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Dynamic competition with consumer inertia☆

Erik Pot, János Flesch, Ronald Peeters*, Dries Vermeulen

Maastricht University, P.O. Box 616, 6200 MD Maastricht, The Netherlands

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ABSTRACT

We study a framework where two duopolists compete repeatedly in prices and where chosen prices potentially affect future market shares, but certainly do not affect current sales. This assumption of consumer inertia causes (noncooperative) coordination on high prices only to be possible as an equilibrium for low values of the discount factor. High discount factors increase opportunism and aggressiveness of competition to such an extent that high prices are no longer sustainable as an equilibrium outcome. Moreover, we find that both monopolization and enduring market share and price fluctuations (price wars) can be equilibrium path phenomena without requiring exogenous shocks in market or firm characteristics.

1. Introduction

An important goal of research on price competition in oligopolistic markets is to determine which circumstances are associated with high prices and which ones with low prices.[1] Often these two modes of pricing behavior are connected; for instance, when firms revert to low prices for a fixed or unlimited period in response to a deviation from a coordinated high price (Friedman, 1971). Most often, the sustainability of high prices requires firms to be sufficiently future-oriented (i.e., the discount factor should be sufficiently high). Moreover, firm and market characteristics are required to be sufficiently stable, since periods of low prices (or, price war behavior) can occur on the equilibrium path when exogenous shocks in market demand (Rotemberg and Saloner, 1986), individual demand (Pot et al., 2008), or individual marginal cost level (Athey et al., 2004) are possible. Without such shocks, the low pricing regime is a phenomenon that typically appears off the equilibrium path.

A common design property of the models that predict high prices for high discount factors is the particular time-tradeoff, where a price undercut leads to an immediate demand and profit increase and a decrease in future profits due to reversion to profit eroding marginal cost pricing in response to the undercut. However, a price decrease may not always lead to an immediate increase in demand that suffices to increase immediate profit, although it may induce increased clientele and profit opportunities in the future. Reasons for this include presence of brand loyalty, switching costs, or demand inertia (cf. Klemperer (1995) and Fishman and Rob (2003)). When the market is characterized by this property, firms are constantly exposed to a reverted time-tradeoff.

In this paper, we present a model that captures the particular time-tradeoff that results when consumers do not immediately respond to price differences. This model contains two duopolists that compete over a discrete infinite time horizon under possibly varying states of the market. The states are represented by a finite number of possible market share divisions, including two absorbing monopolistic states. At each period, given a competitive state where both firms have a positive market share, firms have the option to either charge a high price or a low price. Since we assume sales in a particular period to equal the market share in that particular period, the high price renders a higher immediate profit. But, by charging the high price a firm runs the risk of losing part of its market share in the subsequent period in case the opponent opts for a low price. Within this framework, we study the nature of price competition.[2]

Each period, in a given state, on the one hand, firms have the incentive to exploit currently installed market share by setting a high price (*harvesting incentive*), while, on the other hand, they have the incentive to set a low price thereby foregoing immediate

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* Corresponding author. Tel.: +31 6 25535551.
E-mail address: r.peeters@maastrichtuniversity.nl (R. Peeters).

[1] Excessive pricing may result from collusive agreements, but might as well arise naturally as a consequence of situational characteristics (Porter and Zona, 1999).

[2] Although the model is highly stylized, it contains all essential ingredients for a qualitative study—below and in (the footnotes in) Section 2 we provide the necessary justification for this.

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profit opportunities in exchange for an increased future market share (*investment incentive*).[3] We see two prominent motives for low pricing: A firm may price low in an attempt to increase market share (*offensive motive*), but could as well price low to avoid loss of market share (*defensive motive*). These incentives and motives are important and recurrent aspects in our study. Particular questions that we address are: When can we expect high prices and when low ones?, and Can fluctuations between high and low price periods occur on the equilibrium path? In doing so, we restrict our attention to (symmetric pure) stationary subgame-perfect equilibria. We obtain the following results and insights.

For sufficiently low discount factors the harvesting incentive dominates the investment incentive which results in the unique equilibrium prediction of firms charging high prices. When the discount factor is sufficiently large this dominance relation among incentives reverts and firms will opt for the low price. Surprisingly and in contrast to the standard literature on price competition, coordination on high prices can no longer be supported as stationary subgame-perfect equilibrium.

Moreover, we find monopolization and enduring market share and price fluctuations (price wars) as an equilibrium path phenomenon without requiring the presence of exogenous shocks in market or firm characteristics. Equilibria that induce one of these interesting price dynamics only exist for intermediate values of the discount factors. When the discount factor is too low, firms have no incentive to incur costs today in exchange for future market share, while simultaneously firms do not fear a loss of market share due to the similar lack of offensive motives of the opponent. Hence, both firms exploit their customer base by demanding high prices. When the discount factor is too high, firms resort to aggressive pricing in all states. Incentives to increase market share (or even to monopolize the market) are high and so is the fear for loss of market share.

A noteworthy paper in the light of our findings is Chen and Rosenthal (1996), in which it is also noted that the predicted outcome of traditional Bertrand competition is affected in a crucial yet unrealistic way by the fact that consumers are (too) extremely price-sensitive. Chen and Rosenthal therefore model price competition as a stochastic game in which a state represents a certain proportion of the consumer population that is 'loyal' to a firm. If prices (that are chosen from a continuum) are unequal, there is a shift in consumer loyalty from the higher price firm to the lower price firm. Although our model allows firms to choose out of just two prices, for as far as comparable, all results and insights that we obtain are consistent with those of Chen and Rosenthal, such as that consumer loyalty may soften price competition. Our model can therefore be seen as a reliable alternative to theirs. Moreover, the simplifications that we carried through have as benefit that we can provide more intuition to those results, such as that asymmetric discount factors can lead to a lower normalized profit for the more patient firm.[4] Finally, unlike the model studied by Chen and Rosenthal, our simple but intuitively general setting allows us to provide a full specification of the set of stationary subgame perfect equilibria.

In Radner (2003), demand is 'viscous', by which is meant the notion that consumers switch slowly over time from a higher price firm to a lower price firm. In a duopoly model, Radner is able to prove the existence of a specific family of stationary equilibria. In our model, we focus less on the exact process of how consumers 'flow' from one firm to the other. Instead, like Chen and Rosenthal, we concentrate on the decision problem the firms face, and are consequently able to acquire a deeper understanding of the qualitative impact the changed time-tradeoff has on firms' pricing behavior. Our results confirm Radner's insight that in such situations, competitive outputs might mimic collusive behavior. Furthermore, we find more results on when to expect low prices or mixed behavior in stationary strategies.

The paper proceeds as follows. In the next section, we present our model of dynamic price competition with endogenous market share transitions. In Section 3, we restrict attention to the version of the model that has just one competitive state. This is the most concise and analytically tractable version of the model. Within this limited framework we are able to derive some of the main properties of the general model. Moreover, we are able to make some behavioral inferences by investigating the influence of the discount factor on the firms' incentives. In Section 4 we show illustrating examples that provide extra intuition behind the results presented in Section 3. Next, in Section 5, we add two more competitive states. Within this framework we are able to illustrate some of the interesting price and market share dynamics that are induced by equilibria of our general model. Finally, in Section 6, we generalize the main equilibrium properties found in the earlier sections for the full version of our model. In the final section, we discuss the scope of applicability of our results.

2. General framework

Two duopolists are repeatedly involved in price competition over a discrete infinite time horizon with possibly varying market circumstances. Market circumstances are captured by the state space, consisting of a finite number of states representing market share divisions between the two firms. Besides competitive states in which both firms have a positive market share there are monopolistic states in which one firm serves the full demand. We assume that the two monopolistic states are absorbing; that is, once a firm has reached a state in which it serves the full market it will continue as a monopolist and the opponent has no possibility to regain demand.[5] For simplicity, we assume for our state space a set of equidistant states: $S = \{(s_k, 1 - s_k) \mid k = 0, 1, \ldots, K\}$ with $s_k = \frac{k}{K}$.

Each period, in common knowledge of the present state, the firms simultaneously and independently set prices. Chosen prices have an immediate impact on the profits earned and a delayed effect on the state dynamics. To keep analyses tractable, in our model, we only allow firms to choose between two prices: a high price (action H) and a low price (action L). One could think of the high price as a normal price where the low price as a rebate price.[6] The instantaneous profit of a firm equals its market share times h or ℓ (with $h > \ell > 0$), depending on the firm choosing action H or L respectively. In particular, a chosen price has no immediate impact on current sales and hence our model explicitly

[3] Farrell and Klemperer (2007) provide a detailed overview of different incentives and effects that appear in oligopolistic markets.

[4] The intuition we give is that the higher the discount factor for a firm is, the more attractive it becomes for this firm to choose the low price (for offensive reasons). The less patient firm anticipates this by putting more weight on playing the low price itself (for defensive reasons), thereby decreasing the offensive incentives of the more patient firm.

[5] In Section 4 we show by means of an example that our results also hold when monopoly states are non-absorbing. In the concluding section (Section 7) we provide a further discussion why this assumption is non-critical for the qualitative predictions that we derive in this paper.

[6] In this, we distinct from Chen and Rosenthal (1996), where a continuum of prices are allowed. Noteworthy is that as far as our results are comparable to theirs, they are consistent. This provides some evidence of the robustness of our findings with respect to the action space. An advantage of restricting the action space is that it allows providing a characterization of the full set of stationary subgame perfect equilibria (Chen and Rosenthal study only one equilibrium, where their model may possess multiple equilibria), which can be helpful for studying tacit collusion in a framework with consumer inertia. Moreover, our setting can provide a better understanding of equilibrium properties as it yields insightful best response correspondences.