The incentives for long-term adaptation investment in regulated network industries

Workshop on Barriers to Adaptation to Climate Change

Klaus Eisenack & Anna Pechan

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CARL VON OSSIETZKY universität OLDENBURG

i ö w INSTITUT FÜR ÖKOLOGISCHE WIRTSCHAFTSFORSCHUNG

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Motivation

- Network industries (e.g. transport, energy, water, telecommunication) deliver essential services to modern societies
- If climate change leads to more frequent disruptions or increasing costs, substantial adaptation investments may be beneficial
- Network industries are typically publicly regulated
  - Networks are mostly natural monopolies (can be provided at least cost by a single company; economies of scale)
  - Regulation in order to reduce misuse of monopoly power of private network providers
- Does current regulation set the right incentives for network adaptation? Do regulatory mechanisms need adjustment?
- Objective of paper:
  - Explore existing regulation theory with respect to adaptation
  - Apply it to examples: German rail and electricity grid
  - Indentify research needs

Literature

- Adaptation in the transport sector (e.g. Kirshen et al. 2008, Savonis et al. 2008, TRB 2008, Eisenack et al. 2012)
- Adaptation in the energy sector (e.g. Vine 2008, 2012, Mideksa & Kallbekken 2010, Reiter 2010, Eisenack & Stecker 2012)
- Established economic theory of regulating innovation (Bailey 1974, Sweeney 1981) and quality (Spence 1975, Sheshinski 1976)
- Some consideration of adaptation in context with economies of scale (Lecocq & Shalizi 2007, Hallegatte 2009, Eisenack 2010)
- We are not knowledgable of any study that investigates adaptation in the context of regulated industries

Network regulation & adaptation: different mechanisms

- Monopolist maximizes profits $\pi = R - C - F - rK - D - rA.$ subject to constraints that are imposed by regulation.

  [Revenues $R=px$, price p, quantity x; Costs: variable operating expenditures C, fixed costs F, replacement investment D, capital costs rK, adaptation A]

- There are different standard mechanisms of monopoly regulation
  - Cost plus: allowed revenues R are capped by costs
  - Incentive regulation: allowed price p is capped and has to decrease in time (independently of actual costs)
  - Incentive regulation with review: allowed price caps adjusted from time to time to account for unexpected cost changes
  - (… further in the standard literature and in the paper…)
- One aspect: which costs are eligible for calculating price/revenue caps (the “regulatory asset base”), e.g.
  - Only operating expenditures $C+F$? Capital costs rK?
  - In our context: adaptation costs rA?

Results from a stylized model

- Operating expenditures $ux + F$ increase with climate parameter kappa, but can be reduced by adaptation a

$$\pi = p\bar{x} - u(a, \kappa)x - F - r - ra,$$

- Further assumptions: no replacement investment, fixed capital $K=1$ and network capacity x
- Evaluation criterion: social efficiency

	Mechanism	Ad eligible in B	Ad eligible in E	Ad not eligible	Effect
(1)	cost-plus	n.a.	.	yes	extreme under-ad
(2)		n.a.	yes	.	extreme over-ad
(3)	rate-of-return	.	yes	.	indifferent ad
(4)		.	.	yes	extreme under-ad
(5)		yes	.	.	extreme over-ad
(6)	pure incentive	n.a.	.	yes	efficient ad
(7)	incent. with review	n.a.	.	yes	moderate under-ad
(8)	incent. with review	n.a.	yes	.	efficient ad

Table 1: Summary of the effect of different regulatory mechanisms ("n.a."=not applicable, "."=no"). Column three can only show "yes", if there is no "yes" in column one or two.

German rail grid

- The major German rail grid operator (DB Netz AG) controls about 34 t km rail track (4.9 b € gross investment annually)
- Grid sensitive to climatic conditions (e.g. extreme precipitation, heat)
- DB Netz AG is a private company, ultimately owned by the national government
- Grid charges
  - Need to approved by the regulator annually (BNetzA)
  - Follow cost-plus scheme with eligible operation expenditures
  - Public-private contract (LuFV) stipulates public subsidies for investments, tied to quality indicators
  - No consideration of adaptation costs
- Mal-incentives for adaptation: costs are losses that can neither be passed through, nor financed by subsidies (line (1) in table)
- Probably low-powered incentives from quality indicators

German energy grid

- Four companies control transport grid, distribution grids controlled by hundreds of regional monopolies (4.0 b € gross investment annually)
- Grid sensitive to climatic conditions (e.g. heat, extreme wind)
- Grid charges
  - Need to approved by the regulator annually (BNetzA)
  - Follow an incentive scheme combined with cost-based components
  - Differences between *transport* and distribution grid
  - Investment costs passed through if approved within prescribed budgets
  - Cost-based review every 5 years
  - No explicit consideration of adaptation costs
- Costs and benefits from adaptation are eligible under the incentive component
- This sets the right incentives, if adaptation costs remain eligible in future regulatory periods (line (8) in table)

Discussion and Conclusions

- Different regulatory mechanisms perform differently. A crucial design component is the eligibility of adaptation costs.
  - German rail: current combination of cost-based regulation with subsidies is problematic
  - German electricity transport: incentive regulation with eligible adaptation costs is promising
- Some qualifications and needs for further research, e.g.
  - No explicit consideration of replacement investments
  - Current setup frames adaptation as cost-reducing activity. But may also function a quality-improving activity. Different results expected from theory of quality regulation.
  - Currently static setup, but climate change and investment is about time
- Fundamental problem with (eligible) adaptation costs under uncertainty:
  - Who bears the risk of mal-adaptation: The grid provider? The regulator? Consumers?