Lock-in from the perspective of innovation/transitions theory

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Outline

- Insights from understanding technological change
  - History of technology/innovation (Hughes, David)
  - Evolutionary/complexity economics (Arthur, Nelson)
  - Institutional economics (North, Pierson)
  - Socio-technical transitions (Rip and Kemp, Geels)
- Path dependence and Lock-in
  - Lock-in of technologies
  - Co-evolution leading to lock-in of techno-institutional systems, as emergent property
- Implications for geoengineering

Technological lock-in

- Technological change in path dependent:
- specific sequences of events
- specific timing of outcome-shaping events
- similar starting conditions leading to a wide range of possible outcomes
- small events that can have large consequences
- Lock-in
- increasing returns to adoption (positive feedback) can lead to lock-in of incumbent technologies
- Many examples: QWERTY keyboard, light-water nuclear reactors, VHS video recorders, Microsoft software

Increasing returns (positive feedbacks) to adoption of technologies (Arthur, 1989)

- Scale economies
- spread fixed costs over increasing volume
- Learning effects
- experience gained reduces unit costs
- Adaptive expectations
- adoption reduces uncertainty, as users gain confidence in quality, performance, longevity
- Network or co-ordination effects
- network benefits increase with more users

Institutions

- Institutions are ‘social rule systems’
- Formal social rules:
- legislation
- economic rules
- contracts
- Informal constraints:
- social conventions
- rules of behaviour

Increasing returns for institutions (North, 1990)

- High set-up or fixed costs
- Learning effects for organisations
- Co-ordination effects
- formal constraints, such as contracts
- informal constraints, e.g shared knowledge
- Adaptive expectations
- institutional framework reduces uncertainties

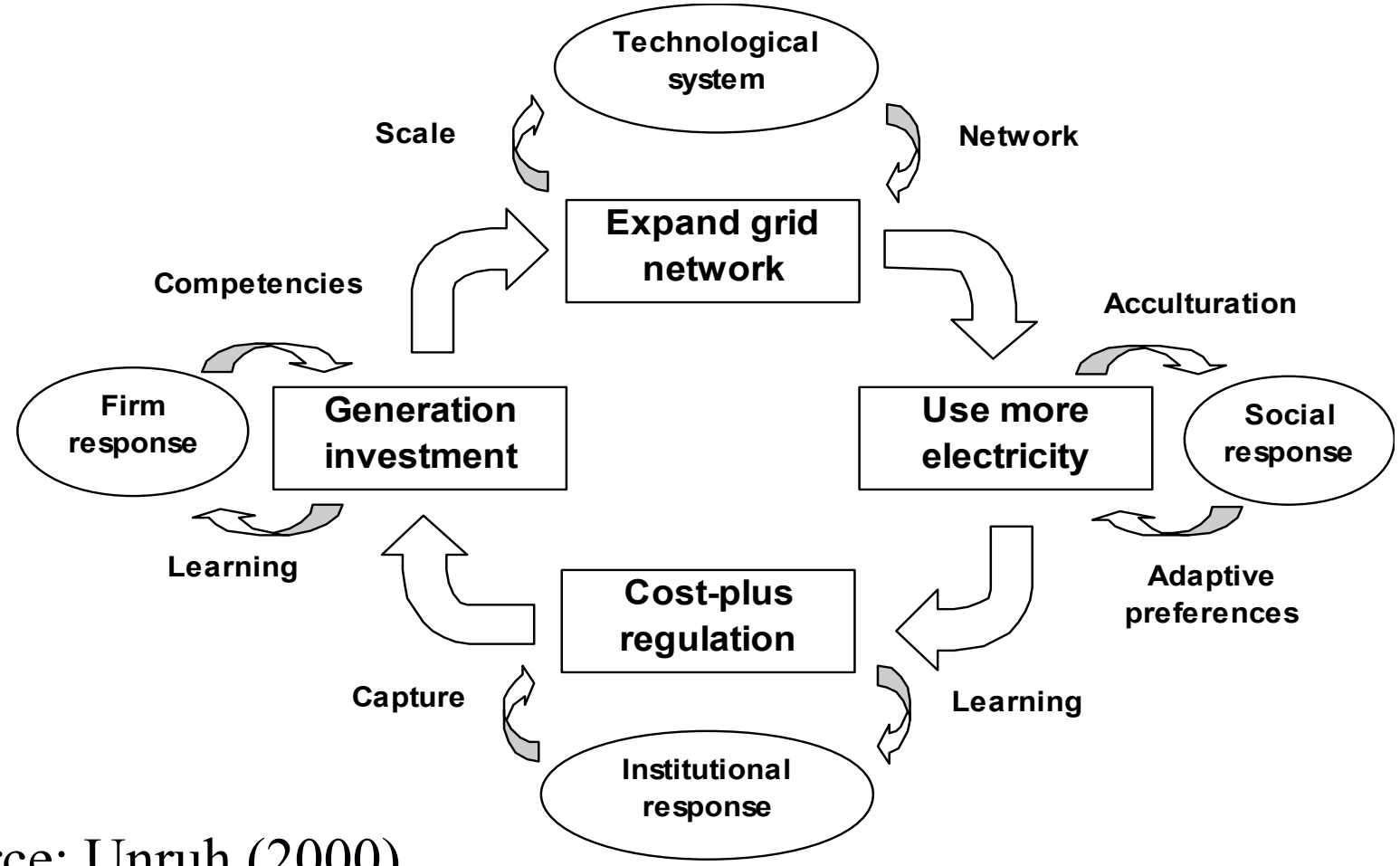
Lock-in of political institutions (Pierson, 2000)

- Collective action
- highly dependent on actions of others
- High density of institutions
- learning, co-ordination and expectations
- Asymmetries of power
- reinforcing current power structures
- Complexity and opacity of politics
- mistakes difficult to rectify

Co-evolution of technological and institutional systems

- Lock-in of technological and institutional systems
- Interacting increasing returns to adoption of technologies and institutions
- Techno-institutional system or complex becomes locked-in
- Carbon lock-in (Unruh, 2000)
- Carbon-based energy system has become locked-in through coevolution of fossil fuel based technologies and supporting institutional rules
- Business models and user practices also co-evolve (Foxon, 2011; Hannon et al., 2013)

Electricity generation techno-institutional system



Source: Unruh (2000)

Electricity generation techno-institutional system

- Institutional factors
- satisfy increasing demand
- reduce unit price
- liberalise markets in 1990s
- Feed back into technological system
- ‘dash for gas’, rapid expansion of gas-fired generation
- Reinforces institutional drivers
- Lobbying to reduce ‘interference’ in markets

Implications for geoengineering

- Alternative pathways for a low carbon transition
- Low carbon options: energy efficiency, renewables, nuclear, carbon capture and storage (CCS)
- Options that attempt to mitigate the consequences of carbon emissions, such as CCS and geoengineering options, could reinforce dominance of fossil fuel based energy system
- Role of adaptive expectations
- Could even serious discussion of geoengineering discourage investment in low carbon options
- Challenge for low carbon policy
- Investment needed to keep options open in face of uncertainty, but at some point, some options have to be closed off