9 Optimal Pricing with Sunk Cost and Uncertainty

James Alleman and Paul Rappoport

Introduction

Marginal-cost pricing results are often employed to justify the imposition of regulatory policy that determines optimal prices. In a more sophisticated form Ramsey pricing is also recommended as a pricing tool (Willig 1979). While the methods are static they are commonly applied to network industries such as telecommunications. Implicitly these methods assume future events are certain and so stochastic cash flow changes are not explicitly modeled. This modeling limitation is important as uncertainty can impact substantially on otherwise optimal prices. Moreover, substantial sunk (irreversible) costs are routinely incurred by incumbent firms in telecommunications network industries. When an investment is sunk the firm has exercised a delay option, i.e., the delay option is no longer available. This opportunity cost is not typically acknowledged by regulators in their pricing decisions. Additionally, in neglecting opportunity costs regulators impact on an incumbent firm’s cost of capital. This chapter develops a model with sunk costs that is solved to determine optimal prices in the spirit of traditional marginal-cost pricing. The modeling demonstrates the impact sunk costs have on the opportunity cost of immediate investment. Real options methods assist in analyzing cash flows that impact on an investments value. The social welfare maximum—the maximal discounted sum of producer and consumer surplus—is obtained.\(^1\) Without regulatory constraint, the modeling shows that ‘uncertainty prices’ differ substantially from traditional marginal-cost and Ramsey prices. Policy implications for the telecommunications industry are important, in particular, total element long run incremental cost (TELRIC) rates are incorrect. Further, should the rates derived from this static theoretical construct be exactly as TELRIC requires they would be erroneous. The chapter is structured as follows. The next section provides a literature review, description of background issues and proposes a framework to address these concerns. The review aims to develop reader intuition toward the real options approach to sunk costs. Next, a model is formalized while a demonstration shows how real option modeling is helpful in understanding the role of irreversible investments as an opportunity cost and that insight on the role of regulation on investment incentives can be gained. A final section concludes and suggests areas for further research.

\(^1\) Models that assume depreciation is exogenously determined fail to include any interaction between demand and economic depreciation, and so provide poor policy direction.
Literature Review

The literature considers in order: the impact of regulation on investment—either rate-of-return or incentive regulation—usually in a static context though occasionally with dynamic models of investment behavior; generic real options analysis; interconnection, wholesale or access pricing; and real options applied to telecommunications and increasingly to access pricing. A review of static and dynamic aspects of investment under alternative regulation and optimal (Ramsey) pricing is provided by Biglaiser and Riordan (2000). Most of this literature assumes an Averch and Johnson (1962) type static framework applies. The models show that rate-of-return regulation does not provide any incentive for firms’ to minimize costs or optimize capital investments. Firm growth is considered via exponential models that have time as an explanatory variable. Economic depreciation is treated as exogenous. The dynamic models are deterministic complete information growth models. The financial real options literature is reviewed and integrated in Trigeorgis (1996). Dixit and Pindyck (1994, 1995) provide an economists perspective on this literature. Dixit and Pindyck focus on the delay option. Conversely, Luenberger (1998) and Hull (2000), in analyzing the received financial real options literature, provide a more extensive coverage of options available to investors. Network interconnection access pricing is another area that has been debated extensively. During the 1990s an important debate considered the correct method to price interconnection. Typically, the debate concerned variants of the efficient component pricing rule (ECPR or Baumol-Willig rule) first proposed by Willig (1979). The rule is based on the contestability theory of Baumol et al. (1984) and the more traditional approach of Laffont et al. (1998a, 1998b), and is summarized by Laffont and Tirole (2000). Criticism of the pricing methods is provided in Alleman (1998a, 1998b). Noam (2001) also extensively reviews interconnection issues. Finally, Vogelsang (2003) provides a critique of access pricing methods and issues. These analyses are based on static or comparative-static models.

Ergas and Small (2000) apply real options techniques to examine the sunk network costs and regulator impact on the distribution of returns. They attempt to establish a link between regulation, the value of the option to delay and economic depreciation. Small (1998) studied investment with uncertain future demand and costs by real options methods. More recently, d’Halluin et al. (2004a) apply real options methods to an ex post analysis of long-distance data service capacity. d’Halluin et al. (2004b) also applies these methods to wireless service issues. Other application of real options techniques to telecommunications markets include Pak and Keppo’s (2004) analysis of network optimization and Kulatilaka and Lin’s (2004) study of strategic investment in technology standards. Finally, several papers address the principal issue concerning this chapter. In particular, Hausman (1999, 2003) uses a real options approach to examine sunk cost of assets and the delay option in the context of unbundled network elements. Similarly, Hausman and Myers (2002) estimate the magnitude of mistakes by the failure of regulators to account for sunk costs in the railroad industry. Hori and Mizuno (2004) employ real options methods to access charges in the telecommunications