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# Optimal risk allocation for regulated monopolies and consumers

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## Abstract

The model shows how a regulated monopolist's price should change as random cost and demand parameters are revealed. The regulator has a Ramsey-type problem. With a linear tariff a trade-off between allocative efficiency and risk sharing typically exists. The attitudes of the consumer and the firm to both income and price risk determine how the price should move. Sufficient conditions are found for price adjustment schemes used in practice to be optimal. These schemes include full, partial and zero pass-through of marginal costs, and price caps, average cost pricing and caps on total revenue for demand risk.

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## 1. Introduction

When a regulated monopoly faces volatile cost or demand conditions how should prices be set? This paper addresses this question using an adaptation of the Ramsey pricing model. We characterize the way risks should be shared in general and find sufficient conditions for some observed price adjustment schemes to be optimal. Regulated monopolies and their customers are exposed to several forms of risk. Marginal costs can vary with the prices of inputs such as oil or natural gas. Costs of building and maintaining networks might be volatile because construction prices fluctuate over the

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business cycle. Demand can change with the state of the world (for example the demand for energy depends on the ambient temperature), consumers' incomes, the prices of substitutes or complements, and with exogenous shifts in the number of customers.

Many power utilities in the United States and in developing countries have fuel adjustment clauses that insure them against cost risk while exposing consumers to variable prices. Similarly Mexican and Argentinian gas distributors can pass through gas purchase costs. Two Californian utilities, though, faced bankruptcy in 2001 because they were required to buy wholesale power in a volatile spot market, where prices had risen sharply, and sell it to consumers at a capped retail price. In the UK the energy utilities and the major airports are allowed to pass through specified cost changes to consumers, but the dominant telecommunications firm, British Telecom (BT) has no such provision.

In the face of demand shocks firms that have fixed prices, such as BT and the UK water companies, bear some profit risk when the price differs from marginal cost. One way to reduce the risk to the firms is to lower the allowed price when demand shifts out and raise the price when there is a negative shock. The UK companies which transmit and distribute electricity and gas have price regulation schemes that soften the effect of demand shocks on profits in this way. The electricity transmission company faces a cap on its total revenue, so as demand shifts out prices are cut to keep revenue constant. Two power transmission grids in Australia have similar regulatory constraints. UK electricity distribution companies are allowed extra revenue as the number of customers rises, but the increase in revenue is less than proportional to customer numbers. Similarly if the quantity sold increases while the number of customers is constant the price must drop. The national gas transportation company, Transco, has a constraint on its total revenue, which can be at most equal to a constant plus a unit rate multiplied by output. This resembles a form of average cost pricing, with the constant being the fixed cost of the network and the unit rate approximating the marginal cost of transporting gas through the network. Under this formula Transco is largely protected against demand volatility.

A firm facing a price cap (or a fixed price) can be expected to have a higher cost of capital than one that operates under a regime of rate-of-return regulation (which can be thought of as equivalent to average cost pricing). Intuitively with continuous average cost pricing the covariance of the firm's return with returns on a well-diversified portfolio should be zero, while a fixed price exposes the firm to both demand and cost risk, and if these risks are correlated with the business cycle there should be positive covariance. [Alexander et al. \(1996\)](#) present empirical evidence that firms with fixed prices have higher beta factors than those operating under rate-of-return regulation. Their analysis does not, however, provide guidance to a regulator about how to balance the risks between consumers and firms.

The aim of this paper is to examine the trade-offs that the regulator faces when allocating price risk between consumers and the firm.<sup>1</sup> The regulator chooses how much the price should respond when the risk factor changes. The attitudes of both the consumer and the firm towards risks, the types of risks involved and the specification of the

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<sup>1</sup> [Owen and Braeutigam \(1978\)](#) argue (p. 7) that 'a major effect of the... regulatory process is to attenuate the rate at which market and technological forces impose changes on individual economic agents'.

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