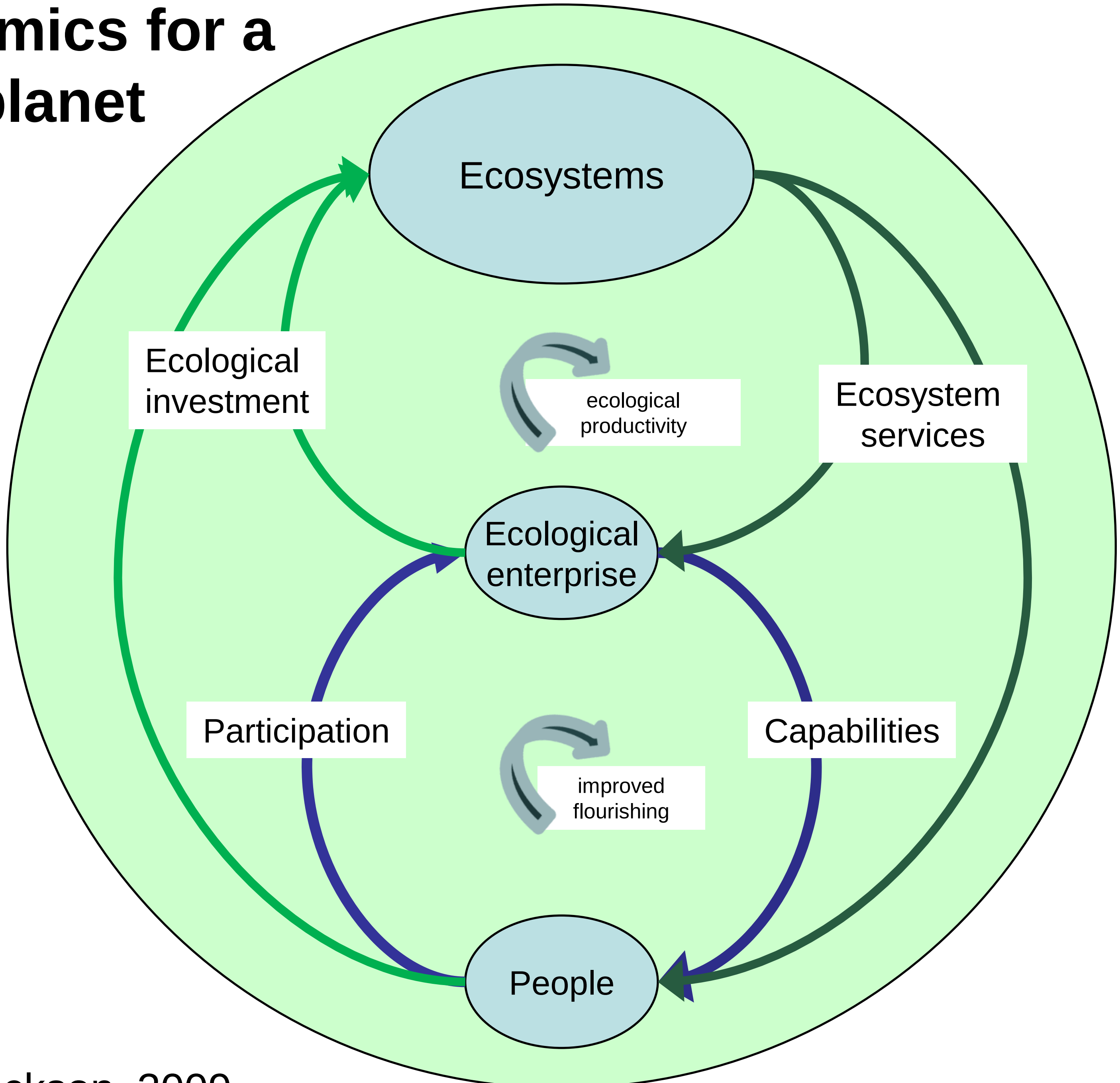
Compatibility of economic growth and sustainability

- Process of wealth creation is now under threat, as economic activity threatens environmental limits (Beinhocker)
  - Understand and apply the lessons from the last Industrial Revolution;
  - Better understand how to achieve a transition to a low-carbon economy with minimal impacts on welfare and growth;
  - Find points of policy leverage for achieving ‘social engineering’ on a massive scale, whilst respecting individuals’ free choices
- Learning from historical energy transitions (Pearson)
  - New energy technologies, such as steam engines, electric lighting, contributed to major economic productivity gains
  - But took many decades for measurable growth effects to appear
  - Similarly, modern energy system transitions would need:
    - To build new enthusiasm, infrastructure & institutions
    - To escape the shackles of path dependence
    - Overcome ‘lock-in’ & turn over old capital stock

‘Prosperity without growth’ (Jackson)

- Dilemma of growth
  - Economic growth is unsustainable
  - But ‘de-growth’ is unstable, as it would lead to rising unemployment, falling competitiveness and economic recession
- Limits to ‘decoupling’
  - Assuming continuing economic growth, rising populations and more equitable incomes, this would require a 130-fold improvement in carbon intensity by 2050 to keep within 2°C target
- Need new engine of growth
  - To retain economic stability whilst remaining within ecological limits
  - Based on ecological investment delivered by ecological enterprises
  - Focus on providing jobs and supporting communities

Economics for a finite planet



Source: Jackson, 2009

Reconciling economic growth and environmental sustainability (Ekins)

- Physical growth: growth in the amount of matter/energy mobilised by the economy - *indefinite growth is impossible*
- Economic (GDP) growth: growth in money flows/incomes/ value added /expenditure - *no theoretical limit on this*
- Growth in human welfare:
  - *dependent on sustaining environmental functions*;
  - *has a complex relationship to economic growth (though, ceteris paribus, more money is better than less)*;
  - *dependent on many other factors (employment, working conditions, leisure, inequality, relationships, security/safety of the future)*
- Improvements in carbon productivity of 6% p.a. are needed
- Would require sustained, wide-ranging and radical policy interventions to bring about technological revolution and change lifestyles

Moving beyond GDP (van den Bergh)

- Most economists agree that GDP (per capita) is not a good measure of social welfare (particularly above low income levels)
  - So why is it still so widely used in this way?
- Being against GDP is not the same as being anti-growth
- But goal of ‘unconditional growth’ is a constraint on more socially beneficial policies, e.g. increasing employment, reducing working hours, contributing to public goods such as climate change mitigation

A Green New Deal (Bowen)

- Benefits to early climate-change mitigation action:
  - induces innovation sooner (by enabling learning, scale and network effects);
  - recognises that diffusion of new technologies takes time;
  - encourages action by establishing a credible policy framework sooner;
  - reduces the need for premature scrappage of capital;
  - enables action to be strengthened if climate change proves more serious;
  - provides greater benefits for win-win opportunities
- Economic stimulus needed of 4% of global GDP, of which 20% or $400bn should be on ‘green stimulus’

‘Economics of enough’ (Fell)

- Human societies are complex open systems, in which resources may be finite, but human ingenuity is not
- They develop by a process of social and technological co-evolution
- Social networks influence the diffusion of change
- Institutions serve as commitment devices – they were fit for purpose at the point at which they evolved, but they can get locked in
- Individuals have needs, and current institutions, designed to meet basic needs, may not be good at meeting higher needs.
- An ‘economy of enough’ should address four key co-evolved and inter-dependent areas:
- *The nature of work*:
  - This would move to tasks, instead of jobs, and create space for social entrepreneurs and a shorter working week, say 21 hours;
- *The accumulation of assets*:
  - This would focus on long-term security, through developing civic institutions and the return of trust;
- *Conspicuous consumption*:
  - This would aim to distance ‘status’ from ‘consumption’, by changing social norms and admitting fulfilment;
- *Energy addiction*:
  - To overcome our energy addiction would require greater decentralisation, and may require governments to take back some power from MNCs.

Steady State Economics (O'Neill)

- A steady state economy is characterised by
  - *Sustainable scale*: energy and material flows within ecological limits;
  - *Just distribution*: reducing inequalities;
  - *Efficient allocation*: but only using markets where appropriate;
  - *High quality of life*: measured in relation to health, time, prosperity and community
- Modelling suggests that it is possible for an economy to have low levels of unemployment, poverty, debt-to-GDP ratio and GHG emissions, whilst GDP per capita stabilises

Conclusions and policy implications

- ‘Complexity economics’ represents an ongoing research programme, rather than a completed theory
- Detailed policy prescriptions are highly debated
- General policy implications suggest that:
  - Complexity economics provides a rich understanding of behaviour of economic actors and systems, relevant for sustainability policies
  - Inform a transition to a sustainable low carbon economy, e.g. role of niches for low carbon innovation and early deployment
  - Range of tools available, including systems analysis, input-output analysis, social network analysis and co-evolutionary approaches
  - Policy needs to understand and address drivers of consumption, as well as production, and take into account social and psychological drivers of behaviour and influence of social context
  - New measures of social and ecological value of economic activity are needed, to go beyond aggregate indicators such as GDP

Detailed policy and research measures

- Policy measures
  - Carbon price is necessary, but not sufficient
  - Institutional changes are also needed, e.g. new regulatory frameworks, new market structures, new business forms
  - Overcome ‘lock-in’ of current technological and institutional systems, e.g. by promoting low carbon innovation
  - Focus on desired outcomes, e.g. reducing unemployment, rather than ‘unconditional growth’
  - Undertake environmental tax reform
  - Reduce systemic inequality
  - Invest in public assets and infrastructures
  - Reduce working hours
- Research needed
  - Better understand dynamic and systemic processes of change
  - Better understand social and political drivers for maintaining current economic systems