Pricing behavior of firms when consumers have an Imperfect Recall

Hasan, Syed Akif and Subhani, Muhammad Imtiaz and Osman, Ms. Amber and Mehar, Ayub

Iqra University Research Centre (IURC), Iqra university Main Campus Karachi, Pakistan, Iqra University

2012

Accepted in

American Journal of Scientific Research (AJSR), 2012

Pricing behavior of firms when consumers have an Imperfect Recall

Muhammad Imtiaz Subhani
Iqra University Research Centre-IURC , Iqra University- IU,
Defence View, Shaheed-e-Millat Road (Ext.) Karachi-75500, Pakistan
E-mail: drsubhani@yahoo.co.uk
Tel: (92-21) 111-264-264 (Ext. 2010); Fax: (92-21) 35894806

Syed Akif Hasan
Office of Registrar, Iqra University- IU,
Defence View, Shaheed-e-Millat Road (Ext.)
Karachi-75500, Pakistan
E-mail: hasandrakif@gmail.com
Tel: (92-21) 111-264-264 (Ext. 1513); Fax: (92-21) 35894806

Amber Osman
Iqra University Research Centre-IURC , Iqra University- IU,
Defence View, Shaheed-e-Millat Road (Ext.) Karachi-75500, Pakistan
E-mail: amber.osman@yahoo.com
Tel: (92-21) 111-264-264 (Ext. 2010); Fax: (92-21) 35894806

Muhammad Nayaz
Iqra University Research Centre-IURC , Iqra University- IU,
Defence View, Shaheed-e-Millat Road (Ext.) Karachi-75500, Pakistan
E-mail: muhammadnayaz@yahoo.com
Tel: (92-21) 111-264-264 (Ext. 2010); Fax: (92-21) 35894806

Ayub Mehar
Iqra University Research Centre-IURC , Iqra University- IU,
Defence View, Shaheed-e-Millat Road (Ext.) Karachi-75500, Pakistan
Tel: (92-21) 111-264-264 (Ext. 2010); Fax: (92-21) 35894806

Abstract

Operating in markets which include the characteristics of both the perfect and imperfect competitions has never been so easy for a firm, while setting an acceptable price. Various firms show various pricing behavior to generate and maximize revenues. This paper is an attempt to encompass pricing behaviors of firms when consumers have imperfect recall for the past prices of the products, while giving a thought to ponder that which of the behaviors has an optimal rationale when a firm sets market price for a commodity. The findings concludes that firms set prices as similar as monopolist when the consumers of their products have imperfect recall for price they offered already in yore.

Keywords: Imperfect recall, pricing behavior, monopolist, hotelling tradeoff

1. Introduction

There is hardly someone who knows the price of a given consumption good in the stores even though the stores; they are operated from the immediate vicinities. One may have a quite fair idea on the average price level at different stores but one does not recall the precise price of golden apples. The textbook model of price competition for homogeneous goods assumes however that consumers, they are fully informed about the prices posted by the firms.

The Marketing literature has commented upon it for decades. Monroe and Lee (1999) in their price-awareness research, confirm that the average absolute recall error ranges from 6% to 19.45% for the correct price. But such recall errors have been neglected by the various firms which implied that in the basic price competition model with a homogeneous good firms charge a markup over the cost and those profits are therefore non-zero. In this paper two models for pricing behavior of firms when consumers have imperfect recall are proposed which includes setting up the price which depends upon firm's own cost and setting up the price which depend upon the other firm's cost. The imperfect recall on prices is modeled in this connection as a random shock (with mean zero) that is added to the real price. Consumers decide where to shop following their wrongly recalled prices, but at the stores the demanded quantity of the goods is a function of their real prices and the firms are however fully rational and maximize their profits anticipating the errors of the consumers. The proposed models are so to speak as the static games; which can be interpreted as the (constant) outcome of a repeated game where there is no learning process by the consumers and the firms then take the advantage of such shortcomings while setting the price on the basis of either its own cost or its competitor's cost.

2. Literature Review

Various pricing behaviors of firms have been interrogated by several of authors from now and then. Hehenkamp (2002) proposed a game where consumers only receive information about the prices of the firms with some given probability. Sellers on the other hand have a probability of learning about the other sellers' prices and profits, while, operating in an imperfect market. Depending on the level of passiveness, i.e. frequency with which they receive new information, the equilibrium price is set between the marginal cost and monopoly pricing regimes. Chen, Iyer, and Pazgal (2005) use the limited memory model of Dow (1991), where consumers do not recall the exact price but only a price range to which it belongs which compels firms to choose a random price strategy, where the number of possible prices equals the number of memory partitions. Gabaix and Laibson (2004); Gabaix, Laibson, and Li (2005) confirmed that the consumers make errors when evaluating the value of a product, which allow an increase in noise of the product evaluation and the utter benefits then go to the firms in shape of setting up high prices. Gabaix and Laibson (2006) stressed that consumers are unable to fully take into account the add-on charge, so that firms have positive profits. The seminal paper by Diamond (1971) assumes that consumers do not know the prices of firms; they visit different stores, only purchase when a price below a given cutoff price is found. Hence, the prices will be adjusted in between the firm's own marginal cost and the monopoly pricing zones. While, Baye and Morgan (2004); Pan, Ratchford, and Shankar (2004) indicate that price dispersion exists in settings which are very close to the textbook Bertrand competition.

Varian (1980) concluded that the firms choose a random pricing strategy, in opposition to a fixed price. That is, the strategy space is a set of probability distributions, not the positive real numbers. Varian (1980) further stressed that the consumers are persistently unaware and uninformed about the prices. Therefore, if stores are allowed to choose a random price distribution, they choose such equilibrium price which might balance the probability of having the lowest price and hence maximizing profits with the uninformed consumers. Spiegler (2006) comes to a similar conclusion when all consumers are unable to memorize the random pricing strategy of firms and has the imperfect recall, which enables most of the firms to set the prices as per their wish while exploiting the consumer's imperfect recall.

3. Basic setup of Model

Consider two risk neutral firms, E and F, selling one homogeneous good whose cost of production is zero (assumed). Firms announce their market prices simultaneously, *pE* by firm E and *pF* by firm F. Consumer $\alpha \in [0,1]$ recalls prices $p_i'^{\alpha} = p_i + e_i^{\alpha}$, for I = E, F, where e_E^{α} and e_F^{α} are independently, autonomously and identically distributed bumps/ shocks for each α with non-degenerate probability density function *f(.)* and cumulative distribution function *F(.)* with an expected value of zero. The consumers/ buyers then do their shopping/ buying at the firm with the lowest recalled price (it can be assumed that they randomize in case of a tie, which happens with probability zero). At the store they learn the real price so the demand curve is therefore given and translated by the real and not the recalled price. The intuition is that the consumer adapts its demand or choice of consumptions when confronted with the real price, in the same that consumer reacts to price promotions and try to bargain with it that he/ she sees in a store.

4. Conceptual Findings

It is assumed that costs of transportation between the two firms are husky. Where *g(x)* is the market share of a firm whose price is lower than its rival's price by *x*. it is given by $g(x) = \int_{-\infty}^{\infty} f(y)f(y + x)dy$. Moreover *g(x)* is independent of α because all consumers have the same price recall shock distribution. Now given the behavior of buyers/ consumers, firm *i, i* = E, F, maximizes expected profits $\prod_i(p_i, p_j) = \mu\, p_i g(p_j - p_i) D(p_i)$ over $p_i \geq 0$, where μ is the number of buyers. Without loss of generality, in terms of price setting, it is assumed that μ = 1. The first order condition for a maximum is

$$\frac{\partial \Pi_i}{\partial p_i} = g(p_j - p_i)D(p_i) - p_i D(p_i) g'(p_j - p_i) + p_i g(p_j - p_i) D'(p_i) = 0 \qquad (1)$$

$$-p_i \frac{D'(p_i)}{D(p_i)} + p_i \frac{g'(p_j - p_i)}{g(p_j - p_i)} = 1$$

$$\varepsilon(p_i) - p_i \frac{d}{dx} ln\, g(p_j - p_i) = 1$$

Where $\varepsilon(p) \equiv \frac{dln\, D(p)}{dlnp}$ is the price elasticity of demand. Notice that this equation can be rewritten as

$$\varepsilon(p) + \varepsilon_i^g(p_i, p_j) = -1 \qquad (2)$$

With $\varepsilon_i^g(p_i, p_j) \equiv p_i \frac{\partial}{\partial p_i} \ln g(p_j - p_i) = -p_i \frac{d}{dx} ln\, g(p_j - p_i)$ being the own price responsiveness of themarket share of firm *i*.

4.1 Recall mistake and Hotelling trade-off

In the basic model where consumers suffer a price recall shock and firms face zero costs, the firms are able to charge a nonnegative price in equilibrium p^* satisfying.

$$2p^* g'(0) = 1 + \varepsilon(p^*) \qquad (3)$$

Each firm opts between the increase of market share achieved through lower price, and the revenue per consumer achieved through higher price. This tradeoff shows up in equation (3) in the term *g'(0),* which stands for the marginal decrease in the market share due to a price increase. In other words, it is the marginal change of the indifferent consumer as in Hotelling models.

Thus, in this model firms are able to manipulate the bounded rationality of consumers. The intuition of the result, in opposition to the zero/ no profit solution, marginal propensity of the indifferent consumer is more or less similar as in Hotelling models.

The term *g'(0)* is lower for huskier variance. The intuition is straightforward, the more difficulties the consumers have in remembering and therefore comparing the prices, the larger price variation the firms have. Suppose the change of the variance is achieved through the "spreading" of the potential random values, that is changing of x to σx with $\sigma > 0$. The new function (density function) f satisfies $\sigma f(\sigma x) = f_o(x)$, with $f_o(x)$ standing for $f(x)$ with $\sigma = 1$, so that $\int f(y)dy = \int \sigma^{-1} f_o(\sigma^{-1} y)\, dy = \int f_o(x)dx = 1$, where $x = \sigma^{-1} y$ and $dy/dx = \sigma$ was used.

The new variance is given by $var(y) = \sigma^2 var(x)$. The term g'(0) appearing in equation (3) changes according to

$$\int_{-\infty}^{\infty} f^2(y)dy = \int_{-\infty}^{\infty} \sigma^{-2} f_o^2(\sigma^{-1} y)dy = \frac{1}{\sigma}\int_{-\infty}^{\infty} f_o^2(x)dx \ ,$$

Or simply $g'(0) = \sigma^{-1} y\, g_o'(0)$, where $g_o'(0)$ is the $g'(0)$ for $\sigma = 1$. The variation in the new equilibrium price is seen in the new version of equation (3)

$$2p^* g'(0) = 1 + \varepsilon(p^*)$$

$$2p^* g_o'(0) = \sigma\,(1 + \varepsilon(p^*))$$

Implicit differentiation of above yields

$$\frac{dp^*}{d\sigma} = \frac{1 + \varepsilon(p^*)}{2g_o'(0) = \sigma\varepsilon'(p^*)} > 0$$

As expected, higher price uncertainty σ means higher price markup. Compared to the fixed demand case (take $(p) = \varepsilon'(p) = 0$) this influence is however smaller, because the denominator is now bigger and the numerator smaller (re-member that $0 \leq 1 + \varepsilon(p^*) < 1$). The intuition is that firms must also take the diminishing demand into account. It is not true that the marginal increase of the price due to σ is always diminishing, for it depends on the value of $\varepsilon'(p^*)$. Two extreme results can however be established.

5. Discussion and Conclusion

As we know that the monopolists always try to charge an additional and maximum markup while exploiting the conditions of imperfect knowledge the consumers have about the market. The findings of this paper also confirms that the firms enjoys the imperfect recall the consumers have for prices of various goods, and thence behave like a monopolist while charging the markups and goes for maximal possible markups. The mark ups increases with the incorrect re call the consumers have for products prices, once the awareness of the price is dropped to zero the price dispersion becomes so husky and due to imperfect recall the consumers do not as such fully react the price differences.

References

[1] Baye, M. R. & J., Morgan. (2004). Price dispersion in the lab and on the internet: Theory and evidence. *Journal of Economics*, 35(3), 449-466.

[2] Chen, Y., G., Iyer & A., Pazgal. (2005). Limited memory and market competition, available at http://groups.haas.berkeley.edu/marketing/ PAPERS/IYER/Memory_july05_final.pdf.

[3] Diamond, P., A. (1971). A model of price adjustment. *Journal of Economic Theory*, 3(2), 156-168.

[4] Dow, J. (1991). Search decisions with limited memory. *Review of Economic Studies*, 58(1), 1-14.

[5] Gabaix, X. & D., Laibson. (2006). Shrouded attributes, consumer myopia, and information suppression in competitive markets. *Quarterly Journal of Economics*, 121(2), 505-540.

[6] Gabaix, X. & D., Laibson. (2004). Competition and consumer confusion; Econometric Society 2004 North American Summer Meetings 663, *Econometric Society*.

[7] Gabaix, X., D., Laibson. & H., Li. (2005). Extreme value theory and the effects of competition on profits, mimeo.
[8] Hehenkamp, B. (2002). Sluggish consumers: An evolutionary solution to the Bertrand paradox. *Games and Economic Behavior*, 40, 44-76.
[9] Monroe, K. B. & A. Y., Lee. (1999). Remembering versus knowing: Issues in buyers' processing of price information. *Journal of the Academy of Marketing Science*, 27(2), 207-225.
[10] Pan, X., B. T., Ratchford. & V. Shankar. (2004). Price dispersion on the internet: A review and directions for future research. *Journal of Interactive Marketing*, 18(4), 116-135.
[11] Spiegler, R. (2006). Competition over agents with boundedly rational expectations. *Theoretical Economics*, 1(2), 207-231.
[12] Varian, H. R. (1980). A model of sales. *American Economic*, 70(4), 651-59.