Principles of price cap regulation

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The background to price cap regulation

Price cap regulation, as an alternative to traditional rate-of-return regulation, developed as a practical regulatory tool in the early 1980s in Britain. While both the undesirable features of rate-of-return regulation and the ideas underlying price caps were understood well before this time, it was in the UK in the 1980s that price caps were first widely used as an alternative regulatory rule for limiting abuse of market power[1].

Following a Mergers and Monopolies Commission (MMC) report in 1982, price cap regulation was used in Britain to limit abuse of market power by a dominant supplier of contraceptive sheaths (Armstrong, Cowan and Vickers, 1994). The MMC argued against traditional rate-of-return regulation on the grounds that (1) it weakened incentives for cost efficiency, (2) for a multi-product firm where only some products were regulated, rate-of-return regulation involved arbitrary allocations of cost and assets and (3) it was difficult to set an appropriate rate-of-return for the regulated company.

The newly privatised British Telecom (BT) was regulated by price caps after the recommendations of a report by Stephen Littlechild in 1983. In his report, Littlechild argued that price cap regulation would give BT desirable incentives to achieve and improve productive efficiency, while reducing the information burden of regulation. Unlike rate-of-return regulation, price caps do not require imprecise and often arbitrary measures of a rate base or return on capital, and eliminate the need to allocate costs when only some parts of a firm are regulated. He also argued that the simplicity of price caps would reduce the likelihood of regulatory capture.

Since the early 1980s, price cap regulation has been adopted in a wide range of countries. In Australia, price caps have been used in the telecommunications, energy and transport industries. For example, the newly privatised airports in Australia are subject to price cap restrictions on some of their services.

What is a price cap?

In its simplest form a price cap simply sets a maximum allowed inter-temporal path for the price of a specific product. The rules for the path are set in advance and only depend on factors that are beyond the control of the regulated firm. For example, the price of a specific product in any given year may be capped at a level which alters over time in response to a price index that is exogenous to the regulated firm and a factor set in advance by the relevant regulator. For example, a standard price cap in the UK (an RPI-X cap) or Australia (a CPI-X cap) involves the regulator setting an initial

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[1]   For example, the possibility of overcapitalisation under rate-of-return regulation was formalised in the economics literature in the early 1960s. See Averch and Johnson, 1962.

maximum price. This maximum price then rises in line with the main index of retail prices (the retail price index in the UK and consumer price index in Australia), but falls at a rate X set in advance by the regulator.

The value of X is meant to reflect potential cost savings by the firm due to either increased efficiency or technological progress. The X factor enables these cost savings to be shared with consumers without adversely effecting the incentives of the firm to minimise and achieve these savings, between review periods. The value of X and the absolute level of the price cap index are reviewed at set intervals. For example the review period for BT was originally set at five years. [2]

In some cases it may be considered that the utility should be allowed to increase its maximum allowed price at a rate faster than the rate of increase of the relevant price index. For example, privatised UK water companies are regulated by an RPI+K system that allows prices to rise at a rate faster than the retail price index.

In practice, price caps tend to be more complex than simply a set price path on a single product. Many regulated firms produce multiple products and these products may be bundled together in the price cap. The price cap may automatically adjust for exogenous changes in specific prices that have strong implications for the profitability of the regulated firm. For example, a price cap on a gas supplier may allow that firm to increase its price if there is an increase in the purchase price of the gas that it buys or in an index of gas prices. Price regulation may have associated regulation covering service quality. These additional features need to be designed to retain the basic desirable incentive properties created by a price cap.

Price cap regulation and efficiency

Why does a price cap promote efficient production? Suppose a regulated firm produces one product. For example, consider a gas retailer/distributor that only sells gas to residential consumers. We will consider two potential regulatory schemes. First, the firm may operate under a regulatory regime that limits profits to a set level, say no greater than $1 million. Alternatively, the firm may operate under price cap regulation. It can set the price of the gas subject to a cap of 5 cents per MJ. At this price it can sell 100 million MJ resulting in $5 million. Firm profits are given by revenue less the costs of production. These costs include billing and servicing customers, routine and emergency maintenance of the distribution system and, most importantly, the cost of wholesale gas. If the costs of retailing and distributing 100 million MJ of gas are (initially) $4 million then the firm will make $1 million in profit under the price cap. In other words, the firm initially makes identical profits under either regulatory regime with identical levels of output and costs of supply.

Suppose the owners and managers of the private gas firm can undertake a variety of activities that effect costs. For example, they can investigate and implement improved

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[2]   Armstrong, Cowan and Vickers, 1994, refer to the length of time between reviews as the period of regulatory lag. Note also that the value of X need not be constant between reviews. Rather a simple price cap requires the time path of X to be fixed in advance by the regulator at each review.

systems of billing, monitor the performance of maintenance teams and seek out cheaper sources of gas. The incentive for owners and managers to pursue activities that reduce costs will depend on the rewards that they receive from any cost reduction. If they receive the full benefit of any cost reduction, then they will have strong (and socially desirable) incentives to pursue activities that reduce costs. In contrast, if the y receive little benefit from activities that reduce costs, they will have no incentive to engage in these activities.

Consider profit regulation. If the owners and managers reduce costs (and increase profits) under this regulatory regime, then this will have to be offset by a reduction in profits, for example, by lowering the price of gas. Any benefits of cost reductions are passed immediately on to gas consumers, but this will destroy the incentives for owners and managers to seek out ways to minimise costs. Consequently, there is little incentive for the firm to operate efficiently and engage in minimum cost production under profit regulation.

In contrast, under price cap regulation, any cost reduction achieved by the firm's owners and managers will be retained by the firm. If the managers and owners are able to reduce the costs of supplying 100 MJ of gas from $4 million to $3 million, then the entire $1 million reduction in costs will be translated into increased profits. Under price cap regulation, the firm can still sell gas at 5cents per MJ so the 25 per cent reduction in costs will result in a 100 per cent rise in profits. Clearly, under price cap regulation there are strong incentives for the firm to operate efficiently and seek out cost minimising production techniques.[3]

Because the firm retains the benefits of cost reductions under price cap regulation, this regulatory regime provides powerful efficiency incentives. In reality, these incentives may be reduced by a number of factors. If the wholesale price of gas makes up a substantial part of the regulated firm's costs, then it may be desirable to allow the firm to pass through any changes in this wholesale price to customers. In the absence of such pass-through, the gas distributor could be driven into bankruptcy by a sudden rise in the price of gas that pushes its costs above the price cap. However, if gas costs can simply be passed through to the consumer, then the firm will have reduced incentives to seek out the cheapest sources of gas. In general, any allowed cost pass through under the price cap will reduce incentives to minimise costs.

Price caps are never set 'forever'. In some industries, price caps may be used as a one shot regulatory tool while competition emerges. More generally, price caps are reviewed and reset at regular intervals.[4] When caps are reset, attention is inevitably paid to the profits of the regulated firm and cost savings gained between reviews, at least partially, are passed on to consumers. Any 'allowed profit' aspect to price cap reviews will tend to reduce the incentives of a regulated firm to reduce costs between review. Further, to the degree that the regulator uses past performance to set the future

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[3]   For a more formal, technical presentation of this material, see Sappington, 1996.

[4]   In Britain, where price caps were initially set for BT as a transitional procedure, the caps have been both reviewed and extended over time as the expected level of competition has not emerged. See Armstrong, Cowan and Vickers, 1994.

price cap, all the administrative issues associated with traditional rate-of-return regulation, such as cost allocation rules, re-emerge.

Even given the caveats above, price cap regulation will provide more incentives for efficient production than traditional profit or cost based regulation. At the same time, the design of the price cap regime will effect these incentives and the regulatory design of price caps must carefully consider the trade-off between providing incentives to reduce costs and the desire by regulators to pass on any cost savings to customers.

CPI-X

The regulated price cap is designed to adjust automatically between regulatory reviews. This occurs in two ways. First, the regulator sets the X-factor which determines the rate of decrease of the cap. The X-factor provides a way for the regulator to allow consumers to benefit from cost reductions and improvements in productive efficiency under price cap regulation without diminishing the incentives for managers and owners to undertake activities that create these efficiencies.

The regulator sets the X-factor to reflect (i) expected firm productivity improvements in excess of those expected for the general economy and (ii) expected changes in input prices for the regulated firm that differ from the general economy-wide rate of price change. When setting the value of X, the regulator often has to rely on historic information about performance of the regulated firm or of other firms in similar industries. The regulator may gain information about productivity improvements from profit studies based on the past rate-of-return achieved by the firm. This raises a number of important issues.

- ✍ If the firm has previously been regulated by profit or cost based regulation, or has been inefficiently operated under public ownership, then future productivity improvements may significantly exceed historic rates. It may be desirable for the regulator to set a relatively high value of X, particularly in the first few years of the price cap regime.

- ✍ If productivity improvements achieved by the firm exceed the X factor by a substantial amount then the firm will make significant profits and there may be pressure on the regulator to adjust either the value of X upwards or the base level of the price cap downwards between review periods. Such regulatory opportunism generally should be avoided. The reputation of the regulator in abiding by the regime between reviews will be an important input to the success of the regulations. If the firm believes that any successful reduction in costs below the amount allowed for in the X factor will simply lead to a reduction in the price cap, then the managers and owners will not seek to achieve these extra cost savings.

- ✍ If rate-of-return or other profit measures are used to reset the base value of the price cap or the future path of X when these values are reviewed, then this will feed into the incentives facing owners and managers in the period leading up to the review. In particular, the incentives for efficient production will tend to fall as the review approaches if managers and owners know that these cost savings will be taken from them in the review process. The regulator can use a number of

simple devices to help reduce this problem. For example, the regulator can base the price cap review on industry wide performance rather than firm specific performance. This may involve explicit benchmarking between similar regulated firms. The regulator may also commit in advance to using a 'glide path' to adjust the price cap at a review.   This means that rather than using a one-shot revaluation to set the new price index at the review, the regulator sets a path by which the base must move down to its new level over time. Thus the price cap will be reduced by the X factor (reflecting future expected productivity gains) and the glide path factor (reflecting past gains above the X factor) between reviews. [5]

The regulator will also need information about input price changes that are idiosyncratic to the regulated industry or firm. Again, this information may be gained from historic data, subject to similar caveats as presented above.

The approach to resetting X will depend both on how the regulator evaluates profits compared to consumer benefits, and the relative importance placed on allocative and productive efficiency. The higher the relative weight placed on consumer benefits relative to profits, the more the regulator will wish to claw back excess profits as they emerge. At the same time, if the regulator seizes profits created through productivity gains in an opportunistic way, then this will simply reduce the incentive for these gains to be made in the future, making both the firm and the consumers worse off in the longer term.

Even if the regulator evaluates profits and consumer benefits equally, it is still desirable to have a positive X factor and to adjust the cap at regular reviews so that excess profits are eventually returned to the consumer. Pricing above true marginal cost (or above a minimum sustainable price) will lead to a loss of allocative efficiency by eliminating potentially mutually beneficial trade. When considering how quickly excess profits should be removed by tightening the price cap, the regulator must weigh up these allocative benefits with the potential reduction in productive efficiency due to weakened incentives for firm owners and managers.

An alternative to a fixed X factor between reviews is a scheme of earnings sharing. This form of price cap, which is more popular in the US than in either Britain or Australia, requires the regulated firm to share any 'excess' earnings with consumers. However, such a sharing scheme reduces efficiency relative to pure price caps.[6] Furthermore, it may raise the costs of regulation by requiring continual monitoring of firm returns.

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[5]   For a summary on the incentive aspects of different methods to 'claw back' excess profits, see Cave, 1997.

[6]   Of course, to the degree that regulators implicitly use sharing schemes when reviewing price caps, there may be little practical difference between the incentives under a scheme of explicit earnings sharing and under an actual price cap regime. In fact, incentives may be improved by making the form of sharing explicit rather than implicit. I thank Mark Jamison for pointing this out to me.

The price cap also adjusts for increases in general input prices over time. Both the adjustment for general and idiosyncratic increases in input prices must be beyond the control of the firm to avoid reducing the incentives to search out the cheapest input prices or creating incentives for managers to manipulate the input price index. It is desirable to use a general inflation measure to adjust the price cap. In practice, it is standard to use a measure of consumer prices to adjust the price cap (the CPI). Such an index is clearly beyond the control of almost any regulated firm. Any differences between the rate of increase in the consumer price index and the rate of increase in the prices of the inputs for the regulated firm should be included in setting the value of X.

Even if the rate of general inflation is used to reflect general economy wide effects on input prices, and idiosyncratic increases in input prices are built into the setting of X, there may still be deviations between the actual change in input prices and those allowed for in the price cap. To prevent firm distress caused by increases in specific input prices that are beyond their control, it may also be desirable to adjust the price cap to allow for the pass through of specific input prices. This is particularly the case when some input prices make up the bulk of the regulated firms costs. For example, 95 per cent of the costs of electricity suppliers in Britain are derived from the costs of generation, transmission and distribution and these costs are passed on directly to the consumers through the price cap (Armstrong, Cowan and Vickers 1994).

Where pass through is allowed, it is desirable to base it on a price index rather than the price paid by the regulated firm, to create appropriate incentives. For example British Gas can pass through an index of wholesale gas prices rather than its particular purchase costs.

Other factors may also be used to adjust the price cap between reviews. For example, where the price cap embodies specific assumptions that can be confirmed at a later date, then the cap may adjust if the initial assumptions are proved false (Cave, 1997).

Multiple products

A variety of forms of price cap are used when a regulated firm produces multiple products. Some of these are presented below.[7]

Suppose that the firm produces two products. Say that the price cap is set at the end of year zero and is to be reviewed at the end of year five. For the present, we ignore both the CPI and X-factor adjustments. The firm sets prices for its products in each year t subject to the price cap. Let the prices set by the firm in year t (where t is 1, 2, 3, 4 or 5) be denoted by p_1^t and p_2^t. The firm sells the amount of each product demanded at

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[7]   For example, Taylor and Weisman, 1996, present a slight variant on the current quantity average revenue regulation formula presented below where p refers explicitly to average revenue rather than a uniform price and the fixed price entering the right hand side of the formula is set each year at the previous years average revenue for each product.

these prices, $q_1^t[p^t]$ and $q_2^t[p^t]$ (where p^t represents the two prices p_1^t and p_2^t). The firm's revenue in year t will be $p_1^t q_1^t ? p_2^t q_2^t$.

Fixed weight price cap. The firm can set prices p_1^t and p_2^t in year t so long as

$$p_1^t \overline{q}_1 ? p_2^t \overline{q}_2 ? \overline{p}_1 \overline{q}_1 ? \overline{p}_2 \overline{q}_2.$$ The values of $\overline{p}_1$ and $\overline{p}_2$ may be set at their $t = 0$ levels with $\overline{q}_1 ? q_1^0[p_1^0]$ and $\overline{q}_2 ? q_2^0[p_2^0]$.

Average revenue regulation (current quantities). The firm can set prices so long as

$$p_1^t q_1^t ? p_2^t q_2^t ? \overline{p}_1 q_1^t ? \overline{p}_2 q_2^t.$$

Average revenue regulation (lagged quantities). The firm can set prices so long as

$$p_1^t q_1^{t?1} ? p_2^t q_2^{t?1} ? \overline{p} q_1^{t?1} ? \overline{p}_2 q_2^{t?1}.$$

Tariff basket regulation. The firm can set prices so long as $p_1^t q_1^{t?1} ? p_2^t q_2^{t?1} ?$

$$p_1^{t?1} q_1^{t?1} ? p_2^{t?1} q_2^{t?1}.$$

Under each of these formulae the firm retains some ability to rebalance prices. In other words, the firm may raise the price of one product and reduce the price of another product without violating the cap. The fixed weight price cap is administratively simpler than the other caps and limits any possibility for the firm to manipulate the cap by setting the quantity weights on the left hand side of the formula and the allowed revenue on the right hand side of the formula at a fixed level that is invariant between reviews. However, this is also the least flexible cap and may prevent the firm from designing price changes that are both profitable and in the consumers' interest.

Tariff basket regulation allows the firm to both alter prices in response to demand changes and to rebalance prices in a way beneficial to both the firm and the customer. To see this, note that under tariff basket regulation, consumers in any year t can always buy the same bundle as they did in the previous year $(t - 1)$ for the same total cost. However, to the degree that prices have changed between year $t - 1$ and year t the consumers may prefer to buy a different bundle of goods. As they can still buy the original bundle at the same cost but may prefer to buy a different bundle, consumers cannot be made worse off by the rebalancing.[8] If the firm finds it profitable to rebalance prices then this reflects a mutual gain — both the firm and consumers are at least as well off under rebalanced prices as under original prices.

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[8] Of course, if consumers' income alters between years, consumers may be better or worse off regardless of any price rebalancing by the firm.

Tariff basket regulation has been used for BT and the British water companies. Sappington (1997) presents a variant of tariff basket regulation designed to avoid penalising a firm for pricing below authorised levels in any year.

Average revenue regulation with current quantities requires the regulator to forecast demand in advance and to establish procedures to compensate either the firm or consumers if these forecasts are in error. Using lagged quantities avoids this problem and lagged quantity average revenue regulation was used in the US to regulate AT&T. Sappington and Sibley (1992) show that if two-part tariffs are incorporated into this scheme (interpreting one of the products as 'access') then rebalancing may lead to a reduction in both consumer surplus and total welfare over time.[9]

The above formulae ignore the adjustment factors for input prices and productivity improvements. These need to be added into the formulae. For example, tariff basket regulation is $p_1^t q_1^{t?1} ? p_2^t q_2^{t?1} ? ?1 ? CPI ? X??p_1^{t?1} q_1^{t?1} ? p_2^{t?1} q_2^{t?1}?$.

Care must be taken under price cap regulation to avoid rebalancing, for example, to prevent or delay entry into one part of the market. In part, this issue overlaps with the question of which prices should be included in the price cap. If competition is expected to emerge for one product but not for another, then usually only the product that is not going to be subject to competition should be included in the price cap.

Price caps often incorporate additional restrictions on particular prices. This may be required for equity reasons, for example, to avoid the rapid dismantling of historic cross-subsidies to certain consumer groups. The individual products may be constrained by a separate specific price cap or may be allowed to move within a certain price band. The band, involving both a ceiling and a floor on the relevant price, may be designed to limit the rate of change of a specific product price.

Conclusion

Price cap regulation offers substantial benefits for regulators, consumers and regulated firms if applied with care. However, if price caps are poorly designed and are subject to arbitrary re-evaluation based on firm performance, then they open the scope for potential abuse by the regulated firm and may be worse than traditional profit and cost based regulation.

This paper has presented a brief overview of the theory of price caps and the practical problems that need to be addressed when establishing price cap regulation. Three points need to be emphasised. First, when designing a price cap, the regulator must carefully consider the bundle of goods and services to be covered by the cap. If the bundle is poorly designed, then the regulation may be subject to potential anti-competitive abuse. However, if the price cap provides too little flexibility to firms,

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[9]   See also Armstrong, Cowan and Vickers, 1994, on the potential for rebalancing that harms
       consumers under average revenue regulation.

then opportunities to rebalance prices for both consumer and firm gain will be limited. Second, the regulator needs to carefully design the review process. Where possible, information used in a price cap review needs to be beyond the control of the regulated firm. If reviews are based on realised profits, then the price cap may degenerate to standard rate-of-return regulation. Thirdly, regulatory credibility is crucial to the success of the price cap. If the regulator sets an X-factor that is too low, then the regulated firm will make large profits. However, if the regulator uses current profit information to arbitrarily revise up the X-factor between reviews, the regulated firm will have little incentive in the future to pursue the cost savings that lead to those profits.

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