Prospects and Limits of Regulating Network Utilities
Lessons from complex adaptive systems theory

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Overview
• Background and basic approach
• Co-evolution of technology and policy
• Conditions of ICT governance
• Implications for regulatory policy
• Insights from the complexity approach

Background
• Seeming mismatch between (U.S.) policy efforts and outcomes
  – Glacial emergence of local competition
  – Renewed increase in market concentration
  – Unexpected effects of ICT unbundling
  – Collapse of ICT stocks and investment climate
  – Losses of jobs and global leadership in ICT
  – CA electricity deregulation
• Policy failure? Theory failure?

Effective governance
• To be effective, governance needs to be sufficient to achieve/prevent an outcome
• Classical model of policy-making:
  \[ W = W(x) \quad \text{...... social objective function} \]
  \[ x = f(a, z) \quad \text{...... policy model} \]
• Find policy variables \( a^* \) that maximize
  \[ W^* = W^*(x^*) \]
• Assumes omniscient, benevolent and omnipotent policy maker

Possible limits
• Instrument seems to work but has unnoticed and unintended effects
• Governance has short term effects but is irrelevant in the medium and long term
• Policy instrument does not achieve the intended effect at all
• No policy instrument is known
• No agreement can be reached
• Constraint is not obeyed and/or is not enforceable
Co-evolution of technology, sector economics, and policy to a complex adaptive system (CAS)

Past: “closed” networks

Present: network of networks

Future: “open” network

Complex adaptive system

• Important features of CAS
  – Many decentralized decision makers (agents)
  – Localized (but limited global) knowledge
  – Agents learn and adapt to changing environs
  – Interrelations and between agents (loosely coupled tightly coupled systems)
  – Feedback, non-linear behavior and unpredictability
• “Complexity” is a matter of degree (order, edge-of chaos, chaos)
• ICT is increasingly complex

ICT governance in conditions of high complexity
Information constraints

• Asymmetric information
  – Incentive compatible design of regulation
  – Efficient regulatory design is complicated
• Ability of planner to improve efficiency
  – Problem of decentralized information
  – Policy neutrality (rational expectations)
• Fundamental limits to knowledge
  – Persistence of false “mental models” (Nelson)
  – “Remediability” criterion (Williamson)

Institutional constraints

• Recognition that institutions matter
  – Organizations (Greif)
  – Rules of the game (North)
  – Outcomes of repeated games (Aoki)
• Institutions are part designed (for which meta-rules exist) and part emergent
• Legal and economic feasibility constraints
• Political feasibility constraints (number of “veto players,” transaction cost)

System constraints

• Arise from three sources
  – Simultaneity of political, economic, legal and other constraints
  – Factors not controllable by policy
  – Complexity of ICT infrastructure
• Difficulty of finding sustainable and effective policy instruments
  – Can “leverage points” be found?
  – Can “superior process” be found?
  – Problems of feedback and indirect effects

Implications for regulatory policy

Governance reconsidered

• Constraints reduce degrees of freedom of policy (but do not render it fully ineffective)
  – Sector design (“order”) critical
    • Markets and competition compatible with various sets of rights and obligations
    • Competing institutional frameworks (e.g., spectrum property + commons) would facilitate learning
  – Most effective discretionary policy instruments are available at the micro level
• Aggregate performance emerges from but is not fully determined by micro-level

Feasible policy instruments
### Competition & BB penetration

![Chart showing competition and broadband penetration](source: Bauer 2003)

### Possible policy instruments

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<tr>
<th>Factor</th>
<th>Sufficient</th>
<th>Necessary</th>
<th>Neither</th>
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<td>Economic growth</td>
<td>Fiscal policy</td>
<td>ICT open entry</td>
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<td>Innovation rate</td>
<td>R&amp;D subsidies</td>
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<td>ICT use</td>
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<td>Broadband access</td>
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<td>Network access</td>
<td>Interconnection, unbundling</td>
<td>Enabling laws and regulations</td>
<td>Open entry</td>
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<td>Wholesale prices</td>
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### Indirect control and emergence

![Diagram showing indirect control and emergence](source: Bauer 2003)

### Indirect control ...

![Diagram showing indirect control](source: Bauer 2003)

### Unbundling and BB diffusion

![Chart showing unbundling and broadband diffusion](source: Bauer 2003)

### Disruptive technologies

- Emerging disruptive technologies
  - Unlicensed wireless (WiFi, UWB, mesh)
  - Voice over Internet Protocol
  - P2P file sharing technologies
- Complex system perspective
  - Examine direct and indirect effects
  - Unfettered market entry can be destabilizing (push infrastructure into the “chaotic” zone)
  - What degree of inertia optimizes benefits?
Institutions and performance

- Substantial evidence that new ICP regime is more efficient than monopoly framework
- Complex rather than simple causation
  - New orthodoxy works “on average”
  - Different “constellations” of institutions work (regions may periodically “luck out”)
  - Conditions for successful reform easiest to specify if gross inefficiencies exist
- Some degree of institutional diversity is desirable as it facilitates social learning

Conclusions

- Complexity approach provides new perspective to understand ICT and regulatory policy design
- Does not offer a prescriptive framework
- Emphasizes importance (and indeterminacy) of overall sector design and therefore desirability of institutional experimentation
- Results in a more humble view of the possibility of discretionary policy (government as a “player”)
- Emergent nature of aggregate level effects
- Advantages of adaptive policy over grand designs

Conclusions ...

- Questions whether more competition and easier market entry is always desirable
- Urges use of new methods to assess effects of regulation (computational, experimental tools)
- Policy may be able to harness features of the system complexity
  - Competition, sustained by antitrust
  - Facilitation of networks and technology diffusion (scale free nature of networks, power law distribution)
- Governance matters but in different and more complicated ways than commonly perceived

References