Incorporating Quality of Service Measures Into Price-caps for Post

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1 INTRODUCTION

While postal liberalisation is a developing phenomenon for the EU and elsewhere[1], the details and structures of the remaining mix of market and regulated business enterprise remain works-in-progress in many jurisdictions. An area of particular concern, for regulators setting prices, or for commercial companies setting targets on liberalised products, is quality of service. Quality of service is a major factor in consumer surplus and demand. Further, the move to incentive-based regulation has the potential to incentivise lower quality of service, if quality of service is not accounted for explicitly in the pricing regulation mechanism. Additionally, pressure on USO from emerging competition could also lead to lower service quality, especially for certain classes or regions. These issues indicate the need for economically sound methods for incorporating quality of service measures into pricing mechanisms for regulated industry such as postal services.

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[1] See for example, the recent debate on price caps for the USPS, in the Final Report of the President's Commission on the USPS (2003). Outside the EU 'Liberalisation' is perhaps a stretch of the term. Enhanced work sharing and more transparent pricing is on the agenda.

Economic intuition suggests that optimal quality of service is found when the marginal benefit of additional quality is set equal to the marginal cost of supplying additional quality.[2] The optimal setting of quality of service targets, from either a regulatory or commercial economic prospective, therefore requires information on the marginal costs and benefits of quality of service improvements/degradation[3]. However, significant difficulties exist in estimating the marginal consumer and producer values for quality. Further appeal to fundamental economic logic suggests that postal firms should be incentivised to improve quality of service, or at least not to allow it to degrade. However, in general, even an unregulated monopolist may provide quality levels that are excessively high or low (relative to the socially optimal level.[4]) Finally, improvement can occur primarily via two mechanisms: one by employing more resources (i.e., incurring cost); and one associated with total factor productivity growth (i.e., costless improvement). The regulatory or commercial challenge is then one of predicting how much of the former is needed along with how much of the latter is achievable.

The idea of incorporating quality of service measures into price caps has been somewhat more developed in other network utility industries. However, the development of quality regulatory measures and methods often pre-dated the economic theory of price caps (and the economic relationships between non-market quality and TFP) and therefore the quality of service indicators were often incorporated into pricing regimes in an *ad hoc* manner. In postal pricing, detailed work has been done by Postcomm on incorporating quality of service measures into a price cap. Other notable exceptions where quality is regulated explicitly in post include Portugal[5].

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[2] The producers' and the social benefits, however, may not coincide, complicating the use of intuition, as we shall see.

[3] Rigorous econometric evidence on the cost/production side has been investigated. Previously, Swinand (2004) argued that quality of service was the endogenous variable in the postal production process, that a production function econometric model captured the production process well, and enabled the estimation of the costs of improved service quality. Reay (2002) and Swinand and Jones (2005) examined empirically the consumer side of quality of service in post.

[4] See Spence (1975) or Sappington (2005).

[5] Many thanks to João Castro and his team at ANACOM for pointing this out to us. In Portugal, ICP-ANACOM has included quality of service measures into the pricing regime since 1995. In general, price variation depends on the compliance by the USP with defined quality of service levels.

However, again, little work linking the theory, the empirical evidence, and the practice has been undertaken. Further, to our knowledge, little if any more formal economic work has been done relating quality of service to postal pricing[6].

This paper develops an approach of how to incorporate quality of service improvements into price caps using economic concepts related to productivity growth measurement and hedonic pricing. The paper advances practical work done by Postcomm (use of the C factor) and is related to empirical work done previously to estimate both consumers' willingness to pay for improved quality of service and the production cost of improving quality of service[7]. The paper first discusses the theory of quality of service and regulated pricing, and relates this large literature to postal issues. The paper then looks at a range of practical issues for incorporating service quality into a pricing regime, and then develops an economic framework for incorporating the marginal consumer values of improved quality of service and producers marginal costs into an incentive-based pricing regime.

The rest of the paper is organised as follows: Section 2 reviews previous research on quality of service and price cap design; section 3 discusses practical issues; section 4 surveys some international experience, while section 5 presents the price cap formulation. Some numerical comparisons of our model and Postcomm work is discussed in section 6 and our conclusions are presented in section 7.

2 GENERAL THEORY OF QUALITY OF SERVICE: UNREGULATED AND REGULATED

While the issue of price cap design in post has been relatively little studied, significant studies in other network industry have recently emerged, most notably in telecoms, but also in electricity distribution. Perhaps not surprisingly[8], work in the economic theory of quality of service in both

[6] The efforts of ANACOM and Postcomm are quite detailed nonetheless. In the case of the former quality is linked legally to prices via the USO. In the case of the UK it is via the price control process which follows legally from Postcomm's power to regulate under the license conditions.

[7] These applications were specific to a particular country, Ireland. Precise estimation would require adjustment for local conditions.

[8] Tirole (1988), for example, laments the lack of empirical work in IO-game theory.

regulated and imperfect competition settings has been prolific. While the more general literature is vast, it is important to review because we believe there *are* some fundamentals that emerge.

There is a vast and interesting literature on quality of service both for regulated and unregulated industry. The seminal works are Swan (1971) and Spence (1975). Sappington (2005) recently produced an excellent comprehensive review and discussion of the issues. It is useful to review here[9] some of the counterintuitive results, as well as further develop and discuss the issues relevant to post and the USO.

The first key result of the theory is that it cannot be invariably assumed that an unregulated monopolist will supply a (socially) sub-optimally low level of service quality (Spence, 1975, Sappington, 2005). Intuitively, the monopolist increases quality as long as marginal revenue from additional quality exceeds the marginal cost of quality. In contrast, the regulator, intent on maximising welfare[10], sees optimal quality at the point where the sum over *all incremental* quality equals marginal cost. As it turns out, if consumers' marginal value of quality is constant, then the unregulated monopolist will provide the socially optimal level of quality. If consumers' demand for the product increases as quality increase, then the unregulated monopolist will provide a level of quality *above* the socially optimal level (and *vice versa)*. Although an empirical question, some research (Swinand and Jones, 2005) and intuition suggest that demand does increase with quality.

The next important theoretical result to recall is that, in many oligopoly settings, competition and entry cannot be unquestionably relied upon to induce the incumbent monopolist to deliver socially optimal levels of service quality[11]. Further, when products are differentiated, or when producers can use quality as a discriminatory device (i.e., to induce the high-value consumers to choose the high price), quality is likely to be below the optimal social level. Other issues, such as network externalities and the verifiability of quality further complicate the issues; and the existence of these factors

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[9] The first part of our review follows Sappington (2005).

[10] Which is akin to maximising consumer surplus subject to production constraint by the firm.

[11] Aoki and Prusa (1997), Sappington (2005).

means reliance on competition to set the socially optimal level of quality is dubious.

Things get more intuitive when considering the supply of quality by regulated industry, but again, one cannot unquestionably assume that the price-constrained regulated firm supplies a sub-optimally low level of quality in the absence of quality regulation. In general though, the firm facing incentive regulation, which divorces prices from realised costs, where service quality is costly, in theory, is likely to produce service quality below the optimal social level (Sappington, 2005)[12]. However, if a firm receives capital expenditure pass-through, or if it operates under rate of return regulation, and the incremental cost of quality is a decreasing function of capital input, then the firm may provide too much quality. So in general, it cannot be assumed that the firm will provide a quality level below the optimal social level[13].

Another issue of importance is the USO. It seems fairly intuitive that if the firm has customers for whom it earns a loss, then if demand is increasing in quality[14], the firm will have an incentive to reduce quality to those customers (i.e., induce a demand reduction via low quality), and this quality level is likely to be socially sub-optimal. The reality in post is probably more complicated, due to network effects, economies of scale, dynamic demand, and the verifiability of quality differentials to the unprofitable regions. The simple intuition probably oversimplifies the USP's incentive structure. The post would have to reduce quality to the USO region, such that a substantial portion of mailers (from any region) would reduce their demand[15] to the USO region. Intuition aside, a deeper investigation into quality and the USO is warranted.

[12] Alternatively, empirical evidence is mixed on this.

[13] There also exists a literature on retail verses wholesale quality provision in telecoms, and this is very relevant for access pricing. While quite complicated, a central message is that the incumbent cannot be *a priori* assumed to lower quality to a retail rival who is also a wholesale customer.

[14] And we argue it is likely to be for post.

[15] In addition, assuming economies of scale, the post would want to take care not to reduce quality such that they increased average cost too much.

Perhaps not surprisingly[16], work in the economic theory of quality of service in both regulated and imperfect competition settings has been prolific. While the more general literature is vast, it is important to review because we believe there *are* some fundamentals that emerge.

It is informative to consider at the outset a simplified model of producer and regulator maximising behaviour to gain insights into the incentives facing both producers and regulators with respect to a post's provision of quality of service under a price constraint. Consider first the producer as monopolist maximising profits.

$$\underset{q}{\text{Max}}\ \pi = \bar{p}D(\bar{p},q) - C(D(\bar{p},q),q)$$

Here π is the profit, p-bar is the fixed/regulated price, D is demand (volume), C is cost, and q is quality of service. Note that the firm's only decision variable is the level of service quality[17], and that quality is modelled to impact cost via an indirect (demand) effect, and a direct effect.

The first-order conditions of this problem can be written as:

$$\bar{p}D_q - C_D D_q - C_q = 0$$

or

$$(\bar{p} - C_D)D_q = C_q \text{ or } \frac{\bar{p} - C_D}{\bar{p}} = \frac{C_q}{\bar{p}D_q}$$

This essentially says that the firm sets price-cost margin equal to the ratio of marginal cost to marginal benefit of additional quality. The marginal benefit of quality flows through the additional demand[18] times the absolute margin on the product.

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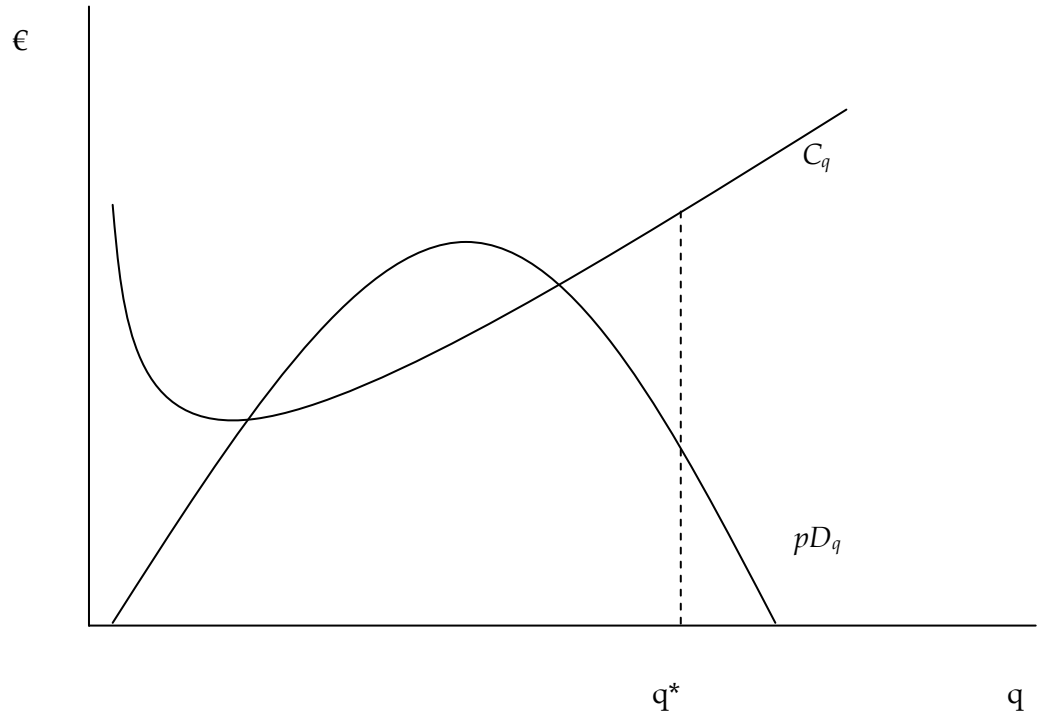
[16] Tirole (1987), for example, laments the lack of empirical work in IO-game theory.

[17] Alternatively, the firm chooses input quantities which determines q.

[18] Throughout the discussion, we focus on the case where additional quality improves demand. Empirical evidence and intuition support this, but the issue is probably far from resolved.

Some insights are immediately evident from this analysis. First (depending on the demand and cost structures), in general, the firm has a maximising level of quality (which may or may not be below the socially optimal level). Second, the firm is incentivised to improve quality up to certain levels when it earns a positive price cost margin; but if the firm earns a negative margin the firm may[19] have an incentive to degrade quality. Part of this depends on the nature of costs and demand. Consider then the following picture below.

We have drawn the figure in a very general form. The marginal benefit of quality starts out at zero, then reaches a peak, and then descends to zero again. Marginal cost of quality is falling and then rising, consistent with the familiar shape of marginal cost. In general, though, one does not know the shape of these curves.



Consider now that there are just two products, but that the firm maximises profit and sets quality for two products in two regions. Price is regulated at a uniform price. The firm's problem now becomes:

[19] There are likely other issues, which we ignore, such as dynamics, etc.

$$\underset{q_1,q_2}{\text{Max}}\ \pi = \bar{p}\left(D_1\left(\bar{p},q_1,q_2\right)+D_2\left(\bar{p},q_1,q_2\right)\right)-C\left(D_1,D_2,q_1,q_2\right)$$

The first-order conditions are:

$$\left(\bar{p}-C_{D_1}\right)+\left(\bar{p}-C_{D_2}\right)\frac{D_{2q_1}}{D_{1q_1}}=\frac{C_{q_1}}{D_{1q_1}}$$

$$\left(\bar{p}-C_{D_2}\right)+\left(\bar{p}-C_{D_1}\right)\frac{D_{1q_2}}{D_{2q_2}}=\frac{C_{q_2}}{D_{2q_2}}$$

Essentially, we have the same condition as in the single market problem. But note now that the margins in the first market are affected by the margins in the second market. Call market 1 'urban' and market 2 'rural' and assume that urban cross-subsidizes rural. Now, it can be seen that the cross subsidy (low margin) incentivizes a lower level of quality in market 1[20]. Alternatively, a higher level of quality may be incentivised in the rural market, if the margins in the urban market are high enough.

The conclusion with regards to the USO then is that the margins the regulator sets in *each* market, and the degree of the cross-subsidisation will affect the firms' incentives to provide quality in either market. It cannot be assumed that the firm provides sub-optimal quality in either market, although the existence of a negative margin on the 'rural' product would tend to incentivise lower quality in the 'urban' zone. Conversely, the higher margins in the urban zone needed to cross-subsidise rural should improve the incentives to provide high quality in both the urban and rural zones.

In addition to the theory on regulated pricing and quality of service, there also exists a large and important theoretical literature on the theory of incentives in procurement and regulation[21]. Our consideration of the regulation of postal prices should also include the basic insights from this theory; Joskow (2005) provides an excellent review. The regulator does not know the firm's true cost and realised cost is a function of effort and stochastic elements. The regulator could give the firm a price cap (high powered contract) that gives the rewards of cost reduction to the firm;

[20] See the figure in Annex 1; we assume marginal cost is increasing in quality while marginal benefit is falling.

[21] See Laffont and Tirole (1998).

alternatively, the regulator could audit costs *ex post* to transfer savings to consumers. The basic problem is that with stochastic costs, the regulator faces a trade-off between: a) setting prices high enough to ensure the firm breaks even (and leaving rent to the firm-*adverse selection*); and b) inducing effort to reduce cost (*moral hazard*).

Thus the following conclusions are probably most relevant from the economic theory. Companies and regulators face a difficult challenge in correctly regulating quality of service. First, even for an unregulated monopolist, quality of service may be higher or lower than the socially optimal levels. Second, for a regulated firm, the same holds, although it is probably more likely (because the price constraint binds) that quality of service, if unregulated, would be below the socially optimal level, at least for some customer groups. Third, however, regulators should recognise that quality of service incentives are fully intertwined with product margins; negative product margins incentivise quality of service that is likely to be below the social optimum absent other regulatory mechanisms. Finally, regulators should recognise that there is a trade-off between incentivising effort (either for cost reduction or quality improvement) and leaving some rent on the table for the firm.

3 OVERVIEW OF PRACTICAL POSTAL QUALITY AND INCENTIVE PRICING ISSUES

Quality of service in post in general can take on many forms but regulators and international agencies (e.g., IPC-UNEX) have generally focused on delivery speed. That is to say, a standard J+n formula is used to measure the number of days it takes to deliver a particular mail product of a particular class. Other aspects of quality in post of course exist and are important. Consumer's often rank reliability[22] as more important than speed. Other aspects of quality include damage to mail, frequency of pick-up and delivery, variance/actual time of pickup and delivery, density of postoffices/boxes, opening hours, waiting times in queues or the amount of time to talk to a customer service representative or resolve a dispute or make an insurance claim. Within this context, a useful grouping of quality issues would be:

[22] In general, though, reliability can be handled within a 'speed' framework, with speed approaching zero in the limit to indicate 'lost' mail. This may ignore other factors, however. For example,

- Network quality (time to deliver, reliability, variance, etc)
- Retail quality (dealing with complaints, time to queue, number/density of offices)
- USO quality (pick-up and delivery frequency)
- Non-price conditions (requirements for size or shape, adressing, bar-coding etc.)

Now that we have discussed the different aspects of service quality, it is also useful to give a more detailed framework of the regulatory or legal instruments available to incentivise the provision of quality by the USP. The options are:

- Regulatory standards, review, and fines;
- Requirements for customer compensation;
- Incorporating into the price cap – via X or an explicit "C" factor, or both.
- Litigation and other legal recourse (e.g., an arbitrator, administrator)

Finally, at this stage it is also useful to flesh out some of the design choices facing the regulatory design process for quality of service. Such issues would include:

- What products should be included in the QoS regulation?
- Should the fines, revenue impacts be "capped"?
- Should there be dead-bands[23] or 'insurance' given to the post?
- Should there be delays or sculpting of the path of QoS improvement?
- Should specific exclusion elements, such as "force majeure" or specific events (storms), be included explicitly in the regulation?

[23] Movements in measured quality which trigger no impact on price.

4 INTERNATIONAL EXPERIENCE

While it is asserted that rigorous economic consideration for the incorporation of quality of service measures directly into the pricing regime has not in general occurred in relation to postal regulation, that is not to say that quality of service is ignored by posts or regulators. In the UK, Postcomm has included a number of quality of service measures as part of their price cap regulation for a number of years. Customers also help monitor quality of service via explicit payments for mail that is lost. Further, other network industries that have been further down the path of liberalisation/comprehensive economic regulation have also considered quality of service more directly, providing more experience on what has been actually applied in this area.

The first price caps were introduced in the UK as part of the liberalisation and regulatory programme for BT. Price cap regulation in telecommunications, in both the UK and the US, has therefore had a longer history than in other regulated industries and more experience with price caps and incentive schemes, which has enabled more detailed empirical research. Seminal work in the area was done by Ai and Sappington (2002). They test empirically the hypothesis that price caps or incentive regulation would cause a degradation in service quality. The hypothesis being that price caps incentivise firms to improve productivity at the expense of service quality, and thus increase profits by reducing inputs, delaying maintenance, reducing capital input, etc, and thus keep profits in the current regulatory period. They found that incentive regulation did not lead to quality degradation in US telecoms[24].

Internationally, electricity regulation and the regulation of distribution network service have also considered quality of service in some detail. Quality of service is a more complex concept in electricity distribution, as it entails technical characteristics of voltage, frequency, as well as outage duration and frequency. Further there are customer related service aspects such as billing, switching, complaints resolutions, etc. Interestingly, contrary to what was found in telecoms, Ter-Martirosyan (2003) found that incentive regulation *did* tend to decrease quality in electricity distribution using a panel of 78 US utilities in 23 States. Joskow (2005) summarises the experience with price caps and quality of service in electricity by saying;

[24] Implicitly, an important issue in the hypothesis is whether productivity defined by *measured outputs* are constant quality-adjusted.

"Quality of service schemes appear to have been bolted on to schemes designed to provide incentives for cost reduction and do not effectively incorporate information on consumer valuations of quality and the costs of varying quality in different dimensions. While the value of lost or unsupplied energy is uncertain, it is better to use an imperfect estimate of the right number than a highly accurate estimate of the wrong number."

In recent years, several EU postal service regulators including the UK, Ireland, and Portugal have incorporated measures of quality of service into their regulation of postal services. In the UK, Postcomm has just completed a full price cap review of Royal Mail's costs, projected productivity growth, and future pricing for the next four years[25]. As part of this process, Postcomm invited submissions from interested parties on how the issue of quality of service should best be addressed and incorporated into the price cap mechanism over the period 2006-2010. Already included in the Royal Mail's price cap is what Postcomm calls a "C" factor, which is an adjustment for quality of service. The "C" factor is a financial incentive to maintain quality of service above defined thresholds set by Postcomm.

In practice, Postcomm's proposals, emanating from their review of Royal Mail's price and quality of service, for the period 2006-2010 include a maximum 5% of revenue penalty for failure to satisfy a revenue weighted composite measure of both transit time (60%) and non-transit time (40%) measures in relation to retail products in the captive market[26]. The performance of bulk products do not affect the "C" factor, as a separate bulk compensation scheme is in place to deal with these products, thus ensuring that the "C" factor adjustment to revenues is reflected in the prices of retail products rather than bulk products. Operationally, this takes the form of an adjustment to the 3% limit on the amount by which the prices of individual retail products within Basket A may be increased above the overall "RPI-X" cap on allowed revenue. In the event of Royal Mail's performance deteriorating, the limit would be tightened, thus reducing the scope for individual product price increases until such time when performance improves. The determinants of the "C" factor are shown in the table below.

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[25] Postcomm (2006).

[26] Postcomm group postal products into two distinct product baskets to reflect those goods that remain as part of Royal Mail's captive market and those that are open to competition. Products that remain in the captive market make up "Basket A" and include First and Second class mail of both retail and bulk products, as well as standard parcel mail.

Determinants of the "C" factor under Condition 19 of Royal Mail's Licence				
Quality of Service Indicator	**Measure**			**Standard (%)**
	No	**Description**	**Weight**	
First class & stamped and metered transit time	1	% of items delivered by next working day	34%	93.0
Second class & stamped and metered transit time	2	% of items delivered by third working day	18%	98.5
Standard Parcel transit time	3	% of items delivered by third working day	1%	90.0
European international delivery	4	% of items delivered by third working day	7%	85.0
Postcode area floor	5	% of PCAs in which at least 90.5% of first class items delivered by the next working day	10%	100.0
Collection completion	6	% of collection points served each day	10%	99.9
Delivery completion	7	% of delivery walks completed each day	10%	99.9
Correct delivery	8	% of items delivered correctly	10%	99.5
Source: Postcomm (2006)				

All of the standards in the above table are subject to a *de minimis* threshold ensuring that Royal Mail will only lose revenue when performance falls materially below the required standard. For the determinants 1-6, Postcomm have proposed to set the *de minimis* threshold at 1% below standard and for the remaining items, the non-transit items, this threshold is proposed to be 0.1% below the standard.

The "C" factor used by Postcomm is unlike many of the other quality of service incentives used by regulators in the UK. With the exception of the

BAA's London airports, all other regulator's incentive schemes are two-sided schemes, rewarding the operator for exceeding standards, as well as penalising them for failing to meet the same prescribed standards. As part of Postcomm's recent review, this issue was included in Royal Mail's submission within which they called for provision for a positive "C" factor, thus providing for a two-sided incentive scheme. This was subsequently rejected by Postcomm (2006), noting;

"[W]hile financial incentives help to signal to Royal Mail the detriment that deteriorations in quality of service impose on customers, Postcomm is not yet fully persuaded that customers are better off to the same extent when performance exceeds targets. Out-performance of regulatory targets will confer its own benefit on Royal Mail as competition develops. The introduction of a positive C factor might also have the effect of incentivising Royal Mail to "gold plate" its service beyond the requirements of its customers."

PostWatch also called for a change to Postcomm's proposal in relation to the use of targets relating to baskets of products rather than individual product targets as this may negatively affect the distribution of compensation resulting from "C" factor adjustments, as well as other compensatory mechanisms. However, Postcomm rejected this call and maintained that the basket system was an important step in the rationalisation of the number standards Royal Mail were forced to meet, a process that had received a broad consensus during the consultation process. They also noted that the impact of the change was minimal in relation to simulations carried out on the outcomes of previous years.

In Portugal, ANACOM requires CTT (the USP) to submit outside audits of postal service quality. The focus is on delivery speed in terms of hitting targets for specific types of mail. The provisions cover reserved services and non-reserved universal postal services provided - CTT. The regulation covers: a) priority letter mail ("correio azul"); b) non-priority letter mail ("correio normal"); c) newspapers and other periodical publications; d) parcels; e) waiting time in queue. Failure to comply with the quality of service levels may affect next year's price variations for reserved services. The variation of the prices of reserved services may be reduced up to 1%[27].

The Portuguese regulators method of linking quality with price is then very interesting. A relative importance (RI) is attached to each of 10 quality of

[27] See the Universal Service Price Convention: http://www.anacom.pt/template12.jsp?categoryId=191402).

service indicators (See Annex 3). The RI's are then used as weights to form a weighted index of total quality. Where each measure is continuous on a scale of 0 to 100, but each measure takes a value of zero if it is below its minimum standard. The revenue impact is capped at 1% of revenue times the relative importance of each indicator. Each QoS indicator is <90% of the total, total allowed revenue is reduced 1% times the RI. If the indicator is between 90 and 100%, the revenue impact is proportional between 0 and 1% times the RI.

5 MODEL OF PRICE CAP WITH QOS

It might be reasonably assumed that the regulator's objective is to incentivise quality improvements above the standard or alternatively, incentivise the firm not to degrade quality below the standard (as the firm may have better information about the costs of doing this). In this case, the regulator would not rely solely on the forecast of quality change as it impacts the X-factor through adjusting TFP for quality change[28] (see Annex 2). The regulator would want to include an updating element in price to quality, in addition to the forecast element. In this case the price cap takes the form:

$$\dot{p}_t^i = RPI - X + C \qquad (1)$$

C now is the quality factor, which will adjust prices over the course of the price control for quality change *ex post*. The C factor should be an estimate of consumers' willingness to pay for additional quality times the increment in quality of service:

$$C = \%\Delta QoS \cdot WTP_{qual} \qquad (2)$$

So then, the total price change is a function of the forecast of achievable quality adjusted TFP growth rate, plus the adjustment for quality improvement C. Note, if the firm is below its current target for quality (and

[28] A theoretical underpinning to this type of adjustment is similar to the derivation of TFP growth via basic neoclassical models of the consumer and producer. A similar derivation of productivity growth measures that incorporate externalities can be found in Gollop and Swinand (2004).

it is deemed achievable to meet its target over the price control), then the forecast of achievable quality adjusted TFP should reflect this; the C-factor and the quality adjusted TFP X-factor should just cancel each other – so prices would hold steady while the firm meets its minimum standard. This is not to say that the firm is not incentivised to improve, because absent the quality improvement over the course of the price control, prices will fall via the quality adjustment to TFP in the X factor (assuming the X-factor's forecasted quality-adjusted TFP growth rate is positive, and input price growth is close to consumer price inflation).

$$\dot{p}_t^i = RPI - E_t\{\tilde{\tilde{TFP}}_{t,t+n}^i\} + (\dot{w}_t^i - RPI) + C \qquad (3)$$

There still remain other practical issues for the development of the price cap. For example, should there be dead-bands around changes in *C*? Should there be caps on the total price change or the total revenue impact of changes in c-dot?

Full economic exploration of these issues would exceed the possible space in this article. We note, however, that practitioners have tended to allow dead-bands around certain elements in the C factor, as well as caps on revenue. We suggest that these are rational, in the following sense. Dead-bands essentially amount to giving the firm insurance with respect to quality of service. It is possible these reduce the amount of revenue the regulator must leave on the table for the firm in order to induce effort. For caps, we suggest that these are crude reflections of diminishing marginal returns for quality (on the upside) and further insurance (on the downside). It is not clear whether a more refined approach to these would be worthwhile.

6 SOME NUMERICAL RESULTS

We present some brief results from numerical simulations. We consider a hypothetical post that charges a €0.48 for a basic letter. Other products would need additional estimates of the willingness to pay for quality improvement. Swinand (2006) estimated that for a particular post, a 10% improvement in percentage of mail hitting the next day target for first class stamped letter mail would lead to between a 1.6 and 4.5euro-cent increase in willingness to pay. PostWatch[29] estimated that each percentage point increase in quality of service would lead to a 0.82p increase in willingness to

[29] See PostWatch (2004), "Royal Mail Quality of Service," available at www.postwatch.gov.uk.

pay, or about a 12 Euro-cent price increase for a 10% increase in quality of service. Thus, over the course of a four year price control, the C-factor would lead to a 1 cent stamp price increase in each year if the firm hit its targets gradually; if the firm hit the target in the first year, then prices would rise accordingly. If the regulator really believes that they have the correct (or at least best unbiased) estimates of willingness to pay, then the rate of price increase should not be a concern. Both the regulator and the USP might still want to let consumers know via a publicity campaign that price rises are due to quality improvements that the post has been incentivised to make.

The difficulty in application of standards and estimated results is partially due to units. Postcomm, for example, fined Royal Mail £271,000 for the late delivery of approximately 2 million letters to specific London postcodes in 2004/05. This works out to 13.6p per letter—but is this excessive in terms of the willingness to pay estimate of 0.82p? We do not know because we do not know how late the letters were, what class they were, or what percentage increase in QoS performance their on-time delivery would have amounted to. In the previous year, Royal Mail was fined £17m for failure to meet service quality targets[30]. We can estimate that the percent increase was approximately 1%, 2%, and 3% from the target for the SE, WC, and E London postcodes (their performance in the most recent periods were (90, 89, and 88% for posted mail in 2004/05 against a 91% target).

7 CONCLUSIONS

This paper has investigated the theory and practice of quality of service standards in postal regulation. We first reviewed the theory of quality of service and pricing regulation—very few generalisations can be made and it cannot be assumed that USPs under-provide quality of service. The theory, while complex, shows that more basic economic intuition cannot be relied upon when setting prices and quality of service targets. Further complications arise when considering dynamics and the theory of incentives in regulation, and the practical complexities of applying price caps and service quality measures in these areas. We extended the analysis to a USO setting, and showed that incentives for postal quality of service are an integral part of the USO and price control decisions. In general, negative margins on certain products gives a disincentive to provide high(er) quality.

[30] Royal Mail's price control has a clause which only allows certain revenue if the company meets service targets.

Many practical considerations arise when incorporating quality of service measures into price caps. The inclusion of dead-bands (areas of the mechanism where the marginal impact on pricing is zero) and caps on total revenue change are particularly important issues. International experience has mainly been outside post and in the UK, with Postcomm's recent efforts a noteable exception. Postcomm included caps and dead-bands. Other measures such as direct compensation to consumers are also included in the Postcomm plan.

However, attempts to equate quality of service marginal costs and benefits have generally not occurred[31], and therefore it is difficult to evaluate the overall economic efficiency of the efforts to date. One cannot assume that these are efficient outcomes, as various interactions in the price cap (capital cost pass-through, strategic behaviour in the face of emerging competition) may affect the USP's incentives to agree to high service quality targets. While regulators such as Postcomm have made rapid advances ahead of other agencies, many questions (should financial incentives be symmetric, are *de minimis* standards efficient) still remain.

We proposed a price cap plan that incorporates quality of service. Quality of service should enter the price cap via two elements; the first is impacts prices *ex ante* via the X factor as a forecast of the achievable rate of quality adjusted TFP growth; the other is an *ex post* (within the price control) update to prices as quality of service targets are achieved or not. The first element adjusts revenues to reflect the costs and benefits forecasted from achieving quality of service improvements. The second element further incentivizes the firm at the margin to improve quality of service. The marginal values of quality of service improvement should be set based on estimates of the willingness to pay for quality improvement. Asymmetry and diminishing marginal willingness to pay could also be incorporated.

ANNEX 1

[31] Postcomm is not alone here. In his review of Ofgem's quality of service regulation, Joskow (2005) concludes, "Overall, about 4% of total revenue on the downside and an unlimited fraction of total revenue on the upside are subject to these quality of service incentive mechanisms. Is this the right allocation of financial risk to variations in service quality? Nobody really knows." Page 51.

MODELS OF QUALITY, PRICE CAP, AND USO

Studying the regulator's objectives and comparing to the firms may also gain insights[32]. The regulator's goal is assumed to be to maximise social welfare. This is assumed to be consumers' surplus less total cost. The problem can be written:

$$\underset{q}{\text{Max}}\, W = \int_0^{\bar{p}} D(p,q)dp - C(D(\bar{p},q),q)$$

The first-order conditions of this problem can be written as:

$$\int_0^{\bar{p}} D_q dp - C_D D_q - C_q = 0$$

or

$$\left(\frac{\int_0^{\bar{p}} D_q dp}{\bar{p} D_q} \frac{\bar{p}}{\bar{p}} - \frac{C_D}{\bar{p}} \right) = \frac{C_q}{\bar{p} D_q}$$

This condition is very much like the firm's decision. Essentially, the regulator sets the average price-demand impact of additional quality over marginal cost equal to the ratio of marginal costs and benefits of additional quality, whereas the firm sets the actual price cost margin equal to the ratio. The firm's and the regulator's conditions differ to the extent that:

$$\frac{1}{\bar{p}} \int_0^{\bar{p}} D_q dp = D_q$$

[32] Sappington (2005) gives a similar case where the firm chooses price; we study the problem with a fixed price where the firm chooses quality.

This of course may or may not be true[33]. The conclusion is that the firm may or may not face optimal incentives to provide quality.

An important aspect of the post is the USO. Consider now that there are just two products, but that the firm maximises profit and sets quality for two products in two regions. The firm's problem now becomes:

$$\underset{q}{\text{Max}}\ \pi = \overline{p}\left(D_1\left(\overline{p}, q_1, q_2\right) + D_2\left(\overline{p}, q_1, q_2\right)\right) - C\left(D_1, D_2, q_1, q_2\right)$$

The first-order conditions are:

$$\overline{p}\left(D_{1q_1} + D_{2q_1}\right) - C_{D_1} D_{1q_1} - C_{D_2} D_{2q_1} - C_{q_1} = 0$$
$$\overline{p}\left(D_{1q_2} + D_{2q_2}\right) - C_{D_1} D_{1q_2} - C_{D_2} D_{2q_2} - C_{q_2} = 0$$

or

$$\left(\overline{p} - C_{D_1}\right) + \left(\overline{p} - C_{D_2}\right)\frac{D_{2q_1}}{D_{1q_1}} = \frac{C_{q_1}}{D_{1q_1}}$$
$$\left(\overline{p} - C_{D_2}\right) + \left(\overline{p} - C_{D_1}\right)\frac{D_{1q_2}}{D_{2q_2}} = \frac{C_{q_2}}{D_{2q_2}}$$

Essentially, we have the same condition as before. But note now that the margins in the first market are impacted by the margins in the second market. Call market 1 'urban' and market 2 'rural' and assume that urban cross-subsidizes rural. Now, it can be seen that the cross subsidy (low margin) incentivizes a lower level of quality in market 1[34]. Alternatively, a higher level of quality may be incentivised in the rural market, if the margins in the urban market are high enough.

The conclusion then is that the margins the regulator sets in each market, and the degree of the cross-subsidisation will affect the firms' incentives to provide quality in either market. It cannot be assumed that the firm provides

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[33] It can be shown that if demand is additively separable and linear in quality, then the condition holds.

[34] Recall the figure; we assume marginal cost is increasing in quality while marginal benefit is falling.

sub-optimal quality in either market, although the existence of a negative margin on the 'rural' product would tend to incentivise higher quality in the 'rural' zone and lower quality in the 'urban' zone.

Thus the following conclusions are probably most relevant from the economic theory. First, even for an unregulated monopolist, quality of service may be higher or lower than the socially optimal levels. Second, for a regulated firm, the same holds, although it is probably more likely that quality of service, if unregulated, would be below the socially optimal level, at least for some customer groups. Third, however, regulators should recognise that quality of service incentives are fully intertwined with product margins; negative product margins incentivise quality of service that is likely to be below the social optimum absent other regulatory mechanisms.

ANNEX 2

In this section, we develop a model of quality change in an RPI-X type price cap. The approach is to allow the price cap to account for costly (more resources) quality change and costless (TFP) quality change, as well as include incentives to improve and maintain quality.

The seminal published work on price caps and productivity growth is Bernstein and Sappington (1999) (B&S). We wish to combine their work (with some modifications) to the notion of quality change in outputs, as well as introduce a forecast element of quality improvement and an updating element. To do this, we appeal to the theory of hedonic pricing. Under the theory of hedonic pricing, prices and price change can be decomposed into pure change and change associated with changes in quality of attributes[35].

B&S posit a regulator who must regulate an industry via an RPI – X type price cap. The regulator's goal is to maximise social welfare. This can be seen as the goal of keeping prices in the industry as low as possible to ensure zero economic profits, while ensuring investment and production[36]. The starting point for their analysis is an accounting identity; output price times quantity must equal input price times quantity.

[35] See Berndt (1991).

[36] Zero economic profits are consistent with the minimum price needed to ensure adequate investment incentives and would result from perfectly competitive markets.

One can write the total price as an index of all output prices, *P*, and an output quantity index *Y*, along with input price and quantity indices, *W* and *Q*, with superscripts *i* to indicate "the industry", giving:

$$P^i Y^i = W^i Q^i \tag{1}$$

By the above specification we can decompose the total price change into a pure-price and a quality induced price effect[37].

$$\overline{P}^i \tilde{P}^i Y^i = W^i Q^i \tag{2}$$

So now, *P*-bar is a constant quality index of price, while *P*-tilde is the price change associated with changes in quality. By taking logarithmic time derivatives, the accounting identity can be converted into growth rates. Writing lowercase letters to indicate the natural log, and a dot over a variable to denote the time derivative, gives the dynamic zero profits[38] condition:

$$\dot{\bar{p}}_t^i + \dot{\tilde{p}}_t^i + \dot{y}_t^i = \dot{w}_t^i + \dot{q}_t^i \tag{3}$$

Defining TFP as the ratio of total output to total input, Y/Q, the dynamic industry zero profits condition can be rearranged to yield two theoretically equivalent measures of TFP growth.

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[37] It is important to distinguish the quality change impact we are working with here from the quality change of more traditional productivity growth accounting, such as the adjusting of labour and capital inputs for quality change à la Jorgenson, Gollop, Fraumeni (1987). There, the "quality adjustments" were a function of "shifts" among the distribution of input types. In their analysis, the bias arising from failure to account for input quality change was due to aggregation errors due to adding, say, labour hours of a PhD-trained economist with hours worked by an undergrad economist. Here, we are not working with aggregation problems in general, as for example, all the mail might be uniformly the same product with the same quality. Further, in the basic Jorgenson-Gollop-Fraumeni framework, market prices are still assumed to be reflective of marginal values or marginal product. In the framework proposed here, we adjust market (or regulated) prices of output for hedonic changes associated with quality.

[38] Bernstein and Sappington (1999) show how to adjust the measure to allow for profits.

$$\dot{y}_t^i - \dot{q}_t^i + \dot{\tilde{p}}_t^i = \dot{w}_t^i - \dot{\bar{p}}_t^i \equiv \dot{\tilde{TFP}}_t^i \quad (4)$$

The first measure above is the quantity measure of TFP growth[39], adjusted for output quality price change. The second is the dual, or price measure, (again, including adjusted 'pure' output price growth) which says that the growth rate in input prices minus the growth rate in output prices, is also equal to TFP growth.

The regulator is interested in setting the rate of growth in output prices for the industry in terms of an X factor and incentivising quality.

$$\dot{p}_t^i = RPI - X \quad (5)$$

If current quality is estimated to be sufficient, then the constant quality rate price increase can be used. We know that p-bar grows at the rate:

$$\dot{\bar{p}}_t^i = \dot{w}_t^i - \dot{TFP}_t^i - \dot{\tilde{p}}_t^i \quad (6)$$

By substitution, then

$$X = \dot{\tilde{TFP}}_t^i - (\dot{w}_t^i - RPI) \quad (7)$$

All the above says is that if quality is at a sufficient standard, then quality enters the price cap by using quality adjusted TFP. Quality adjusted TFP growth is the forecast of output and quality growth less input growth over the course of the price cap.

[39] Note we distinguish this from traditional TFP as TFP-tilde to indicate output quality adjusted TFP

ANNEX 3

Figure 1: Quality of Service Measures in Portugal

Quality of Service Indicators (QSI)				
N.º	Description	R.I. %	2006	
			Minimum	Target
QSI1	Conveyance time for Non-Priority Letter Mail (% in D+3)	45,0%	95,5%	96,3%
QSI2	Conveyance time for Priority Letter Mail (% in D+1) - Mainland	15,0%	93,5%	94,5%
QSI3	Conveyance time for Priority Letter Mail (% in D+2) - CAM	4,0%	84,0%	87,0%
QSI4	Non-Priority Letter Mail not delivered within 15 working days (per 1000 letters)	5,0%	2,3‰	1,4‰
QSI5	Priority Letter Mail not delivered within 10 working days (per 1000 letters)	3,0%	2,5‰	1,5‰
QSI6	Conveyance time for Newspapers and Periodical Publications (% in D+3)	11,0%	95,5%	96,3%
QSI7	Conveyance time for Intra-community Cross-border mail (% in D+3)	3,5%	85,0%	88,0%
QSI8	Conveyance time for Intra-community Cross-border mail (% in D+5)	3,5%	95,0%	97,0%
QSI9	Conveyance time for Non-Priority Parcels (% in D+3)	5,0%	90,5%	92,0%
QSI10	Waiting time in a queue (% of observations ≤ 10 minutes)	5,0%	75,0%	85,0%

Source: ANACOM

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