Price Wars in Two-Sided Markets: The case of the UK Quality Newspapers

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Abstract

This paper investigates the price war in the UK quality newspaper industry in the 1990s. We show that the empirical evidence is in accordance with a substantial change in the optimal finance mix of newspapers as advertising becomes the dominant source of newspaper revenue. The finding holds under weak theoretical assumptions. We then test if this change in the optimal finance mix better fits behaviour within an oligopolisitic competitive or a collusive setting.

1 Introduction

In this paper we investigate the 'price war' in the UK weekly *quality broadsheet newspaper industry* in the 1990s. The public and regulatory discussion of this period has portrayed it as being a case of presumed *predatory pricing*. Recent theoretical advances in economics suggest that the discussion at the time should have been framed within the theory of *two-sided markets*.

A two-sided market (see Armstrong (2006), Rochet & Tirole (2006)) involves two groups of agents who interact via "platforms", where one group's benefit

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from joining a platform depends on the size of the other group that joins the platform. In two-sided markets there may therefore be critical network effects due to externalities not only from the group on the same side but also from that on the other side.

Such complex network effects are known to give rise to multiple equilibria making robust predictions about comparative statics hard to obtain. A solution concept that substantially simplifies this problem is that of *insulating equilibrium* as proposed in White & Weyl (2011) where firms are assumed to take the other firms quality choice (as in Shaked & Sutton (1982) but here with quality being its number of participants) as given.

The media market is a typical two-sided market (see Anderson & Gabszewicz (2006)), as a media firm sells content to consumers i.e. readers, viewers, or listeners and advertising space to advertisers. The firm knows that the number (and characteristics) of consumers influence the demand for advertising space while, vice versa, depending on the media product, the number (or concentration) of advertising spaces may influence the demand from consumers. Weyl's (2010) monopoly analysis is also accompanied by a motivation from the newspaper industry.

In the case of newspapers, clearly the advertisers are concerned with the reach of a newspaper and hence a newspaper with a higher market share will face a higher demand for its advertising slots for any given advertising tariff. Whether readers like or dislike advertising will rather depend on the particular publication (see Chandra & Kaiser (2015)).

Some previous theoretical work has modelled newspaper competition as taking place on the political line using the *Hotelling* (1929) model of *horizontal* product differentiation. Among them, Gabszewicz, Laussel, & Sonnac (2002), endogenize the location/differentiation choice in a first stage, while in most models location is only exogenous. Such endogenous political locations represent as a crucial factor to understand the market events in the UK quality newspaper market and hence our companion paper Behringer & Filistrucchi (2015b) extends the model to more than two firms.

Due to the complexity of the theoretical modelling and the substantial data requirements, *structural econometric work* on the media as two-sided markets is still quite scarce. Rysman (2004) analyses the market for yellow pages in the U.S. and shows that network effects between advertisers and readers are indeed present. He also considers whether the market benefits from monopoly (which takes advantage of network effects) or oligopoly (which reduces market power) and finds that a more competitive market is preferable.

Kaiser & Wright (2006) estimate an adapted version of Armstrong's (2006) model of competition in a two-sided market where magazines compete as Hotelling duopolists and find that, due to the presence of indirect network effects, in Germany the readers' side of the market is subsidized by the advertisers. Argentesi & Filistrucchi (2007) test for market power in the national daily newspaper market in Italy, concluding that the four main national daily newspapers have been colluding on the cover price but not on the advertising one. Fan (2010) analyses the market for daily newspapers in the U.S. and simulates some proposed mergers among them.

The candidate explanation for the observed price war we look at in this paper is a *change in the optimal financing mix* of newspapers that followed a steady increase in the demand for advertising.[1] We look at this explanation both in the context of an oligopolistic and a cartel model. We then investigate how this increase in advertising demand affects the incentives of firms to collude and whether the market data can help to choose between these two competing hypotheses as in Argentesi & Filistrucchi (2007).

Our models encompass demand for products on both sides of the platforms and profit maximization in a monopolistic, oligopolistic, and collusive setting with newspaper editors who recognize the existence of indirect network effects between the two sides. We show that the observed empirical pattern of a constant decline in readership revenue relative to advertising revenue can be explained by noting that this is a fairly *robust prediction* for newspaper's optimizing behaviour following an exogenous increase in advertising demand, once they are properly modelled as two-sided markets.

2 The UK newspaper industry in the 1990s

The labour force of the UK newspaper industry when still located at Fleet Street in London was heavily unionized when in February 1981 News International Newspaper Ltd. (NIN) owned by Rupert Murdoch purchased The Times newspaper. During the 1980s, NIN therefore clandestinely equipped a new printing facility for its UK newspapers in the London district of Wapping where newspapers could be composed electronically rather than using the hot-metal and labour-intensive linotype method.

At the time NIN owned The Times, the Sunday Times, the Sun and the News of the World. When the print unions announced a strike, NIN activated this new plant with the assistance of the Electrical, Electronic, Telecommunications, and Plumbing Union (EETPU). This led to the "Wapping dispute" from January

[1] See Anderson & Jullien (2015) for a survey of advertising-financed business models in two-sided media markets, and Anderson & Shi (2013) as well as Angelucci & Cagé (2015) for closely related work.

1986 to February 1987 which changed the history of UK industrial relations and of the newspaper industry in the UK. By 1988 nearly all the national newspapers had abandoned Fleet Street for the Docklands and started to change their printing practices to those employed by NIN.

Despite these events during the early 1990s the UK quality broadsheet newspaper industry composed of the The Times, the Independent, the Guardian, and the Daily Telegraph, had seen a relatively homogenous and stable pricing pattern for weekly editions. Then, on the 6. September 1993 NIN decided to cut the price for The Times from 45p to 30p, thereby undercutting the Guardian at 45p, The Independent at 45p and the Daily Telegraph at 48p. Public perception had it that a ”price war” in the quality newspaper industry had begun.

The Independent, quoting a media analyst conjectured that the price cut was directed against its market share. ”When the Independent was launched in 1986, it took more readers from The Times than the Guardian or the Telegraph' (...) It has been the Independent holding back The Times ever since”.[2] Immediately after the announcement, Robin Cook, then the Labour party's trade and industry spokesman wrote to the Office of Fair Trading demanding an inquiry into possible unfair competition. The Independent estimated that at the current level of circulation of around 350,000 (August 1993) this price cut came at a cost to The Times of about £ 50,000 per day.

Bryan Carsberg, director general of the Office of Fair Trading (OFT) observed ”with interest” the alleged newspaper ”price war” that Rupert Murdoch ignited. His office's definition of predatory pricing - the deliberate acceptance of losses in the short term with the intention of eliminating competition so that enhanced profits may be achieved in the long term - looks prima facie as if it may indeed apply to the battle between the loss-making Times and the struggling Independent.

Because of its substantial financial difficulties, the Independent decided to raise its price from 45p to 50p on the 12. October 1993 but then came under even more pressure as the Telegraph under Conrad Black also decided to drop its price from 48p to 30p on 1. August 1994.

On 24. June 1994 The Times decreased is price again from 30p to 20p. By this time the issue has received strong political attention. Tam Dalyell, Labour MP said it was an issue of ”the quality of democracy”, and Tony Wright, Labour MP said that the use of monopoly power to drive out competitors was ”offensive” to the public interest. A plurality of opinion was vital. Robin Cook demanded that the OFT should come up with a decision in favour of predatory behaviour since Bryan Carsberg had been talking about a thin dividing line

[2] Independent, 3. September, 1993, ”Media analysts say 'Times' cut is commercial madness”.

between normal and aggressive competition and with the new price cut this line now surely had been crossed.

The Independent quotes Dalyell's estimates that of the 20p The Times received for each copy, 17.5p went to wholesalers and retailers and the cost of printing a copy was 15p. "This is a £ 30m a year subsidy". The Independent reacted on the 1. August 1994 and reduced its price from 50p to 30p permanently in order to stop the decline of its circulation that decreased by 20% since The Times had first reduced its price. Its financial situation was known to be severe. In the beginning of 1994 a substantial refinancing had to take place which prevented the paper from being taken over from Carlo de Benedetti, another newspaper tycoon.

On 21. October 1994, the OFT issued a decision in the case. Bryan Carsberg said that his inquiry into the price cuts had not established a case for formal action under the competition legislation. Subsequently there was a period of increase in cover prices as the costs of news printing were rising for all firms. The Times decided to increase its prices from 20p to 25p on the 3. July 1995 and at the same date The Telegraph also increased from 30p to 35p. The Independent followed on the 17. July and increased its price to 35p. Another wave of price increases was initiated by The Times and The Telegraph on the 20.November 1995 who raised their prices to 30p and 40p respectively. The Independent leapfrogged on the 22. January 1996 ending a period of rapid price fluctuations that lasted for 29 months.

The exact consequences of the alleged price war period are a matter of vigorous public disagreement. In fact no consensus emerged even as to who the alleged predator The Times was preying against. The data shows the following picture between August 1993 and January 1996: The Times has increased circulation market share from about 17% to 28%. The Independent has moved from 16% to 12% and the Daily Telegraph has moved from 49% to 43%. The market share of the Guardian has decreased a little. Looking at these figures one has to keep in mind that the prices of The Times are still 15p, that of the Independent and the Telegraph 5p lower than in 1993.

3 Predatory pricing

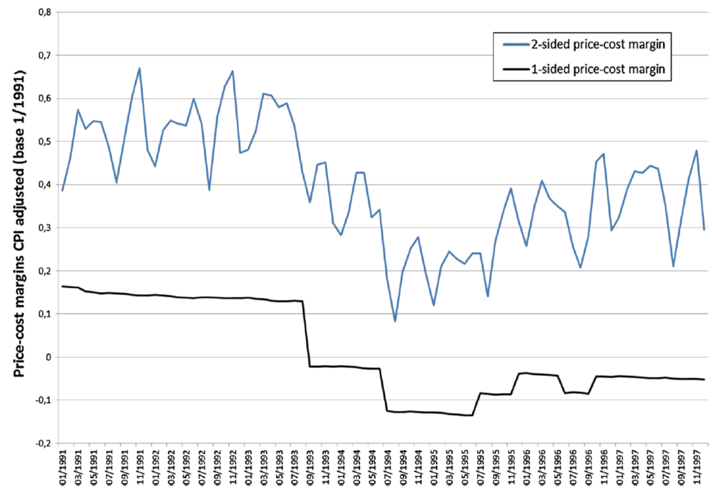
The evidence brought forward at the time is not sufficient to establish a case of predatory pricing as it has neglected the critical two-sidedness of the firms. The standard empirical test for predatory pricing in a single-sided market is the Areeda-Turner rule, according to which a price is predatory if it is below the short-run marginal cost. However this condition is only necessary but not sufficient. It is also necessary to check whether the pricing strategy is likely to lead to the exit from the market of the targeted competitor and whether the predator can expect to recoup the short run losses in the long run.

Yet, as discussed in Evans (2003), in a two-sided market the Areeda-Turner rule is not even a necessary condition and therefore cannot be applied. The reason is that a firm in a two-sided market acts as a platform and sells two products or services to two distinct groups of consumers and recognizes that the demand from one type of consumers depends on the demand from the other type of consumers and vice versa. It is therefore conceivable that by pricing below marginal cost on one side of the market a firm is increasing demand on that side and thus boosting demand on the other side, with an overall positive effect on its profits. Indeed, depending on the size of the own price elasticity on the two-sides of the market and on the size of the network effects, even a monopolist platform might find it profitable to lower the price below marginal cost on one side of the market. Testing for predatory pricing in two-sided markets should therefore take into account the presence of the critical network effects between the two sides.

In Behringer & Filistrucchi (2015a) we propose such an extension of the two-sided market predation definition. We argue that, despite the huge cut in prices, the pricing strategy of The Times in 1993 and 1994 could not be presumed predatory according an Areeda-Turner rule properly modified to take into account two-sidedness of the market. Accepting the claim of the Independent that the average variable cost of the Times was 32.5p (which being reported by the complainant, if should be biased upward), we calculate the overall markups of the Times from 1991 to 1997 per copy sold, taking into account both the cover price and the revenues from advertising as suggested by the two-sided Areeda-Tuner rule.

As shown in Figure 1, although the overall per copy markup of The Times dropped substantially during the price war, it always remained above zero. Clearly, with a marginal cost of 32.5p at a price of 30p or 20p, the price-cost margin on the readers' side alone was instead negative, as also reported in Figure 1. In fact, as shown in Behringer and Filistrucchi, 2015a), the cut in prices led to a substantial increase in circulation. The higher circulation in turn led to an increase in advertising revenues.

Figure 1, Price-cost margins for one- and two-sided case:



4 An empirical finding

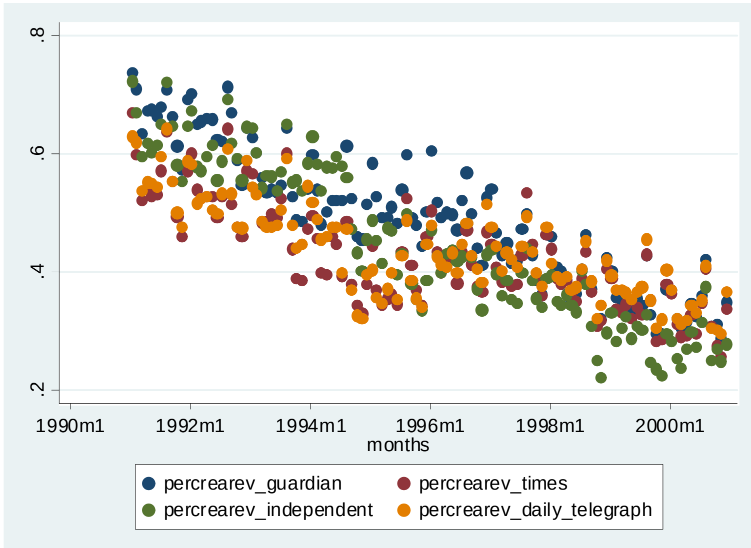
We set out to shed some light on issues of this price war using a model of a *two-sided market*. We first make an important empirical observation in Figure 2, namely that the share of readership revenue over advertising revenue for all firms is steadily declining during the 1990. For the Independent this ranges from over 70% to just above 20%, and even for the Guardian who did not adjust cover prices to readers from over 70% to 30%.

Hence a candidate explanation of the observed 'price war' is that The Times was first to react to this increase in advertising demand and was willing to sacrifice readership revenue thereby generating even higher indirect network benefits for advertisers.

> "How general is this finding theoretically, i.e. what are the assumptions needed to translate a higher demand for advertising into a lower reader price on the other side of the platforms?"

In order to answer this question we now build a formal model of the newspaper industry.

Figure 2, Readership/advertising revenue ratio:



5 Monopoly

As noted above, the existence of direct and indirect network effects on two-sided platforms gives rise to theoretical complications. Demand for advertising will depend on the vector of all advertising prices and all readership demands and vice versa for demand from readers. Such a system is generically non-linear and does not allow for closed form solutions.

Instead we choose to *monetize the disutility* to the reader of some quantity of advertising a with a scalar $\gamma > 0$ as in Anderson & Coate (2005). So the total utility of reading a newspaper with cover price p is

$$U = \bar{U} - p - \gamma a \tag{1}$$

On the revenue side we assume that the *per copy revenue* from advertising is some function $R(a, m)$ where $m > 0$ is an advertising scaling parameter.

As readership revenue is multiplicative in the number of readers the empirical finding implies that the Revenue Ratio:

$$RR = \frac{pN}{R(a,m)N} = \frac{p^*(m)}{R(a^*,m)} \tag{2}$$

has to decline in equilibrium as m increases.

A firm's objective is then:

$$\max_{p,a} \Pi = [R(a,m) + p - c]N(p + \gamma a) \tag{3}$$

for some decreasing general demand form $N(.)$ with $N' < 0$.

Assumption A1: $\frac{\partial^2 R}{\partial a^2} < 0$, (i.e. R is strictly concave in a) and $\frac{\partial^2 R}{\partial a \partial m} > 0$ (i.e. marginal revenue from advertising is increasing in the exogenous shift parameter m). Also, to comply with the interpretation of m we assume that $\frac{\partial R}{\partial m} > 0$.

Hence we assume that if there is too much advertising in the newspaper, readers will stop buying the paper and thus lower the revenues that can be collected from advertisers (or there is a crowding effect between advertisements).

The problem can be simplified by a change of variables:

$$\max_a \Pi = [R(a,m) + f - \gamma a - c] N(\underbrace{p + \gamma a}_{=f}) \tag{4}$$

where $f > 0$ is a constant. Optimizing over a this implies that for each reader marginal costs (the nuisance of advertising) and benefits are equalized at the first order necessary condition w.r.t. a

$$F_a \equiv \frac{\partial R(a,m)}{\partial a} - \gamma = 0 \tag{5}$$

which implicitly defines the optimal advertising level $a^*(m)$.

Optimizing over the cover price p we find the respective first order necessary condition w.r.t. p as

$$F_p \equiv N(p + \gamma a) + [R(a,m) + p - c] \frac{\partial N(p + \gamma a)}{\partial p} = 0 \tag{6}$$

which implicitly defines the optimal paper price p^*.

In order to determine the behaviour of these optimal levels w.r.t. to the exogenous shift parameter we make use of the implicit function theorem as:

$$\frac{\partial a^*}{\partial m} = -\frac{\partial F_a}{\partial m} / \frac{\partial F_a}{\partial a^*} = -\frac{\partial^2 R(a,m)}{\partial a \partial m} / \frac{\partial^2 R(a,m)}{\partial a^2} > 0 \tag{7}$$

i.e. is positive by Assumption A1.

Similarly

$$F_p \equiv N(p + \gamma a^*(m)) + [R(a^*(m), m) + p - c] \frac{\partial N(p + \gamma a^*(m))}{\partial p} = 0 \tag{8}$$

implies that from the implicit function theorem

$$
\begin{aligned}
\frac{\partial p^*}{\partial m} &= -\frac{\partial F_p}{\partial m} / \frac{\partial F_p}{\partial p^*} = -\frac{\frac{\partial F_p}{\partial a}\frac{\partial a^*}{\partial m} + \frac{\partial F_p}{\partial m}}{2\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p^2}} \qquad (9) \\
&= -\frac{\left(\frac{\partial N(p+\gamma a)}{\partial a} + \frac{\partial R(a,m)}{\partial a}\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p \partial a}\right)\frac{\partial a^*}{\partial m} + \frac{\partial R(a,m)}{\partial m}\frac{\partial N(p+\gamma a)}{\partial p}}{2\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p^2}} \\
&= -\frac{\frac{\partial R(a,m)}{\partial m}\frac{\partial N(p+\gamma a)}{\partial p}}{2\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p^2}} \\
&\quad - \left(\frac{\frac{\partial N(p+\gamma a)}{\partial a} + \frac{\partial R(a,m)}{\partial a}\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p \partial a}}{2\frac{\partial N(p+\gamma a)}{\partial p} + [R(a,m)+p-c]\frac{\partial^2 N(p+\gamma a)}{\partial p^2}}\right)\frac{\partial a^*}{\partial m}
\end{aligned}
$$

Assumption A2: The second order condition for profit maximization (SOC^*) is satisfied.

Given A1, and A2 the sign of the first term in (9) is negative. If p and a are strategic substitutes in demand, (i.e. $\frac{\partial^2 N(p+\gamma a)}{\partial p \partial a} < 0$) (**A3**) (sufficient but not necessary) then the second term is also unambiguously negative and, given $\gamma > 0$ so is $\partial p^*/\partial m$.

6 Competition

The profit of a firm in *oligopolistic competition* with differentiated products is:

$$\max_{p_i, a_i} \pi_i = [R_i(a_i, m) + p_i - c_i] N_i(\mathbf{p} + \gamma \mathbf{a}) \qquad (10)$$

where

$$N_i(\mathbf{p} + \gamma \mathbf{a}) = N_i((\overset{-}{p_i}, \overset{+}{\mathbf{p}_{-i}}) + \gamma(\overset{-}{a_i}, \overset{+}{\mathbf{a}_{-i}})) \qquad (11)$$

and firm $i's$ *symmetric residual demand* depend on prices and advertising quantities of *all* n firms.

Again we make use of a change of variables $p_i + \gamma a_i = f$ to find

$$\max_{p_i, a_i} \pi_i = [R_i(a_i, m) + f - \gamma_i a_i - c_i] N_i(\mathbf{p}_{-i} + \gamma \mathbf{a}_{-i}) \qquad (12)$$

and use the Nash assumption to find the FOC w.r.t. advertising quantity a_i

$$F_{a_i} \equiv \frac{\partial R_i(a_i, m)}{\partial a_i} - \gamma = 0 \tag{13}$$

which implicitly defines optimal quantity as

$$a_i^* = a_i^*(m, \gamma). \tag{14}$$

The FOC w.r.t. cover price p_i

$$F_{p_i} \equiv N_i(\mathbf{p} + \gamma\mathbf{a}) + [R_i(a_i, m) + p_i - c_i]\frac{\partial N_i(\mathbf{p} + \gamma\mathbf{a})}{\partial p_i} = 0 \tag{15}$$

implicitly defines

$$p_i^* = p_i^*(a_i^*(m, \gamma), c_i, \gamma, m, \mathbf{p}_{-i}, \mathbf{a}_{-i}). \tag{16}$$

Note $\frac{\partial a_i}{\partial c_i} = -\frac{\partial F_{a_i}}{\partial c_i} / \frac{\partial F a_i}{\partial a_i} = 0$, i.e. equilibrium advertising quantity is *independent* of own marginal costs and $\frac{\partial p_i}{\partial c_i} = -\frac{\partial F_{p_i}}{\partial c_i} / \frac{\partial F_{p_i}}{\partial p_i} = -\frac{-N'}{SOC}$ given that $SOC < 0$ equilibrium cover prices are *increasing* in own marginal cost.

The implicit function theorem yields:

$$\begin{aligned} \frac{\partial p^*}{\partial m} &= -\frac{\frac{\partial F_p}{\partial m}}{\frac{\partial F_p}{\partial p^*}} = -\frac{\frac{\partial F_p}{\partial m}}{SOC^*} = -\frac{\frac{\partial F_p}{\partial a}\frac{\partial a^*}{\partial m} + \frac{\partial F_p}{\partial m}}{\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p^*} + \frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_i(a_i, m) + p_i - c_i]\frac{\partial^2 N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p^*}} \\ &= -\frac{\left(\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial a} + \frac{\partial R_i(a_i,m)}{\partial a}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_i(a_i, m) + p_i - c_i]\frac{\partial^2 N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial a}\right)\frac{\partial a^*}{\partial m} + \frac{\partial R_i(a_i,m)}{\partial m}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}}{\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p^*} + \frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_i(a_i, m) + p_i - c_i]\frac{\partial^2 N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p^*}} \end{aligned}$$

Proposition 1 *If assumptions A1-A3 hold then $\partial p^*/\partial m < 0$ as in the monopoly case.*

If we assume linear demand the condition simplifies to

$$\frac{\partial p^*}{\partial m} = -\frac{\left(\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial a} + \frac{\partial R_i(a_i,m)}{\partial a}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}\right)\frac{\partial a^*}{\partial m} + \frac{\partial R_i(a_i,m)}{\partial m}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}}{\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p^*} + \frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}} \tag{17}$$

6.1 A linear duopoly example

A *duopoly example* with *Dixit (79) type differentiated* products: For $i = 1, 2$ we have profits as

$$\pi_i = [\underbrace{(m - a_i)a_i}_{R(a,m)} + p_i] \underbrace{\left[\frac{1 - \alpha(p_i + \gamma a_i) + \beta(p_j + \gamma a_j)}{\alpha^2 - \beta^2} \right]}_{N(p_i, p_j)}$$

with $\alpha > \beta > 0$ as own and cross-price elasticities. A change of variables again and maximization over a yields

$$a_i^* = a_j^* = \frac{m - \gamma}{2}$$

the same as in monopoly (see Anderson & Shi, (2016)) so that $R^*(a, m) = \frac{m^2 - \gamma^2}{4}$. When $\gamma > m$ the equilibrium involves only cover prices as the advertising level cannot be negative.

Maximization over p yields the symmetric equilibrium cover prices as

$$p^* = \frac{1}{8\alpha - 4\beta} \left(4 - \alpha m^2 - 2\left(m\alpha - m\beta + \beta\gamma\right)\gamma + 3\alpha\gamma^2\right)$$

which is increasing in α if $\beta\left(m - \gamma\right)^2 > 8$ and increasing in β if $\alpha\left(m - \gamma\right)^2 > 4$.

Note that the behaviour of the equilibrium cover price w.r.t. the shift parameter can also be found direclty from (17) as

$$\frac{\partial p^*}{\partial m} = \frac{1}{2\beta - 4\alpha}\left(m\alpha + \alpha\gamma - \beta\gamma\right)$$

The revenue ratio is found as

$$RR^* = \frac{m^2\alpha - 3\alpha\gamma^2 + 2\beta\gamma^2 + 2m\alpha\gamma - 2m\beta\gamma - 4}{\left(2\alpha - \beta\right)\left(-m + \gamma\right)\left(m + \gamma\right)}$$

Lemma 2 *The revenue ratio in linear duopoly equilibrium is decreasing in m if $4m > \gamma\left(m - \gamma\right)^2\left(\alpha - \beta\right)$.*

Proof: The derivative can be written as

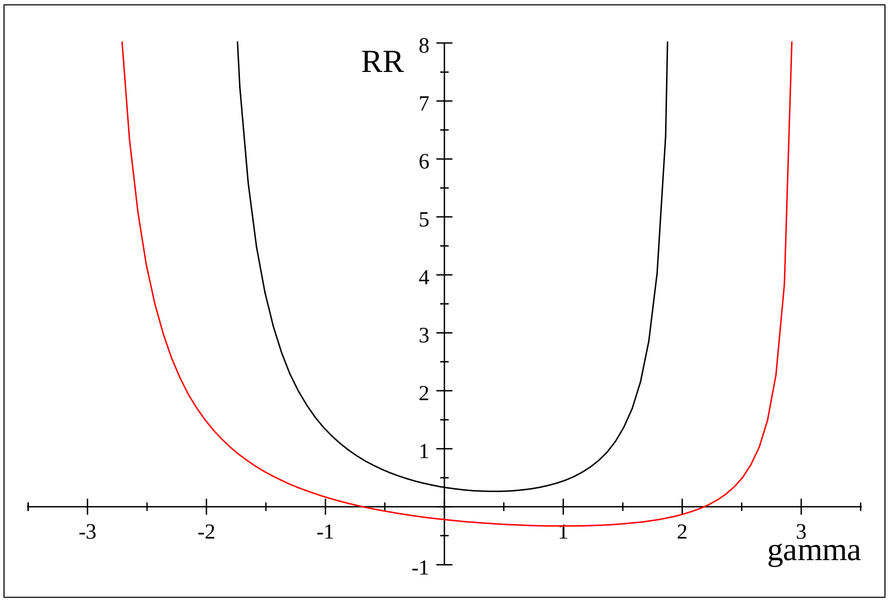
$$\frac{\partial RR^*}{\partial m} = \frac{2\left(4m - \gamma\left(m - \gamma\right)^2\left(\alpha - \beta\right)\right)}{\left(\gamma^2 - m^2\right)^2\left(\beta - 2\alpha\right)}$$

As $\alpha > \beta$ the denominator is always negative. So we need the numerator positive given $-m < \gamma < m$.■

For parameters $m = 2, \alpha = \frac{2}{3}$, $\beta = \frac{1}{3}$, the equilibrium revenue ratio becomes

$$RR^* = \frac{4}{3}\frac{\gamma - \gamma^2 - 1}{\gamma^2 - 4}$$

depicted in black. For $m = 3$ we find the *red* graph as



The equilibrium revenue ration RR^* changes in a and β as p^* does. For the example $m = 2, \alpha = \frac{2}{3}$, $\beta = \frac{1}{3}$, RR^* is decreasing in α for all $-2 < \gamma < 2$ but increasing in β for $-2 < \gamma < -0.45$ and decreasing in β for $-0.45 < \gamma < 2$.

The number of subscribers/consumers/demand in equilibrium duopoly can be found (for one firm) as

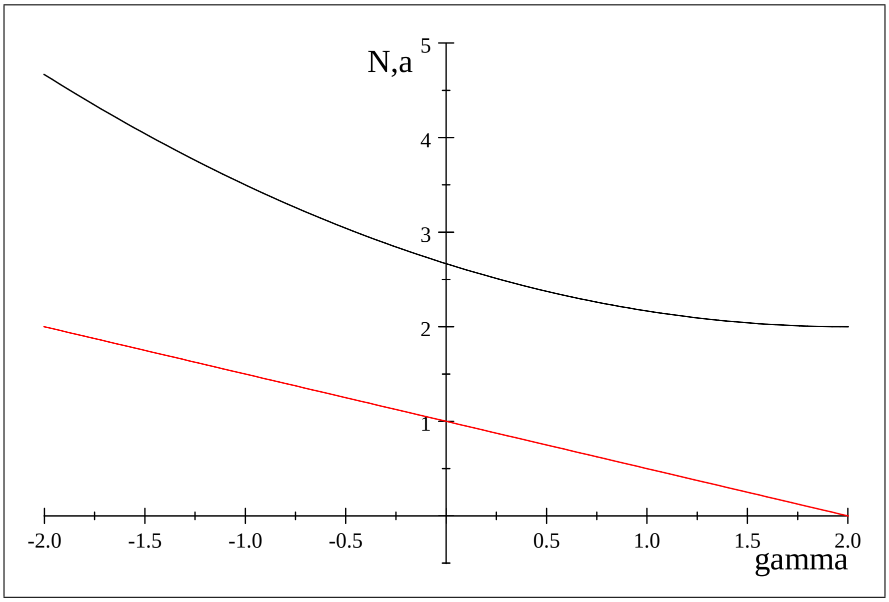
$$N^* = \frac{1}{4}\alpha\frac{m^2\alpha - m^2\beta + \alpha\gamma^2 - \beta\gamma^2 - 2m\alpha\gamma + 2m\beta\gamma + 4}{(\alpha - \beta)(\alpha + \beta)(2\alpha - \beta)}$$

Again for the example $m = 2, \alpha = \frac{2}{3}$, $\beta = \frac{1}{3}$ we find demand as

$$N^* = \frac{1}{6}\gamma^2 - \frac{2}{3}\gamma + \frac{8}{3}$$

and advertising quantities *(red)* as

$$a^* = \frac{2 - \gamma}{2}$$



Equilibrium advertising levels and demands are decreasing up to $\gamma = m = 2$ and remain constant after that.

Ad nuisance (lilac) can be found as

$$\gamma a^* = \gamma \frac{2-\gamma}{2}$$

The *equilibrium cover price (red)* is

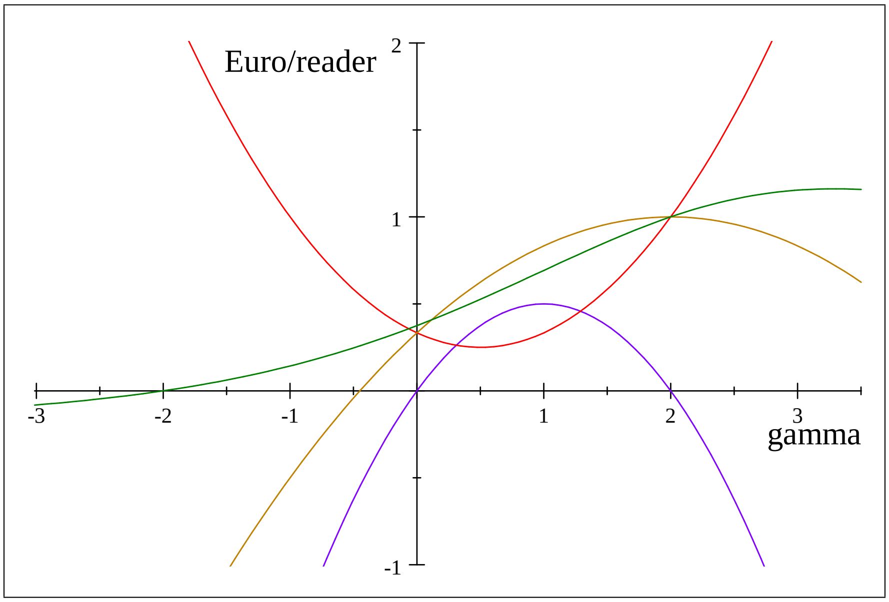
$$p^* = \frac{1}{3}\gamma^2 - \frac{1}{3}\gamma + \frac{1}{3}$$

the *full price (brown)* to be paid

$$p^* + \gamma a^* = -\frac{1}{6}\gamma^2 + \frac{2}{3}\gamma + \frac{1}{3}$$

and the *price per ad per consumer (green)* as

$$\frac{p_a}{N^*} = \frac{(m - a^*)}{N^*} = \frac{3\gamma + 6}{\gamma^2 - 4\gamma + 16}$$



Equilibrium profits are falling in γ up to $\gamma = m = 2$ as in monopoly. From there onwards all functions in the graph should be constant (***).

7 Collusion

A cartel acts like a profit maximizing multi-journal monopolist. The profit of such a monopolist m with n papers is:

$$\begin{aligned}\max_{p_1,\dots p_n,a_1,\dots a_n}\pi_m &= [R_1(a_1,m)+p_1-c_1]N_1(\mathbf{p}+\gamma\mathbf{a})+\\ &[R_2(a_2,m)+p_2-c_2]N_2(\mathbf{p}+\gamma\mathbf{a})+\\ &\dots\\ &[R_n(a_n,m)+p_n-c_n]N_n(\mathbf{p}+\gamma\mathbf{a})\end{aligned}$$

where now cross effects will have to be taken into account.

Again we make a change of variables $p_i+\gamma a_i=\bar{f}_i$ for all $i=1,\dots n$ to find

$$\max_{\mathbf{p},\mathbf{a}}\pi_m=\sum_{i=1}^{n}[R_i(a_i,m)+\bar{f}_i-\gamma a_i-c_i]N_i(\mathbf{p}_{-i}+\gamma\mathbf{a}_{-i})$$

Then the FOC w.r.t. advertising quantity a_i is

$$F_{a_i}\equiv\frac{\partial R_i(a_i,m)}{\partial a_i}-\gamma=0 \tag{18}$$

which implicitly defines optimal quantity for the monopolist as

$$a_i^m=a_i^m(m,\gamma). \tag{19}$$

Now, contrary to the competitive case the monopolist can choose all the cover prices simultaneously. Hence the profit programme can be rewritten as

$$\max_{\mathbf{p}}\pi_m=\sum_{i=1}^{n}[R_i(a,m)+p_i-c_i]N_i(\mathbf{p}+\gamma\mathbf{a})$$

The first order condition w.r.t. cover price p_i for newspaper $i=1,\dots n$ yields:

$$\begin{aligned}F_{p_i} &\equiv N_i(\mathbf{p}+\gamma\mathbf{a})+\sum_{i=1}^{n}[R_i(a,m)+p_i-c_i]\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}= \\ &N_i(\mathbf{p}+\gamma\mathbf{a})+[R_i(a,m)+p_i-c_i]\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}+\\ &\sum_{j\neq i}^{n}[R_j(a,m)+p_j-c_j]\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}=0\end{aligned} \tag{20}$$

which implicitly defines

$$p_i^m = p_i^m(a^m(m,\gamma), c_i, \gamma, m, \mathbf{p}_{-i}, \mathbf{a}_{-i}). \tag{21}$$

Again we may employ the IFT to find:

$$\begin{aligned}
\frac{\partial p_i^m}{\partial m} &= -\frac{\frac{\partial F_{p_i}}{\partial m}}{\frac{\partial F_p}{\partial p^m}} = -\frac{\frac{\partial F_{p_i}}{\partial m}}{SOC} = \\
&= -\frac{\frac{\partial F_{p_i}}{\partial m} + \frac{\partial F_{p_i}}{\partial a}\frac{\partial a^m}{\partial m}}{2\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_i(a,m)+p_i-c_i]\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p_i} + \sum_{j\neq i}^n [R_j(a,m)+p_j-c_j]\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p_i}} \\
&= -\frac{\begin{array}{c}\frac{\partial R_i(a,m)}{\partial m}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \sum_{j\neq i}^n \frac{\partial R_j(a,m)}{\partial m}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \\ \left(\begin{array}{c}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial a} + \frac{\partial R_i(a,m)}{\partial a}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_i(a,m)+p_i-c_i]\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial a} + \\ \sum_{j\neq i}^n \left(\frac{\partial R_j(a,m)}{\partial a}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + [R_j(a,m)+p_j-c_j]\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial a}\right)\end{array}\right)\frac{\partial a^m}{\partial m}\end{array}}{2\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p} + [R_i(a,m)+p_i-c_i]\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p_i} + \sum_{j\neq i}^n [R_j(a,m)+p_j-c_j]\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial p_i}}
\end{aligned}$$

If we assume a *linear demand* the condition simplifies and is easier to investigate. We have:

$$\frac{\partial p_i^m}{\partial m} = -\frac{\begin{array}{c}\left(\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial a} + \frac{\partial R_i(a,m)}{\partial a}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \sum_{j\neq i}^n \frac{\partial R_j(a,m)}{\partial a}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}\right)\frac{\partial a^m}{\partial m} + \\ \frac{\partial R_i(a,m)}{\partial m}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \sum_{j\neq i}^n \frac{\partial R_j(a,m)}{\partial m}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i}\end{array}}{2\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p}} \tag{22}$$

Compare with linear demand competition condition (17). Note that $\gamma > 0$ is necessary and sufficient for $\frac{\partial R_i(a_i,m)}{\partial a} > 0$ and $\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial a} < 0$ and thus sufficient for the RHS of (17) to be negative.

In the competition case $\frac{\partial R_i(a_i,m)}{\partial m} > 0$ was assumed in A1 but in the cartel case we need

$$\frac{\partial R_i(a,m)}{\partial m}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \sum_{j\neq i}^n \frac{\partial R_j(a,m)}{\partial m}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} < 0$$

so that only complementary products are a sufficient condition for this to hold which also guarantee that

$$\frac{\partial R_i(a,m)}{\partial a}\frac{\partial N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} + \sum_{j\neq i}^n \frac{\partial R_j(a,m)}{\partial a}\frac{\partial N_j(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i} < 0.$$

In case of non-linear demand in competition, we additionally assumed that SOC holds and that $\frac{\partial^2 N_i(\mathbf{p}+\gamma\mathbf{a})}{\partial p_i \partial a} < 0$ from A3.

7.1 A linear collusion example

Colluding firms will behave like a *multi-product* monopoly. With *Dixit (79) type differentiated* products for two goods $j = 1, 2$ and separable costs we have monopoly profits as

$$\begin{aligned}\pi^m_{1,2} \quad = \quad & [\underbrace{(m-a_1)a_1}_{R_1} + p_1 - c_1][\underbrace{\frac{1-\alpha(p_1+\gamma a_1)+\beta(p_2+\gamma a_2)}{\alpha^2-\beta^2}}_{N_1(p_1,p_2)}] + \\ & [\underbrace{(m-a_2)a_2}_{R_2} + p_2 - c_1][\underbrace{\frac{1-\alpha(p_2+\gamma a_2)+\beta(p_1+\gamma a_1)}{\alpha^2-\beta^2}}_{N_2(p_1,p_2)}]\end{aligned}$$

with $\alpha > \beta > 0$ as own and cross-price elasticities. A change of variables again and maximization over as yields again

$$a^m_1 = a^m_2 = \frac{m-\gamma}{2}.$$

Now the monopoly is able to internalize the externalities that duopoly cannot. With $\beta > 0$ the goods are substitutes. The monopolist maximizes over both prices to simultaneously satisfy the first order conditions (see 20):

$$\begin{aligned}&[(m-a_1)a_1 + p_1 - c_1]\frac{\partial N_1(p_1,p_2)}{\partial p_1} + N_1(p_1,p_2) + \\ &[(m-a_2)a_2 + p_2 - c_2]\frac{\partial N_2(p_1,p_2)}{\partial p_1} = 0\end{aligned}$$

$$\begin{aligned}&[(m-a_2)a_2 + p_2 - c_2]\frac{\partial N_2(p_1,p_2)}{\partial p_2} + N_2(p_1,p_2) + \\ &[(m-a_1)a_1 + p_1 - c_1]\frac{\partial N_1(p_1,p_2)}{\partial p_2} = 0\end{aligned}$$

For the above example with linear (symmetric) demand this reduces to

$$\begin{aligned}&\left[\frac{m^2-\gamma^2}{4} + p_1 - c_1\right](\frac{-\alpha}{\alpha^2-\beta^2}) + \frac{[1-\alpha(p_1+\gamma\frac{m-\gamma}{2})+\beta(p_2+\gamma\frac{m-\gamma}{2})]}{\alpha^2-\beta^2} + \\ &\left[\frac{m^2-\gamma^2}{4} + p_2 - c_2\right]\frac{\beta}{\alpha^2-\beta^2} = 0\end{aligned}$$

$$\left[\frac{m^2-\gamma^2}{4}+p_2-c_2\right](\frac{-\alpha}{\alpha^2-\beta^2})+\frac{\left[1-\alpha(p_2+\gamma\frac{m-\gamma}{2})+\beta(p_1+\gamma\frac{m-\gamma}{2})\right]}{\alpha^2-\beta^2}+$$
$$\left[\frac{m^2-\gamma^2}{4}+p_1-c_1\right]\frac{\beta}{\alpha^2-\beta^2}=0$$

Solving simultaneously (with $c_1 = c_2 = 0$) yields collusive/monopoly prices:

$$p_1^m = p_2^m = p^m = \frac{1}{8}\frac{4+(m-\gamma)(m+3\gamma)(\beta-\alpha)}{\alpha-\beta} \tag{23}$$

which are u-shaped in γ and decreasing in m.

Note that the behaviour of the equilibrium cover price w.r.t. the shift parameter can also be found direclty from (22) as

$$\frac{\partial p_i^m}{\partial m} = -\frac{1}{4}(m+\gamma).$$

7.2 Comparison of collusion with duopoly

Comparing the collusive/monopoly results with the linear duopoly example we find:

Lemma 3 *The cover price for the colluding firms / multiproduct monopoly p^m is always above that of duopoly $p^*$for substitutes and below for complements. In the former case the price difference is strictly decreasing , in the latter case strictly increasing in γ.*

Proof: $p^m - p^* = \frac{1}{8}\beta\frac{(\alpha-\beta)(m-\gamma)^2+4}{(\alpha-\beta)(2\alpha-\beta)} > 0$ with derivative $\frac{\partial(p^m-p^*)}{\partial\gamma} = -\frac{1}{8}\beta\frac{2(m-\gamma)}{2\alpha-\beta}$.■

Cover prices for the multiproduct monopoly are u-shaped in the nuisance parameter γ (see Anderson & Jullien, 2016) and the same holds in duopoly. When advertising is perceived as strong nuisance consumers can be charged a high price to avoid them whereas when they enjoy them (negative γ) then they can be charged a high cover price to enjoy lots. Hence the level of nuisance for a given (observed) equilibrium price is not unique but may imply advertising attachment or aversion.

Given that goods are substitutes $\beta > 0$ which is likely for newspapers, colluding firms, acting like a multiproduct monopoly charge higher prices than those charged in duopoly for any range of the nuisance parameter. Hence a zero cover price is optimal already at lower levels of m in duopoly.

8 Data

The dataset on the reader's side contains market level data on circulation, cover prices, and content characteristics of the four daily quality national newspapers in the UK (Guardian, The Times, Independent, and Daily Telegraph), with monthly observations from 1990 to 2000. Data on circulation come from the Audit Bureau of Circulation (ABC). Data on prices were collected from newspaper publishers themselves.

Data on the results of the political elections and on the political position of the newspapers were collected from the British Election Surveys (BES) in 1992 and 1997 and from the British Panel Election Survey (BPES) for the years 1992-1997 and 1997-2001. In particular, the relative political position of the newspaper was calculated as the percentage of readers of a given newspaper who a) voted for the conservative (or alternatively the labour) party b) felt closer to the conservative (or alternatively to the labour) party c) thought their newspaper favoured the conservative (or alternatively the labour) party.

On the advertising side of the market we acquired market level data on advertising quantity and revenues of the same newspapers with monthly observations for 1991 to 2000 from Nielsen Media Research UK. The latter directly collects data on quantities and applies list prices in order to calculate advertising revenues. In doing so, however, Nielsen also applies an estimate of the discounts with respect to the posted list prices. We recovered nominal advertising tariffs dividing revenues by quantity. Finally, we deflated cover prices and advertising tariffs by the Consumer Price Index.

9 Empirical Analysis: Testing for Collusion

[to be continued]

10 Conclusion

In this paper we propose a theoretical model encompassing demand on both sides of the market and profit maximization by monopoly and competing oligopolistic publishers who recognize the existence of indirect network effects between the two sides of the market as they simultaneously chose cover and advertising prices.

Our candidate explanation for the events in the UK in the 1990s is that the observed changes in market structure result from an expected *positive shock on the demand side for advertising*. This shock leads to an adjustment process that finally implies lower equilibrium prices on the reader's side as the new optimal mix of newspaper finance has more of its revenue resulting from advertisers than from readers. It is conceivable that Rupert Murdoch, being first to spot this change in the market structure was also first to react. Our model shows that this comparative statics result of optimizing behaviour in two-sided markets holds under very general conditions and is even more likely to result in case of a shake-up of collusive behaviour.

We neglect for the moment any explanation of the classical transition dynamics between a collusive and a non-collusive period, e.g. Green & Porter (1984) and Fershtman & Pakes (2000).

We then investigate whether the observed market changes are in line with a *breakdown of a collusive agreement* on cover prices which was upset when Rupert Murdoch took over The Times and changed old habits. We find that

[to be continued]

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