News Aggregators and Competition Among Newspapers in the Internet (Preliminary and Incomplete)*

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Abstract

In this paper, we study how the presence of a news aggregator affects competition among (horizontally differentiated) newspapers in the Internet. For this purpose, we build a model of multiple issues which allows each newspaper to choose quality on each issue. Our model provides a micro foundation for the service offered by the aggregator and captures both the "business-stealing effect" and the "market-expansion effect" of the aggregator. We find that the presence of the aggregator is likely to lead each newspaper to specialize in the set of issues. In this case, its presence changes quality choices from strategic substitutes to strategic complements, which in turn leads to an increase in the quality of newspapers and an increase in consumer surplus, with an ambiguous effect on newspapers' profits. In addition, we find that allowing each newspaper to choose to opt out sharpens our prediction.

Key words: Newspapers, News Aggregator, Internet, Quality, Strategic Substitutes, Strategic Complements, Advertising, Business Stealing, Market Expansion, Opting Out.

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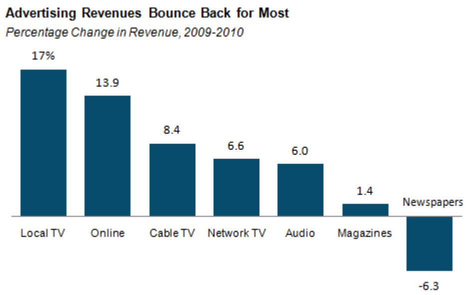
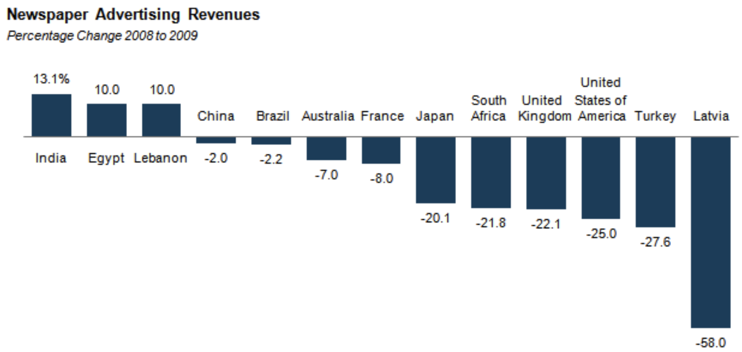


(a) U.S



(b) World

Figure 1: Change in Advertising Revenues

Source: The State of News Media

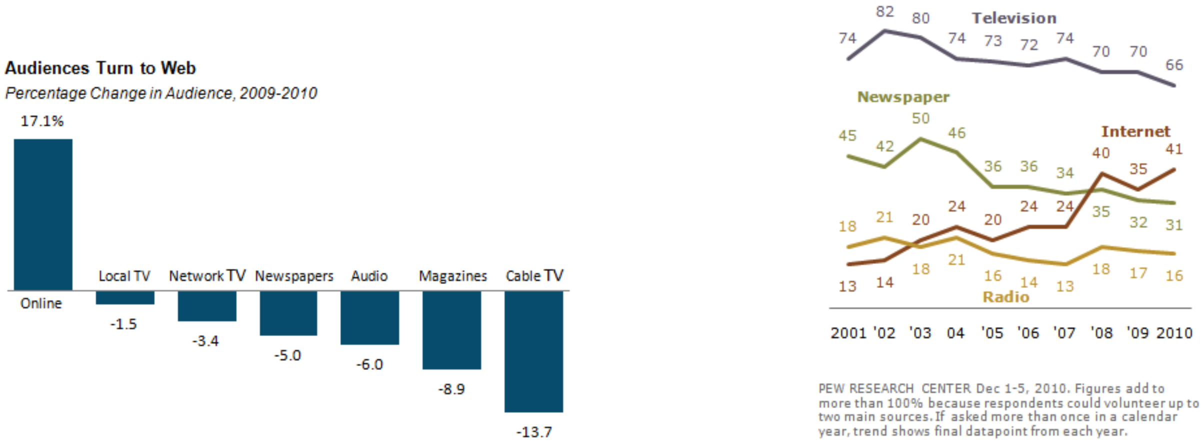
1 Introduction

The Internet has threatened the traditional business model of newspapers by reducing their advertising revenue and by introducing new online media, such as web-only news, blogs and news aggregators. There are serious concerns that this fall in the revenue may lead to a decrease in the quality of journalism.

Newspapers' revenues from advertising have fallen approximately 45% since 2000. For instance, classified advertising accounted for $19.6 billion in revenue for newspapers in 2000, $10.2 billion in 2008, and is estimated to be only $6.0 billion in 2009 [FTC, 2010]. These numbers become more meaningful, if we know that for most newspapers, about 80% of revenues came from advertising, and 20% came from sales, according to FTC [2010]. In addition, the report of The State of News Media [2011] shows that after the recent financial crisis, the advertising revenue bounced back for all media except for newspapers (see Figure 1).

Newspapers are in stiff competition with new online internet (web-only news, blogs and news aggregators). Figure 2a shows that online media was the only one among all media which saw audience growth in 2009-2010. Figure 2b) confirms this as a general trend for the period of 2001-10. Among online media, news aggregators are the most important. According to Outsell report [2009], 57 percent of users now go to digital sources and theyare also likelier to turn to an aggregator (31 percent) than a newspaper site (8 percent) or other site (18 percent). Indeed, Gentzkow and Shapiro [2011] show that two aggregators, Yahoo! News and AOL News, attract more than one third of the traffic of online news in U.S. (see figure 3). Adding Google News would lead to a total share of around 40 percent.

The success of news aggregators raises a hot debate about the effect of news aggregators on



(a) Source: The State of News Media

(b) Source: Pew Research Center

Figure 2: Online News Grows Rapidly Compare to Others

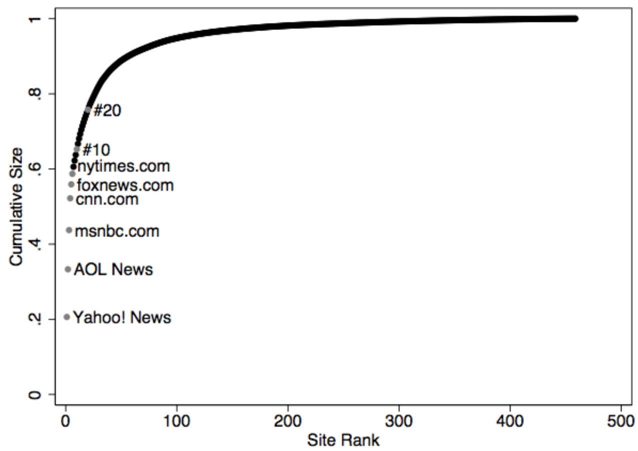
newspapers. At the heart of the debate is the effect on newspapers' incentive to produce high quality content. The debate has already attracted the attention of governments and regulatory bodies. For instance, during 2009-2010 the FTC hosted three workshops on the Future of Journalism and has published a controversial "discussion draft" that hints of copyright reform and protection of newspapers from aggregators.

There are two types of arguments in the debate. On the one hand, one group including content producers argues that news aggregators make money by stealing high quality contents. Since this money is pull out of the content producers' pocket, they have less incentive to produce high quality contents. For instance, Mark Cuban, chairman of HDNet, says "Newspapers are getting their blood sucked by Google and content aggregators"[1]. According to Rupert Murdoch (2009), chairman of News Corp.,

"When this work is misappropriated without regard to the investment made, it destroys the economics of producing high quality content. The truth is that the "aggregators" need news organizations. Without content to transmit, all our flat-screen TVs, computers, cell phones, iPhones and blackberries, would be blank slates. (p.13)."

On the other hand, the other group including news aggregators believes that news aggregators conduct a huge traffic to the news website that they can make money out of it. Google (2010), for instance, in a response to the FTC report, claims that they send more than four billion clicks each month to news publishers via Google Search, Google News, and other products. Google

[1] http://paidcontent.org/article/419-onmedia-mark-cuban-google-content-aggregators-are-vampires-newspapers-/



Source: Gentzkow and Shapiro, 2011

Figure 3: Cumulative Distribution of Internet Unique Visits

believes each click – each visit – provides publishers with an opportunity to show users ads, register users, charge users for access to content, and so forth.

In this paper, we study how the presence of a news aggregator affects competition between newspapers and their quality choice. For this purpose, we build a novel model of multiple issues, which allows us to provide a micro foundation for the functionality of the aggregator and to capture both the "business-stealing effect" and the "market-expansion effect", which are at the core of the debate. In addition, the model creates rich strategic interactions between newspapers by allowing each newspaper to choose quality for each among many issues. Hence, each newspaper's strategy has both a vertical dimension (through quality choice) and a horizontal dimension (through choice of issues to cover in depth). Finally, we embed this feature of multiple issues on the classic Hotelling model, which serves to capture ideological differentiation of newspapers and ideological heterogeneity of consumers (Gentzkow and Shapiro, 2011).

We have in mind a sequential reading process in which a reader first reads the homepage (i.e. the index page) and then click on the issues that he or she wants to read more about. This process is captured by assuming that a reader spends a unit of attention on any given issue and spends extra $\delta > 0$ unit of attention if the issue is covered with high quality. The aggregator's index page provides a link to the highest quality article on each issue. The business-stealing effect arises in our model as long as the aggregator attracts some readers as these readers would read the index pages of the newspapers if the aggregator did not exist. However, there also exists a market-expansion effect since the aggregator improves match between each reader's attention and high quality contents and increases the readership for high quality contents. The newspapers in our model have two options, either differentiate themselves by specializing on different issues, or providing high quality contents on the same issues (no specialization). Specialization maximizes the role of the aggregator while no specialization minimizes it.

We find that the presence of an aggregator would lead each newspaper to specialize in a different set of issue (i.e. maximum differentiation or specialization) when the advertising revenue increases substantially with quality increase and would lead both newspapers to invest in the same issues (i.e. minimum differentiation or no specialization) otherwise. When both newspapers use maximum differentiation strategy, the presence of the aggregator changes the strategic interactions of quality choices from strategic substitutes to strategic complements. As a consequence, the presence of the aggregator increases the average quality of newspapers compared to case of no aggregator, which in turn implies that the presence increases consumer surplus. However, the effect on the newspapers' profits is ambiguous.

The intuition for the change in the strategic interactions is the following. In the absence of the aggregator, if newspaper 2, say, chooses a higher quality, this decreases the market share of newspaper 1 and hence reduces 1's marginal revenue from increase in quality. On the contrary, when both newspapers use maximum differentiation in the presence of the aggregator, if newspaper 2 increases its quality, this expands the market share of the aggregator. This in turn implies that the high quality content of newspaper 1 can reach a larger number of readers since it can reach both its loyal readers and the readers who use the aggregator. Therefore, increase in 2's quality increases 1's marginal revenue from quality increase.

When the presence of the aggregator induces no specialization, the aggregator has zero market share and we find that there is a continuum of symmetric equilibria such that the maximum quality is higher than the quality in the absence of the aggregator while the minimum quality is lower than the quality in the absence of the aggregator. However, when we allow each newspaper to choose to opt out (i.e. to break the hyper link to the aggregator's site), only the equilibrium quality in the absence of the aggregator survives. Therefore, introducing opting out possibility leads to a sharp prediction: the presence of the aggregator either leads to no change or to the specialization equilibrium.

There are few papers who try to investigate this issue. Dellarocas, Katona, and Rand [2012] is one of the first theoretical papers in this area. They consider a single-issue model in which content providers compete for traffic by investing in both contents and links. The aggregator benefits the consumers by providing links to the highest quality contents. They show the presence of aggregator might decrease (increase) competition among content providers if content providers can (can not) link to each others. We consider a model of continuum of issues with endogenous quality and coverage in which the aggregator provides a link to the highest quality site on every single issue. Therefore, the aggregator provides a higher benefit than any single newspaper if we neglect the ideological differentiation of newspapers. Furthermore, our result that the presence of the aggregator changes strategic interactions of quality choices from strategic substitutes to strategic complements does not exist in their paper because they do not determine quality in an endogenous way and that they consider a single issue.

The two empirical papers on news aggregators (Chiou and Tucker, 2011 and Athey and Mobius, 2012) provide evidence for the dominance of the market-expansion effect over the business-stealing effect. Chiou and Tucker [2011] study a natural experiment where Google News had a dispute with the Associated Press and hence did not show Associated Press content for some period. They find that after the removal of Associated Press content, few users subsequently visited other news sites after navigating to Google News relative to users who had used Yahoo! News which did not remove the content. They conclude that users of aggregators are more likely to be provoked to seek additional sources and read further rather than merely being satisfied with the summary. Athey and Mobius [2012] study a case where Google News added local content to their news home page for users who chose to enter their location. By comparing the consumers who use this feature with controlled users, they find that users who adopt the feature increase their usage of Google News, which in turn leads to additional consumption of local news. They conclude that their results support the view that news aggregators are complement for local news outlets. who invest in the creation of news stories. This occurs in our paper if market expansion effect dominates business stealing effect. In addition, they find evidence of business-stealing effect in that adoption of the feature induces a reduction in home page views for local news outlets.

Our work relates to the literature on interconnection among online sites. In particular, Jeon and Menicucci [2011] studies interconnection among academic journal websites either through a multilateral platform (such as CrossRef) or through bilateral arrangements. News Aggregators can be considered a multilateral platform of interconnection. However, this paper is different from Jeon and Menicucci [2011] in the sense that the strategic variables are completely different. The former studies how the presence of a multilateral platform affects newspapers'choice of quality and coverage (when content is free) whereas the latter studies how interconnections interact with pricing of academic journals.

Our paper builds on the large literature on two-sided markets (see for example Rochet and Tirole, 2002, 2003, 2006, Caillaud and Jullien, 2003, Anderson and Coate, 2005, Armstrong, 2006, Hagiu, 2006, 2009, Rochet and Jeon, 2010, Weyl, 2010). Two- sided markets can be roughly defined as industries where platforms provide intermediation services between two (or several) kinds of users. Typical examples are payment cards, software, Internet, academic journals and media. In the application to media (Anderson and Coate, 2005), the two sides refer to readers and advertisers. Instead of explicitly modeling the competition in the market for advertising as Anderson and Coate do, we describe this market with a reduced-form in order to focus on rich strategic interactions in the newspaper content market. Recently, Athey, Calvano, and Gans [2010] study how applying consumer tracking technology to advertising affects competition between online news media in a two-sided market framework.

The rest of the paper is organized as follows. The model is explained in section 2. In section 3, we study as a benchmark newspaper competition in the absence of aggregator. Section 4 studies how the presence of an aggregator affects newspaper competition. Section 5 introduces opting out possibility and refines equilibria obtained in section 4. Section 6 compares the outcome without aggregator with the one with aggregator in terms of quality, consumer surplus and profit. Section 7 is about an extension (in progress) with contents from third party sites. Section 8 concludes the paper. All missing proofs and figures are gathered in the appendix.

2 Model

We consider two newspapers and one aggregator for simplicity; however, the insights can be generalized to a model of $n(> 2)$ newspapers and $m(> 1)$ aggregators. To build an interesting model of competition between newspapers and to provide a micro-foundation for the role of aggregator, we introduce some novel features into the classic Hotelling model. The Hotelling model is used to represent horizontal differentiation between the newspapers: we assume that consumers and newspapers are heterogeneous in their ideological view. The novel features we introduce are multiple issues and endogenous choice of quality and coverage, as is explained below.

2.1 Newspapers and Consumers

Throughout the paper, we assume that consumers single-home[2], which means that a consumer consumes only one of the two newspapers in the absence of the aggregator. In the presence of the aggregator, a consumer consumes one among newspaper 1, newspaper 2 and the aggregator.

2.1.1 Ideological Differentiation

The two newspapers are located at the extreme points of a line of length 1;[3] newspaper 1 on the left extreme point and newspaper 2 on the right point. Mass 1 of consumers are uniformly

[2]Basically, the aggregator's technology allows consumers to have access to contents from all newspapers. Given that we consider only two newspaper, this technological difference between the aggregator and newspapers can be captured by the single homing assumption. However, if we consider a large number of newspapers, we can allow consumers to read two or three newspapers without the aggregator and still capture the technological difference.

[3]We here follow the convention in the Hotelling model. However, our results would hold for any locations of the newspapers with the same distance from the mean.

distributed on the line. A location in the line represents the ideological view of a consumer or a newspaper. A consumer travels to a newspaper site in order to consume its contents and incurs some transportation cost which represents utility losses due to imperfect preference matching. The unit transportation cost is $t > 0$.

2.1.2 Multiple Issues and Choice of Quality and Coverage

We assume that there is a continuum of issues which each newspaper covers. Let S be the set of issues. On each given issue, a newspaper can provide either high quality content or low quality content. So the strategy of newspaper i, with $i \in \{1, 2\}$, is a subset of issues $s_i \in S$ about which it provides high quality contents; for the rest of issues $S - s_i$, the quality of contents is low. Let $\mu(s)$ represent the measure of any set $s \in S$. Without loss of generality, assume $\mu(S) = 1$. Then, $\mu(s_i)$ represents the average quality of newspaper i. Therefore, the strategy s_i has a vertical dimension in terms of average quality: from now on, we simply call $\mu(s_i)$ quality of newspaper i. Furthermore, even when both newspapers choose the same quality, the strategy has a horizontal dimension since each newspaper can cover, with high quality contents, a different subset of issues or the same subset. Given $0 < \mu(s_1), \mu(s_2) \leq 1/2$, for newspaper $i \in \{1, 2\}$, if i chooses s_i such that $s_i \cap s_j = \emptyset$,we say that i uses maximum differentiation strategy (equivalently, specialization strategy). If i chooses s_i such that $\mu(s_1 \cap s_2) = \min(\mu(s_1), \mu(s_2))$, then we say that i uses minimum differentiation strategy (equivalently, no specialization strategy).

2.1.3 Consumer Preferences

We assume that each content on any given issue has two characteristics, the quality and the ideological view. Any consumer prefers high quality content to low quality one for given ideological characteristic. The ideological characteristic is determined by the distance between a consumer's location and a newspaper's location; more precisely, if a consumer located at x reads an article of newspaper 1 (respectively, newspaper 2), he or she incurs a transportation cost of xt (respectively, $(1 - x)t$).

We have in mind is a sequential reading process in which a reader first reads the homepage (i.e. the index page) and then click on the issues that he or she wants to read more about. This reading process is captured by supposing that each consumer spends one unit of attention per low quality article and $1+\delta$ unit of attention per high quality article with $\delta > 0$: an additional δ unit of attention is spent if the quality of content is high. Hence, a simplifying assumption we make is that each consumer is interested in all issues.[4] Let u_0 represent a consumer's gross utility from

[4]Alternatively, we can assume that each consumer is interested in a same constant fraction of issues, which are randomly determined.

reading all issues in a newspaper when all the contents are of low quality. We assume $u_0 > t$, which implies that even when all contents are of low quality, each consumer ends up consuming one of the newspapers. This is a standard full participation assumption in the Hotelling model. Let $\Delta u(\delta)$ represent utility increase that a consumer experiences when a low quality article is replaced by a high quality one. $\Delta u(\delta)$ is increasing with δ with $\Delta u(0) = 0$. The expected utility of a consumer who is located at x from consuming newspaper 1 (or 2) is given by

$$U^1(x) = u_0 + \mu(s_1)\Delta u - xt; \tag{1}$$

$$U^2(x) = u_0 + \mu(s_2)\Delta u - (1-x)t. \tag{2}$$

Define β as $\beta \equiv \Delta u/t$. We can interpret β as *the measure of disloyality*, in the sense that the smaller β is, the more loyal are consumers to newspapers. Small β means that ideological characteristic of newspapers matters more than their quality for consumers. To make sure that each newspaper has a positive market share in the presence of the aggregator, we make the following assumption:[5]

A1: $\beta < 1$ (i.e. consumers are loyal enough to newspapers).

2.1.4 Advertising Revenues and Content Production Technology

We consider a business model based on advertising in which newspapers' contents on Internet are free. Each unit of attention brings an advertising revenue of $\varpi > 0$ to the newspaper.

For tractability,[6] we model the cost of investing in news quality by a quadratic function. Furthermore, we assume the cost of investing in a subset of measure greater than $\frac{1}{2}$ is infinity, which means that it is not possible to cover all issues with high quality by the two newspapers. More precisely, we assume that the cost of investing in a subset s_i with measure $\mu(s_i)$ for newspaper $i \in \{1, 2\}$ is given by

A2:

$$C(\mu(s_i)) = \begin{cases} \infty & \mu(s_i) > \frac{1}{2} \\ c\mu(s_i)^2 & \mu(s_i) \leq \frac{1}{2} \end{cases}$$

where $c > 0$ is a positive constant. A justification for considering $\mu(s_i) \leq \frac{1}{2}$ is that in the Internet era, readers can have access to news sites on real time and hence newspapers should update their

[5] In the absence of the aggregator, it is sufficient to have $\beta < 2$ to discard cornering equilibrium.

[6] As is shown in Lemma 3, in the presence of the aggregator, the denominator in the expression for a given newspaper's market share is a function of the strategies $(\mu(s_1), \mu(s_2))$, which makes the analysis complex.

coverage of issues on real time as well, which can limit the coverage of a given newspaper.[7]

Thus, the profit of newspaper $i \in \{1, 2\}$ in the absence of the aggregator is

$$\pi_i(s_i) = \varpi\alpha_i\left[1 + \mu(s_i)\delta\right] - C\left(\mu(s_i)\right), \tag{3}$$

where α_i is the market share of newspaper i.

In what follows, without loss of generality, we normalize ϖ at one since what matters is only c/ϖ. However, the interpretation of our results will be done in terms of c/ϖ (see the end of Section 6).

2.2 Aggregator

2.2.1 Benefit of Using the Aggregator

The value added of an aggregator consists in recognizing high quality contents ex-post. In the real world, some aggregators, like Huffington Post, use editorial staff, while others, like Google News, use an algorithm to find high quality contents. After finding high quality articles, each aggregator publishes them on its site. However, there are different ways. Someone, like Yahoo! News, publishes the whole article in the site, without putting any link to the original content. Usually, that is because the aggregator pays the newspaper for that content, and so it has the right to publish it. In 2006, Yahoo! signed an agreement with Newspaper Consortium[8] to use their contents. Others, like Google News, publish a very short summary of an article, and provide a link to the original article. The first pages and sample articles of Yahoo! News, and Google News can be seen in figures 8, 9, 10, and 11. Indeed, these two types of aggregators bring revenue to newspapers in different ways, the first one by buying the license and the second by sending traffic to newspaper sites.

We model the aggregator mostly in the form of Google News and relegate the licensing issue for future work. Hence, the aggregator in our model publishes an article on its site with a link to the original article. The aggregator generates benefit to consumers by improving the match between their attention and high quality contents. More precisely, for a given issue, if there is any high quality article, the aggregator finds and publishes it, but if there is no high quality article, the aggregator publishes a low quality one. A consumer who goes to the aggregator's site spends one unit of attention per article on the aggregator site regardless of the quality of

[7] In addition, our main results would be robust to relaxing this assumption if we allow for a continuous quality choice on each issue. However, a model of continuous quality choice would be much less tractable than the current model.

[8] http://www.npconsortium.com/
http://bits.blogs.nytimes.com/2009/04/08/is-yahoo-a-better-friend-to-newspapers-than-google/

content. This captures the idea that consumers read the abstract of the article. After that, if the quality is high, the consumer clicks on the link to read the whole story. By doing this she or he spends δ unit of attention on the newspaper site to which she or he is directed. If the quality is low, the consumer only reads the title and the abstract, and does not click on the link.

While a consumer who goes directly to a newspaper site spends $1 + \delta$ unit of attention for high quality contents and one unit for low ones, a consumer who is directed to a newspaper from clicking the link of the aggregator spends δ unit of attention only for high quality articles. This difference captures *the business stealing effect* of the aggregator. However, there is also *a market expansion effect* since high quality contents of each newspaper can reach not only its loyal readers but also those who use the aggregator.

2.2.2 Cost of Using the Aggregator

There should be a cost for using the aggregator, otherwise all consumers would choose the aggregator. We capture the cost by assuming that if both newspapers or none of them produce high quality contents, the aggregator will provide a link only to one of them randomly. So for a given consumer, using the aggregator involves a higher cost of ideological mismatch than using his or her preferred newspaper. Actually, this is the way the aggregators work. The aggregators, like Yahoo! News, are providing high quality news from one source, even if there are many. The aggregators, like Google News, link to a very large list of content providers. Google News typically provides one link per issue for all topics except for the top story for which it can show multiple links (see figure 11).

So, in summary, for any given consumer, using the aggregator allows her or him to enjoy more high quality contents at a higher cost of ideological mismatch compared to using her or his preferred newspaper.

2.3 Timing

In what follows, we analyze the following two-stage game.

- Stage 1: each newspaper i simultaneously chooses s_i.
- Stage 2: each consumer chooses between the two newspapers if there is no aggregator (otherwise, among the two newspapers and the aggregator).

When there is an aggregator, we also study a two-stage game in which each newspaper is allowed to opt out in stage 1 where opting out means that a newspaper breaks the link with the aggregator. Then, stage 1 is replaced by

- Stage 1': each newspaper i simultaneously decides whether to opt out or not and chooses s_i.

3 No Aggregator

In this section, we analyze the two-stage game in the absence of the aggregator. As usual we use backward induction and start from stage 2. In this section, what matters is only $\mu(s_i) = \mu_i$ for $i = 1, 2$ given our single-homing assumption.

Let x denote the location of the consumer who is indifferent between 1 and 2, which is determined by:

$$\mu_1 \Delta u - tx = \mu_2 \Delta u - t(1 - x).$$

Equivalently, we have

$$x = \frac{1}{2} + \frac{\beta}{2} (\mu_1 - \mu_2).$$

From A1, we have $0 < x < 1$. Therefore, each newspaper's market share is positive: $0 < \alpha_i < 1$ for $i = 1, 2$.

Newspaper i's profit is given by

$$\pi_i = \left[\frac{1}{2} + \frac{\beta}{2} (\mu_i - \mu_j)\right] [1 + \mu_i \delta] - c\mu_i^2 \text{ for } (\mu_i, \mu_j) \in [0, 1/2]^2.$$

If $c \leq \beta\delta/2$, the profit function is convex. As $\pi_i'(0) = \beta + \delta - \beta\delta\mu_j > 0$ for any $\mu_j \in [0, 1/2]$, newspaper i's best response is $1/2$ for any $\mu_j \in [0, 1/2]$.

If $c > \beta\delta/2$, the profit function is strictly concave. The best reply function of i is given by

$$BR_i^N(\mu_j) = \begin{cases} \frac{1}{2} & \text{if } \mu_j \leq 1 - \frac{2c - (\beta + \delta)}{\beta\delta} \\ \frac{\beta + \delta - \beta\delta\mu_j}{4c - 2\beta\delta} & \text{if } \mu_j > 1 - \frac{2c - (\beta + \delta)}{\beta\delta} \end{cases}$$

where the superscript N means no aggregator. In this case, the sign of the best reply function is zero or $-\beta\delta/(4c - 2\beta\delta)$. Therefore, we can conclude:

Lemma 1. *Newspapers' quality choices (μ_1, μ_2) are strategic substitutes, in the absence of aggregator.*

In the absence of the aggregator, if newspaper j increases its quality, this reduces newspaper i's market share and thereby i's marginal revenue from increase in quality. This is why quality choices are strategic substitutes.[9] Figure 4 describes newspaper 1's best reply when $c > \beta\delta/2$.

[9]This is similar Cournot competition in which an increase in firm j's quantity reduces the price of firm i' good

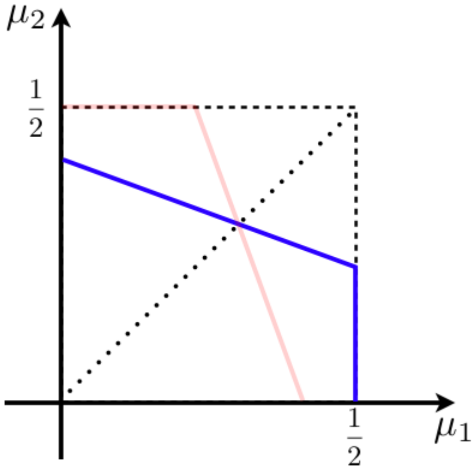


Figure 4: Best reply function in the cas of no aggregator

Let (μ_1^*, μ_2^*) denote the equilibrium quality in the absence of the aggregator. The next proposition shows that there is a unique equilibrium.

Proposition 1. *Under A1 and A2, there is a unique equilibrium, which is symmetric. In the equilibrium,*

(i) the average quality of each newspaper is

$\mu^* = \mu_1^* = \mu_2^* = \frac{1}{2}$, *if* $0 \leq c \leq \frac{\delta\beta}{4} + \frac{\delta}{2} + \frac{\beta}{2}$

$\mu^* = \mu_1^* = \mu_2^* = \frac{\delta+\beta}{4c-\delta\beta}$, *if* $c > \frac{\delta\beta}{4} + \frac{\delta}{2} + \frac{\beta}{2}$

(ii) the profit of each newspaper is $\pi^* = -c{\mu^*}^2 + \frac{\delta}{2}\mu^* + \frac{1}{2}$

One can easily check that μ^* and π^* are increasing in δ and decreasing in c. μ^* is increasing in β but π^* is decreasing in β. It means that newspapers like customer loyalty but their quality decreases with loyalty.

From now on, we assume that the equilibrium quality in the absence of the aggregator is interior (i.e. $\mu^* \in (0, 1/2)$):

A3: $c > \frac{\delta\beta}{4} + \frac{\delta}{2} + \frac{\beta}{2}$.

If A3 does not hold, each newspaper i's best reply is $\mu_i = \frac{1}{2}$ for any $\mu_j \in [0, 1/2]$, which is completely uninteresting.

and hence the latter's marginal revenue from production. The intuition also shows that the result holds even if we allow newspapers to charge for subscriptions: for any given prices, quality choices are strategic substitutes.

4 Aggregator

In this section, the two newspapers compete in the presence of an aggregator.

4.1 Market shares for given qualities

Given (s_1, s_2), the utility that a consumer with location x obtains from using the aggregator is given by:

$$\begin{aligned} U^{Agg}(x) &= u_0 + \mu(s_1 - s_2)(\Delta u - xt) + \mu(s_2 - s_1)(\Delta u - (1-x)t) \\ &\quad + \mu(s_1 \cap s_2)\left(\Delta u - \frac{1}{2}xt - \frac{1}{2}(1-x)t\right) + (1 - \mu(s_1 \cup s_2))\left(-\frac{1}{2}xt - \frac{1}{2}(1-x)t\right) \end{aligned} \tag{4}$$

where $s_1 - s_2$ means $s_1 \cap s_2^c$. Given an issue, when both newspapers provide the same quality content on it, the aggregator displays one of them with equal probability and therefore the consumer's expected transportation cost is $\frac{1}{2}xt + \frac{1}{2}(1-x)t$.

Using $\mu(s_1 \cup s_2) = \mu(s_1) + \mu(s_2) - \mu(s_1 \cap s_2)$ and $\mu(s_i - s_j) = \mu(s_i) - \mu(s_1 \cap s_2)$, we can rewrite $U^{Agg}(x)$, $U^1(x)$ and $U^2(x)$ as follows:

$$\begin{aligned} U^{Agg}(x) &= u_0 - \frac{t}{2} + \mu(s_1 \cup s_2)\Delta u + t(x - \frac{1}{2})(\mu(s_2) - \mu(s_1)); \\ U^1(x) &= u_0 - \frac{t}{2} + \mu(s_1)\Delta u + t(\frac{1}{2} - x); \\ U^2(x) &= u_0 - \frac{t}{2} + \mu(s_2)\Delta u + t(x - \frac{1}{2}). \end{aligned}$$

Hence, it is clear that a consumer located at $x = 1/2$ loses nothing by choosing the aggregator; $U^{Agg}(1/2) \geq \max\{U^1(1/2), U^2(1/2)\}$. Consider now a consumer with location $x < \frac{1}{2}$. We have

$$U^{Agg}(x) - U^1(x) = (\mu(s_1 \cup s_2) - \mu(s_1))\triangle u - t(\frac{1}{2} - x)(1 + \mu(s_2) - \mu(s_1)) \tag{5}$$

The benefit of using the aggregator instead of newspaper 1 is in the term $(\mu(s_1 \cup s_2) - \mu(s_1))\triangle u$, which means the consumer consumes more high quality contents. This benefit comes with the cost of more ideological mismatch since, for a consumer with location $x < \frac{1}{2}$, the favorite newspaper is 1. More precisely, the last term in (5) has always a negative sign for $x < \frac{1}{2}$ and represents the cost of using the aggregator.

More generally, we have the following lemma which shows that newspapers are not directly in competition with each other.

Lemma 2. *Newspapers are not directly in competition with each other: For any given* (s_1, s_2), $\nexists x \in [0,1]$ *such that* $min\{U^1(x), U^2(x)\} > U^{Agg}(x)$.

Proof. To prove the lemma we consider two cases.

1) $x < \frac{1}{2}$, then $U^{Agg}(x) > U^2(x)$ since $\mu(s_2) - \mu(s_1) < \frac{1}{2}$.

2) $x > \frac{1}{2}$, then $U^{Agg}(x) > U^1(x)$ since $\mu(s_1) - \mu(s_2) < \frac{1}{2}$. ∎

Let x_i denote the location of the consumer who is indifferent between newspaper i $(i = 1, 2)$ and the aggregator. Then, for any $x < x_1$, we have $U^1(x) > U^{Agg}(x)$. This, together with Lemma 2, implies $U^1(x) > U^2(x)$ for any $x < x_1$. Therefore, 1's market share is given by x_1. For similar reason, 2's market share is given by $1 - x_2$. Furthermore, $U^{Agg}(1/2) \geq \max\left\{U^1(1/2), U^2(1/2)\right\}$ means that $x_1 \leq 1/2 \leq x_2$. Therefore, in general, we have $x_1 \in [0, 1/2]$ and $x_2 \in [1/2, 1]$ and the aggregator's market share is $x_2 - x_1$. The next lemma shows that each newspaper has a positive market share under A1.

Lemma 3. *Under A1, for any given (s_1, s_2) satisfying $\mu(s_i) \leq 1/2$ for $i = 1, 2$, the market shares of 1 and 2 are*

$$0 < \alpha_1 = \frac{1}{2} - \beta\frac{\mu(s_1) - \mu(s_1 \cap s_2)}{1 - \mu(s_1) + \mu(s_2)} \leq \frac{1}{2}; \tag{6}$$

$$0 < \alpha_2 = \frac{1}{2} - \beta\frac{\mu(s_1) - \mu(s_1 \cap s_2)}{1 + \mu(s_1) - \mu(s_2)} \leq \frac{1}{2}. \tag{7}$$

Proof. We prove it for newspaper 1. $U^1(x_1) = U^{Agg}(x_1)$ is equivalent to

$$x_1 = \frac{1}{2} - \beta\frac{\mu(s_1 \cup s_2) - \mu(s_1)}{1 - \mu(s_1) + \mu(s_2)}.$$

Using $\mu(s_1 \cup s_2) = \mu(s_1) + \mu(s_2) - \mu(s_1 \cap s_2)$, we get

$$x_1 = \frac{1}{2} - \beta\frac{\mu(s_2) - \mu(s_1 \cap s_2)}{1 - \mu(s_1) + \mu(s_2)}.$$

We now show $0 < x_1 \leq 1/2$, which is equivalent to

$$\frac{1}{2} > \beta\frac{\mu(s_2) - \mu(s_1 \cap s_2)}{1 - \mu(s_1) + \mu(s_2)} \geq 0.$$

The second inequality is obvious. The first comes from

$$\beta\frac{\mu(s_2) - \mu(s_1 \cap s_2)}{1 - \mu(s_1) + \mu(s_2)} < \frac{\mu(s_2)}{1 - \mu(s_1) + \mu(s_2)} \leq \frac{\mu(s_2)}{1/2 + \mu(s_2)} < \frac{1}{2}.$$

∎

One of the effects of the aggregator is to decrease the market share of the newspapers. In lemma 3, we have shown that for any given (s_1, s_2) satisfying $\mu(s_i) \leq 1/2$, the market share of a newspaper cannot be larger than $\frac{1}{2}$, whereas it is possible for a newspaper to have a marker share larger than a half (although not in equilibrium) when there is no aggregator. This result holds even when the quality of newspaper 1, say, is the maximum possible, i.e. $\frac{1}{2}$, and the quality of 2 is zero because the consumers located at $x \in (1/2, 1]$ prefer the aggregator to newspaper 1. By using the aggregator, they consume all the high quality contents from 1 whereas they can still consume low quality contents from newspaper 2 half of the time.

The market share of each newspaper decreases in β, which means that the more loyal consumers are, the more market shares the newspapers have. Keeping $(\mu(s_1), \mu(s_2))$ constant, increasing $s_1 \cap s_2$ reduces high quality contents available at the aggregator and thereby increases the market share of both newspapers. In the extreme case of $s_1 = s_2$, there is no room for the aggregator and each newspaper shares the whole market equally.

From Lemma 4, we can see the effect of the quality of $\mu(s_1)$ and $\mu(s_2)$ on the market share of 1:

- α_1 increases, if i $(= 1, 2)$ increases the quality, $\mu(s_i)$, by investing on the issues which are covered by $j (\neq i)$ too, i.e. by increasing $\mu(s_1 \cap s_2)$.
- α_1 decreases, if i $(= 1, 2)$ increases the quality, $\mu(s_i)$, by investing on the issues which are not covered by $j (\neq i)$, i.e. by increasing $\mu(s_i - s_j)$.

The key to understand the effect of quality change on the market share of 1 is to understand how it affects the market share of the aggregator given that the marginal consumer of 1 is indifferent between newspaper 1 and the aggregator. This is why we have some surprising results. For instance, if newspaper 1 increases its quality by investing on the issues not covered by 2, this reduces 1's market share by strengthening the aggregator. Similarly, if newspaper 2 increases its quality by investing on the issues covered by 1, this increases 1's market share by weakening the aggregator.

4.2 Business-stealing vs market-expansion for given qualities

Given (s_1, s_2), newspaper i's profit is given by:

$$\pi_i(s_i) = \alpha_i \left[1 + \mu(s_i)\delta\right] + \delta(1 - \alpha_i - \alpha_j) \left(\mu(s_i - s_j) + \frac{1}{2}\mu(s_i \cap s_j) \right) - c\mu(s_i)^2; \tag{8}$$

where $j \in \{1, 2\}$, $j \neq i$.

The following proposition states that there exists no equilibrium in which the common issues covered by 1 and 2, $s_1 \cap s_2$, is neither the maximum nor the minimum.

Proposition 2. *Given* $0 < \mu(s_1), \mu(s_2) \leq 1/2$*, for newspaper* $i \in \{1, 2\}$*, choosing* s_i *such that* $0 < \mu(s_1 \cap s_2) < \min(\mu(s_1), \mu(s_2))$ *is strictly dominated by choosing* s_i *such that* $\mu(s_1 \cap s_2) = 0$ *or* $\mu(s_1 \cap s_2) = \min(\mu(s_1), \mu(s_2))$*. In other words, each newspaper is always better off to choose max or min differentiation.*

The proof of Proposition 2 shows that newspaper i's profit is convex with respect to $\mu(s_1 \cap s_2)$. So the profit is maximized at the corners. From Lemma 4 and the discussion following the lemma, we know that the aggregator's market share is minimized under minimum differentiation and maximized under maximum differentiation. Hence, Proposition 2 implies that newspaper i finds it optimal either to "accommodate" the aggregator by maximum differentiation or to "fight" it by minimum differentiation.

Consider a given symmetric quality $\mu(s_1) = \mu(s_2) = \mu \in (0, 1/2) \leq 1/2$. Then, if newspaper i uses minimum differentiation strategy, the aggregator gets zero market share and hence each newspaper's profit is not affected by the presence of the aggregator. If i uses instead maximum differentiation strategy, each newspaper has the same market share ($\alpha_1 = \alpha_2 = \alpha = 1/2 - \beta\mu$) and obtains the same profit equal to is $\alpha[1 + \mu\delta] + \delta(1 - 2\alpha)\mu$. Therefore, the difference between a newspaper's profit under maximum differentiation and its profit under minimum differentiation (i.e. the profit without the aggregator) is given by:

$$-\beta\mu[1 + \mu\delta] + \delta 2\beta\mu\mu = \beta\mu(\delta\mu - 1). \tag{9}$$

The first term in the L.H.S. of the above equation shows **the business stealing effect** of the aggregator; the aggregator steals some loyal customers of each newspaper. The second term in the L.H.S. of the above equation shows **the market expansion effect** of the aggregator. Namely, the aggregator improves the match between attention and high quality contents and thereby allows each newspaper i's high quality contents to reach more customers which include some customers who are loyal to the rival newspaper j. From the previous discussion, we have:

Lemma 4. *Consider any symmetric equilibrium candidate* $0 < \mu(s_1) = \mu(s_2) = \mu \leq 1/2$*. Then, in the candidate, the newspapers use the maximum differentiation strategy (respectively, the minimum differentiation strategy) if* $\delta\mu > 1$ *(respectively, if* $\delta\mu < 1$*).*

Although we considered here symmetric quality, this trade-off between the business stealing effect and the market expansion effect is quite general. All other things being equal, as μ_j increases, the aggregator has a larger market share and hence the market expansion effect is more likely to dominate the business stealing effect. As δ increases, the profit from high quality contents is more important relative to the profit from low quality contents, which also makes the market expansion effect more likely to dominate the business stealing effect. More generally, Figure

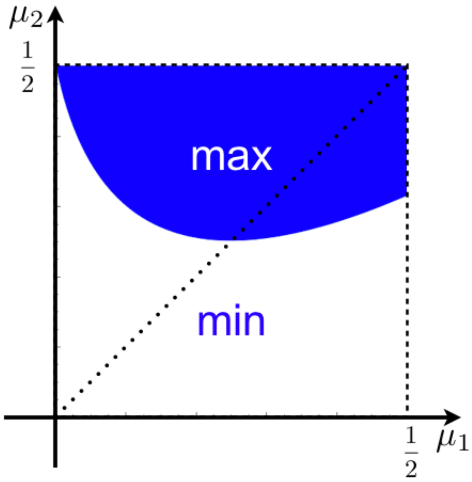


Figure 5: Best reply function given μ_1, and μ_2

5 describes, given $(\mu_1, \mu_2) \in (0, 1/2]^2$, when minimum differentiation (respectively, maximum differentiation) is optimal for newspaper 1.

Remark: The previous discussion shows that the presence of the aggregator can never decrease each newspaper's profit for given symmetric quality since each newspaper can kill the aggregator by using the minimum differentiation strategy and thereby obtain the profit in the absence of the aggregator. However, this is a consequence of the fact that we consider only two newspapers. On the contrary, if there are many newspapers and some of them use maximum differentiation, a single newspaper cannot reduce the market share of the aggregator to zero. Then, it is possible to for the business-stealing effect to dominate the market-expansion effect regardless of whether a given newspaper adopts the minimum differentiation or the maximum differentiation strategy. After completely characterizing the outcomes for two newspapers, we make an extension to the case in which the aggregator provides contents from a third-party different from the two newspapers (see Section 7).

As a consequence of Proposition 2, there are two equilibrium candidates, one with minimum differentiation and the other with maximum differentiation. We go through them in the two next subsections.

4.3 Minimum differentiation (no specialization) equilibrium

In this section, we study the existence of the equilibrium in which the newspapers choose the minimum differentiation, or equivalently $s_1 = s_2$. Let (μ_1^m, μ_2^m) denote the equilibrium qualities under the minimum differentiation strategy. We have:

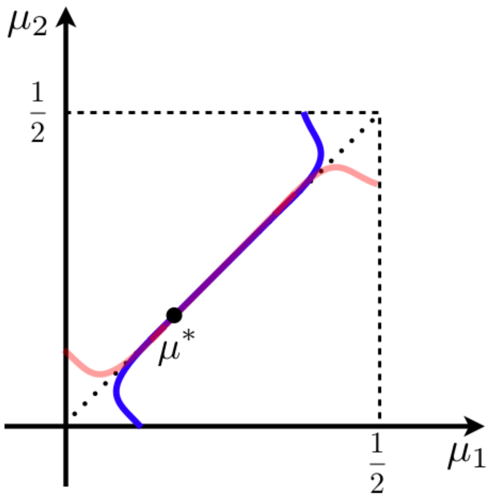


Figure 6: Best reply function given min differentiation

Proposition 3. *Under A1-A3, there are* $0 < \underline{\delta}^m \leq \bar{\delta}^m$*, such that* $\forall\delta > \bar{\delta}^m$ *there exists no symmetric equilibrium in which newspapers invest on the same set of issues: for* $\forall\delta \leq \underline{\delta}^m$ *there exist multiple symmetric equilibria in which newspapers invest on the same set of issues:*
1) $\mu_1^m = \mu_2^m = \mu^m \in \left[\frac{\delta}{4c-\delta\beta}, \frac{1}{2}\right]$*, if* $\frac{\delta}{2} + \frac{\delta\beta}{4} < c \leq \frac{\delta}{2} + \frac{\delta\beta}{4} + \beta$*;*
2) $\mu_1^m = \mu_2^m = \mu^m \in \left[\frac{\delta}{4c-\delta\beta}, \frac{\delta+2\beta}{4c-\delta\beta}\right]$*, if* $\frac{\delta}{2} + \frac{\delta\beta}{4} + \beta < c$*.*

The intuition behind this result is simple. If the revenue from high quality contents is high enough, each newspaper has an incentive to use maximum differentiation strategy since the market expansion effect dominates the business stealing effect. On the contrary, when the revenue from high quality contents is low enough, the business stealing effect dominates the market expansion effect and each newspaper uses minimum differentiation strategy. Since any equilibrium quality μ_1^m is a best response to μ_2^m, for the interval of equilibrium qualities described in Proposition 3, the best reply curve has a slope of 45 degree (see also Figure 6). Hence, quality choices are strategic complements for this interval. The reason is that given $\mu(s_2) = \mu_2^m$, newspaper 1 finds it optimal to "fight" against the aggregator by choosing $s_1 = s_2$, which leaves zero market share to the aggregator. More precisely, conditional on using the minimum differentiation strategy, newspaper 1's profit increases when μ_1 increases to μ_2^m and decreases when when μ_1 increases from μ_2^m. Figure 6 also shows that the equilibrium quality without the aggregator μ^* belongs to the interval of equilibrium quality under minimum differentiation strategy.

4.4 Maximum differentiation (specialization) equilibrium

In this section, we study the equilibrium candidate with maximum differentiation. The profit of newspaper $i \in \{1,2\}$ conditional on maximum differentiation is given by:

$$\pi_i(s_i \mid \max) = \frac{1}{2} + \frac{\delta}{2}\mu_i - \beta\frac{\mu_j}{1+\mu_j-\mu_i} + \delta\beta\frac{\mu_i^2}{1+\mu_i-\mu_j} - c\mu_i^2,$$

Let (μ_1^M, μ_2^M) denote the equilibrium qualities under the maximum differentiation strategy. Figure 7(a) shows the best reply conditional on that both newspapers use maximum differentiation strategy. It shows that the curve crosses the 45 degree line only once and has a positive slope after crossing it. More precisely, we have

$$\frac{\partial\pi_i}{\partial\mu_i\partial\mu_j} = -\beta\frac{1-\mu_i-\mu_j}{(1-\mu_i+\mu_j)^3} + 2\delta\beta\frac{\mu_i(1-\mu_j)}{(1+\mu_i-\mu_j)^3}$$

which is positive for $\delta\mu_i \geq 1/2$. Since from Lemma 4 $\delta\mu^M > 1$, we have that quality choices are strategic complements for quality above μ^M and quality below and close to μ^M. Therefore, we have:

Lemma 5. *In the presence of the aggregator, conditional on that newspaper i uses maximum differentiation strategy, an increase in μ_j induces an increase in μ_i: newspapers' quality choices (μ_1, μ_2) are strategic complements.*

When newspaper 1 uses maximum differentiation strategy, an increase in μ_2 expands the market share of the aggregator and hence increases the market expansion effect. This increased market expansion effect in turn increases the marginal revenue from increase in μ_1, which makes quality choices strategic complements. Figure 7(b) shows that this property holds true even when newspaper is not restricted to maximum differentiation strategy since it is optimal for i to use this strategy for μ_j larger than a threshold (see Figure 5).

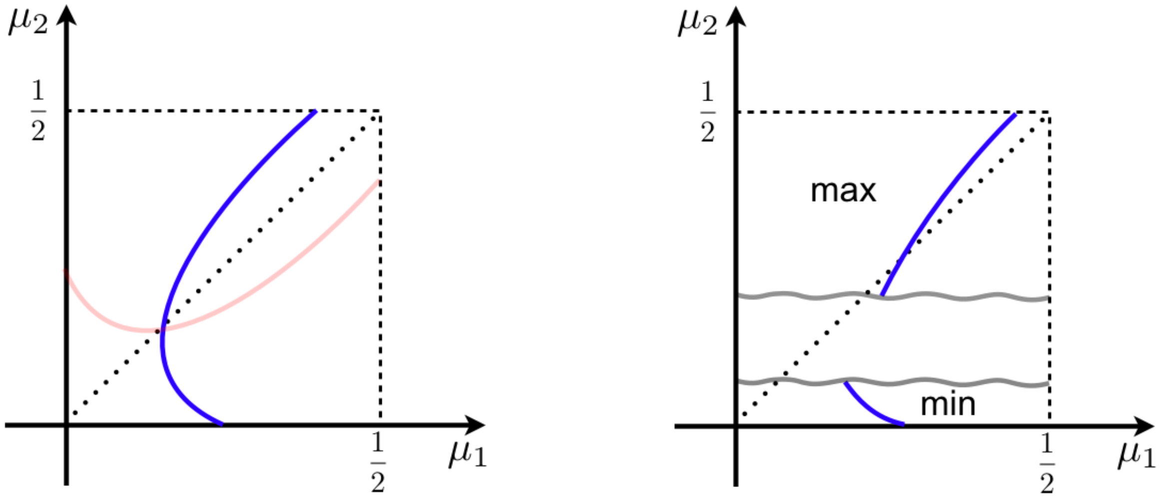
We have:

Proposition 4. *Under A1-A3, there exists a $\bar{\delta}^M > 0$ such that $\forall\delta \geq \bar{\delta}^M$ there is a unique symmetric equilibrium, $\mu_1^M = \mu_2^M = \mu^M$, in which newspapers invest in disjoint sets of issues; μ^M is*

1) $\frac{1}{2}$, *if* $c \leq \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta$

2) $\frac{(-\beta+2\delta\beta-2c)+\sqrt{(-\beta+2\delta\beta-2c)^2+2\delta^2\beta}}{2\delta\beta}$, *if* $c > \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta$

Moreover, there exist $\underline{\delta}^M > 0$ such that $\forall\delta < \underline{\delta}^M$ there exist no equilibrium with maximum differentiation.



(a) Given max differentiation

(b) Actual best reply functions given $\delta > \bar{\delta}^M$

Figure 7: Best reply functions

Note that from Lemma 4, a necessary condition to have an equilibrium with maximum differentiation is $\delta > 2$. One can check that μ^M is increasing in δ. As the revenue from high quality contents increases, the newspapers have more incentive to invest in the quality. Moreover, if the consumers are less loyal (i.e. as β increases), the competition becomes tougher, and so the newspapers invest more on the quality. Moreover, one can check that $\lim_{\beta\to 0}\mu^M = \frac{\delta}{4c} = \lim_{\beta\to 0}\mu^*$, where $\frac{\delta}{4c}$ is the monopoly quality. It means if the consumers are too much loyal, the presence of aggregator has no effect on the quality, which makes sense.

5 Opting out possibility

In this section, we analyze the following two-stage game.

- Stage 1: each newspaper i simultaneously decides whether to opt out or not and chooses s_i.
- Stage 2: each consumer chooses among the two newspapers and the aggregator.

Note that if newspaper i opts out, the aggregator has contents only from j and in this case we assume that consumers prefer using newspaper j to the aggregator. We first check how opting out possibility affects the equilibria under minimum differentiation. Consider a μ^m different from μ^*. Given $\mu(s_j) = \mu^m$, does the opting out possibility induce newspaper i to deviate from choosing $s_i = s_j$? The answer is yes for μ^m is different from μ^*. Note first that in the minimum differentiation equilibrium candidate, each newspaper gets the profit it obtains in the absence of the aggregator for given quality μ^m. Therefore, as long as μ^m is different from $BR_i^N(\mu^m)$, i.e. newspaper i's best response to $\mu(s_j) = \mu^m$ in the absence of the aggregator, newspaper i has an incentive to opt out. Since we have a unique equilibrium without the aggregator, $\mu^m = BR_i^N(\mu^m)$ holds if and only if $\mu^m = \mu^*$. This implies that only $\mu^m = \mu^*$ survives the opting out possibility.

In the case of the maximum differentiation equilibrium, things are different. Given $\mu(s_j) = \mu^M$, if i opts out, its best response is $BR_i^N(\mu^M)$. It is possible that this deviation profit is lower than the equilibrium profit.

Therefore, introducing opting out possibility leads to a sharp prediction: the presence of the aggregator either leads to no change or to the specialization equilibrium. Summarizing, we have:

Proposition 5. *When newspapers can opt out,*

(i) only the equilibrium quality without the aggregator ($\mu_1 = \mu_2 = \mu^*$) survives opting out possibility among all equilibria with minimum differentiation

(ii) the maximum differentiation equilibrium survives opting out possibility if the deviation to "opting out and choosing $\mu_i = BR_i^N(\mu^M)$" is not profitable.

6 Comparison: quality, consumer surplus and profit

In this section, we study how the aggregator affects quality, consumer surplus and profit. From Proposition 5, we compare the equilibrium without the aggregator with the specialization equilibrium.

How the news aggregators affect the quality of newspapers is at the heart of the debate between aggregators and newspapers. The newspapers believe that the aggregators steal their traffic without paying anything to them. They claim this leads to a reduction in the quality, as they do not have enough incentive to invest in the quality, and this would harm consumers. The aggregators come against this argument by emphasizing that they help consumers to find the high quality contents much more easily and thereby provide newspapers with incentives to invest on quality to attract more readers. In fact, these two arguments are the two effects that we captured before, business stealing and market expansion. By now, we have not said anything about which effect dominates the other. In the next proposition, we study this.

Proposition 6. *Under A1-A3, the quality of newspapers is higher in the maximum differentiation equilibrium than in the equilibrium without the aggregator, i.e. $\mu^M > \mu^*$.*

Note that the existence of the maximum differentiation equilibrium requires δ large enough (i.e. $\delta\mu^M > 1$). In the presence of the aggregator, for δ large enough, $\mu_1 = \mu_2 = \mu^*$ is not an equilibrium conditional on that at least one of them did not opt out. Then, the market expansion effect dominates the business stealing effect and hence each newspaper finds it optimal to respond by increasing quality and using maximum differentiation. Furthermore, quality choices are strategic complements. Therefore, they end up choosing $\mu_1 = \mu_2 = \mu^M > \mu^*$.

We now study how the aggregator affects the profit of newspapers and consumer surplus. The consumer surplus and the profit of newspapers when there is no aggregator are

$$CS^* = \int_0^{\frac{1}{2}} (\mu\triangle u + u_0 - xt)\,dx + \int_{\frac{1}{2}}^{1} (\mu\triangle u + u_0 - (1-x)t)\,dx = \mu\triangle u + u_0 - \frac{t}{4}; \tag{10}$$

$$\pi^* = -c\mu^2 + \frac{\delta}{2}\mu + \frac{1}{2}, \tag{11}$$

where $\mu(s_1) = \mu(s_2) = \mu$.

Since the aggregator induces each newspaper to choose a higher quality, this increases every consumer's surplus. Even if a consumer continues to use her preferred newspaper, she benefits from quality increase. In addition, she has the option of using the aggregator.

The profit of newspapers in the specialization equilibrium is $\pi^M = \delta x\mu^M + \alpha + \delta(1-2\alpha)\mu^M - c{\mu^M}^2$, where α is the share of each newspaper and it is equal to $\frac{1}{2} - \beta\mu^M$ due to (6), and (7). Thus, the profit is

$$\pi^M = {\mu^M}^2(\delta\beta - c) + \mu^M(-\beta + \frac{\delta}{2}) + \frac{1}{2}. \tag{12}$$

The profit increases if and only if

$${\mu^M}^2(\delta\beta - c) + \mu^M(-\beta + \frac{\delta}{2}) + \frac{1}{2} \geq \frac{1}{2} + \frac{\delta}{2}\mu^* - c{\mu^*}^2$$

, or equivalently

$${\mu^M}^2(\delta\beta - c) + \mu^M\left(\frac{\delta}{2} - \beta\right) - \frac{\delta}{2}\mu^* + c{\mu^*}^2 \geq 0. \tag{13}$$

We have:

Proposition 7. *If the presence of the aggregator leads to the specialization equilibrium*

i) Every consumer gets a higher surplus

ii)The profits of newspapers increases if the cost is low, and decreases otherwise. More precisely, $\exists \hat{c} \in \left[\frac{\delta}{2} + \frac{\beta}{2} + \frac{\delta\beta}{2}, \frac{\delta}{2} - \frac{\beta}{2} + \frac{3\delta\beta}{4}\right]$ *such that* $\forall c > \hat{c} \mid \pi^M < \pi^*$ *and* $\forall c < \hat{c} \mid \pi^M > \pi^*$.

The profits of newspapers can be lower in the specialization equilibrium than in the equilibrium without the aggregator. This is because the profit from deviating to "opting out and choosing $\mu_i = BR_i^N(\mu^M)$" is lower than π^*. To see this, note that in the absence of the aggregator, an increase in μ_j reduces the marginal profit of i and that $\mu^M > \mu^*$. More generally, Proposition 7 shows that whether profits increase or decrease depend on the level of cost c. As we noted in Section 4.2, for given quality, the aggregator cannot decrease each newspaper's profit. Furthermore, from (9), the profit in the maximum differentiation equilibrium (gross of the investment cost) strictly increases with μ^M. This implies that the aggregator increases each newspaper's profit if the investment cost does not increase much (i.e. if c is low enough).

Actually, the relevant cost is c/ϖ where ϖ is advertising revenue per unit of attention, which was normalized at one. If Internet expands massively advertising possibilities and thereby reduces ϖ, this increases c/ϖ, suggesting that the presence of the aggregator would decrease profits of newspapers. This may explain the current debate.

7 Contents from third-party providers (to be done)

As we remarked in section 4.2, our model of two newspapers provides a best scenario in terms of the newsppers' ability to minimize the impact of the aggregator. More precisely, by using the minimum differentiation strategy or the opting-out strategy, a newspaper can reduce the aggregator's market share to zero and obtain the profit it would obtain in the absence of the aggregator for any given quality. However, in reality, there are many news sites and some of them are very small such that they would receive very negligible visits in the absence of the aggregator. Therefore, small sites have strong incentives to use "the maximum differentiation and opt-in strategy" in order to attract traffics from the aggregator. Furthermore, many major sites can also suffer from coordination failures; if some of them use "the maximum differentiation and opt-in strategy", then a single newspaper can have only a negligible impact on the market share of the aggregator and is likely to find that its best response consists of "the maximum differentiation and opt-in strategy".

In order to capture this more realistic scenario in our model, we introduce one important modification into our model: even if the two newspapers opt out, a consumer can get a utility equal to u_T from using the aggregator where the subscript T means third-party content providers. [10] We have the following conjecture:

- Conjecture 1: For given $\delta > 0$ (and hence given $\Delta u(\delta) > 0$), each newspaper finds it optimal to use "the maximum differentiation strategy and opt-in strategy" for u_T large enough

[10] Although u_T can depend on a consumer's ideological taste, we abtract from this dimension for simplicity.

- Conjecture 2: When both newspaper find it optimal to use "the maximum differentiation strategy and opt-in strategy", the best response quality of newspaper i initially decreases and then increases with the quality j.
- Conjecture 3: When both newspapers find it optimal to use "the maximum differentiation strategy and opt-in strategy", the aggregator increases the quality of each newspaper for $\delta > \widehat{\delta}$ decreases otherwise.

8 Conclusion

To be written.

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Appendix A

8.1 Proof Proposition 1

Proof. There are four equilibrium candidates.

i) $(\frac{1}{2}, \frac{1}{2})$: This is an equilibrium if and only if $\frac{1}{2} \leq 1 - \frac{2c-\delta-\beta}{\delta\beta}$, or equivalently $c \leq \frac{\delta\beta}{4} + \frac{\delta}{2} + \frac{\beta}{2}$.

ii & iii) $\left(\frac{1}{2}, \frac{\delta+\beta-\frac{\delta\beta}{2}}{4c-2\delta\beta}\right)$ and $\left(\frac{\delta+\beta-\frac{\delta\beta}{2}}{4c-2\delta\beta}, \frac{1}{2}\right)$: To have one of them as an equilibrium we should have $\frac{\delta+\beta-\frac{\delta\beta}{2}}{4c-2\delta\beta} \leq 1 - \frac{2c-\delta-\beta}{\delta\beta}$, and $1 - \frac{2c-\delta-\beta}{\delta\beta} < \frac{1}{2}$. By rearranging the inequalities, one get $-8\left(c - \frac{\delta}{2} - \frac{\beta}{2} - \frac{\delta\beta}{4}\right)\left(c - \frac{3}{4}\delta\beta\right) \geq 0$, and $c > \frac{\delta}{2} + \frac{\beta}{2} + \frac{\delta\beta}{4}$ which are totally inconsistent.

iv) $\left(\frac{\delta+\beta}{4c-\delta\beta}, \frac{\delta+\beta}{4c-\delta\beta}\right)$: This is an equilibrium if and only if $\frac{1}{2} > \frac{\delta+\beta}{4c-\delta\beta} > 1 - \frac{2c-\delta-\beta}{\delta\beta}$, or equivalently $c > \frac{\delta\beta}{4} + \frac{\delta}{2} + \frac{\beta}{2}$.

∎

8.2 Proof Proposition 2

Proof. We prove the proposition for $i = 1$; for $i = 2$ is the same. To prove the result, we decompose the profit of the newspaper 1, (8), using (6), (7), $\mu(s_1 \cup s_2) = \mu(s_1) + \mu(s_2) - \mu(s_1 \cap s_2)$, $\mu(s_1 - s_2) = \mu(s_1) - \mu(s_1 \cap s_2)$ and $\mu(s_2 - s_1) = \mu(s_2) - \mu(s_1 \cap s_2)$. So we get

$$\begin{aligned}\pi_1(s_1) &= \delta\alpha_1\mu(s_1) + \alpha_1 + \delta(1-\alpha_1-\alpha_2)\left(\mu(s_1) - \frac{1}{2}\mu(s_1 \cap s_2)\right) - c\mu(s_1)^2 \\ &= h(\mu(s_1), \mu(s_2)) + \frac{\delta\beta\mu(s_1 \cap s_2)}{1 - (\mu(s_1) - \mu(s_2))^2}\left[\mu(s_1 \cap s_2) - g(\mu(s_1), \mu(s_2))\right] \qquad (14)\end{aligned}$$

, where

$$h(\mu(s_1), \mu(s_2)) = \frac{1}{2} + \frac{\delta}{2}\mu(s_1) - \beta\frac{\mu(s_2)}{1 + \mu(s_2) - \mu(s_1)} + \delta\beta\frac{\mu(s_1)^2}{1 + \mu(s_1) - \mu(s_2)} - c\mu(s_1)^2 \qquad (15)$$

$$g(\mu(s_1), \mu(s_2)) = -\frac{3}{2}\mu(s_1)^2 + \mu(s_1)\left(2\mu(s_2) - \frac{1}{\delta} + \frac{3}{2}\right) + (1 - \mu(s_2))\left(\frac{1}{2}\mu(s_2) - \frac{1}{\delta}\right) \qquad (16)$$

There are two cases:

1)$\min(\mu(s_1), \mu(s_2)) < g(\mu(s_1), \mu(s_2))$: In this case, $\mu(s_1 \cap s_2) < g(\mu(s_1), \mu(s_2))$. Therefore, the second term of (14) is negative, if 1 chooses $0 < \mu(s_1 \cap s_2)$. So any s_1 and s_2 such that

$0 < \mu(s_1 \cap s_2)$ is strictly dominated by $\mu(s_1 \cap s_2) = 0$. It worths to mention that it is always possible for 1 to choose s_1 such that $\mu(s_1 \cap s_2) = 0$, thanks to A1.

2)$\min(\mu(s_1), \mu(s_2)) \geq g(\mu(s_1), \mu(s_2))$: 1 is always better off to choose $\mu(s_1 \cap s_2) = \min(\mu(s_1), \mu(s_2))$ rather than $\mu(s_1 \cap s_2) < \min(\mu(s_1), \mu(s_2))$.

In other words, the profit function of 1, (14), is convex with respect to $\mu(s_1 \cap s_2)$. So the maximum is achieved at the corners. ∎

8.3 Proof Proposition 3

Proof. We can rewrite (8) as

$$\pi_1(s_1 \mid \min) = \begin{cases} \frac{\delta}{2}\mu_1 + \frac{1}{2} + \delta\beta\frac{(\mu_1-\mu_2)\left(\mu_1-\frac{1}{2}\mu_2\right)}{1+\mu_1-\mu_2} - c\mu_1^2 & \mu_1 > \mu_2 \\ \frac{\delta}{2}\mu_1 + \frac{1}{2} - \frac{\delta\beta}{2}\frac{(\mu_2-\mu_1)\mu_1}{1+\mu_2-\mu_1} - \beta\frac{(\mu_2-\mu_1)}{1+\mu_2-\mu_1} - c\mu_1^2 & \mu_1 \leq \mu_2 \end{cases}$$

, where $\pi_1(s_1 \mid \min)$ is the profit of 1 given $\mu(s_1 \cap s_2) = \min(\mu(s_1), \mu(s_2))$, which is in fact the maximum intersection. And its first, second and third derivatives are

$$\pi_1'(s_1 \mid \min) = \begin{cases} \frac{\delta}{2} + \delta\beta\frac{(\mu_1-\mu_2)}{1+\mu_1-\mu_2} + \delta\beta\frac{\left(\mu_1-\frac{1}{2}\mu_2\right)}{(1+\mu_1-\mu_2)^2} - 2c\mu_1 & \mu_1 > \mu_2 \\ \frac{\delta}{2} - \frac{\delta\beta}{2}\frac{(\mu_2-\mu_1)}{1+\mu_2-\mu_1} + \frac{\delta\beta}{2}\frac{\mu_1}{(1+\mu_2-\mu_1)^2} + \frac{\beta}{(1+\mu_2-\mu_1)^2} - 2c\mu_1 & \mu_1 < \mu_2 \end{cases}$$

$$\pi_1''(s_1 \mid \min) = \begin{cases} \frac{\delta\beta}{(1+\mu_1-\mu_2)^2} + \delta\beta\frac{(1-\mu_1)}{(1+\mu_1-\mu_2)^3} - 2c & \mu_1 > \mu_2 \\ \frac{\delta\beta}{2(1+\mu_2-\mu_1)^2} + \frac{\delta\beta}{2}\frac{1+\mu_1+\mu_2}{(1+\mu_2-\mu_1)^3} + \frac{2\beta}{(1+\mu_2-\mu_1)^3} - 2c & \mu_1 < \mu_2 \end{cases}$$

$$\pi_1'''(s_1 \mid \min) = \begin{cases} -\delta\beta\left(\frac{2}{(1+\mu_1-\mu_2)^3} + \frac{4-2\mu_1-\mu_2)}{(1+\mu_1-\mu_2)^4}\right) & \mu_1 > \mu_2 \\ \frac{\delta\beta}{(1+\mu_2-\mu_1)^3} + \delta\beta\frac{2+\mu_1+2\mu_2}{(1+\mu_2-\mu_1)^4} + \frac{6\beta}{(1+\mu_2-\mu_1)^4} & \mu_1 < \mu_2 \end{cases}$$

We consider two cases:

1)$\frac{\delta}{2} + \frac{\beta}{2} + \frac{\delta\beta}{4} < c \leq \frac{\delta}{2} + \frac{\delta\beta}{4} + \beta$: Any equilibrium candidate,(μ_1, μ_2), can be seen in two sub-cases:

i)$\mu_1, \mu_2 < \frac{\delta}{4c-\delta\beta}$: In this case, always there is a deviation, and so there is not any equilibrium in this form. To show that, suppose $\mu_2 \leq \mu_1 < \frac{\delta}{4c-\delta\beta}$. We will show there is a deviation for 1.

$$
\begin{aligned}
\pi_1'\left(s_1 \mid \min\right)^+ &= \frac{\delta}{2} + \delta\beta\frac{(\mu_1-\mu_2)}{1+\mu_1-\mu_2} + \delta\beta\frac{(\mu_1-\frac{1}{2}\mu_2)}{(1+\mu_1-\mu_2)^2} - 2c\mu_1 \\
&> \frac{\delta}{2} + \delta\beta\frac{(\mu_1-\mu_2)}{1+\mu_1-\mu_2} + \delta\beta\frac{(\mu_1-\frac{1}{2}\mu_2)}{(1+\mu_1-\mu_2)^2} - \frac{\delta}{2} - \frac{\delta\beta}{2}\mu_1 \\
&= \frac{\delta\beta}{(1+\mu_1-\mu_2)^2}\left((\mu_1-\mu_2)(1+\mu_1-\mu_2) + (\mu_1-\frac{1}{2}\mu_2) - \frac{\mu_1}{2}(1+\mu_1-\mu_2)^2\right) \\
&= \frac{\delta\beta(\mu_1-\mu_2)}{(1+\mu_1-\mu_2)^2}\left(\frac{3}{2}-\mu_1+(\mu_1-\mu_2)\left(1-\frac{\mu_1}{2}\right)\right) \geq 0
\end{aligned}
$$

[11]

Thus, 1 benefits from investing more on quality.

ii)$\exists j \in \{1,2\} \mid \mu_j \geq \frac{\delta}{4c-\delta\beta}$: We will show if $\mu_j \geq \frac{\delta}{4c-\delta\beta}$ the best response of the other newspaper, i, should be equal to the average quality of j, $\mu_j = \mu_i$. First, we show any $\mu_i > \mu_j$ is strictly dominated by $\mu_i = \mu_j$.

$$
\begin{aligned}
\pi_i\left(s_i \mid \min, \mu_i \geq \mu_j\right) &= \frac{\delta}{2}\mu_i + \frac{1}{2} + \delta\beta\frac{(\mu_i-\mu_j)\left(\mu_i-\frac{1}{2}\mu_j\right)}{1+\mu_i-\mu_j} - c\mu_i^2 \\
&= \frac{1}{2} + \frac{\delta}{2}\mu_j - c\mu_j^2 + (\mu_i-\mu_j)k(\mu_i,\mu_j)
\end{aligned}
$$

, where

[11] The first inequality is obtained from the fact that $\mu_1 < \frac{\delta}{4c-\delta\beta}$, and so $2c\mu_1 < \frac{\delta}{2} + \frac{\delta\beta}{2}\mu_1$

$$\begin{aligned}
k(\mu_i,\mu_j) &= \frac{\delta}{2}+\delta\beta\frac{(\mu_i-\frac{1}{2}\mu_j)}{1+\mu_i-\mu_j}-c(\mu_i+\mu_j)\\
&= \frac{\delta}{2}+\delta\beta\frac{(\mu_i-\frac{1}{2}\mu_j)}{1+\mu_i-\mu_j}-c(\mu_i-\mu_j)-2c\mu_j\\
&\leq \frac{\delta}{2}+\delta\beta\frac{(\mu_i-\frac{1}{2}\mu_j)}{1+\mu_i-\mu_j}-c(\mu_i-\mu_j)-\frac{\delta}{2}-\frac{\delta\beta}{2}\mu_j\\
&= (\mu_i-\mu_j)\left(\delta\beta\frac{(1-\frac{1}{2}\mu_j)}{1+\mu_i-\mu_j}-c\right)\\
&\leq (\mu_i-\mu_j)\left(\delta\beta(1-\frac{1}{2}\mu_j)-c\right)\\
&\leq (\mu_i-\mu_j)\left(\delta\beta(1-\frac{1}{2}\frac{\delta}{4c-\delta\beta})-c\right)\\
&\leq \frac{(\mu_i-\mu_j)}{4c-\delta\beta}\left(-4c^2+5\delta\beta c-\delta\beta\left(\delta\beta+\frac{\delta}{2}\right)\right)\\
&\leq \frac{(\mu_i-\mu_j)}{4c-\delta\beta}\left(-4c^2+5\delta\beta c-\delta\beta\left(\delta\beta+\frac{\delta\beta}{2}\right)\right)\\
&= \frac{(\mu_i-\mu_j)}{4c-\delta\beta}(-4)\left(c-\frac{3}{4}\delta\beta\right)\left(c-\frac{\delta\beta}{2}\right)<0
\end{aligned}$$

Therefore, this part of the proof completes since $\pi_i\left(s_i \mid \min,\mu_i>\mu_j\right)<\pi_i\left(s_i \mid \min,\mu_i=\mu_j\right)$. Now, we will proof that any $\mu_i<\mu_j$ is also strictly dominated by $\mu_i=\mu_j$.

$$\begin{aligned}
\pi_i\left(s_i \mid \min,\mu_i\leq\mu_j\right) &= \frac{\delta}{2}\mu_i+\frac{1}{2}-\frac{\delta\beta}{2}\frac{(\mu_j-\mu_i)\mu_i}{1+\mu_j-\mu_i}-\beta\frac{(\mu_j-\mu_i)}{1+\mu_j-\mu_i}-c\mu_i^2\\
&= \frac{1}{2}+\frac{\delta}{2}\mu_j-c\mu_j^2+(\mu_i-\mu_j)z(\mu_i,\mu_j)
\end{aligned}$$

, where

$$
\begin{aligned}
z(\mu_i,\mu_j) &= \frac{\delta}{2}+\frac{\delta\beta}{2}\frac{\mu_i}{1+\mu_j-\mu_i}+\frac{\beta}{1+\mu_j-\mu_i}-c(\mu_i+\mu_j) \\
&\geq \frac{\delta}{2}+\frac{\delta\beta}{2}\frac{\mu_i}{1+\mu_j-\mu_i}+\frac{\beta}{1+\mu_j-\mu_i}-\left(\frac{\delta}{2}+\frac{\delta\beta}{4}+\beta\right)(\mu_i+\mu_j) \\
&= \frac{\delta}{2}(1-\mu_i-\mu_j)+\frac{\delta\beta}{2}\frac{\mu_i}{1+\mu_j-\mu_i}-\frac{\delta\beta}{4}(\mu_i+\mu_j)+\frac{\beta}{1+\mu_j-\mu_i}\left(\mu_i^2-\mu_i+1-\mu_j-\mu_j^2\right) \\
&\geq \frac{\delta\beta}{2}(1-\mu_i-\mu_j)+\frac{\delta\beta}{2}\frac{\mu_i}{1+\mu_j-\mu_i}-\frac{\delta\beta}{4}(\mu_i+\mu_j)+\frac{\beta}{1+\mu_j-\mu_i}\left(1-2\mu_j\right) \\
&\geq \frac{\delta\beta}{4}\frac{1}{1+\mu_j-\mu_i}\left(3\mu_i^2-3\mu_i+2-\mu_j-3\mu_j^2\right) \\
&\geq \frac{\delta\beta}{4}\frac{1}{1+\mu_j-\mu_i}\left(2-4\mu_j\right)>0
\end{aligned}
$$

As a result, $\pi_i\left(s_i \mid \min,\mu_i<\mu_j\right)<\pi_i\left(s_i \mid \min,\mu_i=\mu_j\right)$. Therefore, the proof completes. The equilibrium candidates in this case are (μ_1,μ_2) such that $\mu_1=\mu_2\in\left[\frac{\delta}{4c-\delta\beta},\frac{1}{2}\right]$.

2)$\frac{\delta}{2}+\frac{\delta\beta}{4}+\beta<c$: We consider four cases:

i)$\mu_1,\mu_2<\frac{\delta}{4c-\delta\beta}$: There can't be an equilibrium satisfying this condition. For proof, see part (i) of 2nd case.

ii)$\mu_1,\mu_2>\frac{\delta+2\beta}{4c-\delta\beta}$: We will show there is always a deviation. Suppose $\mu_1\leq\mu_2$.

$$
\begin{aligned}
\pi_1'\left(s_1 \mid \min\right)^- &= \frac{\delta}{2}-\frac{\delta\beta}{2}\frac{(\mu_2-\mu_1)}{1+\mu_2-\mu_1}+\frac{\delta\beta}{2}\frac{\mu_1}{(1+\mu_2-\mu_1)^2}+\frac{\beta}{(1+\mu_2-\mu_1)^2}-2c\mu_1 \\
&< \frac{\delta}{2}-\frac{\delta\beta}{2}\frac{(\mu_2-\mu_1)}{1+\mu_2-\mu_1}+\frac{\delta\beta}{2}\frac{\mu_1}{(1+\mu_2-\mu_1)^2}+\frac{\beta}{(1+\mu_2-\mu_1)^2}-\frac{\delta}{2}-\frac{\delta\beta}{2}\mu_1-\beta \\
&= -\frac{\delta\beta}{2}\frac{(\mu_2-\mu_1)}{1+\mu_2-\mu_1}+\left(\frac{\delta\beta}{2}+\beta\right)\left(\frac{1}{(1+\mu_2-\mu_1)^2}-1\right)<0
\end{aligned}
$$

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Therefore, 1 benefits from reducing its investment on quality. As a consequence, there is no equilibrium in this form.

iii)$\exists j\in\{1,2\}\mid\frac{\delta}{4c-\delta\beta}\leq\mu_j\leq\frac{\delta+2\beta}{4c-\delta\beta}$: We show that any $\mu_i\neq\mu_j$ is strictly dominated by $\mu_i=\mu_j$. We know from part (ii) of 2nd case that any $\mu_i>\mu_j$ is strictly dominated. If we compute the right and left derivative of π_i at $\mu_i=\mu_j$ we get

[12] The first inequality is obtained from the fact that $\mu_1>\frac{\delta+2\beta}{4c-\delta\beta}$, and so $2c\mu_1>\frac{\delta}{2}+\frac{\delta\beta}{2}\mu_1+\beta$

$$\pi_i'\left(s_j \mid \min, \mu_i = \mu_j\right)^+ = \frac{\delta}{2} + \frac{\delta\beta}{2}\mu_j - 2c\mu_j$$

$$\pi_i'\left(s_j \mid \min, \mu_i = \mu_j\right)^- = \frac{\delta}{2} + \frac{\delta\beta}{2}\mu_j - 2c\mu_j + \beta$$

Therefore, $\pi_i'\left(s_j \mid \min, \mu_i = \mu_j\right)^+ \leq 0 \leq \pi_i'\left(s_j \mid \min, \mu_i = \mu_j\right)^-$. If we do the same computation for the second derivative of π_i we get

$$\pi_i''\left(s_j \mid \min, \mu_i = \mu_j\right)^- = \frac{\delta\beta}{2}(2 + \mu_i + \mu_j) + 2\beta - 2c$$

$\pi_i''\left(s_j \mid \min, \mu_i = \mu_j\right) < 0$ thanks to $c > \frac{\delta}{2} + \frac{\delta\beta}{4} + \beta$. And $\pi_i''\left(s_j \mid \min, \mu_i \leq \mu_j\right) < 0$ since $\pi_i'''\left(s_j \mid \min\right)^- > 0$. Therefore, we have $\pi_i'\left(s_j \mid \min, \mu_i \leq \mu_j\right) > 0$, which means any $\mu_i < \mu_j$ is strictly dominated. As a result, the equilibrium candidates in this case are (μ_1, μ_2) that $\mu_1 = \mu_2 \in \left[\frac{\delta}{4c-\delta\beta}, \frac{\delta+2\beta}{4c-\delta\beta}\right]$.

So far, we pin down all symmetric equilibrium candidates - which means there is no deviation given $\mu(s_1 \cap s_2) = \min\left(\mu(s_1), \mu(s_2)\right)$. However, we should check for any deviations which decreases $\mu(s_1 \cap s_2)$. When $s_1 = s_2$ with $\mu_1 = \mu_2 = \mu \in \left[\frac{\delta}{4c-\delta\beta}, \frac{\delta+2\beta}{4c-\delta\beta}\right]$, the most profitable deviation for newspaper $i \in \{1, 2\}$ consists in going from minimum differentiation, $s_i = s_j$, to maximum differentiation, $s_i \cap s_j = \emptyset$ according to proposition 2. To rule out this type of deviation we should have

$$\forall \mu_i \in [0, \frac{1}{2}] \qquad \frac{\delta}{2}\mu + \frac{1}{2} - c\mu^2 \geq \delta x_i \mu_i + x_i + \delta(1 - x_i - x_j)\mu_i - c\mu_i^2 \tag{17}$$

, where the left hand side is the profit of i when $s_i = s_j$ and $\mu(s_i) = \mu$, while the right hand side is the profit of i where $s_i \cap s_j = \emptyset$, $\mu(s_i) = \mu_i$, and $\mu(s_j) = \mu$. By rearranging (17), we get:

$$\begin{aligned} d(\mu_i, \mu, , \delta, \beta, c) &= c\mu_i^4 - \left(\frac{\delta}{2} + \delta\beta + 2c\mu\right)\mu_i^3 + \left(\frac{3\delta}{2}\mu + \delta\beta(1+\mu) - c\right)\mu_i^2 \\ &\quad + \left(\frac{\delta}{2} - \frac{3\delta}{2}\mu^2 - \beta\mu + 2c\mu^3\right)\mu_i - \frac{\delta}{2}\mu + \frac{\delta}{2}\mu^3 - \beta\mu + \beta\mu^2 + c\mu^2 - c\mu^4 \\ &\leq 0 \end{aligned}$$

First, we compute the $\lim\limits_{\delta \to 0} d(\mu_i, \mu, , \delta, \beta, c)$.

$\lim\limits_{\delta \to 0} d(\mu_i, \mu, , \delta, \beta, c) = c\mu_i^4 - (2c\mu)\mu_i^3 + (-c)\mu_i^2 + \left(-\beta\mu + 2c\mu^3\right)\mu_i - \beta\mu + \beta\mu^2 + c\mu^2 - c\mu^4$ As $\delta \to 0$, two cases can happen depending on the value of c[13]:

[13] We assume that $, \beta > 0$, otherwise the result of the game is trivial.

i)$c \leq \beta$: Any $\mu \in \left[0, \frac{1}{2}\right]$ can be an equilibrium.

$$\begin{aligned}
\lim_{\delta \to 0} d(\mu_i, \mu, , \delta, \beta, c) &= c\mu_i^4 - (2c\mu)\,\mu_i^3 + (-c)\,\mu_i^2 + \left(-\beta\mu + 2c\mu^3\right)\mu_i - \beta\mu + \beta\mu^2 + c\mu^2 - c\mu^4 \\
&\leq c\mu_i^2(\mu_i^2 - 1) - (2c\mu)\,\mu_i^3 + \left(-\beta\mu + 2\beta\mu^3\right)\mu_i - \beta\mu(1 - 2\mu + \mu^3) < 0
\end{aligned}$$

ii)$\beta < c$: In this case, any $\mu \in \left[0, \frac{\beta}{2c}\right]$ could be an equilibrium.

$$\begin{aligned}
\lim_{\delta \to 0} d(\mu_i, \mu, , \delta, \beta, c) &= c\mu_i^2(\mu_i^2 - 1) - (2c\mu)\,\mu_i^3 + \left(-\beta\mu + 2c\mu^3\right)\mu_i - \beta\mu + \beta\mu^2 + c\mu^2 - c\mu^4 \\
&\leq c\mu_i^2(\mu_i^2 - 1) - (2c\mu)\,\mu_i^3 + \left(-\beta\mu + \beta\mu^2\right)\mu_i - \beta\mu(1 - \mu - \frac{1}{2} + \frac{\mu^2}{2}) < 0
\end{aligned}$$

Thus, we have shown that $\lim_{\delta \to 0} d(\mu_i, \mu, , \delta, \beta, c) < 0$. This implies that there exist a $\underline{\delta}^m > 0$ such that $\forall \mu_i \in \left[0, \frac{1}{2}\right], \forall \delta \leq \underline{\delta}^m \mid d(\mu_i, \mu, , \delta, \beta, c) < 0$ due to continuity of d; which means $\mu_1 = \mu_2 = \mu$ is an equilibrium.

We can also find a large enough δ in which no symmetric equilibrium with minimum differentiation can be sustained any more. To have an equilibrium, we should have $\forall \mu_i \in \left[0, \frac{1}{2}\right] \mid d(\mu_i, \mu, , \delta, \beta, c) < 0$. Therefore, if $d(\mu_i = \mu, \mu, , \delta, \beta, c) > 0$ holds, no equilibrium can be sustained.

$$\begin{aligned}
d(\mu_i = \mu, \mu, , \delta, \beta, c) &= \delta\beta\mu^2 - \beta\mu > 0 \\
&\Leftrightarrow \delta\mu > 1
\end{aligned}$$

For any $c, 0 <, 0 < \beta < 1$ we can find $\hat{\delta}$ such that $c < \frac{\delta}{2} + \frac{\delta\beta}{4}$; which means $\mu = \frac{1}{2}$. Therefore, $\forall \delta > \bar{\delta}^m = \max(2, \hat{\delta}) \mid d(\mu_i = \mu, \mu, , \delta, \beta, c) > 0$, which means μ can't be sustained as an equilibrium.

∎

8.4 Proof Proposition 4

Proof. In this case, we can rewrite the profit of $i \in 1, 2$ as

$$\pi_i(s_i \mid \max) = \frac{1}{2} + \frac{\delta}{2}\mu_i - \beta\frac{\mu_j}{1 + \mu_j - \mu_i} + \delta\beta\frac{\mu_i^2}{1 + \mu_i - \mu_j} - c\mu_i^2$$

The derivatives are

$$\pi_i'(s_i \mid \max) = \frac{\delta}{2} - \beta\frac{\mu_j}{(1 + \mu_j - \mu_i)^2} + 2\delta\beta\frac{\mu_i}{1 + \mu_i - \mu_j} - \delta\beta\frac{\mu_i^2}{(1 + \mu_i - \mu_j)^2} - 2c\mu_i \tag{18}$$

$$\pi_i''(s_i \mid \max) = -2\beta \frac{\mu_j}{(1+\mu_j-\mu_i)^3} + \frac{2\delta\beta(1-\mu_j^2)}{(1+\mu_i-\mu_j)^3} - 2c$$

$$\pi_i'''(s_i \mid \max) = -6\beta \frac{\mu_j}{(1+\mu_j-\mu_i)^4} - \frac{6\delta\beta(1-\mu_j^2)}{(1+\mu_i-\mu_j)^4}$$

At the end of this proof we will show that $\delta > 2$ which is a necessary condition to have a maximum differentiation equilibrium. For now, we use this condition.

$$\begin{aligned}\pi_i'(s_i \mid \max, \mu_i = 0) &= \frac{\delta}{2} - \beta\frac{\mu_j}{(1+\mu_j)^2} \\ &\geq \frac{\delta}{2} - \beta\frac{2}{9} > 0\end{aligned}$$

This and the negativity of π_i''' imply that the solution of $\pi_i'(s_i \mid \max) = 0$ is a global maximum of $\left[0, \frac{1}{2}\right]$, given the solution is in $\left[0, \frac{1}{2}\right]$; and if the solution is out of it the global maximum is reached at $\frac{1}{2}$. Therefore, the best response of i is either $\frac{1}{2}$ or the solution of $\pi_i'(s_i \mid \max) = 0$. As we are looking for symmetric equilibriums, there are not more than two possibilities, $\mu_1 = \mu_2 = \frac{1}{2}$, and $\mu_1 = \mu_2 = \hat{\mu}$ where $\hat{\mu}$ is the solution of

$$Q(\hat{\mu}) = \hat{\mu}^2(-\delta\beta) + \hat{\mu}(-\beta + 2\delta\beta - 2c) + \frac{\delta}{2} = 0 \tag{19}$$

which is obtained from putting $\mu_i = \mu_j = \hat{\mu}$ in (18).

1)To have $(\frac{1}{2}, \frac{1}{2})$ as an equilibrium we should have $\pi_i'(s_l \mid \max, \mu_i = \mu_j = \frac{1}{2}) > 0$ for $i, j \in \{1, 2\}$. This is equivalent to $c \leq \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta$.

2) It is simple to check $\frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta < c$ implies $\hat{\mu} < \frac{1}{2}$. As a result, given $\mu_j = \hat{\mu}$, $\mu_i = \hat{\mu}$ is the best response of i as it is discussed before.

To show the existence of the equilibrium, we should prove there is no deviation. So far we have shown that there is no deviation given the maximum differentiation. However, there is another possible deviation to check. The only possible deviation is increasing the $s_i \cap s_j$. According to the proposition 2, the most profitable deviation is choosing the maximum intersection.

Suppose (μ, μ) is the equilibrium candidate. We consider two cases:

i)$\mu_i \leq \mu$: To rule out profitable deviation, we should have

$$\frac{1}{2} + \frac{\delta}{2}\mu - \beta\mu + \delta\beta\mu^2 - c\mu^2 \geq \frac{1}{2} + \frac{\delta}{2}\mu_i - \frac{\delta\beta}{2}\frac{(\mu-\mu_i)\mu_i}{1+\mu-\mu_i} - \beta\frac{\mu-\mu_i}{1+\mu-\mu_i} - c\mu_i^2$$

, where the left hand side represent the profit in equilibrium, (μ, μ), and the right hand side shows the profit of i when she deviates from equilibrium. This inequality is equivalent to

$$(\mu-\mu_i)\left(\delta\left(-\frac{}{2}-\frac{\beta}{2}\frac{\mu_i}{1+\mu-\mu_i}\right)+c(\mu+\mu_i)-\beta\frac{1}{1+\mu-\mu_i}\right)+\beta\mu-\delta\beta\mu^2\leq 0$$

This should hold $\forall\mu_i \leq \mu$. For particular case $\mu_i = \mu$, this inequality is equivalent to $\delta\mu \geq 1$. Therefore, $\delta \geq 2$ is a necessary condition to have an equilibrium with maximum differentiation.

As the coefficient of δ in the inequality is negative, there exist a $\hat{\delta} > 0$ such that $\forall\delta > \hat{\delta}$ the left term takes negative values. The negativity of the right term is a necessary condition, $\delta > \frac{1}{\mu}$.

ii)$\mu_i \geq \mu$: In this case $\mu(s_i \cap s_j) = \mu$. This deviation is profitable if $\min(\mu_i, \mu) > g(\mu_i, \mu)$. If it is not the case i can increase its profit by reducing the measure of intersection with j to zero, but we know there is no profitable deviation if the sets are disjoint, since i is choosing the best reply given the empty intersection.

From (16), we know $\frac{\partial g(\mu_i,\mu)}{\partial\mu_i} = 3(\frac{1}{2}-\mu_i)+2\mu-\frac{1}{\delta} > 0$, if $\mu > \frac{1}{\delta}$ (which is a necessary condition for case (i)). As $g(\mu_i = \mu, \mu) = 2\mu - \frac{1}{\delta} > \mu$, it means $\forall\mu_i \geq \mu, \quad \mu < g(\mu_i, \mu)$. This means this case does not matter as long as there is no deviation in case (i).

There exists a $\hat{\hat{\delta}}$ such that $\forall\delta > \hat{\hat{\delta}} \mid c < \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta$ which implies $\mu = \frac{1}{2}$. Hence, there is a $\bar{\delta}^M = \max\left(2, \hat{\delta}, \hat{\hat{\delta}},\right)$ such that $\forall\delta > \bar{\delta}^M$ there exists an equilibrium in which newspapers invest on different sets of issues.

Moreover, we can set $\underline{\delta}^M = 2$ which implies $\forall\delta < \underline{\delta}^M$ there exists no equilibrium in which newspapers invest on different sets of issues. This is due to the fact that the necessary condition, $\delta \geq \frac{1}{\mu}$, is violated. ∎

8.5 Proof Proposition 6

Proof. In terms of c, we have two cases:

1)$c > \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta$:

First of all, to have a specialization equilibrium, we have shown in the proof of proposition 4 it is necessary $\mu^M > \frac{1}{\delta}$. From (19), we have

$$Q(\mu^M) = \mu^{M^2}(-\delta\beta) + \mu^M(-\beta + 2\delta\beta - 2c) + \frac{\delta}{2} = 0$$

In other hand, from proposition 1 we know, $\frac{\delta}{2} = 2c\mu^* - \frac{\beta}{2} - \frac{\delta\beta}{2}\mu^*$. By substituting this in the $Q(\mu^M)$ we get

$$\begin{aligned} 2(\mu^M-\mu^*)(c-\frac{\delta\beta}{4}) &= \mu^{M^2}(-\delta\beta)+(\frac{3\delta\beta}{2}-\beta)\mu^M-\frac{\beta}{2} \\ &= \delta\beta\mu^M(\frac{1}{2}-\mu^M)+\beta\mu^M(\frac{\delta}{2}-1)+\frac{\beta}{2}(\mu^M\delta-1) \\ &\geq 0 \end{aligned}$$

Hence, $\mu^M \geq \mu^*$ since $c \geq \frac{\delta\beta}{4}$.

2)$c \leq \frac{\delta}{2}-\frac{\beta}{2}+\frac{3}{4}\delta\beta$: In this case, $\mu^M=\frac{1}{2}$ which for sure is greater than μ^*.

∎

8.6 Proof Proposition 7

Proof. We consider three cases:
i)$c \geq \frac{\delta}{2}-\frac{\beta}{2}+\frac{3}{4}\delta\beta$: In this case, $\mu^* < \mu^M < \frac{1}{2}$. From (13), we have

$$(\mu^M-\mu^*)\left(-c(\mu^M+\mu^*)+\frac{\delta}{2}\right)+\beta\mu^M(\delta\mu^M-1)$$

Moreover from (19), and proposition 1 we know $c\mu^M = -\frac{\delta\beta}{2}\mu^{M^2}+(2\delta\beta-\beta)\frac{\mu^M}{2}+\frac{\delta}{4}$, and $c\mu^*=\frac{\delta}{4}+\frac{\beta}{4}+\frac{\delta\beta}{4}\mu^*$. By substituting them in the above equation we get

$$\frac{\delta\beta}{2}\mu^{M^3}+\left(\frac{\beta}{2}-\frac{\delta\beta}{2}\mu^*\right)\mu^{M^2}+\left(-\frac{5}{4}\beta+\frac{3\delta\beta}{4}\mu^*-\frac{\beta}{2}\mu^*\right)\mu^M+\frac{\beta}{4}\mu^*+\frac{\delta\beta}{4}\mu^{*^2}$$

If we add $\frac{\mu^M}{2}$ of (19) to the above equation we get

$$b(x=\mu^M)=\left(-\frac{\delta\beta}{2}\mu^*+\delta\beta-c\right)\mu^{M^2}+\left(-\frac{5}{4}\beta+\frac{3\delta\beta}{4}\mu^*-\frac{\beta}{2}\mu^*+\frac{\delta}{4}\right)\mu^M+\frac{\beta}{4}\mu^*+\frac{\delta\beta}{4}\mu^{*^2}$$

As $b(x=\mu^*)<0$ and $c>\delta\beta$, $b(x)<0$ for all $x \geq \mu^*$. Hence, $b(x=\mu^M)<0$.

ii)$c \leq \frac{\delta}{2}+\frac{\beta}{2}+\frac{\delta\beta}{4}$: In this case, $\mu^*=\mu^M=\frac{1}{2}$. We can write (13) as:

$$(\mu^M-\mu^*)\left(-c(\mu^M+\mu^*)+\frac{\delta}{2}\right)+\beta\mu^M(\delta\mu^M-1)$$

This is positive as the right term is zero and the left term is positive.

iii)$\frac{\delta}{2}+\frac{\beta}{2}+\frac{\delta\beta}{4} < c < \frac{\delta}{2}-\frac{\beta}{2}+\frac{3}{4}\delta\beta$: In this case, $\frac{\delta}{4c-\delta\beta}=\mu^* < \mu^M=\frac{1}{2}$. (13) can be written as:

$$h(c) = \frac{1}{4}(\delta\beta - c) + \frac{1}{2}\left(\frac{\delta}{2} - \beta\right) - \frac{\delta}{2}\mu^* + c{\mu^*}^2$$

From (i), and (ii) wen know $h(c = \frac{\delta}{2} - \frac{\beta}{2} + \frac{3}{4}\delta\beta) < 0 < h(c = \frac{\delta}{2} + \frac{\beta}{2} + \frac{\delta\beta}{4})$. Moreover, $h'(c) = -\frac{1}{4} - \frac{\delta}{2}{\mu^*}' + 2c\mu^*{\mu^*}' + {\mu^*}^2 = -\frac{1}{4} + {\mu^*}^2 + {\mu^*}'\left(-\frac{\delta}{2} + 2c\mu^*\right) = -\frac{1}{4} + {\mu^*}^2 + {\mu^*}'\left(\frac{\delta\beta}{2}\mu^*\right) < 0$. Therefore, there exists $\hat{c}$ such that for any c greater than it the profit of newspapers decreases with presence of aggregator; and the opposite for any $c < \hat{c}$.

∎

Appendix B

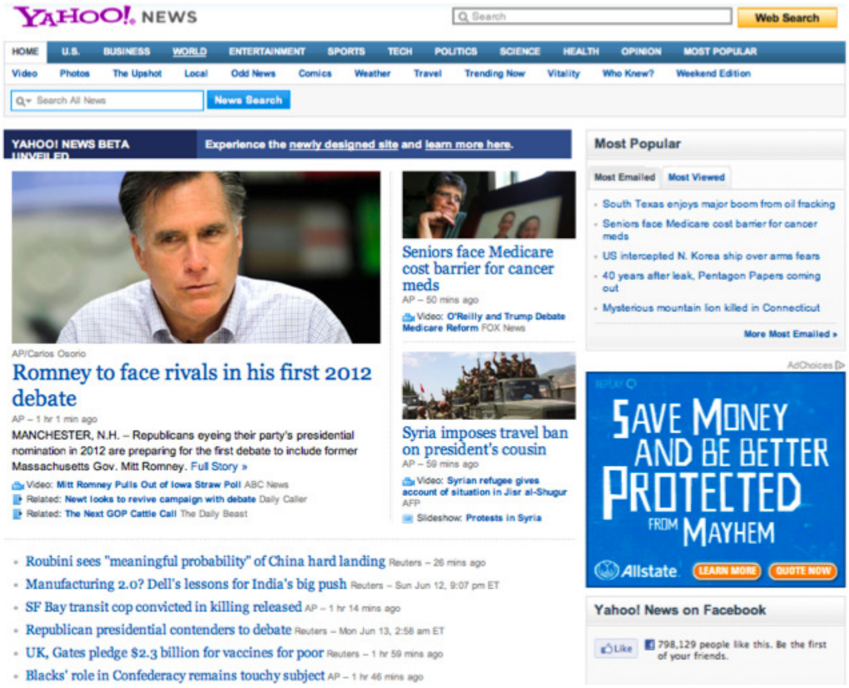

Figure 8: The Yahoo! News

Figure 9: An article in the Yahoo! News. As you can see there is no link to the original article.

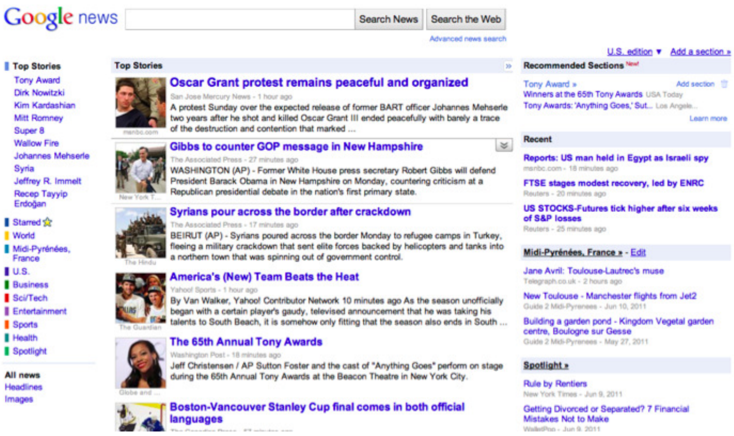

Figure 10: The Google News

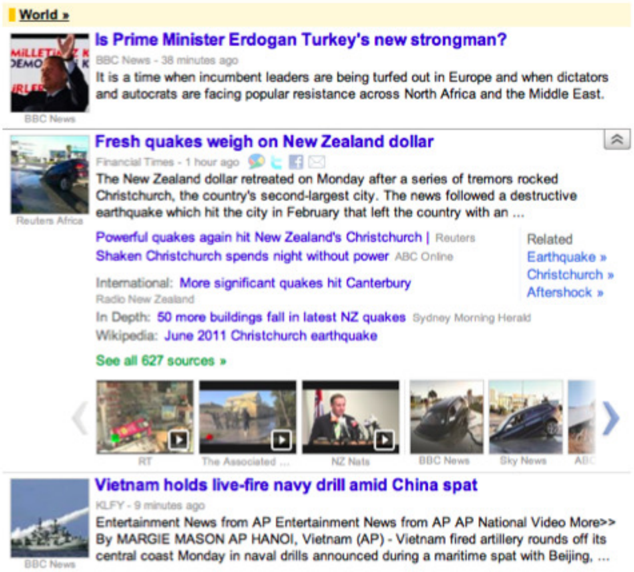

Figure 11: An article from Financial Times in the Google News. There is a short abstract of the article in the two or three lines, and a link to the original article.