

Working Paper Series

No. 4

Price discrimination and targeted advertising: a welfare analysis

Rosa Branca Esteves
Paulo Guimarães

November 2000

Núcleo de Investigação em Microeconomia Aplicada
Universidade do Minho



Price Discrimination and Targeted Advertising: A Welfare Analysis

Rosa Branca Esteves
Universidade do Minho and NIMA

Paulo Guimarães*
Universidade do Minho and NIMA

November 24, 1999

Abstract

We present a monopolistic model of price discrimination by means of targeted informative advertising. Targeting is defined as the ability of the monopolist to direct messages with differentiated contents to groups of buyers with different valuations for the good. We show that only if targeting is perfect will the monopolist behave in a socially desirable way.

Keywords: informative advertising, targeting, price discrimination.

JEL classification: D42, D83

*Corresponding Author: Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal. E-mail: paulog@eeg.uminho.pt

1 Introduction

The welfare properties of advertising have been the subject of an ongoing debate that goes back to Kaldor's (1940-41) classical paper. The strand of industrial organization literature that followed helped to clarify several concepts such as those pertaining to the distinction between informative and persuasive advertising. The seminal paper of Butters's (1977), represented the first successful attempt at modelling the impact of informative advertisement in a context where all involved agents act in an optimal fashion. He formally showed that in a monopolistically competitive structure, if informative advertising was the sole source of information and ads were sent in a purely random fashion to homogeneous consumers, then firms would select a socially optimal level of advertising. This puzzling result, was confirmed by Stahl (1994) who extended it to oligopolistic markets and more general advertising technologies. Variations on Butters's (1977) model such as the introduction of product differentiation, (Grossman & Shapiro 1984), or heterogeneity among buyers, (Stegeman 1990) were shown to easily offset this result and helped establish the idea that increased competition stimulated additional advertising, (the *business stealing effect*) while the inability of the firm to appropriate the social surplus it generates acts as a deterrent to advertising (Tirole 1988). Thus, we may conclude that with heterogeneous buyers the monopolist will have an incentive to underprovide informative advertising.

Nowadays, it is more realistic to admit that firms have an increasing ability to target their messages to particular market segments. This fact has not been ignored by researchers who have analysed the implications of targeted advertising. Those authors [e.g. Hernández-García (1997), Grossman & Shapiro (1984)] have concentrated on the role of targeting as a mechanism that can improve the reach of the firm and thus more efficiently bring information to selected market segments. However, the ability of a firm to target its ads opens up the possibility of sending messages with differentiated contents according to their intended target groups. Price discrimination becomes a possibility and it is not clear what welfare implications result in this new setting.

In our paper we focus on a monopoly market to analyse the welfare properties of an equilibrium obtained in the presence of price discrimination by means of targeted advertising. We show that with imperfect targeting the monopolist will overadvertise to the consumers that value most the good and will underadvertise to the other group of buyers. As expected, with perfect advertising he behaves in a socially desirable way.

2 Model Assumptions

2.1 Demand Side

We assume the existence of M potential buyers each demanding one unit of a homogeneous product. Buyers are all identical except for the maximum prices they are willing to pay (their reservation values). Thus, we assume that λM ($0 < \lambda < 1$) buyers have a reservation value of v_1 and the remaining have a reservation value of v_2 , with $v_1 > v_2$. As in Butters (1977) buyers only become aware of the existence of the product if they receive a message from the monopolist¹. They will enter the market if the price advertised in the message is below their reservation value.

2.2 Supply Side

There is a single firm producing one homogeneous product at a constant marginal production cost which, without loss of generality, is assumed to be zero. The firm sends messages to consumers informing about the price (and existence) of the product. Thus, the firm has to choose the price and the number of messages to send. The firm is unable to identify individual buyers.

2.3 Advertising Technologies

As in Butters (1977) we admit that messages are sent out in a purely random fashion at a fixed cost per unit. If L messages are sent to M buyers and both L and M are large, then the fraction of buyers who do not receive any ad is $1 - \phi = (1 - \frac{1}{M})^L \simeq \exp^{-\frac{L}{M}}$. If each ad has a fixed cost of δ then the total advertising cost is δL . Implicit in the derivation of this advertising technology is the idea that the firm is unable to direct (or target) its messages. Whenever it sends a message, the probability that it reaches any individual buyer is $1/M$. Thus, the probability that a message will reach a buyer type 1, p_1 , is simply λ .

We define targeting as the ability of the firm to increase its probability of reaching a particular group of buyers. We can do this by letting $p_1 = \lambda + (1 - \lambda)\beta$, where β is a parameter taking values in the unit interval. On a way, β measures the ability of the firm to target a message. Thus, if $\beta = 0$, the firm is unable to target its messages while if $\beta = 1$ then targeting is perfect. Similarly, we let $p_2 = (1 - \lambda) + \lambda\beta$ designate the probability that a message directed to group 2 reaches it.

If the firm decides to send L_1 messages targeted to group 1 then only $p_1 L_1$ of those messages will actually reach that particular group. By a similar

¹ Ads provide information about product existence and characteristics. For alternative models where informative advertising only provides price information see Bester (1994) and Bester & Petrakis (1995).

argument to the one exposed above those messages will inform a proportion $\phi_{11} = 1 - \exp(-\frac{p_1 L_1}{\lambda M})$ of buyers type 1. Thus, ϕ_{11} is the proportion of buyers of type 1 that received messages directed to group 1. However, $(1 - p_1)L_1$ messages do not reach its intended target and consequently we can define $\phi_{12} = 1 - \exp(-\frac{(1-p_1)L_1}{(1-\lambda)M})$ as the proportion of buyers of type 2 that received messages intended for group 1. Likewise, ϕ_{22} and ϕ_{21} are defined by interchanging group 1 with group 2 and λ with $1 - \lambda$. We also assume that the cost of a targeted message is simply δ .²

3 Equilibrium Analysis

3.1 Monopoly Equilibrium

If the monopolist was constrained to selecting a unique price, then, it could be optimal to cater only to the group of buyers with the highest reservation value³. However, his capacity to target messages with different contents allows him to price discriminate consumers and consequently to serve the entire market. It is easy to verify that if a message is being targeted at group 1 then it must contain a price of v_1 while those targeted at group 2 will advertise a price of v_2 . In this circumstance his profits are,

$$\begin{aligned} \pi = & \lambda M [v_1 \phi_{11}(1 - \phi_{21}) + v_2 \phi_{21}] \\ & + (1 - \lambda) M v_2 \phi_{22} - \delta(L_1 + L_2). \end{aligned} \quad (1)$$

The monopolist will sell to both groups of buyers at the advertised prices, but, with imperfect targeting a share of the highest valued market will be able to acquire the product at the price of v_2 .

From the first order conditions with respect to L_1 and L_2 we get,⁴

$$\begin{aligned} \frac{\partial \pi}{\partial L_1} &= p_1 v_1 (1 - \phi_{11})(1 - \phi_{21}) - \delta = 0 \\ \frac{\partial \pi}{\partial L_2} &= (v_2 - \phi_{11} v_1)(1 - p_2)(1 - \phi_{21}) + v_2 p_2 (1 - \phi_{22}) - \delta = 0. \end{aligned} \quad (2)$$

We can not solve explicitly for L_1 and L_2 but, from the first equation, we can establish a relation between the optimal values of the number of messages for each group,

$$L_1^* = \frac{\lambda M}{p_1} \ln\left(\frac{p_1 v_1}{\delta}\right) - \frac{(1 - p_2)}{p_1} L_2^* \quad (3)$$

²The assumption of a fixed cost *per* message is innocuous. We might as well admit that δ was an increasing function of β without changing our main results.

³In that case he would select a price equal to v_1 if $v_2 < v_1 \lambda$. and otherwise he would select a price of v_2 .

⁴Second order conditions for a maximum hold provided $\beta > 0$.

where L_2^* is defined implicitly by,

$$v_2 p_2 (1 - \phi_{22}) - (v_1 - v_2)(1 - p_2)(1 - \phi_{21}) = \frac{\delta \beta}{p_1}. \quad (4)$$

3.2 Welfare Results

We use the conventional definition of total welfare as the sum of consumer surplus plus profits. Thus,

$$W = \lambda M v_1 (\phi_{11} + \phi_{21} - \phi_{11} \phi_{21}) \quad (5)$$

$$+ (1 - \lambda) M v_2 \phi_{22} - \delta (L_1 + L_2). \quad (6)$$

The social planner will maximize the above expression with respect to L_1 and L_2 and the following first order conditions result:

$$\begin{aligned} \frac{\partial W}{\partial L_1} &= p_1 v_1 (1 - \phi_{11})(1 - \phi_{21}) - \delta = 0 \\ \frac{\partial W}{\partial L_2} &= v_1 (1 - \phi_{11})(1 - \phi_{21})(1 - p_2) + v_2 p_2 (1 - \phi_{22}) - \delta = 0. \end{aligned} \quad (7)$$

Solving these equations for L_1 and L_2 we obtain,

$$L_1^W = \frac{\lambda M}{p_1} \ln\left(\frac{p_1 v_1}{\delta}\right) - \frac{(1 - p_2)}{p_1} L_2^W \quad (8)$$

and,

$$v_2 p_2 (1 - \phi_{22}) = \frac{\delta \beta}{p_1}. \quad (9)$$

Our main result can be obtained by comparing this last expression with (4). It is clear that L_2^* is always less than L_2^W unless $\beta = 1$. In this latter case, because targeting is perfect, we verify Shapiro's (1980) conjecture that if the monopolist is able to perfectly price discriminate he will behave in a socially optimal manner. However, with imperfect targeting, the monopolist will overadvertise to those buyers who value most the good and will underadvertise to those with the lowest valuation.

4 Conclusion

In this paper we provide a monopolistic price discrimination model of targeted advertising. We define targeting as the ability of the firm to direct its ads to two groups of buyers. We show that if the monopolist is able to target its messages with different contents it will not underprovide information. If targeting is perfect the firm will behave in a socially optimal manner but otherwise it will overadvertise to the highest valued buyers and underadvertise to the lowest reservation group.

References

- Bester, H. (1994), 'Random advertising and monopolistic price dispersion', *Journal of Economics and Management Strategy* **3**(3), 545–559.
- Bester, H. & Petrakis, E. (1995), 'Price competition and advertising in oligopoly', *European Economic Review* **39**, 1075–1088.
- Butters, G. (1977), 'Equilibrium distribution of sales and advertising prices', *Review of Economic Studies* **44**, 465–491.
- Grossman, G. & Shapiro, C. (1984), 'Informative advertising with differentiated products', *Review of Economic Studies* pp. 63–81.
- Hernández-García, J. M. (1997), 'Informative advertising, imperfect targeting and welfare', *Economics Letters* **55**, 131–137.
- Kaldor, N. (1940-41), 'Economic aspects of advertising', *Review of Economic Studies* **18**, 1–27.
- Shapiro, C. (1980), 'Advertising and welfare: Comment', *Bell Journal of Economics* **11**, 749–752.
- Stahl, D. O. (1994), 'Oligopolistic pricing and advertising', *Journal of Economic Theory* **64**, 162–177.
- Stegeman, M. (1990), 'Advertising in competitive markets', *American Economic Review* **81**, 210–223.
- Tirole, J. (1988), *The Theory of Industrial Organization*, MIT Press, Cambridge, MA.

Working Papers - NIMA series

No.

1. Lígia Pinto , Glenn Harrison, *Multilateral negotiations over climate change policy*, May 2000
2. Paulo Guimarães, Douglas Woodward, Octávio Figueiredo, *A tractable approach to the firm location decision problem*, May 2000
3. Miguel Portela , *Measuring skill: a multi-dimensional index*, September 2000
4. Rosa Branca Esteves , Paulo Guimarães, *Price discrimination and targeted advertising: a welfare analysis*, November 2000
5. Anabela Botelho , Lígia Pinto , *Has Portugal gone wireless? Looking back, looking ahead*, December 2000
6. Pedro Barros, Clara Dismuke , *Hospital production in a national health service: the physician's dilemma*, December 2000
7. Anabela Botelho , Mark A. Hirsch, Elisabet E. Rutström, *Culture, nationality and demographics in ultimatum games*, December 2000
8. Miguel Portela , *The impact of segregation on wage inequality: a look at recruitment and pay policies at the firm level*, January 2001
9. Pedro Portugal, Ana Rute Cardoso, *Disentangling the minimum wage puzzle: an analysis of job accessions and separations from a longitudinal matched employer-employee data set*, April 2001
10. Ana Rute Cardoso, Priscila Ferreira , *The dynamics of job creation and destruction for University graduates: why a rising unemployment rate can be misleading*, May 2001
11. Octávio Figueiredo, Paulo Guimarães, Douglas Woodward, *Asymmetric information and location*, July 2001
12. Anabela Botelho , Lígia Pinto , *Hypothetical, real, and predicted real willingness to pay in open-ended surveys: experimental results*, September 2001
13. Anabela Botelho , Lígia Pinto , Miguel Portela , António Silva, *The determinants of success in university entrance*, September 2001

14. Anabela Botelho , *Strategic behavior at trial. The production, reporting, and evaluation of complex evidence*, September 2001
15. Paulo Guimarães, *The state of Portuguese research in economics: an analysis based on publications in international journals*, September 2001
16. Anabela Botelho , Glenn Harrison, Marc Hirsch, Elisabet E. Rutström, *Bargaining behavior, demographics and nationality: a reconsideration of the experimental evidence*, December 2001
17. João Cerejeira da Silva , *Identification of the Portuguese industrial districts*, February 2002
18. Octávio Figueiredo, Paulo Guimarães, Douglas Woodward, *Modeling industrial location decisions in U.S. Counties*, April 2002
19. Aslan Zorlu , Joop Hartog, *The effect of immigration on wages in three European countries*, October 2002
20. Elvira Lima , David K. Whynes, *Finance and performance of Portuguese hospitals*, February 2003
21. Aslan Zorlu , *Do ethnicity and sex matter in pay? Analyses of 8 ethnic groups in the Dutch labour market*, June 2003
22. Cécile Wetzels , Aslan Zorlu , *Wage effects of motherhood: a double selection approach*, June 2003
23. Natália Barbosa , *What drives new firms into an industry? An integrative model of entry*, October 2003
24. Elvira Lima , Teresa Josefina Lopes Esquerdo , *The economic costs of alcohol misuse in Portugal*, October 2003
25. Anabela Botelho , Lúcia Pinto , Isabel Rodrigues , *How to comply with environmental regulations? The role of information*, October 2003
26. Natália Barbosa , Helen Louri, *Corporate performance: does ownership matter? A comparison of foreign - and domestic - owned firms in Greece and Portugal*, October 2003
27. Anabela Botelho , Lúcia Pinto , *Students' expectations of the economic returns to college education. Results of controlled experiment*, December 2003

28. Paula Veiga , *Income-related health inequality in Portugal*, July 2005
29. Anabela Botelho , Glenn Harrison, Lúcia Pinto , Elisabet E. Rutström, *Testing static game theory with dynamic experiments: a case study of public goods*, November 2005
30. Anabela Botelho , Glenn Harrison, Lúcia Pinto , Elisabet E. Rutström, *Social norms and social choice*, November 2005
31. Anabela Botelho , Glenn Harrison, Lúcia Pinto , Elisabet E. Rutström, Paula Veiga , *Discounting in developing countries: a pilot experiment in Timor-Leste*, November 2005
32. Paula Veiga , Ronald P. Wilder , *Maternal smoking during pregnancy and birthweight - A propensity score matching approach*, January 2006

The Working Papers of the Applied Microeconomics Research Unit (NIMA) can be downloaded in PDF format from <http://nima.eeg.uminho.pt>
