Is Network Reliability A Public Good?

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The Public Good Nature of Grid Reliability

- Conventional wisdom
- Often asserted but not often examined, either theoretically or empirically
- Used to justify cost sharing, mandatory reliability standards, and resource adequacy planning

Examples

"In the present movement towards competitive electricity markets, it is important to remember that electric system reliability is, in many respects, a classic public good. By the laws of physics, the essential attributes of adequacy, voltage, and frequency are available to all interconnected users simultaneously." – Cowart (June 2001)

"The transmission system is fundamentally a public good. Much like our interstate highway system, paying for regional transmission systems must be spread equitably across the broad base of transmission users." – Fox-Penner (October 2003)

Examples – Distinction Between Security and Adequacy?

"From an economic point of view security and adequacy are quite distinct in the sense that the former is a public good while the latter can potentially be treated as a private good." – Oren (June 2003)

"Further, as long as regional resources are made available to all regional load-serving entities and their customers during a shortage, such entities have the incentive to lower their supply costs by depending on the resource development investments of others, a strategy that leads to systematic under-investment in infrastructure by all load-serving entities in the region." FERC SMD NOPR (August 2002)

Summary of Our Argument: I

- Reliability is a name for a collection of attributes of electric power as delivered to consumers. Some of these attributes are public goods and others are private goods
- Public good characteristics often arise from institutional design choices
  - Examples: use of load profiles instead of interval meters, “inability” to prevent free riding from investments in resource adequacy, socialization of costs of ancillary services

If public good problems are creating significant inefficiencies, the solution may require rethinking of the prior institutional choice creating the public good

Summary of Our Argument: II

- Simple cost sharing methods may not improve overall efficiency in the provision of public goods in network reliability; agent heterogeneity and private good characteristics of reliability must be accounted for
- “Internalize the externalities” is not a sufficient guide for policy. Inframarginal externalities not policy relevant
- Agent heterogeneity, network and agent changes over time, and the private good characteristics of reliability should be considered

Hallmark Network Features

- Connectedness
  - Actions of one agent in the network affect the outcomes that other agents experience
- Capacity
  - The (finite) capability of the network to allow the agents to achieve their outcomes
- Congestibility
  - As more agents use the network, outcomes diminish
  - Examples: blackouts/brownouts in electricity, slow data transfer in oversubscribed data networks

These Ideas Are Related

- Note the interaction of connectedness, capacity, and congestibility
- If each agent on a network makes decisions that affect others, with finite capacity then congestion becomes possible (or even likely) in the absence of coordinated decision-making
- That statement applies to both short-run network use decisions and long-run capacity investment decisions

Reliability As A Public Good

- This combination is the genesis of the argument that network reliability is a public good
- Public good: nonexclusive and nonrival
  - Congestible public good: becomes rival at some point
  - Network reliability is excludable -- exclusive to those on network -- and is congestible
- Theoretical implication: PG => underprovision in equilibrium
- History: Pigou, Samuelson
- PG as a subset of externality in general

Logic Of The Public Good Argument

- Because an agent does not reap all of the benefits of providing an additional unit, he/she has an incentive not to provide that additional unit, even if his/her marginal benefit of doing so exceeds his/her marginal cost
- Thus agents free ride on each other's provision, and the good is underprovided
- Policy implication example: mandatory "resource adequacy" investments in electric power networks, cost sharing for those investments

This Argument Is Overstated And Misleading

- Conflates two questions
  - Efficiency/inefficiency of private provision of public goods
  - Free rider problem
- Reliability is a name for a collection of attributes of electric power as delivered to consumers. Some of these attributes are public goods and others are private goods
- Network agents are heterogeneous
- A tradeoff exists between the benefits of free riding and the benefits of managerial control

Buchanan & Stubblebine (1962)

- General neoclassical framework for analyzing externality issues
- Taxonomy of externalities
  - Marginal/inframarginal
  - Potentially relevant/potentially irrelevant
  - Pareto-relevant/Pareto-irrelevant
- The policy-relevant externalities should ***only*** be the Pareto-relevant ones

Model

Value function:

$V_i = V_i(X_i, Y)$ where $Y = Y(y_1, \ldots, y_n)$

Marginal externality:

$\partial V_i / \partial y_j \neq 0$

Inframarginal externality:

$\partial V_i / \partial y_j = 0$

Implications From B&S

- Only marginal externalities are potentially relevant or Pareto-relevant
- Inframarginal externalities can occur where one agent is satiated as a result of the actions of another/others
- Only Pareto-relevant externalities can affect whether the optimal amount of the public good is provided
- Only Pareto-relevant externalities should be policy relevant, and the policy should focus on reducing transaction costs to enable agents to internalize contractually

Model With Reliability as a Public and Private Good

$$V_i = V_i(X_i, Y, y_i)$$

Satiation for agent j occurs when

$$\partial V_i/\partial y_i > 0 \qquad \partial V_i/\partial y_j = 0$$

Specification: Andreoni (1990)

Heterogeneity

- The Pigouvian/Samuelsonian models (and policies based on them) assume homogeneous agents
- Heterogeneity of preferences over reliability opens up the opportunity to see the private good aspects of reliability
- Suppose we rank the n agents according to value of reliability: V_H to V_L
- If I have V_H and you don't and you free ride on me and are satiated, so what? If it doesn't change my behavior, it's an irrelevant externality
- Agents in a bulk power electric network are primarily LSEs, but they are heterogeneous in costs, technologies, and consumers (derived demand)

Managerial Control

- Free riders get no say in the management & strategy of the network
- That control has a benefit and a cost, as does free riding
- “If you don’t pay, you can’t play” as a policy approach that enables excludability and reduces the public good characteristics
- Aligns with property right creation
- Property rule: if you don’t invest in the stock, you are a low priority flow user of the network
  - Does not differ dramatically from rules already in use (e.g., firm/nonfirm transmission rates, LMP rationing trigger price)

Policy Recommendations

- Think critically about the extent to which reliability is treated as a public good by choice instead of necessity
- Don’t approach the grid as more of a commons than is technically necessary
- Focus policy on reducing transaction costs that prevent agents from internalizing contractually
- Create institutions/rules that leverage the private aspects of reliability and diversity among network users, instead of mandating uniform reliability and cost sharing rules

How To Enable This?

- Priority insurance (Chao & Wilson AER 1987)
- Forward contracts and options
  - Agents choose level of price risk based on their own value
- Enable large customers to participate in wholesale markets if they choose
- Treat demand reduction as an asset
  - Contract over trigger prices for interruption
  - Contract over package, then procure remainder in spot markets

Conclusion

- The “who, what, where” of how we manage reliability should be open questions.
- We are using the externality & public good literature to open these questions

Is Reliability A Public Good?

- Yes, but it's also a private good
  - Valued differently by agents with heterogeneous preferences
  - The benefits of managerial control reinforce the private good characteristics
- Yes, but that does not axiomatically imply that it will be underprovided in the absence of central coordination
- Knowledge problem: the ability of the regulator to create a central institution that will amass as much information as agents interacting in flow markets and investment markets
  - Demsetz's Nirvana fallacy

Recommended Readings

- Buchanan & Stubblebine (1962)
- Coase (1960)
- Haddock (2003) on SSRN
- Chao & Wilson (1987)
- Kiesling & Giberson (forthcoming, eventually)