Network externalities, coalition of consumers and product differentiation

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Abstract

We present a dynamic game of location-price competition between two firms. Differently from other Hotteling's type models, we assume that consumers are positively influenced by the product choices of others and decide in groups of limited sizes where to consume from.

Our model suggests the existence of three types of oligopolies. Depending on the strength of the network externalities and on the size of consumers' coalitions, firms may agglomerate, separate, or keep intermediary distances to one another. This result generalizes the standard result on location-price competition. It provides insights into product differentiation behaviors in cases where consumers enjoy consuming products in the company of others (Becker, 1991).

Keywords: product differentiation, network externalities, coalition dynamics, strong Nash equilibrium.

JEL Classification codes: D11, D4, M30

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Extended Abstract

As pointed out by Pal (1998), in most of the papers on location theory, one conclusion is generally unanimous: firms never agglomerate in a location-price game.[2] The present paper deals with the exception in which consumers enjoy consuming the product in the company of others.

Indeed, when firms offer identical products and network effects prevail, the only factor determining individual choices are differences in aggregate demands. In this case, herd behavior is almost unavoidable and polarization of demand is expected to happen. Since consumers highly evaluate to consume the product in the company of others, an over-demanded firm can charge a relatively large price compared with its under-demanded competitor. Taking into account that any of the firms may become the market leader with equal probability, depending on how intensive consumers are influenced by each other's choices, the expected profits of the firms may be higher when they agglomerate rather than separate. By coming close together competitors tend to produce a more profitable social (rather than physical or geographical) product differentiation. This may explain agglomerations (or similarities) of firms like bars, restaurants, night clubs, and dispersions of firms like gas stations and drug stores. In the former case, consumers put high value on consuming a product in the company of others, whereas in the latter case, they are primarily interested in the accessibility of the product.

As a second additional (and also realistic) ingredient, we shall assume that social interacting consumers decide in groups of limited size from which firm the product should be consumed. One typical example of such a market of social entertainment is presented by Becker' (1991). Becker considers the following case of two similar restaurants placed across each other: "A popular seafood restaurant in Palo Alto, California, does not take reservations, and every day it has long queues for tables during prime hours. Almost directly across the street is another seafood restaurant with comparable food, slightly higher prices, and similar service and other amenities. Yet this restaurant has many empty seats most of the time." (p. 1109).

Even though Becker has not approached the problem from the point of view of the Game Theory (nor has he analyzed the question of the restaurant location and the role of consumer coalitions), his analysis concerning the behavior of demand polarization motivates the investigation of new strategic games involving both social influences among consumers, in the way suggested by Weber et al. (1997), and coalitions among consumers.

In order to explain the role of consumer coalitions, let us suppose that a group of people meets at a restaurant. Imagine that, after taking into account the cost-benefit relation offered by the place, these people prefer to search for a second alternative. Although every one is a little unsatisfied with the choice of the restaurant, it is likely that each person on

[2]For exceptions see dePalma et al. (1985) and Anderson and dePalma (1988) where firms are differentiated by attributes other than location and there may exist an equilibrium in which all firms locate at the center. Also see Stahl (1982) where consumers search for optimal product characteristics and their search cost can be influenced by firm location choice. This leads to a spatial concentration of demand where sellers find it profitable to locate close to one another.

his/her own is not willing to abandon the place without others doing so too, even because, besides food and service quality, consumers are benefited from the social contact with the group. Nonetheless, these people could identify the group's generalized unstatisfaction, call off the orders and search for a better alternative for everybody. However, this situation only shows itself realistic as every individual may question each other at a non-prohibitive "coordination cost". It could be, for example, that each individual is ready to consult at most a limited number of people (closest neighbors, for instance), whereby a change of decision would be individually more advantageous only in groups whose size is larger than this limit. In this case, we could say that the "coordination cost" is prohibitive, in such a way that all individuals remain in the same original place, even though they might be better in another place.

Bearing in mind that social players coordinate their strategies aiming at maximizing their goals, it seems reasonable to assume that certain Nash equilibria, which correspond to mere individual responses (but not best group responses), were discarded (or not) depending on the coordination cost among players. If this coordination cost is too high, then all equilibria characterized by best individual responses, i.e., all Nash equilibria (of pure strategies) are equally expected. However, as the coordination cost diminishes, we should discharge those Nash equilibria which do not correspond to best group responses, yet those correspond to best individual responses.

The idea above leads us to a generalization of the equilibrium concept suggested by Aumann (1959). According to Aumann, a Nash equilibrium is a *strong Nash equilibrium* when there is no group of players (coalition) that can benefit all their members by deviating from equilibrium. We shall generalize the notion of strong Nash equilibrium, and say that a Nash equilibrium of a game with a measurable set of players (of measure 1) is a $\gamma-$*strong Nash equilibrium* when γ is the largest fraction of players ($\gamma \in [0,1]$) for which there is no subset of players of measure lower than γ that can benefit all their members by deviating from equilibrium.

The above generalization becomes particularly interesting whenever we assume that players incur coordination costs in order to form deviating coalitions against the equilibrium. We assume that these coordination costs are increasing functions of the measures of the coalitions (the sizes of coalitions). If, due to prohibitive coordination costs, only coalitions of measure smaller than α are fusible, then we should consider not only strong Nash equilibria, but also γ-strong Nash equilibria with $\gamma \geq \alpha$. The idea is to include those Nash equilibria, of which the measures of deviating coalitions are not fusible.

We shall present a location-price game between two firms (two restaurants, for example), which compete for socially interacting consumers distributed along a measurable address space (conveniently, a circle of circumference 1). We assume that consumers are able to form coalitions of limited measure, not larger than α (we adopt the Lebesgue measure along the circle) in order to decide collectively where to go. The firms differ their products as they choose their geographic locations along the address space of consumers. We focus on the distance between firms in Nash equilibrium. This distance will depend on α, the maximum allowed measure for deviating coalitions among consumers and J, the strength of social interactions among consumers, i.e., the strength of positive externalities

in consumers' decisions.

Assuming quadratic transportation costs as in D' Aspremont et al. (1979), we derive the following results: if J, the strength of social interactions among consumers, is lower than a critical value, then the distance between firms is maximal in Nash equilibrium. This corresponds to the standard result of D' Aspremont et al. (1979), who does not assume social interactions among consumers. On the other hand, if the strength of social interactions among consumers is larger than a critical value and if α, the limit measure for consumer coalitions, is smaller than a critical measure, then the distance between firms is zero. (The explanation of this behavior is briefly explained in the second paragraph of the present section).

Interestingly enough, an intermediary distance between firms comes out when both the strength of social interactions and the limit measure for consumer coalitions are sufficiently large. The economic reasoning for this behavior is the following: assume that consumers highly evaluate the company of others (that is, J is very large). Assume also that there is no restriction for consumer coalitions ($\alpha = 1$). Suppose by contradiction that the firms would not differentiate products at all. Since the two products are identical, and consumers are able to form large coalitions, they would decide collectively for the less expensive competitor. Thus, competition in price would drive profits close to zero. Now, suppose that the firms would differentiate products as much as they can. Due to dispersion in consumers' locations, the market will be shared symmetrically between the two firms. Since consumers are divided into two separated groups, restricted socializing among consumers obligates firms to charge a relatively low price.

In order to exploit at most the network externalities among consumers without driving the prices to the competitive level, firms tend to differentiate products up to a moderate extent. Particularly remarkable in this market behaviour is the fact that a certain level of heterogeneity in consumers' preferences (induced by a moderated product differentiation) accounts for locking consumers at the majority site. At first glance, this seems to be counter-intuitive. However, since consumers put high value in keeping together at the majority side, they are not willing to change to the under-demanded competitor, unless they do so in large coalitions. Now, such large deviating coalitions do not exist when consumers are sufficiently heterogeneous.

The model suggests the existence of three types of location-price competitions: one characterized by small distances between players, another characterized by intermediary distances between players, and a third one characterized by large distances between them. That result generalizes the standard result of location-price competition. It provides insights into product differentiation behaviors in cases where consumers enjoy consuming a product in the company of others (Becker, 1991) and decide in groups of limited sizes where to consume from.