International Journal of Industrial Organization 30 (2012) 593–604

Contents lists available at SciVerse ScienceDirect

International Journal of Industrial Organization

journal homepage: www.elsevier.com/locate/ijio

Product differentiation decisions under ambiguous consumer demand and pessimistic expectations☆

Michał Król

Department of Economics, The University of Manchester, United Kingdom

ARTICLE INFO

Article history:
Received 21 November 2010
Received in revised form 22 April 2012
Accepted 23 May 2012
Available online 6 June 2012

JEL classifications:
C72
D43
D81
L13
R32

Keywords:
Hotelling
Uncertainty
Non-unique prior
Pessimism

ABSTRACT

This paper studies product differentiation decisions in a spatial duopoly with limited information on consumer demand. In particular, a situation is discussed in which the firms do not know the exact distribution of the random location of consumer demand and its responsiveness to price changes (measured by the scale of transport costs), but resolve the resulting ambiguity using the α-maxmin or minimax regret criteria. When the firms are sufficiently pessimistic (α is high enough), results are in contrast with the existing literature. In particular, an increase of demand location uncertainty decreases the equilibrium product differentiation, intensifying the second-stage competition in prices, although the effect is dampened by uncertainty about transport costs. Endogenizing the choice of objective function leads to the dominance of an extreme form of pessimism, which turns out to be socially-optimal.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Over the last few decades, the Hotelling model of spatial competition has been used to explain a wide variety of social phenomena, from the location of retail outlets to competition among political parties. A relatively new strand of the relevant literature investigates the effects of random demand fluctuations on the firms' location decisions. This typically entails introducing some form of demand uncertainty into a modified Hotelling setting. For instance, Balvers and Szerb (1996) consider the effect of random shocks to the products' quality/desirability when prices are fixed. The last restriction is relaxed by Harter (1997), who studies uncertainty as a uniformly distributed random shift of the (uniform) customer distribution, given that firms locate sequentially.

Relatively few studies are concerned with the effect of demand uncertainty in an otherwise unchanged Hotelling framework. In particular, Casado-Izaga (2000) uses the same form of uncertainty as Harter, but the duopolists locate simultaneously, before observing the customer distribution and only then naming prices. This setting is generalized by Meagher and Zauner (2005), who parametrize the support of the (uniform) random variable that shifts the customer distribution. They report that demand uncertainty increases the equilibrium level of product differentiation. In another study (henceforth, MZ), Meagher and Zauner (2004) consider a random shock arbitrarily, rather than uniformly, distributed on a fixed interval. Tractability of the model is maintained by assuming that the variance of the shock is small enough relative to the ex-post differentiation of tastes, so that no firm would ever choose to capture the entire market in any state of nature. Once again, it turns out that more uncertainty results in a higher equilibrium level of product differentiation.

The intuition for those results is simple. If the demand is more likely to be located away from the center of the market, then it is natural for the firms to venture into more distant areas and away from one another, relaxing the second-stage price competition.

Nevertheless, all the studies above rely on the common prior assumption. Not only are the firms able to estimate the probability distribution of random factors affecting their profits, but they also arrive in this respect at exactly the same conclusions. This may often be impossible in reality, particularly at times when the scale of market disturbances is indicative of structural changes in the patterns of consumer choice, rather than merely random fluctuations around an otherwise unchanged standard of behavior. In such crises, as well as at the opening of new markets, sellers are confronted with an ambiguously distributed demand, until they are able to gather sufficient information,

☆ I would like to thank Prof. Paul Madden for all his support, and Prof. Roger Hartley and Prof. Leo Kaas for their comments on the paper, as well as two anonymous reviewers and the editor, Prof. Bruno Jullien, for their helpful suggestions. All the remaining errors are my own. Part of this work was supported by the Economic and Social Research Council [grant number ES/G016321/1].

E-mail address: michal.krol@manchester.ac.uk.

0167-7187/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijindorg.2012.05.004

e.g. via market research practices or price experimentation (see Aghion et al., 1993).

Faced with such ambiguity, firms might at least be able to place the potential demand variations within certain bounds. For instance, in the classic 'Main Street' example, a sudden influx of tourists to the city could make retailers ignorant of the likelihood that consumers will cluster in one part of the street or the other. Even so, sellers might still reasonably expect their customers to be confined to the physical boundaries of the Main Street. Similarly, many product characteristics, such as sugar content in food, are naturally restricted by certain bounds (in this case zero and one hundred percent).

The purpose of this paper is then to investigate how the firms' product differentiation decisions would change if the information on potential demand fluctuations was limited in the above manner. In addition, since the absence of a unique prior precludes expected profit maximization, it would be interesting to see how the choice of objective function used as an alternative affects the outcome of the firms' interaction.

In particular, for a given location decision the duopolists are able to identify the worst- and best-case scenarios within the range of possible demand variations. Hence, one natural objective is to maximize a weighted average of the associated extreme profit values, i.e. use the Arrow and Hurwicz (1972) alpha-maxmin criterion to resolve the ambiguity, where the weight assigned to the lowest possible profit can be said to constitute a measure of the player's pessimism. It turns out that, contrary to the existing literature, firms that are sufficiently pessimistic in this sense locate closer together in response to an increase of uncertainty (represented by a spread of the range of possible demand variations). This is because an increase in the scale of potential demand fluctuations means a player has to consider a possibility of the worst-case demand shifting even more to her disadvantage (and in favor of the competitor). To reduce one's exposure to this threat, a pessimistic player will then make her product resemble that of the rival, leaving less room for becoming handicapped, even at the cost of less product differentiation inducing more competitive pricing.

As detailed in Section 5, this could explain some of the observable industrial behaviors. For instance, due to their traditional objective of 'balancing the odds', bookmakers effectively concentrate on the lowest-profit scenario, in which the outcome of a sporting event that attracted the largest volume of bets is realized. Similarly, many financial institutions focus on the worst-case scenario so as to satisfy the self-imposed or government enforced stress tests. In both of these situations, evidence can be given of reduced product differentiation as a result of an increase in uncertainty.

In contrast, it is shown that applying an alternative minimax regret objective function, as initially proposed by Savage (1951), reproduces the existing 'common prior' comparative statics results. This is in line with the work of Bergemann and Schlag (2008a,b), who studied monopolistic pricing by sellers aware of only the support (but not the exact distribution) of buyers' valuations. They find that more uncertainty reduces prices given a maxmin objective, but not necessarily under the minimax regret scheme.

To resolve the present discrepancy between the alternative payoff specifications, in Section 4 I consider a possibility of the firms choosing their objective function (out of the alpha-maxmin class, as well as the minimax regret), before moving on to location decisions. It turns out that focusing exclusively on the worst-case scenario is a dominant strategy *regardless of the resolution of the uncertainty*. This is in contrast with existing studies on optimism in trading/investment (e.g. Kyle and Wang, 1997, Englmaier, 2010), as well as in more general competitive contexts (Heifetz et al., 2007a,b), which predict optimism becoming prevalent due to the pessimistic agents being outperformed.

Section 6 discusses and further elaborates on the above results. Firstly, out of all the considered objective functions, the outcome associated with the most pessimistic (maxmin) approach is shown to be not only the most competitive, but also the most socially-desirable one, whatever the actual distribution of the random shock. Furthermore, it is demonstrated that the same competitive outcome may be approximated under probabilistic information via an optimally set progressive corporate taxation scheme, making the firms effectively risk-averse. What is then interesting about ambiguity is that it makes such a government intervention unnecessary due to the pessimistic attitudes becoming prevalent. However, a distinguishing factor between risk aversion under probabilistic information and pessimism under ambiguity is how uncertainty about the demand location interacts with that about other aspects of the demand, such as its sensitivity to price changes. This is represented by the scale of transportation costs,[1] which has no effect on location decisions under certainty. Nevertheless, uncertainty about costs makes the outcome less competitive under ambiguity, while with probabilistic information it can have an opposite effect. Finally, Section 6 concludes with a discussion of robustness of the obtained results to changes in the timing of moves or the transport cost specification.

2. The model

The setting is, in general, very similar to Meagher and Zauner (2004) (MZ). In the first stage of the game, two firms simultaneously choose locations x_1, x_2 (without loss of generality set $x_1 \le x_2$) and then proceed to simultaneous setting of their respective prices p_1, p_2 in the second stage.[2] As usual, a consumer located at x chooses to buy a unit of the good from firm $i \in \{1,2\}$, so as to minimize the total purchase cost of $p_i + t(x_i - x)^2$, where $t > 0$ is the transportation cost parameter. The good costs nothing to produce and the consumers are uniformly distributed on the interval $\left[M - \frac{1}{2}, M + \frac{1}{2}\right]$, where the duopolists get to know the value of M, as well as t, once they choose the locations, but before setting prices. Initially, all they know is that the joint probability distribution of (M,t) has support $S \equiv [-L, L] \times [t_0, 1]$, where $L \in \left[0, \frac{1}{2}\right]$[3] and $t_0 \in (0,1]$. Note that the upper bound of t is set to 1 without loss of generality, while the assumption that $t > 0$ is present in all product differentiation models (otherwise, the consumers only consider prices and location/product design decisions are inconsequential). It should also be emphasized that, as in MZ, the two firms have identical information, which in this case means they agree on what the support S is. In reality, it may at times be the case that firms have different beliefs in this respect, but this possibility is not pursued here.

The first difference from MZ is introducing uncertainty about transportation costs. MZ assumes $t = 1$, which may be done without loss of generality, so long as the scale of transportation costs is constant. However, with probabilistic information uncertainty about costs may interact with that about the demand location and influence location decisions, just as it turns out to be the case in the present model. See Section 3 and Section 6 for a more detailed discussion of this issue.

The second difference from MZ is the fact that the exact probability distribution of (M,t) is unknown, and so is the expected value of the second stage pure-strategy Nash Equilibrium profits (which continue to be uniquely determined for any location-pair and any outcome of the uncertainty). Hence, in their location decisions, the duopolists must pursue an objective different from expected profit maximization.

One possibility is to consider a weighted average of the lowest and highest possible profits, i.e. to use the Arrow/Hurwicz α-maxmin criterion instead of the expected value. More specifically, let $\pi_i^*(x_i, x_{-i}, M, t)$ be the unique second-stage Nash Equilibrium profit associated

[1] The total consumer demand is, by assumption, completely inelastic in the Hotelling framework. However, when the transport cost parameter decreases, the individual demand of each firm for given locations and the counterpart's price becomes more elastic in the firm's own price.

[2] Note that the analysis is restricted to pure strategies in both locations and prices — see Bester et al. (1996) for a study of mixed strategy location choice, and Osborne and Pitchik (1987) for an analysis of mixed strategy pricing.

[3] The assumption that was imposed in MZ for the purpose of mathematical tractability and is equally useful here.

Download English Version:

https://daneshyari.com/en/article/5078031

Download Persian Version:

https://daneshyari.com/article/5078031

Daneshyari.com