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CONNECTING PEOPLE

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Connecting People

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Abstract

This paper presents a model in which firms invest on their customer-networks to maintain current and future profitabilities. The model is used to illustrate how the costs of maintaining networks and uncertainties about the customer-networks reduce the importance of making investments on the customer-base. Empirical evidence provides support for the theory.

Keywords: Network Costs, Uncertainty, Pricing.

JEL classification: D43; D80; L11

1. Introduction

For certain firms acquiring a large customer base has two visible benefits. The first is that a big customer base naturally leads to a larger volume of sales. The second benefit is that it can create the potential for a network externality à la Katz and Shaprio (1985) but from the sellers viewpoint in that it can encourage customers to use more the services provided by the seller between themselves since it may either be cheaper or more convenient thereby generating extra business. Consider the example of the communications network where people connected to a network find it cheaper to stay in touch and contact more frequently with people subscribed to the same network than they would otherwise do. Alongside these benefits also come some costs for both the firm and the customer. Indeed, the firm needs to invest on connecting people in this way while the customer has to abide by a binding contract, often annual, to benefit from such a connection. Also, there

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is no guarantee for the firm that people will utilize such connections in the way it hopes which introduces some element of unpredictability in the sales generated from the network externality.

To the authors knowledge there have been few attempts to model such an environment from the firm's viewpoint. A study that comes close is Katz and Shapiro (1985) which rather takes consumer's viewpoint. Two other studies deserve mentioning; Phelps and Winter (1970) in the past and more recently in this issue Konigstein and Muller (2001). Indeed, the former discusses the information-frictions and the latter the customer-orientation aspects of the product markets.

In this paper we develop a simple dynamic pricing model to analyze a market that exclusively incorporates the second dimension of the customer base. In particular we study the effects of the costs of investing on a customer-network and the uncertainties related to these investments on the optimal price. The types of costs a firm may incur to maintain a network are offering discounted prices for people in the network, free-equipment in exchange for a binding contract, dedicated sales staff, satisfaction surveys and market research (See Homburg and Rudolph (2001)).

Our model investigates this environment within the customer-market framework initiated by Phelps and Winter (1970). Our model belongs to the class of dynamic models of product-market imperfections in which customers are treated like assets. Such models have been especially applied to explain the cyclical behavior of markups (Rotemberg and Woodford (1989), Bils (1987), Choudhary and Orszag (2001)). In our model the firm sets its price and the customers are bound to the firm by a contract[1] for a fixed period. Thus, when customers find a better

[1]There are two other reasons why customers may be reluctant to change supppliers. The first is that they have monetary and non-monetary 'switching-costs ' à la Klemperer. The

deal they only gradually switch to a new seller. As a result of these delays, each customer (or their volume) becomes an asset and can be exploited through higher prices. Hence, the firm faces a trade-off in that it can raise prices but only at the expense of gradually losing sales generated from its customers base. Thus, the pricing policy has a long-term implication; we call this the customer-market effect.

We introduce in this dynamic setup networking-costs and uncertainty related to the customer-base as a determinant of the pricing policy. We will show that a high level of uncertainty in the network together with costly maintenance of customer-networks reduce the incentives for firms to invest on their customers. We also find a negative relationship between uncertainty and various measures of investments on the customer networks.

The following section lays out the structure of the model and Section 3 examines the empirical relationship between uncertainty and customer-network costs. Section 4 concludes.

2. Model

Consider an industry with an arbitrary number of identical monopolistically-competitive firms. The representative firm invests on customers and uses its price policy to maintain and expand its sales through its network of customers, x_i. There are costs of connecting people and maintaining the network and those are captured by $M(x_i)$. The demand for each member of network (i.e. a single

second, the original Phelps and Winter's (1970) intution, is that there can be imperfections in the dissemination of information on prices that creates delays in the customer's decesion to switch.

customer) is assumed to take to take the form

$$y_i = f(p_i/p) = A\,(p_i/p)^{-\eta}\,, f'(.) < 0, 0 \le f''(.) \le -2f'(.)f^{-1}(.) \tag{1}$$

where η, p_i/p, y_i, A denote demand elasticity, the ratio of the firm's own price and the average market price for similar products, output and a shift parameter respectively. Thus, demand is higher when the firm is more competitive in terms of prices relative to other firms. This type of demand explicitly results from a model where customers conduct a sequential-search for the cheapest product with a uniform distribution of search costs across buyers (see Carlson and McAfee (1983)). Thus, total sales are then given by, $y_i x_i$. So, when the size of the customer-network, $x_{i,}$ is small so are the sales.

Overtime, the success of a customer-network depends on relative prices but there are unpredictabilities so that growth in the firm's customer-network can be written as a geometric Brownian motion $dx_i/x_i = g_0(p^i/p)dt + \sigma^2\sqrt{g_1(p_i/p)}dz$ where z is a Wiener process; $dz = \varepsilon\sqrt{dt}$ since it is normally-distributed random variable with mean zero standard deviation of unity. The function g_0 assumes that growth in the network is a function of the price set by the firm, p_i, and the average price elsewhere in the industry, p. The term σ captures the relative importance of uncertainty in the growth of the network. The functions g_0 and g_1 are the same except that the latter has a positive constant added. This ensures that the firm faces uncertainty at all times. Assuming that the function[2] $g_0 = \gamma - \gamma(p_i/p)^{\mu}$, the marginal change in customer-network size when the relative price differs is $-\gamma\mu(p_i/p)^{\mu-1}$ where $\gamma\mu$ determines implicitly the strength of delays in customer

[2]Note that at $p_i = p$ we have $g_0(1) = 0$.

movements between sellers or networks which are caused by the temporary locking of customers in contracts.

Using Ito's lemma, the customer-network Brownian motion and Eq. (1), the representative firm's profit maximization can be described by the following Bellman equation:

$$\rho F(x_i) = p_i y_i x_i - c y_i x_i - M(x_i) + x^i F_{x^i} g_0 + \frac{1}{2} x_i^2 \sigma^2 F_{x^i x^i} g_1(p_i/p) \qquad (2)$$

$F(.)$ denotes the value of the firm, ρ is real interest rate and the convex function $M(x_i)$ are the investments the firm makes on maintaining customer-network. The intuition for a convex customer-network costs structure is that as the customer base expands so do customer types, their needs and the packages they require. These together can drive up the costs of sustaining a large customer network. The first three terms on the right-hand-side represent the immediate profit from x_i units of the customer-network whereas the remaining two terms represent the value of an increase in the customer network. For simplicity it is assumed that marginal costs of production, c, are constant.

The first-order condition for p_i is

$$\begin{aligned} 0 &= A\left(p_i/p\right)^{-\eta} x_i - \eta A \left(p_i/p\right)^{-\eta} x_i + \eta A p_i^{-1} \left(p_i/p\right)^{-\eta} c x_i \\ &\quad -(x_i F_{x_i} + \frac{1}{2} x_i^2 \sigma^2 F_{x_i x_i}) \gamma \mu (p_i/p)^{\mu} p_i^{-1} \qquad (3) \end{aligned}$$

At the equilibrium where $p_i = p$ the necessary condition can be expressed as a pricing equation

$$p_i = \frac{\eta c}{\eta - 1} - \frac{\mu \gamma F_{x_i}}{A(\eta - 1)} - \frac{\mu \gamma \sigma^2 x_i F_{x_i x_i}}{2A(\eta - 1)} \qquad (4)$$

The first term on the right-hand-side is the textbook monopoly markup assuming that elasticity exceeds unity. The second term is the investment that the firm makes- in terms of lower prices- when it accounts for the intertemporal aspect of its network. The third term captures the effect of uncertainty on the intertemporal aspect of the customer-network.

Substituting the first-order condition in (2) and assuming the equilibrium condition that $p_i = p$ gives the following equation:

$$\rho F(x_i) = \frac{Acx_i}{\eta - 1} - M(x_i) - \frac{\mu\gamma}{\eta - 1}(x_i F_{x_i} + \frac{1}{2}x_i^2\sigma^2 F_{x_i x_i}) \tag{5}$$

Assuming a simple convex cost function for customer-network costs $M(x_i) = mx_i^2$, Eq.(5) has the solution

$$F(x_i) = \frac{Acx_i}{\rho(\eta - 1) + \mu\gamma} - \frac{m(\eta - 1)x_i^2}{\rho(\eta - 1) + \mu\gamma(\sigma^2 + 2)} \tag{6}$$

The customer-network is more valuable at the margin when the marginal costs of production, demand and uncertainty (due to the option value see Dixit and Pindyeck (1994)) are high but is less valuable when the customer-network costs are high.

We use Eqs. (6) and (4) to obtain an explicit solution for the price:

$$p_i = \frac{\eta c}{\eta - 1} - \frac{\mu\gamma c}{A(\rho(\eta - 1) + \mu\gamma)(\eta - 1)} + \frac{(\sigma^2 + 2)\mu\gamma m}{\rho(\eta - 1) + \mu\gamma(\sigma^2 + 2)} \tag{7}$$

The first term on the right hand side is the textbook monopoly markup. The second term captures the investment the firm makes – in the form of lower prices – when it takes in to account the intertemporal value of its customer-network.

This arises from the market frictions ($\mu\gamma$) which generate the customer-network dynamics. Thus, the firm sacrifices some of its current profits in favor of keeping its customer network. The third term, however, shows that uncertainty reduces this intertemporal value in that the non-instantaneous effect on prices that results from a dynamic network is reduced. Similarly, this third term also shows that high customer-network costs can also short-circuit the importance of maintaining future networks. Altogether, these can cause firms to invest smaller amounts – in the form of higher prices– on their customer base. A profound implication of these result is that network-unpredictability and customer-network costs soften and can even reverse the customer-market effects. The following section presents empirical evidence on customer investments and uncertainty.

3. Empirical Testing

We use the estimated average level of markups and a proxy for customer-network costs as measures of investments on customers. We test for the relationship between markups and customer-network costs and uncertainty implied by Eq.(7). Following Hall's papers (1986) and Haskel et al. (1995) the average markups are estimated using a two-stage fixed-effect model:

$$\Delta(y-k)_{it} = a_i + b_1 d7480 + b_2 d8191 + \mu_i \alpha_{it} \Delta(l+h-k)_{it}$$

where $\Delta(y-k)$, $\Delta(l+h-k)$, μ, h, l, α are the growths in output and labor per unit of capital, the markup, actual labor hours, labor, share of capital in the production respectively. The term a is the Solow residual and to control for its variation overtime we have included two dummy variables over the periods of

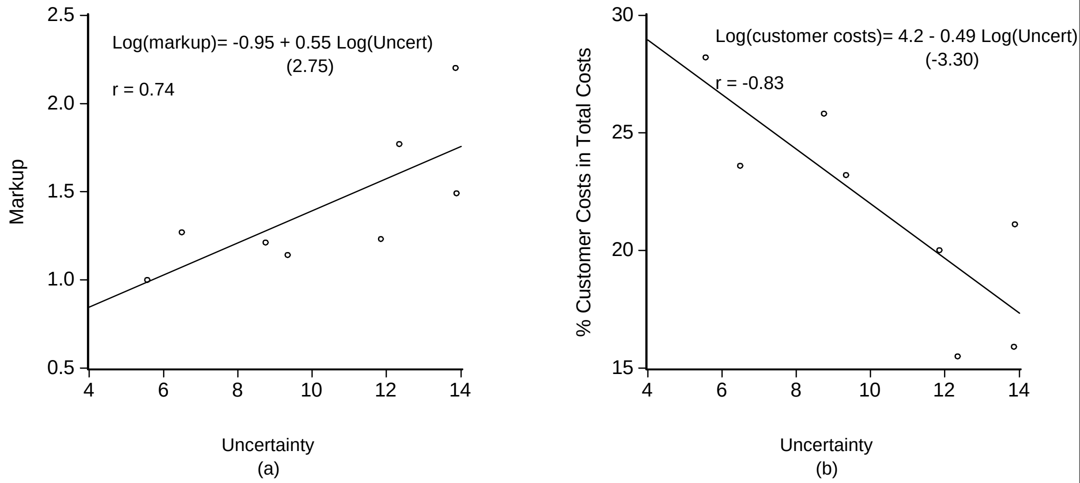

Figure 1:

1974-1980 and 1981-1991. The markups are estimated for eight British industries[3] over the period of 1968-1991 using data from UK's Census of Production and Employment Gazette. We proxy for customer network costs by collecting data on over the same period on 'non-industrial services costs[4]' and 'costs of operatives[5]' from UK's Annual Manufacturers Survey. Uncertainty is proxied by the standard deviation of sales between for those industries over 1968-1991.

Figs. (a) and (b) plots the various relationships implied by Eq.(7) with their correlation coefficients. Both are statistically significant even though we have only 8 industries. These results suggest that on the one hand industries with

[3] Industries include : Chemical, Metal Manufacturing, Motor Vehicle, Electrical, Textile, Mechnical, Other Metal, Clothing and Footwear.

[4] Non-industrial services compormise of customer-relation management, telecommunications, shipping costs, market resarch and advertising.

[5] These include costs of hiring operatives such as builders, fitters, maintenance workers, tranporters, sales personnel.

higher uncertainty tend to charge higher markups, hence lower investment on their customer base. On the other hand industries with higher uncertainty appear to spend less on customer-networking. Thus both channels of investment on customers are negatively correlated with uncertainty. Figs (a) and (b) also imply that industries that invest less on customer-networking also charge the highest markups and are thus less keen on building their networks.

4. Conclusion

We have derived a dynamic pricing model with customer-networks costs and randomness in the customer networks. Our model predicts that with higher uncertainty and customer-network costs firms are less keen on investing on their customer-network to maintain and build their future profitability. We found statistically significant relationships between markups and customers-costs and uncertainty on UK data.

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