

Price Cap Regulation: What Have We Learned from Twenty-Five Years of Experience in the Telecommunications Industry?

by

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Abstract

Price cap regulation (PCR) has now been employed in the telecommunications industry for more than a quarter century. We review the experience with PCR and offer an explanation for its popularity. PCR's design flexibility, its ability to limit undesirable strategic behavior, declining industry costs, and developing competition all enhanced the appeal of PCR. We also review some surprises that have arisen under PCR and discuss the implications of the experience with PCR in the telecommunications industry for regulatory policy in other industries.

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1. Introduction

Regulators in the United Kingdom (UK) adopted price cap regulation (PCR) in their telecommunications industry in 1984 (Littlechild, 1983, 2003a; Crew and Kleindorfer, 1996b). Since that time, PCR has been employed extensively in many telecommunication markets throughout the world. With more than twenty-five years of experience with PCR and other alternatives to rate of return regulation (ROR), it seems appropriate to review the experience with PCR and to assess the reasons for its widespread adoption. We offer a first step in this regard.

We examine the adoption of “incentive regulation” (i.e., PCR and other alternatives to ROR) in the telecommunications industry since 1984. We explain how regulators can, and have, varied the parameters of PCR plans to adapt PCR to the environment in which it is implemented. PCR can resemble ROR, affording little pricing discretion to the regulated firm and providing limited incentives for innovation and cost reduction.¹ However, PCR also can afford the firm substantial pricing discretion and provide strong incentives for innovation. The most appropriate variant of PCR depends in part upon regulatory goals and the intensity of market competition.

In addition to reviewing the principles that underlie the design of PCR and other alternatives to ROR, we summarize recent empirical findings regarding the impact of incentive regulation on industry performance. In doing so, we identify several expected effects of incentive regulation as well as some “surprises.”

After reviewing the experience with incentive regulation in the telecommunications industry, we consider the implications of this experience for regulatory policy in other industries. Definitive conclusions are difficult in light of important institutional and technological differences across industries. For example, energy conservation concerns can complicate the design of incentive regulation in the energy industry. Although definitive conclusions are elusive, we suggest why some trends in the telecommunications industry seem likely to persist more broadly while others do not.

¹ In contrasting ROR and PCR as practiced in the UK, Armstrong et al. (1994, p. 172) note that “As a rough characterization, under rate-of-return regulation reviews are infrequent, and the regulatory lag is endogenous because either side can request a review, whereas under price caps the lag is relatively long, and the date of the next review is fixed in advance. The difference is one of degree rather than kind.” (Regulatory lag refers to the time period between rate reviews under ROR.) Crew and Kleindorfer (1996b) describe the differences between the implementation of PCR in the United States (US) and in the UK.

Our discussion of these issues proceeds as follows. Section 2 reviews the key features of ROR, PCR, and earnings sharing regulation (ESR). Section 3 documents the use of these regulatory policies in selected telecommunications markets around the world. Section 4 notes the need to ensure adequate levels of service quality under incentive regulation plans and explains some of the difficulties in doing so. Section 5 summarizes the findings of recent empirical studies of industry performance under incentive regulation. Section 6 analyzes the key parameters of PCR plans that can be varied to reflect the environment in which PCR is implemented. Section 7 explains how the ability to tailor PCR plans to the prevailing environment has contributed to PCR's popularity. Section 8 recounts some "surprises" that have arisen under incentive regulation in the telecommunications industry. Section 9 concludes, in part by considering the extent to which the experience with incentive regulation in the telecommunications industry can be employed to inform the design of regulatory policy in other industries.²

2. Three Common Regulatory Regimes

When competition is unable to impose meaningful discipline on incumbent suppliers of essential services, regulation can be employed as an imperfect substitute for the missing market discipline.³ ROR, PCR, and ESR have all been called upon to serve this role.

Under ROR, the regulator typically sets the prices that the regulated firm can charge for each of its regulated services. The prices are set to provide the firm with a reasonable opportunity to earn a fair rate of return on its regulated investments. Should the firm's realized rate of return diverge substantially from its expected level under ROR, the regulator can adjust the firm's prices accordingly.⁴

² Crew and Kleindorfer (2002) provide a broad review of regulatory theory and practice in several industries in recent years. Our work complements their work by focusing on the design and implementation of PCR in the telecommunications industry and by reviewing the recent empirical literature on the effects of PCR and other alternatives to ROR.

³ Kahn (1970, p. 17) observes that "the single most widely accepted rule for the governance of the regulated industries is regulate them in such a way as to produce the same results as would be produced by effective competition, if it were feasible."

⁴ ROR typically functions like other forms of cost of service regulation in that the regulator determines which of the firm's expenditures constitute legitimate costs when calculating the firm's rate of return. This process is typically partitioned into two separate stages a revenue requirement stage and a rate design phase. As Robinson and Nachbar (2008, pp.483-4) observe, "The objective is to find a rate that

Under PCR, the regulator initially studies the firm's capabilities and its operating environment in order to determine the revenues that would likely allow the firm to secure reasonable earnings. When PCR is first implemented, the regulator often implements rate rebalancing, modifying the rate structure to align prices more closely with underlying costs.⁵ The regulator then sets the maximum rate at which the inflation-adjusted prices of the firm's regulated services can increase, on average, each year until the PCR plan is reviewed. Formally, PCR often restricts annual average price increases to be less than the economy-wide rate of price inflation by a specified amount, called the "X factor." To illustrate, suppose the X factor is 3% and the economy-wide inflation rate is 2% during each of the four years before the scheduled review of a PCR plan. Under this plan, the regulated firm would be required to reduce the prices that it charges, on average, by 1% annually during the plan (since $2\% - 3\% = -1\%$).

PCR differs from ROR in two important respects. First, PCR grants the firm some discretion in setting prices for its services. Although PCR constrains the rate at which the firm's prices can increase on average, it affords the firm some freedom in setting individual prices that comply with the cap on average prices.⁶ Second, the required decline in inflation-adjusted prices under PCR (i.e., the X factor) is not revised before the scheduled review of the price cap plan even if the firm earns considerably more or less profit than originally anticipated.⁷

matches shareholders' expectations, but ... the regulators' very act of setting rates creates substantial circularity (because investor expectations are in turn a function of the rates being determined)." Bonbright (1961, pp. 135-36) also discusses the interplay between rate levels and rate structures. He notes that "The levels must suffice to make rates as a whole cover costs as a whole, including (or plus) a proper allowance for interest and profits. But the ability of a company to secure adequate over-all revenues depends on the structure of the rates as well as on their average height ..."

⁵ Rate rebalancing helps to ensure that PCR promotes industry cost reduction. It does so by encouraging competitors to focus on attracting customers that they can serve at lower cost than the incumbent supplier rather than providing services whose rates have been set well above the incumbent's costs in order to finance below-cost rates for other services. Even when competition is limited, however, rate rebalancing can lead to allocative efficiency gains in the short-run by reducing price-cost margins and in the long-run by increasing the likelihood that rate changes mandated under PCR move prices in the direction of underlying costs.

⁶ Some PCR plans limit the amount by which the price of a particular service can change. For example, a PCR plan might prohibit a substantial increase in the price of basic local telephone service regardless of the average level of other prices.

⁷ It is important to differentiate PCR from regulatory policies that place an upper bound on the revenue that the regulated firm can earn. As Crew and Kleindorfer (1996a) demonstrate, "revenue caps" can lead the regulated firm to set prices that exceed the unregulated monopoly level, since the firm bears the full cost of output expansion but may not be allowed to secure any of the associated revenue.

ROR can foster industry investment by ensuring a high likelihood of a reasonable return on investment.⁸ However, to the extent that ROR requires the regulated firm to reduce its prices as its realized production costs decline (and thus its realized earnings rise), ROR can limit the firm's incentive to reduce its operating costs. Thus, although ROR can ensure that the firm's actual return on investment never departs too radically from what is deemed to be a reasonable return, ROR may discourage innovation and cost reduction of all forms (e.g., the elimination of unnecessary perquisites for employees of the regulated firm). In contrast, PCR can promote innovation and cost reduction by severing the link between realized costs and allowed prices (at least temporarily). PCR secures these enhanced incentives by permitting the firm's actual returns to diverge substantially from anticipated returns.

Earnings sharing regulation (ESR)⁹ can provide intermediate incentives for innovation and cost reduction by tolerating moderate variation between realized and anticipated earnings. A typical ESR plan specifies a target rate of return on investment (like the 12% target in Figure 1).¹⁰ It also specifies a "no sharing" range of earnings around the target return (e.g., earnings that generate rates of return between 10% and 14% in Figure 1). The firm is authorized to keep all earnings that it secures within the no sharing range, and so ESR functions much like PCR in this range.¹¹ The two policies differ for higher or lower earnings, however. Incremental earnings above and below the no sharing range of earnings are shared with customers.¹² Under the ESR plan illustrated in Figure 1, the regulated firm and its customers each receive one-half of incremental earnings when earnings are in the range that, after sharing, secures rates of return between 9% and 10% and between 14% and 16%. This plan also incorporates upper (16%) and

⁸ This is the case if the regulator truly ensures a high likelihood of a reasonable return on investment. The same is not true if the regulator severely limits the firm's return on all successful investments and forces the firm to bear the full financial consequences of all unsuccessful investments. See Kolbe and Tye (1991) for further discussion of this issue.

⁹ ESR is sometimes referred to as sliding-scale regulation (e.g., Braeutigam and Panzar, 1993).

¹⁰ This illustration of ESR is drawn from Hauge and Sappington (2010).

¹¹ Lyon (1996) refers to this zone in which no sharing of earnings occurs as the "deadband."

¹² This sharing can be implemented by reducing prices (perhaps by increasing the X factor) when earnings exceed the upper bound of the no sharing range and by increasing prices when earnings fall below the lower bound of the range. Earnings above the upper bound of the no sharing range can be shared with customers in a variety of ways. For instance, customers might receive direct cash payments or reductions in their monthly bills. Alternatively, the earnings might finance network expansion into regions that are relatively unprofitable to serve.

lower (9%) bounds on the realized rate of return. Such bounds are common in practice. The bounds in Figure 1 ensure that all incremental earnings above the earnings that provide a 16% return accrue entirely to the firm's customers. In contrast, if the firm would secure less than a 9% return under the prevailing regulated price structure and earnings sharing arrangement, the regulator would increase prices to ensure the firm secures the specified lower bound on the rate of return (9%).¹³ Thus, an earnings sharing plan of this type resembles ROR when realized earnings are sufficiently far above or below the target rate of return.¹⁴

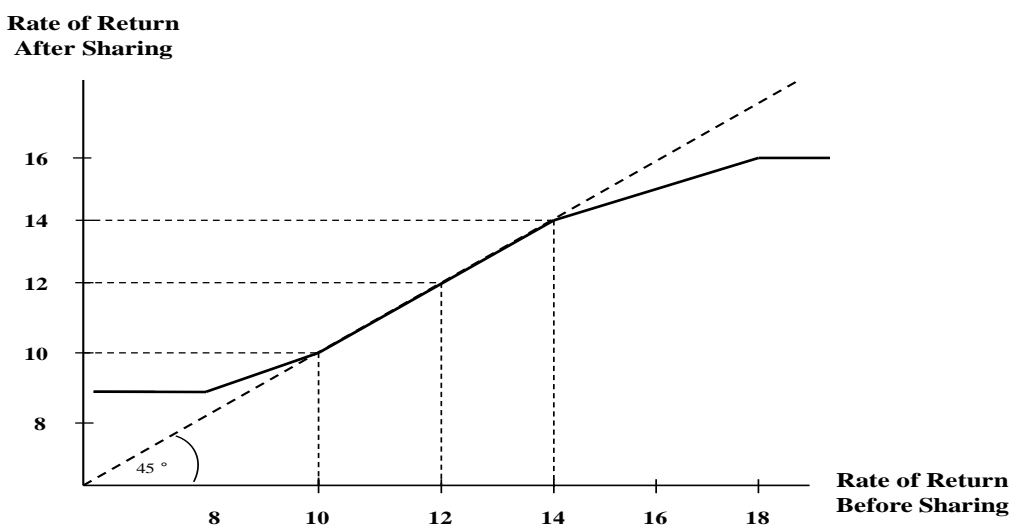


Figure 1. An Earnings Sharing Regulation Plan.

¹³ Earnings need not be shared equally under ESR. Furthermore, the share of incremental earnings awarded to customers need not increase as realized earnings increase. To illustrate, consider the ESR plan awarded to Rochester Telephone (RT) operated in the United States in 1991 and 1992. The plan awarded to RT's customers the first fifty basis points of return in excess of the target return. The next 50 basis points accrued to RT. More pronounced incremental earnings were shared equally by RT and its customers. Earnings sharing plans of this type can provide the regulated firm with strong incentives to secure relatively large reductions in operating costs. See Blackmon (1994, Chapter 4) and Sappington and Weisman (1996a, pp. 142-143) for further discussion of this issue.

¹⁴ ESR plans do not always protect the regulated firm against relatively low earnings, as the plan in Figure 1 does. (See, for example, Alberta Utilities Commission, 2009). ESR plans that require the regulated firm to share relatively high earnings with customers but do not raise prices in the event of relatively low earnings can increase the firm's cost of capital by limiting favorable financial outcomes without mitigating unfavorable financial outcomes.

3. Regulatory Plans in Practice

ROR, PCR, and ESR all are employed in practice throughout the world in many industries. Table 1 summarizes the results of a survey of electricity, gas, and telecommunications regulators in developing and transition countries. Regulators from 60 regulatory bodies in 36 countries responded to the survey conducted by Kirkpatrick et al. (2005). The survey found that PCR was employed in 24 (40%) of these 36 countries, ROR regulation was employed in 17 (28%) of the countries, and ESR was employed in 7 (12%) of the countries. The adoption of PCR was most pronounced in the telecommunications industry. 16 of the 21 countries (76%) that reported use of either PCR or ROR in their telecommunications sector employed PCR.¹⁵

Region	Rate of Return Regulation	Earnings Sharing Regulation	Price Cap Regulation
Africa	7	1	7
Asia	4	2	7
Latin America	2	3	5
Other	4	2	5
Total	17	7	24

Table 1. The Number of Developing and Transition Countries Employing the Identified Regulatory Policy.

PCR has also been adopted extensively in telecommunications sectors in developed countries, including Argentina, Australia, Canada, Chile, Columbia, Denmark, Ecuador, France, Germany, Greece, Hungary, Ireland, Mexico, Pakistan, Portugal, Sweden, the UK, the United States (US), and Venezuela.¹⁶ To provide some feel for the pattern of PCR adoption over time,

¹⁵ 7 of the 18 countries (39%) that reported use of ROR or PCR in their electricity sector employed PCR.

¹⁶ See Intven and Tétrault (2000, p. 4-24), OECD (1997, pp. 34-35), and Wallsten et al. (2004). Hope and Moore (2007) review the PCR plan in Barbados, and compare it to the PCR plan in Jamaica. Façanha and Resende (2004) describe Brazil's PCR plan. Price cap regulation also has been employed in the postal sector in many countries. See Correia da Silva et al. (2004) and Eccles and Kuipers (2006), for example.

Table 2 reviews the state level experience in the US. The table reports the number of states that employed the identified regulatory policy in selected years between 1985 and 2007 to regulate the activities of the primary incumbent supplier of telecommunications services in the state.¹⁷

Year	Rate of Return Regulation	Earnings Sharing Regulation	Rate Case Moratoria	Price Cap Regulation
1985	50	0	0	0
1987	36	3	10	0
1990	23	14	9	1
1993	17	22	5	3
1995	18	17	3	9
1998	13	2	3	30
2000	7	1	1	39
2003	6	0	0	40
2007	3	0	0	33

Table 2. The Number of US State Telecommunications Regulatory Agencies Employing the Identified Regulatory Policy.

Table 2 reveals that the use of ROR in the US telecommunications industry has declined steadily since 1985. The use of ESR has also declined steadily since its peak in 1993. ESR is no longer employed by state regulators in the US.¹⁸ Since the turn of the century, PCR has been the predominant form of regulation in the US telecommunications sector.¹⁹ PCR has been the primary form of telecommunications regulation during this period in many other countries as well, including Canada and the UK.

¹⁷ The statistics reported in Table 2 are drawn from Sappington (2002), Ai et al. (2004), and Pérez-Chavolla (2007).

¹⁸ ESR was never employed in the Canadian or the UK telecommunications sectors.

¹⁹ In recent years, state regulators in the North America have begun to replace PCR with substantial deregulation of all but the most basic access services, just as OFCOM has done in the UK.

The US experience with alternatives to ROR can be partitioned into three phases. In the late 1980s, rate case moratoria (RCM) were the primary alternative to ROR. RCM suspend rate hearings, which typically are employed under ROR to revise the prices charged by the regulated firm to reflect realized production costs. Thus, RCM functions like PCR in that it reduces the direct link between prices and production costs (at least temporarily). In contrast to PCR, RCM typically does not afford the regulated firm much flexibility to adjust prices. Thus, RCM might be viewed as a form of PCR in which the X factor is set equal to the economy-wide rate of inflation (so prices cannot change, on average) and the firm has little or no freedom to restructure prices. Rate case moratoria typically were adopted for relatively short periods of time (often one or two years).

PCR was adopted more frequently and RCM were imposed less frequently during the 1990s. The PCR plans adopted in the US during this period typically scheduled reviews only after a substantial period of time had elapsed (often three or four years). In addition, the plans often afforded the firm considerable pricing flexibility. The X factors under these plans often were set to offset any advantages that regulated telecommunications suppliers were perceived to enjoy relative to other suppliers in the economy. These advantages included less rapid growth in input prices and higher potential productivity growth rates.²⁰

Many state regulators in the US employed PCR by the turn of the century. Indeed, 40 of the 50 states (80%) employed PCR in 2003. The PCR plans adopted during this period implemented fairly long time periods between reviews (often four or five years) and afforded the firm substantial pricing flexibility. Price controls often were applied to a diminishing set of services, as competitive forces were now helping to constrain prices on many telecommunications services.²¹ The strengthening of competitive forces also reduced the need for regulators to predict the extent to which regulated suppliers could reasonably achieve more rapid productivity growth than other firms in the economy and to adjust the X factor accordingly.

²⁰ See Bernstein and Sappington (1999) for a formal analysis of this approach and Crew and Kleindorfer (1996b) for a critique of the approach. Tardiff and Taylor (2003) report that the average X factor in state PCR plans in the US telecommunications industry was approximately 2.7% as of 2003. Intven and Tétrault (2000, p. 4-24) review the (generally higher) X factors employed in national telecommunications regulation plans in selected countries.

²¹ The Telecommunications Act of 1996 (Pub. L. No. 104-104, 110 Stat. 56 (codified at 47 U.S.C. §§ 151 *et seq.*)) opened nearly all US telecommunications markets to competition.

Instead, regulators often set the X factor equal to the rate of inflation (as they had implicitly done under RCM), thereby simply requiring prices not to increase, on average.²²

The declining adoption of PCR after 2003 identified in Table 2 reflects the growing trend toward deregulation of most or all retail telecommunications services in the US.²³ Retail telecommunications services also were largely deregulated throughout the UK in 2006.²⁴

The widespread adoption of PCR in telecommunications markets throughout the world likely reflects in part generally favorable experience with PCR. Before reviewing this experience in section 5, we consider briefly one important dimension of industry experience under incentive regulation – service quality.

4. Designing Complementary Service Quality Regulation.

The foregoing discussion has focused on the manner in which PCR, ESR, and ROR attempt to secure low prices for consumers. Yet consumers value high levels of service quality just as they value low prices. Consequently, it is important to consider how adequate levels of service quality are secured under ROR and its alternatives.

Under ROR, the regulator typically authorizes higher prices to compensate the firm for the increased costs of delivering higher levels of service quality. In contrast, the firm usually is not automatically reimbursed for the costs of increased service quality under incentive regulation plans like PCR. When it faces a binding price ceiling, a regulated monopolist is unable to capture the full incremental surplus generated by an increase in service quality. Consequently, when the firm bears the full cost of the increased quality, it will deliver less than the surplus-maximizing

²² Substantial price reductions compelled by a very high X factor can discourage competitive entry. UK regulators considered this effect when setting the X factor equal to the rate of inflation in 2003. The regulators noted that “such a safeguard control reduces the risk of distortion of competition” (OFTEL, 2003, ¶ 6.17).

²³ The state of Nebraska was a pioneer in the deregulation of telecommunications services in the US. After limiting regulation to basic local service rates, the Nebraska Public Service Commission announced in 1987 that it would only investigate proposed rate increases for basic local service if these increases exceeded 10% in any year or if more than 2% of the telephone company’s customers signed a formal petition requesting regulatory intervention (Mueller, 1993).

²⁴ Hauge and Sappington (2010) review the UK experience with price cap regulation.

level of quality. As Spence (1975, p. 420, note 5) observes, “where price is fixed ... the firm always sets quality too low.”²⁵

Because the price controls in incentive regulation plans alone may not provide ideal incentives for the delivery of service quality, the plans often specify service quality standards and associated financial penalties for failure to achieve the standards.²⁶ For example, some plans specify the speed with which customer service representatives must answer telephone calls. Other plans monitor the frequency and duration of network outages. The number of customer complaints and reports of service trouble are also frequently recorded, and the regulated firm is penalized either formally (through explicit financial penalties) or informally (through less generous treatment on other policy matters) for what is deemed to be sub-standard performance.

The design and enforcement of service quality regulations is challenging for at least three reasons. First, it can be difficult to assess the benefits and the costs of improving service quality. Absent accurate knowledge of the value that consumers place on elevated levels of service quality and the associated costs, it is difficult to identify appropriate service quality standards.²⁷ It can be particularly challenging to assess the benefits and costs of improved service quality in settings where new products and services are introduced frequently.²⁸

Second, the level of service quality that is actually delivered sometimes can be difficult to measure. For example, consumers may value courteous service representatives, and yet the courtesy provided by any particular representative may be difficult to measure precisely. When relevant performance dimensions are difficult to monitor, enforcing desired levels of service quality can be problematic.

²⁵ In settings where the regulated monopolist faces potential competition, increased quality may help to deter competitive entry by increasing the costs that rival suppliers must incur in order to compete successfully.

²⁶ Laffont and Tirole (2000, p. 88).

²⁷ Much like X factors, service quality standards that are unduly high can limit competitive entry.

²⁸ In practice, regulated suppliers tend to have better information about both the benefits and the costs of increased service quality than do regulators. Consequently, consumers can be well served by service quality regulations that afford some discretion to the regulated firm. Much like the pricing discretion it is afforded under PCR, the firm might be permitted to reduce service quality on some dimensions provided it increases service quality on other dimensions so as to maintain a specified average level of service quality (e.g., Lynch et al., 1994). DeFraja and Iozzi (2008) propose a novel regulatory policy along these lines. Sappington (2005) reviews the literature on the design of service quality regulation.

Third, it can be difficult to identify the party or parties that bear primary responsibility for realized service quality problems. To illustrate, a customer may lose telephone service because an underground cable is accidentally sliced. This loss of service could be the fault of the telephone company if the company fails to bury the cable at an appropriate depth in the ground or fails to notify appropriate entities of the location of the cable. Alternatively, the loss of service might reflect a lack of due diligence by field workers from other companies who slice a telephone cable that is buried at an appropriate depth and whose location has been clearly identified.²⁹

Given the limited incentives for the delivery of high levels of service quality that incentive regulation can provide and given the difficulty in designing and enforcing appropriate service quality standards, relatively low levels of service quality might be anticipated under incentive regulation.³⁰ The extent to which perceived problems with service quality have arisen under incentive regulation in practice is reviewed in the next section.

5. Industry Performance under Incentive Regulation

Many authors have conducted empirical investigations of the impact of PCR and other forms of incentive regulation on performance in telecommunications markets throughout the world. The key studies have been reviewed by Abel (2000), Sappington (2002), and Vogelsang (2002), among others.³¹ We will not review the early literature that other authors have surveyed. Instead, we will assess the extent to which recent studies support the broad conclusions drawn from earlier research.

²⁹ Service quality regulation also can be challenging because common policies do not always have their intended effect. As Weisman (2005) observes, penalties for poor service quality can sometimes provide (perverse) incentives to decrease service quality, rather than increase it. This can be true of penalties that take the form of a share of realized revenues. As Sappington and Weisman (1996c) note, revenue sharing can discourage the firm from investing in quality because it requires the firm to bear the full costs of such investments, but allows the firm to retain only a fraction of the resulting revenues.

³⁰ Given the inherent difficulty in identifying the ideal (i.e., the welfare-maximizing) level of service quality and given the tendency to reimburse the regulated firm for all expenditures on improving service quality under ROR, more than the ideal level of quality may be supplied under ROR. When this is the case, a reduction in service quality under PCR will increase welfare if it reduces the costs of supplying quality by more than it reduces the associated consumer benefits.

³¹ See Hemphill et al. (2003), Joskow (2008), and Kwoka (2009) for additional reviews of relevant studies in telecommunications and energy industries.

The identified reviews of the empirical literature report substantial gains from PCR and other alternatives to ROR. Abel (2000, pp. 66-68) concludes that:

Under price-cap regulation, telephone prices have either fallen or remained the same, productivity has generally increased, modern infrastructure has been deployed at a more rapid pace, and firms have performed at least as well financially relative to the other methods of regulation available. ... In addition, the evidence so far suggests that the response has been more pronounced under pure price-cap regulation compared to hybrid plans having an earnings sharing component. This result is particularly true along the productivity and network modernization dimensions. Therefore, the existing evidence suggests that it is likely that the introduction of price-cap regulation in the United States telecommunications industry has produced benefits to consumers, producers, and regulators alike.³²

Sappington (2002, p. 285) concludes that:

Incentive regulation appears to increase the deployment of modern switching and transmission equipment, to spur an increase in total factor productivity growth, and to foster a modest reduction in certain service prices. There is little evidence, though, that incentive regulation leads to a significant reduction in operating costs.³³ There is some evidence that earnings may be higher under price cap regulation. There is little evidence of a systematic decline in service quality under incentive regulation.

Vogelsang (2002, pp. 11, 13) provides a similar assessment. He concludes that under incentive regulation:

Little if any operating cost reductions were found ... In contrast, there is more evidence for increased productivity growth and substantial evidence for accelerated network

³² See Lehman and Weisman (2000a, pp. 343-356) for further discussion of the Pareto gains that PCR can facilitate.

³³ The lack of systematic evidence of lower operating costs under PCR could reflect in part regulatory vigilance under ROR. Such vigilance can limit the ability of regulated firms to pass unnecessary costs on to customers in the form of higher prices, and thereby limit the incidence of such "cost padding." Limited cost padding under ROR can decrease the potential for cost reduction under PCR. See also note 40 *infra*.

modernization. ... Taken as a whole, the findings suggest that incentive regulation induced the firms to improve input efficiency, while paying higher prices for inputs and investing in future cost reductions. ... [Furthermore,] most studies show a modest decrease in basic local rates under incentive regulation. ... [T]here is little empirical evidence to support the contention that quality under price caps has actually deteriorated.

Recent empirical work generally supports these broad conclusions. To illustrate, Ai and Sappington (2002) conclude from their study of the US telecommunications industry between 1986 and 1999 that network modernization is more pronounced under several forms of incentive regulation (including PCR) than under ROR. However, the authors do not find that aggregate investment is higher under incentive regulation than under ROR. The authors report lower operating costs under PCR than under ROR when industry competition is sufficiently intense. This finding suggests that a combination of PCR and competition may spur cost reductions more effectively than PCR alone.

Seo and Shin (2010) study the impact of PCR on productivity growth in the US telecommunications industry between 1988 and 1998. The authors identify a “pronounced positive effect of PCR on productivity growth.” They find that 24 of the 25 firms in the sample “experienced an increase in mean technological change” and that 23 of the 25 firms “experienced an increase in annual productivity growth following the implementation of incentive regulation” (Seo and Shin, 2010, p. 8).³⁴

In her study of local exchange markets in the US between 1991 and 2002, Eckenrod (2006) corroborates earlier findings that price cap regulation is associated with higher earnings for regulated suppliers.³⁵ She observes that the higher earnings reflect reductions in both prices and production costs. Eckenrod (2006, p. 226) concludes that “The mean marginal cost for basic

³⁴ Uri (2001, 2003) finds little impact of incentive regulation on productivity growth rates. Uri’s analysis relies upon a distance function that is presumed to take on a convenient (trans-log) form. Uri also employs a corrected least squares methodology. Seo and Shin (2010) employ a stochastic frontier methodology and test explicitly for the appropriate estimation technique. The authors find that ordinary least squares does not provide the best fit to the data. Hope and Moore (2007) report high productivity growth rates under price cap regulation in Barbados.

³⁵ Hope and Moore (2007) report high earnings under price cap regulation in Barbados.

residential service ... decreased by 14.057% following price cap implementation while the mean real residential price decreased by 8.104% following the shift to price cap regulation.” The author finds even more pronounced declines for some business services.³⁶

Banerjee (2003)’s findings about the impact of incentive regulation on service quality are consistent with earlier conclusions. Banerjee examines twelve measures of retail telephone service quality delivered by forty-nine local exchange carriers in the US between 1991 and 1999. The author reports no significant changes in service quality under incentive regulation plans that entail earnings sharing, but identifies some significant changes under other forms of incentive regulation. However, the changes are neither pronounced nor systematic. To illustrate, Banerjee finds that residential and business customers report fewer problems with their phone service under incentive regulation. However, business customers register more complaints under incentive regulation. The author suggests that the increased number of complaints could reflect “greater service disruptions after markets were opened to local competition” (p. 259). Banerjee’s (2003, p. 264) overriding conclusion is that “average ILEC retail service quality, with a few exceptions, has not suffered major lapses despite the significant changes that have marked the US telecommunications industry over the past decade or so.”³⁷

Façanha and Resende (2004, 2005) identify mixed impacts of incentive regulation on service quality. The authors note that service quality was relatively low in the Brazilian telecommunications industry immediately after the privatization of the industry suppliers in 1998. However, service quality tended to increase between 1998 and 2002, as progressively more stringent price cap controls were implemented. In contrast, the authors find that US local exchange carriers (LECs) that operated under PCR between 1996 and 1998 tended to supply lower levels of service quality than their counterparts that did not operate under PCR. Thus, the

³⁶ Ai and Sappington (2002) also report declines in basic local service rates for some business customers under PCR.

³⁷ Uri (2004, p. 13) reports “relatively small” declines in the level of service quality that US local exchange carriers delivered to inter-exchange carriers under price cap regulation between 1991 and 2000. Recall that a decline in service quality relative to the level provided under ROR does not necessarily reduce welfare if the quality supplied under ROR exceeds its welfare-maximizing level.

authors conclude that “one cannot discard the possibility of an inferior quality-performance of LECs under PCR” (p. 10).³⁸

Ai et al. (2004) also find that incentive regulation had mixed effects on retail service quality in the US telecommunications industry between 1991 and 2002. The authors report that incentive regulation was associated with more rapid installation of new telephone service, fewer customer reports of trouble with their telephone service, and increased customer satisfaction. However, suppliers that operated under incentive regulation during this period met a smaller fraction of their commitments to install new telephone service and took longer to resolve reported service problems.

In summarizing the relevant empirical literature on the impacts of incentive regulation on telephone service quality, Ai and Sappington (2005, p. 208) conclude that:

“recent studies reveal neither a systematic increase nor a systematic decrease in retail telephone service quality under incentive regulation. Service quality has increased on several dimensions under incentive regulation relative to [ROR] ... but quality also has declined on some dimensions ...”

In summary, recent studies add some support for the general conclusions that incentive regulation plans like PCR tend to promote increased network modernization, productivity growth rates, and lower prices for some services while admitting higher earnings for regulated suppliers.³⁹ Recent studies also suggest that PCR may promote some cost reduction, particularly

³⁸ Recent studies of the impact of incentive regulation in the electricity industry provide corresponding conclusions. To illustrate, Crouch (2006) and Jamasb and Pollitt (2007) report lower retail prices for electricity under incentive regulation in the UK. Jamasb and Pollitt (2007) present evidence of lower costs under incentive regulation in the UK. Ter-Martirosyan (2003) finds that the average duration of service outages tend to be more pronounced under incentive regulation, but Kwoka and Ter-Martirosyan (2010) report that declines in service quality can be avoided with explicit financial penalties for sub-standard levels of service quality.

³⁹ The increased network modernization that arose under PCR may reflect in part the “price” that some regulated suppliers were willing to pay in advance to secure PCR. In such cases, increased network investment may have been mandated as a precondition for PCR rather than motivated by PCR itself. See Sappington and Weisman (1996b) for further discussion of this issue.

in the presence of substantial industry competition.⁴⁰ In addition, the studies confirm the lack of a systematic relationship between PCR and service quality.⁴¹

6. The Design of Price Cap Regulation

PCR has been popular in practice in part because of its flexibility. The key elements of a PCR plan can be adjusted to adapt to the environment in which PCR is implemented. These key elements include the X factor, the Z factor, the duration of the plan, the nature of the plan review, and the structure of the basket(s) of regulated services.

The X Factor

The X factor is arguably the most critical element of any PCR plan. Because the X factor determines the rate at which the firm's inflation-adjusted prices must decline on average throughout the scheduled duration of the PCR plan, a small change in the X factor can have a pronounced impact on the firm's earnings for an extended period of time. In particular, an X factor that is "too high" can undermine the regulated firm's financial viability. It can also render industry entry unprofitable. An X factor that is "too low" can enable the regulated firm to earn supra-normal profit. The regulator's challenging task under PCR is to set an X factor that balances these risks appropriately.

Conceptually, the regulator's task in this regard bears some resemblance to the regulator's task in setting an appropriate allowed rate of return under ROR. A key difference is that under ROR, the regulator can revise the prices charged by the regulated firm as information arrives to suggest that the firm's actual rate of return varies substantially from the authorized return. Under PCR, any corresponding reconciliation of actual and expected return is postponed

⁴⁰ It should also be noted that realized innovation and cost reduction likely are influenced by policies other than retail price controls. These policies include the obligation that is often imposed on incumbent telecommunications suppliers to unbundle their networks and share essential network elements with competitors at cost-based rates. Such obligations reduce the private returns to network investment and innovation and so may discourage these activities, as Grajek and Röller (2009) document. (Also see Cambini and Jiang (2009).) See Weisman (2002a) and the *Telecommunications Policy Review Panel* (2006, pp. 3-35) for further discussion of this issue.

⁴¹ We are not aware of studies that compare price volatility under PCR and ROR. Because it severs the link between prices and costs, PCR may reduce price volatility relative to ROR. Reduced price volatility can benefit risk-averse consumers.

until the scheduled review of the PCR plan. Consequently, the actual return can depart significantly from the expected return under PCR.⁴²

The Z Factor

It can be challenging to specify in advance an X factor that will be “just right” throughout the duration of a PCR plan. Such a specification requires accurate knowledge of the firm’s capabilities as well as present and future industry conditions. Because it is difficult for even the most omniscient regulator to anticipate all relevant industry events, many PCR plans include a Z factor. The Z factor adjusts the rate at which inflation-adjusted prices must fall to reflect the financial impact of unanticipated events.⁴³ An event for which a Z factor adjustment is considered under PCR typically exhibits three distinguishing characteristics. First, the event is beyond the control of the regulated firm. Second, the event has a pronounced financial impact on the firm. Third, the event has a disproportionate effect on the regulated firm that is not accounted for by other elements of the PCR plan. Typical events that may warrant Z factor adjustments include an industry-specific tax change, new legislation, and a *force majeure* or “act of God” (e.g., floods, hurricanes and tornadoes).

Z factor adjustments are designed to insure the regulated firm against large, unanticipated financial shocks that are beyond its control. Absent any prospect of a Z factor adjustment, the regulated firm must deliver its services at the mandated prices regardless of its realized earnings. If unanticipated industry developments arise, the regulated firm may experience wide variation in earnings. Such variation entails risk for investors, which can increase the regulated firm’s cost of capital. Appropriately designed Z factor adjustments can reduce the firm’s capital costs without limiting the firm’s incentive to innovate and reduce its operating costs.⁴⁴

⁴² Furthermore, because the value of X can influence the firm’s incentive to gather valuable planning information and to innovate, X need not be set to generate precisely a fair return on investment. See Littlechild (2003b) for further discussion of this issue.

⁴³ Formally, the firm’s prices are permitted to rise, on average, at the rate of inflation plus the Z factor minus the X factor.

⁴⁴ In order to reduce the firm’s capital costs without limiting desirable incentives, Z factor adjustments must be designed and implemented appropriately. If, in practice, these adjustments are employed to preclude all windfall gains for the firm but never compensate the firm for unavoidable, unanticipated losses, then Z factors can increase the firm’s cost of capital, just as ESR plans can if they limit large financial gains without mitigating severe financial losses. Future research might determine whether regulated firms that incorporate explicit Z-factor adjustments in their PCR plans face higher or lower costs of capital. (Note that if a Z-factor changes the cost of capital, it could affect the rate of growth of

Z factor adjustments are only made for exogenous events to avoid compensating the firm for financial losses that it could reasonably have avoided. To illustrate, the firm might be compensated for the reduction in earnings it suffers due to a new tax on regulated telecommunications services or for the uninsured losses it incurs from facility damage caused by an unanticipated flood.⁴⁵ In contrast, the firm would receive no compensation for facility damage caused by faulty design, improper use, or inadequate maintenance.

It can be difficult and time consuming to identify the exact financial impact of an exogenous, unanticipated event. Therefore, to reduce the costs associated with the frequent regulatory hearings that would otherwise be required, Z factor adjustments typically are limited to events with pronounced financial impact.

Z factor adjustments also are reserved for events that affect the regulated firm disproportionately. This restriction helps to avoid compensating or penalizing the firm twice for the same financial shock. To illustrate, suppose the regulated firm incurs a large, unanticipated increase in labor costs due to a pronounced increase in the power of labor unions throughout the economy. A Z factor adjustment for these increased costs typically would not be appropriate under a PCR plan that allows the firm to increase its prices, on average, at the rate of economy-wide price inflation (less the X factor). In this case, the widespread unionization would likely increase inflation throughout the country, and so the regulated firm would be authorized to increase its prices accordingly without a Z factor adjustment.⁴⁶

Z factor adjustments help PCR to replicate the discipline of competitive markets. Suppliers in competitive markets typically can pass along to customers in the form of higher prices unavoidable cost increases that affect the entire industry (e.g., a substantial increase in the cost of essential inputs). In contrast, a supplier that is less diligent than its rivals in controlling its

input prices and hence the appropriate X factor. Thus, the various parameters in the price cap formulae are intimately linked.)

⁴⁵ A regulated firm might reasonably be required to bear the financial losses associated with a risk against which the firm could have insured at reasonable cost, but declined to do so. Of course, the firm's cost of acquiring insurance should be viewed as a legitimate cost of operation in such a setting.

⁴⁶ A Z factor adjustment would be appropriate in this case only to the extent that the exogenous wage inflation affects the regulated supplier disproportionately relative to other firms in the economy. Note, more generally, that Z factor adjustments typically are not "all-or-nothing" adjustments. A regulated firm may ultimately be judged to be responsible for one-half of the financial loss associated with an unanticipated event (e.g., an unusually severe storm). In such a case, the Z factor adjustment should compensate the firm for only half of the financial loss it incurred due to the event.

operating costs cannot increase its prices to recover these costs. The supplier's (former) customers will simply purchase the product in question from the more efficient rival suppliers who offer to sell the same product at a lower price.

The Duration of the Price Cap Plan

A PCR plan typically specifies the length of time for which the plan will operate before it is reviewed. A relatively short PCR plan can help to ensure that prices do not diverge too far from underlying production costs and that realized earnings do not depart too far from the target level of earnings for an extended period of time. A short PCR plan can function much like ROR in this regard. A short PCR plan also may function like ROR by diminishing the firm's incentive to innovate and reduce its operating costs. In particular, if the X factor is re-set frequently to pass on to consumers in the form of lower prices any cost reductions that the regulated firm has achieved, then the firm's incentive to secure these cost reductions will be limited.⁴⁷

The Nature of the Plan Review

Holding constant the length of a PCR plan, the incentives for innovation and cost reduction that the plan provides vary with the nature of the plan review. If the review entails revising the X factor to pass on to consumers any and all cost reductions that the firm has achieved, then PCR will function much like ROR with an exogenous regulatory lag (Pint, 1992).⁴⁸ In contrast, if the review serves primarily to determine whether the industry has experienced any major structural changes (e.g., a substantial increase in actual or potential competition) since the last review of the PCR plan and to adjust plan parameters only to reflect such changes, then the PCR plan will provide the regulated firm with substantial incentive to innovate and reduce its operating costs.⁴⁹

⁴⁷ Armstrong et al. (1995) analyze the optimal duration of a PCR plan.

⁴⁸ Such a PCR plan also will function much like earnings sharing regulation in that high earnings are shared (intertemporally) with consumers. In settings where multiple local monopolies operate in similar settings, the X factor for each firm can be adjusted to reflect the recent performance of the other regulated firms. Such adjustments allow X factors to be updated to reflect recent industry changes without penalizing individual firms for exceptional performance. See Shleifer (1985) and Meran and Hirschhausen (2009), for example, for thoughts on how to design such "yardstick regulation."

⁴⁹ As noted above, a smaller X factor can be appropriate in the presence of an increased potential for competition so as not to stifle competitive entry unduly. Increased competition also can justify a lower

Service Baskets

For simplicity, the discussion to this point has considered the case in which all of the firm's regulated services are placed in a single basket and the restriction on the rate at which inflation-adjusted prices can rise is applied to this single basket of services. In practice, PCR plans often group the firm's services into distinct baskets of services and apply separate average price restrictions to each basket.

To illustrate, services sold to residential customers can be placed in one basket and services sold to business customers can be placed in a second basket. Such separation can have important implications even if the same constraint on average prices is applied to each basket. When all services are placed in the same basket, a reduction in the price of one service enables an increase in the price of any other service without altering the average price of all services. In contrast, when residential services and business services are placed in distinct baskets, the average price of residential services does not change when the prices of some or all business services are reduced. Therefore, when residential and business services are placed in distinct baskets and a separate average price constraint is imposed on each basket, a reduction in the price of a business service does not automatically authorize the firm to increase the price of a residential service, as would be the case if all services were placed in a single basket.

Through appropriate segregation of services into distinct baskets, a PCR plan can ensure reasonable price levels both on average and for particular groups of services. The plan can thereby selectively provide the greatest regulatory protection where it is most needed.⁵⁰

Of course, regulatory protection should be reserved for settings where it is needed. In particular, once competition has developed to the point where it alone can constrain prices effectively on some services, these "competitive" services should be removed from price cap regulation. Otherwise, the prices of non-competitive services may rise unduly. This is the case

X factor to the extent that it promulgates faster input price growth rates (by bidding up the prices of scarce inputs) or reduces the regulated supplier's operating scale and thereby increases its unit cost of production.

⁵⁰ PCR plans can afford special protection to the regulated firm's smallest customers (i.e., those who spend the least on the firm's services) even without placing the services that these customers purchase in a separate basket. This special protection can be achieved by weighting particularly heavily the expenditures of small customers when calculating the average price of the firm's services. See Hauge and Sappington (2010) for a description of this weighting procedure (which has been employed in the UK telecommunications sector).

because, as noted above, PCR permits the firm to increase the prices of non-competitive services when it reduces the prices of competitive services in the same basket of services.

7. The Popularity of PCR

Having examined the key elements of PCR plans, we can now consider why PCR has been widely adopted in telecommunications industries throughout the world in recent years. The popularity of PCR likely stems in part from its ability to adapt to the environment in which it is implemented and to the primary goals it is intended to serve.

The design and implementation of PCR may seem to be a daunting task for regulators who have limited knowledge of the regulated firm's capabilities and the environment in which the firm operates. If the regulator cannot specify an X factor that is "just right," the regulated firm may enjoy supra-normal profit or suffer financial distress. However, the regulator can ensure that financial distress is short-lived by scheduling a review of the PCR plan soon after it is implemented. The regulator also can allow Z factor adjustments for moderate financial shocks. Furthermore, the regulator can limit objections to relatively high earnings for the firm by choosing an X factor that guarantees for consumers smaller price increases than they experienced under ROR.

As noted above, enhanced incentives for innovation can produce cost savings that enable gains for both consumers and the regulated firm. The X factor effectively determines how potential gains are shared by the firm and its customers. A key difference between PCR and ESR in this regard is that PCR can guarantee gains for consumers by imposing the same reductions in inflation-adjusted prices regardless of the cost savings that PCR engenders. In contrast, the gains that consumers receive under ESR vary with the cost reductions (and thus the earnings) that the firm ultimately achieves.

Of course, if a PCR plan is reviewed soon after it is implemented and if the X factor is reset at the review to award to consumers on an ongoing basis the entire productivity gain that the firm has secured, then the plan will function much like ROR. Such a plan is unlikely to foster significant cost reduction. Therefore, a regulator that has reasonable knowledge of the firm's capabilities and industry conditions can implement a PCR plan with a longer period of time between reviews. Such a plan can provide the firm with substantial incentive to innovate and

reduce its operating cost with little risk of allowing the firm excessive profit or forcing the firm to suffer financial distress.

PCR plans also can be adjusted to afford particular protection to consumers for whom the market provides the least protection. The protection can be provided, for example, by identifying the services that these consumers tend to purchase and by placing separate, stringent controls on the prices charged for these services.

The pricing flexibility that PCR affords the regulated firm can be particularly valuable in settings where the incumbent supplier faces competitive pressure. Competitors often make every effort to attract the incumbent supplier's most profitable customers – a practice known as “cream-skimming.” To avoid losing these customers, the incumbent must respond to competitors' price reductions in a timely fashion. PCR facilitates timely responses to targeted competitive challenges and permits a broader restructuring of prices that can help to avoid undue financial stress for the incumbent supplier.⁵¹

By granting the incumbent supplier substantial flexibility to structure prices, PCR empowers the regulated firm to employ its privileged knowledge of production costs and consumer demand to maximize its profit while delivering the mandated inflation-adjusted average price reductions. With appropriate specification of the X factor and the weights employed to calculate the average price level, PCR can thereby induce the regulated firm to set prices that maximize the welfare of consumers while ensuring the firm a reasonable return on its regulated investments.⁵² A regulator that attempts to set prices directly based on her imperfect knowledge of production costs and consumer demand typically would be unable to secure the same outcome.

⁵¹ The structure and composition of service baskets can be important in this regard. As noted in section 6, if residential and business services are placed in the same basket of services, then the regulated firm is effectively authorized to increase the prices of residential services when it reduces prices for business services in response to competitive pressures. Such authorization can encourage excessive price reductions for business services (i.e., prices below incremental production costs) by insulating the firm from the financial impact of price reductions. See Armstrong and Vickers (1993) for additional analysis of this possibility.

⁵² See Laffont and Tirole (1996). This conclusion holds if all of the regulated firm's services are placed in the same basket, a single constraint on the firm's average price level is applied to this basket, and the weights applied to individual service prices reflect the relative quantities of the services sold at the identified ideal outcome.

PCR is well-suited for environments with developing competition for an additional reason. When competitive forces strengthen to the point where they can effectively limit the prices that the incumbent supplier charges for some of its services, it is appropriate to terminate price regulation of these services. Such selective deregulation leaves the incumbent supplier producing both regulated and unregulated services. When these distinct groups of services are produced using the same production facilities, the firm's cost of supplying regulated services can be difficult to measure. Regulatory policies that link prices to measured costs in such settings can be contentious and difficult to implement. PCR can avoid these difficulties by declining to link prices to measured costs.

The widespread adoption of PCR may also reflect the technological changes that, in recent years, have produced reductions in the costs of key inputs (e.g., digital switches and optical fiber) employed to produce telecommunications services. PCR provides a convenient means to pass these (exogenous) cost reductions on to consumers in the form of lower prices without the need for frequent formal rate hearings.

In summary, PCR has enjoyed considerable popularity in telecommunications industries throughout the world in recent years. This popularity likely reflects in part the prevailing industry conditions and in part the ease with which PCR can be adapted to the setting in which it is implemented. The X factor, Z factor policies, the length of the plan, the nature of the plan review, and the structure of service baskets all can be adjusted to reflect prevailing regulatory goals and resources.

In principle, ESR adds an additional element of flexibility that might tend to make ESR even more popular than PCR. ESR permits realized surplus to be divided between consumers and the regulated firm according to the level of earnings that the firm generates. In contrast, PCR effectively guarantees in advance the benefits that consumers will receive and allocates to the regulated firm any incremental surplus that it generates.⁵³

⁵³ Because consumer benefits are guaranteed in advance under PCR, consumer advocates may have an incentive to lobby for excessively liberal competitive entry policies. Such policies can benefit consumers in the short run by promoting lower industry prices. In the long run, though, such actions can limit investment by the regulated firm and thereby harm consumers by reducing industry innovation. See Fazzari et al. (1988), Lehman and Weisman (2000a, pp. 343-356), and Weisman (2002a,b) for further discussion of this issue.

Although the ability to vary the division of surplus according to its realized magnitude offers potential advantages, it also introduces important disadvantages. These disadvantages, which are considered in detail in the next section, likely explain why ESR has proved to be less popular than PCR in many jurisdictions.

Before proceeding, we note that PCR has not been universally adopted in telecommunications markets around the world despite its many benefits. Variation in regulatory commitment powers may help to explain different rates of PCR adoption in different jurisdictions. PCR will realize its full potential benefits only if the promise to reward the regulated firm for superior performance is credible. The firm will have little incentive to innovate and discover ways to reduce its operating costs if it believes the regulator will simply pass all of the resulting gains on to consumers in the form of lower prices. In practice, political pressure to reduce substantial earnings by a regulated firm can be intense, regardless of the source of the earnings.⁵⁴ When this political pressure is so intense as to preclude substantial earnings for the firm, the potential gains from PCR will be limited, and so PCR may not be implemented.

8. “Surprises” Under Incentive Regulation

For the most part, incentive regulation in general and PCR in particular have played out in practice as predicted by the theory. However, two “surprises” identified above have arisen – the short tenure of ESR and the lack of pervasive, persistent declines in service quality. We provide additional possible explanations for these surprises in this section. After doing so, we identify and explain a third “surprise” that does not appear to have been anticipated in the early literature on PCR. This surprise pertains to the behavior of regulators rather than the behavior of regulated suppliers.

⁵⁴ As Braeutigam and Panzar (1989, p. 320) note, “A regulatory agency is likely to be subjected to considerable political pressure to change the price cap or price cap formula over time. If a firm regulated by price caps begins to earn large profits, consumers will no doubt petition the regulator to lower the price in the core market.” Weisman (1993, pp. 364-365) notes that increased earnings for the regulated firm are sometimes viewed as a failure of regulation itself. This view can place regulators under extreme pressure to limit the firm’s earnings, which in turn can reduce the firm’s incentive to realize the gains that PCR could otherwise secure. Panteghini and Scarpa (2008) analyze the merits of ESR in settings where the regulator has limited ability to allow exceptionally high earnings.

The short tenure of earnings sharing regulation in the US telecommunications industry may be somewhat surprising for at least three reasons. First, as noted above, earnings sharing coupled with price cap regulation would seem to provide even greater flexibility than pure price cap regulation to adapt to changing industry conditions. Second, the literature suggests that in the presence of limited knowledge of industry conditions, earnings sharing can generate greater consumer welfare than can pure PCR.⁵⁵ Third, regulators can face serious political ramifications if the regulated firm's earnings exceed levels that the public deems to be acceptable (Braeutigam and Panzar, 1989, p. 320; Weisman, 1993, pp. 364-65). Earnings sharing tempers these concerns by automatically delivering a portion of abnormally high earnings to consumers. Hence, the fact that regulators often choose to operate without the "safety net" that ESR can provide may be surprising.

There are at least three possible explanations for this surprise. The first explanation for the short tenure of ESR in the US is that regulators may have discovered fairly quickly that ESR retains many of the drawbacks of ROR. In particular, a plan that allocates more surplus to consumers as realized surplus increases limits the firm's incentive to increase surplus. Thus, ESR does not provide the same strong incentives for cost reduction and innovation that PCR provides.⁵⁶ Furthermore, ESR requires precise measurement of earnings. As noted above, such measurement is difficult when the regulated firm supplies both regulated and unregulated services (e.g., basic telephone service and broadband internet access) using the same production facilities. Some allocation of common production costs is required in these settings, and such allocations can be contentious.

The greater is the fraction of common costs allocated to regulated services, the lower are the measured earnings derived from regulated services. Consequently, the regulated firm has an incentive to allocate common costs to regulated services while consumer advocates have an incentive to encourage the allocation of common costs to unregulated services when the regulated firm operates under ESR. Consumer advocates also have an incentive to encourage regulators to disallow costs that the firm has incurred prudently in supplying regulated services.

⁵⁵ See, for example, Schmalensee (1989), Lyon (1996), and Armstrong and Sappington (2007). Blank and Mayo (2009) demonstrate the value of ESR regulation in a setting where consumers and regulated firms lobby for favorable treatment.

⁵⁶ Consequently, a lower X factor can be appropriate.

When costs are disallowed, measured earnings rise, thereby increasing the financial benefits that consumers enjoy under ESR.⁵⁷ Thus, ESR introduces contentious technical issues that can be difficult and costly to resolve – issues that do not arise under PCR because PCR does not base surplus sharing rules on the level of measured earnings.

The costly, contentious issues that ESR can introduce have led regulators to eschew the sharing – and even the reporting – of earnings. As a former regulator in the state of Massachusetts reports (Vasington, 2003, p. 459):

The [Massachusetts regulatory] commission decided that earnings sharing was not appropriate because it introduces many of the cost-of-service disincentives for efficiency that price cap regulation is designed to eliminate. The commission also did not want to have to rule on the prudence of investments in an increasingly risky and speculative industry, which would have been required for an earnings calculation. Also, earnings sharing would require an annual review of earnings, which the commission thought would be a significant administrative burden. Some parties suggested that the calculation of earnings in each annual filing could be a pro-forma exercise, but . . . the commission's own experience . . . showed the difficulty, if not impossibility, of limiting the scope or depth of a review of earnings in an administrative proceeding. The commission decided that it did not even want to see a calculation of the company's earnings, and, to this day, such a calculation has not been filed with the Massachusetts commission by Verizon.

Earnings sharing can be viewed as costly insurance against extremely high or extremely low earnings for the regulated firm. Despite the substantial cost of this insurance, regulators may choose to “purchase” the insurance when their knowledge of the capabilities of the regulated firm and the environment in which it operates is limited. In contrast, when regulators are better able to predict the earnings that the regulated firm will generate under a specified X factor and/or when market competition is better able to discipline incumbent suppliers, regulators may implement PCR and thereby avoid the high cost of the insurance provided by ESR.

Such considerations may underlie the pattern of regulatory policy adoption described in section 3. Recall that when US state regulators first considered alternatives to ROR in the 1980s,

⁵⁷ See Braeutigam and Panzar (1993) and Weisman (1993) for additional discussion of these issues.

they often adopted ESR. The primary suppliers of intrastate telecommunications services – the Regional Bell Operating Companies (RBOCs) – were created by the divestiture of AT&T in 1984. Consequently, state regulators had relatively little knowledge about the RBOCs’ capabilities in the 1980s. As regulators acquired better knowledge of these capabilities in the 1990s and as competitive forces gained strength, PCR began to replace ESR as the primary alternative to ROR. As noted in section 3, US state regulators had abandoned ESR entirely by 2003.⁵⁸

The second explanation for the short tenure of ESR in the US is that regulated suppliers may have been willing to “bribe” regulators with guaranteed consumer benefits like expanded infrastructure investment and lower retail prices in return for the opportunity to operate under “pure” PCR with no earnings sharing (Sappington and Weisman, 1996a, Chapter 3). Regulators may have determined that these guaranteed gains for consumers exceeded the potential gains that earnings sharing might deliver.⁵⁹

The third possible explanation is that regulators may have been willing to forego earnings sharing because they had other instruments at their disposal to protect against inordinately high earnings on the part of the regulated firm. These other instruments are discussed further below. First, though, we suggest some possible explanations for the second surprise under PCR – the absence of a pervasive, persistent reduction in service quality.

As noted in section 4, Spence (1975) predicted that the imposition of a price ceiling on the supplier of a single product would induce the supplier to reduce its service quality. However, as noted in section 5, the telecommunications industry has not experienced lasting declines in service quality under PCR predicted by the theory. This outcome may reflect at least four considerations.

⁵⁸ Similar considerations may also help to explain why ESR has not been phased out as rapidly in some developing countries. (Recall the experience summarized in Table 1, for example.) Regulatory resources are severely constrained in many developing countries. Resource constraints can lead to limited knowledge of the capabilities of regulated suppliers. In the presence of such limited knowledge and in the absence of strong competitive pressures, regulators may opt to “purchase” the insurance against exceptionally high or low profit that ESR can provide.

⁵⁹ Regulators may also have realized that an earnings sharing provision would obligate them to raise prices on key services if competition on other services substantially eroded the earnings of the regulated firm, and preferred to avoid this obligation.

First, as noted in section 4, incentive regulation plans often stipulate service quality standards and impose financial penalties if the standards were not met. Although the penalties are not always stringent, they may help to limit substantial reductions in service quality.⁶⁰

Second, some early incentive regulation plans were terminated because of perceived problems with service quality.⁶¹ The early terminations signaled to regulated firms that they must maintain desirable levels of service quality if they wish to continue to operate under incentive regulation. Firms that subsequently operated under incentive regulation may have received and heeded the message.

Third, suppliers of regulated telecommunications services often sell additional unregulated services, including long-distance, broadband and wireless services. Consumers who experience poor service quality of regulated telephone service may decline to purchase other services from the regulated supplier.⁶² To avoid such erosion of consumer demand for (relatively profitable) unregulated services, a regulated supplier may choose to deliver relatively high levels of service quality for regulated telecommunications services.

Fourth, regulated suppliers may face political and regulatory pressure to maintain high levels of service quality other than the pressure imposed directly by the regulatory plan itself. To illustrate, Ameritech faced an onerous multi-state investigation of perceived shortcomings in its service quality.⁶³ Concerns about poor service quality also complicated the merger of Ameritech and SBC and the approval of their applications to provide InterLATA long-distance service (Sunderland, 2000).

We turn now to the third surprise under PCR, a surprise that pertains to the behavior of regulators rather than the behavior of regulated suppliers. Much like the foregoing discussion, the early literature focuses primarily on the ability of PCR to influence the behavior and

⁶⁰ Joskow (2008, p. 556-7) provides a corresponding observation with regard to incentive regulation in the energy sector. He notes that “incentive regulation has not led, as some had feared, to deterioration in ... service quality. This is likely to have been the case because quality standards and associated mechanisms were included in the portfolio of incentive regulation mechanisms adopted in the UK.”

⁶¹ This was the case, for example, in Oregon (Oregon Public Utility Commission, 1996).

⁶² For example, in a 2001 price cap proceeding in Canada, the Canadian Radio-television and Telephone Commission (CRTC) received numerous letters from customers indicating an intention to switch long distance, wireless, and Internet service providers if local telephone companies increased prices and/or decreased quality for basic local telephone service (CRTC, 2001).

⁶³ See Banerjee (2003).

performance of regulated firms.⁶⁴ The early literature does not emphasize the impact of PCR on the likely behavior of regulators. Consequently, the literature does not predict that PCR might endow regulators with particularly strong incentives to promote the entry and operation of new industry competitors.⁶⁵

By precluding substantial increases in retail prices even when the regulated firm's earnings are very low, PCR can encourage regulators to undertake actions that they believe will benefit consumers, even if the actions reduce the firm's earnings substantially.⁶⁶ These actions include facilitating industry competition by, for example, requiring incumbent suppliers to provide unbundled network elements (UNEs) to rival retail competitors at very low prices. The evidence suggests that some regulators may have undertaken such actions. UNE prices tend to be lower in states where PCR is employed than in states where ROR is employed.⁶⁷ Such outcomes were not anticipated, and so can be viewed as a surprise. However, the outcomes seem apparent once the incentives that PCR creates for regulators are considered.

The ability of regulators to limit earnings by facilitating competitive entry may also help to explain the short tenure of earnings sharing regulation. The 1996 Telecommunications Act endowed regulators with new instruments (e.g., UNE prices) to control the level of competitive intensity and, in turn, the earnings of the regulated firm. Hence, in giving up earnings sharing in return for guaranteed benefits for consumers, regulators may have given up little more than the sleeves from their vests.⁶⁸

⁶⁴ The literature notes, for example, that PCR can enhance the firm's incentive to reduce its operating costs and undertake efficient levels of diversification. The literature also notes that PCR can limit the firm's incentive to misrepresent its production costs, choose inefficient production technologies, and waste resources. See, for example, Braeutigam and Panzar (1989, 1993), Weisman (1993), and Blackmon (1994).

⁶⁵ Weisman (2000) refers to this behavior as *regulatory moral hazard*.

⁶⁶ In contrast, an earnings deficiency under ESR or ROR typically triggers an increase in the prices of regulated services.

⁶⁷ See Weisman (1994, 2002a), Lehman and Weisman (2000a,b), and Onemli (2010, Chapter 3).

⁶⁸ The limited evidence of substantial reductions in operating costs under PCR also may be somewhat of a surprise. The limited evidence may reflect in part the difficulty of measuring the costs of producing regulated services when the firm supplies both regulated and unregulated services. Relevant changes in production costs also can be difficult to measure accurately when production technologies, products, and service qualities are changing. It is also possible that regulated suppliers do not secure all potential efficiencies when they operate under PCR because they anticipate that future prices will be revised downward to reflect the achieved efficiencies when the price cap plan is reviewed

9. Conclusions

As noted at the outset, PCR is a flexible form of regulation that is readily adapted to the environment in which it is implemented. PCR can operate much like ROR, for example, by limiting the regulated firm's pricing discretion, implementing frequent plan reviews, and updating the X factor to deliver to consumers the bulk of realized productivity gains. In contrast, PCR can function more like unfettered market competition by affording the regulated firm considerable pricing discretion, implementing infrequent plan reviews, and avoiding any retroactive usurping of realized earnings. This flexibility of PCR helps to explain its widespread adoption in telecommunications markets throughout the world in recent years.

Because PCR is a flexible form of regulation, it can be structured to pursue different goals in different settings. To illustrate, when a primary goal is to attract the investment required for network expansion, PCR can be structured to operate much like ROR in order to ensure investors consistent, moderate returns. PCR can be adapted to provide enhanced incentives for innovation and cost reduction where these elements of industry performance are more highly valued. PCR also can be structured to afford particular protection to customers who are not adequately protected by market competition.⁶⁹ In addition, PCR can be readily adjusted over time as market competition intensifies.⁷⁰

It is difficult to draw from the experience with PCR in one industry definitive conclusions about how PCR would fare in other industries. Political, institutional, technological, and other factors can vary across industries, and each factor can affect industry outcomes. To illustrate, the common concern with energy conservation can complicate the design and implementation of

(Vogelsang, 2002). In addition, the obligation to supply unbundled network elements to competitors at cost-based rates may limit an incumbent supplier's incentive to reduce its operating costs. See also note 40 *supra*.

⁶⁹ As noted in section 4, PCR plans also can protect consumers by including specific service quality requirements.

⁷⁰ Thus, PCR is well suited to implement the transition from natural monopoly to competition that Tardiff and Taylor (2003, p. 345) envision: "... industries initially in need of regulation (that is, natural monopoly providers of services essential to consumers and/or competitors) are heavily regulated at first. Yet as competitive conditions change (essentially the erosion of the natural monopoly conditions that called for regulation), regulation itself must evolve in order for it to deliver the economic benefits that competition, supplemented by regulation where necessary, can bring. And that evolution entails both reducing the range of services still subject to regulation and replacing particular regulatory mechanisms when they are no longer effective. The end-state of this evolutionary continuum is full competition with no regulation."

incentive regulation in the energy industry. If the productivity gains fostered by PCR are passed on to consumers in the form of lower energy prices, the price reductions can encourage energy consumption. Therefore, consumption taxes or explicit rewards for reduced energy consumption may be necessary to achieve conservation goals. The best manner in which to modify standard PCR plans in order to achieve goals such as energy conservation awaits further research.

Further research also is necessary to develop a comprehensive assessment of the implications of the experience with PCR in the telecommunications industry for the likely corresponding experience in other industries.⁷¹ However, before concluding, we identify six possible implications of the experience in the telecommunications industry that may warrant consideration when assessing the merits of employing incentive regulation in other industries, such as the energy industry.

First, recall that PCR was adopted in the telecommunications industry in part to facilitate the transition to a more competitive industry by providing incumbent providers with the pricing flexibility they need to respond quickly to competitive pressures. To the extent that energy markets are not experiencing similar opportunities for increased competition, this potential benefit of PCR may be less relevant.⁷² However, PCR and other forms of incentive regulation offer potential benefits relative to ROR even in the presence of limited competition. Therefore, alternatives to ROR merit ongoing consideration in energy markets.

Second, as in the telecommunications sector, regulators who are first considering alternatives to ROR in the energy sector may be tempted to err on the side of caution and retain some explicit earnings sharing. The experience in the telecommunications sector suggests that while earnings sharing may provide some insurance against extreme levels of earnings, it may also dampen industry performance on other dimensions (e.g., network modernization, price reductions, and cost reductions). Furthermore, because ESR requires many of the same

⁷¹ Sappington et al. (2001), Hemphill et al. (2003), and Joskow (2008) discuss alternatives to ROR in the electric power industry. The Alberta Utilities Commission (2009) describes an incentive regulation plan for the electric power industry that resembles some of the earnings sharing plans that were employed in the early stages of incentive regulation in the US telecommunications industry. Also see Weisman and Pfeifenberger (2003).

⁷² Joskow (2006b) and Pollitt (2010) provide assessments of competition in the electricity industry.

regulatory considerations and procedures as ROR, ESR is unlikely to streamline the regulatory process.

Third, recall that the regulated suppliers were the primary advocates of PCR in the telecommunications industry. To ensure the adoption of PCR, the suppliers agreed to deliver a variety of consumer benefits, including network modernization. Consequently, as noted in section 5, the increased network modernization that was observed under PCR (Greenstein et al., 1995) may reflect outcomes that were mandated as a prerequisite for PCR rather than motivated by PCR itself (Sappington and Weisman, 1996b). In settings where industry suppliers are not avid supporters of alternatives to ROR, they are unlikely to make up-front concessions in order to ensure the implementation of new regulatory regimes. Consequently, the same (mandated) outcomes that were observed in the telecommunications industry may not arise in energy and other industries. More generally, the pattern of initial support for a new regulatory regime can influence the industry performance that is ultimately realized under the regime.

Fourth, although pervasive, persistent reductions in service quality did not arise under PCR in the telecommunications industry, significant transitory declines in service quality arose that raised the ire of public officials. The general public and their representatives are likely to be less tolerant of power outages than disruptions in telephone service. Consequently, energy regulators are likely to be even less tolerant of service outages than their counterparts in the telecommunications industry. Special concern with network reliability may lead energy regulators to implement particularly stringent stipulations to ensure reliability,⁷³ especially since energy regulators may lack some of the complementary instruments that regulators enjoy in the telecommunications industry.

In particular, unlike telecommunications suppliers, energy suppliers typically do not sell other, relatively profitable, unregulated services. Consequently, energy suppliers typically will not be as concerned with negative financial repercussions in other markets caused by service quality problems in energy markets. In addition, if energy suppliers are not strong proponents of incentive regulation, then the threat of terminating incentive regulation if network outages arise

⁷³ See the Federal Energy Regulatory Commission (2010).

under incentive regulation may not have the same motivational impact that it had in the telecommunications industry.⁷⁴

Fifth, as noted in section 8, the experience in the telecommunications industry suggests that PCR may have influenced the incentives of regulators and regulated firms alike. When assessing the likely impacts of a new regulatory policy in any industry, it is important to consider how the policy will affect the incentives of all relevant parties. In the energy sector, incentive regulation plans that are designed to improve the performance of transmission or distribution companies may affect not only the incentives of regulators, but also the incentives of Independent System Operators (ISOs). Similarly, incentive regulation plans designed to improve the performance of ISOs may affect the incentives of both regulators and transmission and distribution companies. In order to predict the full impacts of regulatory plans, all of the entities affected by the plans and all of the potential interactions among the plans must be carefully assessed.⁷⁵

Sixth, as noted above, PCR can take on a variety of forms. The practice of ROR also can vary across jurisdictions. Consequently, the differences between PCR and ROR can be quite pronounced or relatively minor in practice. This fact may help to explain why several studies identify similar industry performance under PCR and ROR.⁷⁶ This fact should also be kept in mind when assessing the likely impacts of incentive regulation in energy and other industries. The impacts will vary with the details of the plan and with its implementation. If, despite its classification as incentive regulation or performance based regulation, a plan functions much like ROR in practice, then the plan should not be expected to produce substantial changes in industry performance.

In closing, we note that just as PCR can be adjusted as the intensity of industry competition varies, PCR also can be adjusted to reflect relevant institutional differences across industries. To illustrate, PCR plans in the telecommunications industry seldom link allowed prices directly to realized input costs. However, such linkage is natural in settings where the

⁷⁴ Because the “owners” of a municipal energy supplier are also the customers, the owners may exert substantial pressure on the supplier to achieve high levels of service quality.

⁷⁵ See Joskow (2006a) for further thoughts on the importance of coordinating the distinct elements of an incentive regulation plan (or plans).

⁷⁶ Kridel et al. (1996) summarize early evidence of similar industry performance under PCR and ROR.

regulated supplier's production costs are influenced heavily by exogenous input prices. The linkage might appear in the form of a fuel adjustment clause, for example, whereby the maximum prices that an energy supplier can charge rise and fall as the price of the fuel that the supplier employs to generate electricity (or as the cost of energy that a distribution company delivers) increases or decreases.

In settings where infrastructure investment is of critical importance, PCR plans can be modified to enhance investment incentives. For instance, the X factor in a PCR plan can be reduced as the regulated firm undertakes more extensive (prudent) investments.⁷⁷ Such adjustments can further blur the distinction between PCR and ROR in practice.⁷⁸

These potential adjustments and others render PCR a flexible regulatory policy that has the potential to secure substantial gains in many industries. Future research should document the key differences among PCR plans that are implemented in different industries and assess the performance of PCR plans and other forms of incentive regulation in different industries. In the meantime, the experience with incentive regulation in the telecommunications industry may help to inform the policy debate about the most appropriate forms of regulation to employ in other industries.⁷⁹

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⁷⁷ Saal and Parker (2001) review the use and performance of such “K-factor” adjustments under PCR plans in the UK water and sewerage industries.

⁷⁸ See Joskow (2006a, 2008) and Vogelsang (2010) for additional thoughts on how the revenues of regulated suppliers can be linked to their investments in order to encourage necessary investment while discouraging unnecessary investment.

⁷⁹ The forms of regulation that merit consideration include the oversight of settlements negotiated by industry participants. See Doucet and Littlechild (2006) and Littlechild (2009a,b), for example.

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