MARKET TRANSPARENCY

Arvid Nilsson

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Market Transparency

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PREFACE

This report is a result of a research project carried out at the Department of Economics at the Economic Research Institute at the Stockholm School of Economics.

This volume is submitted as a doctor's thesis at the Stockholm School of Economics. As usual at the Economic Research Institute, the author has been entirely free to conduct and present his research in his own ways as an expression of his own ideas.

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Bo Sellstedt	Bengt Jönsson
Director of the	Professor, Chairman of
Economic Research Institute	the Department of Economics
at the Stockholm School of Economics	at the Stockholm School of Economics

Contents

Acknowledgements

In February 1994, my Norwegian teacher in microeconomics at the undergraduate level gave me a convincing argument in favour of joining the graduate program. He said that "once you have joined the graduate program, you can always quit and start working, but the opposite is not possible." He then continued by stating some examples that proved his point. I dwelled on the decision for some time, trying to figure out if *graduate studies* $\gtrsim$ *business*. I finally joined the program six years ago, and so far, I have not experienced any serious preference reversal.

Tore Ellingsen, the Norwegian, soon became my thesis supervisor and a very good one too. Always interested, almost fascinated by my ideas and, of course, ready to pinpoint the weak spots in a matter of seconds. Thank you for your support Tore, without it; I would not have reached this far.

Looking back to the undergraduate studies, there was more than Tore's argument that got me to join the graduate program. Several people deserve to be thanked. Rickard Eriksson, with whom I wrote the undergraduate thesis, had an early determination to write a doctoral thesis in economics. Rickard, I think you infected me! Together with Martin Flodén, Mattias Danielsson and Robert Moldén, we worked through the last undergraduate courses in economics with great result.

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The internet has helped me a great deal when it comes to information gathering, communication and needed distraction. Money is a necessary but not sufficient condition for completion of a doctoral thesis, and I am grateful to the Stockholm School of Economics, Tore Browaldh's Foundation and Jan Wallander's and Tom Hedelius' Foundation.

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My family has always been supportive and as understanding as reasonable when someone spends nearly six years writing less than 80 pages. I believe, they will find my dissertation as strange as the latest dissertation in the family, some 60 years ago, which dealt with three ancient French prepositions.

Last, but not least, Helena, you have made these last stages of the dissertation work more than endurable. You're the best!

Bodbysund, August 2001

Introduction and summary

The starting point in industrial organization is the notion of perfect competition. In a market with perfect competition, everything is transparent. In particular, there is perfect information about price, product value and firms' actions. This dissertation deals with exceptions from the world of perfect competition. The first two essays deal with imperfect information about prices and firms' actions, whereas the third essay considers imperfect information about the value of the traded goods.

The first essay "Transparency and Competition" asks the question: If prices are more or less transparent, does that favour consumers or producers? Starting from a search model, where some consumers know prices and other have to search, it is shown that a greater price transparency, i.e. a lower search cost, reduces the price in a single play of the game. When the game is repeated, however, the lower is the search cost, the easier it is to sustain collusion. Thus, promoting greater price transparency reduces the price in the stage game at the risk of increased opportunity for collusion.

The second essay "Does Advertising Prevent Collusion?" analyses the case when firms can transmit price information to consumers by advertising. In contrast to the first essay, improved price transparency through advertising always reduces the price. It is even shown that the mere possibility of advertising can reduce the price, when firms are colluding. Thus, it is important to distinguish between advertising by firms and price publication by a third party. The first fosters competition, whereas the second may be harmful.

In the third essay "Underwriter Competition" it is not the price that is more or less transparent. Instead, we consider a situation where sellers cannot transfer knowledge about their product values to the buyers. In order to overcome this problem, sellers may hire a renowned third party, an underwriter, who can certify that the products are of a certain value. The question that is posed in this essay is: What happens if sellers can chose between different underwriters? It is shown that the underwriter market is a natural monopoly, where the underwriter with the highest ability to assess the value of the products gets the whole market.

Transparency and Competition

Transparency and Competition

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Abstract

This paper examines the effects of search costs on prices in a Bertrand duopoly. It is shown that if the search cost is lowered, the expected price falls in a single play of the stage game. However, if the game is repeated, collusion is more easily sustained, the lower is the search cost. In other words, increased transparency can facilitate collusion even if the sellers' information is unaffected.

Keywords: Bertrand Oligopoly, Collusion, Competition Policy, Imperfect Information, Transparency

JEL Classification: C 72, C 73, L 13, L 41

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1. Introduction

What is the relationship between transparency and competition? Or more specifically, does improved price information lead to higher or lower prices? The question is relevant for the design of competition policy. Should competition authorities promote price transparency or not? The traditional view has been that there is a trade off between the positive effects of improved price information for consumers; they can more easily make their purchases in the cheapest shop, and the negative effects of improved price information for producers; it may help firms collude. Consumers' councils and organizations working for the protection of consumers have stressed the importance of transparent prices and have engaged in the publication of comparative price lists. Economists and competition authorities, on the other hand, have generally paid attention to information sharing agreements between firms and have disregarded the issue of transparent prices. This paper considers price transparency for consumers, with complete information for the firms, and shows that there is still a trade off. On the one hand, lower search costs tend to reduce the static equilibrium price; on the other hand, it is easier for the sellers to sustain collusion when consumers are better informed.

1.1. Framework

The starting point is a simple search model, essentially due to Burdett and Judd [9], with heterogeneous consumers and a homogeneous goods duopoly. Some consumers have a search cost of zero, whereas it is positive for the others. The search cost measures the difficulty in getting information on prices; the more transparent are prices, the lower is the search cost. How transparent the market is can be considered to be determined by the competition authority. By publishing price lists, the competition authority can lower the search cost and hence, make the market more transparent. In other words, policy discussions about transparency can be linked to search costs, which has previously not been done.

The stage game is then repeated and the question of collusion in search markets is studied. If a firm cheats on the collusive agreement and lowers its price, this will only be noticed by the consumers with zero search cost, who will always search, and the gain from deviating will be lower than in the standard case. The price cutting firm will gain all the informed consumers, but as the uninformed consumers do not know the prices before deciding which shop to enter, 50 per cent of these will still go to the high price firm. A firm can always secure a positive profit by only serving half of the uninformed consumers at a high price. Thus, there are two countervailing effects of imperfect price information on the ability to sustain collusion. It reduces the incentives to deviate from a collusive agreement, but also reduces the severity of the punishment.

1.2. Competition Policy

Transparency is not mentioned in the US competition law, but the effects of transparent prices are sometimes touched on. In several cases, the US government has argued that price pre-announcements are in violation of the Sherman Act, while the US Courts have argued that the violation does not lie in the price announcements per se, but rather in the way they are used. Kühn and Vives [20] find a distinction, in the ruling of the Courts, between price pre-announcements acting as commitments to consumers and those which can easily be withdrawn by the firms. The first category implies greater transparency for consumers, and has therefore been viewed as positive, while the latter acts as coordination mechanisms for the firms.

The EU view on price transparency is mixed. Examining several cases, Kühn and Vives [20] come to the conclusion that the Commission has regarded increased price transparency through price pre-announcements as harmful to competition. In the Wood Pulp Case [26], the Commission found that firms in the European wood pulp industry violated Article 85(1), both by colluding on prices and by exchanging prices between firms. The publication of prices in advance made the market "artificially transparent" according to the Commission. The potential benefits for consumers, from the possibility to compare prices before purchase were not discussed.

In contrast to the Commission's negative view on transparency in these cases, there are examples where only the positive aspects are discussed. In the Council Directive on Consumer Protection 79/581/EEC[10], it is argued that increased market transparency ensures greater protection for consumers. Further, the argument that the move to a single European currency will increase price transparency and hence, competition, has been raised numerous times by several EU institutions[1]. In a speech in Copenhagen in 1997, the EU Commissioner responsible for Competition Policy, Karel Van Miert [35], stated: "For the first time real price transparency across borders will exist. Consumers will be able to source their purchases from anywhere in the Community free from the uncertainties, costs and complexities of exchange rate fluctuations. This can only bring benefits to consumers."

The Commission has even taken actions in order to increase the price transparency between the Member States. By bi-annually publishing lists of car prices the Commission hopes "...that greater price transparency will release market forces which will reduce price differentials."[27]

The most positive opinion on the competitiveness of transparency might be held by the competition authorities in the Scandinavian countries. In a report by the Swedish Competition Committee [24], the aim to decrease the search cost for consumers is stated as one of the objectives of the competition policy. The Norwegian Competition Act of 1993 [25] states it as a duty of the competition authorities to "implement measures to increase the markets' transparency." In Denmark, the Danish Competition Council argues that transparency could be an

[1] See e.g. the Declaration by the Council (Ecofin) and the Ministers Meeting in that Council in the Official Journal of the European Communities L 139 [28].

instrument against anti-competitive behaviour. The argument is that improved information would push the market further towards perfect competition. This view has recently been criticised by Albæk, Møllgaard and Overgaard [4] and Kofmann Christensen [19], who argue that the principle of transparency is counterproductive since it helps firms coordinate on a collusive price.

1.3. Related Literature

Changes in the price information available to consumers have already been studied in the price advertising literature. The difference is that this paper considers an exogenous change in the transparency, whereas in the price advertising literature, firms decide to make their prices public or not. A common feature in this literature is that price advertising leads to lower prices[2]. As in the search market literature, the issue of collusion has not been studied in the framework of a price advertising model.

In repeated games, theoretical research on the relationship between price information and price levels has completely ignored the effect on buyers' search behaviour. Conventionally, it is assumed that even if firms cannot observe each others' prices, consumers can do so without cost. Under this somewhat peculiar assumption, the literature has focused on sellers' information about each others' prices. Several authors have concluded that better and faster price information facilitates collusion[3]. In a repeated game with perfect monitoring, it is generally easier to sustain collusion, the sooner any cheating is discovered. On the other

[2]Bester and Petrakis [7] consider price advertising as a means of attracting customers from other locations and they find that sellers will advertise a low price with positive probability. Salonen [30] analyses a duopoly where firms can make binding price announcements and finds two Perfect Bayesian Equilibria. If the firms announce prices, they both commit to marginal cost pricing, if not, both charge the monopoly price. Baye and Morgan [6] consider a medium where firms may advertise and consumers can get the advertised information and they find that advertised prices are lower than nonadvertised prices.

[3]E.g. Phlips [29], Scherer and Ross [31], Stigler [33] and Tirole [34].

hand, Abreu, Milgrom and Pearce [3] show that, under imperfect monitoring, faster reporting may destroy the ability to sustain collusion. In an experiment, Faminov and Benson [14] find weak support for the hypothesis that the reporting of past prices leads to higher prices. Since the only information aspects that have been studied are those affecting producers, the case in favour of transparency has never been theoretically evaluated. The objective of the present paper is thus to fill this gap.

The evidence of increased price information from empirical studies is mixed. Albæk, Møllgaard and Overgaard [5] examine the effect of the Danish Competition Council publishing list prices on ready-mixed concrete. Prices increased and no other explanation than facilitation of collusion can be found. Numerous authors have studied the effects of advertising bans in the American optometry market[4]. In those states where price advertising is legal, and where optometrists advertise their price, the prices are lower. Several studies of the effect of the Canadian retail food price reporting systems have been conducted, all with the conclusion that prices fall during the reporting[5]. The present model might explain the differing results, without assuming any change in the information available to sellers.

Section 2 sets up the model and derives the stage game equilibrium. The analysis of the repeated game is found in section 3, section 4 outlines some empirical implications and the final remarks are found in section 5.

[4] See e.g. Bond, Kwoka Jr, Phelan and Taylor Whitten [8], Feldman and Begun [15] and Kwoka Jr [21].

[5] See e.g. Devine and Hawkins [11], Devine and Marion [12] and McCracken, Boynton and Blake [23].

2. The Model

2.1. Setup

Consider a price-setting duopoly with identical firms and a constant marginal cost normalised to zero. There is a continuum of consumers, normalised to one, each only observing the price of one firm. The model is a slight modification of the nonsequential search model in Burdett and Judd [9]. The difference is the presence of a share $\alpha \in (0, 1)$ of the consumers with zero search cost who search even if the expected gain is zero. These consumers can be considered as people enjoying the act of shopping, an enjoyment that outweighs the search cost so that the net search cost is zero. Another interpretation of α could be that a share α of the consumers have free access to a superior information technology, such as the internet. Instead of searching for prices in the traditional way, these consumers can, through a few mouse-clicks, obtain lists of prices for an increasing number of products. As in Stahl [32], we will call these consumers "shoppers". The other consumers have a positive search cost, s. They maximize their expected utility, comparing the expected gain from searching with the search cost. The timing of the game is the following: First, firms set prices simultaneously, then consumers decide whether to search for prices or not, taking into account the expected gain from searching. In equilibrium, a fraction $\beta \in [\alpha, 1]$ of the consumers search and obtain perfect price information. These consumers purchase at the shop with the lowest price, whereas the others go to either shop with equal probability. When firms collude on a fixed price, the expected gain from searching is zero, and only the shoppers will search. The share of informed consumers β will then coincide with the share of shoppers α.

All consumers have an individual demand of one unit of the good, with a reservation price of p^r. Confining the attention to the case where $\min\{p_i, p_j\} \leqslant p^r$, the β fully informed consumers have a total demand of

$$E_i(p_i, p_j) = \begin{cases} \beta, & \text{if} \quad p_i < p_j; \\ \\ \dfrac{\beta}{2}, & \text{if} \quad p_i = p_j; \\ \\ 0, & \text{if} \quad p_i > p_j; \end{cases}$$

for firm i's products. We are interested in the aggregate demand facing firm i, which simplifies to

$$D_i(p_i, p_j, \beta) = \begin{cases} \dfrac{1+\beta}{2}, & \text{if} \quad p_i < p_j; \\ \\ \dfrac{1}{2}, & \text{if} \quad p_i = p_j; \\ \\ \dfrac{1-\beta}{2}, & \text{if} \quad p_i > p_j. \end{cases}$$

Whether firms can or cannot observe each other's prices is of no importance in this setup, since they can infer each other's actions from their observed demand.

2.2. Stage Game Equilibria

We first look at equilibria in the stage game. Each firm wants to undercut the other firm's price as long as the profit from this is greater than the profit from charging the reservation price. If one firm sets p^*, where p^* solves the equation

$$\frac{1+\beta}{2}p^* = \frac{1-\beta}{2}p^r,$$

the other firm wants to set the reservation price and serve half of the uninformed consumers. First, note that $\beta = \alpha = 0$ implies the reservation price as the unique equilibrium like the Diamond [13] result, where a positive search cost for all consumers inevitably leads to monopoly pricing. With $\beta = 1$, we have returned to the standard Bertrand equilibrium where the price equals the marginal cost. For $0 < \beta < 1$, we have the following results:

Lemma 1. *In any equilibrium, no price is set with positive probability.*

Proof. No price lower than p^* or higher than p^r can be part of any equilibrium. Profits could then be increased by increasing or decreasing the price, respectively. If firm i sets a price p_i with positive probability and firm j plays according to some arbitrary strategy, firm j could increase its profit by assigning probability mass on $p_j = p_i - \varepsilon$.■

Proposition 1. *For any β, there is a unique symmetric mixed strategy equilibrium. In this equilibrium, each firm randomizes according to the cumulative distribution function*

$$F(p_i) = \begin{cases} 0, & \text{if} \quad p_i \leqslant p^*; \\ 1 - \dfrac{1-\beta}{2\beta}\left(\dfrac{p^r}{p_i} - 1\right), & \text{if} \quad p^* < p_i < p^r; \\ 1, & \text{if} \quad p_i \geqslant p^r. \end{cases}$$

Proof. The unique symmetric equilibrium is characterised by a cumulative distribution function $F(p)$ on $[p^*, p^r]$. All prices in the interval $[p^*, p^r]$ must yield the same expected payoff, in particular setting p_i or p^r, when the other plays $F(p)$ should be equivalent. We obtain the profit from charging p_i, when the other firm randomizes according to $F(p)$,

$$E\Pi_i(p_i, F) = \left(\beta\left(1 - F(p_i)\right) + \frac{1-\beta}{2}\right) p_i, \tag{2.1}$$

where the first component is the probability that the price p_i is lower than p_j, times the share of informed consumers. The second component is firm i's share of the consumers who do not search. Equating this expression with the profit from charging the reservation price

$$E\Pi_i\left(p^r, F\right) = \frac{1-\beta}{2}p^r, \tag{2.2}$$

we get

$$\left(\beta\left(1 - F(p_i)\right) + \frac{1-\beta}{2}\right)p_i = \frac{1-\beta}{2}p^r,$$

which gives the unique distribution function

$$F(p_i) = 1 - \frac{1-\beta}{2\beta}\left(\frac{p^r}{p_i} - 1\right), \text{ if } p^* < p_i < p^r. \blacksquare$$

Corollary 1. *The higher the* β, *the lower the expected price.*

Proof. This follows from p^* being decreasing in β,

$$\frac{dp^*}{d\beta} = \frac{-2p^r}{\left(1+\beta\right)^2} < 0,$$

and the density function $f\left(p_i\right)$ being decreasing in β. The corresponding density function $f\left(p_i\right)$ to the distribution function $F(p_i)$ is

$$f\left(p_i\right) = \frac{1-\beta}{2\beta}\frac{p^r}{p_i^2},$$

which is indeed decreasing in the share of searchers,

$$\frac{df\left(p_i\right)}{d\beta} = \frac{-p^r}{2\beta^2 p_i^2} < 0. \blacksquare$$

Lemma 1, Proposition 1 and Corollary 1 are similar to related propositions in Burdett and Judd [9], Guimarães [17], Stahl [32] and Varian [36].

2.3. Search Behaviour

We will distinguish between exogenous and endogenous changes of the price transparency. Exogenous changes are parameterized by changes in α. The fact that more people fancy shopping around might be due to the emergence of new internet shopping guides or cheaper internet access as well as changes in the consumers' behaviour. Endogenous transparency is determined in equilibrium through search costs and expected price setting.

The $1-\alpha$ consumers with search cost s maximize their expected utility, comparing the expected gain from searching with s. The expected gain from searching $v(p^r, \beta)$ is the difference between the expected price $\overline{p}$ and the expected minimal price $\overline{p}_{\min}$, $v(p^r, \beta) = \overline{p} - \overline{p}_{\min}$. A searcher faces the expected minimal price $\overline{p}_{\min}$ and a consumer abstaining from searching expects the price $\overline{p}$. The distribution of the minimal price $p_{\min}$ is

$$G(p_{\min}) = \begin{cases} 0, & \text{if} \quad p_{\min} \leqslant p^*; \\ 1 - \dfrac{(1-\beta)^2}{4\beta^2}\left(\dfrac{p^r}{p_i} - 1\right)^2, & \text{if} \quad p^* < p_{\min} < p^r; \\ 1, & \text{if} \quad p_{\min} \geqslant p^r. \end{cases}$$

Proposition 2. *Depending on the search cost s, two cases may arise, first that only the shoppers search and second that a share β of the consumers search.*

Proof. When $s > v(p^r, \alpha)$, the search cost is higher than the gain from searching when only the shoppers search, there always exists an equilibrium where only the shoppers search. It is not profitable for the first consumer to search, so no one will start. Furthermore, when $s > v(p^r, \beta)$ for all β, it is never profitable for the consumers with a positive search cost to search, so only the shoppers search. In the second case, the $1-\alpha$ consumers with search cost s are indifferent between searching or not. The share β is such that $s = v(p^r, \beta)$ where both $\overline{p}$ and $\overline{p}_{\min}$ depend on β. The equilibrium condition is

$$
\begin{aligned}
s &= v(p^r,\beta) = \overline{p} - \overline{p}_{\min} \\
&= \int_{p^*}^{p^r} p dF(p_i) - \int_{p^*}^{p^r} p dG(p_{\min}) \\
&= \int_{p^*}^{p^r} p \frac{1-\beta}{2\beta} \frac{p^r}{p^2} dp - \int_{p^*}^{p^r} p_{\min} \frac{(1-\beta)^2}{2\beta^2} \frac{p^r}{p_{\min}^2} \left(\frac{p^r}{p_{\min}} - 1 \right) dp_{\min} \\
&= p^r \left(\frac{1-\beta}{2\beta} \ln \frac{1+\beta}{1-\beta} - \frac{(1-\beta)^2}{2\beta^2} \left(\frac{2\beta}{1-\beta} - \ln \frac{1+\beta}{1-\beta} \right) \right) \\
&= p^r \frac{1-\beta}{2\beta} \left(\frac{1}{\beta} \ln \frac{1+\beta}{1-\beta} - 2 \right) . \blacksquare
\end{aligned}
$$

The graph of the function $v(p^r,\beta)$ is illustrated in Figure 2.1. Note that $v(p^r,\beta)$ attains a unique maximum at some β^*, is strictly increasing for $\beta \in (0, \beta^*)$ and strictly decreasing for $\beta \in (\beta^*, 1)$.[6] Given the reservation price p^r, there exists a unique $s^* > 0$, satisfying $v(p^r, \beta^*) = s^*$. As in Burdett and Judd [9], there are several equilibria to be analysed. If s is larger than s^*, only shoppers will search. If $s = s^*$, we have a unique equilibrium with $\beta = \beta^*$, and if $s < s^*$, there are two equilibria corresponding to β_1 and β_2 in Figure 2.1. As Fershtman and Fishman [16] have shown, when $s < s^*$ only one of the equilibria is stable. Consider the neighbourhood of β_1 in Figure 2.1. If $\beta < \beta_1$, the gain from searching is less than the search cost and thus, β will always decrease away from β_1. If $\beta > \beta_1$, the gain from searching is larger than the search cost, so that β will always increase away from β_1. The equilibrium with the share of searchers β_2 is, on the other hand, stable. When $\beta_1 < \beta < \beta_2$, then $v(p^r, \beta) > s$, and β will increase to β_2. If $\beta > \beta_2$, then $v(p^r, \beta) < s$, and β will decrease to β_2. In the rest of the analysis, we will restrict the attention to this stable equilibrium.

[6] For proof, see Burdett and Judd [9].

Proposition 3. *A reduction of s will lead to a higher or an unchanged β.*

Proof. Given that we are in the stable equilibrium, the figure shows that $d\beta_2/ds < 0$, so that the lower is the search cost, the more people search, which is a common result in the search market literature. Consider now a reduction of the search cost when the initial search cost is larger than s^*. To increase the number of searchers, the search cost must be significantly reduced. β will remain at α until the search cost is lower than the gain from searching, when only α of the consumer search. Thus,

$$\beta^*(s) = \begin{cases} \alpha, & \text{if} \quad s > v(p^r, \alpha); \\ \\ \beta_2, & \text{if} \quad s < v(p^r, \alpha). \end{cases}$$

If $\alpha = \alpha_2$ in the figure, a reduction of the search cost to s' will induce β_2 of the consumers to search. If, on the other hand, $\alpha = \alpha_1$ in the figure, reducing the search cost to s' is not sufficient to raise the search activity.■

Potentially, there are two effects of a price publication by the competition authority. First, a reduction of the search cost which will raise β. Second, some consumers that did not previously search will start studying the price lists and derive enjoyment from this and hence, raise α. Indeed, some people read price surveys for goods they do not even consider buying, just because they happen to stumble over the survey in their newspaper. Likewise, those connected to the internet are likely to look up prices of e.g. books and compact discs on the net before their purchase, something they would not have done a few years ago. Promoting the use of the internet would certainly raise α in these markets. The more α increases, the less s must be reduced to induce a jump to β_2. In markets where the shoppers are very responsive to changes, a search-intensive equilibrium is almost guaranteed and hence, low prices.

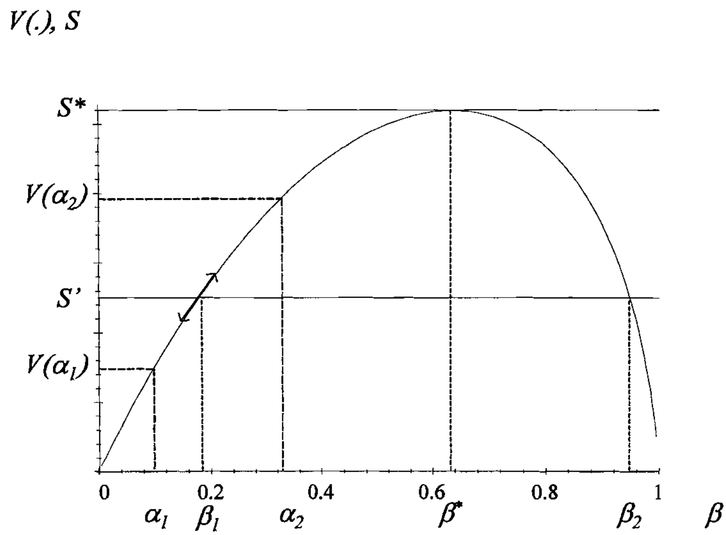

Figure 2.1: The function $v(p^r, \beta)$

3. Repeated Game

When the game is repeated, there are intuitively two countervailing effects of imperfect price information. First, the profit from deviating from a collusive agreement is lower than under complete information. A deviating firm does not gain the whole market by ε-undercutting. Second, the possible punishment imposed on a deviator should be less severe, since a firm can always gain a positive profit by charging the buyers' reservation price.

When the search cost is so low that some consumers with positive search costs search, we may not have the same stage game in every period. Specifically, the stage game changes after a deviation. Recall the timing of the game; consumers know the expected price and the expected gain from searching before deciding to search or not. During collusion, only the shoppers search since the expected gain from searching is zero, as both firms charge the same price. In the deviation phase, one firm sets a price just ε below the collusive price, so that the expected gain from searching is still zero and only the shoppers react to the deviation. In the first punishment phase, those consumers that shopped at the deviating shop know that the expected gain from searching is substantial. Thus, a larger fraction of the consumers search. In the following period, all consumers will know that firms are in a punishment period and we have returned to the stage game equilibrium.

As a basis for comparison, we first review the perfect information case, when all consumers observe both prices. In the imperfect information case, we continue by analysing collusion supported by trigger strategies.[7]

[7] The alternative, optimal punishments suggested by Abreu [1] [2], are not feasable since they are deterministic and the consumers know which firm deviated and what price will be charged the next period. Thus, the consumers have no incentive to search which, in turn, means that the firms will deviate from their punishment and charge a high price and the punishment scheme will breake down. The idea is that this stick and carrot setup means that it pays for the deviator to participate in its own punishment. Refraining from doing so prolongs the first stage of the punishment. Abreu originally developed this punishment for Cournot games; Lambson [22] and

3.1. Perfect Information

In the perfect information case, the punishment payoff is zero. A deviation from the collusive agreement implies ε-undercutting the collusive price and gaining all consumers. Collusion on the collusive price p^c is sustainable if

$$\frac{p^c}{2(1-\delta)} \geqslant p^c + \frac{\delta}{1-\delta}0,$$

or equivalently, if

$$\delta \geqslant \frac{1}{2}.$$

As long as the discount factor is larger than one half, collusion is sustainable.[8]

3.2. Trigger Strategies

A deviation from collusion will lead more people to search, since the expected gain from searching is positive in the punishment phase. This implies that the punishment payoff will be lower. Collusion supported by trigger strategies implies that a deviation from the collusive agreement is punished by an eternal reversion to the stage game equilibrium. Firms set the collusive price p^c in the collusive phase and firm i receives profit $p^c/2$. If firm i deviates, the profit is

$$\Pi_i^d = (1+\alpha)\frac{p^c}{2}.$$

In the first punishment phase, those consumers that shopped at the deviating shop know that firms will mix prices, while the other consumers do not and still think that they will face the collusive price in both shops. Depending on the β in the stage game equilibrium, two cases may arise, so that the payoff in the first

Häckner [18] have later adapted it to Bertrand games with capacity constraints and product differentiation, respectively.

[8] Regardless of the collusive price, collusion is sustainable for discount factors larger than one half.

punishment period is

$$\Pi_i^{p1} = \begin{cases} \dfrac{1-\beta}{2} p^r & \text{if } \beta \leqslant \dfrac{1+\alpha}{2}, \\ \dfrac{1-\dfrac{1+\alpha}{2}}{2} p^r & \text{if } \beta > \dfrac{1+\alpha}{2}, \end{cases}$$

and in the second punishment phase, firms revert to the stage game mixed equilibrium forever, with profit

$$\Pi_i^{p2} = \frac{\Pi(\overline{p})}{2} = \frac{1-\beta}{2} p^r.$$

All the results are in the same direction, whether the required β is higher or lower than $(1+\alpha)/2$; in the following calculations we will thus restrict attention to the first case. Collusion is sustainable if

$$\frac{p^c}{2(1-\delta)} \geqslant (1+\alpha)\frac{p^c}{2} + \frac{\delta}{1-\delta}\frac{(1-\beta)}{2} p^r,$$

or equivalently, if

$$\delta \geqslant \frac{\alpha p^c}{(1+\alpha)p^c - (1-\beta)p^r}.$$

We can now establish a first result.

Proposition 4. *The higher the collusive price, the easier it is to sustain collusion.*

Proof. Taking the derivative of the critical discount factor, δ, with respect to the collusive price, p^c, yields

$$\frac{d\delta}{dp^c} = \frac{-\alpha(1-\beta)p^r}{((1+\alpha)p^c - (1-\beta)p^r)^2} < 0,$$

for $p^c < p^r$.■

So if firms collude, this is done on the reservation price p^r. In the perfect information case, the collusive price does not affect the ability to sustain collusion, and in most other models, a higher collusive price makes it harder to sustain collusion. The reason for the opposite result in this model is that the value of sticking to the collusive agreement changes more than the gain from deviating, when the collusive price changes. In the following analysis, we can use the simple restriction on collusion on the reservation price, which is

$$\delta \geqslant \frac{\alpha}{\alpha + \beta}. \tag{3.1}$$

We see that it is now possible to sustain collusion for discount factors smaller than one half, since $\beta > \alpha$.

A special case arises when the search cost s is larger than the gain from searching in the stage game. In this case, we have a repeated game where $\beta = \alpha$, and the condition for collusion to be sustainable is $\delta \geqslant 1/2$, i.e. the same as in the perfect information case. The intuition is straightforward; the small gain from deviating is perfectly outweighed by the weaker punishment. It is the same fraction of consumers, the shoppers, that the deviator gains when deviating and loses in the punishment phase.

3.3. Price Publication

The competition authority's aim with price publications is to increase the transparency and reduce the price in the market. As noted earlier, a price publication has two potential effects; both α and β may increase. The effects of an exogenous increase of α, and an endogenous increase of β through a lower search cost, are quite different, however.

Proposition 5. *The more shoppers there are, the harder it is to sustain collusion.*

Proof. This follows from

$$\frac{d\delta}{d\alpha} = \frac{\beta}{(\alpha + \beta)^2} > 0.$$

■

Since shoppers are the ones reacting to a deviation, a higher share of shoppers increases the incentives to deviate from the collusive agreement, but the punishment is not affected.

Proposition 6. *The lower the search cost, the easier it is to sustain collusion.*

Proof. This follows from $d\beta/ds \leqslant 0$, and

$$\frac{d\delta}{d\beta} = \frac{-\alpha}{(\alpha+\beta)^2} < 0.$$

■

Contrary to the result in the stage game where a higher search intensity will lead to lower prices, a reduction of the search cost that raises β will strengthen the punishment, and facilitate collusion. Thus, it is not increased information for the firms that makes collusion easier, but the fact that consumers react to the lower search cost. The incentive for the firms to collude is also strengthened, since the profit in the stage game is lowered by the competition authority's act of publishing prices. Making the prices more transparent lowers the price in the stage game, at the risk of increased opportunity for collusion.

Proposition 7. *A transitory price publication will never facilitate collusion.*

Proof. Consider the case when the search cost s is larger than the gain from searching v, and only α of the consumers search in the stage game. Suppose that the competition authority starts publishing prices and declares that it will do so for a specific number of periods. The search cost is only reduced during the publication, so everyone knows that at the end of the publication, only α of the consumers will search. This implies that a deviation from a collusive agreement in the last publication period is only punished with the punishment payoff $(1-\alpha)p^r/2$, as in the repeated game. Collusion is only sustainable for $\delta \geqslant 1/2$ in that period. In the last publication period but one, both firms know that collusion in the next period is not possible for discount factors δ lower than one half. If the discount factor is indeed lower than one half, both firms will deviate from the collusive agreement. By backward induction, it is easy to see that it is not possible to sustain collusion in any period for discount factors lower than one half, when the publication of prices is temporary.■

4. Empirical Implications

The model in this paper entails some empirical predictions. A reduced search cost, or a facilitation of price comparisons, should either lead to lower prices or higher prices coupled with reduced price dispersion. The first case occurs when firms compete without collusion, both before and after the reduction of the search cost. In the second case, firms start colluding after the reduction of the search cost.

In the absence of collusion, the price falls when the search cost is reduced. This is in line with the findings from the food market in Canada. All reports show a decrease in the price level, some also show a decline in the dispersion of prices, while others do not. Looking at the price variance,

$$var\left(p\right) = \left(1-\beta\right) p^{r^2} \left(\frac{1}{1+\beta} - \frac{1-\beta}{4\beta^2}\left(\ln\frac{1+\beta}{1-\beta}\right)^2\right),$$

we find that it exhibits a non-monotonic relationship with the search cost. Recall that the price varies from marginal cost when everyone is informed to reservation price when no one is informed. In both extreme cases, the variance is zero, while being positive in between. On the one hand, the possible price range widens as the search cost declines, on the other hand, the distribution shifts towards lower prices, so that high prices will be less common. The first effect dominates for small β and the second for large β. We have

$$\begin{aligned}\frac{dvar(p)}{ds} &= \frac{dvar(p)}{d\beta}\frac{d\beta}{ds}, \\ &= p^{r^2}\left(\frac{1-\beta}{\beta^2}\left(\ln\frac{1+\beta}{1-\beta}\right)\left(\frac{1}{2\beta}\ln\frac{1+\beta}{1-\beta}-\frac{1}{1+\beta}\right)-\frac{2}{(1+\beta)^2}\right)\frac{d\beta}{ds},\end{aligned}$$

which is negative for β lower than some $\widehat{\beta}$, and positive for β larger than $\widehat{\beta}$. In the relevant range, $\beta > \beta^*$, it is possible to observe both increased and decreased variance after a reduction of the search cost, due to the fact that $\widehat{\beta}$ is larger than β^*.

The profit in the stage game declines when the search cost is lowered, so that the incentives to initiate collusion are greater. A reduced search cost, that is perceived to be permanent, also makes it easier to sustain collusion, as the lowest possible discount factor declines. It would therefore be natural to observe an increase in the price level as a result of a price publication, just as found by Albæk et al. [5] in the Danish concrete market. Prices increased by 15 - 20 percent and the price dispersion was significantly reduced, which is in line with the model's predictions.

Another explanation for the differing results could be the difference in market structure. In markets like food retailing, there are more active firms than in the concrete market. If the model is calculated with N firms instead of two, the expected price can be shown to be decreasing in N. Furthermore, the critical discount factor for the ability to sustain collusion is increasing in N, so that the more firms there are in the market, the less likely it is that a price publication leads to firms' initiating collusion.

5. Final Remarks

Whenever it is possible to identify a change in the price information in a market, it would be possible to test the model on time series data, comparing the price level and the price dispersion before and after the change. Different price information regimes in different regions could also be a basis for testing the model on cross sectional data.

One issue that it would be interesting to look into is the arrival of the internet. With the help of shopping guides that search most of the internet shopping facilities, the effective search cost has been dramatically reduced. Whether this new technology has lead to increased competition or not is a topic for future research.

The welfare implications of a model with unit demand are well known; there are no distortions due to collusive prices. With a more elaborate demand side, there would be an efficiency loss from high prices and it would be clearer that the competition authority's aim should be to lower prices. As the model now stands, the competition authority is only interested in reducing prices if it puts more weight on the consumer surplus than the producer surplus.

There is an important distinction between the effects of a permanent and a transitory increase in the transparency. Whereas a permanent increase results in a lower expected price in the stage game, but facilitates collusion, a transitory increase in the transparency is unambiguously positive. Publication in a limited period should lower the expected price in the stage game without increasing the possibilities of sustaining collusion. An increase in price transparency that is perceived to be permanent can, on the other hand, give a result that is exactly the opposite the intended.

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Does Advertising Prevent Collusion?

Does Advertising Prevent Collusion?

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Abstract

This paper examines the effects of price advertising in a Bertrand duopoly. It is shown that increased advertising reduces the price in a single play of the stage game. In a repeated game, there may not be advertising in the most collusive equilibrium. Nonetheless, the mere possibility of advertising can reduce the collusive price.

Keywords: Advertising, Bertrand Oligopoly, Collusion, Competition Policy, Imperfect Information

JEL Classification: C 72, L 13, L 41

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1. Introduction

In the EU, there is a wide divergence between countries regarding their price advertising policy [12]. Whereas Germany has a very restrictive view on price discount advertising, Swedish law promotes comparative price advertising between firms. Countries whose legal tradition is linked to consumer protection tend to encourage price advertising, arguing that consumers gain from increased information. Other countries are more restrictive, arguing e.g. that price advertising can facilitate dumping. These differences highlight the importance of analysing the competitive effects of price advertising.

Another reason for the renewed interest in price advertising is that the arrival of the internet has greatly affected advertising costs. With the help of shopping guides that search most of the internet shopping facilities, the effective search cost has been dramatically reduced. Interestingly, some firms are unwilling to let netsurfers sample their prices, a practise which can be seen as the reverse of price advertising.

1.1. Framework

The relationship between advertising and competition has been subject to considerable research. Therefore, it is somewhat curious that the issue of collusion has not been raised in the framework of a price advertising model. How does the cost of advertising affect the firms' ability to collude? In particular, do advertising bans support or destroy collusion? In this paper, I argue that the ability to advertise is detrimental to collusion. Intuitively, under an advertising ban, a firm cannot inform the consumers of a price reduction and hence, it does not gain from a deviation from the collusive agreement. Allowing firms to advertise makes it harder to sustain collusion and may force firms to reduce the collusive price.

The potentially collusive effect of advertising bans was noted in the recent case of 44 Liquormart, where the U.S. Supreme Court struck down on Rhode Island's ban on advertising prices of alcoholic beverages [18]. The attorney arguing the case against the ban claimed that "everybody in the courtroom knew that in reality the ban was a way of helping liquor dealers fix prices." The Rhode Island Liquor Stores Association openly supported the ban arguing that "smaller retailers would be devastated by the kind of advertising splash that big chains would sponsor," a behaviour consistent with the predictions of the model in this paper.

In order to examine the effects of advertising, the natural starting point is a model with imperfect price information for consumers. If consumers were informed about prices, there would be no need for advertising or search. Consumers have the choice of buying a newspaper where firms may advertise, or go directly to a shop and purchase the product if the price is at or below their reservation price. In this paper, advertising is seen as the easiest way of conveying price information to consumers, and has no other function. Even though the focus is on price advertising, the results carry over to other forms of advertising. For example, any kind of persuasive advertising that shifts consumer preferences between firms can be analysed in the same model, as long as market demand is independent of advertising expenditures.

1.2. Related Literature

A recurrent theme in the advertising literature is that price advertising leads to lower prices. Bagwell and Ramey [3] [4] show that advertising can function as a coordination mechanism for consumers. Firms that advertise will offer lower prices. Bester and Petrakis [8] consider price advertising as a means of attracting customers from other locations and find that sellers will advertise a low price with positive probability. Salonen [20] analyses a duopoly where firms can make binding price announcements and finds two Perfect Bayesian Equilibria. If firms announce prices, they both commit to marginal cost pricing, if not, both charge the monopoly price. Baye and Morgan [6] consider a medium where firms may advertise and consumers can get the advertised information. They find that advertised prices are lower than nonadvertised prices.

The empirical literature on price advertising has focused on the effects of advertising bans, but also on how the volume of advertising influences prices. Numerous authors have studied the effects of advertising bans in the American optometry market[1]. They find that in those states where price advertising is legal, and where optometrists advertise their price, prices are lower, even for the firms that do not advertise. Cady [10] estimates the effects of restrictions on drug price advertising in the US and finds prices to be higher under restrictions. Eckard [11] studies the impact of the introduction of the American cigarette TV advertising ban, with the finding that it raised profit margins. Moreover, the relationship between advertising intensity and margins was found to be negative. Milyo and Waldfogel [18] found advertised prices of alcoholic beverages to be lower and quantities to be higher at newspaper-advertising shops in Rhode Island. Schroetter, Smith and Cox [21] consider advertising in routine legal service markets in the US and conclude that it reduces price. Gomes [14] gives empirical support for the competitive hypothesis of advertising on aggregate American data; advertising provides consumers with information and increases competition.

The effects of changes in consumer price information in general and price advertising in particular have not been explored in a repeated oligopoly setting. In our model, firms have perfect information, whereas consumers are imperfectly informed. The informational assumptions are the same as in Nilsson [19], who examines the effects of an exogenous change in price transparency and finds that increased transparency may facilitate collusion. The difference is that the present paper considers endogenous information transmission; firms decide to advertise or not.

Section 2 sets up the model and derives the stage game equilibrium. The

[1] See e.g. Benham [7], Bond, Kwoka Jr, Phelan and Taylor Whitten [9], Feldman and Begun [13] and Kwoka Jr [16].

analysis of the repeated game is found in Section 3, Section 4 outlines some empirical implications and the final remarks are found in Section 5.

2. The Model

The static model builds on Baye and Morgan [6], but has two types of consumers rather than one. The static model is here infinitely repeated, allowing us to analyse the firms' possibilities to collude on a high price. Consider a price-setting duopoly with identical firms and a constant marginal cost normalised to zero. There is a continuum of consumers, normalised to one. All consumers have an individual demand of one unit of the good, with a reservation price of $p^r \in (0, \infty)$. The information transmission between firms and consumers takes place in a medium, "the newspaper". Firms can advertise their price in the newspaper for a fee of $\phi > 0$. A share $\alpha \in (0, 1)$ of the consumers subscribes to the newspaper for other reasons than to get price information, and hence always reads it. Their cost of subscribing is outweighed by the joy of reading the paper. The rest of the consumers can purchase the newspaper for a fee κ. Everyone reading the newspaper, the subscribers (α) and the single copy purchasers, gets the information from the advertisements in the newspaper. Another interpretation of α could be that a share α of the consumers have free access to a superior information technology, such as the internet.

Those who do not read the paper will go to either firm with equal probability. Consumers reading the newspaper will buy from the firm advertising the lowest price as long as it is not higher than p^r. In equilibrium, a share $\beta \in [\alpha, 1]$ of the consumers will purchase the newspaper, comparing the cost κ with the expected gain from seeing the potential advertisements. Denoting firm i's decision to advertise or not $a_i \in \{A, N\}$, we have the profit for firm i,

$$\pi_i(p_i, p_j, a_i, a_j) = \begin{cases} \frac{1+\beta}{2} p_i - \phi, & \text{if} \quad p_i < p_j,\ a_i = A,\ a_j = A; \\ \frac{1}{2} p_i - \phi, & \text{if} \quad p_i = p_j,\ a_i = A,\ a_j = A; \\ \frac{1-\beta}{2} p_i - \phi, & \text{if} \quad p_i > p_j,\ a_i = A,\ a_j = A; \\ \frac{1+\beta}{2} p_i - \phi, & \text{if} \quad a_i = A,\ a_j = N; \\ \frac{1-\beta}{2} p_i, & \text{if} \quad a_i = N,\ a_j = A; \\ \frac{1}{2} p_i, & \text{if} \quad a_i = N,\ a_j = N. \end{cases}$$

From Baye and Morgan [6], we have Proposition 1 and Proposition 2:

Proposition 1. *Let $\beta \in [\alpha, 1]$ and $\phi \in (0, p^r\beta/2)$ be given. Then, in the unique Nash equilibrium, each firm advertises its price with probability*

$$\rho^*(\beta, \phi) = 1 - \frac{2\phi}{p^r\beta}.$$

The advertised price is drawn at random from the cumulative distribution function

$$F(p; \beta, \phi) = \frac{[p(\beta+1) - p^r(1-\beta) - 4\phi]\, p^r}{2p(p^r\beta - 2\phi)} \quad \text{on} \quad \left[\frac{p^r(1-\beta) + 4\phi}{\beta+1}, p^r\right].$$

With probability $(1 - \rho^*)$, a firm does not advertise and sets its price at p^r. Each firm earns the expected profits of

$$E\pi_i = \frac{1-\beta}{2} p^r + \phi.$$

We see that firms always make a positive profit even after paying the advertising fee. Consumers will compare the expected gain from buying the newspaper with the cost κ. There is a probability of $(\rho^*)^2$ that both firms advertise in the paper, and the expected price is the minimum of two draws from $F(p;\beta,\phi)$, denoted $p_{\min 2}$. With probability $2\rho^*(1-\rho^*)$, only one firm advertises and the expected price is $p_{\min 1}$. With the remaining probability $(1-\rho^*)^2$, neither firm advertise, so that the expected utility of buying the paper is

$$EU(B) = p^r - (\rho^*)^2 p_{\min 2} - 2\rho^*(1-\rho^*) p_{\min 1} - (1-\rho^*)^2 p^r - \kappa,$$

where B stands for buying. Non-buying consumers go to either shop with equal probability, so when both firms advertise, the expected price is $p_{\min 1}$. In the case when only one firm advertises, the price is either $p_{\min 1}$ or p^r, with equal probability. The expected utility of not buying the paper is then

$$EU(NB) = p^r - (\rho^*)^2 p_{\min 1} - \rho^*(1-\rho^*)(p_{\min 1} + p^r) - (1-\rho^*)^2 p^r,$$

where NB stands for not buying. Hence, the gain from purchasing the paper, G, is

$$G = \left(1 - \frac{2\phi}{p^r\beta}\right)\left[\left(1 - \frac{2\phi}{p^r\beta}\right)(2p_{\min 1} - p_{\min 2} - p^r) + p^r - p_{\min 1}\right] - \kappa,$$

noting that $\rho^*(\beta,\phi) = 1 - 2\phi/p^r\beta$ in equilibrium. As long as the newspaper price κ is low enough, a share β of the consumers will purchase it and there will be a dispersed price equilibrium in the static game. When consumers expect everyone to buy the newspaper, the critical κ is thus defined as

$$\kappa^*(\phi) \equiv \left(1 - \frac{2\phi}{p^r}\right)\left[\left(1 - \frac{2\phi}{p^r}\right)(2p_{\min 1} - p_{\min 2} - p^r) + p^r - p_{\min 1}\right],$$

which is the price that makes the gain from buying the newspaper equal to zero when all consumers buy it.

Proposition 2. *Suppose* $\alpha \in (2\phi/p^r, 1)$, $\phi \in (0, p^r/2)$, *and* $\kappa \in (0, \kappa^*(\phi))$. *Then, the homogenous product price-setting game with endogenous information transmission and acquisition has two equilibria.*

(a) ***A Dispersed Price Equilibrium with Imperfect Consumer Information:*** *A fraction* $\beta^* \in (2\phi/p^r, 1)$ *of the consumers buys the paper, where* β^* *solves*

$$\left(1 - \frac{2\phi}{p^r\beta^*}\right)\left(\left(1 - \frac{2\phi}{p^r\beta^*}\right)(2p_{\min 1} - p_{\min 2} - p^r) + p^r - p_{\min 1}\right) = \kappa.$$

Each firm advertises with probability $\rho^*(\beta, \phi) = 1 - 2\phi/p^r\beta$, *and the advertised price is drawn at random from the cumulative distribution function* $F(p; \beta, \phi)$, *defined in Proposition 1. Firms that do not advertise charge the reservation price* p^r, *and each firm earns the expected profits of* $(1 - \beta) p^r/2 + \phi$.

(b) ***A Dispersed Price Equilibrium with Full Consumer Information:*** *All consumers buy the paper* ($\beta^* = 1$). *Each firm advertises with probability* $\rho^* = 1 - 2\phi/p^r$, *and the advertised price is drawn at random from the cumulative distribution function* $F(p; 1, \phi)$, *defined in Proposition 1. Firms that do not advertise charge the reservation price* p^r, *and each firm earns the expected profits of* ϕ.

Only the second equilibrium is stable. To see this, note that the gain from buying the paper when $\beta = 1$ is always higher than any $\kappa \in (0, \kappa^*(\phi))$. For β just below 1, it is profitable for the remaining consumers to buy the newspaper until everyone has done so. Consider now the environment around the first equilibrium. If β is just below β^*, the gain from buying the newspaper is lower than κ, fewer people will buy it and we move away from the equilibrium. If β is somewhat larger than β^*, the gain from buying the newspaper is higher than κ, so that more people will purchase the paper and we will move towards the second equilibrium.

It is now possible to establish some results:

Corollary 1. *A lower advertising fee and a higher consumer participation rate increase advertising.*

Proof. This follows from the comparative statics

$$\frac{d\rho^*}{d\phi} = \frac{-2}{\beta p^r} < 0$$

and

$$\frac{d\rho^*}{d\beta} = \frac{2\phi}{\beta^2 p^r} > 0.$$

■

Corollary 2. *Increased advertising lowers the price.*

Proof. This follows from the fact that advertised prices are never higher and with positive probability lower than nonadvertised prices. ■

It also follows that firms' profits are higher, the higher is the advertising fee, since a high advertising fee reduces advertising intensity. Firms prefer the outcome where advertising fees are prohibitive or price advertising is prohibited by law.

3. Repeated Game

When the game is repeated, firms can coordinate on setting a high price with the threat of a severe punishment if someone deviates. As a basis for comparison, we will first review the perfect information case, when all consumers observe both prices. In the imperfect information case, we continue by analysing collusion supported by trigger strategies.[2]

[2] Trigger strategies have several appealing features (they are simple and do involve negative prices.) However, they are not always optimal. Optimal punishments for this setting where firms have two choice variables, price and advertising, have, as far as I know, not been derived.

3.1. Perfect Information

In the perfect information case, when all consumers observe both prices, trigger strategies and optimal two-phase punishments coincide, and the punishment payoff is zero. A deviation from the collusive agreement implies ε-undercutting the collusive price and gaining all consumers. Firms discount future profits with the discount factor δ. Collusion on the collusive price p^c is sustainable in our model if

$$\frac{p^c}{2(1-\delta)} \geqslant p^c + \frac{\delta}{1-\delta}0,$$

or equivalently, if

$$\delta \geqslant \frac{1}{2}.$$

As long as the discount factor is larger than one half, collusion is sustainable.[3] We can keep this result in mind when considering the imperfect information case. As we shall see, collusion may be easier to sustain when consumers are imperfectly informed.

3.2. Trigger Strategies

We now continue the analysis in the imperfect information setting from Section 2. Collusion supported by trigger strategies implies that a deviation from the collusive agreement is punished by an eternal reversion to the stage game equilibrium.

Typically, the simple two-phase optimal punishment suggested by Abreu [1] [2], which implies a harsh punishment in one period and then a reversion to the collusive agreement, does not carry over here. Abreu [2] originally developed it for Cournot games; Lambson [17] and Häckner [15] have later adapted it to Bertrand games with capacity constraints and product differentiation respectively.

[3]Note that the critical discount factor is here independent of the collusive price.

Firms set the collusive price p^c in the collusive phase and firm i receives profit $p^c/2$. If firm i deviates and advertises, the profit is

$$\Pi_i^d = \frac{(1+\alpha)}{2}p^c - \phi,$$

which is the profit from serving half of the uninformed consumers and all subscribers. During collusion, the expected gain from buying the newspaper is zero since both firms charge the same price, and only the subscribers, who always read the paper, will notice the deviation. In the punishment phase, firms revert to the stage game mixed strategy equilibrium forever. In the first punishment phase, those consumers that shopped at the deviating shop know that firms will mix prices, while the other consumers do not know this and still think that they will face the collusive price in both shops. Depending on the β in the stage game equilibrium, two cases may arise, so that the payoff in the first punishment period is

$$\Pi_i^{p1} = \begin{cases} \dfrac{1-\beta}{2}p^r + c & \text{if } \beta \leqslant \dfrac{1+\alpha}{2}, \\[2ex] \dfrac{1 - \dfrac{1+\alpha}{2}}{2}p^r + \phi & \text{if } \beta > \dfrac{1+\alpha}{2}, \end{cases}$$

and in the second punishment phase, they revert to the stage game mixed equilibrium forever, with profit

$$\Pi_i^{p2} = \frac{1-\beta}{2}p^r + \phi.$$

All the results are in the same direction, whether the required β is higher or lower than $(1+\alpha)/2$, so in the following calculations we will restrict the attention to the first case. Collusion is sustainable if

$$\frac{p^c}{2(1-\delta)} \geqslant \frac{(1+\alpha)}{2}p^c - \phi + \frac{\delta}{1-\delta}\left(\frac{1-\beta}{2}p^r + \phi\right),$$

or equivalently, if

$$\delta \geqslant \frac{\alpha p^c - 2\phi}{(1+\alpha)p^c - (1-\beta)p^r - 4\phi}. \tag{3.1}$$

We see that it is now possible to sustain collusion for discount factors smaller than one half, since $\beta > \alpha$.

A special case arises when the newspaper price κ is larger than the gain from reading the paper in the stage game. In this case, we have a repeated game where $\beta = \alpha$, and the condition for collusion to be sustainable on the reservation price p^r is $\delta \geqslant 1/2$, the same as in the perfect information case. The intuition is straightforward. The small gain from deviating is perfectly outweighed by the weaker punishment. It is the same fraction of consumers, the subscribers, that the deviator gains when deviating and loses in the punishment phase.

Another interesting case concerns advertising bans. Suppose advertising was forbidden, then firms could charge p^r in every period. Giving firms the opportunity to advertise could then lower the price, even if no advertising is seen in equilibrium.

Proposition 3. *The ability to advertise can be enough to reduce the price.*

Proof. Suppose firms have the discount factor $\widehat{\delta}$, in the following region:

$$\frac{\alpha p^c - 2\phi}{(1+\alpha)\, p^c - (1-\beta)\, p^r - 4\phi} \leqslant \widehat{\delta} < \frac{\alpha p^r - 2\phi}{(\alpha+\beta)\, p^r - 4\phi}. \tag{3.2}$$

Then, collusion is sustainable on p^c, but not on p^r, so that the price is forced down when firms are allowed to advertise.■

Firms prefer consumers not to be informed about their prices, and would like to prevent price advertising. This is exactly what the California Dental Association did until they were stopped by the Federal Trade Commission [5]. The Dental Association had agreed on a ban on advertising low prices, thereby hindering the competition between dentists.

Proposition 4. *Collusion on the reservation price p^r is facilitated by a high advertising fee and a low subscription rate.*

Proof. This follows directly from the comparative statics where

$$\frac{d\delta}{d\phi} = \frac{2\,(\alpha-\beta)\, p^r}{[(\alpha+\beta)\, p^r - 4\phi]^2} < 0,$$

and

$$\frac{d\delta}{d\alpha}=\frac{(\beta p^{r}-2\phi)\,p^{r}}{[(\alpha+\beta)\,p^{r}-4\phi]^{2}}>0.$$

■

A high advertising fee makes a deviation more expensive and hence, less attractive. Likewise, the lower the subscription rate, the lower the gain from deviating, since only the subscribers react to the deviation. This suggests that product prices should tend to be higher in markets where transmitting advertising messages to consumers is expensive.

4. Empirical Implications

Both the possibility of price advertising and the volume of advertising should be significant and negative in a regression with price as the dependent variable. Comparing regimes with and without price advertising restrictions, it is possible to test if the threat of advertising reduces price. Results from several markets in the US confirm the hypothesis that advertising bans harm competition. In markets where advertising is present, the price should be lower, the more firms advertise. Advertising could indicate a breakdown of collusion but also that firms are unable to collude and permanently adopt the stage game equilibrium.

5. Final Remarks

Price advertising reduces the price in the stage game and makes it harder to sustain collusion in the repeated game. In some cases, giving firms the possibility of advertising is enough to reduce price. In other words, denying firms the ability to advertise by introducing an advertising ban is harmful for competition.

The model is not only applicable to price advertising but also to persuasive non-price advertising as long as the total demand is constant. Persuasive advertising attracts consumers to the advertising firm in the same way as a lower price.

The welfare implications of a model with unit demand are well known; there are no distortions due to collusive prices. With a more elaborate demand side, there would be an efficiency loss from high prices and it would be clearer that the competition authority's aim should be to lower prices. As the model now stands, the competition authority is only interested in reducing prices if it puts more weight on the consumer surplus than the producer surplus.

The arrival of the internet shopping guides that provide on-line consumers with price information is something to analyse in the future. The fact that some firms chose not to reveal their prices to these establishments suggests that they prefer not to advertise even when it is costless to do so.

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Underwriter Competition

Underwriter Competition

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Abstract

This paper studies the competition between underwriters when entrepreneurs sell shares in an IPO. It is shown that the underwriter market is a natural monopoly where the underwriter with the highest ability to distinguish high value entrepreneurs from those of low value gets the whole market.

Keywords: Certification, Natural Monopoly, Perfect Bayesian Equilibrium

JEL Classification: D 82, G 21, L 15

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1. Introduction

How come underwriting fees are so high? Why are the best analysts payed transfer money to change employers? Despite the recent debate, there have not been many attempts to try to theoretically analyse the competition in the underwriting market. In this paper, I will show that being the best underwriter is extremely profitable, since it can drive the competitors out of the market.

The problem of selling high quality products on a market with imperfect information has been discussed since Akerlof's [1] famous "lemons" article. When buyers cannot distinguish between products of high and low quality, sellers of low quality products (lemons) can claim that their products are of high quality and thus fool buyers. The buyers will, however, adjust their willingness to pay so that, on average, they do not lose money. This may destroy the market for high quality products as the sellers of those products cannot sell at a reasonable price. To overcome this problem, the sellers of high quality products would like to prove this high quality. This can be done either by signalling or by engaging a trustworthy third party.

A simple model of signalling was developed by Spence [14]. He showed that seemingly useless activities can signal quality. Leland and Pyle [12] showed that an entrepreneur with a good project can signal his quality by retaining some ownership when selling shares.

Another way of proving one's quality would be to obtain some kind of quality label from a third party. These kinds of establishments are popping up on a broad range of markets, such as credit market certification, securities underwriting, ISO 9000 quality assurance standard, ethics, environment and, indeed, Akerlof's example of the used cars market.

There are some theoretical papers analysing the role of the certifier. Biglaiser [3] shows that a middleman with expert knowledge can act as a certifier for sellers of high quality products. The presence of a middleman can be welfare improving since the middleman has higher incentives than the sellers to report the true quality of the product. Kuhn [10] derives conditions under which a centrally administered auditing can promote the entry of high quality products. Albano and Lizzeri [2] and Lizzeri [13] consider a monopoly certifier who can choose not to reveal all his knowledge of the tested products. Thereby, the certifier can capture a large share of the surplus but still raise welfare compared to the case without any certifier. Boom [4] analyses the case of a monopolistic credit rating agency and finds that there is an undersupply of the rating services.

Competition in the certification industry has not been thoroughly examined, however. In this paper, the focus is on the competition between certifiers or underwriters of different quality, and it is the first paper to allow underwriters to be of different quality. A better underwriter is thought to have a better accuracy, i.e. a higher probability of separating the good firms from the bad firms. The investors know about these differences. The action of the entrepreneurs will thus be to chose which underwriter to hire, given the prices of the underwriting services and the probabilities that the underwriters will value the entrepreneurs' firms correctly. It may be so that an entrepreneur with a low value project will prefer an underwriter with a low accuracy, whereas the high value ones are willing to pay more to be analysed by a better underwriter. Investors will, of course, take into account the probabilities that a firm is given an incorrect signal and adjust their willingness to pay accordingly.

Allegations of collusion have been made both in the academic and the popular press, for example The Economist [6] writes: "In the US, the fees investment banks charge to underwrite share offerings have not changed in more than a decade. In Britain, fixed underwriting fees are the subject of an antitrust investigation, which began hearing this month. Studies in both countries suggest issuing companies are overcharged." In the US, the frequency of a 7% spread in initial public offerings (IPOs) has been noted by Chen and Ritter [5]. However, Hansen [9] finds no support for collusive prices when testing the hypothesis on American data.

This paper does not analyse the case of collusion but shows that in a model without capacity constraints, the underwriting market is a natural monopoly. The model is set up in section 2, section 3 analyses the monopoly case and the duopoly case is found in section 4. In section 5, the model is altered in order to capture competition with capacity constraints and section 6 concludes.

2. The Model

I will present a simple model inspired by Ellingsen and Rydqvist [7]. It has a broad class of applications and can help analyse any situation where one party seeks help from another party to signal quality to a third party. The first party can e.g. be a car owner, the second a garage and the third a potential car buyer. In this analysis, I will focus on the context of an entrepreneur seeking funds in an IPO. The entrepreneur can then turn to an underwriter who values the firm and gives it a quality stamp. Potential investors look at the signals from the underwriters and decide what to pay, depending on the signal.

Consider an entrepreneur with his own firm. The entrepreneur's valuation of the firm is v. Investors value the firm at kv, where $k > 1$. This means that there are gains from trade. Investors know that $v \in \{\underline{v}, \overline{v}\}$, where $\underline{v} < \overline{v}$. The prior probability that a firm is of value $\overline{v}$ is h, which is common knowledge. The uncertainty of the firm's value is the raison d'être of the underwriters. Without uncertainty, there would be no need for the quality signal. High (low) value firms would sell directly for $k\overline{v}$ ($k\underline{v}$).

The timing of the model is the following. First the underwriters decide simultaneously on their underwriting fees c_j, then the firms decide whether to hire an underwriter or not and in the case they hire one, they decide which one. Finally, the underwriters value the firms and investors invest in the firms.

2.1. Direct sale

The entrepreneur could sell the firm directly to the investors for a price p_d. The investors are willing to pay the expected value

$$p_d = k\left[h\overline{v} + (1-h)\underline{v}\right].$$

Owners of good firms only sell if $p_d > \overline{v}$, which corresponds to a lower critical limit of the share of good firms.

$$h > \frac{\overline{v} - k\underline{v}}{k\left(\overline{v} - \underline{v}\right)} = h^*.$$

This implies that, depending on the share of good firms, the price is

$$p_d = \begin{cases} k\left[h'\overline{v} + (1-h')\underline{v}\right], & \text{if} \quad h' > h^* \\ k\underline{v} & \text{if} \quad h' \leq h^*, \end{cases}$$

where h' is the proportion of good firms that are sold directly.

Proposition 1. *If no underwriter exists, and $h > h^*$, all firms can be sold directly at a price $p_d = k\left[h\overline{v} + (1-h)\underline{v}\right]$. If $h \leq h^*$, only bad firms can be sold directly.*

Proof: Investors are willing to pay $p_d = k\left[h\overline{v} + (1-h)\underline{v}\right]$ and owners of good firms do not accept a price below $\overline{v}$. It follows that for all firms to sell, $p_d > \overline{v}$, or equivalently that $h > h^*$.■

This is the classic lemons problem at which Akerlof [1] pointed. If the share of bad firms is high enough, the owners of good firms cannot sell them. This problem can be alleviated by the introduction of an underwriter.

2.2. Underwriter

If the entrepreneur chooses to contact an underwriter, the underwriter values the firm at a fee c, and gives a signal $S \in \{G, B\}$, where G stands for good and B for bad. The valuation is an imperfect but useful signal of the firm's quality

$$
\begin{aligned}
0 &\leq \Pr(B \mid \overline{v}) < \Pr(G \mid \overline{v}) \leq 1 \\
0 &\leq \Pr(G \mid \underline{v}) < \Pr(B \mid \underline{v}) \leq 1.
\end{aligned}
$$

Let $m \in [0,1]$ and $l \in [0,1]$ denote the share of good and bad firms respectively that hire an underwriter. Investors are willing to pay the expected value of a firm given its signal

$$
\begin{aligned}
p_G &= k\left[\Pr(\overline{v} \mid G)\,\overline{v} + \Pr(\underline{v} \mid G)\,\underline{v}\right] \\
p_B &= k\left[\Pr(\overline{v} \mid B)\,\overline{v} + \Pr(\underline{v} \mid B)\,\underline{v}\right].
\end{aligned}
$$

The underwriter's problem can be written

$$
\begin{aligned}
&\max_{c}\ c\,(mh + l(1-h)) \\
&\text{s.t.}
\end{aligned}
$$

$$
p_G \Pr(G \mid \overline{v}) + p_B \Pr(B \mid \overline{v}) - c \geq p_d \tag{2.1}
$$

$$
p_G \Pr(G \mid \underline{v}) + p_B \Pr(B \mid \underline{v}) - c \geq p_d, \tag{2.2}
$$

where c is the price of the underwriting service. We will now go through three different cases. First, the monopoly underwriter, then the case with competition between underwriters and finally we will consider the case where underwriters are capacity constrained. We will restrict attention to pure strategy equilibria.

3. Monopoly

As a basis for comparison, we will first go through the perfect valuation case. Then, we proceed with the more realistic imperfect information case.

3.1. Perfect valuation

Here, the underwriter sees directly if the firm is good or bad, so the probabilities are

$$\begin{aligned} 0 &= \Pr(B \mid \overline{v}) < \Pr(G \mid \overline{v}) = 1, \\ 0 &= \Pr(G \mid \underline{v}) < \Pr(B \mid \underline{v}) = 1. \end{aligned}$$

Investors know that the underwriter has valued the firms correctly and are thus willing to pay

$$\begin{aligned} p_G &= k\overline{v}, \\ p_B &= k\underline{v}. \end{aligned}$$

Bad firms cannot gain by hiring the underwriter, so they sell directly for

$$p_d = k\left[(1-m)\overline{v} + \underline{v}\right].$$

Good firms hire the underwriter if $k\overline{v} - c \geq p_d = k\left[(1-m)\overline{v} + \underline{v}\right]$. It is easy to see that the monopoly profit, $cmh = k(m\overline{v} + \underline{v})mh$, is maximized for $m = 1$. Thus, all good firms will hire the underwriter and, in equilibrium, not hiring the underwriter is a signal of low value so $p_d = k\underline{v}$. Likewise, since only good firms hire the underwriter, $p_G = k\overline{v}$. The monopoly price the underwriter can charge is

$$c^* = \begin{cases} k(\overline{v} - \underline{v}) \text{ if } k\underline{v} > \overline{v} \\ (k-1)\overline{v} \text{ if } k\underline{v} \leq \overline{v} \end{cases}$$

and the profit of the underwriter Π_U is c^*h, since $m = 1$ and $l = 0$.

3.2. Imperfect valuation

In the imperfect valuation case, the underwriter's signal is an imperfect signal of the firm's value. The probability that a good firm gets a good signal is, however, higher than the probability that it gets a bad signal, so that the signal is informative:

$$
\begin{aligned}
0 &< \Pr(B \mid \overline{v}) < \Pr(G \mid \overline{v}) < 1, \\
0 &< \Pr(G \mid \underline{v}) < \Pr(B \mid \underline{v}) < 1.
\end{aligned}
$$

Investors are willing to pay the expected value of a firm, given signal G or B,

$$
\begin{aligned}
p_G &= k\left[\Pr(\overline{v} \mid G)\,\overline{v} + \Pr(\underline{v} \mid G)\,\underline{v}\right], \\
p_B &= k\left[\Pr(\overline{v} \mid B)\,\overline{v} + \Pr(\underline{v} \mid B)\,\underline{v}\right].
\end{aligned}
$$

The probabilities that a firm given a certain signal is of a certain value can be calculated by Bayes' rule, so that the prices are

$$
\begin{aligned}
p_G &= k\left[\frac{\Pr(G \mid \overline{v})\,mh}{\Pr(G \mid \overline{v})\,mh + \Pr(G \mid \underline{v})\,l\,(1-h)}\overline{v} + \frac{\Pr(G \mid \underline{v})\,l\,(1-h)}{\Pr(G \mid \overline{v})\,mh + \Pr(G \mid \underline{v})\,l\,(1-h)}\underline{v}\right] \\
p_B &= k\left[\frac{\Pr(B \mid \overline{v})\,mh}{\Pr(B \mid \overline{v})\,mh + \Pr(B \mid \underline{v})\,l\,(1-h)}\overline{v} + \frac{\Pr(B \mid \underline{v})\,l\,(1-h)}{\Pr(B \mid \overline{v})\,mh + \Pr(B \mid \underline{v})\,l\,(1-h)}\underline{v}\right]
\end{aligned}
$$

The equilibria we are looking for are perfect Bayesian equilibria (PBE). In a PBE, each agent applies a best response to the others' strategies, given his beliefs. These beliefs should be initially correct and updated by Bayesian updating.

Intuitively, we can rule out the possibility of fully separating equilibria since the underwriter's signal would be uninformative in such an equilibrium. Suppose investors believe that only high value firms hire the underwriter. Then, p_G and p_B would be identical and it would be profitable for a low value firm to hire the underwriter as well.

Proposition 2. *Any Pareto optimal PBE in which there is a positive probability that firms hire the underwriter is either i) pooling, with $l = m = 1$ or ii) semi-separating, with $0 < l < m = 1$.*

Proof: See Appendix.■

3.3. Equilibrium description

With a monopoly underwriter, we get two types of equilibria, pooling and semi-separating. The difference between them is the share of low value firms hiring the underwriter. The lower the share of low value firms, the higher the c that the underwriter can charge. As we shall see, the underwriter and the high value firms have differing interests regarding which type of equilibria is desirable. The low value firms are always indifferent.

3.3.1. Pooling equilibrium

Here, all firms hire the underwriter, and condition (2.2) holds with equality which gives the optimal c^*. High value firms would lose from a deviation whereas low value firms are indifferent. Since investors believe that no firm will sell directly, the price, p_d cannot be higher than $k\underline{v}$. Thus, the pooling equilibrium has the following features:

$$
\begin{aligned}
p_d &= k\underline{v}, \\
p_G &= k\left[\frac{\Pr(G \mid \overline{v})\,h}{\Pr(G \mid \overline{v})\,h + \Pr(G \mid \underline{v})\,(1-h)}\overline{v} + \frac{\Pr(G \mid \underline{v})\,(1-h)}{\Pr(G \mid \overline{v})\,h + \Pr(G \mid \underline{v})\,(1-h)}\underline{v}\right], \\
p_B &= k\left[\frac{\Pr(B \mid \overline{v})\,h}{\Pr(B \mid \overline{v})\,h + \Pr(B \mid \underline{v})\,(1-h)}\overline{v} + \frac{\Pr(B \mid \underline{v})\,(1-h)}{\Pr(B \mid \overline{v})\,h + \Pr(B \mid \underline{v})\,(1-h)}\underline{v}\right], \\
c^* &= p_G \Pr(G \mid \underline{v}) + p_B \Pr(B \mid \underline{v}) - p_d, \\
\Pi_U &= c^*, \\
\Pi_{\underline{v}} &= k\underline{v}, \\
\Pi_{\overline{v}} &= p_G \Pr(G \mid \overline{v}) + p_B \Pr(B \mid \overline{v}) - c^*.
\end{aligned}
$$

3.3.2. Semi-separating equilibrium

This equilibrium is separating in the sense that if some firm sells directly, everyone knows that that must be a firm of low value and $p_d = k\underline{v}$. On the other hand, it is not fully separating since both types of firms hire the underwriter. All good firms and some bad firms hire the underwriter, $0 < l < m = 1$. Condition (2.2) holds with equality which gives the optimal c^*. As in the pooling equilibrium, good firms would lose from a deviation whereas bad firms are indifferent. The equilibrium thus entails:

$$\begin{aligned}
p_d &= k\underline{v}, \\
p_G &= k\left[\frac{\Pr(G \mid \overline{v})\, h}{\Pr(G \mid \overline{v})\, h + \Pr(G \mid \underline{v})\, l\,(1-h)}\overline{v} + \frac{\Pr(G \mid \underline{v})\, l\,(1-h)}{\Pr(G \mid \overline{v})\, h + \Pr(G \mid \underline{v})\, l\,(1-h)}\underline{v}\right], \\
p_B &= k\left[\frac{\Pr(B \mid \overline{v})\, h}{\Pr(B \mid \overline{v})\, h + \Pr(B \mid \underline{v})\, l\,(1-h)}\overline{v} + \frac{\Pr(B \mid \underline{v})\, l\,(1-h)}{\Pr(B \mid \overline{v})\, h + \Pr(B \mid \underline{v})\, l\,(1-h)}\underline{v}\right], \\
c^* &= p_G \Pr(G \mid \underline{v}) + p_B \Pr(B \mid \underline{v}) - p_d, \\
\Pi_U &= c^*(h + l\,(1-h)), \\
\Pi_{\underline{v}} &= k\underline{v}, \\
\Pi_{\overline{v}} &= p_G \Pr(G \mid \overline{v}) + p_B \Pr(B \mid \overline{v}) - c^*.
\end{aligned}$$

Considering plausible equilibria, we restrict attention to the best pooling and semi-separating equilibria from point of view of the underwriter. By setting the price of the underwriting services, c, high or low, the underwriter can chose between the equilibria. The higher c is, the lower will the share of low value firms hiring the underwriter be. Depending on the parameters, four cases may arise. In the view of the monopoly underwriter, either a pooling equilibrium or an almost-separating equilibrium with as low a share of bad entrepreneurs as possible is most profitable. Good entrepreneurs would either prefer the pooling equilibrium or a semi-separating equilibria with a higher share of bad entrepreneurs. Assuming that $\Pr(G \mid \overline{v}) = \Pr(B \mid \underline{v}) = \Pr$, varying Pr and h, we get these four cases:

3.3.3. Case 1

The underwriter prefers the smallest possible share of bad entrepreneurs and good entrepreneurs prefer a pooling equilibrium. This is the case when the underwriter is accurate in its evaluation, $\Pr(G \mid \overline{v})$ is high, and the share of good entrepreneurs, h, is very low or high. Intuitively, when the underwriter is accurate, the high value firms are almost certain of receiving a good signal, so they would prefer a low underwriting fee that attracts all firms.

3.3.4. Case 2

The underwriter prefers the smallest possible share of bad entrepreneurs and the good entrepreneurs prefer a semi-separating equilibrium. This is the case when the underwriter is quite inaccurate in its evaluation and the share of good entrepreneurs is low or when the underwriter is accurate and the share of good entrepreneurs is high.

3.3.5. Case 3

Both the underwriter and the good entrepreneurs prefer a pooling equilibrium. This is the case when the underwriter is really inaccurate in its evaluation and the share of good entrepreneurs is high.

3.3.6. Case 4

The underwriter prefers a pooling equilibrium and the good entrepreneurs prefer a semi-separating equilibrium. This is the case when the underwriter is very inaccurate in its evaluation and the share of good entrepreneurs is intermediate. Here, the risk of receiving a bad signal is significant so that the high value firms would prefer to pay a higher fee to discourage the low value firms from hiring the underwriter.

The four cases are illustrated in figure (3.1). In regions 1 and 2, the underwriter makes most money if it can almost separate the high value from the low value firms. By charging a high price for its underwriting services, the underwriter

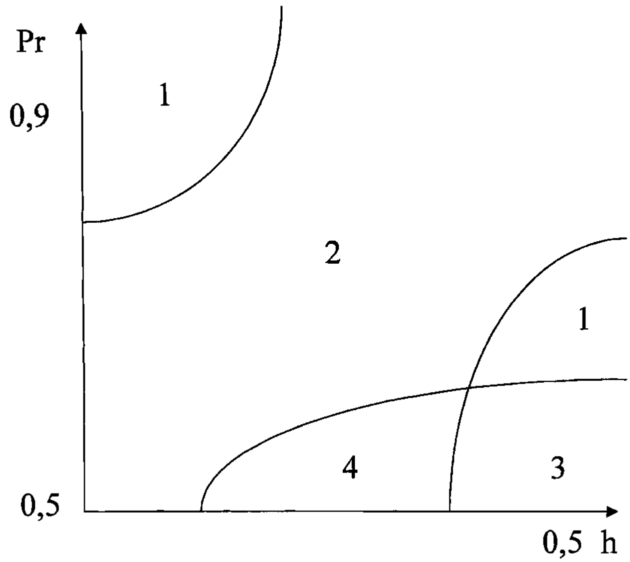

Figure 3.1: Preferences over equilibrium types

attracts a low share of low value firms, l. High value firms would, on the other hand, prefer c to be lower, and thus l to be higher in almost every case. The only exception is in region 4, where the underwriter prefers a pooling equilibrium and good entrepreneurs prefer a semi-separating equilibrium. If $l = 1$ prices p_G and p_B would be so low that the good entrepreneurs would benefit from a higher c. A higher c would result in a semi-separating equilibrium where hiring an underwriter would signal that you are of high value. This case is the most interesting one when it comes to competition between underwriters. When underwriters compete for the high value firms they would have to raise the underwriting fee to attract them. Thus, competition can lead to a higher price than the monopoly price. We will return to this paradox in the next section.

4. Competition

With two underwriters, the analysis becomes more complex. We will focus on the case where the two underwriters are of different quality, since we know that underwriters are ranked according to their reputation. We will show that being the better underwriter is extremely important. The most accurate underwriter can drive the other out from the market. It is not the level of accurateness that matters but the fact that one is more accurate than the other.

First, we will go through two stylized examples before tackling the most interesting case where both underwriters are imperfect in their valuation but one is more accurate than the other.

4.1. Equal perfect valuation

If both underwriters valued firms correctly with probability one, it is easy to see that they will compete à la Bertrand for the high value firms. Investors are willing to pay

$$\begin{aligned} p_G &= k\overline{v}, \\ p_B &= k\underline{v}, \end{aligned}$$

so that bad firms cannot gain by hiring an underwriter. They will sell directly for

$$p_d = k\underline{v}.$$

Good firms will hire underwriter i if:

$$\begin{aligned} k\overline{v} - c_i &\geq p_d, \\ k\overline{v} - c_i &\geq k\overline{v} - c_j. \end{aligned}$$

In equilibrium, Bertrand competition reduces the underwriter fee to zero. We have not assumed any entry costs but it is clear that if one underwriter has perfect valuation, entry by another is not profitable.

4.2. Perfect versus imperfect valuation

Suppose underwriter 1 has perfect valuation whereas underwriter 2 is imperfect. First, note that only good firms hire the perfect underwriter, and this is done if

$$k\overline{v} - c_1 \geq p_d$$

and

$$k\overline{v} - c_1 \geq p_{G2} \Pr_2 (G \mid \overline{v}) + p_{B2} \Pr_2 (B \mid \overline{v}) - c_2.$$

Further, they hire the imperfect underwriter if

$$p_{G2} \Pr_2 (G \mid \overline{v}) + p_{B2} \Pr_2 (B \mid \overline{v}) - c_2 \geq p_d$$

and

$$p_{G2} \Pr_2 (G \mid \overline{v}) + p_{B2} \Pr_2 (B \mid \overline{v}) - c_2 \geq k\overline{v} - c_1.$$

Bad firms hire the imperfect underwriter if

$$p_{G2} \Pr_2 (G \mid \underline{v}) + p_{B2} \Pr_2 (B \mid \underline{v}) - c_2 \geq p_d.$$

It is straightforward to see that the perfect underwriter can drive out the imperfect one from the market. The imperfect underwriter must set a lower price, $c_2 < c_1$, to attract the high value firms, but the perfect underwriter will set c_1 low enough to drive out the other. In any equilibrium

$$\begin{aligned}
p_d &= k\underline{v}, \\
c_2 &= p_{G2} \Pr_2 (G \mid \underline{v}) + p_{B2} \Pr_2 (B \mid \underline{v}) - k\underline{v}, \\
c_1 &\leq k (\overline{v} - \underline{v}) - p_{G2} \left(\Pr_2 (G \mid \overline{v}) - \Pr_2 (G \mid \underline{v})\right) - p_{B2} \left(\Pr_2 (B \mid \overline{v}) - \Pr_2 (B \mid \underline{v})\right),
\end{aligned}$$

c_1 is set so that good firms go to underwriter 1 and bad firms sell directly.

4.3. Unequal imperfect valuation

Now, we turn to the most interesting case, where both underwriters are imperfect in their valuation. Underwriter 1 is assumed to be the more accurate.

$$\begin{aligned} 0 &< \Pr_1(B \mid \overline{v}) < \Pr_2(B \mid \overline{v}) < \Pr_2(G \mid \overline{v}) < \Pr_1(G \mid \overline{v}) < 1, \\ 0 &< \Pr_1(G \mid \underline{v}) < \Pr_2(G \mid \underline{v}) < \Pr_2(B \mid \underline{v}) < \Pr_1(B \mid \underline{v}) < 1. \end{aligned}$$

From Lemma 1 in the Appendix, we know that for an equilibrium to exist, both types of firms must hire the same underwriter. Since we have two underwriters, this translates to both types of firms being indifferent to both underwriters. The low value firms hire underwriter 2 if

$$p_{G2} \Pr_2(G \mid \underline{v}) + p_{B2} \Pr_2(B \mid \underline{v}) - c_2 \geq p_d$$

and

$$p_{G2} \Pr_2(G \mid \underline{v}) + p_{B2} \Pr_2(B \mid \underline{v}) - c_2 \geq p_{G1} \Pr_1(G \mid \underline{v}) + p_{B1} \Pr_1(B \mid \underline{v}) - c_1. \quad (1)$$

They hire underwriter 1 if

$$p_{G1} \Pr_1(G \mid \underline{v}) + p_{B1} \Pr_1(B \mid \underline{v}) - c_1 \geq p_d$$

and

$$p_{G1} \Pr_1(G \mid \underline{v}) + p_{B1} \Pr_1(B \mid \underline{v}) - c_1 \geq p_{G2} \Pr_2(G \mid \underline{v}) + p_{B2} \Pr_2(B \mid \underline{v}) - c_2. \quad (2)$$

Likewise, the high value firms hire underwriter 2 if

$$p_{G2} \Pr_2(G \mid \overline{v}) + p_{B2} \Pr_2(B \mid \overline{v}) - c_2 \geq p_d$$

and

$$p_{G2} \Pr_2 (G \mid \overline{v}) + p_{B2} \Pr_2 (B \mid \overline{v}) - c_2 \geq p_{G1} \Pr_1 (G \mid \overline{v}) + p_{B1} \Pr_1 (B \mid \overline{v}) - c_1, \quad (3)$$

and they hire underwriter 1 if

$$p_{G1} \Pr_1 (G \mid \overline{v}) + p_{B1} \Pr_1 (B \mid \overline{v}) - c_1 \geq p_d$$

and

$$p_{G1} \Pr_1 (G \mid \overline{v}) + p_{B1} \Pr_1 (B \mid \overline{v}) - c_1 \geq p_{G2} \Pr_2 (G \mid \overline{v}) + p_{B2} \Pr_2 (B \mid \overline{v}) - c_2. \quad (4)$$

The first thing we can note is that underwriter 2 must set a lower fee, $c_2 < c_1$, in order to attract the high value firms. If $c_2 \geq c_1$ no firm of high value would take the higher risk of receiving a bad signal. The algebra becomes somewhat muddled, but the intuition is clear. If there is an equilibrium where both types of firms are indifferent between the two underwriters, then this equilibrium will not prevail if it is perturbed. Any small perturbation of the share of good firms, m, will cause the equilibrium to break down. Thus we can conclude with the following proposition:

Proposition 3. *There are no stable equilibria with two underwriters.*

Proof: See Appendix.■

4.4. Competition

As we have seen, the more accurate underwriter drives out the less accurate one from the market. It remains to analyse what happens to the price of underwriting, c, when the monopoly faces entry. Recall the four cases:

4.4.1. Case 1

The underwriter prefers the smallest possible share of bad entrepreneurs and good entrepreneurs prefer a pooling equilibrium. Here, competition would drive down the price of the underwriting services since the good entrepreneurs would prefer a lower price.

4.4.2. Case 2

The underwriter prefers the smallest possible share of bad entrepreneurs and the good entrepreneurs prefer a semi-separating equilibrium. Competition yields the same result as in case 1, price will go down.

4.4.3. Case 3

Both the underwriter and the good entrepreneurs prefer a pooling equilibrium. Here, the threat of entry would not affect the price of the monopolist since it already charges a price low enough to attract all entrepreneurs.

4.4.4. Case 4

The underwriter prefers a pooling equilibrium and good entrepreneurs prefer a semi-separating equilibrium. This is the really interesting case when it comes to competition. Since the monopolist charges a low fee to attract all entrepreneurs and the good entrepreneurs would prefer a higher price, competition would increase the price. A monopoly facing the threat of entry would charge a higher price than the monopoly price when entry is not allowed. This could be an explanation to the high underwriting fees that are observed. Too much competition, rather than too little, can lead to increased prices.

5. Competition with Capacity Constraints

First, consider the case with two underwriters. If the best underwriter's capacity, q_1, is larger than the share of good firms, first note that an underwriter cannot charge a positive c with only low value firms. Thus, if all the high value firms chose the first underwriter, then the second underwriter will only get low value firms, which contradicts Lemma 1. Both types of firms must be indifferent to both underwriters as was the case without capacity constraints, but then the result is the same as without capacity constraints, the second underwriter cannot compete. If $q_1 < h$, we know from Lemma 1, that there are no equilibria where one underwriter only attracts one type. Thus, a rationing rule that results in only good firms ending up at the best underwriter cannot be part of an equilibrium. We are once again back in the case where both types of firms must be indifferent to both underwriters, and the result is thus the same. The only remaining case is when good firms are indifferent between the two underwriters and the bad firms are indifferent between the bad underwriter and direct sale. This is not possible, however, as was proved in Lemma 1. Thus, we can conclude with the following proposition:

Proposition 4. *There are no stable equilibria with two underwriters with capacity constraints.*

Proof: This follows from Lemma 1 and Proposition 3.■

Allowing for capacity constraints, does not alter the natural monopoly result; the best underwriter can gain the whole market. Still, in reality we do observe several underwriters. Could a simple change in the model admit this? In the next section, we will go through a slightly changed model, that could indeed result in equilibria with multiple underwriters.

5.1. A model with n firms and N underwriters

In order to study the case with more than two underwriters, we need to change the model. What we want to capture is a market with many underwriters of continuous quality where they are ranked according to accuracy. Everyone knows that U_1 is better than U_2 and so on. Firms will also be of continuous value instead of just being of high or low value, which is required to obtain an equilibrium with more than one underwriter.

Consider a model with n firms of continuous value, where the firms' values are: $0 \leqslant v_1 < v_2 < ... < v_{n-1} < v_n \leqslant 1$. There are N underwriters who differ in their ability to value the firms correctly. Underwriter U_j gives firm v_i a signal s_i, where

$$s_{ij} = \begin{cases} v_i, & \text{with probability} \quad \Pr_j \\ \emptyset, & \text{with probability} \quad 1 - \Pr_j . \end{cases}$$

The underwriters' probabilities are ranked according to $0.5 \leqslant \Pr_N < \Pr_{N-1} < \Pr_2 < \Pr_1 \leqslant 1$. Investors are willing to pay the expected value

$$p_{s_{ij}} = \begin{cases} ks_{ij} & \text{if} \quad s_{ij} \geqslant 0 \\ k\left[E\left(v_i \mid s_{ij} = \emptyset\right)\right] & \text{if} \quad s_{ij} = \emptyset. \end{cases} \tag{5.1}$$

They know the probabilities of the underwriters and they know that firms are either valued correctly or not given any signal, i.e. the empty set signal.

With this model, it is possible to show that there is an equilibrium with multiple underwriters.

Proposition 5. *There is an equilibrium with multiple underwriters, characterised by:*

a) $c_1 > c_2 > ... > c_{N-1} > c_N$

b) Firms are grouped according to their value so that the ones with highest value hire U_1*, the next group hires* U_2 *and so on.*

Proof: See Appendix.■

The important difference between the main model and the one in this section is that, here, no firm can hope to get another firm's signal. Either they get the correct signal, or they receive the empty set signal. In the previous model, it was assumed that good (bad) firms could receive bad (good) signals, respectively. These kinds of overlapping signals create a natural monopoly, whereas non-overlapping signals allow for competition between underwriters. The results could perhaps be generalized to any signalling games where the signals are overlapping. Clearly, more research could be done on the topic of competition in signalling games.

6. Conclusion

The main result of the analysis is that the underwriting market seems to be a natural monopoly where the best underwriter can drive the others out of the market. This could explain the need for underwriters to have the top analysts even though they demand high wages. The only way to increase revenues is to increase the accurateness, so that it is better than the competitors'. This is also true when underwriters are capacity constrained. Revenues are entirely based on the ranking of underwriters, highest for the best and lowest for the worst.

We have also seen that competition between underwriters can lead to a higher underwriting fee than would be the case with a monopoly underwriter. This is due to the urge from high value firms to separate from the low value ones. They are willing to pay a higher fee than the fee that maximizes the profits of the monopoly. Observing unusually high underwriting fees could then indicate a competitive market and need not imply that firms are colluding.

Appendix

Proof of Proposition 2

Let $\gamma \equiv hm + (1-h)\,l$

Lemma 1. *In any PBE where* $\gamma > 0$, $l > 0$ *and* $m > 0$.

Proof: Suppose $m = 0$. Then $p_G = p_B = k\underline{v}$. Since $p_d = k\left[h\overline{v} + (1-l)(1-h)\underline{v}\right] > k\underline{v}$, $\pi(\underline{v}) < 0$ so $l = 0$. Now suppose $m > 0$ and $l = 0$. Then $p_G = p_B = k\overline{v}$. Since $p_d = k\left[(1-m)\,h\overline{v} + (1-h)\,\underline{v}\right] < k\overline{v}$, $l > 0$.■

Lemma 2. *Any PBE in which* $0 < m < 1$ *is weakly Pareto-dominated by some PBE in which* $m = 1$.

Proof: Consider first an equilibrium with $l < m < 1$. Let $c \equiv 1/m$. Since $p_s(S)$ only depends on l and m through the fraction m/l, we can construct a new equilibrium with $m' = cm = 1$ and $l' = cl < 1$, keeping $p_s(S)$ constant. This new equilibrium has the same payoff as the old one. Now, consider the case where $m < l < 1$. Let $d \equiv 1/l$. This time, we can construct a new equilibrium with $m' = dm < 1$ and $l' = dl = 1$, keeping $p_s(S)$ the same. Increasing m will raise $p_s(S)$, which improves the expected payoff for both types of sellers.■

This concludes the proof of Proposition 2.

Proof of Proposition 3

Assume without loss of generality that $\Pr_i(G \mid \overline{v}) = \Pr_i(B \mid \underline{v})$. It follows from Lemma 1 that for both underwriters to exist, both good and bad firms must be indifferent between the two underwriters. Combining (1) and (2), and (3) and (4), respectively gives,

$$
\begin{aligned}
c_1 - c_2 &= p_{G1} \Pr_1(G \mid \underline{v}) + p_{B1}\left(1 - \Pr_1(G \mid \underline{v})\right) - p_{G2} \Pr_2(G \mid \underline{v}) + p_{B2}\left(1 - \Pr_2(G \mid \underline{v})\right), \\
c_1 - c_2 &= p_{G1} \Pr_1(G \mid \overline{v}) + p_{B1}\left(1 - \Pr_1(G \mid \overline{v})\right) - p_{G2} \Pr_2(G \mid \overline{v}) + p_{B2}\left(1 - \Pr_2(G \mid \overline{v})\right),
\end{aligned}
$$

which simplifies to

$$(p_{G1}-p_{B1})\left(\Pr_1(G\mid \underline{v})-\Pr_1(G\mid \overline{v})\right)=(p_{G2}-p_{B2})\left(\Pr_2(G\mid \underline{v})-\Pr_2(G\mid \overline{v})\right). \tag{6.1}$$

If (6.1) holds, there is an equilibrium with two underwriters. This potential equilibrium is not stable, however. Recall that the prices are

$$\begin{aligned}
p_{B1} &= k\left[\Pr_1(\overline{v}\mid B)\overline{v}+\left(1-\Pr_1(\overline{v}\mid B)\right)\underline{v}\right],\\
p_{B2} &= k\left[\Pr_2(\overline{v}\mid B)\overline{v}+\left(1-\Pr_2(\overline{v}\mid B)\right)\underline{v}\right],\\
p_{G1} &= k\left[\Pr_1(\overline{v}\mid G)\overline{v}+\left(1-\Pr_1(\overline{v}\mid G)\right)\underline{v}\right],\\
p_{G2} &= k\left[\Pr_2(\overline{v}\mid G)\overline{v}+\left(1-\Pr_2(\overline{v}\mid G)\right)\underline{v}\right],
\end{aligned}$$

and the Bayesian probabilities are

$$\begin{aligned}
\Pr_1(\overline{v}\mid G) &= \frac{\frac{m_1 h}{(m_1+m_2)h+(l_1+l_2)(1-h)}\Pr_1(G\mid \overline{v})}{\Pr_1(G\mid \overline{v})m_1 h+\Pr_1(G\mid \underline{v})l_1(1-h)},\\
\Pr_1(\overline{v}\mid B) &= \frac{\frac{m_1 h}{(m_1+m_2)h+(l_1+l_2)(1-h)}\Pr_1(B\mid \overline{v})}{\Pr_1(B\mid \overline{v})m_1 h+\Pr_1(B\mid \underline{v})l_1(1-h)},\\
\Pr_2(\overline{v}\mid G) &= \frac{\frac{m_2 h}{(m_1+m_2)h+(l_1+l_2)(1-h)}\Pr_2(G\mid \overline{v})}{\Pr_2(G\mid \overline{v})m_2 h+\Pr_2(G\mid \underline{v})l_2(1-h)},\\
\Pr_2(\overline{v}\mid B) &= \frac{\frac{m_2 h}{(m_1+m_2)h+(l_1+l_2)(1-h)}\Pr_2(B\mid \overline{v})}{\Pr_2(B\mid \overline{v})m_2 h+\Pr_2(B\mid \underline{v})l_2(1-h)}.
\end{aligned}$$

Suppose one of the good firms moves from underwriter 2 to underwriter 1. This raises m_1 and lowers m_2. This will, in turn, raise $p_{G1}$and p_{B1}, and reduce p_{G2} and p_{B2}. Then, it is better for all good firms to move to underwriter 1 and thus the equilibrium is not stable.■

Proof of Proposition 5

Suppose, without loss of generality, that $q_j = 1$ for all underwriters and that $n = N$. We know from (5.1) that investors pay the expected value of a $\emptyset$ signal. In this equilibrium, the expected value of the $\emptyset$ signals from different underwriters is straightforward since everyone knows which firm will go to which underwriter. The firm with the highest quality will go to the best underwriter, the one with second highest quality will go to the second best and so on. In equilibrium, investors will pay the same price regardless of the underwriter's signal; it is just the identity of the underwriter that counts. First, we will show that the firm with the lowest quality will be indifferent between U_N and direct sale

$$k\left[v_1 \Pr_N + v_1\left(1 - \Pr_N\right)\right] - c_N = 0.$$

Investors believe that any firm selling directly is of quality $v = 0$. From this we get an expression for c_N

$$c_N = kv_1.$$

Now, we establish that the next firm will be indifferent between U_N and U_{N-1}

$$k\left[v_2 \Pr_{N-1} + v_2\left(1 - \Pr_{N-1}\right)\right] - c_{N-1} = k\left[v_2 \Pr_N + v_1\left(1 - \Pr_N\right)\right] - kv_1.$$

Note that investors only pay kv_1 for a zero signal from U_N. The cost of hiring U_{N-1} is then

$$c_{N-1} = k\left[v_2 - (v_2 - v_1)\Pr_N\right].$$

We can now se that $c_{N-1} > c_N$

$$\begin{aligned} c_{N-1} - c_N &= k\left[v_2 - (v_2 - v_1)\Pr_N\right] - kv_1 \\ &= k\left[(v_2 - v_1)\left(1 - \Pr_N\right)\right] > 0 \end{aligned}$$

since $v_2 > v_1$. It then follows that any $c_{j-1} > c_j$. It remains to be shown that the worst firm does not prefer U_{N-1}

$$
\begin{aligned}
k\left[v_1 \Pr_{N-1} + v_2\left(1 - \Pr_{N-1}\right)\right] - k\left[v_2 - (v_2 - v_1)\Pr_N\right] &< 0 \\
k\left[(v_1 - v_2)\left(\Pr_{N-1} - \Pr_N\right)\right] &< 0
\end{aligned}
$$

since $v_2 > v_1$ and $\Pr_{N-1} > \Pr_N$. Finally, we need to show that the second worst firm does not prefer to sell directly

$$
\begin{aligned}
k\left[v_2 \Pr_{N-1} + v_2\left(1 - \Pr_{N-1}\right)\right] - k\left[v_2 - (v_2 - v_1)\Pr_N\right] &> 0 \\
k\left[(v_2 - v_1)\Pr_N\right] &> 0
\end{aligned}
$$

This concludes the proof of Proposition 5.■

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