WHO PAYS AT THE END?

INTERACTION OF NETWORK DIFFERENTIATION AND PRICING POLICY IN TELECOMMUNICATIONS[1]

Keightley Reynolds[2]

RYNKEI001

Supervised by Emanuele Giovannetti

Submitted in February 2007

[1] Submitted to the University of Cape Town in partial fulfillment of a Commerce Masters degree specializing in Economics

[2] Graduate Economics student at the University of Cape Town.

ABSTRACT

The effect of spatial differentiation à la Hotelling on the equilibrium position of the telecommunications industry is investigated. When networks are differentiated and use linear pricing they can charge prices about the Ramsey social optimal. Under both uniform pricing and termination-based price discrimination interconnection fees can be used to support collusion. When networks are located in the same location in a Hotelling model they are perfect substitutes. Prices fall to the Ramsey optimal as they can undercut each other without concern over an access deficit. When a spatially differentiated network enters the industry collusion, through the incumbents' avoidance of an access deficit with the entrant, is restored.

ACKNOWLEDGEMENTS

I wish to thank my supervisor, Emanuele Giovannetti, for his time and patience. I also thank Anthony Leiman for his interest and advice.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

Telecommunication prices in South Africa are notoriously high, despite the presence of five network providers and a regulator, the Independent Communications Authority of South Africa (ICASA). Four of the five networks use termination-based price differentiation. Virgin Mobile, who entered the market in 2006, charges consumers the same price for calls terminating on and off their network. While the high fixed-line prices may be attributed to the network, Telkom, having monopoly power, the high mobile prices are harder to explain. The four mobile providers appear to offer consumers the same service, but consumers are not benefiting as much as hoped from price competition.

In this work I examine the effect of network differentiation on the telecommunication industry equilibrium. The predominant model of the telecommunication industry involves firms which are located at each end of a continuum of consumers, à la Hotelling's spatial differentiation model. The networks are not perfect substitutes and can use high interconnection fees and linear tariffs to sustain high prices. I examine whether both uniform pricing and price discriminating networks can maintain high prices when they are perfect substitutes.

I then briefly consider the impact on social welfare and industry equilibrium of entry by a differentiated network. New entrants are usually welcomed as customers expect price decreases through increased competition. If the entrant offers a differentiated service consumers also expect to benefit from purchasing a service closer to their taste. Entrants may however use differentiation to aid collusion, and solve a Bertrand paradox. I discuss the entry of a differentiated firm into an undifferentiated oligopoly and the impact on social welfare under pricing policies.

I have based my research on prior work by Laffont, Rey and Tirole (1998, 2000) and Armstrong (1998, 2002). Their models both included spatial differentiation as developed by Hotelling. This dissertation is theoretical, although there is some application to the South African market. I employ game theoretic models common to industrial organisation.

The paper is divided into eight sections. In the first section, I will review the seminal literature on the economics of telecommunications. The review includes a detailed explanation of Laffont, Rey and Tirole's model on which mine is based. In the second section my model will be introduced, and explained. In the next two sections I will calculate the oligopoly equilibrium when there is no network differentiation. In the fifth and sixth sections I discuss the effects of entry by a uniform pricing and price-discriminating differentiated network. In the seventh section I apply insights from the model to the current market structure in South Africa. I then conclude.

2. LITERATURE REVIEW

This dissertation is an extension of the work by Laffont *et al* on industrial organization of the telecommunications sector. There are many subdivisions within telecommunication economics. Laffont and Tirole (2000) divide up their book *Competition in Telecommunications* accordingly. Chapters 3 and 4 focus on one way access, but this work is concerned with the work in Chapter 5 (co-authored by Rey) on two-way access. Two-way access occurs when there exist at least two networks and customers from each network want to connect with customers on other networks. More detailed work on two-way access is found in two papers from *The RAND Journal of Economics* that the three co-authored in 1998: "Network Competition: I. Overview and Nondiscriminatory Pricing" and. "Network Competition: II. Price Discrimination". The model included in these papers is the basis of my work, and hence shall be discussed in depth. Armstrong (1998) independently reached the same results as Laffont *et al* and the review includes his supplementing insights.

Laffont *et al* (2000) use a discrete–choice model to illustrate how interconnection fees aid collusion in a duopoly. They then discuss four methods of lessening collusion: build-up of market share, nonlinear pricing, termination-based price discrimination, and reception subsidies. This paper focuses on the impact of uniform prices versus termination based price discrimination within different oligopoly structures, thus it is the focus of this literature review.

To coherently present the arguments and conclusions the literature review is divided up into six sections: interconnection fees and the cost structure; the demand structure and spatial differentiation; uniform pricing and collusion; termination-based price discrimination and collusion; interconnection fees and entry; and the location of my work in relation to the literature.[3]

a. Interconnection Fees and the Cost Structure

Networks charge each other an interconnection (termination) fee every time a call is terminated on their network. When a customer of $Network_1$ calls a customer of $Network_2$, $Network_1$ pays a fee to $Network_2$ to terminate the call. In some countries, including the United States, Canada, China and Mexico, the mobile receiver pays the termination fee when they are called (Lessem, 2005; p3). While this may make some economic sense it impinges on individuals'

[3] While the review may appear lengthy and more detailed than normal, an in-depth understanding of the model presented is essential. By including the analytical details of Laffont, Rey and Tirole's model in the literature review the reader will not mistakenly credit me with any of their contributions.

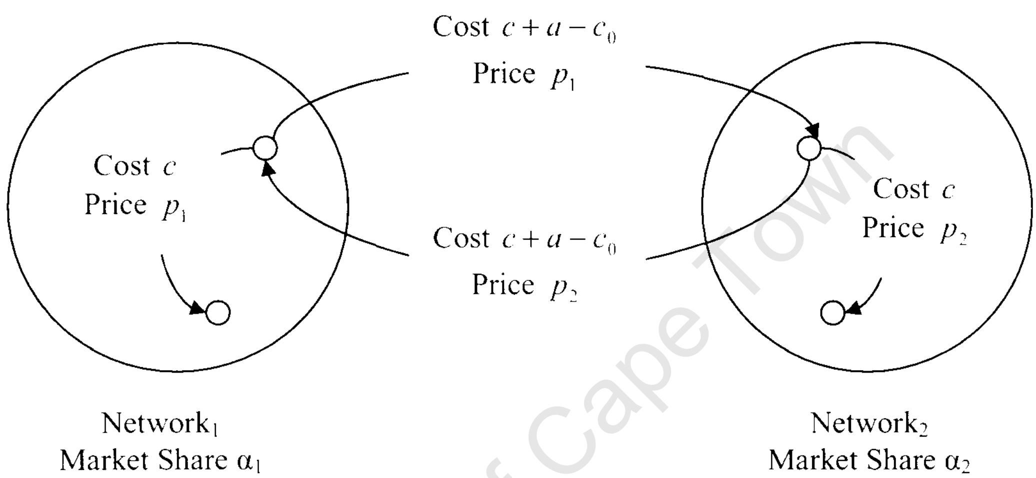
freedom to choose their consumption level. Laffont *et al* assume that the originating caller pays the full fee for the call, as will I. Each network can charge equal interconnection fees, or each network can set its own fee. In the absence of regulatory interference interconnection fees can be set equal to marginal cost, above it or below it. If the interconnection fee is not equal to marginal cost of interconnection then networks are faced with different marginal costs for calls originating and terminating on their network (on-net calls) and calls originating on their network but terminating on another network (off-net calls). If networks price discriminate according to whether a call terminates on or off their network, they are practicing termination based price discrimination. When networks charge the same price for on-net and off-net calls they are using a uniform pricing policy.

Laffont *et al* (1998a; p6) formulate the marginal cost to a network of a call unit as

$$c = 2c_0 + c_1 \qquad (2.1).$$

Where c_0 is the marginal cost of originating and terminating the call, and c_1 is the intermediate cost. The nature of the intermediate marginal cost, c_1, differs with the type of call. For local loop calls it could be interpreted as the switching cost. With long distance calls it may be the marginal cost of trunk lines. When a customer phones someone on the same network c is the marginal cost to their network. There is also a fixed cost, *f*, to the provider of connecting a customer to the network.

Figure 1: Cost and Price Structure with Uniform Pricing



Network$_1$ is charged an interconnection fee, a, whenever its customers phone someone on network$_2$. Laffont *et al* assume that there is reciprocal access pricing, which means that all networks charge an equal fee to terminate a call. The marginal cost for the originating network of an off-net call is therefore:

$$c_0 + c_1 + a$$

This can also be formulated as

$$c + a - c_0 .$$

The marginal cost / revenue of the terminating network to terminate a call is

$$c_0 - a$$

If α_i is the market share of $network_i$ then the average (or perceived) marginal cost of a call for $network_i$ is:

$$c + (1 - \alpha_i)(a - c_0)$$

If the interconnection fee is set to cost, perhaps due to industry regulation, then the perceived marginal costs of on-and off- net calls are both equal to c.

The marginal cost of originating an off-net call and the marginal cost or revenue of terminating an off-net call sum to the marginal cost of an on-net call, since the interconnection fee and revenue cancel out. Even if networks do cancel out interconnection fees they may be left with a surplus / deficit at the end of the month if traffic is not balanced. Laffont *et al* (1998a; p3) assume that there is a balanced calling pattern, implying that the percentage of calls which originate and terminate on a particular network is equal its market share. The access surplus/deficit is thus given by:

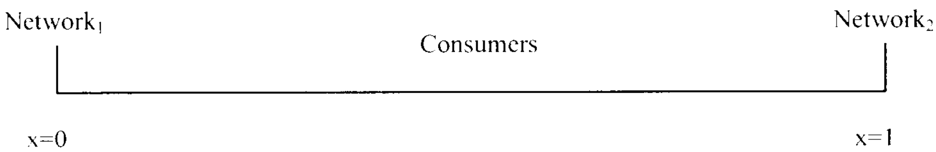
$$A_i = \alpha_i \alpha_j (q(p_i) - q(p_j))(a - c_0)$$

The access surplus/deficit is minimized when the market is cornered by a monopoly and no off-net calls are made. In an oligopoly it is minimized by equal market shares. If $p_i = p_j$ the interconnection fees paid and revenue received will cancel out for each network. This must be distinguished from the scenario where interconnection fees are set equal to their marginal cost, often referred to as the 'bill and keep' system. Here there is no access surplus or deficit, but the interconnection fee does not affect the perceived marginal cost either (Lessem, 2005; p13). Networks may choose to pass the interconnection fee to the consumer, and this becomes interesting when the interconnection fee is different to the marginal cost of terminating the call.

b. The Demand Structure and Spatial Differentiation

Laffont *et al* (1998a; p6) then formulate the demand structure of the industry, which they base on Hotelling's model of spatial positioning of firms. They assume that consumers are uniformly distributed along x = [0, 1] with one network located at each extremity; $network_1$ at 0 and $network_2$ at 1. I have not found a theoretical explanation in their work for using Hotelling's model. While it may be an attempt to introduce product differentiation into the model this is not explicitly stated. In reality joining a telecommunications network does not mean driving to the other side of town and an analogy between travel and product difference needs to be justified. I attempt to rationalise the use of Hotelling's model in reference to technology differences in latter sections of this dissertation.

Figure 2: Basic Spatial Network Distribution



Continuing with the demand structure, the utility of a consumer with income y and telephone consumption q is given by:

$$y + v_0 - t\left|x - x_i\right| + u(q)$$

There is a fixed connection surplus of v_0, which can be set sufficiently high causing the entire population to be connected to a network, even if they make no calls (1998a; p7). Practically it could be the utility from knowing that emergency phone calls could be made, or from receiving calls. The cost of being connected to a network which is at a different 'address'[4] to the consumers is given by $t[x-x_i]$ where $i = [1, 2]$. This is the disutility of not receiving the preferred service. The variable gross surplus, $u\ (q)$, is defined by:

$$u(q) = \frac{q^{1-(1/\eta)}}{1-\frac{1}{\eta}}$$

This results in a constant elasticity demand function since:

$$u'(p) = p \Leftrightarrow q = p^{-\eta}$$

[4] This is the term used by Laffont *et al* (1998a; p6). Since address is contained in inverted commas it suggests that it is not a physical address to which they refer, but that there is some analogy to physical location which justifies their use of Hotelling's spatial model.

As Armstrong (1998; p550) notes explicitly in the model consumers gain utility only from making calls, they are indifferent to receiving calls.

Laffont *et al* assume for technical convenience that the elasticity of demand, η, is greater than one, although they note that empirical studies do not support this assumption (1998a; p7). Griffin (1982; p66) found the long run price elasticity of long distance services to be -0.6, and only -0.1 for local calls. He used a pooled cross-sectional study of quarterly data from five south-western states in the USA over the period 1964 to 1978 (p59). This is obviously for fixed line telecommunications. Laffont *et al* (1998a; p7) cite Taylor (1994) who also found a price elasticity of less than one. In the last thirteen years the price elasticity of short and long distance calls may have increased with the increasing popularity of substitutes such as text messaging and email.

Laffont *et al* (2000; p192) define the consumer's variable net surplus under uniform pricing as

$$v(p) = \max_{q}\{u(q) - pq\} = \frac{p^{-(\eta-1)}}{\eta - 1}$$

By Shepard's lemma

$$v'(p) = -q(p)$$

A consumer located at $x=\alpha$ is indifferent between the two networks when

$$v(p_1) - t\alpha = v(p_2) - t(1-\alpha)$$

Hence the market share for network$_i$ is given by

$$\alpha_i = \frac{1}{2} + \sigma[v(p_i) - v(p_j)]$$

Where

$$\sigma \equiv \frac{1}{2t}$$

is an index of substitutability between the two networks (1998a; p7). If $t \approx \infty$ or $p_i = p_j$ then the market share is split evenly.

Total consumer welfare under is the sum of the consumers' variable net surplus and their disutility from not consuming their optimal service (1998b; p42). The disutility of the average consumer is equal to

$$T(\alpha) = t(\alpha^2 + (1-\alpha)^2)/2$$

For the price vector $P = \{p_1, p_2\}$ the total consumer welfare under linear uniform pricing is equal to

$$W(P) = \alpha(P)v(p_1) + (1-\alpha(P))v(p_2) - T(\alpha(P))$$

If the industry is symmetrical in prices and market share then the welfare maximizing price is

$$p_1 = p_2 = p^R$$

If the joint and common cost to establishing a network are ignored, then the price which maximizes social welfare, subject to the industry breaking even, is the minimum price at which the networks break even on each consumer (Laffont *et al*, 2000; p193). This is the Ramsey price, calculated by

$$(p^R - c)q(p^R) = f$$

In a symmetric market with Ramsey prices the average consumer welfare is

$$W(P) = v(p^R) - t/4$$

In contrast the monopoly price which maximizes industry profits is given by the inverse elasticity rules as

$$\frac{p^M - c}{p^M} = \frac{1}{\eta}$$

For uniform pricing oligopolies the Ramsey and the monopoly prices are the lower and upper bounds of sustainable rational call prices. When networks use two-part tariffs the welfare maximizing price is equal to the marginal cost, however under linear tariffs pricing equal to marginal cost would result in a loss as the fixed cost, *f*, would not be paid by consumers (Armstrong, 2002; p360).

c. <u>Uniform Pricing and Collusion</u>

The profit of network$_i$ is

$$\pi_i = \alpha_i\{[p_i - c - \alpha_j(a - c_0)]q(p_i) - f\} + \alpha_i\alpha_j(a - c_0)q(p_j)$$

This can be separated into retail profit from consumers and access revenue (deficit) from (to) network$_j$, given by

$$\pi_i = \underbrace{\alpha_i[(p_i - c)q(p_i) - f]}_{Retail\ Profit} + \underbrace{\alpha_i\alpha_j(a - c_0)[q(p_j) - q(p_i)]}_{AccessSurplus\ /\ Deficit}$$

If the interconnection fee exceeds the marginal cost of termination, $(a>c_0)$, then network$_i$ will only make an access surplus if it terminates more calls than it originates and given a balanced calling pattern this requires $q(p_j) > q(p_i)$. This will occur only if network$_i$ charges a higher price than network$_j$, i.e. $p_i > p_j$.

Interconnection fees can aid collusion as an increase in the access charge increases the perceived marginal cost of the call. The average cost of a call depends on the market share of the service provider. For the duopolists to share the market evenly they must charge the same price. The first order condition for a symmetric solution is:

$$\frac{p^* - (c + \frac{a - c_0}{2})}{p^*} = \frac{1}{\eta}[1 - 2\sigma\pi(p^*)]$$

This equation is a variation of Lerner's inverse elasticity rule, and on the left hand side of this equation is the Lerner index (Laffont *et al*, 2000; p193). Since the market shares are even half of the calls made are made to consumers off the network. This increases the perceived marginal cost to

$$c + \frac{a - c_0}{2}$$

By increasing the interconnection fee the perceived marginal cost increases, as does p^*.

Armstrong (2002) approaches the question slightly differently. He analyses a two-stage game where networks first jointly choose an interconnection fee and then non-cooperatively set the price. Using notation $\Pi(p) = (p - c)q(p)$ and given interconnection fee a, the first order profit maximizing requirement is that (p363):

$$\frac{-q(p)}{2t}(\Pi(p) - f) + \frac{1}{2}\Pi'(p) - \frac{1}{4}(a - c_o)q'(p) = 0 .$$

Joint profits are maximized by price p^* where

$$\Pi'(p^*) = \frac{\partial[(p - c)q(p)]}{\partial p^*} = q(p) + (p - c)(-\eta p^{-\eta-1}) = 0 .$$

Knowing this the interconnection fee which will sustain collusion if it is sustainable is

$$a^* = c_0 + \frac{q(p^*)}{-q'(p^*)}\frac{2}{t}(\pi(p^*) - f) > c_0 .$$

If the interconnection fee is set to a* then networks do not have an incentive to undercut each other as the gain in retail profits is exactly offset by the increased interconnection fee payment (Armstrong, 2002; p364). The optimal interconnection fee, a*, is high when demand is inelastic, the maximum profit per subscriber and the substitutability of the networks is high (p363). When t is very high the optimal access charge is set at cost, as the market shares are fixed.

Importantly collusion only works if the two services are not close substitutes. If they are close substitutes then, by deviating and charging $p_i<p^*$, network$_i$ can capture the whole market, provided that[5]

$$v(p_i) \geq v(p^*) + t .$$

If p_i is sufficiently close to p*, so that

$$\pi(p_i) - f > \frac{1}{2}[\pi(p^*) - f],$$

then the collusive price cannot be sustained. The attempted collusion devolves Bertrand style (Armstrong, 2002; p364).

With two-part tariffs the network's optimum call tariff is its perceived marginal cost, not the industry cost (Laffont et al, 1998a; p21). There is more competition as networks can compete for market share by lowering the fixed fee while keeping prices equal to the perceived marginal cost (Armstrong, 2002; p366). There is more competition than with two-part tariffs, but unless the interconnection fee is set equal to cost social welfare is not maximized.

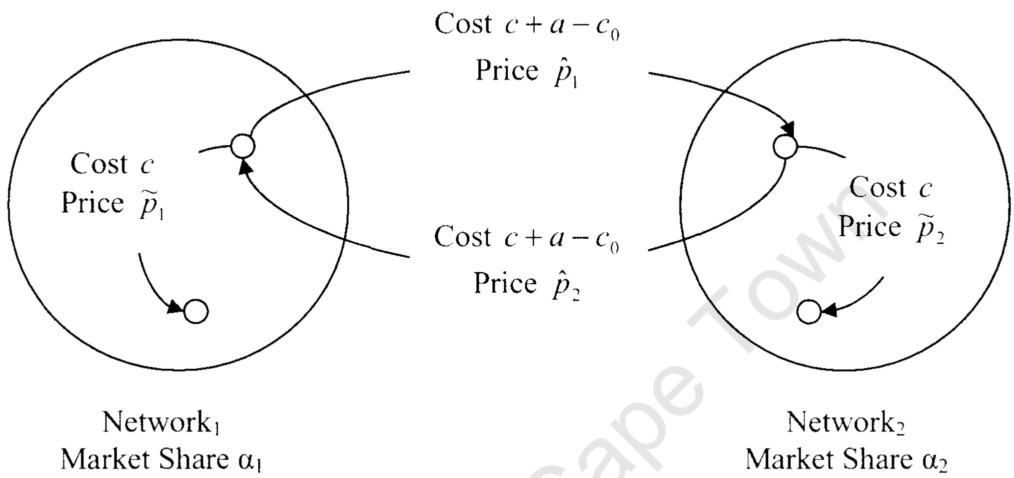
d. Termination-Based Price Discrimination and Collusion

Under termination based price discrimination networks charge a different price for off- and on-net calls. This reflects the different marginal costs of the calls.

[5] I think that if $v(p_i) = v(p^*) + t$ consumers would be indifferent, and the two networks would share the market. Only if $v(p_i) > v(p^*) + t$ would network$_i$ capture the entire market.

I have used $\tilde{p}_i$ to denote the price of on-net calls and $\hat{p}_i$ for off-net calls.

Figure 3: Cost and Price Structure with Price Discrimination



(Laffont *et al*, 1998b; p42).

Termination price discrimination introduces network externalities to the consumers. If off- and on-net calls cost the same then consumers are indifferent to which network they call (Laffont *et al*, 2000; p201). However if they pay less for on-net calls than for off-net calls then they will want to join the network that their friends and family are on. These network externalities, known as *tariff-mediated network externalities*, affect the market share of networks.

Let network$_i$ have price $\tilde{p}_i$[6] on-net calls and $\hat{p}_i$ for off-net calls (2000; p203). The consumer's net variable surplus is now given by

$$\omega_i = \alpha_i v(\tilde{p}_i) + (1-\alpha_i)v(\hat{p}_i)$$

This is the sum of the net variable surplus gained from phoning consumers on their network, $\alpha_i v(\tilde{p}_i)$, and from phoning consumers on the rival network(s), $(1-\alpha_i)v(\hat{p}_i)$. Thus the market share of network$_i$ in a duopoly is now

$$\alpha_i = \frac{1}{2} + \sigma(\omega_i - \omega_j).$$

However there is circularity as market shares depend on consumer surplus, which in turn depends on market shares. This can be circumvented using expectations of the consumers (2000; p204). If all consumers expected all other consumers to join network$_j$, then network$_i$ would receive a market share equal to

$$M_i = \frac{1}{2} + \sigma[\upsilon(\hat{p}_i) - \upsilon(\tilde{p}_j)].$$

The real market shares are given by

$$\alpha_i = \frac{M_i}{M_i + M_j}.$$

[6] This notation is different to that used in Laffont *et al* (1998a, 1998b and 2000), but it is for clarity as I include uniform, on-net and off-net prices in my models.

The profit of network$_i$ with price discrimination is

$$\pi_i = \alpha_i[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + \alpha_j(\hat{p}_i - c - a + c_0)q(\hat{p}_i) - f] + \alpha_i\alpha_j(a - c_0)q(\hat{p}_j).$$

This can also be separated into retail profit from consumers and access revenue (deficit) from (to) network$_j$

$$\pi_i = \underbrace{\alpha_i[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + \alpha_j(\hat{p}_i - c)q(\hat{p}_i) - f]}_{Retail\,Profit} + \underbrace{\alpha_i\alpha_j(a - c_0)[q(\hat{p}_j) - q(\hat{p}_i)]}_{Termination\,Revenue/Deficit}$$

A proportionality rule holds for prices, meaning that the ratio of the off-net to the on-net call price is equal to the ratio of the off-net to the on-net marginal call cost, i.e.

$$\frac{\hat{p}_i}{\tilde{p}_i} = \frac{c + a - c_0}{c}$$

In order to maximize profit the Lerner indices of the services are proportional to the inverse elasticities of demand. The elasticity of demand for off-net calls is equal to that for on-net calls, and the Lerner indices are also be identical, i.e.

$$\frac{\hat{p}^* - c + a - c_0}{\hat{p}^*} = \frac{\tilde{p}^* - c}{\tilde{p}^*},$$

hence the proportionality rule.

If the access charge is above cost then price discrimination raises the price of off-net calls and lowers the price for on-net calls. The average price is lower than under uniform pricing since people will increase their consumption of cheaper on-net calls and decrease the amount of more expensive off-net calls which they make (2000; p204). Lower prices will cause consumer welfare to increase.

Networks can build market share if they reduce their on-net price (2000, p202). Since the interconnection fee deficit relies on the volume of off-net calls of the networks, reducing the on-net price will not increase their interconnection fee deficit. Thus price discrimination increases competitiveness.

The total effect of price discrimination on consumer welfare is uncertain. Total consumer welfare is the sum of the consumers' variable net surplus and their disutility from not consuming their optimal service (1998b; p42). For the price vector $P = (\tilde{p}_{1,} \hat{p}_1, \tilde{p}_2, \hat{p}_2)$ consumer welfare is equal to

$$W(P) = \alpha(P)w(\tilde{p}_{1,} \hat{p}_1) + (1 - \alpha(P))w(\tilde{p}_2, \hat{p}_2) - T(\alpha(P))$$

The Ramsey optimum is given by

$$\tilde{p}_1 = \hat{p}_1 = \tilde{p}_2 = \hat{p}_2 = p^R,$$

which is identical to the Ramsey price under uniform pricing. If the market is regulated then uniform Ramsey prices are optimal for consumers. Along with competitiveness price discrimination introduces a distortion in consumption (1998b; p42).

e. Interconnection Fees and Entry

When a service provider enters the market they can either build their own network (facilities based entry), lease services from the incumbent (resale entry), or lease some services and build the remainder (unbundling). I am most concerned with facilities based entry, where the only fee which the entrant will pay the incumbent(s) is the interconnection fee. This interconnection fee can be mandated by a regulator or completely unconstrained (1998a; p15).

Laffont *et al* (1998a & 1998b) used their model to explore entry scenarios. They examined entry into a monopoly market, under both discriminatory and non-discriminatory pricing. With entry under both pricing policies the entrant incurs a fixed cost, *f*, for each customer they connect (1998a; p15). Under facilities-based entry the entrant chooses their coverage $\mu \in [0,1]$ and incurs a cost of $d(\mu)$ which is increasing and convex (1998a; p16). It is assumed that the incumbent has full coverage.

The market shares are dependent on the size of μ, as the extent of the entrant's coverage determines the size of the overlap containing consumers which can be served by both firms (1998a, p17). The market share of the incumbent, network$_i$, is

$$\alpha_i = 1 - \mu(1 - \alpha)$$

and the share of the entrant, network$_e$, is

$$\alpha_e = \mu(1-\alpha)$$

Substituting in the original market share for full coverage the market shares are now given by

$$\alpha_i = 1 - \frac{\mu}{2} + \frac{\mu}{2t}[v(p_i) - v(p_e)]$$

and

$$\alpha_e = \frac{\mu}{2} + \frac{\mu}{2t}[v(p_e) - v(p_i)]$$

Under uniform tariffs Laffont *et al* examine two forms of entry: unbundling and facilities based. When the entrant does not build all the necessary infrastructure themselves they must lease some from the incumbent. The incumbent charges ζ for connecting the entrant to each consumer. The incumbent is faced with costs, *f*, for connecting each consumer, and *C*, the joint and common cost of the network. The Ramsey price must be adjusted to take account of C. The socially optimal interconnection fee is set below marginal cost in order to offset the incumbent market power. The socially optimal lease price, ζ*, is equal to the fixed cost, *f*, plus the joint and common cost, *C* (1998a, p16). This ensures fair competition.

Facilities based entry is of more relevance to in this paper. When the regulator mandates interconnection at a set price then the entrant undercuts the incumbent and incurs access deficit. The entrant strategically under-invests, which allows the incumbent to retain a wider captive market. The incumbent can then keep prices high and exploit this portion of the market. The entrant benefits from the incumbent's high prices. They can increase their price or market share, and hence their profit (1998a; p18).

When a regulator mandates interconnection but leaves the networks free to bilaterally negotiate the interconnection fee the incumbent can force the entrant to accept asymmetrical interconnection fees (1998a; p18). If the entrant enters with a low coverage, it will be very difficult to entice consumers before there is interconnection as there are few people they can phone. This is a strong position for the incumbent as they can threaten to hold out on reaching an agreement on interconnection until it suits them. The entrant will be forced to accept asymmetrical interconnection fees. If the entrant enters with high coverage they are in a stronger bargaining position as there is the potential for them to supply most of the market and have a minimum need of interconnection. The entrant thus has an incentive to over-invest in coverage.

Laffont et al (1998b) found that when networks price discriminate the incumbent can block a small entrant through setting strategic off-net and on-net prices, even if the access price is reciprocal (p55). The incumbent sets an extremely high interconnection fee, which forces the entrant either to charge high prices and not attract consumers, or to make a negative profit on calls. To avoid this situation the entrant has to enter with a minimum coverage of

$$\mu_0 > \frac{v(p^M) - \frac{1}{2\sigma}}{v(p^R)}.$$

The greater the level of substitutability between the networks, σ, the greater the minimum coverage required.

f. Context of this Work

My works fits into the prior research by exploring equilibrium and entry into an oligopolistic telecommunications market. I will begin by examining the oligopolistic equilibrium without spatial differentiation. I will then examine entry of a differentiated network and how this impacts on the equilibrium prices and the social welfare.

My work is useful as most countries no longer have monopolistic telecommunication markets; there is a mobile operator and a fixed line service provider, at least. While entry of a differentiated firm may appeal to consumers by increasing their product choice it may allow networks to benefit from interconnection fees and collude. This will result in equilibrium prices above the Ramsey socially optimal price. There are two opposing effects on social welfare to be examined, the increase in product choice and a price increase.

3. THE MODEL

Unlike Laffont *et al* who analysed entry into a monopoly market, I will examine entry into an existing oligopoly, and investigate whether entry supports collusion. Before studying entry I determine the oligopoly equilibrium. In comparison to the reviewed literature I model the two incumbents in the same spatial location, $x=0$. The entrant network is differentiated, hence located at $x=1$. I have used Laffont *et al*'s model, described in the previous section, where possible. This should allow easy comparison between their and my results. However my model has differences, which shall be explained.

a. The Players

The Networks - The strategic players in the model include two incumbent firms and the entrant. The networks are profit maximisers. The entrant is denoted as network$_e$ and the oligopolists are as network$_i$ for $i=1,2$. As a group the incumbent firms are referred to as the oligopoly, and denoted network$_o$.

I do not spatially differentiate the incumbents as I am interested in the effect of network differentiation on collusion. The use of Hotelling's spatially differentiated networks in the reviewed model intrigued me and may be necessary to prevent a Bertrand equilibrium.

The incumbent networks each have the capacity to serve the entire market. If oligopolists each had the capacity to cover only half the market they could split the market evenly and each charge the monopoly price. The rival network would not have the capacity to serve more customers, thus there would be no competition for the subscribers. The entrant network selects its coverage, μ, in the range $\mu=[0,1]$. It faces cost $d(\mu)$ of building infrastructure.

In this paper the different spatial location of the entrant is due to different technology used by the different networks. In particular I am considering the differentiation between fixed and mobile service providers, but the model can be used to capture any real experienced difference in technology.

The oligopoly may consist of either fixed-line or mobile service providers. The entrant uses the opposite technology to the incumbents. Other than spatial positioning I do not draw a distinction between the services. This is where the first complication arises, as fixed and mobile services might not face identical costs or offer consumers the same variable net surplus. Mobile phones have the obvious advantage of being portable, but they often have worse reception than fixed line phones. They are compliments to the extent that if the price of calls on one network drops more people who were not previously connected to any network may join the network. This increases the number of people who can be phoned by any consumer. Many people may use both mobile and a fixed line phones, they are not mutually exclusive services. The differences could perhaps be modeled with different elasticities of demand and different cost functions. Vertical differentiation, where firms differentiate their products through quality may also be appropriate (Tirole, 1988; p296). I will treat the two services as substitutes, so the model can be used for mobile and fixed line entrance. This also ensures that the model can be applied to other forms of service differentiation.

By including both fixed-line and mobile service providers in the model we have clearly have two differentiated products. Cellular telephone providers may differ in small ways, such as the services they offer, their price plans, their marketing image and the phones which they offer. While Hotelling's linear model is applicable here if there were more than two types of service it would not be appropriate. One could adapt to a circular "city" spatial model as discussed by Tirole (1998; p283). In this model the firms are arranged equidistant from each other on the perimeter of a circle. However this is not ideal as firms in this model practically compete with their two neighbours only. Canoy and Peitz (1997) develop a model of triangle differentiation where there are three firms, two producing goods of high quality and one of low quality. The model includes vertical differentiation through quality and horizontal differentiation between the two high quality goods. This may be extendable to the telecommunications industry; particularly to model a fixed-line monopolist and two differentiated mobile providers.

With spatial differentiation of the entrant and the incumbents the networks are not perfect substitutes. However if the average disutility caused by using a non-ideal service is small a network may still entice more customers through a relatively small price drop, though not an infinitesimal one. There is still the possibility of a Bertrand solution, although the equilibrium price will be higher than if the goods were perfect substitutes as there is no incentive for dropping the price if no more consumers will join the network.

Consumers - They are assumed to be utility maximisers, but they are not strategic actors. There is no consumer action in the form of boycotting uncompetitive firms. The utility functions of the consumers are from the model by Laffont *et al.* The consumers' service preference are distributed along $x=[0,1]$. Consumers at each end have a clear preference for either fixed or mobile phones. Those whose preference are distributed in the range $x=(0,1)$ have a preference for technology that combines fixed and mobile characteristics in different proportions.

There is number portability, so consumers can easily port to another service provider.[7] This ease of movement does not mean that the switching cost is zero or even trivial. There are time costs in researching price plans and porting a phone number. Consumers may need to pay for a new SIM card. Number portability has still done much to reduce the hassle of changing provider. A practical concern with number portability is that customers would not know which network the call receiver was on. This problem is resolved in South Africa by a warning tone which sounds when a ported number is dialed.

The cost of switching networks can be included in the model without product differentiation. This cost, s, could be included in the consumer's cost benefit analysis when deciding whether to move networks. Even if network_i charges the lowest prices, the saving in call costs from porting may not be worth time cost and SIM card fee. The effect of switching costs on the oligopoly equilibrium is briefly discussed

Laffont *et al* (1998a; p7) assume that the utility of being connected to a network, v_0, is sufficient for everyone to be connected, even if they do not make phone calls. This is somewhat true. The number of cellular phone subscribers

[7] This implies unfortunately that consumers can port between mobile and fixed line providers and retain their number. This is fallacious. However if they changed their handset and could keep their number it would not such an outlandish assumption, and is probably technically possible.

in South Africa grew from 11 million to 25 million over the period 2001 to 2005 (South Africa Foundation, 2005; p17). There remain 15-25 million South Africans without cellular phone subscriptions. However some of the citizens have fixed-line phones. In poorer families people may share handsets, and even in wealthy households people share fixed-line phones. For simplicity I will use their assumption but with different wording, that the citizens who are not connected to a network cannot afford the initial cost of the instrument. This implies that even if unit call charges decrease new customers will not enter the market. Since the entire market is connected before entry, this implies that the incumbents can serve the entire market together.

Consumers cannot be connected to more than one network at a time. This is to prevent them from circumventing termination based price discrimination by joining all networks and vary the originating network they use according to whom they call. This assumption may not be necessary if modeling two-part tariffs as consumers would have to pay each network a fixed fee. Even without the fixed fee the hassle of alternating SIM cards may outweigh the benefit of lower call costs for most consumers.

The Regulator- It is not a strategic actor, but is represented as boundaries to the strategy set. Thus if the regulator has capped prices then this appears as an upper limit to the prices which firms can charge.

For simplicity I assume that the regulator is interested in ensuring that the licensed networks do not go out of business. Thus it sets a price floor equal to the industry budget constraint, the Ramsey price. The networks' call price must be equal to of greater than the Ramsey price. This ensures that if networks face the industry marginal cost, *c*, they will break even on each consumer.

b. Tariff Strategies

Laffont *et al* consider the existence of two part tariffs, which consist of a fixed subscription fee and a unit call charge, and their debilitating effect on collusion. For simplicity and empirical accuracy I will treat tariffs as a straight charge per unit, as is the case with pre-paid cell phones[8]. The service providers recoup fixed costs from the call revenue.

The incumbents and the entrant can select whether to use termination-based price differentiation or uniform pricing. The interconnection fee, *a*, is equal to or greater than the marginal cost of interconnection, c_0. This fee is determined exogenously from the model.

[8]This is appropriate given that 80- 85% of cell-phone users in South Africa are on pre-paid, which has no fixed monthly fee (South Africa Foundation, 2005; p20).

c. Game Structure

Time Frame – The game has is sequential, but contains simultaneous moves. Akin to Laffont *et al* and Armstrong the simultaneous price setting moves in the game are not infinitely repeated, as it is a one-shot game. This may be appropriate as networks spend money advertising their prices creating large menu costs if they change them frequently. In South Africa contract subscribers have to contract for two years and prices are fixed for that period.

Oligopoly Form – While networks may select coverage, it is difficult for them to limit the quantity of calls made by each subscriber. Therefore networks optimize through setting prices, not by setting quantities. The firms face equal demand and cost functions. Thus a Bertrand price-setting oligopoly is more appropriate than a Cournot quantity-setting structure. Since the game is not infinitely repeated a Bertrand paradox may occur. The entrant also competes on prices, but is not a perfect substitute for the incumbent networks.

Sequence – The games is sequential, but contains simultaneous pricing decisions.

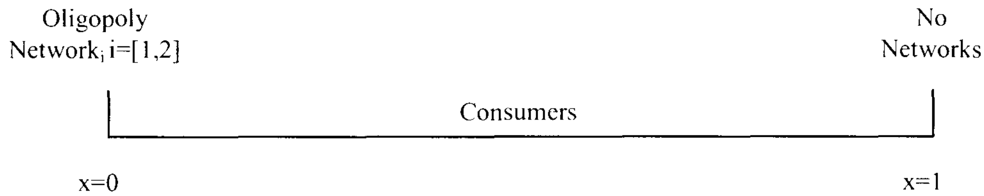
1. The incumbents simultaneously and non-cooperatively set prices; $P = (\tilde{p}_{1.}\hat{p}_1, \tilde{p}_2, \hat{p}_2)$.

2. The entrant selects coverage, μ, between 0 (no coverage) and 1 (full coverage.
3. The entrant then sets a policy of uniform or discriminatory pricing[9].
4. The incumbents and the entrant then set prices simultaneously and non-cooperatively; $P = (\tilde{p}_1, \hat{p}_1, \tilde{p}_2, \hat{p}_2, \tilde{p}_e, \hat{p}_e)$.

4. UNIFORM PRICING OLIGOPOLY

In an oligopoly without termination based price discrimination subscribers are charged the same price, p_i, for on- and off-net calls by their service provider. While consumers are still located evenly over the interval $x=[0,1]$, there is no spatial differentiation between the two incumbents; they are both located at x=0. Without spatial differentiation the variable utility of the consumers and thus the market share of the networks is entirely determined by the price. The disutility from receiving a non-optimal service is equal across the networks.

Figure 4: Spatial Network Distribution of a Non-Differentiated Oligopoly



a. Market Shares

Consumers are indifferent between the two networks if

$$v(p_i) - t\alpha = v(p_j) - t\alpha .$$

Since the two networks are perfect substitutes the market shares are discreet. If one network prices lower than the other they capture the entire market;

$$p_i < p_j \Leftrightarrow v(p_i) > v(p_j) \Leftrightarrow \alpha_i = 1, \alpha_j = 0 .$$

If the networks have equal prices they share the market as consumers are indifferent between the two networks;

$$p_i = p_j \Leftrightarrow v(p_i) = v(p_j) \Leftrightarrow \alpha_i = [0,1], \alpha_j = 1 - \alpha_i$$

If consumers are indifferent they will randomize between the two networks. Given the law of large numbers the market will tend towards an even split, i.e. $\alpha_i \to \frac{1}{2}$. It must be noted that when there is no differentiation under uniform pricing there is never an access surplus/ deficit.

There are three possible outcomes of market share divisions

1. That $network_1$ charges the lower price and captures the market
2. That $network_2$ charges the lower price and captures and market
3. That the networks charge equal prices, hence sell equal quantities of calls to each consumer and the interconnection fees cancel out.

---

[9] This is done publicly so it can function as a signal. If they invest in then marketing of their price policy then they are unlikely to renege, so it will be a credible threat / offer.

b. Profit Maximization

The incumbent networks are strategic profit maximisers. Their profit function under uniform pricing is given by

$$\pi_i = \underbrace{\alpha_i[(p_i - c)q(p_i) - f]}_{Retail\,Profit} + \underbrace{\alpha_i\alpha_j(a - c_0)[q(p_j) - q(p_i)]}_{Access\,Surplus/Deficit}.$$

The first order condition for profit maximization is, as normal, that

$$\frac{\partial \pi_i}{\partial p_i} = 0,$$

which written in full is

$$\frac{\Delta\alpha_i}{\Delta p_i}[(p_i - c)q(p_i) - f] + \alpha_i[q(p_i) + (p_i - c)(-\eta p_i^{-\eta-1})] + \frac{\Delta\alpha_i}{\Delta p_i}\alpha_j(a - c_0)[q(p_j) - q(p_i)]$$
$$+ \frac{\Delta\alpha_j}{\Delta p_i}\alpha_i(a - c_0)[q(p_j) - q(p_i)] + \alpha_i\alpha_j(a - c_0)(-\eta p_i^{-\eta-1}) = 0$$

Given that $\alpha_i(p_i, p_j)$ is not continuous, it is not differentiable. However we do know that

$$\frac{\Delta\alpha_i}{\Delta p_i} = -\frac{\Delta\alpha_j}{\Delta p_i}$$

since the market is fully subscribed. If a consumer leaves network$_i$ they are assumed to join network$_j$. Thus the first order condition of can be simplified to:

$$\frac{\Delta\alpha_i}{\Delta p_i}\{(p_i - c)q(p_i) - f + (\alpha_j - \alpha_i)(a - c_0)[q(p_j) - q(p_i)]\}$$
$$+ \alpha_i(-\eta p_i^{-\eta-1})[q(p_i) + (p_i - c) + \alpha_j(a - c_0)] = 0$$

Substituting $q(p_i) = p_i^{-\eta}$ gives

$$\frac{\Delta\alpha_i}{\Delta p_i}[(p_i - c)(p_i^{-\eta}) - f + (\alpha_j - \alpha_i)(a - c_0)(p_j^{-\eta} - p_i^{-\eta})]$$
$$+\alpha_i(-\eta p_i^{-\eta-1})[p_i^{-\eta} + p_i - c + \alpha_j(a - c_0)] = 0$$

For a unilateral price increase it equals

$$-\alpha_i[(p_i - c)(p_i^{-\eta}) - f + (a - c_0)(p_j^{-\eta} - p_i^{-\eta})] + 0$$

This is negative for all prices greater than the statutory minimum, the Ramsey price.

For a unilateral price decrease it equals

$$\alpha_j[(p_i - c)(p_i^{-\eta}) - f - (a - c_0)(p_j^{-\eta} - p_i^{-\eta})] - \eta p_i^{-\eta-1}[p_i^{-\eta} + p_i - c],$$

which expands to

$$\alpha_j[p_i^{1-\eta} - cp_i^{-\eta} - f - ap_j^{-\eta} + ap_i^{-\eta} + c_0 p_j^{-\eta} - c_0 p_i^{-\eta}] - \eta p_i^{-2\eta-1} - \eta p_i^{-\eta} + c\eta p_i^{-\eta-1}.$$

This is also negative at the Ramsey price.

The first term captures the indirect change in profit from change in the market share due to the price change. It will be negative if the networks price symmetrically at any price below the Ramsey price.

$$-\alpha_i[(p_i - c)(p_i^{-\eta}) - f + (a - c_0)(p_j^{-\eta} - p_i^{-\eta})] + 0 = 0$$

The second term captures the increase in profit from the increased consumption of each consumer. If networks are pricing symmetrically and charging the Ramsey price then the effect of a price increase on profit per consumer is equal to

$$-0.5\eta p_i^{-2\eta-1} - 0.5\eta p_i^{-\eta} + 0.5c\eta p_i^{-\eta-1} - 0.25a\eta p_i^{-\eta-1} + 0.25c_0\eta p_i^{-\eta-1}.$$

c. Nash Equilibrium

The applicable market structure is a Bertrand oligopoly. The usual solution in a Bertrand setting is that firms charge marginal cost and make no profit, $p = mc$. Under uniform pricing the perceived marginal cost of network$_i$ is equal to $c + (1-\alpha_i)(a - c_0)$. The industry marginal cost is c. If the networks share the market evenly and $p > mc$ then one firm can gain the entire market by charging slightly less than marginal cost, $mc - \varepsilon$. If they do this they will be faced with a lower marginal cost, $mc = c$, and be making a positive profit. However since networks set prices simultaneously they will both consider this in their pricing policy. If they all follow this policy the perceived marginal cost will remain

$$c + (1-\alpha_i)(a - c_0)$$

However the industry cost is c, and when the networks have equal prices there is no access surplus or deficit.

If networks charge the industry marginal cost, c, then

$$\pi_i = \underbrace{\alpha_i[-f]}_{\text{Retail Profit}}$$

since the access deficit cancels out. This is not sustainable. The lowest sustainable price which the networks can charge is the Ramsey price, which satisfies the industry budget constraint and the regulator's restrictions

$$(p^R - c)q(p^R) = f.$$

At all prices above the Ramsey price the industry profit is positive. By dropping prices fractionally networks which were sharing the industry profit can enjoy the entire profit. Knowing that the rival network is thinking this will result in both networks dropping prices for fear of losing their half of the industry profit.

The Ramsey price is a Nash equilibrium. If a network increases its price it will lose its consumers. If a network lowers its price it will make a loss on each consumer. It is also not allowed by the regulator to charge below the Ramsey price. There is no incentive for either network to deviate from the Ramsey price. Collusion does not work when there is no spatial differentiation and uniform prices.

If there are unequal market shares then the perceived marginal cost of a call is different for different networks. The larger network$_i$'s market share the lower their perceived marginal cost. In a Bertrand oligopoly with asymmetric costs the firm with the lower cost can charge a price just under their rival's marginal cost and capture the entire market (Tirole, 1988; p211). However firms know that the industry marginal cost is *c*, and if they both charge equal prices then there is no access deficit. Thus even with different market shares initially the firms still charge the Ramsey price.

Note that the level of the interconnection fee is irrelevant to equilibrium prices. Since market shares are discreet networks are not concerned with an access deficit. Networks will charge equal prices, and if they undercut their rival they will capture the entire market and not pay interconnection fees anyway. Hence the interconnection mark-up is not relevant. The interconnection fee affects the individual profit made per consumer, but does not affect the competition for market share.

d. <u>Switching Costs</u>

When switching costs exist a network will not be able to capture its rivals' customers by undercutting them by an infinitesimally small amount. The difference in the total cost to the customer must be greater than the switching cost. Thus the equilibrium price in an oligopoly will be equal to the higher of the industry marginal cost plus the switching cost and the Ramsey price. The higher the switching cost the higher the price of calls.

With switching costs consumers of network_i are indifferent between the two networks when

$$v(p_i) = v(p_j) - s \Leftrightarrow \alpha_i = [0,1], \alpha_j = 1 - \alpha_i$$

Thus the additional utility gained from the rival network's lower price must compensate the consumer for switching networks. Note that if the industry is new and no consumers are signed up then switching costs are not relevant.

d. Welfare

For the price vector $P = (p^R, p^R)$ average consumer welfare is equal to

$$W(P) = v(p^R) - T(\alpha(P))$$

The disutility from not being connected to the ideal service is larger when there is no spatial differentiation

$$T(\alpha) = t/2$$

So the average consumer welfare equals

$$W(P) = v(p^R) - t/2$$

This is lower than the average welfare when firms are spatially differentiated and charging the Ramsey price since consumers lose more utility from not consuming their preferred service.

Consumer disutility from not receiving the optimal service,

$$T(\alpha) = t(\alpha^2 + (1-\alpha)^2)/2,$$

is minimized when

$$dT(\alpha)\big/d\alpha = t/2 \times (2\alpha - 2(1-\alpha)) = t(2\alpha - 1) = 0.$$

Which occurs when $t=0$ or $\alpha=1/2$. Ideally networks locate in the middle of the consumers at $x=1/2$. This is a standard result of the Hotelling model. Unfortunately the firms have no incentive to locate in the centre of the distribution if they have to locate together. Their location will affect neither market share nor profit. If possible the regulator should license the incumbents to provide telecommunications services using technology in the middle of the distribution.

4. PRICE DISCRIMATING OLIGOPOLY

In an oligopoly with termination-based price discrimination consumers are charged different prices for on- and off-net calls by their service provider. This complicates the calculation of market shares as consumers suddenly have an interest in joining the network which they expect to have the bigger market share, provided that off-net calls are more expensive than on-net calls.

a. Market Shares

The net variable surplus which consumers receive from network$_i$ is

$$\omega_i = \alpha_i v(\tilde{p}_i) + \alpha_j v(\hat{p}_i).$$

With equal disutility from non-optimal service, $t\alpha$, consumers are indifferent between the two networks if

$$\omega_i = \alpha_i v(\tilde{p}_i) + \alpha_j v(\hat{p}_i) = \alpha_j v(\tilde{p}_j) + \alpha_i v(\hat{p}_i) = \omega_j$$

The disutility from not receiving their optimal service cancels out as the two networks offer identical services.

The market share in a price-discriminating duopoly is usually given by

$$\alpha_i = \frac{Mi}{M_i + M_j}$$

In a duopoly

$$M_i = \frac{1}{2} + \frac{1}{2t}[v(\hat{p}_i) - v(\tilde{p}_j)],$$

which is the market share that network$_i$ would receive if all consumers expected all other consumers to belong to network$_j$. However without spatial differentiation t does not apply. Instead M_i is discrete. When

$$M_i = 1 \Leftrightarrow v(\hat{p}_i) > v(\tilde{p}_j) \Leftrightarrow \hat{p}_i < \tilde{p}_j$$

$$M_i = \frac{1}{2} \Leftrightarrow v(\hat{p}_i) = v(\tilde{p}_j) \Leftrightarrow \hat{p}_i = \tilde{p}_j$$

$$M_i = 0 \Leftrightarrow v(\hat{p}_i) < v(\tilde{p}_j) \Leftrightarrow \hat{p}_i > \tilde{p}_j.$$

From this the market shares given different price orderings can be calculated. Below are some important orderings used to calculate the Nash equilibrium:

$$\tilde{p}_i = \tilde{p}_j = \hat{p}_i = \hat{p}_j \Rightarrow M_{i,j} = \frac{1}{2} \Rightarrow \alpha_{i,j} = \frac{1}{2}$$

$$\tilde{p}_i = \tilde{p}_j < \hat{p}_i = \hat{p}_j \Rightarrow M_{i,j} = 0$$

and market shares are indeterminate due to division by zero. They should be equal however as consumers are indifferent between the two networks.

$$\tilde{p}_i = \tilde{p}_j > \hat{p}_i = \hat{p}_j \Rightarrow M_{i,j} = 1 \Rightarrow \alpha_{i,j} = \frac{1}{2}$$

$$\tilde{p}_i > \tilde{p}_j, \hat{p}_i = \hat{p}_j \Rightarrow M_i = 0, M_j = 1 \Rightarrow \alpha_i = 0, \alpha_j = 1$$

$$\tilde{p}_i = \tilde{p}_j, \hat{p}_i > \hat{p}_j \Rightarrow M_i = 0, M_j = 1 \Rightarrow \alpha_i = 0, \alpha_j = 1$$

b. Profit Maximization

The incumbent networks earn profit

$$\pi_i = \underbrace{\alpha_i[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + \alpha_j(\hat{p}_i - c)q(\hat{p}_i) - f]}_{Retail\ Profit} + \underbrace{\alpha_i\alpha_j(a - c_0)[q(\hat{p}_j) - q(\hat{p}_i)]}_{Termination\ Revenue\ Deficit}.$$

The first order conditions of profit maximization are given by

$$\frac{\partial \pi_i}{\partial \tilde{p}_i} = 0; \frac{\partial \pi_i}{\partial \hat{p}_i} = 0.$$

Given that $\alpha_i(\tilde{p}_i, \hat{p}_i, \tilde{p}_j, \hat{p}_j)$ is not continuous, it is not differentiable. However we do know that

$$\frac{\Delta\alpha_i}{\Delta\tilde{p}_i} = -\frac{\Delta\alpha_j}{\Delta\tilde{p}_i} \text{ and } \frac{\Delta\alpha_i}{\Delta\hat{p}_i} = -\frac{\Delta\alpha_j}{\Delta\hat{p}_i}.$$

The first order conditions then expand to

$$\frac{\partial\pi_i}{\partial\tilde{p}_i} = \frac{\Delta\alpha_i}{\Delta\tilde{p}_i}[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + \alpha_j(\hat{p}_i - c)q(\hat{p}_i) - f] + \alpha_i[\frac{\Delta\alpha_i}{\Delta\tilde{p}_i}(\tilde{p}_i - c)q(\tilde{p}_i)]$$

$$+\alpha_i\alpha_i[q(\tilde{p}_i) + (\tilde{p}_i - c)(-\eta\tilde{p}_i^{-\eta-1})] - \alpha_i[\frac{\Delta\alpha_i}{\Delta\tilde{p}_i}(\hat{p}_i - c)q(\hat{p}_i)]$$

$$+\frac{\Delta\alpha_i}{\Delta\tilde{p}_i}[\alpha_j(a - c_0)(q(\hat{p}_j) - q(\hat{p}_i)] - \frac{\Delta\alpha_i}{\Delta\tilde{p}_i}[\alpha_i(a - c_0)(q(\hat{p}_j) - q(\hat{p}_i)] = 0$$

and

$$\frac{\partial\pi_i}{\partial\hat{p}_i} = \frac{\Delta\alpha_i}{\Delta\hat{p}_i}[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + \alpha_j(\hat{p}_i - c)q(\hat{p}_i) - f] + \alpha_i[\frac{\Delta\alpha_i}{\Delta\hat{p}_i}(\tilde{p}_i - c)q(\tilde{p}_i)]$$

$$-\alpha_i[\frac{\Delta\alpha_i}{\Delta\tilde{p}_i}(\hat{p}_i - c)q(\hat{p}_i)] + \alpha_i\alpha_j[q(\hat{p}_i) + (\hat{p}_i - c)(-\eta\hat{p}_i^{-\eta-1})]$$

$$+\frac{\Delta\alpha_i}{\Delta\tilde{p}_i}[\alpha_j(a - c_0)(q(\hat{p}_j) - q(\hat{p}_i)] - \frac{\Delta\alpha_i}{\Delta\tilde{p}_i}[\alpha_i(a - c_0)(q(\hat{p}_j) - q(\hat{p}_i)]$$

$$+\alpha_i\alpha_j(a - c_0)(-\eta\hat{p}_i^{-\eta-1}) = 0$$

Note that a change in off-net prices affects the quantity of off-net calls and hence the access surplus / deficit directly, unlike on-net call prices which only affect it indirectly through changes in market share.

c. <u>Nash Equilibrium</u>

The networks compete for market share and profit through prices. The two networks can compete for market share without increasing their access deficit by decreasing their on-net call prices, $\widetilde{p}$. This will increase consumer welfare, ω, but will only increase the on-net call volume per consumer. The quantity of off-net calls made by each consumer will remain constant. The on-net call price will be set at marginal cost, c, as a network can gain the entire market and not increase their access deficit by undercutting the other network. Knowing this they will both set on-net prices to c, so $\widetilde{p}_i = \widetilde{p}_j$.

The market shares, and hence profit are now dependant on the off-net prices. If the on-net prices are both set equal to marginal cost, c, the network can capture the entire market by undercutting their rival's off-net price. Unlike on-net prices, a change in off-net prices will affect the quantity of off-net calls made by each customer. If the rival network does not also change prices there will not be an access deficit since the undercutting network will capture the entire market. If networks charge equal prices there will be no deficit / surplus. Knowing this, networks will both reduce off-net prices to the industry marginal cost, c.

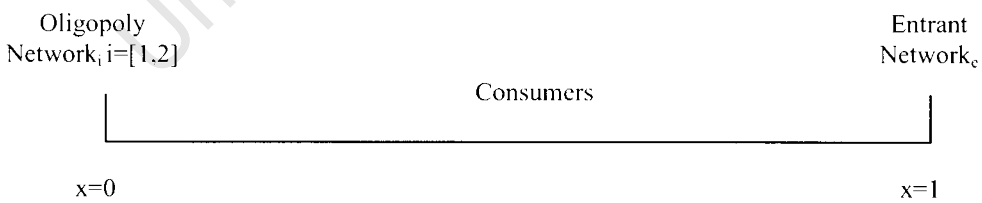
Due to the required minimum Ramsey price the Nash equilibrium will at $\widetilde{p}_i = \widetilde{p}_j = \hat{p}_i = \hat{p}_j = p^R$ and the market will be shared evenly. The regulator will not allow firms to decrease their prices to c as they will make a loss and be unsustainable. Firms will not increase either their on- or off-net prices as consumers will receive a greater surplus from the rival network and switch networks.

Average consumer welfare is identical as under uniform pricing. The interconnection mark-up is not relevant for calculating equilibrium. Termination based price discrimination is not sustainable under non-differentiation

6. ENTRY OF A UNIFORM-PRICING NETWORK

An entrant decides to enter the market. They position spatially at x=1. I assume that due to technology limitations a network has a discrete choice of either 0 or 1 when deciding where to locate.

Figure 5: Spatial Network Distribution with a Differentiated Entrant



a. <u>Coverage and Market Share</u>

The entrant must first determine their level of coverage, μ, between not entering and full coverage, $\mu \in [0,1]$ incurs a cost of $d(\mu)$ which is increasing and convex (1998a; p16). It is assumed that each incumbent has full coverage.

The market shares are dependent on the size of the overlap in the market, u, which can be served by both the entrant and the oligopoly firms. The market share of the oligopoly is

$$\alpha_o = 1 - \mu(1-\alpha)$$

and the share of the entrant, network$_e$, is

$$\alpha_e = \mu(1-\alpha),$$

where

$$\alpha = \alpha(p_o, p_e) = \frac{1}{2} + \frac{1}{2t}[v(p_o) - v(p_e)]$$

is the market share of the oligopoly in the overlap (1998a; p17). Note that

$$1\text{-}\alpha = \alpha(p_o, p_e) = \frac{1}{2} + \frac{1}{2t}[v(p_e) - v(p_o)].$$

Substituting in the original market share for full coverage the market shares are now given by

$$\alpha_o = 1 - \mu(\frac{1}{2} + \frac{1}{2t}[v(p_e) - v(p_o)]) \text{ and } \alpha_e = \mu(\frac{1}{2} + \frac{1}{2t}[v(p_e) - v(p_o)])$$

It is important to note that the entrant competes solely with the cheaper oligopolist. The market share of the entrant is thus determined by the pricing policy of the cheapest oligopolist. The market shares of the oligopolists are determined through the reasoning in the above sections. From this reasoning it is assumed that the incumbents will price symmetrically and share the oligopoly market, i.e.

$$p_i = p_j = p_o \Leftrightarrow \alpha_{i,j} = \frac{1}{2}\alpha_o \Leftrightarrow \frac{\partial \alpha_i}{\partial p_i} = \frac{1}{2}\frac{\partial \alpha_o}{\partial p_o}.$$

The market shares between the entrant and the oligopoly as a whole are affected by a change in prices in the following manner:

$$\frac{\partial \alpha_o}{\partial p_o} = -\frac{\mu}{2t}[q(p_o)] < 0 \text{ and } \frac{\partial \alpha_e}{\partial p_o} = \frac{\mu}{2t}[q(p_o)] > 0$$

$$\frac{\partial \alpha_o}{\partial p_e} = \frac{\mu}{2t}[q(p_e)] > 0 \text{ and } \frac{\partial \alpha_e}{\partial p_e} = -\frac{\mu}{2t}[q(p_e)] < 0.$$

The effect on market shares of rival networks is equal and opposite due to the limited, fully-subscribed market. The market shares of the individual oligopolists are determined discreetly.

The market shares are affected by a change in the entrant's coverage, μ, as well. The effects are:

$$\frac{\partial \alpha_o}{\partial \mu} = \alpha - 1 = \frac{1}{2} + \frac{1}{2t}[v(p_o) - v(p_e)] - 1 = \frac{1}{2t}[v(p_o) - v(p_e)] - \frac{1}{2}$$

and

$$\frac{\partial \alpha_e}{\partial \mu} = 1 - \alpha = \frac{1}{2} - \frac{1}{2t}[v(p_o) - v(p_e)] = \frac{1}{2} + \frac{1}{2t}[v(p_e) - v(p_o)]$$

b. <u>Profit Maximization</u>

The profit of the entrant includes the cost of building the network, and is

$$\pi_e = \underbrace{\alpha_e[(p_e - c)q(p_e) - f]}_{Retail\ Profit} + \underbrace{\alpha_e\alpha_o(a - c_0)[q(p_o) - q(p_e)]}_{Termination\ Revenue\ Deficit} - \underbrace{d(u)}_{Infrastructure}.$$

The first order condition for profit maximization of the entrant is that

$$\frac{\partial \pi_e}{\partial p_e} = 0,$$

which written in full is:

$$\begin{aligned}
&\frac{\partial \alpha_e}{\partial p_e}[(p_e - c)q(p_e) - f] + \alpha_e[q(p_e) + (p_e - c)(-\eta p_e^{-\eta-1})] \\
&+ \frac{\partial \alpha_e}{\partial p_e}\alpha_o(a - c_0)(q(p_o) - q(p_e)) \\
&+ \frac{\partial \alpha_o}{\partial p_e}\alpha_e(a - c_0)(q(p_o) - q(p_e)) + \alpha_e\alpha_o(a - c_0)(-\eta p_e^{-\eta-1}) = 0
\end{aligned}$$

Substituting the market share derivatives and simplifying gives:

$$\begin{aligned}
&-\frac{\mu}{2t}[q(p_e)][(p_e - c)q(p_e) - f] + (\alpha_o - \alpha_e)(a - c_0)(q(p_o) - q(p_e))] \\
&+ \alpha_e[\alpha_o(a - c_0)(-\eta p_e^{-\eta-1}) + q(p_e) + (p_e - c)(-\eta p_e^{-\eta-1})] = 0
\end{aligned}$$

Given there optimal price, p*, the optimal coverage of the entrant is given by

$$\frac{\partial \pi_e}{\partial \mu} = 0,$$

which written in full is:

$$\frac{\partial \alpha_e}{\partial \mu}[(p_e - c)q(p_e) - f] + \frac{\partial \alpha_e}{\partial \mu}\alpha_o(a - c_0)[(q(p_e) - q(p_o)]$$
$$+ \frac{\partial \alpha_o}{\partial \mu}\alpha_e(a - c_0)[(q(p_e) - q(p_o)] = 0$$

Substituting in the derivatives of market share with regard to the entrant's coverage and the market shares the first order condition becomes:

$$(1-\alpha)[(p_e - c)q(p_e) - f + (1 - \mu + \mu\alpha)(a - c_0)[(q(p_e) - q(p_o)]]$$
$$+ \mu(\alpha - 1)(1 - \alpha)(a - c_0)[(q(p_e) - q(p_o)] = 0$$

This simplifies to

$$(1-\alpha)[(p_e - c)q(p_e) - f]$$
$$+ (1 - 2\mu + 4\mu\alpha - \alpha - 2\alpha^2\mu)(a - c_0)[(q(p_e) - q(p_o)] = 0$$

The extent of the coverage affects the size of the access deficit.

The budget constraint of the entrant is

$$\underbrace{\alpha_e[(p_e - c)q(p_e) - f]}_{\text{Retail Profit}} + \underbrace{\alpha_e\alpha_o(a - c_0)[q(p_o) - q(p_e)]}_{\text{Termination Revenue / Deficit}} \geq \underbrace{d(u)}_{\text{Infrastructure}}.$$

The profit of an incumbent, network$_i$, where network$_j$ is the rival oligopolist, is

$$\pi_i = \underbrace{\alpha_i[(p_i - c)q(p_i) - f]}_{Retail\,Profit} + \underbrace{\alpha_i\alpha_e(a - c_0)[q(p_e) - q(p_i)] + \alpha_i\alpha_j(a - c_o)[q(p_j) - q(p_i)]}_{Termination\,Revenue\ Deficit}$$

Note that the third term of each incumbent's profit function will always equal zero, as the networks price symmetrically can cancel out the access deficit or else one of the oligopolists undercuts the other and captures the entire market share of the oligopoly. Thus for simplicity

$$\pi_i = \underbrace{\alpha_i[(p_i - c)q(p_i) - f]}_{Retail\,Profit} + \underbrace{\alpha_i\alpha_e(a - c_0)[q(p_e) - q(p_i)]}_{Termination\,Revenue\ Deficit}$$

The total oligopoly profit is double that of the incumbents

$$\pi_o = \underbrace{\alpha_o[(p_o - c)q(p_o) - f]}_{Retail\,Profit} + \underbrace{\alpha_o\alpha_e(a - c_0)[q(p_e) - q(p_o)]}_{Termination\,Revenue\ Deficit}.$$

The individual incumbent's profit is maximized when

$$\frac{\partial \pi_i}{\partial p_i} = 0.$$

When expanded this equals

$$\frac{\partial \alpha_i}{\partial p_i}[(p_i - c)q(p_i) - f] + \alpha_i[q(p_i) + (p_i - c)(-\eta p_i^{-\eta-1})] + \frac{\partial \alpha_i}{\partial p_i}\alpha_e(a - c_0)(q(p_e) - q(p_i))$$
$$+ \frac{\partial \alpha_e}{\partial p_i}\alpha_i(a - c_0)(q(p_e) - q(p_i)) + \alpha_i\alpha_e(a - c_0)(\eta p_i^{-\eta-1}) = 0$$

Assuming symmetric pricing of the incumbent oligopolists means we can differentiate

$$\frac{\partial \alpha_i}{\partial p_i} = \frac{1}{2}\frac{\partial \alpha_o}{\partial p_o} = -\frac{1}{2}\frac{\partial \alpha_e}{\partial p_o}.$$

Substituting gives

$$\frac{1}{2}\frac{\partial \alpha_o}{\partial p_o}[(p_i - c)q(p_i) - f] + \alpha_i[q(p_i) + (p_i - c)(-\eta p_i^{-\eta-1})]$$
$$+\frac{1}{2}\frac{\partial \alpha_o}{\partial p_o}\alpha_e(a - c_0)(q(p_e) - q(p_i)) - \frac{\partial \alpha_o}{\partial p_o}\alpha_i(a - c_0)(q(p_e) - q(p_i))$$
$$+\alpha_i\alpha_e(a - c_0)(\eta p_i^{-\eta-1}) = 0$$

c. Nash Equilibrium

While the incumbents want to compete for market share with each other and the entrant they are faced with the dilemma that if they undercut the entrant their access deficit with the entrant will rise. They will drop prices to the point that benefit of gaining the entirety of the oligopoly profit is equal to the cost of increasing their market deficit.

The incumbents welcome the entrant as it allows them to make a positive profit, even though reducing their market share. The greater the coverage of the entrant, μ, the greater the increase of the incumbents' access deficits when they drop their prices. They will welcome a wide coverage as it aids high prices.

c. Welfare

For the price vector $P = (p_o, p_o, p_e)$ average consumer welfare is equal to

$$W(P) = \alpha_o v(p_o) + \alpha_e v(p_e) - T(\alpha(P))$$

The disutility from not being connected to the ideal service is smaller when there is spatial differentiation and is equal to

$$T(\alpha) = t/4$$

So the average consumer welfare equals

$$W(P) = \alpha_o v(p_o) + \alpha_e v(p_e) - t/4$$

Whether welfare has increased or decreased from the levels under a non-differentiated oligopoly depends on the size of *t* and the loss to the variable surplus from the price increase.

7. ENTRY OF A PRICE DISCRIMINATING NETWORK

a. Coverage and Market Share

The market share of network$_e$ in a price discriminating oligopoly is calculated through several steps, firstly the consumer's variable surplus is

$$\omega_e = \alpha_e v(\tilde{p}_e) + (1 - \alpha_e) v(\hat{p}_e).$$

The market share of the entrant is given by

$$\alpha_e = \frac{M_e}{M_e + M_o} \text{ and } M_e = \frac{1}{2} + \frac{1}{2t}[v(\hat{p}_e) - v(\tilde{p}_o)],$$

which is the market share that network$_e$ would receive if all consumers expected all other consumers to belong to either of the incumbents. Market share can thus be expanded to

$$\alpha = \frac{v(\hat{p}_e) - v(\tilde{p}_o)}{v(\hat{p}_e) - v(\tilde{p}_e) + v(\hat{p}_o) - v(\tilde{p}_o)}.$$

Given coverage of μ the entrant's market share is given by

$$\alpha_e = \mu \frac{v(\hat{p}_e) - v(\tilde{p}_o)}{v(\hat{p}_e) - v(\tilde{p}_e) + v(\hat{p}_o) - v(\tilde{p}_o)}.$$

The total market share of the incumbent firms is given by

$$\alpha_o = 1 - \mu \frac{v(\hat{p}_e) - v(\tilde{p}_o)}{v(\hat{p}_e) - v(\tilde{p}_e) + v(\hat{p}_o) - v(\tilde{p}_o)}.$$

It is assumed that the incumbent oligopolists do price symmetrically, and hence share the oligopoly market evenly, thus

$$\alpha_i = \frac{1}{2}[1 - \mu \frac{v(\hat{p}_e) - v(\tilde{p}_o)}{v(\hat{p}_e) - v(\tilde{p}_e) + v(\hat{p}_o) - v(\tilde{p}_o)}].$$

b. Profit Maximization

The profit of the entrant is given by

$$\pi_e = \underbrace{\alpha_e[\alpha_e(\tilde{p}_e - c)q(\tilde{p}_e) + (\alpha_o)(\hat{p}_e - c)q(\hat{p}_e) - f]}_{Retail\ Profit}$$
$$+ \underbrace{\alpha_e\alpha_o(a - c_0)[q(\hat{p}_o) - q(\hat{p}_e)]}_{Termination\ Revenue/Deficit} - \underbrace{d(u)}_{Infrastructure}$$

The profit of the individual incumbents is given by

$$\pi_i = \underbrace{\alpha_i[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + (1-\alpha_i)(\hat{p}_i - c)q(\hat{p}_i) - f]}_{Retail\ Profit}$$
$$+ \underbrace{\alpha_i\alpha_j(a - c_0)[q(\hat{p}_j) - q(\hat{p}_i)] + \alpha_i\alpha_o(a - c_0)[q(\hat{p}_e) - q(\hat{p}_i)]}_{Termination\ Revenue/\ Deficit}$$

Given that the incumbents either have identical prices or else there exists only one incumbent, there is never an access deficit between them. Hence the incumbent's simplified profit is

$$\pi_i = \underbrace{\alpha_i[\alpha_i(\tilde{p}_i - c)q(\tilde{p}_i) + (1-\alpha_i)(\hat{p}_i - c)q(\hat{p}_i) - f]}_{Retail\ Profit} + \underbrace{\alpha_i\alpha_o(a - c_0)[q(\hat{p}_e) - q(\hat{p}_i)]}_{Termination\ Revenue\ Deficit}$$

c. <u>Nash Equilibrium</u>

Without uniform pricing the incumbents can compete more amongst themselves for market share by dropping their on-net prices. They can set these to the Ramsey price. However if they compete with each other by dropping off-net prices below that of the entrant's off-net price they will incur an access deficit.

From the preceding discussion it has been shown that uniform pricing is more effective for inflating prices as networks cannot compete over on-net prices without raising their access deficit. If an entrant has a choice it is unlikely that they will enter a uniform-pricing oligopoly and price discriminate.

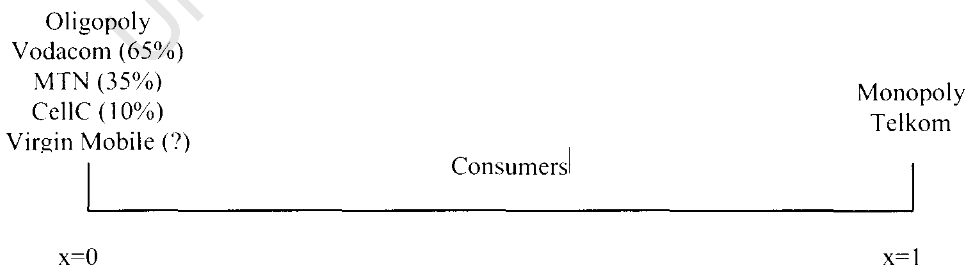
d. Welfare

Social welfare will be higher than under uniform pricing as the average prices are lower. Prices are higher then before the entrant, but disutility from not consuming the preferred service has halved. The exact impact on welfare thus depends on the size of the price increase and *t*.

8. SOUTH AFRICAN CASE STUDY

South Africa has four mobile service providers and one fixed line provider. A rival fixed line provider, Neotel, should start serving residential consumers in early 2007. Currently the South African market is a perfect example of an oligopoly of undifferentiated networks interacting with a single differentiated network.

Figure 6: South African Spatial Network Distribution



Lessem (2005) investigates the strategic use of interconnection charges in the South African mobile sector. He finds that the incumbents, Vodacom and MTN, may have made use of above-cost interconnection fees and termination based price discrimination to limit price competition and entry by Cell-C, the third mobile operator (p30). He recommends disallowing the use of termination based price discrimination, thus using non-linear uniform tariffs to ensure further competition (p30). Lessem overlooks the fact that, although non-linear tariffs are available in South Africa, 80-85% of subscribers use pre-paid phones and a linear tariff structure. With linear tariff structures, on which this paper focuses, termination-based price discrimination may be preferable.

In Lessem's analysis he treats mobile and fixed line services as complements and hence does not consider the role played by South Africa's fixed line monopolist Telkom. He notes that Hodge (2005) finds low incomes South Africans to consider mobile and fixed-line as substitutes whereas high-income South Africans see them as complements. For consumers spending less than $11.94 a month on communication the saving from lower variable costs of fixed line telephones is not sufficient for incurring the monthly line rental.

In 1999, when Cell C was licensed, Vodacom and MTN raised the interconnection fee, resulting in off-net call costs increasing from below average on-net costs to above them. Cell C only entered the South African

Telecommunications market in 2001 and they responded to the incumbents' termination based price discrimination through price discriminating themselves.

The entry strategy of Virgin Mobile in 2006 is interesting in that they only offer pre-paid linear tariffs and contrary to the rival networks they do not use termination-based price discrimination. While it is free to port to Virgin Mobile users still have to purchase a SIM card for R55, so there is a switching cost to consumers.

Consumers are indifferent between subscribing to the incumbent oligopoly (MTN, Vodacom and Cell C), and Virgin Mobile when they offer the same utility.

Virgin Mobile is a profit maximiser, which suggests that there is some benefit to them to entering with uniform pricing. Their profit function under uniform pricing, where the incumbent oligopoly, network$_o$, consists of MTN, Vodacom and Cell C, is given by

$$\pi_{vm} = \underbrace{\alpha_{vm}[(p_{vm} - c)q(p_{vm}) - f]}_{Retail\,Profit}$$
$$+ \underbrace{\alpha_{vm}(\alpha_o - \alpha_{vm})(a - c_0)[q(\hat{p}_o) - q(p_{vm})] + \alpha_{vm}\alpha_t(a - c_0)[q(\hat{p}_t) - q(p_{vm})]}_{AccessSurplus\,/\,Deficit}$$

If they had practiced termination-based price discrimination their profit function would have been

$$\pi_{vm} = \underbrace{\alpha_{vm}[(\tilde{p}_{vm} - c)q(\tilde{p}_{vm}) - f]}_{Retail\ Profit}$$
$$+ \underbrace{\alpha_{vm}(\alpha_{o} - \alpha_{vm})(a - c_0)[q(\hat{p}_o) - q(\hat{p}_{vm})] + \alpha_{vm}\alpha_t(a - c_0)[q(\hat{p}_t) - q(\hat{p}_{vm})]}_{Access Surplus / Deficit}$$

By entering with uniform pricing Virgin Mobile is signaling to the market that they will not be fierce competitors. They cannot compete easily with the other incumbent mobile providers for market share as they cannot drop on-net prices. They would have to drop average prices and incur an access deficit.

It would be ideal for the networks if they could all soften competition through uniform pricing. Virgin Mobile has introduced a shift in the pricing policy which can be followed by Neotel. Uniform pricing policies benefit undifferentiated oligopolies immensely as they can no longer drop their on-net prices to marginal cost.

9. CONCLUSION

In this work I have examined the impact of spatial differentiation à la Hotelling on the equilibrium of oligopolies. I reason that, under both uniform pricing and termination-based price differentiation, the Nash equilibrium is for the rival networks to charge the Ramsey price and split the market. There is never an access deficit. Non-differentiation does not support price discrimination.

Entry of a differentiated network, which is not a good substitute to the incumbents, restores prices above the Ramsey social optimum. While the incumbents are still concerned with incurring an access deficit with each other for market share they are reluctant to drop their prices too low as they will incur an access deficit with the entrant. The effect on consumer welfare is uncertain; it is increased through more product choice, but decreased by the price increase. An extension of the work would be a more rigorous examination of entry, of which the foundation has been laid. Oligopolists welcome differentiated entry, unlike monopolists who may attempt to bankrupt the entrant.

The model is then applied to the South African oligopoly. A potential extension of the work would be to model the entry of Neotel, the newly licensed fixed-line provider, into the South African market. To make the model more realistic one should allow for wealthy consumers who treat mobile and fixed line phones as complements and may own both.

10. REFERENCE LIST

ARMSTRONG, M. (2002) "The Theory of Access Pricing and Interconnection", in CAVE, M. E, MAJUMDAR, S. K, and VOGELSANG, I. (eds) (2002). *Handbook of Telecommunications Economics Vol. 1: Structure, Regulation and Competition.* North Holland. Amsterdam: 295-384.

ARMSTRONG, M. (1998) "Network Interconnection in Telecommunications", in *The Economic Journal*, Vol. 108: 545-564.

ARMSTRONG, M., DOYLE, C., and VICKERS, J. (1996) "The Access Pricing Problem: A Synthesis", in *The Journal of Industrial Economics*, Vol. 44: 131-150.

ARMSTRONG, M., and VICKERS, J. (1998) "The Access Pricing Problem with Deregulation: A Note", in *The Journal of Industrial Economics*, Vol. 46: 115-121.

CAVE, M. and VOGESLANG, I. (2003). "How Access Pricing and Entry Interact", in *Telecommunications Policy,* Vol. 27: 717-727.

CANOY, M. and Peitz, M. (1997) "The Differentiation Triangle", in *The Journal of Industrial Economics*, Vol. 45: 305-328.

CHURCH, J. R. and WARE, R. (2000). *Industrial Organisation: A Strategic Approach*. Irwin McGraw Hill. Boston.

DESSEIN, W. (2003). "Network Competition in Nonlinear Pricing" in The RAND Journal of Economics, Vol. 34: 593-611.

DIXIT, A and SKEATH, S. (1999). *Games of Strategy*. W. W. Norton and Company. New York.

FARELL, J. and SHAPIRO, C. (1988). "Dynamic Competition with Switching Costs", in *The RAND Journal of Economics*, Vol. 19: 123-137.

GIOVANETTI, E. (2005). "Diagonal Mergers and Foreclosure on the Internet", in *Review of Network Economics*, Vol. 4: 33-62.

GRIFFIN, J. M. (1982). "The Welfare Implications of Externalities and Price Elasticities for Telecommunications Pricing" in *The Review of Economics and Statistics*, Vol. 64: 59-66.

HODGE, J. (2001). "Promoting Competitive Outcomes in the Fixed Line Telecommunications Sector in South Africa", from *Butterworths LexisNexis*

HODGE, J. (2005). "Tariff Structures and Access Substitution of Mobile Cellular for Fixed Line in South Africa", in *Telecommunications Policy*, Vol. 29: 493-505.

JEON, D., LAFFONT, J. and TIROLE, J. (2004). "On the 'Receiver Pays' Principle", in *The RAND Journal of Economics*, Vol. 35: 85-110.

LAFFONT, J and TIROLE, J. (2000) *Competition in Telecommunications*. MIT Press. Massachusetts.

LAFFONT, J., REY, P. and TIROLE, J. (1998a). "Network Competition: I. Overview and Nondiscriminatory Pricing", in *The RAND Journal of Economics*, Vol. 29: 1-37.

LAFFONT, J., REY, P. and TIROLE, J. (1998b). "Network Competition: II. Price Discrimination", in *The RAND Journal of Economics*, Vol. 29: 38-56.

LAPUERTA, C., and TYE, W. B. (1999). "Promoting Effective Competition through Interconnection Policy", in *Telecommunications Policy*, Vol. 23: 129-145.

LESSEM, N. (2005). *Interconnection and Strategic Competition in the South African Mobile Sector*. Unpublished Paper submitted in partial fulfillment of an Economics Honours Degree to the University of Cape Town.

SOUTH AFRICA FOUNDATION. (2005). *Reforming Telecommunications in South Africa: Twelve Proposals for lowering costs and improving access*. Occasional Paper No 2/2005.

TAYLOR, L. D. (1994). *Telecommunications Demand in Theory and Practice*. Boston. Kluwer Academic Publishers.

TIROLE, J. (1988). *The Theory of Industrial Organisation*, MIT Press. London.

THORNTON, L (Ed.). (2006). *Telecommunications Law in South Africa*. STE Publishers. Johannesburg.

VALLETTI, T. M., and CAMBINI, C. (2003). "Investments and Network Competition", Unpublished Paper.

VARIAN, H. R. (1992). *Microeconomic Analysis*. 3rd Edition. W. W. Norton & Company. New York.

PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

2. This paper entitled *Who Pays at the End?: Termination Based Price Discrimination and Entry in Telecommunications* is my own work.

3. I have used the Harvard convention for citation and referencing. Each contribution to and quotation in this paper from the work of others has been cited and referenced.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

Signature:

Date: 21 May 2007

TMHJUS001

http://www.crfonline.org/orc/cro/cro-9-1.html
21-05-07 12:41

Understanding and Using Letters of Credit, Part I

Letters of credit accomplish their purpose by substituting the credit of the bank for that of the customer, for the purpose of facilitating trade. There are basically two types: commercial and standby. The commercial letter of credit is the primary payment mechanism for a transaction, whereas the standby letter of credit is a secondary payment mechanism.

Commercial Letter of Credit

Commercial letters of credit have been used for centuries to facilitate payment in international trade. Their use will continue to increase as the global economy evolves.

Letters of credit used in international transactions are governed by the International Chamber of Commerce Uniform Customs and Practice for Documentary Credits. The general provisions and definitions of the International Chamber of Commerce are binding on all parties. Domestic collections in the United States are governed by the Uniform Commercial Code.

A commercial letter of credit is a contractual agreement between a bank, known as the issuing bank, on behalf of one of its customers, authorizing another bank, known as the advising or confirming bank, to make payment to the beneficiary. The issuing bank, on the request of its customer, opens the letter of credit. The issuing bank makes a commitment to honor drawings made under the credit. The beneficiary is normally the provider of goods and/or services. Essentially, the issuing bank replaces the bank's customer as the payee.

Elements of a Letter of Credit

- A payment undertaking given by a bank (issuing bank)
- On behalf of a buyer (applicant)
- To pay a seller (beneficiary) for a given amount of money
- On presentation of specified documents representing the supply of goods
- Within specified time limits
- Documents must conform to terms and conditions set out in the letter of credit
- Documents to be presented at a specified place

Beneficiary

The beneficiary is entitled to payment as long as he can provide the documentary evidence required by the letter of credit. The letter of credit is a distinct and separate transaction from the contract on which it is based. All parties deal in documents and not in goods. The issuing bank is not liable for performance of the underlying contract between the customer and beneficiary. The issuing bank's obligation to the buyer, is to examine all documents to insure that they meet all the terms and conditions of the credit. Upon requesting demand for payment the beneficiary warrants that all conditions of the agreement have been complied with. If the beneficiary (seller) conforms to the letter of credit, the seller must be paid by the bank.

Issuing Bank

The issuing bank's liability to pay and to be reimbursed from its customer becomes absolute upon the completion of the terms and conditions of the letter of credit. Under the provisions of the Uniform Customs and Practice for Documentary Credits, the bank is given a reasonable amount of time after receipt of the documents to honor the draft.

The issuing banks' role is to provide a guarantee to the seller that if compliant documents are presented, the bank will pay the seller the amount due and to examine the documents, and only pay if these documents comply with the terms and conditions set out in the letter of credit.

Typically the documents requested will include a commercial invoice, a transport document such as a bill of lading or airway bill and an insurance document; but there are many others. Letters of credit deal in documents, not goods.

Advising Bank

An advising bank, usually a foreign correspondent bank of the issuing bank will advise the beneficiary. Generally, the beneficiary would want to use a local bank to insure that the letter of credit is valid. In addition, the advising bank would be responsible for sending the documents to the issuing bank. The advising bank has no other obligation under the letter of credit. If the issuing bank does not pay the beneficiary, the advising bank is not obligated to pay.

Confirming Bank

The correspondent bank may confirm the letter of credit for the beneficiary. At the request of the issuing bank, the correspondent obligates itself to insure payment under the letter of credit. The confirming bank would not confirm the credit until it evaluated the country and bank where the letter of credit originates. The confirming bank is usually the advising bank.

Letter of Credit Characteristics

Negotiability

Letters of credit are usually negotiable. The issuing bank is obligated to pay not only the beneficiary, but also any bank nominated by the beneficiary. Negotiable instruments are passed freely from one party to another almost in the same way as money. To be negotiable, the letter of credit must include an unconditional promise to pay, on demand or at a definite time. The nominated bank becomes a holder in due course. As a holder in due course, the holder takes the letter of credit for value, in good faith, without notice of any claims against it. A holder in due course is treated favorably under the UCC.

The transaction is considered a straight negotiation if the issuing bank's payment obligation extends only to the beneficiary of the credit. If a letter of credit is a straight negotiation it is referenced on its face by "we engage with you" or "available with ourselves". Under these conditions the promise does not pass to a purchaser of the draft as a holder in due course.

Revocability

Letters of credit may be either revocable or irrevocable. A revocable letter of credit may be revoked or modified for any reason, at any time by the issuing bank without notification. A revocable letter of credit cannot be confirmed. If a correspondent bank is engaged in a transaction that involves a revocable letter of credit, it serves as the advising bank.

Once the documents have been presented and meet the terms and conditions in the letter of credit, and the draft is honored, the letter of credit cannot be revoked. The revocable letter of credit is not a commonly used instrument. It is generally used to provide guidelines for shipment. If a letter of credit is revocable it would be referenced on its face.

The irrevocable letter of credit may not be revoked or amended without the agreement of the issuing bank, the confirming bank, and the beneficiary. An irrevocable letter of credit from the issuing bank insures the beneficiary that if the required documents are presented and the terms and conditions are complied with, payment will be made. If a letter of credit is irrevocable it is referenced on its face.

Transfer and Assignment

The beneficiary has the right to transfer or assign the right to draw, under a credit only when the credit states that it is transferable or assignable. Credits governed by the Uniform Commercial Code (Domestic) maybe transferred an unlimited number of times. Under the Uniform Customs Practice for Documentary Credits (International) the credit may be transferred only once. However, even if the credit specifies that it is nontransferable or nonassignable, the beneficiary may transfer their rights prior to performance of conditions of the credit.

Sight and Time Drafts

All letters of credit require the beneficiary to present a draft and specified documents in order to receive payment. A draft is a written order by which the party creating it, orders another party to pay money to a third party. A draft is also called a bill of exchange.

There are two types of drafts: sight and time. A sight draft is payable as soon as it is presented for payment. The bank is allowed a reasonable time to review the documents before making payment.

A time draft is not payable until the lapse of a particular time period stated on the draft. The bank is required to accept the draft as soon as the documents comply with credit terms. The issuing bank has a reasonable time to examine those documents. The issuing bank is obligated to accept drafts and pay them at maturity.

Standby Letter of Credit

The standby letter of credit serves a different function than the commercial letter of credit. The commercial letter of credit is the primary payment mechanism for a transaction. The standby letter of credit serves as a secondary payment mechanism. A bank will issue a standby letter of credit on behalf of a customer to provide assurances of his ability to perform under the terms of a contract between the beneficiary. The parties involved with the transaction do not expect that the letter of credit will ever be drawn upon.

The standby letter of credit assures the beneficiary of the performance of the customer's obligation. The beneficiary is able to draw under the credit by presenting a draft, copies of invoices, with evidence that the customer has not performed its obligation. The bank is obligated to make payment if the documents presented comply with the terms of the letter of credit.

Standby letters of credit are issued by banks to stand behind monetary obligations, to insure the refund of advance payment, to support performance and bid obligations, and to insure the completion of a sales contract. The credit has an expiration date.

The standby letter of credit is often used to guarantee performance or to strengthen the credit worthiness of a customer. In the above example, the letter of credit is issued by the bank and held by the supplier. The customer is provided open account terms. If payments are made in accordance with the suppliers' terms, the letter of credit would not be drawn on. The seller pursues the customer for payment directly. If the customer is unable to pay, the seller presents a draft and copies of invoices to the bank for payment.

The domestic standby letter of credit is governed by the Uniform Commercial Code. Under these provisions, the bank is given until the close of the third banking day after receipt of the documents to honor the draft.

Procedures for Using the Tool

The following procedures include a flow of events that follow the decision to use a Commercial Letter of Credit. Procedures required to execute a Standby Letter of Credit are less rigorous. The standby credit is a domestic transaction. It does not require a correspondent bank (advising or confirming). The documentation requirements are also less tedious.

Step-by-step process:

- Buyer and seller agree to conduct business. The seller wants a letter of credit to guarantee payment.
- Buyer applies to his bank for a letter of credit in favor of the seller.
- Buyer's bank approves the credit risk of the buyer, issues and forwards the credit to its correspondent bank (advising or confirming). The correspondent bank is usually located in the same geographical location as the seller (beneficiary).
- Advising bank will authenticate the credit and forward the original credit to the seller (beneficiary).
- Seller (beneficiary) ships the goods, then verifies and develops the documentary requirements to support the letter of credit. Documentary requirements may vary greatly depending on the perceived risk involved in dealing with a particular company.
- Seller presents the required documents to the advising or confirming bank to be processed for payment.
- Advising or confirming bank examines the documents for compliance with the terms and conditions of the letter of credit.
- If the documents are correct, the advising or confirming bank will claim the funds by:
    - Debiting the account of the issuing bank.
    - Waiting until the issuing bank remits, after receiving the documents.
    - Reimburse on another bank as required in the credit.
- Advising or confirming bank will forward the documents to the issuing bank.
- Issuing bank will examine the documents for compliance. If they are in order, the issuing bank will debit the buyer's account.
- Issuing bank then forwards the documents to the buyer.

Standard Forms of Documentation

When making payment for product on behalf of its customer, the issuing bank must verify that all documents and drafts conform precisely to the terms and conditions of the letter of credit. Although the credit can require an array of documents, the most common documents that must accompany the draft include:

Commercial Invoice

The billing for the goods and services. It includes a description of merchandise, price, FOB origin, and name and address of buyer and seller. The buyer and seller information must correspond exactly to the description in the letter of credit. Unless the letter of credit specifically states otherwise, a generic description of the merchandise is usually acceptable in the other accompanying documents.

Bill of Lading

A document evidencing the receipt of goods for shipment and issued by a freight carrier engaged in the business of forwarding or transporting goods. The documents evidence control of goods. They also serve as a receipt for the merchandise shipped and as evidence of the carrier's obligation to transport the goods to their proper destination.

Warranty of Title

A warranty given by a seller to a buyer of goods that states that the title being conveyed is good and that the transfer is rightful. This is a method of certifying clear title to product transfer. It is generally issued to the purchaser and issuing bank expressing an agreement to indemnify and hold both parties harmless.

Letter of Indemnity

Specifically indemnifies the purchaser against a certain stated circumstance. Indemnification is generally used to guaranty that shipping documents will be provided in good order when available.

Common Defects in Documentation

About half of all drawings presented contain discrepancies. A discrepancy is an irregularity in the documents that causes them to be in non-compliance to the letter of credit. Requirements set forth in the letter of credit cannot be waived or altered by the issuing bank without the express consent of the customer. The beneficiary should prepare and examine all documents carefully before presentation to the paying bank to avoid any delay in receipt of payment. Commonly found discrepancies between the letter of credit and supporting documents include:

- Letter of Credit has expired prior to presentation of draft.
- Bill of Lading evidences delivery prior to or after the date range stated in the credit.
- Stale dated documents.
- Changes included in the invoice not authorized in the credit.
- Inconsistent description of goods.
- Insurance document errors.
- Invoice amount not equal to draft amount.
- Ports of loading and destination not as specified in the credit.
- Description of merchandise is not as stated in credit.
- A document required by the credit is not presented.
- Documents are inconsistent as to general information such as volume, quality, etc.
- Names of documents not exact as described in the credit. Beneficiary information must be exact.
- Invoice or statement is not signed as stipulated in the letter of credit.

When a discrepancy is detected by the negotiating bank, a correction to the document may be allowed if it can be done quickly while remaining in the control of the bank. If time is not a factor, the exporter should request that the negotiating bank return the documents for corrections.

If there is not enough time to make corrections, the exporter should request that the negotiating bank send the documents to the issuing bank on an approval basis or notify the issuing bank by wire, outline the discrepancies, and request authority to pay. Payment cannot be made until all parties have agreed to jointly waive the discrepancy.

Tips for Exporters

- Communicate with your customers in detail before they apply for letters of credit.
- Consider whether a confirmed letter of credit is needed.
- Ask for a copy of the application to be fax to you, so you can check for terms or conditions that may cause you problems in compliance.
- Upon first advice of the letter of credit, check that all its terms and conditions can be complied with within the prescribed time limits.
- Many presentations of documents run into problems with time-limits. You must be aware of at least three time constraints - the expiration date of the credit, the latest shipping date and the maximum time allowed between dispatch and presentation.
- If the letter of credit calls for documents supplied by third parties, make reasonable allowance for the time this may take to complete.
- After dispatch of the goods, check all the documents both against the terms of the credit and against each other for internal consistency.

Summary

The use of the letters of credit as a tool to reduce risk has grown substantially over the past decade. Letters of credit accomplish their purpose by substituting the credit of the bank for that of the customer, for the purpose of facilitating trade.

The credit professional should be familiar with two types of letters of credit: commercial and standby. Commercial letters of credit are used primarily to facilitate foreign trade. The commercial letter of credit is the primary payment mechanism for a transaction.

The standby letter of credit serves a different function. The standby letter of credit serves as a secondary payment mechanism. The bank will issue the credit on behalf of a customer to provide assurances of his ability to perform under the terms of a contract.

Upon receipt of the letter of credit, the credit professional should review all items carefully to insure that what is expected of the seller is fully understood and that he can comply with all the terms and conditions. When compliance is in question, the buyer should be requested to amend the credit.