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Ramsey Pricing and Competition: The Consequences of Myopic Regulation[1]

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Abstract
This paper addresses the welfare consequences of applying the Ramsey rule when the regulated firm is not a monopolist in all of its markets. The partially regulated optimum and the outcome of myopic regulation, the "Short-Sighted Ramsey Equilibrium" (SSRE), are examined in a differentiated duopoly model. In the optimum, the markup of competitive substitute goods is relatively high. In the SSRE, the regulator is likely to set the price of competitive substitute goods lower than optimal, and complementary goods higher than optimal. Strategic reactions by a competitor may reverse the result.

1. Introduction

When a regulator must set prices for a multi-product natural monopolist and is not allowed to subsidize the firm, it maximizes social welfare by setting prices according to the well-known Ramsey rule (Ramsey 1927, 47-61; Baumol and Bradford 1970, 265-283). Current rate proposals are often inspired by the Ramsey rule, even when the regulated firm faces unregulated rivals. For example, Baumol and Sidak (1994, 39) note that Ramsey pricing analysis plays a significant and growing role in telecommunications regulation. GTE, Pacific Bell, and other local exchange carriers have recently petitioned to lower prices for services also provided by competitors (such as intra-LATA toll calls) and to raise the price of basic phone service, of which they are the sole provider. To justify the price shift the firms typically argue that demand for services that face competition is highly elastic because consumers can switch to other providers.[2] Underlying such arguments is an appeal to the traditional Ramsey rule—but using the elasticities for the firm's demand (which reflect the degree of competition the firm faces) instead of the market elasticities (i.e., the elasticities faced by a monopolist without competition).

1 I thank Kenneth Train, Michael Crew (the editor), seminar participants at the University of California, Berkeley, and an anonymous referee for comments and suggestions. The usual disclaimer applies.
2 Hartman and Naqvi (1994, 197-220) found that price elasticities for a single firm in the competitive long-distance calling market were as high as 28.8.

The question of myopic regulation is not merely academic; a supposedly "revenue neutral" price change in 1995 resulted in a $120 million loss of profit for Pacific Bell's parent company.[3] This paper addresses the welfare consequences of applying the Ramsey rule using the firm's elasticities when the traditional assumption that the regulated firm is a monopolist in all of its markets is violated. Early literature, examining models in which a regulated firm faces a competitive fringe, appears to show that competition does not alter the optimality of Ramsey pricing (Braeutigam 1979, 38-49). However, later work demonstrates that the invariance of the Ramsey rule with respect to competition depends crucially upon the assumption that competitors wield no market power (Sherman and George 1979, 685-695; Braeutigam 1984, 127-134; Ware and Winter 1986, 87-97; Mitchell and Vogelsang 1991; Laffont and Tirole 1993, 247-272; Biglaiser and Ma 1995, 1-19).

The approach in the literature has been to determine how the Ramsey rule must be modified to reflect various competitive and informational structures. A common finding is that the optimal markup is greater for goods facing competition from substitutes than for those produced by a regulated firm alone. This result is robust to the specification of the problem, and holds both for partial regulation (Sherman and George 1979, 685-695; Ware and Winter 1986, 87-97) and for total regulation (Braeutigam 1984, 131). From this finding, some authors have inferred that a myopic regulator sets the price of a good facing competition from unregulated substitutes too low (e.g., Sherman and George (1979, 690)). However, the finding stated above compares the optimal markups of goods facing competition with the optimal markups of goods not facing competition, and does not compare the optimal markup of a good facing competition with the *myopic* markup of the same good. This distinction has not been made clear. To extend the result to "myopic" regulation, in which a regulator applies the traditional Ramsey rule to the dominant firm despite the presence of rivals, requires proof which the literature has not supplied. To correct this omission and to formalize the analysis I describe the myopic regulator's decision-making process with the Short-Sighted Ramsey Equilibrium (SSRE), which enables direct comparison of the optimal markups with those chosen by a myopic regulator.

The main conclusion of this paper is that for the case of goods with unregulated substitutes a myopic regulator is likely to set prices too low, whereas in the case of unregulated complements the prices are likely to be set too high. The results mainly confirm the suggestions in the literature but uncover the potential for strategic reactions by a competitor to reverse the result. The conclusion holds generally when the competitor does not respond to the dominant firm's prices but requires additional assumptions when the competitor responds strategically to the regulator's actions.

I examine a differentiated duopoly model of a dominant firm facing an unregulated rival. The regulator first sets prices for the dominant firm, and then a competitor sets its price. This model captures the main features of the telecommunications market, where the unregulated firms are able to adjust their prices quicker than the regulated firms. The model is similar to that of Ware and Winter (1986, 87-97), with sequential rather than simultaneous competition. Section 2 introduces the model and section 3 examines its partially regulated social optimum as a benchmark. Section 4 introduces the SSRE and considers a regulator who sets

3 Leslie Cauley, "Pacific Telesis Earnings Fell 12% in Fourth Quarter," *Wall Street Journal*, B4(E), January 19, 1996.

prices myopically using the traditional Ramsey rule, the results of which are discussed in section 5. Section 6 concludes and an appendix provides proofs and additional propositions to which the text refers.

2. The Model

Consider a regulated dominant firm that is a monopolist in one market and faces competition from an unregulated rival in a second market. Competition in the second market is imperfect since consumers differentiate their demand for the products or services of the firms.[4] Assume that the dominant firm's rival has market power of its own in the second market and prices above cost. As depicted in figure 1, the regulated firm (hereafter the "dominant firm") produces good x_1 in market A by itself, say due to scale economies that render the market a natural monopoly. The dominant firm also produces good x_2 in market B, where a rival produces good x_r. Prices for the dominant firm's goods, p_1 and p_2, are set by the regulator according to a possibly non-binding minimum-profit constraint (hereafter assumed to be a zero-profit constraint). The rival is assumed to set price p_r of good x_r as a Stackelberg follower: it takes the prices charged by the dominant firm as fixed and chooses its own price to maximize profit. For comparison, I also examine the case where the rival does not respond to the regulator's actions.

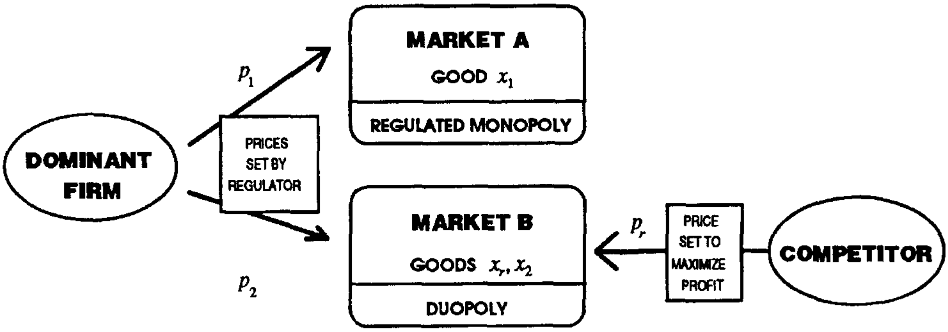

Figure 1. A Simple Model of a Multi-Market Regulated Firm Facing Competition

Assume that the demand in market A for x_1, $D_1(p_1)$, is independent of demand in market B. Let $D_2(p_2, p_r)$ and $D_r(p_2, p_r)$ be the demand functions for x_2 and x_r, respectively. Demand is differentiated in market B, so that the cross-price elasticities between x_2 and x_r are non-zero. The rivals' goods may be imperfect gross substitutes for one another, so that, for $i,j = 2,r$,

4 Services like intra-LATA toll calls offered by different carriers are not perfectly substitutable. For example, often a caller must dial an access code to bypass the primary carrier, causing consumers to strongly prefer the primary carrier (Hartman and Naqvi 1994, 197-220). Services are also differentiated through firm reputation, delays in initiation of service following subscription, and service bundling (e.g., counting intra-LATA calls toward a threshold monthly expenditure level as part of a promotional plan offered by a long distance carrier) (Tardiff 1995, 353-366).

$$0 < \frac{\partial D_i}{\partial p_j}(p_2, p_r) < \infty \tag{1}$$

although some results will be stated for complements, which require the opposite inequalities in (1). Demand for each good is downward sloping in its own price and wealth effects are assumed to be absent. The cost functions of the firms are

$$C_d(x_1, x_2) = F_1 + F_2 + V_1(x_1) + c_2 x_2$$

$$C_r(x_r) = F_r + c_r x_r$$

for the dominant firm and rival, respectively, where F_i is a positive fixed cost required to produce x_i and $V_1(x_1)$ is a variable cost function such that the conditions for a natural monopoly are met in market A. Fixed and marginal costs are separable in each good (the dominant firm's goods are independent in production) and marginal costs for x_2 and x_r are constant for simplicity.

3. The Partially Regulated Optimum

If the regulator has information on all demands and costs, he or she can maximize total welfare by choosing prices for the dominant firm subject to the condition that the firm earn non-negative profit. The solution is the partially regulated optimum, termed the Partially Regulated Second Best (PRSB) by Braeutigam (1979, 38-49). Since telecommunications regulators usually have authority over only a single firm in any particular region, the partially regulated optimum is the relevant benchmark, not the first best (which requires subsidies to the firms) or the totally regulated second best (which requires authority over all firms).

The rival responds strategically to p_2, choosing p_r to solve

$$G(p_2, p_r) \equiv \frac{\partial \pi_r(p_2, p_r)}{\partial p_r} = D_r(p_2, p_r) + \frac{\partial D_r(p_2, p_r)}{\partial p_r}(p_r - c_r) = 0\,, \tag{2}$$

where $\pi_r \equiv p_r x_r - C_r(x_r)$, the rival's profit function. Equation (2) is the first-order condition (FOC) for profit maximization given p_2. Assume that $\pi_r(p_2, p_r)$ is concave in p_r for all p_2. Given concavity, (2) is both necessary and sufficient for an interior solution (all solutions will be assumed to obtain at non-zero prices). Total welfare in this model is taken to be the sum of consumer surplus and producer profits. Therefore, total welfare W is

$$W \equiv CS(p_1, p_2, p_r) + \pi_d(p_1, p_2, p_r) + \pi_r(p_2, p_r)\,, \tag{3}$$

where π_d is the dominant firm's profit from x_1 and x_2 and CS is the total consumer surplus generated by all three goods. That is,

$$\pi_d(p_1, p_2, p_r) \equiv \sum_{i=1}^{2} p_i x_i - C_d(x_1, x_2), \text{ and}$$

$$CS(p_1, p_2, p_r) \equiv CS_1(p_1) + CS_2(p_2, p_r) + CS_r(p_r) \tag{4}$$

$$= \int_{p_1}^{\infty} D_1(p)dp + \int_{p_2}^{\infty} D_2(p, p_r)dp + \int_{p_r}^{\infty} D_r(\infty, p)dp \tag{5}$$

so that $\partial CS/\partial p_i = -x_i$ for $i = 1, 2, r$, as usual.[5]

The partially regulated optimal price vector, (p_1^*, p_2^*), is the solution to

$$\max_{p_1, p_2, p_r \in R_+^3} CS(p_1, p_2, p_r) + \pi_d(p_1, p_2, p_r) + \pi_r(p_2, p_r) \text{ s.t. } \pi_d \geq 0 \text{ and } G(p_2, p_r) = 0, \quad (6)$$

where $G(\cdot)$ captures the rival's strategic response to p_2, as defined in equation (2). The solution can be characterized by a modification of the Ramsey equations.

Proposition 1 (P1): The solution to (6), (p_1^*, p_2^*), necessarily satisfies

$$L_1\varepsilon_1 = \frac{\mu}{1+\mu} \text{ and} \quad (7)$$

$$L_2\varepsilon_2\left[1 - \frac{\eta\varepsilon_{2r}}{\varepsilon_2}\right] - \frac{1}{1+\mu}L_r\varepsilon_{2r} = \frac{\mu}{1+\mu} \quad (8)$$

where L_i is the Lerner index[6] for good i, ε_{ij} is the cross-price elasticity of x_i with respect to p_j,[7] η is the "strategic price elasticity" (the elasticity of the rival's price reaction: $\eta \equiv [dp_r/dp_2]/[p_r/p_2]$), and μ is the multiplier associated with the profit constraint.

P1 reveals why traditional Ramsey pricing goes astray when the competition has market power. In the familiar version of the Ramsey rule, the left hand side of (8) is merely $L_2\varepsilon_2$. Note that when there is no competing good (so that $\eta = \varepsilon_{2r} = 0$) equation (8) reduces to standard Ramsey form. Under certain conditions we can pinpoint the direction of the departure of the markups from the Ramsey rule.

Proposition 2 (P2): At the partially regulated optimum, if the goods in market B are substitutes, if $p_2^* > c_2$, and if $\eta > 0$ (i.e., the goods in the competitive market are strategic complements),[8] then $L_2\varepsilon_2 > L_1\varepsilon_1$.

The conclusion of P2 is a common finding in the literature on competitive Ramsey rules. However, if the competing goods are strategic substitutes the conclusion need not hold in this model. Thus strategic reactions complicate a result that is unambiguous in other models. For example, in Braeutigam's (1984, 127-134) Viable Firm Ramsey Optimum (a form of

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5 Note there is some leeway in specifying consumer surplus, since the only conditions that must be satisfied are $\partial CS/\partial p_i = -x_i$ for all i and the boundary condition $CS(\infty, \infty, \infty) = 0$. The equality of the cross-partial demand derivatives (following from the assumed lack of income effects) thus allows the arguments of the last two integrands of (5) to be reversed, with CS_2 being a function of p_2 alone. However, in section 4 the regulator will treat p_r as exogenous, and may be able to estimate $D_2(p_2; p_r)$, i.e., demand for x_2 conditioned on p_r, but not the counterfactual $D_2(p_2, \infty)$. Defining CS as in (5) allows $CS_1 + CS_2$ to be the short-sighted regulator's objective function below without respecification.

6 The Lerner index is defined as the ratio of the profit margin and the price: $L_i \equiv (p_i - c_i) / p_i$.

7 Elasticity is defined to be $\varepsilon_{ij} \equiv [\partial D_i/\partial p_j] / [x_i/p_j]$ and $\varepsilon_i \equiv -\varepsilon_{ii}$.

8 The term was coined by Bulow, Geanakoplos, and Klemperer (1985). Formally, two goods are strategic complements (substitutes) if the *marginal* profitability of one good in its own price increases (decreases) as the quantity of the other good rises. When the profit function is concave in own-price, then the sign of marginal profitability is also the sign of dp_r/dp_2, and therefore of η. The role of strategic complementarity in the present model is examined in the next section.

total regulation in which the regulator maximizes welfare respecting a break-even constraint for each firm), the product of markup and elasticity is *always* higher on goods in competitive markets.[9] Ware and Winter (1986, 87-97) also found that the product of markup and elasticity is always higher on rival substitutes in the simultaneous move version of the present model.[10] P2 shows that their result depends on simultaneity of price-setting, an unrealistic assumption for the industries considered here.

Strategic reactions can nullify P2 through another channel as well. P2 requires x_2 to be priced above cost, which need not be the case here, even though in traditional Ramsey analysis substitutes are always marked up. If the market B goods are strong strategic complements, the bracketed term in (8) may be negative, requiring a price below cost to preserve equality. A similar result may obtain when goods are conventional complements in traditional Ramsey analysis (e.g., Crew and Kleindorfer (1980)). Thus strategic complementarity can lead to pricing rules similar to those for conventional complements, even though the goods are substitutes. In such cases, even when demand interdependencies with a rival are recognized, ignoring the strategic reaction will lead the myopic regulator astray. Allowing cross-elasticities in market B but taking p_r to be fixed causes the term involving η to drop out of (8), so that x_2 always has a positive markup if x_r does, even if the optimal markup should be negative.

4. Short-Sighted Ramsey Pricing

What happens when the regulator applies the traditional Ramsey rule using the regulated firm's elasticities of demand, perhaps due to the belief that it is the best thing to do under the circumstances? It is tempting to infer from P2 that the regulator following the Ramsey rule necessarily sets the price of the good with competitive substitutes too low. However, this does not follow from the proposition. P2 is a comparison between markups at the optimum, not a comparison between the markup of the competitive good under optimal and myopic regulation. This section shows that under "short-sighted" Ramsey pricing, the regulator will indeed most likely set the price of x_2 lower than is socially optimal when the competing good is a substitute. The opposite result holds for complements.

To motivate the concept of "short-sightedness", one can imagine that a regulator might attempt to apply the traditional Ramsey rule by estimating price elasticities for the dominant firm's goods as functions of their own prices and exogenous demand shifters, including the price of rival goods.[11] Such behavior is short-sighted in the present model because it treats the rival's price as exogenous, when in reality the rival's price is endogenous to the problem.

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9 As long as the break-even constraint binds on the competitor, that is. See principle 4 of Braeutigam (1984, 127-134).

10 Their proposition 2.

11 Such behavior appears to describe the recent actions of telecommunications regulators. The California Public Utilities Commission approved a 44% decrease in the toll prices of Pacific Bell, who began facing competition for local toll calls January 1, 1995. This largest price cut in PacBell's history was offset by a 35% increase in the rates for basic phone service, an adjustment described as "revenue neutral." Apparently CPUC envisioned moving along a fixed-profit locus in the direction of Ramsey prices. PacBell in fact saw revenues drop 2% and profit 8%, evidence that perhaps CPUC had not accounted for the strategic responses of competitors.

I define a *short-sighted planner* to be one who fails to account for the feedback effect on the dominant firm's profit of the rival's strategic reaction. The short-sighted planner also includes neither the surplus nor the profit generated by sales of the rival's good in his or her analysis (other possible forms of myopia are discussed in the conclusion). Thus, a short-sighted planner seeks to maximize the benefits to consumers of the dominant firm's goods, doing so by holding the profit of the dominant firm at the break-even point (as in the traditional Ramsey problem), treating p_r as a parameter. Formally, the problem of the short-sighted regulator is to solve the program

$$\max_{p_1, p_2 \in R_+^2} CS_1\left(p_1\right) + CS_2\left(p_2; p_r\right) \text{ s.t. } \pi_d\left(p_1, p_2; p_r\right) = 0. \tag{9}$$

Notice that the consumer surplus generated by the sale of the dominant firm's output in market B is calculated *given the price of the other firm's output.* Surplus from x_2 is a function of both p_2 and p_r in the competitive market, although the short-sighted regulator does not acknowledge the interdependency between the two.

Assume that market B is in *Short-Sighted Ramsey Equilibrium* (SSRE): the prices are a vector (p_1^R, p_2^R, p_r^R) such that (p_1^R, p_2^R) solves (9) given p_r^R and that $G(p_2^R, p_r^R)=0$. In words, the rival sets its price to maximize its profit given the dominant firm's prices, and consumer surplus from the dominant firm's goods is maximized (subject to the profit constraint) given the price that the rival charges. [12] The SSRE is not socially optimal in any sense; it is not second best or even a partially regulated third best. By adjusting the prices under its control, the regulator can make consumers collectively and both firms individually better off.

To demonstrate that the SSRE is not a partially regulated social optimum, consider the following experiment: starting from (p_1^R, p_2^R, p_r^R), let the regulator raise the price of x_2 and lower the price of x_1 a marginal amount so that the zero profit constraint still holds (given p_r^R). The regulator is thus moving along the line tangent to the zero-profit locus at the SSRE (see figure 2). By examining the welfare effect of this price change, one determines whether p_2^R was too high or too low.

True social welfare in this model is not just the maximand of the short-sighted Ramsey pricing problem in (9), but includes the profits of the firms and the surplus of the rival's customers. To examine the welfare impact of the price change, differentiate (3) with respect to p_2 (treating p_1 and p_r as functions of p_2):

$$\frac{dW}{dp_2} \equiv \frac{dCS_1(p_1)}{dp_1}\frac{dp_1}{dp_2} + \frac{\partial CS_2(p_2, p_r)}{\partial p_2} + \frac{\partial CS(p_1, p_2, p_r)}{\partial p_r}\frac{dp_r}{dp_2} + \frac{d\pi_d(p_1, p_2, p_r)}{dp_2} + \frac{d\pi_r(p_2, p_r)}{dp_2} \tag{10}$$

where each term is understood to be evaluated at (p_1^R, p_2^R, p_r^R). As usual, d's denote total derivatives and ∂'s denote partial derivatives.

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12 Formally, one obtains the SSRE by obtaining parametric solutions to (9), $p_1(p_r)$ and $p_2(p_r)$, and then obtaining p_rR as a fixed point of the function $\Gamma(p_r) \equiv G(p_2(p_r), p_r) + p_r$. The pair ($p_1$R, p_2R) is then ($p_1(p_r$R), $p_2(p_r$R)).

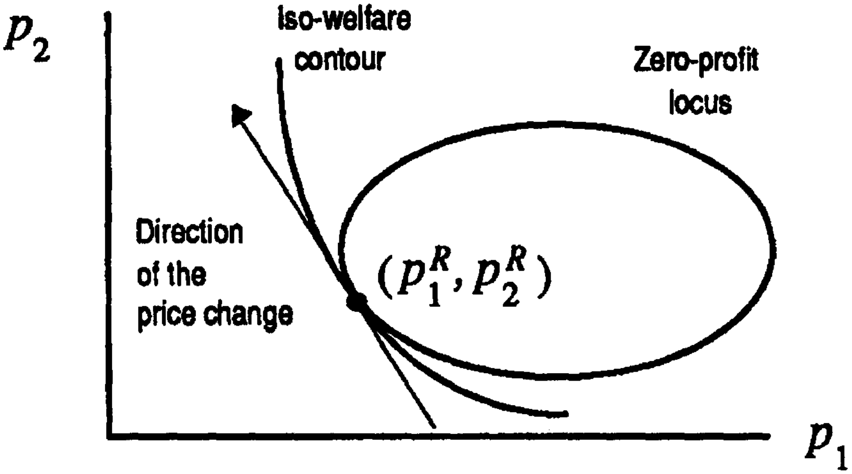

Figure 2. Illustration of the Price Change

The first two terms sum to zero from the first-order condition of (9). Note that the price change has no direct effect on CS_r, since by definition p_2 does not enter into CS_r [see (4) and (5)]. In the first part of the third term, we have $\partial CS/\partial p_r = -x_r$. The fourth term, the effect of the price change on the dominant firm's profit, consists entirely of the indirect effect from the change in p_r. The direct effect on the dominant firm's profit is zero since the price change was subject to the zero-profit constraint. For the final term, note that since the rival's price maximizes its profit, we need consider only the direct effect of p_2 on π_r by the envelope theorem. Thus (10) reduces to

$$\frac{dW\left(p_1^R, p_2^R, p_r^R\right)}{dp_2} = -x_r \frac{dp_r}{dp_2} + \frac{\partial \pi_d}{\partial p_r}\frac{dp_r}{dp_2} + \frac{\partial \pi_r}{\partial p_2} \tag{11}$$

for all price changes along the zero-profit locus at the SSRE. For convenience, the first term on the right hand side will be called the "surplus effect," the second term the "strategic profit effect," and the final term the "direct profit effect." Using the notation from the previous section, we have

$$sgn\left(\frac{dW}{dp_2}\right) = sgn\left(\frac{\varepsilon_{r2}}{\varepsilon_r} + \eta\left[L_2\varepsilon_{r2} - 1\right]\right) \tag{12}$$

Before looking at (12) for the present model, it will be instructive to consider the simpler case in which there is no strategic reaction to the regulated prices. In that case, η is zero and the sign of (12) is determined by the first term. Thus when the goods in market B are substitutes, welfare increases as p_2 rises, whereas for complements it decreases (provided D_r is not perfectly elastic). Similar claims have been made in the literature about the myopic outcome (e.g. Sherman and George (1979, 690)) arguing from the FOCs of the optimum. Indeed, when η is zero the FOCs (7) and (8) do lead to condition (12).

However, although the informal FOC approach is confirmed in this special case, it is not valid in the more general model. Suppose that one were to try to sign (11) from the FOC (8) when η is non-zero. In this case the FOC approach leads to a condition that may be either weaker or stronger than the true condition, (12) (see P5 in the appendix). Thus, one must examine the SSRE or risk falsely concluding that p_2 is too high or too low.

For the more general case where η is non-zero, the sign of (11) is indeterminate without additional assumptions. In particular, the sign of the surplus effect depends on whether the market B goods are strategic complements or substitutes, the sign of the direct profit effect depends on whether they are conventional complements or substitutes, and the strategic profit effect depends on both interdependencies. Thus the sign of (11) cannot be determined in general, although it will typically be non-zero. However, for an important class of demand functions, the direction of the welfare change depends only on whether the goods are conventional complements or substitutes.

Consider the class of functions

$$D_i\left(p_2, p_r\right) \equiv \begin{cases} (\alpha_i - \beta_i p_i^{\lambda} + \gamma p_j^{\lambda})^{1/\lambda} & \text{for } \lambda \in (0,1] \\ e^{\alpha_i} p_i^{-\beta_i} p_j^{\gamma} & \text{for } \lambda = 0, \end{cases} \tag{13}$$

where α, $\beta > 0$, and $2\beta\left(p_i^R\right)^{\lambda} > \alpha_i + \gamma(p_j^R)^{\lambda}$ for $i = 2,r$, and $j \neq i$, so that each firm's profit function is locally concave in its own price at the SSRE. [13] This is the Box-Cox family of demand functions, familiar in applied work, in which λ parameterizes the curvature of the demand function. Polar cases comprise linear demand when $\lambda = 1$ and iso-elastic demand when $\lambda = 0$, so that by varying λ one obtains an approximation to any demand function that is "between" linear and iso-elastic. The sign of γ determines whether the goods are substitutes or complements. For this family of demand functions, we have

Proposition 3 (P3): For any pair of demand functions for x_2 and x_r that are members of the family of functions specified in (13), the direct profit effect outweighs the surplus effect, so that (11) is positive for substitutes and negative for complements. Furthermore, the goods are strategic complements if they are substitutes and strategic substitutes if they are complements.

Thus, the price change has increased welfare for substitutes and decreased welfare for complements, so that the SSRE cannot be an optimal price vector even in the sense of the second or third best. P3 shows that the results from the special case where η is zero continue to hold for this class of demand functions even when η is non-zero. It is necessary to restrict the class of demand functions because substitution or complementarity alone are not enough to determine the sign of (11). For example, from (12) we see that even when the goods are substitutes and strategic complements, the first term could still be negative and could outweigh the second, leading to a result opposite to that of P3. The indeterminacy comes from the higher-order cross-price demand effects embodied in η. When the non-linear cross-price effects are small enough, the direct profit effect dominates (11). The Box-Cox demand functions have small enough second-order effects that this condition is met. While

13 For $\lambda = 0$, the inequality can be replaced with the simpler condition $\beta_i > 1$, which ensures global own-price concavity.

the restriction on the class of demand functions is arbitrary, specification testing in any particular market can determine its validity case by case.

What then is the role of strategic complementarity and substitution in determining whether prices are too high or too low? Although in general knowing the direction of the strategic reaction is neither necessary nor sufficient to determine the sign of (11), the next proposition shows that the strategic effects are nonetheless closely linked to the direction of the welfare change:

Proposition 4 (P4): For substitutes,[14]

- if $D_r(p_2^R, p_r)$ is concave in p_r, then strategic complementarity is sufficient for (11) to be positive; and
- if $D_r(p_2^R, p_r)$ is convex in p_r, then strategic complementarity is necessary for the direct profit effect to outweigh the surplus effect.

The proof of P4 shows that the strategic reaction and the sign of (11) are linked because when the non-linear cross-price effect is small enough, first, substitutes are strategic complements, and second, substitution implies that (11) is positive. Thus, although strategic complementarity does not "cause" p_2 to be too low, it will tend to be correlated with that result.

5. Winners and Losers

Moving away from the SSRE with the price change examined above is not Pareto improving. When goods in market B are substitutes, for example, consumers face higher prices for both goods after the price change, even though total welfare increases. The price change translates the lost surplus from market B into higher surplus in market A and more profit for the two firms. Since the strategic profit effect is positive (in the case of strategic complementarity), the regulated firm enjoys positive profit after the price change. Since the rival restricts quantity due to its market power, the regulator stimulates consumption of the rival's good by raising p_2. The dominant firm earns profit as a by-product of the price shift. The regulator can mitigate the loss of surplus of the consumers in market B if it can transfer some or all of the dominant firm's profit to them.

If the regulator is susceptible to political pressure, then we would expect that consumers in the captive market and both firms would lobby to move away from short-sighted Ramsey pricing. This is a curious result, given that it is the regulated firms who advocate Ramsey pricing in the current arena, as noted in the introduction. The firms most likely are starting from a disadvantaged position, so that the SSRE is a step in the right direction. Before divestiture AT&T traditionally charged higher prices on toll calls to subsidize basic phone service. The toll calling markets are now opening to competition, and many Baby Bells find themselves saddled with high prices on toll calls. These prices would fall in the SSRE and allow the Bells to compete more vigorously with the newcomers.

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14 The conditions change slightly for complements.

As the competition in market B increases, one would expect that the SSRE would move closer to the partially regulated optimum, given Braeutigam's (1979, 38-49) result that the two coincide when the rival supplies at cost. A task for future research is to derive this result from a formal model of oligopolistic competition. The relevant question in any particular case is whether or not the rival in market B has market power. If it does not, then the price change described above will not affect welfare, since all terms in (11) are then zero.

6. Conclusion

This paper has examined Ramsey pricing in the context of a dominant firm enjoying monopoly position in one market and facing an unregulated rival in another market. In the benchmark case of the partially regulated optimum, the regulator does best to follow the traditional Ramsey rule if the competitors to the regulated firm wield no market power. If, however, one of the competitors is also a price-setter, then strategic considerations render the Ramsey rule suboptimal. A modified Ramsey rule for this case requires not only information about price elasticities of the goods, but also about the expected pricing response of the competitor. The regulator adjusts the prices under its control to stimulate consumption of the competitor's good, which is restricted due to the competitor's market power. If the competing substitute goods are strategic complements and the regulated good facing competition is priced above cost, then the dominant firm's markup on its competing good is greater than that on the monopoly good. Strong strategic effects between the substitutes, however, can lead to pricing below marginal cost, a result previously found only for complements.

This paper extends the literature by providing a tool to examine myopic regulation, the Short-Sighted Ramsey Equilibrium. The SSRE is sub-optimal by any measure. When the competitor does not respond to the regulated prices, ignoring the interdependencies between goods leads to a lower than optimal price for the regulated good with substitutes and a higher than optimal price with complements. This confirms a result posited in the literature. When the rival does respond strategically to the regulator, the same results hold whenever demand is of the Box-Cox form. The result need not hold, however, under other conditions; I find that strategic reactions complicate a previously unambiguous result.

There are two other potential forms of myopic regulation in this model. In the first, the regulator recognizes the interdependencies between the goods in market B and includes the surplus of all consumers in the welfare criterion while still ignoring the profit and strategic reaction of the rival. In the second, the regulator includes the rival's profit but still ignores the strategic interdependency between the goods. Of the two, the first is probably the most relevant to the telecommunications example discussed in the introduction, where state regulators have a public mandate to protect consumers but not the profits of unregulated firms. In this case, however, all of the results discussed above carry though exactly. As formulated here, the prices of the regulated goods do not enter into the consumer surplus of the rival's customers [see (4)], so adding CS_r to the maximand in (9) does not alter the solution. The second form of myopia leads to indeterminacy in most results even with strong assumptions, so that to compare optimal markups with myopic ones requires case-by-case scrutiny.

In actual regulatory decisions the Ramsey rule is used more qualitatively than quantitatively. Baumol and Sidak (1994, 39) state that although Ramsey-pricing analysis plays a significant and growing role in telecommunication regulation, it is "unlikely to determine the actual magnitudes of regulated pricing." If this is indeed the case, then the lesson for regulators here should be stated in broad terms: when the regulated firm faces a competitor offering substitutes, prices of competing goods generally should not be set as low as in the case of a pure monopoly; when the competitor offers complements, prices of competing goods generally should not be set as high as in the pure monopoly case.

Appendix

Proof of Proposition 1

The second constraint in (6) implicitly defines p_r as a function of p_2. After substituting $p_r(p_2)$ for p_r into the maximand, the associated Lagrangian is

$$\begin{aligned}\mathscr{L}(p_1, p_2, \mu) &= CS(p_1, p_2, p_r(p_2)) + p_r D_r(p_2, p_r(p_2)) - C_r(D_r(p_2, p_r(p_2))) \\ &+ (1+\mu)[p_1 D_1(p_1) + p_2 D_2(p_2, p_r(p_2)) - C_d(D_1(p_1), D_2(p_2, p_r(p_2)))] .\end{aligned}$$

Assuming the solution obtains at positive prices, the Kuhn-Tucker necessary conditions imply that $\partial\mathscr{L}(p_1^*, p_2^*, \mu^*)/\partial p_i = 0$, for $i = 1, 2$. When evaluated at (p_1^*, p_2^*, μ^*), we have:

$$\frac{\partial\mathscr{L}}{\partial p_2} = -x_2 + (1+\mu)\left[x_2 + (p_2 - c_2)\frac{dx_2}{dp_2}\right] + (p_r - c_r)\frac{dx_r}{dp_2} + x_r\frac{dp_r}{dp_2} = 0 ,$$

where $\frac{dx_r}{dp_2} = \frac{\partial x_r}{\partial p_2} + \frac{\partial x_r}{\partial p_r}\frac{dp_r}{dp_2} = \frac{x_r}{p_2}(\varepsilon_{r2} - \varepsilon_r\eta)$ and $\frac{dx_2}{dp_2} = \frac{\partial x_2}{\partial p_2} + \frac{\partial x_2}{\partial p_r}\frac{dp_r}{dp_2} = \frac{x_2}{p_2}(\eta\varepsilon_{2r} - \varepsilon_2)$.

We have

$$\frac{\partial\mathscr{L}}{\partial p_1} = 0 \quad \Rightarrow \quad L_1\varepsilon_1 = \frac{\mu}{1+\mu} , \tag{7}$$

Making use of the integrability condition ($\partial x_2/\partial p_r = \partial x_r/\partial p_2$; allowable since there are no wealth effects), some algebra leads to

$$L_2\varepsilon_2\left[1 - \frac{\eta\varepsilon_{2r}}{\varepsilon_2}\right] - \frac{1}{1+\mu}\frac{\varepsilon_{2r}}{\varepsilon_r} = \frac{\mu}{1+\mu} . \tag{14}$$

A Stackelberg follower sets $L_r = 1/\varepsilon_r$, so (14) is equivalent to (8).

Proof of Proposition 2

Continuing from the previous proof, (7) and (14) imply that

$$L_2\varepsilon_2 - L_1\varepsilon_1 = \frac{1}{1+\mu}\frac{\varepsilon_{2r}}{\varepsilon_r} + \eta L_2\varepsilon_{2r}. \tag{15}$$

Another of the Kuhn-Tucker conditions is that μ is ≥ 0. Thus (15) is positive under the assumptions.

Proof of Proposition 3

We have

$$\frac{\partial^2 \pi_r}{\partial p_2 \partial p_r} = \frac{\partial D_r}{\partial p_2} + (p_r - c_r)\frac{\partial^2 D_r}{\partial p_2 \partial p_r}$$

$$= \frac{\partial D_r}{\partial p_2} + \frac{p_r}{\varepsilon_r}\frac{\partial^2 D_r}{\partial p_2 \partial p_r}, \tag{16}$$

making use of (2). For $\lambda \in (0,1]$, (16) reduces to $\lambda\gamma(x_r/p_2)^{1-\lambda}$, the sign of which is determined by γ. For $\lambda = 0$, we have $\partial^2\pi_r/\partial p_2\partial p_r = 0$. Since π_r is locally concave in p_r at the SSRE by assumption, $\partial^2\pi_r/\partial p_2\partial p_r \geq 0$ for substitutes implies that x_2 and x_r are strategic complements, and $\partial^2\pi_r/\partial p_2\partial p_r \leq 0$ for complements implies that they are strategic substitutes (see note 7). To prove that the direct profit effect outweighs the surplus effect, note first that for $\lambda = 0$, we have

$$-x_r\frac{dp_r}{dp_2} = x_r\frac{\partial^2\pi_r}{\partial p_2\partial p_r}\bigg/\frac{\partial^2\pi_r}{\partial p_r^2}. \tag{17}$$

by applying the Implicit Function Theorem to (2). But the numerator is zero, as shown above, so that the surplus effect is zero.

For $\lambda \in (0,1]$, the sum of the surplus effect and the direct profit effect is

$$-x_r\frac{dp_r}{dp_2} + \frac{\partial\pi_r}{\partial p_2} = x_r\frac{\partial^2\pi_r}{\partial p_2\partial p_r}\bigg/\frac{\partial^2\pi_r}{\partial p_r^2} + \frac{\partial\pi_r}{\partial p_2} \tag{18}$$

$$= \frac{\varepsilon_{r2}p_r x_r}{\varepsilon_r p_2}\left[\frac{(\varepsilon_r - 1) + \lambda}{(\varepsilon_r - 1) + \lambda + \lambda\varepsilon_r}\right], \tag{19}$$

after some algebra. Since $\lambda > 0$ and $\varepsilon_r > 1$ (a Stackelberg follower, like a monopolist, always produces in the elastic region of demand), all terms in (19) are positive, except possibly ε_{r2}. Thus, the sign of (19) is governed by the sign of ε_{r2}, proving the proposition.

Proof of Proposition 4

To have $\eta > 0$ requires that the numerator of the RHS of (17) be negative, since the assumed concavity of π_r in p_r assures that the denominator is negative. Thus, we have

$$\eta > 0 \iff (p_r - c_r)\frac{\partial^2 x_r}{\partial p_2\partial p_r} < \frac{\partial x_r}{\partial p_2}. \tag{20}$$

For the direct profit effect to outweigh the surplus effect requires that (18) be positive, or

$$\{\text{direct profit effect} + \text{surplus effect} > 0\} \iff (p_r - c_r)\frac{\partial^2 x_r}{\partial p_2\partial p_r} < A\frac{\partial x_r}{\partial p_2}, \tag{21}$$

$$A \equiv \frac{p_r - c_r}{x_r}\left(-\left[(p_r - c_r)\frac{\partial^2 x_r}{\partial p_r^2} + 2\frac{\partial x_r}{\partial p_r}\right]\right) - 1. \tag{22}$$

From (2) and (22), we have

$$A = 1 - \frac{(p_r - c_r)^2}{x_r}\frac{\partial^2 x_r}{\partial p_r^2}.$$

Thus, when $D_r(p_2^R, p_r)$ is concave in p_r, $A > 1$ and (20) is the stricter condition. When $D_r(p_2^R, p_r)$ is convex in p_r, $A < 1$ and (21) is the stricter condition.

Proposition 5 (P5)

The "FOC approach" to determining the direction of the welfare change from adjusting p_2 gives the condition that p_2 is too low if

$$\frac{1}{1+\mu} L_r\varepsilon_{2r} + \eta L_2\varepsilon_{2r} < 0, \tag{23}$$

which is incorrect.

Proof of P5

The approach taken in Sherman and George (1979, 690) to determine the effect of ignoring the interdependencies with the private sector is to look at the sign of terms involving cross-price effects in the FOCs for the partially regulated optimum. If the terms are positive, then they conclude that p_2 was set too low. Under this approach, (8) implies (23), which cannot be the correct condition because it does not match (12).

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