Entry and Component Pricing in Regulated Markets

IAN M. DOBBS and PAUL RICHARDS

ABSTRACT *This paper discusses work on computable models of entry into regulated markets. Cournot, Stackelberg and Fringe entry are considered for the case where the incumbent operator's profitability is regulated and component pricing influences the desirability of entry. The simulation results illustrate that welfare optimal component pricing can be highly sensitive to model specification (behavioural assumptions about agents, the nature of competition, the extent of product differentiation etc.) and that no welfare ranking of simple component pricing rules (such as marginal cost, average cost, opportunity cost or efficient component price) exists. In addition, the welfare desirability of entry is seen to be sensitive to the choice of welfare benchmark for comparison.*

Key words: Component pricing; Network access pricing; Entry; Regulation; Oligopoly.

JEL classifications: D43, L40, L51, L90, L98.

1. Introduction

One of the major issues to arise out of the recent privatisation/regulation program in the UK is that of whether competitors should be allowed access to the network of the incumbent operator, and if so, at what price. This arises, for example, in Gas, Electricity, Telecoms, Water, Rail and Postal services. In general, the privatisation of these network industries has been accompanied by a regulatory regime with a pro-competitive remit to encourage and facilitate new entry Thus the typical scenario is one in which, initially, the incumbent operator has a monopoly (often statutory) over its product, is regulated (through allowed rates of return, price caps etc) and is required to offer network access. Left to its own devices, the incumbent might 'allow access' but only at a prohibitive price; it follows that there could be a need to regulate the access price to a level which encourages entry when this is welfare beneficial.

Potential competitors often find it difficult to compete in the supply of the overall product because of natural monopoly characteristics in the supply of that product.

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However, cost subadditivity (typically associated with economies of scale and scope) often applies to only some components of the incumbent's overall business. That is, there are often components of the overall product or service over which competition may be possible. Thus, in electricity supply for example, the generation of electricity is an area of possible competition whilst distribution is not. Similarly in fixed link telecommunications, long distance transmission may be a competitive segment but final distribution (local loop) is through the facilities of the incumbent supplier. The same point applies to other network industries. For example, the UK government in its Citizen's Charter (HMSO, 1991) put forward a number of proposals[1] for extending competition in the postal business through opening up the letters business to competition and, in particular, requiring the Post Office to offer delivery network access. Since this is a principal component of the business featuring cost subadditivity, the incumbent is expected to retain its monopoly over it.

In practice of course, entry may not give rise to a fully competitive situation.[2] Certainly in several of the UK natural monopoly industries, entry seems likely to be restricted to a relatively small number of firms, either because of the nature of the technology involved or through regulatory control (as with UK Telecoms and Postal services—see Dobbs and Richards, 1992). Furthermore, the purchase of components from the incumbent is not always for the purpose of producing an identical product. Often entrants are considering developing differentiated products (and product positioning may be considered part of the optimization process and entry decision). These considerations suggest that the second best problem of optimal component pricing is likely to be more complex.

Extant UK access/component pricing recommendations (e.g. Gas, Telecoms) seem to have been primarily focussed on some version of fully allocated cost although recently, the Telecom regulator announced that it was prepared to consider alternatives:

> OFTEL believes that the basis on which the costs of interconnection charges are calculated should be the most appropriate for ensuring effective competition for the benefit of customers. Fully allocated costs (using historic cost accounting) is the approach currently used for essential interconnection services but, in the longer run, alternatives such as long run incremental costs will be considered. OFTEL (1994)

An alternative approach to the component pricing problem is that of 'Efficient Component Pricing' (ecp) as initially developed by Baumol (1991) (Baumol and Sidak, 1994, provides a published account of the efficient component pricing argument). The situation envisaged by Baumol is of a final (homogeneous) product comprising several component parts; the incumbent supplies the final product but also has a monopoly over one of the components, the other components being supplied by the incumbent in competition with other firms. The incumbent is obliged by regulation to supply the monopoly component to other firms in order to ensure competition in the final market. Baumol argues that, in these circumstances, the welfare optimal price for the monopolistically provided component is one which covers the full incremental cost of supply including the opportunity cost associated with the lost contribution to the incumbent's common fixed costs which results from the lost business and increased competition it now faces. Kahn and Taylor (1994) endorsed the Baumol/Sidak approach although they noted that it implicitly assumes the pre-entry regulation of the incumbent is of a broadly satisfactory standard. On the other hand, Tye (1994) disputed the generality of the applicability of the efficient component pricing principle on the grounds that:

(i) The ecp only seeks to achieve "efficient use of inputs but not competition in the sale of the final products".
(ii) There is no incentive for an incumbent operator to voluntarily adopt the ecp rule or to maintain it after entry has occurred.
(iii) The rule ignores the problem of recovery of sunk costs to the entrant.

One might well argue that regulation of access pricing removes the second of these, whilst the issue of sunk costs is closely related to the issues raised in (i), namely of whether entry is likely to lead to a competitive or oligopolistic market (an issue addressed in this paper).

Laffont and Tirole (1993) argue that the key to understanding access pricing is to view the intermediate product and the incumbent's final product as an example of multi-product selling where the products are substitutes. It then follows that the access pricing problem becomes a standard Ramsey pricing problem in which the optimal Ramsey access price is a function of the regulatory targets, marginal costs, own-price, cross-price demand elasticities and the type of competition envisaged.[3] It follows that Baumol's efficient component pricing rule is only welfare optimal under a restrictive set of assumptions.

The principles of setting the access charge will fundamentally affect the ability of competitors to compete in the final product market. Since regulatory uncertainty would inhibit entry, it is usually argued that the regulatory agency should decide on, and then commit itself to holding to, certain regulatory principles. In the case of the access price, this suggests giving a reasonably transparent formula (such as marginal cost, average incremental cost or the efficient component price discussed above) such that entrants can base their entry decisions knowing that the pricing principles will not change post-entry. Accordingly, in this paper, it is assumed that the incumbent is regulated (on profitability and access price) and that entry decisions are based on knowledge of this fact. We examine the problem of access pricing when the incumbent is faced with either imperfect competition (Cournot, Stackelberg) or competitive fringe entry, into a final market which features product differentiation. In particular, the performance of some simple candidate access pricing rules vis a vis the Ramsey welfare optimal access pricing rule is assessed.

The possibility that the final product market is differentiated and that entry may lead only to imperfect competition means that the optimal Ramsey rule for access pricing is complex.[4] The other pricing formulae (marginal cost, average incremental cost, efficient component price) have the merit of not involving such complexities (in particular, of demand side information which would always be disputable in a regulatory hearing). It would seem that Ramsey pricing rules are unlikely to find favour in regulatory practice -whilst the other rules could well do so, given their seductive simplicity. The question then arises as to what cost this simplicity—Does it matter which rule is chosen? Clearly, relative performance is likely to vary depending upon circumstances, and it is difficult to address this question of relative performance within a general qualitative analysis. Accordingly, a computable model is developed in order to illustrate how variations in model structure and assumptions impact on the Ramsey pricing rule and the relative performance of this vis a vis the other rules. The approach involves specific cost and demand functions for which analytic solutions can be obtained. This allows sensitivity analysis through varying parameter values, regulatory constraints and pricing rules to assess their impact on welfare as the market changes from one of monopoly to oligopoly or competition.

The problems of entry and component pricing are discussed in the context of the UK Postal system, and when computable models are examined, the base case parameter values chosen relate to work done on demand and cost estimation in this area (Cuthbertson and Richards, 1990; Cuthbertson and Dobbs, 1994). However, the general form of the models is not specific to this industry, and it is possible to draw conclusions from this type of analysis which are of broader applicability. The use of computable models gives considerable insight into how choice of component prices might influence entry and the consequences of such entry on welfare. The parameters can be judiciously chosen to mimic real world situations and the analysis reveals the sensitivity of optimal component pricing to modelling assumptions—the assumptions about entrants expectations in particular. Furthermore, since a single counter example suffices to refute a general proposition, the approach is useful in refuting any assumption that pricing rules might be reasonably robust to changing parameter values and behavioural assumptions.

2. The Framework and Welfare Benchmarks

The scenario to be analysed is as follows; initially, the incumbent (in the postal context, the Post Office) operates as a regulated monopoly. The regulatory constraint is that of zero profitability (the model is easily modified to accommodate alternative constraints such as return on sales, return on capital, etc.). The monopolist produces a single product or service which comprises two component parts (for example, in the case of the Post office, collection and trunking might be deemed one component, the other being delivery). Entry, if it occurs, leads to either oligopoly or a competitive situation. In the former case, the model involves a potential rival firm (or colluding group of rival firms) who intends producing a similar but to some extent differentiated product (which requires the purchase of a component service from the incumbent). The latter case is modelled as entry by a competitive fringe of firms (again these firms need to buy in the incumbent's monopoly component service).

Clearly, the rival's profitability, and hence potential for entry will be influenced by the expected post-entry price offered by the incumbent for component supply. The issue then arises; can anything be said about what price ought to be set? If the market can be said to be one of effective competition, the concept of 'efficient component pricing' has certain desirable properties. However, in situations of imperfect competition, this is no longer the case. Indeed, as a second best problem, one can expect that the 'optimal' component price will be one which attempts to correct for the distortions implied by imperfect competition.

In what follows, this kind of effect is illustrated, along with the sensitivity of optimal component prices to the modelling assumptions made. Candidate component prices such as marginal cost, average incremental cost, and versions of efficient component pricing, are compared with the welfare optimal component price (hereafter referred to as a 'Ramsey price'). The complexity of this second best problem is that entry depends upon expected post-entry profitability and this in turn depends upon the entrant's expectations as to the incumbent's reaction to entry; the latter depends upon, amongst other things, the nature of the regulatory constraints.

Estrin and de Meza (1988, 1991) (EDM in what follows) examined computable models of oligopolistic entry with a regulated incumbent subject to a profitability (or return on sales) constraint. Bertrand and Cournot competition were considered and the models were analysed for a range of parameter values in the ball park of those considered to be relevant for the case of the UK Post Office Letters business. In what follows, the EDM simulation approach is extended to include component pricing and additionally, Stackelberg and Fringe entry. For each model, the effect of alternative component pricing rules is then examined.

The model is linear in both cost and demand systems (these may be regarded as approximations to non-linear cost, demand systems in the region of equilibrium solutions). Linearity facilitates computation of equilibria, welfare and so on. Notation is as follows; q_j, p_j, C_j, π_j, denote quantity, price, cost, profit, for $j = i, e$ (i denotes incumbent; e, entrant). W denotes willingness to pay and CS, consumers surplus. P_c denotes the component price. The demand and associated inverse demand functions are

$$q_i = \alpha_1 - \beta_1 p_i + \gamma_1 p_e \tag{1}$$

$$q_e = \hat{\alpha}_1 - \hat{\beta}_1 p_e + \gamma_1 p_i \tag{2}$$

$$p_i = \alpha - \beta q_i + \gamma q_e \tag{3}$$

$$p_e = \hat{\alpha} - \hat{\beta} q_e + \gamma q_i \tag{4}$$

where α_1, β_1, $\hat{\alpha}_1$, $\hat{\beta}_1$, γ_1 are given constants and these imply values for $\alpha, \ldots, \gamma$ (and vice versa). The integrability assumption implicit in the above specification ($\partial q_i/\partial p_e = \partial q_e/\partial p_i$) is reasonable for postal markets according to a recent econometric analysis testing this functional form (Cuthbertson and Dobbs, 1994). Firms' costs are given as

$$C_i = F_0 + F_1 + a_0 q_i + a_1(q_i + q_e) \tag{5}$$

$$C_e = \hat{F} + \hat{a} q_e + p_c q_e \tag{6}$$

Marginal costs are a_0 for the initial (upstream) component (e.g. collection and trunking) and a_1 for the (downstream) component also made available to competitors (e.g. delivery). The incumbent's overall marginal cost for the two components is $a \equiv a_0 + a_1$. The incumbent's overall fixed costs F are divided into F_1, denoting the allocatable fixed costs of the component also provided by the incumbent to the rival, whilst F_0 denotes its remaining fixed costs. Thus F_0 contains fixed costs allocatable to the upstream component plus unallocatable fixed costs associated with the business as a whole. The entrants fixed costs are $\hat{F}$ and its marginal costs are $\hat{a}$ for the component it provides and p_c, the component price, for the bought-in component. Whenever fixed costs are set positive, the cost functions exhibit economies of scale and hence cost subadditivity.[5] Given these demand and cost functions, profits are

$$\pi_i = p_i q_i + p_c q_e - C_i \tag{7}$$

$$\pi_e = p_e q_e - C_e, \tag{8}$$

and willingness to pay (W) is

$$W = (\alpha q_i - 0.5\beta q_i^2) + (\hat{\alpha} q_e - 0.5\hat{\beta} q_e^2) + \gamma q_i q_e. \tag{9}$$

Net social benefits (B) are thus

$$B = W - F_0 - F_1 - a q_i - a_1 q_e - \hat{F} - \hat{a} q_e \tag{10}$$

whilst consumers' surplus (CS) is simply

$$CS = W - p_i q_i - p_e q_e \tag{11}$$

Given numerical values for all the associated parameters, the above equations allow the evaluation of firms' profits, net welfare etc. conditional on final outputs (q_i, q_e) or prices (p_i, p_e) (via (1) and (2)) and a given specification of the component price (p_c).

In examining entry and welfare under different models and pricing regimes, it is useful to have a benchmark for comparison. Two plausible benchmarks are considered below.

2.1. Benchmark Cases

2.1.1. Single firm monopoly, uniform pricing over the two products. Two justifications for this benchmark seem possible. Firstly, the incumbent may be viewed as, prior to entry, producing both products (bundled); the regulator dictates that one of these is to be opened to competition and essentially given away to the competition. An alternative interpretation might be that the incumbent currently produces just a single product, and entry, if it occurs, is by a firm or firms producing a new and differentiated good. A natural question to ask is; what would welfare have been if the incumbent had added this new good to its own list of products? Of course, an alternative benchmark here would be to consider unbundled Ramsey pricing. By relaxing the constraint of uniform pricing, this would typically imply an even higher benchmark welfare level and hence a tougher test of whether entry is welfare improving.

With a uniform price p, the regulated incumbent sets p to solve

$$\pi_i = (p - a)(q_i + q_e) - F = 0 \tag{12}$$

where q_i, q_e are defined by (1), (2) with $p_i = p_e = p$ and $F \equiv F_i + F_e$ denotes total fixed costs. These equations give a solution[6] for q_i, q_e, p and hence welfare B may be computed as in (10).

2.1.2. Single firm monopoly over q_i *alone.* With this benchmark, the incumbent alone is producing a single good. Entry, if it takes place, involves the introduction of a differentiated product. In comparison to the first benchmark, this one tends to cast a more favourable light on entry since the introduction of a new product, in so far as it is significantly differentiated, tends to increase welfare. In this benchmark case, $q_e = 0$ and the only (inverse) demand function is (3) (with $q_e = 0$). The solution to the regulated monopoly problem is given by solving the following quadratic equation for q_i (the larger root being selected);

$$\pi_i = (\alpha - \beta q_i)q_i - F - aq_i = 0 \tag{13}$$

Again these equations give a solution for q_i, q_e, p and hence welfare B may be computed as in (10).

In what follows, we consider entry under varying cost conditions for the entrant (+, = ,−20% relative to the incumbent), the cost structure for the incumbent remaining fixed. The welfare benchmarks outlined above therefore assume that there is no impact on the productive efficiency of the incumbent's operations. It can be argued that one rationale for promoting competition and network access is that such competition may induce efficiency gains by the incumbent. To take this into account, the model could be run with variations in the incumbents cost structure, post-entry. However, to restrict the considerable volume of data to be examined below, a simpler way to bear this possibility in mind in examining the output is to interpret the cost structure used for the incumbent as its post-entry cost structure. If pre-entry costs are higher, this will adversely affect the level of welfare computed under the above benchmarks. Thus, when entry occurs in such a case, the welfare benefits of entry will be greater (relative to the pre-entry benchmark) in each case considered.

3. The Market Models

With space considerations in mind, attention is confined to Cournot, Stackelberg and Fringe entry (it is straightforward to extend the analysis to the case of Bertrand competition). In solving these models, it is assumed that the incumbent is subject to a zero profit constraint and is also constrained in its choice of component price offered to the entrant. The basic format for the above models is that they are 'single shot' games. The question arises; to what extent are such games likely to capture the essence of what in practice is undoubtedly a repeated and dynamic game? Certainly, one can argue that the strategic choice variables ought not to be such that they can be easily or quickly adjusted—which tends to suggest that the Bertrand model is less likely to be so appropriate in comparison to the quantity setting of Cournot (particularly in the Postal context). Furthermore, as Kreps and Scheinkman (1983) have shown, a two stage model involving capacity precommitment followed by Bertrand competition gives rise to essentially Cournot outcomes.

3.1. Simple Cournot Entrant, Regulated Incumbent

A Cournot entrant is assumed to take the incumbent's output as given, and in addition, the component price p_c associated with this output level. The entrant's reaction function is defined by the equation $\partial\pi_e/\partial q_e = 0$. This implies

$$q_e = (\hat{\alpha} - \hat{a} + \gamma q_i - p_c)/(2\hat{\beta}) \tag{14}$$

The incumbent's reaction function is given by the zero profit regulatory constraint

$$\pi_i = 0 \tag{15}$$

where π_i is defined by (7).

Equilibrium is given by the solution (q_i, q_e) which satisfies equations (14), (15). This amounts to solving the quadratic equation

$$(\hat{\alpha} - \hat{a} + \gamma q_i - P_c)(\gamma q_i + P_c - a_1) - 2\hat{\beta}(F + aq_i - (\alpha - \beta q_i)q_i) = 0 \tag{16}$$

for q_i (the larger of the two solutions being chosen), with q_e then being determined by (14). Once, q_i, q_e are found, it is straightforward to compute welfare, profitability etc. using equations (7)–(11).

Of course, economically meaningful entry occurs under this solution only if π_e,q_e, and q_i are non-negative. Entry only occurs if $\pi_e \geq 0$, whilst, if entry is too vigorous, it may render it impossible for the incumbent to attain its profit target. These observations apply equally to the models discussed below. It is straightforward to numerically check these conditions (see Section 5, where the results are discussed).

3.2. Stackelberg Entrant, Regulated Incumbent

In a simple profit maximising single stage Cournot game, the firms choose outputs simultaneously. The firms have knowledge of the demand conditions and the market structure but neither can observe the other's production plan. They bring their outputs to market and the price adjusts to clear supply. In such a model, Cournot conjectures make sense (see, for example, Daughety, 1985; Kreps, 1990). As in (i), it is possible to solve the Cournot Model with a regulated incumbent. However, an alternative solution concept, that of Stackelberg also merits attention. The Stackelberg model assumes that one firm (the 'leader') chooses output first, the follower, in making an output decision, being able to observe this decision. The Cournot reaction function, equation (14), thus appropriately defines the second firm's choice of output, since the output of its rival is already fixed. The leader, in choosing its output, can take this reaction into account.

It has been a common assumption, in modelling entry into an oligopolistic industry, that the incumbent has a first mover advantage, and is thus the Stackelberg leader (see, for example, Dixit, 1979, 1980).[7] However, in the presence of regulation of the form discussed above (and in a multi-period context), it is more appropriate to assume that it is the entrant who has the first mover advantage. This argument runs as follows. Given an inflexible regulatory framework, if the potential entrant chooses to enter with a certain volume of production, it knows that, whilst in the short run this may drive the incumbent temporarily away from its target level of profitability,[8] in due course, the incumbent will be forced to adjust its price/output choice in order to achieve its target.[9] That is, given the constraints faced by the incumbent, the entrant knows that the incumbent's long run price/output configuration is determined by the entrant's choice of output. This confers on the entrant the role of Stackelberg leader.

Adding a preliminary stage to the above game in which the incumbent has a first move (say in choosing installed capacity which then becomes a sunk cost as in Dixit (1989) for example) does not alter the characteristics of the sub-game which we have analysed: in the sub-game, according to the above argument, the entrant remains the Stackelberg leader. However, adding such a preliminary stage might affect the welfare assessment. By ignoring this preliminary stage, we are taking the extant situation (incumbent monopoly with given installed capacity) as the benchmark for welfare comparisons—it could be argued that the relevant benchmark is that of an incumbent whose choice of capacity has not been influenced by the threat of entry. However, this possibility is not pursued further here.

If, as part of the regulatory regime, there was a formula specification for the component price the incumbent must offer to potential entrants, it is also possible that such an entrant could also take into account the implied adjustments in this price as a consequence of the output effects of entry (for example, with an average cost component price, a reduction in either the incumbent's final output or the entrant's purchase of the monopoly supplied component increases the incumbent's assignable average cost for the provided component). In its present formulation, the Stackelberg model outlined below involves the leader taking account of the direct output effect on the incumbent's final product price/output but (for simplicity) not taking account of the possible knock-on effects on the component price. Whether there would be any such knock-on effect depends upon the way the component price is regulated. Regulatory authorities might in practice impose component pricing constraints in terms of actual prices (pre- and post-entry) or in terms of the formulae by which such component prices are calculated.[10]

Equation (15) defines the incumbent's reaction function (its choice of q_i for a given q_e and p_c[11]). Denote this as $q_i = f(q_e)$ The entrants profits are given by (8); taking into account the incumbent's reaction function amounts to maximising

$$\pi_e = (\hat{\alpha} - \hat{\beta} q_e + \gamma f(q_e))q_e - \hat{F} - \hat{a}q_e - p_c q_e, \tag{17}$$

a first order condition being that $\partial\pi_e/\partial q_e = 0$. A value for q_e, the equilibrium output of the entrant in the Stackelberg game, is a value which solves this condition; computationally, it can be obtained by an iterative search procedure. The output for the incumbent, q_i, can then be obtained from the incumbent's reaction function, equation (15).

3.3. Fringe Entry, Regulated Incumbent

The final case of entry to be considered is that by a competitive fringe of firms each producing an identical product but one which is differentiated from the incumbent's. As in the case of entry by a single firm (or colluding group), these firms also require access to the monopolistically provided component supplied by the incumbent. Again, component price will influence the extent of entry. Fringe entry is characterised by constant average cost for their component. That is, in terms of the variables already defined, $\hat{F}$ is set to zero and $\hat{a}$ denotes average cost (equal to marginal cost) for this component. Given the component price p_c, the overall average cost for fringe production is $\hat{a} + p_c$. Thus entry takes place until fringe output leads to a price p_e at equilibrium given by

$$p_e = \hat{a} + p_c \tag{18}$$

Substituting this into the demand equations (1), (2) and hence into the regulatory constraint (15) then allows a solution for q_i, q_e, p_e, the overall solution being conditional on the value of p_c.

4. Component Pricing Rules

The regulatory regime within which the incumbent is required to operate is assumed to involve a specification of the pricing rule to be set for component provision. We consider the following cases;

4.1. Marginal Cost

$$p_c = a_1 \tag{19}$$

The models described above can be solved directly in this case since (19) implies P_c is not affected by output changes (etc.).

4.2. Average Incremental Cost

$$p_c = a_1 + F_1/(q_i + q_e) \tag{20}$$

F_1 denotes the assignable costs to the component being provided, and the total volume of traffic on this component is the sum of the incumbent's and entrant's throughput. A problem in solving the models under this component pricing regime is that, as q_i,q_e vary, so does average incremental cost. Computationally, an iterative search procedure is used for each model such that in each case the values q_i, q_e, p_c satisfy the equilibrium first order conditions and equation (20).[12]

4.3. Efficient Component Pricing

A rather naive version of the 'efficient component price' might start from the initial (uniform pricing) monopoly position; that is,

$$p_c = p - a_0 \tag{21}$$

The idea here is that the incumbent was originally providing this service; what is the per unit loss involved in letting it go to the entrant, given that the incumbent still has to provide the stage 1 component? A simple view is that originally, the incumbent was making an incremental profit of $p - a_0 - a_1$ per unit on the second good; if this is taken over by the entrant, the incumbent still has to provide the component with marginal cost a_1, hence the opportunity cost (the lost contribution per unit of output) of giving up the service is $p - a_0$ (calculations for this case are reported in Tables 1 3 under the heading ECP1). The defect of this reasoning is that prices change with entry (and also with changes in the component price). This suggests that the efficient component price might be calculated to be consistent with the equilibrium final product prices, p_i, p_e (equivalently quantities q_i, q_e). Thus, the overall solution involves finding q_i, q_e, p_c which simultaneously satisfy the equilibrium first order conditions and equation (21). An iterative search procedure is used (cf. the average cost case) to obtain this solution (reported in Tables 1–3 under the heading ECP2)

4.4. Welfare Optimal Component Pricing

For each model, as the component price is varied, so does the computed economic welfare (measured as the sum of consumers' surplus plus firms' profits, or willingness to pay minus costs). Thus, in each case, an iterative search procedure may be employed to determine the component price which maximises welfare. Some care is needed in interpreting the Ramsey welfare optimal component price as reported in these tables. The reported price, P_R, is that which yields maximum welfare conditional on entry taking place and on the incumbent being able to achieve its profit target. Let P_c^{min} denote the minimum component price consistent with the incumbent achieving its regulatory target and P_c^{max} denote the maximum price consistent with entry taking place ($\pi_e \geq 0$). Figures 1 and 2 illustrate the kind of solutions that can occur. In Figure 1, there is an interior solution for the Ramsey price (denoted P_R). The associated level of welfare is denoted $B(P_R)$.[13] The horizontal dotted lines labelled B1, B2 denote the two benchmark levels of welfare (for example, in Table 1, case 6, B1 = 2.6225, B2 = 1.6650). Thus in Figure 1, P_R is optimal relative to benchmark B2. However, had B2 taken a welfare value greater than $B(P_R)$, it would have been welfare optimal to price the entrant out of the market. The benchmark B1 corresponds to the case where the incumbent originally supplied both products; entry, even with a Ramsey optimal component price is inferior to retaining the original monopoly. Thus, in this case, the reported Ramsey price is only a local welfare optimum. It is preferable to set a component price $p_c \geq p_c^{max}$ and price the potential entrant out of the market. Another possibility is illustrated in Figure 2; here, welfare increases with decreases in the component price and the optimal price P_R is equal to the minimum consistent with the incumbent attaining

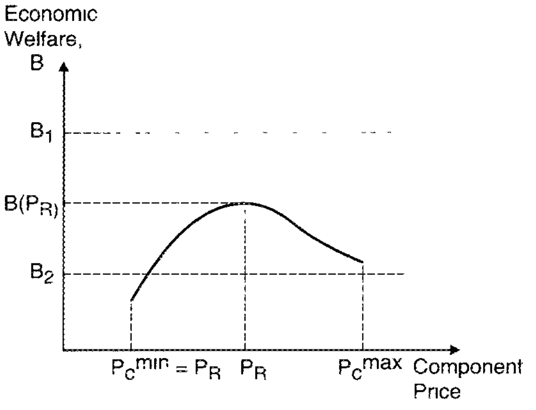

Figure 1.

its regulatory constraint. Again this reported solution may be regarded as optimal relative to benchmark B2 but not relative to B1 (again it is better to price the entrant out of the market).

5. Discussion of Results

To illustrate the basic sensitivity to specification requires only a relatively small number of cases to be reported. On the demand side, the base case parameter estimates are those used in the EDM Study. The demand parameters are chosen to normalise price and output to unity for the single product regulated monopoly case (as in EDM's work) and to yield an overall elasticity for the postal business of around −0.3 (this fits in with the latest econometric estimates—see, for example, Cuthbertson and Richards, 1990; Cuthbertson and Dobbs, 1994). The demand equations are also symmetric ($\alpha = \hat{\alpha} = 4.33$ whilst $\beta = \hat{\beta} = 3.33$ as in EDM's benchmark cases); equal final product prices by incumbent and entrant result in a 50/50 split of the overall market. Naturally, many alternative demand scenarios

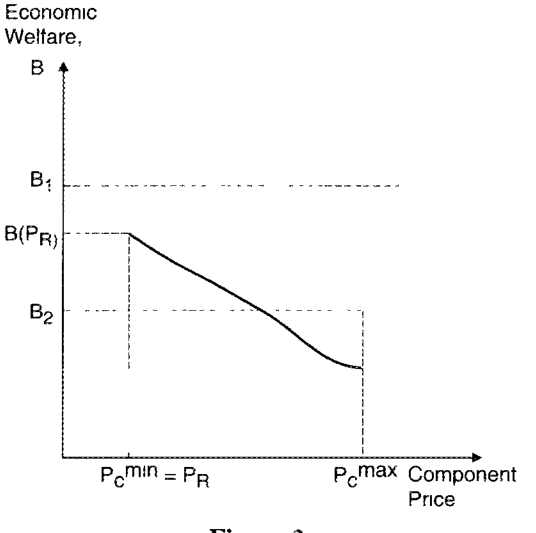

Figure 2.

could be envisaged but, to limit the number of cases to be considered, only the parameter γ is varied; this affects primarily the cross price elasticity and so allows consideration of cases where the products are close substitutes and where they are significantly differentiated.

Costs are also normalised to unity for the unit level of output. When both firms have fixed costs, the benchmark case involves a total cost allocated 40% fixed, 60% variable at the unit output rate. The two components, for both products also represent a 40/60 split both in respect of fixed and variable costs.[14] The incumbent's fixed costs $F = 0.4$ are split between the two components 40/60 as $F_0 = 0.16$, $F_1 = 0.24$ and marginal costs ($a \equiv a_0 + a_1$) totalling 0.6 are likewise $a_0 = 0.24$, $a_1 = 0.36$. The entrant provides only the 0-component with fixed costs, marginal costs either equal to or plus or minus 20% of those of the incumbent in cases 1–6.

We now discuss in some detail Tables 1–3 in order to bring out the salient features embodied in a rather considerable mass of data (despite the fact that we do not report equilibrium final product prices or quantities, elasticities, market shares etc.). Each table contains the results for 6 different parameter sets; 1–3 involve low product differentiation (cross-price elasticities of greater than 9.5) whilst 4–6 involve much greater product differentiation (with cross price elasticities of less than 0.15).[15] For each parameter set, for each type of competition (Cournot, Stackelberg, Fringe) and for each component price (marginal cost, average incremental cost, efficient component price, Ramsey price), we report the equilibrium values for economic welfare, B, the entrants profitability, π_e, the component price, p_c, and the size of the total market, q (the sum of incumbent and entrants outputs[16]).

Table 1. Duopoly models: positive fixed costs for both the entrant and regulated incumbent*

Case	Low product differentiation			High product differentiation		
	1 20%Lower costs	2 Equal costs	3 20%Higher costs	4 20%Lower costs	5 Equal costs	6 20%Higher costs
(a) With Cournot Entrant						
Key parameters						
γ	−3 25	−3.25	−3 25	−1 25	−1.25	−1.25
$\hat{a}$	0 192	0 24	0 288	0 192	0.24	0.288
$\hat{F}$	0.128	0 16	0 192	0 128	0 16	0.192
Benchmark case BC1—uniform pricing, zero profit monopoly						
B1	1 6908	1 6908	1 6908	2 6225	2 6225	2 6225
η†	−0.2982	−0 2982	−0.2982	−0 2494	−0 2494	−0 2494
η_{ei}‡	12 1134	12 1134	12 1134	0 1499	0 1499	0 1499
$q = q_i + q_e$	1.0138	1 0138	1.0138	1 5134	1 5134	1 5134
Benchmark case BC2 –single product zero profit monopoly						
B2	1 6650	1 6650	1 6650	1 6650	1.6650	1.6650
q	1 0	1 0	1 0	1 0	1 0	1.0
Alternative component pricing solutions						
1. P_c = marginal cost						
B	1.545	1 5052	1 4668	2.2641	2 2034	2 1433
π_e	−0 0192	−0 0711	−0.1208	0 4421	0.3885	0.3354
q	0 9728	0 9763	0.9795	1 2317	1.2274	1 2231
P_c	0.36	0 36	0.36	0 36	0.36	0.36
2 P_c = average incremental cost						
B	1 5464	1 5094	1 4739	2 2311	2.1711	2.1117
π_e	−0 1028	−0 1425	−0.1808	0 3423	0.2908	0 2397

Table 1. *continued*

Case	Low product differentiation			High product differentiation		
	1 20% Lower costs	2 Equal costs	3 20% Higher costs	4 20% Lower costs	5 Equal costs	6 20% Higher costs
q	0.9971	0.9977	0.9982	1.2413	1.2363	1.2313
P_c	0.6007	0.6006	0.6004	0.5533	0.5541	0.5549
3. P_c = ECP1 (naive ecp)						
B	1.5422	1.5072	1.4734	2.2169	2.1574	2.0984
π_e	-0.1231	−0.1580	−0.1916	0.3092	0.2589	0.2090
q	1.0010	1.0006	1.0003	1.2427	1.2375	1.2323
P_c	0.7545	0.7545	0.7545	0.6243	0.6243	0.6243
4. P_c = ECP2 (consistent ecp)						
B	1.5420	1.5070	1.4734	2.2047	2.1452	2.0862
π_e	−0.1235	-0.1582	−0.1917	0.2837	0.2335	0.1836
q	1.0010	1.0006	1.0003	1.2431	1.2378	1.2324
P_c	0.7596	0.7597	0.7599	0.6818	0.6832	0.6846
5. P_c = RP (the welfare optimal or 'Ramsey' component price)						
B	1.5475	1.5096	1.474	2.2851	2.2241	2.1637
π_e	-0.0741	−0.1346	−0.1861	0.5999	0.5443	0.4891
q	0.9896	0.9957	0.9995	1.200	1.1968	1.1936
P_c	0.4881	0.5565	0.6502	0.1087	0.1060	0.1034
(b) With Stackelberg Entrant						
Alternative component pricing solutions						
1. P_c = marginal cost						
B	1.0821	1.0246	0.9672	1.4440	1.3727	1.3019
π_e	0.5454	0.4964	0.4476	0.8348	0.7776	0.7207
q	0.5710	0.5664	0.5618	0.6852	0.6777	0.6702
P_c	0.36	0.36	0.36	0.36	0.36	0.36
2. P_c = average incremental cost						
B	1.0830	1.0148	0.9469	1.1472	1.0745	1.0024
π_e	0.5464	0.4924	0.4387	0.6766	0.6183	0.5603
q	0.5699	0.5623	0.5546	0.5688	0.5605	0.5522
P_c	0.7811	0.7868	0.7928	0.7820	0.7882	0.7946
3. P_c = ECP1 (naive ecp)						
B	1.0833	1.0162	0.9497	1.2558	1.1862	1.1171
π_e	0.5464	0.4929	0.4398	0.7370	0.6804	0.6242
q	0.5701	0.5629	0.5556	0.6107	0.6037	0.5968
P_c	0.7545	0.7545	0.7545	0.6243	0.6243	0.6243
4. P_c = ECP2 (consistent ecp)						
In all cases, the ECP becomes so large that the rival is driven out of the market (see discussion in text)						
5. P_c = RP (the welfare optimal or 'Ramsey' component price)						
B	1.0838	1.0259		1.7939	1.7326	1.6719
π_e	0.5464	0.4972	N1	1.0055	0.9535	0.9020
q	0.5708	0.5669		0.8280	0.8235	0.8190
P_c	0.6384	0.0058		−0.3368	−0.3607	−0.3851

N1: No interior solution. Decreasing the component price increases welfare. When the price becomes sufficiently negative, the incumbent is no longer able to break even. At this point, the level of welfare is much lower than either of the monopoly benchmarks.

* $F_0 = 0.16$, $F_1 = 0.24$, $a_0 = 0.24$, $a_1 = 0.36$ for all cases

† Overall market elasticity

‡ Cross price elasticity

5.1. *Table 1: Positive Fixed Costs for Both Entrant and Incumbent*

5.1.1. Cournot case. Here, the incumbent has positive fixed costs for both components of its product, as does the entrant, so both feature economies of scale. Postal services could be an example of this case; recent work (Rogerson and Takis, 1992) suggests there may be economies of scale and scope in most segments of postal operations.

A first point to notice in Table 1 is the relationship between the benchmark cases B1, B2. Where there is little product differentiation (columns 1–3), these yield similar levels of monopoly welfare, whilst where there is significant product differentiation (columns 4–6), the welfare in B1 is markedly higher. This is so because, relative to B2, B1 involves the introduction of a new and significantly differentiated good and this gives a boost to welfare. With similar goods, this effect disappears. As we shall see, whether entry is welfare improving or not will often turn on which benchmark is deemed appropriate.[17]

For each product differentiation level (low, high), the entrant's cost are set to 20% below, equal to, and 20% above the incumbent's for its parallel component. In columns 1–3, where there is little product differentiation, even a 20% cost advantage to the entrant is insufficient for the entrant to get a foothold in the market (π_e<0 in all cases). Turning to columns 4–6 (high product differentiation), entry is always possible and is always welfare beneficial in comparison with benchmark B2 and harmful relative to B1. The other key point here is that the Ramsey component price lies significantly below marginal cost—this is optimal relative to B2 but, relative to B1, it is preferable to retain the monopoly. Finally, efficient component pricing rules give much higher prices and lower welfare compared to the other pricing rules.

5.1.2. Stackelberg case. In all cases, a Stackelberg entrant is able to profitably enter and manipulate the market, usually with a considerable adverse effect on welfare and aggregate output. Relative to benchmark B1, entry is always welfare adverse, even with welfare optimal component pricing.[18] Indeed, entry is adverse relative to B2 when there is little product differentiation, although with greater differentiation it is possible that it is welfare improving. As in the Cournot case, welfare optimal component prices are often lower than marginal cost, and in the case of significant product differentiation, amount to absolute subsidies (negative prices).

In the postal context it has sometimes been suggested (particularly by those working in the industry) that entrants may be multi-product firms who are able to 'piggy back' entry on already installed related capacity. In this scenario, so the argument goes, the entrant has low or zero fixed costs associated with entry. Whether or not this is a reasonable assumption, it is straightforward to assess its significance in the light of Table 1. This scenario amounts to setting $\hat{F} = 0$ in the above cases 1–6. In fact, changing entrant's fixed costs does not affect the equilibrium outputs or prices, merely the entrant's profits and the overall welfare. In fact reducing $\hat{F}$ from 0.128 to 0 simply increases π_e and B by the same amount (0.128). We may conclude that in this case this makes entry profitable in all cases even for the Cournot entrant. The general point about entry being welfare improving relative to B2 and adverse relative to B1 continues to hold however.

5.2. *Table 2: Zero Fixed Costs for Entrant*

In general, it might be expected that the components over which the incumbent has a natural monopoly are those which are likely to feature economies of scale (i.e.

Table 2. Duopoly models: positive fixed costs for incumbent, zero fixed costs for potential entrant*

Case	Low product differentiation			High product differentiation		
	1 20%Lower marginal costs	2 Equal marginal costs	3 20%Higher marginal costs	4 20%Lower marginal costs	5 Equal marginal costs	6 20%Higher marginal costs
(a) With Cournot Entrant						
Key parameters						
γ	−3.25	−3.25	−3.25	−1.25	−1.25	−1.25
$\hat{a}$	0.192	0.24	0.288	0.192	0.24	0.288
$\hat{F}$	0.0	0.0	0.0	0.0	0.0	0.0
Benchmark case BC1 uniform pricing, zero profit monopoly						
B1	1.6908	1.6908	1.6908	2.6225	2.6225	2.6225
η†	−0.2982	−0.2982	−0.2982	−0.2494	−0.2494	−0.2494
η_{e}, ‡	12.1134	12.1134	12.1134	0.1499	0.1499	0.1499
$q = q_i + q_e$	1.0138	1.0138	1.0138	1.5134	1.5134	1.5134
Benchmark case BC2 single product zero profit monopoly						
B2	1.6650	1.6650	1.6650	1.6650	1.6650	1.6650
q	1.0	1.0	1.0	1.0	1.0	1.0
Alternative component pricing solutions						
1 P_c = marginal cost						
B	1.6730	1.6652	1.6588	2.3921	2.3634	2.3353
π_e	0.1088	0.0889	0.0712	0.5701	0.5485	0.5274
q	0.9728	0.9763	0.9795	1.2317	1.2274	1.2231
P_c	0.36	0.36	0.36	0.36	0.36	0.36
2 P_c = average incremental cost						
B	1.6744	1.6694	1.6659	2.3591	2.3311	2.3037
π_e	0.0252	0.0175	0.0112	0.4703	0.4508	0.4317
q	0.9971	0.9977	0.9982	1.2413	1.2363	1.2313
P_c	0.6007	0.6006	0.6004	0.5533	0.5541	0.5549
3 P_c = ECP1 (naive ecp)						
B	1.6702	1.6672	1.6654	2.3449	2.3174	2.2904
π_e	0.0049	0.0020	0.00034	0.4372	0.4189	0.4010
q	1.0010	1.0006	1.0003	1.2427	1.2375	1.2323
P_c	0.7545	0.7545	0.7545	0.6243	0.6243	0.6243
4 P_c = ECP2 (consistent ecp)						
B	1.6670	1.6670	1.6654	2.3327	2.3052	2.2782
π_e	0.0045	0.0018	0.0003	0.4117	0.3935	0.3756
q	1.0010	1.0006	1.0003	1.2431	1.2378	1.2324
P_c	0.7596	0.7597	0.7599	0.6818	0.6832	0.6846
5 P_c = RP (the welfare optimal or 'Ramsey' component price)						
B	1.6755	1.6696	1.6660	2.4131	2.3841	2.3557
π_e	0.0539	0.0254	0.0059	0.7279	0.7043	0.6811
q	0.9896	0.9957	0.9995	1.200	1.1968	1.1936
P_c	0.4881	0.5565	0.6502	0.1087	0.1060	0.1034
(b) With Stackelberg Entrant						
Alternative component pricing solutions						
1 P_c = marginal cost						
B	1.2101	1.1846	1.1592	1.5720	1.5327	1.4939
π_e	0.6734	0.6564	0.6396	0.9628	0.9376	0.9127
q	0.5710	0.5664	0.5618	0.6852	0.6777	0.6702
P_c	0.36	0.36	0.36	0.36	0.36	0.36

Table 2. *continued*

Case	Low product differentiation			High product differentiation		
	1 20%Lower marginal costs	2 Equal marginal costs	3 20%Higher marginal costs	4 20%Lower marginal costs	5 Equal marginal costs	6 20%Higher marginal costs
2 P_c = average incremental cost						
B	1.2110	1.1748	1.1389	1.2752	1.2345	1.1944
π_e	0.6744	0.6524	0.6307	0.8046	0.7783	0.7523
q	0.5699	0.5623	0.5546	0.5688	0.5605	0.5522
P_c	0.7811	0.7868	0.7928	0.7820	0.7882	0.7946
3 P_c = ECP1 (naive ecp)						
B	1.2113	1.1762	1.1417	1.3838	1.3462	1.3091
π_e	0.6744	0.6529	0.6318	0.8650	0.8404	0.8162
q	0.5701	0.5629	0.5556	0.6107	0.6037	0.5968
P_c	0.7545	0.7545	0.7545	0.6243	0.6243	0.6243
4 P_c = ECP2 (consistent ecp) In all cases, the ECP becomes so large that the rival is driven out of the market (see discussion in text)						
5 P_c = RP (the welfare optimal or 'Ramsey' component price)						
B	1.2118	1.1859		1.9210	1.8926	1.8639
π_c	0.6744	0.6572		1.1335	1.1135	1.0940
q	0.5708	0.5669	N2	0.8280	0.8235	0.8190
P_c	0.6384	0.0058		−0.3368	−0.3607	−0.3851

N2 see N1, Table 1

* $F_0 = 0.16$, $F_1 = 0.24$, $a_c = 0.24$, $a_1 - 0.36$ in all cases.

† Overall market elasticity

‡ Cross price elasticity

positive fixed costs in this model) whilst those which are subject to competition are more likely to be subject to constant returns to scale (zero fixed costs here). For example, Panzar (1991) suggested that the Postal service featured approximately constant returns in collection and trunking, but economies of scale in delivery.[19] Table 2 illustrates this scenario. The demand and cost variations parallel those of Table 1 (the latter swinging from −20% to +20%). Fixed costs on the competing components are zero ($F_0 = \hat{F} = 0$) so average equals marginal cost for these components. For the Cournot entrant, in all cases, entry is feasible (π_e>0) and is welfare improving relative to B2, adverse relative to B1. The welfare optimal price ranges from well below marginal cost (and absolute subsidies in columns 4 6) to intermediate between marginal and average incremental cost. The Stackelberg entrant is also always able to enter, and again, with little product differentiation, this is welfare worsening relative to both benchmarks, whilst with more product differentiation, it improves on B2 but remains much worse than B1.

5.3. *Table 3: Fringe Entry*

Here, entry takes place with constant average costs (equal to marginal costs) and zero profits for fringe entry. The incumbent has economies of scale (positive fixed costs) for the component over which it has a monopoly, and constant average costs for the other component of its product. As usual, the three cases are considered for entrant's average costs (below, equal and above the incumbent's for its associated component). With low product differentiation, the situation is very much on a knife

Table 3. Fringe entry: incumbent has zero fixed costs for competitive component, positive fixed costs for the provided component*

Case	Low product differentiation			High product differentiation		
	1 20%Lower marginal costs	2 Equal marginal costs	3 Equal average costs	4 Lower marginal costs	5 Equal marginal costs	6 Equal average costs
Key parameters						
γ	-3.25	-3.25	-3.25	-1.25	-1.25	-1.25
$\hat{a}$	0.192	0.24	0.288	0.192	0.24	0.288
$\hat{F}$	0.0	0.0	0.0	0.0	0.0	0.0
Benchmark case BC1: uniform pricing, zero profit monopoly						
B1	1.8667	1.8667	1.8667	2.7926	2.7926	2.7926
η	0.2355	0.2355	0.2355	0.2107	0.2107	0.2107
η_{et}	9.5665	9.5665	9.5665	0.1267	0.1267	0.1267
$q = q_i + q_e$	1.0653	1.0653	1.0653	1.5617	1.5617	1.5617
Benchmark case BC2: single product zero profit monopoly						
B2	1.8329	1.8329	1.8329	1.8329	1.8329	1.8329
q	1.0218	1.0218	1.0218	1.0218	1.0218	1.0218
Alternative component pricing solutions						
1 P_c = marginal cost						
B				2.5935	2.5093	2.4300
π_e				0.0	0.0	0.0
q	N1	N1	N1	1.5048	0.4803	1.4558
P_c				0.36	0.36	0.36
2 P_c = average incremental cost						
B	1.8467			2.6068	2.5215	2.4411
π_e	0.0			0.0	0.0	0.0
q	1.0575	N2	N2	1.5069	1.4794	1.4518
P_c	0.5870			0.5193	0.5222	0.5253
3 P_c = ECP1 (naive ecp)						
B	1.8467			2.6068	2.5215	2.4411
π_e	0.0			0.0	0.0	0.0
q	1.0576	N2	N2	1.5070	1.4798	1.4525
P_c	0.5853			0.5137	0.5137	0.5137
4 $P_c$eqECP2 (consistent ecp)						
B	1.8467			2.6068	2.5215	2.4411
π_e	0.0			0.0	0.0	0.0
q	1.0575	N2	N2	1.5069	1.4794	1.4518
P_c	0.5870			0.5222	0.5193	0.5253
5 P_c = RP (the welfare optimal or 'Ramsey' component price)						
B	1.8467			2.6068	2.5215	2.4412
π_e	0.0			0.0	0.0	0.0
q	1.0576	N2	N2	1.5070	1.4798	1.4526
P_c	0.5853			0.5136	0.5131	0.5123

* $F_0 = 0.0$, $F_1 = 0.24$, $a_0 = 0.24$, $a_1 = 0.36$ for all cases

N1 at these component prices, the incumbent is unable to attain its profit target

N2 at these component prices, no entry is possible

edge—between the incumbent being unable to meet its profit target and entry not being feasible. With greater product differentiation however, entry becomes possible, although again, even with a 20% cost advantage, entry is rarely welfare improving relative to benchmark B1 (although it is relative to B2). As might be expected, the naive efficient component pricing rule performs quite well in this scenario.

General Comments on the Simulation Results

Cournot and (especially) Stackelberg entry tend to reduce welfare for the parameter sets considered here. The reason for this, even where the entrant has cost advantages, seems to lie in the adverse effects of entry on the incumbent's output. The demand system parameters are chosen to mimic the UK letters business which features an overall market demand elasticity of around −0.3 (as in Tables 1–3). This is really quite inelastic; the consequence of entry thus tends to have a severe impact on incumbent's output and this in turn entails price increases (in order to achieve the profit target). It turns out that, in welfare terms this adverse effect outweighs any beneficial aspects of entry.[20]

Another feature of the cases discussed here is the relative insensitivity of welfare to the choice of component pricing rule. Although the welfare optimal component price varies considerably across the different cases, it can be argued that getting pricing right does not seem too critical in this application since there is a relatively small welfare loss associated with incorrect pricing. However, it is worth noting that this conclusion is valid only under the assumption that entry takes place; that is, once it has occurred, welfare is relatively insensitive to changes in price. However, the component price also affects whether entry occurs at all, and the difference in welfare as between entry and no entry is often considerable.

It is also worth emphasising the significance of the choice of benchmark Benchmark B1 seems more appropriate for a case where entrants are given a section of what was previously the incumbent's business, whilst B2 seems more appropriate where entrants introduce new products which utilise components of the incumbent's production system. The point of course is that B1 is a tougher benchmark to beat; under B2, entrants introducing new and differentiated products generate a boost to welfare because of this product differentiation and this increases the chance of entry being overall welfare favorable. This product differentiation aspect is by assumption absent under B1. Finally, as discussed in Section 2, these benchmarks assume that the incumbent is cost efficient both pre- and post-entry. If costs were higher pre-entry, the welfare levels under B1, B2 would be reduced to some extent (depending on the degree of inefficiency), so the possibility that entry could be welfare improving increases.

6. Concluding Comments

Computable models can be used to generate counter-examples which refute general propositions; the above analysis establishes that:

(i) no welfare ranking of simple component pricing rules exists;
(ii) that optimal component price may be considerably above average incremental cost or considerably below marginal cost, or anywhere in between, depending on modelling assumptions;[21]
(iii) that the desirability of allowing entry may be substantially affected by the choice of benchmark for comparison;
(iv) that the desirability of allowing entry may be substantially affected by behavioural assumptions (e.g. Cournot cf. Stackelberg conjectures);
(v) that entry, when it occurs, is by no means certain to generate welfare gains.

The results discussed in Sections 4 and 5 indicate that the welfare ranking of component pricing schemes can vary considerably across cases and models (Cournot, Stackelberg, Fringe). There is thus no general ranking of pricing schemes (marginal cost, average incremental cost, efficient component price) and the welfare optimal Ramsey price can be less than marginal cost (and indeed may be negative), or may lie above average incremental cost. Although there is no general ranking, it is interesting to observe that in most cases, a routinely calculated efficient component price tends to be too high; the welfare optimal (Ramsey) component price tends to be below average incremental cost and often nearer to or below marginal cost.

In very few cases does entry improve on the uniform pricing benchmark (where the incumbent originally provides both products and then subsequent to entry, gives up one of these to the entrant), although entry can often be welfare improving in comparison to the second benchmark (that where the entrant introduces a new and differentiated good). However, whilst in Cournot competition, entry often improves welfare, Stackelberg entry is much more likely to have adverse welfare consequences—not only relative to Cournot entry (which is always the case) but also relative to this second benchmark. This observation of Stackelberg entry leading to adverse welfare consequences relative to the Cournot case contrasts interestingly with the standard comparison of Cournot–Stackelberg models; for example, with a linear model and a homogeneous product the Stackelberg leader-follower model gives rise to greater output and welfare than is the case in the Cournot model. The difference in conclusions here lies with the change in the nature of the reaction function for the incumbent (a Stackelberg entrant may tend to increase output—relative to the Cournot case—but this diminishes demand for the regulated incumbent's product and pushes up its average costs and hence final product price; overall output can be adversely affected as is the case in these simulations).

These simulation results are naturally contingent on the ranges of parameter values considered (being centred on values appropriate for the UK letters business). However, the results do emphasise the fact that optimal component pricing necessarily depends upon the market structure and the assumed modes of behaviour within those markets. If entry occurs and the technology is such that the natural number of firms in the industry is small, the kind of oligopoly situation and the associated problem of welfare optimal component pricing as modelled here arises. The general inference to be drawn from the present analysis seems to be that, for such markets, both optimal component pricing and the desirability of entry itself are likely to be sensitive to modelling assumptions and the choice of benchmarks. It suggests that, in such markets, considerable caution is advisable; simple rules of thumb (regarding setting rights to entry and component pricing rules) cannot be guaranteed to yield beneficial outcomes.

In the context of the postal sector, full consideration of the implication of these results is beyond the scope of this paper. The key point which emerges is that the aims of liberalisation are critical; For example, it matters whether competition in one or more input processes is intended to play a major role in shaping the competitive environment—or whether entry is more limited (impacting only on selected customer groups or services). If the latter, it could be argued (Khan and Taylor, 1994) that an ecp-type rule is appropriate, interestingly, this is broadly compatible with the current discount policy of the incumbent operator. On the other hand, if an even more radical plan is envisaged in which not only is there liberalisation on components of the overall service but also final product competition across a substantive range of the incumbent's services then it would appear that the likely nature of this competition becomes important; in the postal context, it could well involve differentiated products and feature oligopolistic rather than competitive entry. Our paper suggests that regulatory policy in these circumstances requires a careful analysis of the type of competition which could be expected to develop.[22]

Notes

1 The Citizen's Charter (1991) put forward proposals
   (i) to reduce the price reservation limit of £1 "to a level much closer to that of the first class letter stamp".
   (ii) to allow network access to customers through "an extension of the existing schemes under which the Royal Mail offers discounts to large customers who wish to pre-sort their mail· customers will in future be able to obtain discounts for trucking mail to the final office of delivery To this end the Post Office will provide access to the delivery network on fair terms".
   (iii) to allow network access to all parties "later we expect to grant operators the same flexibility to sort and trunk mail for third parties".

   A possible interpretation of these proposals, is that eventually third parties may be able to directly compete with the services of the incumbent supplier by being able to access the network of the latter at 'fair terms'

   Dobbs and Richards (1991) give a detailed description of the institutional background for the UK postal sector including the legal and economic principles of price setting and regulation of the dominant supplier, namely the Post Office Key points in the context of the proposals outlined above. are the implicit requirements of a uniform tariff, the use of avoided incremental costs in setting discounts for customers who pre-sort their mail, and a system of interlocking financial controls which determine the absolute level of prices

2 Indeed, several of the examples discussed in Baumol (1991) seem better placed in this category.

3 Laffont and Tirole (1993) also examine the impact of agency costs which naturally lead to further 'incentive corrections' to the welfare optimal Ramsey pricing rule

4 Laffont and Tyrole (1993) provide a brief account of the Ramsey rule here for the case where the incumbent is an n-product monopolist, the $n+1$th product being the component sold to competitors The incumbent's final products are assumed independent, only the nth and $n+1$th have non-zero cross price elasticities When, as is normally the case, the incumbents product line involves a set of products with non-zero elasticities, the solution for Ramsey prices becomes even more complex.

5 F and F need not be interpreted as fixed costs Equations (5), (6) could be interpreted simply as linear approximations to what are in reality non-linear cost functions. In such an interpretation, the intercepts have no direct economic interpretation It may also be worth mentioning that in general, it can often be important to distinguish whether or not such fixed costs are sunk or not (see Sutton, 1991)—in the postal business, most of the assets are fixed but not significantly sunk

6 This equation. and several of those that follow give rise to multiple solutions (here, two, since it is a quadratic) In all cases, the incumbent is assumed to be a welfare maximiser and hence chooses to produce the larger amount

7 There is a large literature on the precommitment to irreversible investment in capacity as an entry barrier (see also, for example, Eaton and Lipsey, 1980) along with the accumulation of inventory (e g Arvan, 1985)

8 Or any other other specified target.

9 And in the long run this includes adjustments to capacity

10 Given they may be concerned with predatory behaviour

11 Thus p_c is taken as given A possible extension is to take account of the feedback effect on p_c of choices for q_i, q_e

12 It is also possible to define a fully distributed cost pricing rule (to include an arbitrary allocation of general overhead) but this is not reported for space considerations, such a component price is slightly higher than the average incremental cost price so the welfare consequences tend to be intermediate between the latter and those arising from the efficient component pricing rules

13 $B(P_R)$ is the value of economic welfare calculated using (10) for outputs for the incumbent and entrant associated with the component price P_R

14 This division between fixed/variable and between the two components is motivated by the Postal case, with component 0 denoting collection and trunking, 1 being distribution.

15 With linear demand functions, both own price and cross price elasticities vary depending upon the equilibrium solution The reported measure of cross price elasticity is that associated with the incumbent producing both products, setting a uniform final product and just achieving its target profitability, i e as in benchmark B1

16 This gives an indication of the extent to which entry 'expands the market' (it is a crude index since it ignores the fact that the products are not homogenous) Space considerations preclude reporting final product prices and outputs

17 Estrin and de Meza (1989, 1991) discussed entry under Cournot and Bertrand Competition (without component pricing), and on examining a wide range of parameter sets, concluded that in most cases entry was welfare beneficial—but this was relative to benchmark B2 The alternative benchmark B1 introduced in this paper would have changed this conclusion in many cases. It is also true that their conclusions are radically altered if Stackelberg entry is deemed to be relevant, as was noted by Dobbs and Richards (1991) We have examined the Stackelberg version of their model in the context of their parameter sets and found that entry occurred in all cases, and furthermore, in all cases, welfare was *reduced* by entry)

18 Recall that the welfare optimal component price is conditional on entry; clearly overall it is 'optimal' to set a sufficiently high price to exclude entry (which returns welfare to one of the benchmark cases)

19 In contrast to Rogerson and Takis (1991), who suggest the economies of scale and scope are rather widespread across the Postal system, as in Table 1.

20 Naturally, it is possible to choose other parameter sets where entry is welfare improving The analysis presented here however suffices to establish that entry is by no means certain to be welfare improving

21 The idea that welfare optimal pricing when there is imperfect competition (e g monopoly) elsewhere in the economy may involve subsidies is of course both intuitive and well known; imperfect competition tends to restrict output below that which is socially desirable, the subsidy helps to correct for this (see Laffont and Tyrole, 1993 253, for example).

22 In addition, of course, to its likely impact on the incumbent's operating efficiency (the 'galvanising' effect) and the sustainability of its current pricing policies (such as, for the Letters Business, uniform spatial pricing when face with cream skimming by entrants)

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