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Product differentiation, price discrimination and collusion

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ABSTRACT

The existing literature which analyses the relationship between the product differentiation degree and the sustainability of a collusive agreement on price assumes that firms cannot price discriminate, and concludes that there is a negative relationship between the product differentiation degree and the critical discount factor. This paper, in contrast, assumes that firms are able to price discriminate. Within the Hotelling framework, three different collusive schemes are studied: perfect collusion on discriminatory prices; perfect collusion on a uniform price; collusion not to discriminate. We obtain that the critical discount factor of the first and the third collusive scheme does not depend on the product differentiation degree, while the critical discount factor of the second collusive scheme depends positively on the product differentiation degree. Moreover, we show that imperfect collusion is more difficult to sustain than perfect collusion.

1. Introduction

Product differentiation affects both the way in which the firms compete and the way in which they collude. When the firms produce differentiated goods, their pricing decisions depend on the substitutability between the products: if the products are good substitutes no firm can command a high price for its product. Therefore, the lower the product differentiation degree the lower the non-cooperative equilibrium price. For this reason, the firms may try to coordinate their pricing decisions in order to jointly raise the price above the competitive level. However, a low product differentiation degree not only increases the opportunity for collusion, but it also increases the incentive to cheat the collusive agreement. Indeed, with highly substitutable products, a cheating firm can capture a large fraction of the market and obtain large short-term profits by slightly lowering the price unilaterally. Therefore, the impact of the product differentiation degree on the sustainability of a collusive agreement is not *a priori* an obvious issue.

The relationship between the product differentiation degree and the ability of the firms to collude has been studied by Chang (1991, 1992) and Hackner (1995) among others. Chang (1991) employs the spatial competition framework of Hotelling (1929) with quadratic transportation costs. He assumes fixed and symmetric locations of the firms. The sustainability of the cartel agreement is measured by the minimum discount factor supporting the joint maximum profits as a sub-game perfect equilibrium of an infinitely repeated game. Chang (1991) shows that collusion is easier to sustain when the firms are more differentiated. In fact, the critical discount factor monotonically increases as the product differentiation decreases. A similar result is found in Chang (1992), where the initial degree of differentiation is exogenous, but firms can relocate once the collusive agreement has been broken. Chang (1992) concludes that a higher initial product differentiation degree makes collusion easier to sustain. Hackner (1995) instead considers the possibility that firms collude not only with respect to the price but also with respect to the location. When the market discount factor is high enough, firms collude to locate at 1/4 and 3/4. The lower the market discount factor the more the firms collude on a higher product differentiation

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degree in order to keep collusion from breaking down. Hackner (1995) concludes that there is "*a fairly general tendency within the Hotelling framework for differentiation to facilitate collusion*" (p. 293).[1]

All these articles are characterized by the assumption that firms cannot price discriminate. In this paper we remove this hypothesis, and we study how the product differentiation degree affects the sustainability of a collusive agreement *when firms can perfectly price discriminate*. To our knowledge, the only article that studies the sustainability of collusion taking into account price discrimination is Liu and Serfes (2007). They assume that firms are maximally differentiated on the Hotelling segment, while they allow for different customer-specific information quality. Firms have access to information of a given quality which allows them to partition consumers into different groups and charge each group with a different price. Higher information quality is modelled as a refinement of the partition. At the limit, firms know the position of each consumer in the market and can charge each consumer with a different price (perfect price discrimination). Liu and Serfes (2007) show that collusion becomes more difficult to sustain as the quality of consumer-specific information improves. Better information allows for higher collusive profits and harsher punishment, but at the same time makes deviation more profitable: this last effect dominates, and the critical discount factor is a positive function of the quality of information.

On the one hand, our analysis is less general than Liu and Serfes (2007), since we consider only the case of perfect price discrimination.[2] On the other hand, our analysis is more general, since we do not limit the analysis to the case of maximally differentiated firms, but we allow for different product differentiation degrees. As in Liu and Serfes (2007), we study three different collusive schemes: (1) collusion on discriminatory prices; (2) collusion on a uniform price; (3) collusion not to discriminate. In the first collusive scheme firms coordinate on the price to be applied to each consumer, without the constraint that the price must be equal for all consumers. Clearly, this collusive scheme yields the highest collusive profits, since it allows the colluding firms to perfectly target the price on the willingness to pay of each consumer. However, such collusive scheme may be very difficult to implement, since it requires negotiating on a huge number of prices (one for each consumer). A less "extreme" collusion is represented by the second collusive scheme: here firms try to coordinate on a uniform price. This scheme is less profitable, but it is easier to implement, because it requires firms to agree only on one price. Finally, in the third collusive scheme firms do not agree directly on the price(s), but agree not to price discriminate. Since in the spatial competition framework price discrimination causes lower equilibrium profits,[3] firms have the incentive to coordinate in order to compete less fiercely: an agreement not to discriminate has precisely this purpose.[4]

For each collusive scheme we search the minimum discount factor which sustains the joint maximum profits. We are mainly interested in the following question: how does the easiness of collusion change with the product differentiation degree? A linked question is the following: which collusive scheme is easier to sustain in equilibrium for any given product differentiation degree? We obtain the following results. The sustainability of the first and the third collusive scheme does not depend on the product differentiation degree. The sustainability of the second collusive scheme instead depends *negatively* on the product differentiation degree. This result contrasts with the findings by Chang (1991, 1992) and Hackner (1995): the hypothesis of price discrimination reverses the relationship between the sustainability of collusion and the product differentiation degree. Moreover, in contrast with Chang (1991), the sustainability of collusion depends *negatively* on the transportation costs. We obtain also that, independently on the product differentiation degree, the first collusive scheme is easier to sustain than the second collusive scheme, which in turn is easier to sustain than the third collusive scheme. In addition, we consider the possibility that firms collude on a less then maximum discriminatory price schedule and on a less than maximum uniform price. In both cases we obtain that if perfect collusion is not sustainable, imperfect collusion is not sustainable too. Finally, we extend the analysis of the second and third collusive scheme to a third-degree price discrimination framework *à la* Liu and Serfes (2004, 2007), and we show that the results do not change.

This paper is structured as follows. In Section 2 the model is introduced. In Section 3 the sustainability of each collusive scheme is studied, while in Section 4 the model is extended to include the possibility of imperfect collusion. Section 5 considers the case of imperfect price discrimination. Section 6 summarizes. Proofs are relegated in Appendix.

2. The model

Assume a linear market of length 1. Consumers are uniformly distributed along the market. Denote by $x \in [0, 1]$ the location of each consumer. Each point in the linear market represents a certain variety of a given good. For a consumer positioned at a certain point, the preferred variety is represented by the point in which the consumer is located: the more the variety is far from the point in which the consumer is located, the less it is appreciated by the consumer. Each consumer

[1] Other papers that investigate the relationship between product differentiation and sustainability of collusion adopting non-spatial frameworks are Deneckere (1983), Ross (1992) and Albaek and Lambertini (1998) which find a non-monotonic relationship. Hackner (1994) instead considers the relationship between collusion sustainability and product differentiation in a vertical differentiation model and finds that when firms are similar collusion is easier to sustain. Lu and Wright (2009) assume a "price-matching" punishment mechanism and find that collusion becomes easier to sustain as product differentiation increases.

[2] In Section 5, however, we extend the analysis of two of the three collusive schemes we analyze to the case of third-degree price discrimination.

[3] See for example Thisse and Vives (1988).

[4] Each of these collusive schemes is well documented in European antitrust cases. Examples of the first collusive scheme are: *Cast Iron and Steel* (D. Comm. Oct. 17, 1983) and *Pre-insulated Pipes* (D. Comm. Oct. 21, 1998); examples of the second collusive scheme are: *Austrian Banks* (D. Comm. June 12, 2002) and *Specialty Graphite* (D. Comm. Dec. 17, 2002); examples of the third collusive scheme are: *IFTRA Glass* (D. Comm. May 15, 1974), *IFTRA Aluminium* (D. Comm. July 15, 1975) and *Far East Trade Tariff Charges and Surcharges Agreement* (*FETTCSA*) (D. Comm. May 16, 2000).