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A dynamic model for firm-response to non-credible incentive regulation regimes

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HIGHLIGHTS

- Incentive regulation relies on fixed revenue for operators.
- In existing theory the efficiency-inducing effect is model-independent.
- A dynamic game exposes the firm to a regulation that may fail.
- One optimal policy is to pad cost and wait for the failure.
- The Swedish DSOs show this policy 2003–2006, when the regime failed.

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ABSTRACT

Economic network regulation increasingly use quantitative performance models (from econometrics and engineering) to set revenues. In theory, high-powered incentive regulation, such as revenue-caps, induces firms to cost-efficient behavior independent of underlying model. However, anecdotal evidence shows regulated firms occasionally maintaining cost-inefficiency under incentive regulation even under slumping profitability. We present a model for firm-level efficiency under a regime with a probability of failure explaining this phenomenon. The model is based on the hypothesis that the regulatory choice of method can be associated with intrinsic flaws leading to judicial repeal and replacement of it by a low-powered regime. The results show that the cost efficiency policy is proportional to the type of firm (cost of effort), value of time (discount factor) and the credibility of the method (risk of failure). A panel data set for 2000–2006 for 128 electricity distributors in Sweden is used to validate the model predictions (radical productivity slowdown, failing profitability and efficiency) at the launch and demise of a non-credible regulation method. The work highlights the fallacy of viewing incentive regulation as a method-independent instrument, a result applicable in any infrastructure regulation.

1. Introduction

Inefficient operations, imprudent expenditures, low staff productivity and excessive investments by regulated firms are all classical indications that the sector regulation is inadequate and in need of reform. Conventional wisdom would focus at the *incentive power* of the regulation, arguing that the methods and paths to reach a new situation are irrelevant to the final welfare effects. In this paper we show theoretically that this is not true in the case of an imperfect regulation method and strategic firms. We will also estimate this phenomenon empirically with a data set for the detailed firm response under a disputed change in regulatory regime. Although the strategic player in our model is the firm, the policy backdrop for our paper is robust regulatory design.

Regulatory authorities attempt to achieve the dual objectives of assuring a comprehensive, continuous and environmentally compatible service as well as controlling for rent extraction through excessive direct tariffs or by discriminatory pricing of access to impede competitive entry. The National Regulatory Authorities (NRA) define the business perspectives of the regulated operators affecting the operations and economic conditions at a given time. But beyond this, their rulings also signal their commitment for future investments, entry and development of operators. The underlying task is further complicated by the existence of multi-output production (capacity provision, transport work and

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customer services) and heterogeneous input conditions (specific assets, geographical and systemic constraints, different interfaces) under a steady technological development. The NRA is facing an evident asymmetry of information with respect to the capacity, cost and capabilities of the regulated entities. This excludes a naive direct command and control approach to regulation, leaving the room to the traditional economic regulatory approaches: low-powered cost-recovery and high-powered incentive regulation, cf. Joskow (2011).

This paper contributes to the energy policy literature by challenging the conventional conclusions from regulatory economics according to which only the commitment and not the method of determination count for the incentive effects in regulation. We review the existing diverse methods in energy infrastructure regulation, including the models used for determining efficient costs. Noting that some failures can be linked to specific features in the regulatory models, we conjecture that rational firms observe the weaknesses of such models and anticipate their failure. We explore the properties of the model, derive optimal policies that extend the intuition for incentive regulation and state a set of formal results from the model. In competitive markets, an analogy can be made with the credit risks. It is therefore a well-known result that the incentives for client-specific investments decrease with increasing bankruptcy risks. The regulation literature is rarely addressing client or regulatory failures of this type. We have not found any paper modelling the lack of credibility undermining the trust in a regulatory regime. We model credibility as a failure probability and provide empirically verifiable hypotheses that apply to the case of energy network regulation. Using panel data for electricity distributors and a narrative for the failed introduction of a regulatory method in Sweden, we then validate the hypotheses. Our model, combined with a rigorous economic methodology to decompose the drivers of profitability, provides a rational explanation for the behavior of the firms and the demise of the regime. A second contribution lies in the detailed analysis of the sector-level impact in terms of profitability, productivity and efficiency resulting from a regulatory policy error of this type. To our knowledge, both the theoretical and the empirical contribution are seminal in the literature.

The outline of the paper is as follows. In Section 2, we review energy network regulation models, in particular for electricity distribution. In Section 3 we present a decision model for firm-level response to non-credible regulation. In Section 4 we provide the methodological framework for the productivity analysis to test the model. In Section 5 we provide a narrative for the Swedish case, followed by Section 6 on the data and the activity model used for the estimation. Section 7 contains the analysis of a number of hypotheses derived from the theoretical results. The paper is closed in Section 8 with a discussion and some policy conclusions.

2. Regulation of electricity distribution

In Europe, the preamble to the Third Energy Market Directive European Commission (2009) implicitly supposes that incentive (high-powered) regulation of the revenue-cap type is implementable and effective for network regulation of the distribution system operators (DSO) and the transmission system operators (TSO). Empirical evidence shows that DSOs achieve cost savings above any *a priori* expectations, particularly in combination with private or mixed ownership (Cambini and Rondi, 2010). However, although the Directive prescribes the application of a well-defined method *ex ante*, no supra-national model is defined by the legislator. The detailed modus of regulation is then left to national legislators to decide. In practice this has resulted in heterogeneity with respect to the modes, models and methods used by NRAs, see Haney and Pollitt (2009, 2013) for recent surveys.

The decentralized regulatory regimes for independent firms or decision makers are conventionally classified in order of their *incentive power* as either low- or high-powered regulation mechanisms. The incentive power represents the share of 1$ cost savings or cost increases that the firm can retain or must absorb, respectively. Cost-plus regulation is the classical low-powered alternative, with incentives for over-investment and cost inefficiency. Rate-of-return regulation is currently found in many countries, including the United States, as a low-powered option that determines the financial return of the industry. Here, any (prudent) capital investment is covered by the regime, but operating expenditure are capped under an allowance proportional to the regulatory asset base. The seminal work by Averch and Johnson (1962) points out the incentives for overcapitalization to increase the rate base under this regime.

The seminal RPI-X price cap from Littlechild (1983) and its revenue cap variant are examples of high-powered regimes. Incentive regulation is widely applied to electricity transmission and distribution in Europe, *e.g.*, in England and Wales (Pollitt, 1995). Liston (1993) shows that the fixed income induces cost efficiency by the agent's cost minimization. However, the RPI-X model is associated with several theoretical and practical problems; strategic behavior on behalf of the agents fearing punishment in subsequent periods for productivity improvements, the ratchet effect (Weitzman, 1980; Freixas et al., 1985); sensitivity to, and lack of foundation for, the X-term (Cambini and Rondi, 2010); and inability to accommodate changes in the output profile.

The yardstick competition regime (Shleifer, 1985) is a promising addition to the regulatory arsenal. The main problem of the original yardstick model is the comparability between agents and in particular its inability to accommodate variations in the output profiles and operating conditions between the agents, cf. Agrell et al. (2005a). Yardsticks also rely on econometric modeling in general, which requires skills and care not to introduce other errors and bias, cf. Cronin and Motluk (2007).

One instrument in the regulatory arsenal is the *engineering cost model*, also known as a technical normative model. In electricity distribution operations, engineering cost models are, or have been active, in Chile (Rudnick and Donoso, 2000; Recordon and Rudnick, 2002), in Spain (Grifell-Tatjé and Lovell, 2003) and in Sweden, as discussed in Section 5. A normative cost model is based on an attempt to come closer to the true production frontier, or to draw on other information than merely the observations. The concept is tempting in regulation because of its potential profit reduction possibility and its integration in yardstick regulation. However, given the high cost of failure and service interruption in network services, the issue of feasibility in the normative estimation is primordial. In general, technical normative models are just special cases of engineering cost functions with varying levels of information requirements. As such, they are used to *prescribe* rather than to *predict* the optimal or allowable cost for a certain level of operation. Thus, the model's estimate can be made feasible by parameterization and construction.

Our model addresses the risk of regulatory failure explicitly. Our empirical illustration is based on the engineering cost model in Sweden, but other examples of failed regulation models have been documented in the Netherlands (Nillesen and Pollitt, 2007) and in Belgium (Agrell and Teusch, 2015). The qualitative findings in these cases are consistent with our predictions and results.

Theoretically, any implemented model will evoke the same response from the regulated firms. However, we argue that high-powered models must be economically and technically sound to result in the intended incentive effects. In the next section, we present a model to explain why firms, not even subject to the potential flaws of a given high-powered model, have incentives to stall investments in cost efficiency improvements under regimes based on unstable methods.