USER-GENERATED CONTENT IN NEWS MEDIA

JOB MARKET PAPER

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Abstract

In this study, we investigate a newspaper's decision to expand its product line by adding an online edition that incorporates user-generated content, and the impact of this decision on its slanting of news. We demonstrate that adding an online edition results in reduced profits for competing newspapers in comparison to an environment in which they offer only print editions. However, at the equilibrium, each newspaper offers the online version in order to avoid losing market share to rivals. The results also show the mitigating effect of such a product line extension on the extent of bias in print media.

Keywords: Media Competition; Bias in News; User-Generated Content; Product Line

1. INTRODUCTION

User-generated content (UGC) is increasingly common in the online economy, often appearing in forms of blogs, wikis, podcasts, pictures, videos and social networks (Lee 2008). In 2008, 42.8% of Internet users (82.5 million people) contributed to some form of UGC; and it is expected that this number will reach 51.8% by 2012 (114.5 million people) (Verna 2009). The addition of online platforms to integrate UGC, range from operating completely on UGC (e.g., Flickr, Youtube) to addition of UGC to existing services (e.g., customer feedback on products such as on Amazon and Ebay).

In the case of news media, use of websites to integrate user content has intensified and UGC is becoming an alternative to the professionally created news reports. While newspapers continually include letters to the editor and readers' comments in their print version, online readers can more actively respond to published news or even generate news stories themselves. For example, the Wall Street Journal (WSJ), on its online version, offers readers the opportunity to add content under the section titled "Journal Community". In this digital platform, readers create groups having particular interests (e.g. "The Mideast," "The New Regulation Economy," "American Views on European Politics", etc.) and share opinions on the subject. In addition, using this platform, news readers can make comments or ask questions about stories published by WSJ journalists. The New York Times (NYT), on its digital version, publishes news stories and opinions of readers in the form of letters and op-eds, and has a separate 'Public Editor' assigned in charge of responding to comments and opinions of readers. CNN and Fox News have been broadcasting news videos (called 'I-reports' and 'U-reports') that are submitted by their audience. For these news companies, the impact of UGC on profitability is unknown, as it can be a substitute to the professionally prepared content. A report by Accenture confirms this concern

by arguing that media owners see UGC as the biggest threat to the survival of their businesses (Accenture 2007).

In this paper, we investigate whether newspapers find it optimal to offer online editions to supplement their print editions, and how such product diversification affects bias in news reporting. We find that diversifying the product mix is a dominant strategy for newspapers. However, adding an online edition results in reduced profitability in comparison to an environment where each newspaper offers a print edition only.

The main characteristic that distinguishes the online from the print edition in our model is the ability of readers to add UGC to the former variant of the product. We assume that this feature of the online edition is especially appreciated by readers who have extreme political opinions. We conjecture that such readers have a stronger desire to be heard and/or convince other readers of their views. This assumption is consistent with recent research in psychology that investigates how people's opinions deviate from that of the average group member. For example, using a series of studies, Morrison and Miller (2008) show that people whose opinions are extreme in the direction of the norm that reflects the common attitudes of their group (e.g., liberal positions for college students), are more likely to express their opinions than moderates. Participants (Stanford undergraduates) were asked to imagine being required to deliver a speech advocating their positions on one of three important campus issues: wages of full-time Stanford employees, the presence of ethnic-theme dormitories on the Stanford campus, and the use of affirmative action in college admissions. The authors found that students with extreme liberal views were more comfortable delivering the speech. They were also more willing to give

permission to researchers to show their actual videotaped speeches to other students.[1]

As a result of the added appreciation of some consumers for UGC, the diversification of the product mix leads to possible segmentation of readers according to their political opinions. Readers who are moderates prefer the print edition of the newspaper, or at least, have no particular desire to add content to the online edition. In contrast, readers who are extreme in their opinions opt for the online edition in order to be active in generating content on the newspaper's site.[2, 3] To illustrate the extreme nature of the content generated online, consider some excerpts on the topic of healthcare reform as they appeared on the online editions of two newspapers. For the WSJ, readers write "But then who is going to pay for all the deadbeat sickos who can't afford to care for themselves" or "Health insurance works like Marxism." And for the NYT, they write "As a rule, distrust "advice" given by free market 501 (c) (3) organizations that rely on rich backers…" or "Cut Medicare for the top 80% of households, leave it for the poor." Such extreme expressions of political opinions on the right for the WSJ and the left for the NYT are unlikely to

[1] In another related research Miller and Morrison (2009) show that group members whose opinions were more extreme in the direction of the group prototype (pro-alcohol attitudes of college students), were more willing to express their views than moderates.

[2] This segmentation is consistent with what some journalists feel is happening with the growth of UGC. For example, Jan Leach, in a Harvard Nieman Journalism Report, suggests that it is readers "overlooked in mainstream media coverage including people espousing unpopular causes" who are likely to use the Internet to voice their opinions, and UGC might transfer news organizations' authority to information that is biased (Leach 2009).

[3] In a separate analysis we provided further support for this segmentation by comparing reader comments in WSJ online with those in the print edition of WSJ (i.e., Letters to the Editor). Our data set comprised of all the online and offline subscriber comments to 46 articles on Health Care Reform that appeared between 1-1-10 and 1-31-11 in the print edition. In the print edition, there were 132 Letters to the Editor written by 130 readers and in the online edition there were 5818 comments made by 2030 subscribers. Two raters independently rated all the comments using a 7 point rating scale with 1 (7) representing strong support for liberal (conservative) policies. Correlation between the scores of the two raters was positive and statistically significant: $\rho = 0.54$ ($p < 0.01$) for Letters to the Editor, and $\rho = 0.64$ ($p < 0.01$) for online comments. In order to determine a political opinion rating for a reader, for each article we first calculated the average score of the two raters. Then, as some readers provided comments to more than one article, we calculated overall political rating of a reader by taking the average of her (rater-averaged) ratings across all of the articles. Using this procedure the obtained mean ratings were 5.27 and 4.82 for the online and print commentators, respectively. Further, the difference between these ratings was statistically significant ($t_{2158} = 4.39, p < 0.01$).

appear in the print versions of these newspapers. (In a Web Appendix we include some additional comments that are even more extreme and almost border profanity.)

We demonstrate that the segmentation of readers reduces the extent of bias in reporting of the print edition but intensifies the extent of bias of the online edition. This intensified bias is mostly generated by the readers themselves as they add news stories and opinions to the online edition. In fact, we demonstrate that if newspapers could completely prevent readers from adding UGC to their online editions, they would choose bias to be identical in their print and online editions. In contrast, when UGC is added by readers to the online editions, each newspaper is indirectly forced by subscribers to offer two differentiated versions of its product. With this added differentiation, the profitability of the newspaper declines in comparison to an environment where it has the exclusive right to choose the bias of both editions.

It is noteworthy that the reduced profitability that is predicted in our model at the equilibrium when each newspaper adds an online version stems from two characteristics of our formulation. First, the extension of the product mix results in reduced bias of the print editions of the newspapers, translating to reduced product differentiation and intensified competition on subscription fees. Second, since the extent of slant of the online editions is partly determined by subscribers, the ability of the newspapers to extract consumer surplus via price discrimination is restricted. Several recent empirical findings in the literature support the reduced profitability our model predicts. In particular, Filistrucchi (2005) and Gentzkow (2007) find that adding an online version reduces print sales and profits. Even though those studies demonstrate this finding in an environment where access to online content is free, our model predicts that profits decline even when newspapers charge for access to their online editions.

Given our goal of investigating the role of UGC in affecting political bias in news reporting, our model focuses primarily on the political opinions of readers as the sole determinant of their choice between the print and online editions. There are obviously many other attributes that distinguish consumers who prefer one edition over the other. Online users are likely to be younger or have higher valuation for the technological features provided by online newspapers (such as content sharing-digging, mobile applications, and so on). In an extension of our model we incorporate a second dimension of heterogeneity, unrelated to politics that differentiates among readers. We show that this additional heterogeneity leads to increased bias of the print edition and to a reduction of the average size of the online segment. Essentially, this additional heterogeneity moves the equilibrium closer to the outcome that arises when newspapers have full control over the attributes of both variants of their products.

To formulate the competition between the newspapers, we extend a model that was developed by Mullainathan and Shleifer (MS 2005). In this model, consumers prefer reading news consistent with their opinions and two newspapers can slant their reporting of the news towards these opinions. This assumption is consistent with recent experimental evidence of ideological selectivity in media use (see Iyengar and Hahn 2009). As in MS (2005), we assume that the only source of revenues of the newspapers is from subscription fees. Even though advertising is also an important source of revenue, in recent years newspapers have reduced their reliance on advertising, as more advertisers switch to Internet advertising. In 2009, the NYT reported, for instance, that its revenues from circulation surpassed advertising revenues for the first time (Chittum 2009). We assume that the newspapers can charge subscription fees for both their print and online editions. The WSJ, for instance, has different subscription fees for print and

online subscriptions, and the NYT has recently announced that it will start charging for access to its online edition in 2011.

Our paper contributes to several strands of literature. First is the literature on media bias that is implied by the media's attempt to appeal to consumers who have different opinions. In addition to MS (2005), several other researchers also develop theoretical models to explain such bias. Gabszewicz et al. (2002) investigate how advertising affects the political message of newspapers. In Gentzkow and Shapiro (2006) bias occurs since media firms slant their reports toward consumer priors in order to maintain reputation for high quality reporting. Xiang and Sarvary (2007) investigate media bias in the presence of conscientious consumers who seek the truth. Finally, Gal-Or et al. (2010) examine slanting in news media when advertisers wish to target readers who are receptive to their messages. None of these studies addresses, however, the question of how introducing an online edition to supplement a print edition is likely to affect the extent of slant in reporting the news and the profits of newspapers.

The second strand of literature to which this study contributes deals with how competing sellers choose the breadth of their product lines in order to facilitate improved segmentation. Some of this literature assumes exogenous product attributes (e.g., Brander and Eaton 1984, Gilbert and Matutes 1993). Our work is more similar to the literature that examines product line rivalry when product characteristics are endogenously chosen (e.g., Katz 1984, Champsaur and Rochet 1989, Desai 2001, Schmidt-Mohr and Villas-Boas 2008). In contrast to this literature on competitive product line design, in our study the enrichment of the product line occurs by active participation of customers in determining the (non-price) characteristics of the products included in the line.

Finally, our paper contributes also to literature related to UGC. There has been significant amount of research that involves empirical measurement of the effects of UGC on sales (Chevalier and Mayzlin 2006, Liu 2006, Dhar and Chang 2009, and Zhu and Zhang 2010) and on other similar variables such as TV ratings (Godes and Mayzlin 2004) or new customer acquisition (Trusov et al. 2009). However, analytical work in this area has been limited. Further, all such work has addressed UGC in the context of the exchange of information about products among online readers (e.g., Mayzlin 2006, Chen and Xie 2008, Kuksov and Shachar 2010). In contrast, our research focuses on UGC in generating news reports online.

2. MODEL

Consider a market with two newspapers, $i = 1, 2$, where each can decide on whether to add an online version to supplement the print version of its publication. We assume that due to technological advancement, the online version facilitates far greater capabilities for the readers to add content to the publication than the print version. For simplicity, we assume that only the online version can incorporate readers' input. We will refer to the activity of readers on the online version as User-Generated Content (UGC). We assume that the only source of revenues of the newspapers is from subscription fees[4], and that the unit cost of offering the print version is higher than the online version. We designate by c and δc, with $0 < \delta < 1$, the unit cost incurred by the newspaper to produce the print and online versions, respectively. The added cost of the print version may relate, for instance, to added distribution costs. Consumers choose whether to subscribe to the print or online versions of one newspaper[5].

[4] This assumption is relaxed in the Web Appendix.

[5] In a recent study, Gentzkow (2007) investigates the newspaper market in Washington DC and demonstrates that the print and online versions of newspapers are considered substitutes rather than complementary goods by readers. This empirical finding lends some support to our formulation.

There are several reasons why different consumers may prefer one type of subscription over another. Older consumers, for instance, may prefer the traditional way of reading the paper. They may be less accustomed to reading material online and, in general, to adapt to new types of media. Since the objective of our paper is to examine how a newspaper's decision to add an online version affects the extent to which it slants news reports, initially we focus on a single differentiating variable among customers that is most likely to affect the newspapers' slanting strategy. Specifically, we conjecture that customers who have extreme political opinions are likely to be attracted to the greater capabilities offered by the online version to share stories and opinions with other readers. Hence, in our model customers are segmented according to the intensity of their political opinions. Those who have more moderate opinions choose the print version, since they do not plan to engage in UGC, and those who have extreme opinions choose the online version since they value the UGC feature of this medium. In Section 4 we introduce an additional dimension of heterogeneity among readers that is independent of political beliefs, and reflects the preference of readers for the medium itself (online vs. print).

To capture the heterogeneity of customers according to political opinions we adopt the model developed by MS (2005). Specifically, there is a unit mass of consumers who are uniformly distributed according to their political opinions, designated by b, on the interval $[-b_0, b_0]$. Readers with left leaning opinions belong to the negative region of this interval and those with right leaning opinions belong to the positive region. Information about news items t is normally distributed according to $N(0, \sigma_t^2)$. Newspapers provide the readers with news about t. A reader of type b, has prior beliefs about these news items that is normally distributed according to $N(b, \sigma_t)$. Hence, in comparison to the true distribution, readers have biased beliefs about the

news, determined by their political opinions. The variable *b* measures the extent to which the beliefs of the reader are biased relative to the true mean of the distribution of *t*.

Newspapers receive some data $d = t + \varepsilon$, where the random variable ε is independently distributed of *t* according to $\varepsilon \sim N(0, \sigma_\varepsilon^2)$. Newspapers may choose to slant their reporting so that $n_i = d + s_i$, where n_i is the reported news, and s_i is the slant in reporting. While the newspaper has full control over the extent of slanting of its print version, the slant of the online version may depend also on the UGC added by subscribers to this product. To allow for the possibility of different levels of slanting, we designate by s_i and s_i^o the slant of the print and online products, respectively, and similarly, by n_i and n_i^o the reported news in the two variants.

As in MS (2005), we assume that readers incur disutility when reading news inconsistent with their opinions, as measured by the distance between the reported news and the readers' opinions: $(n_i - b)^2$ and $(n_i^o - b)^2$. As well, holding constant the extent of inconsistency with their opinions, readers dislike slanting. When Newspaper *i* chooses the subscription fees P_i and K_i for its print and online versions, the net utility of a consumer having opinion *b* is:

$$U_b = \begin{cases} \bar{u} - \chi s_i^2 - \phi\,(n_i - b)^2 - P_i & if\ she\ subscribes\ to\ print\ version\ of\ i \\ \bar{u} - \chi (s_i^o)^2 - \phi\,(n_i^o - b)^2 - K_i & if\ she\ subscribes\ to\ online\ version\ of\ i, \end{cases} \quad (1)$$

where $\phi > 0$ calibrates the reader's preference for hearing news consistent with her political opinions, and $\chi > 0$ calibrates her preference for reduced slant. Using the utility framework in (1), readers first choose a newspaper and then decide whether to subscribe to the online or print versions of the newspaper, while incorporating the fact that the online version includes UGC.

Similar to MS (2005), we assume full coverage[6] of the market of consumers and focus on linear slanting strategies $s_i(d) = \frac{\phi}{\phi+\chi}(B_i - d)$, where B_i is the location choice of the print

[6] The full coverage assumption is relaxed in the Web Appendix.

version of Newspaper i, a measure of its bias in reporting news. This location choice can be a point inside or outside of the interval $[-b_0, b_0]$. By choosing location B_i the paper becomes more appealing to readers with opinions close to B_i . Notice that the extent of slanting decreases with χ and increases with ϕ. Thus, as readers place more importance on receiving accurate information and less importance on hearing confirmatory news, newspapers choose lower slanting in their reporting. In particular, when $\chi \to \infty$, implying that readers care only about accuracy in their utility function, the newspapers do not introduce any slanting in news reporting and $s_i = 0$. Without loss of generality, we assume that Newspaper *2* is located to right of Newspaper *1* ($B_1 < B_2$). That is, while Newspaper *1* has a left-wing bias, Newspaper *2* has a right-wing bias.

The location choice B_i of Newspaper *i* is the sole determinant of the overall bias in reporting of its print version. In contrast, since subscribers to the online version are active in generating additional content, the bias in reporting of the online product reflects both the positioning of the newspaper and the UGC supplied by subscribers to this variant of the product. We designate the combined positioning of the online variant of Newspaper *i* by ${B_i}^o$ and specify it as follows: [7]

$$ {B_i}^o = B_i + \alpha(E[b_i^o]) \qquad 0 < \alpha < 1, \tag{2}$$

where $E[b_i^o]$ measures the mean opinion of subscribers to the online version of Newspaper *i*. Hence, the modified bias of the online version is the sum of the position chosen by the newspaper and the mean opinion of subscribers to this product multiplied by a positive fraction α that measures the extent of discretion awarded to online readers to generate content online. The

[7] Note that the specification in (2) can be generalized to allow for any weighted average of B_i and $E[b_i^o]$. We chose the weights 1 and α, respectively, without loss of generality.

fact that $\alpha < 1$, reflects the sensible assumption that the effect of the newspaper itself in determining the bias of the online variant is higher than that of its readers[8].

It is noteworthy that when readers make their choice among the different media, the realization of the data supporting the news stories (the random variable *d*) is yet to be determined. At the time the reader makes her choice, she is familiar with the subscription fees of the newspapers (P_i and K_i), their locations (B_1 and B_2), and her own political opinion *b*. Hence, in comparing the different media, the reader evaluates her prior expected utility calculated from (1) by integrating over all possible realizations of the random variable *d* and using the distributional properties of *d* (namely, $E[d] = 0$ and Var$[d]$= ${\sigma_d}^2$.) Hence, we obtain:

$$E[U_b] = \begin{cases} \bar{u} - \frac{\phi^2}{(\phi+\chi)}(B_i - b)^2 - \frac{\chi\phi}{(\phi+\chi)}(b^2 + {\sigma_d}^2) - P_i & for\ print\ version\ of\ i \\ \bar{u} - \frac{\phi^2}{(\phi+\chi)}\left({B_i}^O - b\right)^2 - \frac{\chi\phi}{(\phi+\chi)}(b^2 + {\sigma_d}^2) - K_i & for\ online\ version\ of\ i. \end{cases} \quad (3)$$

Our specification implies that when a newspaper decides to add an online variant to supplement its print version, it expands its product mix to consist of two products with differing levels of bias in reporting. According to (2), the bias in reporting is higher online due to the added input supplied by subscribers to this product. The expanded product mix is likely to support, therefore, improved segmentation of readers as described in Figure 1, when both newspapers offer an expanded product mix. Later in Section 3.1, we show that such segmentation can indeed exist.

Online Subscribers to Newspaper *1*	Print Subscribers to Newspaper *1*	Print Subscribers to Newspaper *2*	Online Subscribers to Newspaper *2*

$-b_0$ $\quad$ $\hat{b}_1$ $\quad$ b_{indif} $\quad$ $\hat{b}_2$ $\quad$ b_0

[8] We will later have to restrict the value of α even further to guarantee that segmentation is feasible.

Figure 1: Segmentation when Both Newspapers Offer both Print and Online Variants

The segmentation depicted in Figure 1 follows from (3). Note that the expected utility of readers satisfies the property that $\frac{\partial E[U_b]}{\partial b \partial B_i} = \frac{2\phi^2}{(\phi+\chi)} > 0$ throughout the interval $[-b_0, b_0]$. Given that this cross partial derivative never changes sign, "the single crossing property" holds and readers can potentially be segmented. Moreover, since this cross derivative is positive, a reader's opinion and the location choice of a newspaper are positively correlated, thus yielding the segmentation in Figure 1. In the Figure, readers having extreme political opinions ($b > \hat{b}_2$ and $b < \hat{b}_1$) choose to subscribe to one of the online products and those having moderate opinions ($\hat{b}_1 < b < \hat{b}_2$) choose to subscribe to one of the print products. Since bias in reporting is more extreme online than in the print version, it is readers with extreme political opinions who self select to subscribe to the product that is more consistent with their extreme preferences. Moreover, since those subscribers choose to add UGC to the website of the newspaper, the modified bias of the online version reflects the extreme opinions of these subscribers. Specifically,

$$B_2{}^o = B_2 + \alpha\frac{(b_0+\hat{b}_2)}{2} \text{ and } B_1{}^o = B_1 + \alpha\frac{(-b_0+\hat{b}_1)}{2}. \quad (4)$$

Note that in spite of the improved segmentation facilitated by the expansion of the product mix and the lower cost of producing the online variant, it is unclear that adding the online version is necessarily profitable for the newspapers. It has been demonstrated in the literature that expanding the product mix in order to support second degree price discrimination may not always enhance the profits of a seller (see Gilbert and Matutes 1993, for instance). This is especially true in our environment, where the characteristics of the added product (its positioning) is partly determined by consumers and is not under the full control of the

newspaper. We will investigate whether such a product expansion can be sustained as equilibrium in our setting, and if it does, how it affects the extent of bias in news reporting.

We model the game as consisting of three stages. In the first stage, the newspaper decides whether to supplement its print version with an online product. We designate this choice by E_i and NE_i when expanding and not expanding the product mix, respectively. In the second stage, each newspaper decides the political positioning of its print version, B_i. In the third stage, each newspaper chooses its subscription fees P_i and K_i, where the latter choice is relevant only if an online version is added in the second stage. Following the three stages, consumers decide on their subscription patterns (prior to the realization of *d*), newspapers gain access to news and report them according to the biases selected in Stage 2, and readers of the online version add UGC to the newspapers' website[9].

3. DERIVATION OF THE EQUILIBRIA

Contingent upon the expansion decision of the two newspapers in the first stage, four different possibilities may arise, as follows: $\{E_1, E_2\}$, $\{E_1, NE_2\}$, $\{NE_1, E_2\}$, and $\{NE_1, NE_2\}$. The last possibility refers to the case that both newspapers offer only the print version. This case has already been investigated in MS (2005). The authors find that the positioning of the newspapers when only a print version is offered by each is $B_1 = -\frac{3}{2}b_0$ and $B_2 = \frac{3}{2}b_0$. Hence, extreme bias in reporting arises at the equilibrium. Such extreme positioning leads to greater differentiation between the newspapers and alleviated competition on subscription fees. In what follows, we characterize the remaining two cases: the symmetric case when both newspapers choose to add an online product and the asymmetric case when only one newspaper adds the online version.

[9] Note that data supporting news stories is a random variable and, therefore, its realization may be different for the two newspapers. While a newspaper can observe its own data, it does not necessarily observe the data available to its competitor. Nevertheless, since the demand of subscribers is based upon prior expectations before data is actually realized, this lack of observability has no bearing on our derivations.

3.1 Both Newspapers Add an Online Version

When both papers choose to add the online product, the segmentation of consumers is characterized in Figure 1. For simplicity, we will use the superscript $\{E,E\}$ to characterize the equilibrium variables in this symmetric case. Considering the stage when consumers choose their subscription patterns, we start by identifying the threshold reader ${b_{indif}}^{E,E}$, the reader who is indifferent between the print editions of Newspapers *1* and *2*, and ${\hat{b}_1}^{E,E}$ (${\hat{b}_2}^{E,E}$), the readers who are indifferent between the print and online editions of Newspaper *1*(*2*), respectively.

The marginal reader ${b_{indif}}^{E,E}$ has the same expected utility from subscribing to the print editions of Newspapers *1* and *2*. That is, from (3):

$${b_{indif}}^{E,E} = \frac{{B_2}^{E,E}+{B_1}^{E,E}}{2} + \frac{({P_2}^{E,E}-{P_1}^{E,E})}{({B_2}^{E,E}-{B_1}^{E,E})}\frac{\phi+\chi}{2\phi^2}. \qquad (5)$$

From (5), the location of the subscriber indifferent between Newspapers *1* and *2* is shifted away from the average biases of the two newspapers, $\left(\frac{{B_2}^{E,E}+{B_1}^{E,E}}{2}\right)$, in a manner dependent on the discrepancies between the fees charged for the print subscriptions and the biases of the two newspapers. Specifically, this shift favors Newspaper *1* (by raising the value of ${b_{indif}}^{E,E}$) the lower its subscription fee for the print edition relative to that charged by Newspaper *2*. Moreover, when ${P_2}^{E,E}-{P_1}^{E,E} > 0$, the shift favorable to Newspaper *1* is more significant the smaller the distance between the locations of the two newspapers (the smaller ${B_2}^{E,E} - {B_1}^{E,E}$ is, namely the smaller the extent of differentiation between the newspapers).

Similarly, the location of the indifferent reader ${\hat{b}_i}^{E,E}$ is a function of the biases of the online and print editions of newspaper *i* and the difference between the prices of these editions:

$${\hat{b}_i}^{E,E} = \frac{({B_i}^{O})^{E,E}+{B_i}^{E,E}}{2} + \frac{({P_i}^{E,E}-{K_i}^{E,E})}{({B_i}^{E,E}-({B_i}^{O})^{E,E})}\frac{(\phi+\chi)}{2\phi^2}, \quad i=1,2. \qquad (6)$$

Note that the right hand side of (6) is also a function of $\hat{b}_i^{E,E}$ given that the bias of the online edition $(B_i^o)^{E,E}$ is a function of $\hat{b}_i^{E,E}$ from (4). Specifically, the bias of the online version is determined by the mean opinion of the segment of readers who find it optimal to subscribe to this version of the product. Solving the system of equations (6) for $\hat{b}_i^{E,E}$ in terms of the locations and fees of the newspapers yields:

$$\hat{b}_1^{E,E} = \frac{(2\,B_1^{E,E}+(2-\alpha)b_0)}{(4-\alpha)} - \frac{2\sqrt{(B_1^{E,E}-b_0)^2 - \frac{(4-\alpha)}{\alpha}(P_1^{E,E} - K_1^{E,E})\frac{(\phi+\chi)}{\phi^2}}}{(4-\alpha)}, \quad (7)$$

$$\hat{b}_2^{E,E} = \frac{(2\,B_2^{E,E}-(2-\alpha)b_0)}{(4-\alpha)} + \frac{2\sqrt{(B_2^{E,E}+b_0)^2 - \frac{(4-\alpha)}{\alpha}(P_2^{E,E} - K_2^{E,E})\frac{(\phi+\chi)}{\phi^2}}}{(4-\alpha)}. \quad (8)$$

Note that if the subscription fee for the print version of the paper is higher than for the online version (if $P_i^{E,E} - K_i^{E,E} > 0$ in (7) and (8))[10], the indifferent reader between the print and online variants of each paper has a more extreme political opinion, the higher her preference to hear confirming news (higher ϕ) and the lower the disutility she incurs from slanting (lower χ). This indifferent reader will also have a more extreme opinion when the newspaper itself chooses more extreme positioning (bigger $|B_i|$). In order to support the segmentation depicted in Figure 1, the solution for $\hat{b}_i^{E,E}$ should satisfy the inequalities $-b_0 < \hat{b}_1^{E,E} < b_{indif}^{E,E} < \hat{b}_2^{E,E} < b_0$. From the expressions derived in (7) and (8), this may not necessarily be the case. In particular, when the print edition of the newspaper is significantly more expensive than the online edition ($P_i^{E,E} \gg K_i^{E,E}$), $\hat{b}_1^{E,E}$ may be bigger and/or $\hat{b}_2^{E,E}$ may be smaller than $b_{indif}^{E,E}$. Hence, the print edition may not attract any subscribers. This result is consistent with the experience of the NYT when it started to provide free access to its digital content in 2007, leading to a significant

[10] Later we prove that the inequality $P_i^{E,E} - K_i^{E,E} > 0$ indeed holds.

decline of the circulation of the newspaper. Given this experience, it recently announced that it will start charging for access to content online in 2011 (Clark 2010, Economist 2010).

It may be interesting to point out that the threshold consumers $\hat{b}_i^{E,E}$ play a dual role in our model. The first is the traditional role that exists in any environment with market segmentation. Specifically, these threshold levels designate consumers who are indifferent between two adjacent variants of a given product. The second role is new to our model, and relates to the active role that online subscribers play in determining the characteristics of the online variant of the product. According to (2), the bias in reporting online depends upon the composition of subscribers to this product. As the threshold levels $\left|\hat{b}_i^{E,E}\right|$ increase, the segment of consumers who choose the online subscription has more extreme political opinions, thus generating more extreme content online via the UGC. As a result, the slant in reporting of the online variant intensifies.

Further, note that in traditional models of horizontal product differentiation, when consumers cannot affect the characteristics of the different variants the threshold consumers that demarcate the different segments are given by equations similar to the system (6). However, in contrast to our setting, product characteristics (represented by $(B_i^o)^{E,E}$ for the online editions in our model) are considered exogenous by consumers in the traditional models. When UGC plays a role in affecting the bias of the online versions, $(B_i^o)^{E,E}$ is no longer considered exogenous by the readers. Instead, they are fully cognizant of the fact that when readers with more extreme political opinions subscribe to the online edition, the content of this edition becomes more politically biased. Readers use this information in deciding whether to choose between the print and online editions. Such considerations transform the system of equations (6) to the expressions for $\hat{b}_i^{E,E}$ in (7) and (8).

Given the locations of the indifferent consumers expressed in (5), (7) and (8), in stage three newspapers choose their subscription fees ${P_i}^{E,E}$, ${K_i}^{E,E}$ to maximize their profits as follows:

$$\pi_1{}^{E,E} = \frac{1}{2b_0}\Big(\Big(b_0 + \hat{b}_1{}^{E,E}\Big)\big(K_1{}^{E,E} - c\delta\big) + \Big(b_{indif}{}^{E,E} - \hat{b}_1{}^{E,E}\Big)\big(P_1{}^{E,E} - c\big)\Big), \tag{9}$$

$$\pi_2{}^{E,E} = \frac{1}{2b_0}\Big(\Big(b_0 - \hat{b}_2{}^{E,E}\Big)\big(K_2{}^{E,E} - c\delta\big) + \Big(\hat{b}_2{}^{E,E} - b_{indif}{}^{E,E}\Big)\big(P_2{}^{E,E} - c\big)\Big). \tag{10}$$

Optimizing (9) and (10) with respect to ${P_i}^{E,E}$, yields the subscription fees of the print editions of both newspapers as functions of the choices made in the first two stages of the game:

$$P_1{}^{E,E} - c = \frac{\phi^2}{(\phi+\chi)}\big(B_2{}^{E,E} - B_1{}^{E,E}\big)\Big(\frac{\big(B_1{}^{E,E}+B_2{}^{E,E}\big)}{3} + 2b_0\Big), \tag{11}$$

$$P_2{}^{E,E} - c = \frac{\phi^2}{(\phi+\chi)}\big(B_2{}^{E,E} - B_1{}^{E,E}\big)\Big(-\frac{\big(B_1{}^{E,E}+B_2{}^{E,E}\big)}{3} + 2b_0\Big).$$

Optimizing (9) and (10) with respect to ${K_i}^{E,E}$ yields:

$$K_1{}^{E,E} - P_1{}^{E,E} = -c(1-\delta) - \frac{\big(\hat{b}_1{}^{E,E}+b_0\big)}{\frac{\partial \hat{b}_1{}^{E,E}}{\partial K_1{}^{E,E}}}, \tag{12}$$

$$K_2{}^{E,E} - P_2{}^{E,E} = -c(1-\delta) + \frac{\big(b_0-\hat{b}_2{}^{E,E}\big)}{\frac{\partial \hat{b}_2{}^{E,E}}{\partial K_2{}^{E,E}}},$$

where the expressions for $\frac{\partial \hat{b}_i{}^{E,E}}{\partial K_i{}^{E,E}}$ are derived from (7) and (8). Note that while the first term of the right hand side of (12) is negative, the second term is positive since $\frac{\partial \hat{b}_1{}^{E,E}}{\partial K_1{}^{E,E}} < 0$ and $\frac{\partial \hat{b}_2{}^{E,E}}{\partial K_2{}^{E,E}} > 0$. We will show, however, that the magnitude of the first term always dominates, thus yielding a lower subscription fee for the online than the print version due to the lower cost of producing the online variant. However, since the second term is positive, (12) implies that ${K_i}^{E,E} - \delta c > {P_i}^{E,E} - c$. As a result, the profit margin of the online edition is higher than that of the print edition. As is usually the case with price discrimination, expanding the product mix may

facilitate enhanced profit margins, since the added variant of the product constitutes a better match with the preferences of online subscribers.

We can use (7) and (8) to express the relationship between ${K_i}^{E,E}$ and ${P_i}^{E,E}$ in terms of ${\hat{b}_i}^{E,E}$ and the location choices of the newspapers as follows:

$$ {K_1}^{E,E} - {P_1}^{E,E} = -c(1-\delta) + \frac{\phi^2}{(\phi+\chi)} \frac{\alpha\left(b_0 + {\hat{b}_1}^{E,E}\right)\left((2-\alpha)b_0 - (4-\alpha){\hat{b}_1}^{E,E} + 2{B_1}^{E,E}\right)}{2}, \quad (13) $$

$$ {K_2}^{E,E} - {P_2}^{E,E} = -c(1-\delta) + \frac{\phi^2}{(\phi+\chi)} \frac{\alpha\left(b_0 - {\hat{b}_2}^{E,E}\right)\left((2-\alpha)b_0 + (4-\alpha){\hat{b}_2}^{E,E} - 2{B_2}^{E,E}\right)}{2}. $$

It may be interesting to evaluate (11) and (13) at the symmetric equilibrium, when $-{B_1}^{E,E} = {B_2}^{E,E} = B^{E,E}$ and $-{\hat{b}_1}^{E,E} = {\hat{b}_2}^{E,E} = \hat{b}^{E,E}$, because this type of equilibrium will be the main focus of this paper. We obtain:

$$ {P_i}^{E,E} - c = \frac{\phi^2}{(\phi+\chi)} 4B^{E,E} b_0, \quad (14) $$

$$ {K_i}^{E,E} - c\delta = \frac{\phi^2}{(\phi+\chi)}\left(4B^{E,E} b_0 + \frac{\alpha\left(b_0 - \hat{b}^{E,E}\right)\left((2-\alpha)b_0 + (4-\alpha)\hat{b}^{E,E} - 2B^{E,E}\right)}{2}\right). $$

The second term inside the parentheses of the expression of (${K_i}^{E,E} - c\delta$) measures the added markup that each newspaper may be able to derive due to the improved match between the added online variant and the preferences of online subscribers. Note that fees are higher when ϕ increases, χ decreases, and b_0 or $B^{E,E}$ increase. Hence, as subscribers care more about confirming reports, less about accuracy, and are more heterogeneous, competition on fees is alleviated. This is also the case when newspapers choose more biased reporting.

Substituting (11) and (13) back into (9) and (10), yields the second stage payoff functions of the newspapers given that both chose to add the online option. Each newspaper chooses its location ${B_i}^{E,E}$ to maximize this second stage payoff function. We illustrate this second stage

optimization by considering only Newspaper *2*. A similar approach is also valid for Newspaper *1*. Using the Envelope Theorem in (10) when optimizing with respect to ${B_2}^{E,E}$, we obtain:

$$\frac{\partial {\pi_2}^{E,E}}{\partial {B_2}^{E,E}} = \frac{\partial {\pi_2}^{E,E}}{\partial {\hat{b}_2}^{E,E}} \frac{\partial {\hat{b}_2}^{E,E}}{\partial {B_2}^{E,E}} + \frac{\partial {\pi_2}^{E,E}}{\partial {b_{indif}}^{E,E}} \frac{\partial {b_{indif}}^{E,E}}{\partial {B_2}^{E,E}} + \frac{\partial {\pi_2}^{E,E}}{\partial {b_{indif}}^{E,E}} \frac{\partial {b_{indif}}^{E,E}}{\partial {P_1}^{E,E}} \frac{\partial {P_1}^{E,E}}{\partial {B_2}^{E,E}} . \quad (15)$$

A change in ${B_2}^{E,E}$ has a direct effect on ${\pi_2}^{E,E}$ via the expressions for ${b_{indif}}^{E,E}$ and ${\hat{b}_2}^{E,E}$ in (5) and (8) and an indirect effect via the effect of Newspaper *2*'s location on the print subscription fee of Newspaper *1*, ${P_1}^{E,E}$ (by the Envelope Theorem the effect on ${P_2}^{E,E}$ and ${K_2}^{E,E}$ vanishes and ${K_1}^{E,E}$ does not affect ${\pi_2}^{E,E}$ at all). We substitute from (5), (8), (11) and (13) in the derivatives on the right hand side of (15) and evaluate the resulting expression at the symmetric equilibrium to obtain a relationship between ${B_2}^{E,E}$ and ${\hat{b}_2}^{E,E}$ as follows:

$$-{B_1}^{E,E} = {B_2}^{E,E} = B^{E,E} = \frac{3}{4b_0}\left(\alpha\left(\hat{b}^{E,E}\right)^2 + (2-\alpha){b_0}^2\right). \quad (16)$$

It is easy to see from (16) that if segmentation arises, namely if $\hat{b}^{E,E} < b_0$, then $B^{E,E} < \frac{3b_0}{2}$. Hence, the bias of the print version declines in comparison to the case that newspapers do not add an online option (the case considered in MS (2005)). This result is not surprising given that each newspaper expanded its product mix to include a variant that is more politically biased. It reduces, therefore, the bias of the product that is chosen by the segment of the consumers who have moderate preferences.

To investigate whether a symmetric equilibrium with segmentation by both newspapers is feasible, we now use (16) to derive conditions under which there exists $\hat{b}^{E,E} \in (0, b_0)$. We designate by $\Delta U_P(b, \hat{b}^{E,E})$ the added utility that a reader having beliefs *b* derives from the print over the online edition, given that the online segment comprises of readers in the interval $\left[\hat{b}^{E,E}, b_0\right]$. At the equilibrium with segmentation, $\Delta {U_P}^*\left(\hat{b}^{E,E}, \hat{b}^{E,E}\right) = 0$, namely the reader of

type $\hat{b}^{E,E}$ is indifferent between the print and online editions. Moreover, for $0 < b < \hat{b}^{E,E}$, readers prefer the print version and $\Delta U_P\left(b, \hat{b}^{E,E}\right) > 0$, and for $\hat{b}^{E,E} < b \leq b_0$ readers prefer the online version and $\Delta U_P\left(b, \hat{b}^{E,E}\right) < 0$. We define by $T \stackrel{\text{def}}{=} c(1-\delta)\frac{(\phi+\chi)}{2\phi^2}$, an adjusted cost advantage measure of the online over the print versions of the product. In Lemma 1 we derive conditions on α and T that support segmentation.

Lemma 1

(i) To support market segmentation at the symmetric equilibrium, $0 < \alpha < \alpha^* \approx 0.376$ *and* $LB_T < T < UB_T$*, where*

$$LB_T \stackrel{\text{def}}{=} \frac{\alpha}{2}(\alpha+1){b_0}^2 \text{ and } \quad UB_T \stackrel{\text{def}}{=} \frac{(4-\alpha)\left(2(\alpha+2)-\sqrt{(4-\alpha)^2-3\alpha(2-\alpha)}\right)^2}{72\alpha}{b_0}^2 .$$

(ii) Otherwise, when $\alpha \geq \alpha^*$ *or if* $T \leq LB_T$*, only the print version of each newspaper can be supported at the equilibrium.*

(iii) If $\alpha < \alpha^*$ *and* $T > UB_T$*, only the online version of each newspaper can be supported at the equilibrium.*

Note that the extension of each newspaper's product mix can be supported only if the extent of discretion given to online readers to generate UGC is relatively moderate. Specifically, the relative control of online readers over the bias of the online edition can be no more than 0.376 of the control of the newspaper itself [11]. Even with such limited discretion awarded to readers, segmentation may still fail unless the adjusted cost advantage of the online version, *T*, lies in the interval specified in part *(i)* of the Lemma. In particular, in the absence of any cost advantage, so that at $T = 0$, each newspaper will choose not to extend its market offering at the symmetric equilibrium. The adjusted cost advantage should be bigger than LB_T, an expression

[11] Recall that the relative weights awarded to the paper and readers in determining B_i^o in (2) are 1 and α, respectively.

that increases with α and b_0. However, the print version of each newspaper might be cannibalized altogether if the cost advantage is extremely big. This happens when $T \geq UB_T$, an expression that increases in α and b_0, once again.

In Table 1, we demonstrate how the limits on the adjusted cost advantage term T change with α and b_0.

$\boldsymbol{\alpha}$	$\boldsymbol{b_0 = 0.1}$		$\boldsymbol{b_0 = 0.5}$		$\boldsymbol{b_0 = 0.9}$	
	Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
$\boldsymbol{\alpha = 0.0001}$	5×10^{-7}	7.8×10^{-7}	1.25×10^{-5}	1.95×10^{-5}	4.1×10^{-5}	6.3×10^{-5}
$\boldsymbol{\alpha = 0.1}$	0.00055	0.00076	0.01375	0.01892	0.04455	0.06130
$\boldsymbol{\alpha = 0.2}$	0.00120	0.00146	0.0300	0.03660	0.0972	0.11859

Table 1: Lower and Upper Limits on $T \stackrel{\text{def}}{=} c(1-\delta)\frac{(\phi+\chi)}{2\phi^2}$

Note that as the control of readers over online bias increases (higher α), the newspaper expects a more significant cost advantage of the online product in order to consider extending its product mix. This result is consistent with earlier findings in the literature (Katz (1984) for instance) that demonstrated the possible reluctance of sellers to diversify their product mix in order to support second degree price discrimination. With second degree price discrimination, buyers are able to retain rents, since they self select among the options offered by the seller. This is especially true in our case, since buyers can endogenously affect the characteristics of the added product to the mix by their ability to generate content for the variant of the product they consume.

In Lemma 2 we further demonstrate that, since each newspaper loses control of the characteristics of its online version due to UGC, when segmentation can be supported, the size of the print segment is bigger than the size of the online segment.

Lemma 2 *When segmentation can be supported at the symmetric equilibrium,* $\frac{b_0}{2} < \hat{b}^{E,E} < b_0$.

Given the results reported in Lemma 2, we can now compare the extent of bias in reporting when newspapers extend their product mix to the bias when only the print version is offered by each newspaper.

Proposition 1 *When both newspapers offer both print and online editions:*

(i) $(B^o)^{E,E} = B^{E,E} + \alpha \frac{(b_0 + \hat{b}^{E,E})}{2} > \frac{3b_0}{2}$,

(ii) $B^{E,E} < \frac{3b_0}{2}$,

(iii) $\frac{B^{E,E}\ \hat{b}^{E,E} + (B^o)^{E,E}\,(b_0 - \hat{b}^{E,E})}{b_0} < \frac{3b_0}{2}$.

Recall that when only the print version is offered, $B^{NE,NE} = \frac{3b_0}{2}$. Hence, extending the product mix to include an online version reduces bias of the print version but increases the bias of the online version. In essence, product diversification facilitates obtaining a better match between the preferences of the readers and the variants of the products they choose to consume. According to part *(iii)* of the Proposition, however, the weighted average bias of each newspaper, with weights determined by the relative market shares of the two editions, declines as a result of segmentation.

Next we investigate how changes in the parameters of the model affect the equilibrium values of $\hat{b}^{E,E}$ and $B^{E,E}$. Notice from (16) that the extent of bias $B^{E,E}$ of the print edition is an increasing function of $\hat{b}^{E,E}$. Hence, any change in a parameter of the model affects the equilibrium level of $B^{E,E}$ in the same direction as it affects the threshold level of the consumer $\hat{b}^{E,E}$ who is indifferent between the print and online versions of each newspaper. When $\hat{b}^{E,E}$ increases readers with more extreme political opinions generate UGC in the online edition. As a

result, the online edition becomes more politically biased, and so does the print edition, which competes against it.

Proposition 2 *If both newspapers offer print and online subscription options:*

(*i*) $\frac{\partial B^{E,E}}{\partial b_0} > 0$, $\frac{\partial B^{E,E}}{\partial \phi} > 0$, $\frac{\partial B^{E,E}}{\partial \chi} < 0$, $\frac{\partial B^{E,E}}{\partial \delta} > 0$, and $\frac{\partial B^{E,E}}{\partial \alpha} > 0$,

(*ii*) $sgn\left\{\frac{\partial \hat{b}^{E,E}}{\partial \zeta}\right\} = sgn\left\{\frac{\partial B^{E,E}}{\partial \zeta}\right\}$, *for any parameter* ζ *of the model,*

(iii) $\frac{\partial \pi_i{}^{E,E}}{\partial \alpha} < 0$.

According to Proposition 2, each newspaper increases the bias of its print edition when the extent of heterogeneity of the readers (b_0) is higher and when readers care more about listening to confirming news (ϕ increases) and less about accurate reporting (χ declines). When readers are more heterogeneous, newspapers have greater incentives to differentiate, which in the context of our model, implies greater bias in reporting. Similarly, when consumers care relatively more about confirming their opinions than accuracy, newspapers respond by introducing greater differentiation (i.e. bias) in order to alleviate price competition. Bias in the print version intensifies also when the segment of consumers who choose the online version shrinks as a result of a decline in the cost advantage of the online edition (δ increases). When this segment shrinks, the bias of the online version intensifies since readers with more extreme opinions provide UGC in this case. As the online version becomes more biased, so does the print version.

Table 2 further illustrates the comparative statics reported in Proposition 2, for fixed values of discretion awarded to readers α and heterogeneity level b_0. We calculate the levels of $\hat{b}^{E,E}$ and $B^{E,E}$ for different values of *T* between the upper and lower bounds given in Table 1. Recall from the definition of *T*, that this variable increases as δ and ϕ decline and/ or as χ increases.

	$b_0 = 0.5$			Market Size (%)	
$\alpha = 0.2$	T	$\hat{b}^{E,E}$	$B^{E,E}$	Online Version of Newspaper *2*	Print Version of Newspaper *2*
	0.0305	0.4950	0.7485	0.5%	49.5%
	0.0330	0.4680	0.7407	3.2%	46.8%
	0.0365	0.4232	0.7287	7.7%	42.3%

Table 2: Comparative Statics with Respect to $T \stackrel{\text{def}}{=} c(1-\delta)\frac{(\phi+\chi)}{2\phi^2}$.

Note that the value of $\hat{b}^{E,E}$ is always greater than $\frac{b_0}{2}$ and the value of $B^{E,E}$ is smaller than $\frac{3b_0}{2}$. In addition, the equilibrium values of $\hat{b}^{E,E}$ and $B^{E,E}$ increase when T is smaller. This happens when the cost advantage of the online edition declines (δ increases), when consumers value confirming news more highly (ϕ increases) and when they place less emphasis on accuracy (χ decreases).

To understand the role of α in explaining the comparative statics reported in Proposition 2, recall from (2) that as α increases, the bias of the online edition intensifies. Hence, readers with more extreme political opinions self select to subscribe to the online version when α increases ($\hat{b}^{E,E}$ increases). Since the bias of the print edition $B^{E,E}$ moves in the same direction as $\hat{b}^{E,E}$, $B^{E,E}$ increases with α. Part (iii) of Proposition 2 states that as the discretion awarded to readers increases, the profits of the newspapers decrease. Bigger values of α translate to a more significant transfer of control from the newspaper to the readers themselves in determining the characteristics of the online version. Such a transfer of control leads to lower profits.

3.2 Only One Newspaper Adds an Online Version

In this section we consider the asymmetric case when only one newspaper extends its product mix. Without any loss of generality, we assume that Newspaper *2* offers both versions and Newspaper *1* offers the print version only. We use the superscripts {*NE*, *E*} to designate this case. Figure 2 depicts the segmentation of the market for such an asymmetric environment.

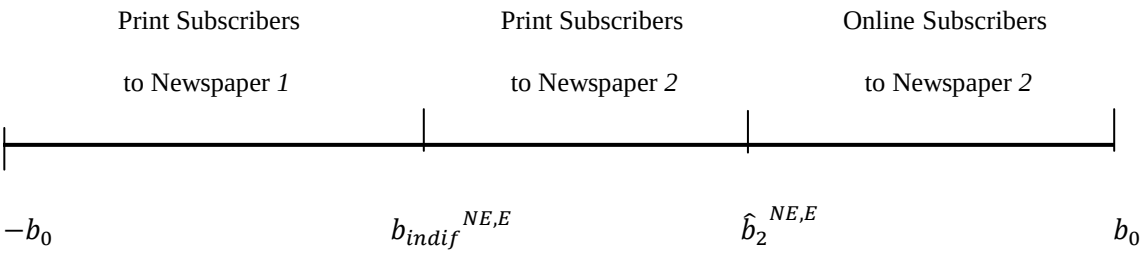

Figure 2: Market Segmentation when only Newspaper *2* Extends Its Product Mix.

Using a similar approach, as in the previous section, the expressions for the threshold consumers $b_{indif}^{NE,E}$ and $\hat{b}_2^{NE,E}$ as functions of the decisions made by the newspapers in the three stages of the game are:

$$b_{indif}^{NE,E} = \frac{(B_1^{NE,E}+B_2^{NE,E})}{2} + \frac{(P_2^{NE,E}-P_1^{NE,E})}{(B_2^{NE,E}-B_1^{NE,E})}\frac{\phi+\chi}{2\phi^2}, \tag{17}$$

$$\hat{b}_2^{NE,E} = \frac{2B_2^{NE,E}-(2-\alpha)b_0}{(4-\alpha)} + \frac{2\sqrt{(B_2^{NE,E}+b_0)^2-\frac{(4-\alpha)}{\alpha}(P_2^{NE,E}-K_2^{NE,E})\frac{(\phi+\chi)}{\phi^2}}}{(4-\alpha)}. \tag{18}$$

The payoff functions of the newspapers are:

$$\pi_1^{NE,E} = \frac{(b_{indif}^{NE,E}+b_0)}{2b_0}\left(P_1^{NE,E}-c\right), \tag{19}$$

$$\pi_2^{NE,E} = \frac{\left(b_0-\hat{b}_2^{NE,E}\right)}{2b_0}\left(K_2^{NE,E}-c\delta\right) + \frac{\left(\hat{b}_2^{NE,E}-b_{indif}^{NE,E}\right)}{2b_0}\left(P_2^{NE,E}-c\right). \tag{20}$$

In the third stage newspapers choose their subscription fees to maximize the above payoff functions. Solving for the print subscription fees as functions of the locations selected in the second stage, we still obtain equations similar to (11), and differentiating (20) with respect to $K_2^{NE,E}$, we obtain the relationship between $K_2^{NE,E}$ and $P_2^{NE,E}$ as in (12). Specifically,

$$K_2^{NE,E} - P_2^{NE,E} = -c(1-\delta) + \frac{\left(b_0 - \hat{b}_2^{NE,E}\right)}{\frac{\partial \hat{b}_2^{NE,E}}{\partial K_2^{NE,E}}}, \quad (21)$$

where the expression for $\hat{b}_2^{NE,E}$ is as derived in (18). In particular, since $\frac{\partial \hat{b}_2^{NE,E}}{\partial K_2^{NE,E}} > 0$ $K_2^{NE,E} - c\delta > P_2^{NE,E} - c$, implying, once again, that the markup on the online version is higher than on the print version. Substituting the optimized values of the subscription fees back into (19) and (20), and optimizing with respect to the locations $B_1^{NE,E}$ and $B_2^{NE,E}$, yields relationships between the locations of the print versions and the threshold reader $\hat{b}_2^{NE,E}$ as follows:

$$B_1^{NE,E} = -\frac{3}{4}\left(b_0 + \sqrt{-\alpha\left(\hat{b}_2^{NE,E}\right)^2 + (1+\alpha){b_0}^2}\right), \quad (22)$$

$$B_2^{NE,E} = \frac{3}{4}\left(5b_0 - 3\sqrt{-\alpha\left(\hat{b}_2^{NE,E}\right)^2 + (1+\alpha){b_0}^2}\right). \quad (23)$$

Proposition 3 follows directly from equations (17), (18), (22), and (23).

Proposition 3 *When Newspaper 1 offers only the print edition and Newspaper 2 offers both the print and online editions:*

(i) $B_1^{NE,E} < -\frac{3}{2}b_0,\ B_2^{NE,E} < B^{E,E} < \frac{3}{2}b_0,$

(ii) $b_{indif}^{NE,E} = \frac{1}{2}\left(b_0 - \sqrt{-\alpha\left(\hat{b}_2^{NE,E}\right)^2 + (1+\alpha){b_0}^2}\right) < 0.$

According to part *(i)* of Proposition 3, since Newspaper *2* extends its product mix while its competitor does not, it chooses to reduce the bias of its print version below the level established when both newspapers extend their lines. Such a choice facilitates Newspaper *2* to steal market share from Newspaper *1*. As a result, Newspaper *1* is forced to shift its location further to the left in order to differentiate itself from the print version of Newspaper *2*. Part *(ii)* of the Proposition states, indeed, that when Newspaper *1* limits its product mix in comparison to

Newspaper *2*, it loses market share, and Newspaper *2* attracts more than 50% of the readers to one of its two editions.

With the characterization of the symmetric and asymmetric cases complete, we can now investigate whether segmenting the market by both newspapers corresponds to a Nash Equilibrium. In Proposition 4, we prove even a stronger result, namely that extending the product mix for each newspaper constitutes a dominant strategy. Unfortunately, in spite of being a dominant strategy, the equilibrium profits of the newspapers are lower with segmentation than if both offer only the print versions of their papers.

Proposition 4

(i) Offering both print and online versions is a dominant strategy for each newspaper. Specifically, for Newspaper 1 $\pi_1^{E,E} > \pi_1^{NE,E}$ *and* $\pi_1^{E,NE} > \pi_1^{NE,NE}$ *, and similarly for Newspaper 2.*

(ii) In spite of being a dominant strategy, the profit of each newspaper are lower with segmentation than if both offer just print editions, namely $\pi_i^{NE,NE} > \pi_i^{E,E}$.

According to Proposition 4, competitive forces lead each newspaper to offer two different versions of the product. The resulting improved segmentation of consumers does not lead, however, to higher profits.

There are two reasons why the profits of the newspapers decline with segmentation. First, note from (14) that equilibrium subscription fees decline when the newspapers reduce the bias of their print editions. Since $B^{E,E} < B^{NE,NE}$, segmentation diminishes the extent of product differentiation between the print editions, and newspapers are forced to compete more aggressively for their print subscribers, thus leading to lower fees. Second, given that online subscribers are active in determining the extent of slant in the online editions, the ability of the

newspapers to extract rents from consumers diminishes, as each newspaper loses some control over the attributes of its extended product line. In spite of the reduced profitability, though, each newspaper is forced to offer the online edition in order to prevent the rival from gaining market share. Such a gain in market share is predicted according to Proposition 3 when one newspaper has a broader product line than its competitor.

In order to further understand the results reported in Proposition 4, next we consider an environment where each newspaper offers both editions but has full control over the bias of the online edition. Essentially, the newspapers do not permit readers to add UGC online. Instead, newspaper *i* has the exclusive rights to choose both B_i and $B_i{}^o$. In Proposition 5 we report that in such an environment, each newspaper eliminates any product differentiation between its print and online editions, thus preventing further segmentation of its readers according to the intensity of their political opinions.

Proposition 5 *When newspapers have the exclusive rights to choose the extent of bias of both the print and online editions, at the equilibrium each newspaper does not introduce any differentiation in the bias of the two editions (i.e.,* $B_i = B_i{}^o$).

In view of the result reported in Proposition 5 it is now easier to explain part *(ii)* of Proposition 4. Specifically, even though at the equilibrium both newspapers choose to extend their product lines by introducing online editions, their profits actually decline in comparison to an environment where both offer only print editions. As readers become involved in generating UGC on the online versions, each newspaper is forced to de-facto offer two differently biased versions of its product. According to Proposition 5, the newspapers would not choose to offer such differentiation if they could fully control the characteristics of both editions.

4. AN ADDITIONAL DIMENSION OF HETEROGENEITY AMONG READERS

In this section we extend our model by allowing for a second dimension of heterogeneity among readers with respect to their preference for the print versus the online editions unrelated to political opinions. As mentioned earlier, this preference may be related, for instance, to the age of the reader, with younger readers usually preferring the online edition, and older readers being more comfortable with the traditional, print edition. Specifically, we assume that the expected utility of a young reader increases by ξ^{young} and that of an older reader decreases by ξ^{old} when choosing the online edition. Modifying (3) we obtain:

$$E[U_b]^{online} = \begin{cases} \bar{u} - \frac{\phi^2}{\phi+\chi}\left[\left(B_i{}^O - b\right)^2\right] - \frac{\chi\phi}{\phi+\chi}[b^2 + \sigma_d{}^2] - K_i + \xi^{young} & if\ reader\ is\ young, \\ \bar{u} - \frac{\phi^2}{\phi+\chi}\left[\left(B_i{}^O - b\right)^2\right] - \frac{\chi\phi}{\phi+\chi}[b^2 + \sigma_d{}^2] - K_i - \xi^{old} & if\ reader\ is\ old. \end{cases}$$

With the above modified expected utility, the threshold reader who is indifferent between the online and print editions of a given newspaper is different for the young and old populations. Specifically, $\hat{b}_1{}^{old} < \hat{b}_1{}^{young}$ and $\hat{b}_2{}^{old} > \hat{b}_2{}^{young}$. For Newspaper *2*, for instance, adjusting (8) yields:

$$\hat{b}_2{}^{young} = \frac{2\,B_2 - (2-a)b_0}{(4-a)} + \frac{2\sqrt{(B_2{}^{NE,E} + b_0)^2 - \frac{(4-\alpha)}{\alpha}(P_2 - K_2 + \xi^{young})\frac{(\phi+\chi)}{\phi^2}}}{(4-a)},$$

$$\hat{b}_2{}^{old} = \frac{2\,B_2 - (2-a)b_0}{(4-a)} + \frac{2\sqrt{(B_2{}^{NE,E} + b_0)^2 - \frac{(4-\alpha)}{\alpha}(P_2 - K_2 - \xi^{old})\frac{(\phi+\chi)}{\phi^2}}}{(4-a)}.$$

We assume that the populations of young and old readers are still each uniformly distributed on the interval [$-b_0, b_0$] according to their political opinions, and that these distributions are independent of age. The proportions of young and old in the general population of readers are (*1-q*) and *q*, respectively. In Proposition 6, we demonstrate that adding a second dimension of heterogeneity, unrelated to political preferences, intensifies bias of the print

editions of the newspapers and leads to an overall reduction in the expected size of the online segment.

Proposition 6

When there exists an additional dimension of reader heterogeneity, unrelated to political opinions, each newspaper chooses to intensify the bias of its print edition and the expected size of the online segment declines. Moreover, when the variability in the population that is unrelated to political opinions increases (i.e., when $q(1-q)$ *and* $(\hat{b}_{2_{old}} - \hat{b}_{2_{young}})$ *are bigger), the polarization of the newspapers becomes more significant.*

The result reported in Proposition 6 is consistent with that reported in Proposition 5. According to Proposition 5, if newspapers could fully control the bias of their online editions, they would choose it to be identical to the bias of their print editions. Once some of this control is transferred to readers via UGC, the political segmentation of readers leads to intensified bias of the online version and reduced bias of the print version. However, if there is additional heterogeneity among readers that is unrelated to politics, newspapers can move closer to the outcome they would choose if they had full control over the characteristics of the online editions. Specifically, the bias of the print version moves closer to $-\frac{3}{2}b_0$ and $\frac{3}{2}b_0$ for newspapers *1* and *2*, respectively. As well, the segment of consumers who choose the more biased online editions shrinks. Moreover, as the variability in the population that is unrelated to political opinions increases, the equilibrium moves closer to that described in Proposition 5, when newspapers have the exclusive right to choose the online bias.

5. CONCLUDING REMARKS

Over the past decade news media have been increasingly publishing opinions and news stories of their readers. This is facilitated by online editions which provide technical capabilities for

readers to add their own content to the publications. In this paper, we investigate a newspaper's decision to extend its product line to include an online edition that incorporates such UGC and the impact of this product mix expansion on news reporting.

We show that extending the product line to include online editions leads to increased bias of the online editions and reduced bias of the print editions. The intensified bias of the online edition is primarily generated by the readers themselves who choose to add content to this variant of the product. Since readers with more extreme political opinions subscribe to the online editions, the print editions reduce their bias in news reporting in order to appeal to moderate readers. This, in turn, causes reduced product differentiation between the print editions of competing newspapers, thus putting downward pressure on their subscription fees. We find that when the newspapers add online editions to their product lines this decline in subscription fees leads to an overall reduction in the profitability of the newspapers. In spite of such reduced profitability, at the equilibrium each newspaper chooses to include an online edition in order to avoid losing market share to the competing newspaper.

Our model assumes that subscription fees are the sole source of revenue for the newspapers and that the market of readers is fully covered. In the Web Appendix, we investigate the implications of relaxing each of these two model assumptions. We show that if the revenues of online editions stem from advertising instead of subscription fees, newspapers' profits decline even further when adding the online variants. When advertising is added as a source of revenue, newspapers moderate their bias in order to deliver larger readerships to advertisers. As a result, the extent of differentiation between the newspapers declines and downward pressure on subscription fees intensifies. However, our results also show that the profits of each newspaper may rise with the introduction of an online edition if adding such editions allows the papers to

expand their readership. Specifically, if in the absence of offering the online editions the market of readers is not fully covered.

In addition to the two extensions that we investigate in the Web Appendix, our model can be extended in several other directions. First, we focus on only two characteristics that distinguish the print from the online version: cost of production and the UGC component that is added to the online version. In future research it may be worthwhile to investigate other attributes of the two versions that might determine the consumers' choice between them. For instance, we assume that the accuracy of the data that is available to the two editions is the same. However, one can argue that the print edition provides higher accuracy reporting[12] than the online edition due to the newspaper's reduced control over the content generated by users. This may translate to reduced market share of the online version and, therefore, increased bias of the print version.

Second, in our analysis we do not explicitly allow newspapers to offer a subscription to a bundle that consists of both the print and online editions. If such a bundle is considered by all customers to be superior to a subscription to only one variant of the product, an element of vertical product differentiation has to be incorporated in the analysis. We conjecture that adding such a universal preference in favor of the bundle is likely to reduce the segment of subscribers who choose exclusively the print edition. As a result, a bigger number of readers will have access to the online version, including those who have relatively moderate opinions. Given the likely moderation of opinions of readers with access to the online version, we predict an overall reduction in the extent of bias when the bundle is added as an explicit option to the product line.

Finally, we have assumed that readers are uniformly distributed according to their political opinions. We do not expect our qualitative results to change dramatically for different

[12] In our model we assume identical accuracy, as measured by σ_ε, for both editions.

distribution functions. If the distribution of readers is tilted towards moderate opinions, for instance, the profitability of adding an online version is likely to decline. However, competitive forces may still induce each newspaper to offer an online edition in order to avoid losing market share to the competitor.

APPENDIX

Proof of Lemma 1: In order to support segmentation the expression inside the radicals in (7) and (8) (the discriminants of the quadratic equations) have to be positive. From (8) for $\sqrt{(B_2{}^{E,E} + b_0)^2 - \frac{(4-\alpha)(P_2{}^{E,E} - K_2{}^{E,E})}{\alpha}\frac{(\phi+\chi)}{\phi^2}} > 0$, we need,therefore:

$$(4-\alpha)\hat{b}_2{}^{E,E} - 2\,B_2{}^{E,E} + (2-\alpha)b_0 > 0. \qquad \text{(A.1)}$$

Using (16) in (A.1), the last inequality is satisfied when $\frac{(4-a)-\sqrt{(4-a)^2-6a+3a^2}}{3a}b_0 < \hat{b}_2{}^{E,E} < \frac{(4-a)+\sqrt{(4-a)^2-6a+3a^2}}{3a}b_0$. Notice that $\frac{(4-a)-\sqrt{(4-a)^2-6a+3a^2}}{3a}b_0 > 0$ and $\frac{(4-a)+\sqrt{(4-a)^2-6a+3a^2}}{3a}b_0 > b_0$ for $0 < \alpha < 1$. Thus, $\frac{(4-a)-\sqrt{(4-a)^2-6a+3a^2}}{3a}b_0 < \hat{b}_2{}^{E,E} < b_0$. The restrictions for Newspaper *1* are similarly found. Thus, $\frac{(4-\alpha)-\sqrt{(4-\alpha)^2-6\alpha+3\alpha^2}}{3\alpha}b_0 \stackrel{\text{def}}{=} \underline{\hat{b}^{E,E}} < \hat{b}^{E,E} < \overline{\hat{b}^{E,E}} \stackrel{\text{def}}{=} b_0$.

We define $H(\hat{b}^{E,E})$ as the function obtained by multiplying $\Delta U_P{}^*(\hat{b}^{E,E}, \hat{b}^{E,E})$ by $\frac{(\phi+\chi)}{2\phi^2}$, then: $H(\hat{b}^{E,E}) \stackrel{\text{def}}{=} \frac{(\phi+\chi)}{2\phi^2}\,\Delta U_P{}^*(\hat{b}^{E,E}, \hat{b}^{E,E}) = \frac{\alpha}{8}\left(2\hat{b}^{E,E}(4B^{E,E} + \alpha b_0) + (4-\alpha)\left(-3\hat{b}^{E,E}{}^2 + b_0^2\right)\right) - T = 0$. Note that for $\alpha \in [0,1]$, $H(\cdot)$ is a concave function of $\hat{b}^{E,E}$, implying that it can change sign from positive to negative at most once. To guarantee that a root to the equation $H(\hat{b}^{E,E}) = 0$ exists, we investigate whether $H(\cdot)$ changes its sign from positive to negative over the interval $\left(\underline{\hat{b}^{E,E}}, \overline{\hat{b}^{E,E}}\right)$ Specifically, whether $H(\underline{\hat{b}^{E,E}}) > 0$ and $H\left(\overline{\hat{b}^{E,E}}\right) < 0$. Evaluating the function $H(\cdot)$ at $\underline{\hat{b}^{E,E}}$ and $\overline{\hat{b}^{E,E}}$ yields:

$$H(\underline{\hat{b}^{E,E}}) = \frac{(4-\alpha)\left(2(a+2)-\sqrt{(4-\alpha)^2-3\alpha(2-\alpha)}\right)^2}{72\alpha}b_0{}^2 - T, \text{ and} \qquad \text{(A.2)}$$

$$H\left(\overline{\hat{b}^{E,E}}\right) = \frac{\alpha}{2}(\alpha+1)b_0{}^2 - T\,. \qquad \text{(A.3)}$$

Requiring that $H\left(\underline{\hat{b}^{E,E}}\right) > 0$ and $H\left(\overline{\hat{b}^{E,E}}\right) < 0$ yields: $LB_T \equiv \frac{\alpha}{2}(\alpha+1){b_0}^2 < T < \frac{(4-\alpha)\left(2(a+2)-\sqrt{(4-\alpha)^2-3a(2-a)}\right)^2}{72\alpha}{b_0}^2 \equiv UB_T$. $LB_T < \mathrm{UB_T}$ if and only if $0 < \alpha < \alpha^* \approx 0.376$.

Proof of Lemma 2: Note that the function $H(.)$ is concave because $\frac{\partial^2 H\left(\hat{b}^{E,E}\right)}{\partial\left(\hat{b}^{E,E}\right)^2} = \frac{\alpha}{4}\left(\frac{18\alpha}{b_0}\hat{b}^{E,E} - 3(4-\alpha)\right) < 0$ when $\alpha < \alpha^*$ and $\hat{b}^{E,E} < b_0$. It obtains its maximum value in the range [0, b_0] at $\hat{b}^{E,E}{}_{\max} \equiv \frac{(4-\alpha)-\sqrt{(4-\alpha)^2-8\alpha(3-\alpha)}}{6\alpha}b_0$. It is easy to show that $\underline{\hat{b}^{E,E}} < \frac{b_0}{2} < \hat{b}^{E,E}{}_{\max} < b_0$. Because $H\left(\underline{\hat{b}^{E,E}}\right) > 0$ from Lemma 1, it follows that $H\left(\hat{b}^{E,E}{}_{\max}\right) > 0$ as well. The threshold reader who is indifferent between the print and the online editions satisfies the equation $H\left(\hat{b}^{E,E}\right) = 0$. It follows, therefore, that the root of the last equation is bigger than $\frac{b_0}{2}$.

Proof of Proposition 1: From (9) and (10) optimizing with respect to the subscription prices ${P_1}^{E,E}$, ${K_1}^{E,E}$ ${P_2}^{E,E}$, and ${K_2}^{E,E}$ yields the following first order conditions:

$$\frac{\partial \pi_1{}^{E,E}}{\partial {K_1}^{E,E}} = \frac{1}{2b_0}\left(\left(\frac{\partial \hat{b}_1{}^{E,E}}{\partial {K_1}^{E,E}}\right)\left(\left({K_1}^{E,E} - c\delta\right) - \left({P_1}^{E,E} - c\right)\right) + \left(b_0 + \hat{b}_1{}^{E,E}\right)\right) = 0, \quad \text{(A.4)}$$

$$\frac{\partial \pi_1{}^{E,E}}{\partial {P_1}^{E,E}} = \frac{1}{2b_0}\left(\left(\frac{\partial \hat{b}_1{}^{E,E}}{\partial {P_1}^{E,E}}\right)\left(\left({K_1}^{E,E} - c\delta\right) - \left({P_1}^{E,E} - c\right)\right) + \frac{\partial {b_{indif}}^{E,E}}{\partial {P_1}^{E,E}}\left({P_1}^{E,E} - c\right) + \left({b_{indif}}^{E,E} - \hat{b}_1{}^{E,E}\right)\right) = 0, \quad \text{(A.5)}$$

$$\frac{\partial \pi_2{}^{E,E}}{\partial {K_2}^{E,E}} = \frac{1}{2b_0}\left(\left(-\frac{\partial \hat{b}_2{}^{E,E}}{\partial {K_2}^{E,E}}\right)\left(\left({K_2}^{E,E} - c\delta\right) - \left({P_2}^{E,E} - c\right)\right) + \left(b_0 - \hat{b}_2{}^{E,E}\right)\right) = 0, \quad \text{(A.6)}$$

$$\frac{\partial \pi_2{}^{E,E}}{\partial {P_2}^{E,E}} = \frac{1}{2b_0}\left(\left(-\frac{\partial \hat{b}_2{}^{E,E}}{\partial {P_2}^{E,E}}\right)\left(\left({K_2}^{E,E} - c\delta\right) - \left({P_2}^{E,E} - c\right)\right) - \left(\frac{\partial {b_{indif}}^{E,E}}{\partial {P_2}^{E,E}}\right)\left({P_2}^{E,E} - c\right) + \left(\hat{b}_2{}^{E,E} - {b_{indif}}^{E,E}\right)\right) = 0. \quad \text{(A.7)}$$

According to (7) $\frac{\partial \hat{b}_1{}^{E,E}}{\partial {K_1}^{E,E}} = -\frac{\partial \hat{b}_1{}^{E,E}}{\partial {P_1}^{E,E}}$. Using this relation and summing (A.4) and (A.5), we get:

$${P_1}^{E,E} - c = -\frac{\left(b_0 + {b_{indif}}^{E,E}\right)}{\frac{\partial {b_{indif}}^{E,E}}{\partial {P_1}^{E,E}}}. \quad \text{(A.8)}$$

Substituting into (A.8) we obtain:

$${P_1}^{E,E} = \frac{c}{2} - \frac{\phi^2}{\phi+\chi}\left({B_1}^{E,E} - {B_2}^{E,E}\right)\left(b_0 + \frac{{B_2}^{E,E} + {B_1}^{E,E}}{2}\right) + \frac{{P_2}^{E,E}}{2}. \quad \text{(A.9)}$$

Using a similar approach, the subscription fee for the print edition of Newspaper *2* can be derived as:

$$P_2^{E,E} = \frac{c}{2} - \frac{\phi^2}{\phi+\chi}\left(B_1^{E,E} - B_2^{E,E}\right)\left(b_0 - \frac{B_2^{E,E}+B_1^{E,E}}{2}\right) + \frac{P_1^{E,E}}{2}. \quad \text{(A.10)}$$

Solving (A9) and (A10) for $P_1^{E,E}$ and $P_2^{E,E}$ we get the expressions in (11). Rewriting (A.4) as $\left(K_1^{E,E} - c\delta\right) - \left(P_1^{E,E} - c\right) = -\frac{\left(\hat{b}_1^{E,E}+b_0\right)}{\frac{\partial \hat{b}_1^{E,E}}{\partial K_1^{E,E}}}$, and substituting $\frac{\partial \hat{b}_1^{E,E}}{\partial K_1^{E,E}} = \frac{(\phi+\chi)}{\phi^2}\frac{1}{\frac{\alpha}{2}\left(\alpha b_0 - 2\left(B_1^{E,E}+b_0\right)+\hat{b}_1^{E,E}(4-\alpha)\right)}$ from (7), we obtain:

$$\left(K_1^{E,E} - c\delta\right) - \left(P_1^{E,E} - c\right) = \frac{\phi^2}{(\phi+\chi)}\frac{\alpha\left(\hat{b}_1^{E,E}+b_0\right)\left((2-\alpha)b_0 - \hat{b}_1^{E,E}(4-\alpha) + 2B_1^{E,E}\right)}{2}. \quad \text{(A.11)}$$

Using a similar approach for Newspaper *2* we find:

$$\left(K_2^{E,E} - c\delta\right) - \left(P_2^{E,E} - c\right) = \frac{\phi^2}{(\phi+\chi)}\frac{\alpha\left(b_0 - \hat{b}_2^{E,E}\right)\left((2-\alpha)b_0 + \hat{b}_2^{E,E}(4-\alpha) - 2B_2^{E,E}\right)}{2}. \quad \text{(A.12)}$$

Substituting the equilibrium strategies back into the profit functions (9) and (10), we obtain the second stage profit function $V_i^{E,E}(B_i^{E,E}, B_j^{E,E})$. From the Envelope Theorem:

$$\frac{\partial V_1^{E,E}}{\partial B_1^{E,E}} = \frac{\partial \pi_1^{E,E}}{\partial B_1^{E,E}} + \frac{\partial \pi_1^{E,E}}{\partial P_2^{E,E}}\frac{\partial P_2^{E,E}}{\partial B_1^{E,E}} = 0 \quad \text{(A.13)}$$

$$\frac{\partial V_2^{E,E}}{\partial B_2^{E,E}} = \frac{\partial \pi_2^{E,E}}{\partial B_2^{E,E}} + \frac{\partial \pi_2^{E,E}}{\partial P_1^{S,S}}\frac{\partial P_1^{E,E}}{\partial B_2^{E,E}} = 0. \quad \text{(A.14)}$$

To illustrate the derivation of the equilibrium location choices, we focus on the optimization of Newspaper *2*. From (10): $\frac{\partial V_2^{E,E}}{\partial B_2^{E,E}} = \frac{1}{2b_0}$

$$\left(-\frac{\partial \hat{b}_2^{E,E}}{\partial B_2^{E,E}}\left(\left(K_2^{E,E} - c\delta\right) - \left(P_2^{E,E} - c\right)\right) - \left(\frac{\partial b_{indif}^{E,E}}{\partial B_2^{E,E}} + \frac{\partial b_{indif}^{E,E}}{\partial P_1^{E,E}}\frac{\partial P_1^{E,E}}{\partial B_2^{E,E}}\right)\left(P_2^{E,E} - c\right)\right) = 0 \quad \text{(A.15)}$$

Using $\frac{\partial b_{indif}^{E,E}}{\partial B_2^{E,E}} = \frac{1}{2} + \frac{\left(B_2^{E,E}+B_1^{E,E}\right)}{3\left(B_2^{E,E}-B_1^{E,E}\right)}$, $\frac{\partial \hat{b}_2^{E,E}}{\partial B_2^{E,E}} = \frac{2}{(4-\alpha)}\left(1 + \frac{2\left(B_2^{E,E}+b_0\right)}{\left((2-\alpha)b_0 + \hat{b}_2^{E,E}(4-\alpha) - 2B_2^{E,E}\right)}\right)$, and $\frac{\partial P_1^{E,E}}{\partial B_2^{E,E}} = \frac{2\phi^2}{(\phi+\chi)}\left(\frac{B_2^{E,E}}{3} + b_0\right)$ from (5), (8), and (11) in (A.15) yields: $\frac{\partial V_2^{E,E}}{\partial B_2^{E,E}} = 0 =$

$$\frac{\phi^2}{2b_0(\phi+\chi)}\left(-\left(b_0 + \hat{b}_2^{E,E}\right)\alpha\left(b_0 - \hat{b}_2^{E,E}\right) - \left(\frac{\left(B_1^{E,E} - 3B_2^{E,E} + 6b_0\right)}{6}\right)\left(\frac{\left(B_1^{E,E}+B_2^{E,E}\right)}{3} - 2b_0\right)\right). \quad \text{(A.16)}$$

At the symmetric equilibrium, $-B_1^{E,E} = B_2^{E,E}$, therefore, we can replace $-B_1^{E,E}$ with $B_2^{E,E}$ in (A.16) and solve for $B_2^{E,E}$:

$$-B_1{}^{E,E} = B_2{}^{E,E} = \frac{3}{4b_0}\left((2-\alpha){b_0}^2 + \alpha\left(\hat{b}_2{}^{E,E}\right)^2\right) = \frac{3}{2}b_0 - \frac{3\alpha}{4b_0}\left({b_0}^2 - \left(\hat{b}_2{}^{E,E}\right)^2\right). \quad \text{(A.17)}$$

Notice that $\hat{b}_2{}^{E,E} < b_0$ implies $-B_1{}^{E,E} = B_2{}^{E,E} \stackrel{\text{def}}{=} B^{E,E} < B^{NE,NE} = \frac{3}{2}b_0$. Further,

$(B^o)^{E,E} = B^{E,E} + \alpha\frac{(b_0+\hat{b}^{E,E})}{2} = \frac{3(2-\alpha)b_0}{4} + \frac{3\alpha\left(\hat{b}^{E,E}\right)^2}{4b_0} + \alpha\frac{(b_0+\hat{b}^{E,E})}{2}$

$> \frac{3(2-\alpha)b_0}{4} + \frac{3\alpha b_0}{16} + \frac{3\alpha b_0}{4} = \frac{3(8+\alpha)b_0}{16} > B^{NE,NE} = \frac{3b_0}{2}$, since $\hat{b}^{E,E} > \frac{b_0}{2}$. Finally,

$\frac{B^{E,E}\ \hat{b}^{E,E} + (B^o)^{E,E}\left(b_0-\hat{b}^{E,E}\right)}{b_0} = B^{E,E} + \frac{\left(b_0-\ \hat{b}^{E,E}\right)}{b_0}(\alpha\frac{(b_0+\ \hat{b}^{E,E})}{2})$

$= \frac{3b_0}{2} - \frac{\alpha}{4b_0}\left({b_0}^2 - \left(\ \hat{b}^{E,E}\right)^2\right) < B^{NE,NE} = \frac{3b_0}{2}$ since $b_0 > \ \hat{b}^{E,E}$.

Proof of Proposition 2: First observe from (16) that $\frac{\partial B^{E,E}}{\partial \hat{b}^{E,E}} = \frac{3\alpha\hat{b}^{E,E}}{2b_0} > 0$. From the proofs of Lemmas 1 and 2 we know $\frac{H(\hat{b}^{E,E})}{\partial \hat{b}^{E,E}} < 0$ when $H\left(\hat{b}^{E,E}\right) = 0$, given that $H(\cdot)$ changes its sign from positive to negative at this point. Using the Implicit Function Theorem we can write:

$\frac{\partial \hat{b}^{E,E}}{\partial \zeta} = -\frac{\frac{\partial H\left(\hat{b}^{E,E}\right)}{\partial \zeta}}{\frac{\partial H(\hat{b}^{E,E})}{\partial \hat{b}^{E,E}}}, \zeta = \phi, \chi, b_0, \delta$ or α. It is immediate from the expression derived for $H(\cdot)$ that $sgn\left\{\frac{\partial H(\hat{b}^{E,E})}{\partial \phi}\right\} > 0, sgn\left\{\frac{\partial H(\hat{b}^{E,E})}{\partial \delta}\right\} > 0$ and , $sgn\left\{\frac{\partial H(\hat{b}^{E,E})}{\partial \chi}\right\} < 0$. Thus, $\frac{\partial \hat{b}^{E,E}}{\partial \phi}, \frac{\partial B^{E,E}}{\partial \phi} > 0$, $\frac{\partial \hat{b}^{E,E}}{\partial \delta}, \frac{\partial B^{E,E}}{\partial \delta} > 0$, and $\frac{\partial \hat{b}^{E,E}}{\partial \chi}, \frac{\partial \mathrm{B}^{E,E}}{\partial \chi} < 0$.

Notice that $sgn\left\{\frac{\partial \hat{b}^{E,E}}{\partial b_0}\right\} = sgn\left\{\frac{\partial H(\hat{b}^{E,E})}{\partial b_0}\right\} = sgn\left\{\alpha\frac{\phi^2\left(-3\alpha\left(\hat{b}^{E,E}\right)^3 + 2(3-\alpha)\hat{b}^{E,E}{b_0}^2 + (4-\alpha){b_0}^3\right)}{2{b_0}^2(\phi+\chi)}\right\} > 0$.

Thus, using (16) $\frac{\partial B^{E,E}}{\partial b_0} = \frac{3(2-\alpha)}{2} - \frac{3}{4{b_0}^2}\left((2-\alpha){b_0}^2 + \alpha\left(\hat{b}^{E,E}\right)^2\right) + \frac{3\alpha\hat{b}^{E,E}}{2b_0}\frac{\partial \hat{b}^{E,E}}{\partial b_0} = \frac{3(2-\alpha)}{4} - \frac{3\alpha}{4}\frac{\left(\hat{b}^{E,E}\right)^2}{{b_0}^2} + \frac{3\alpha\hat{b}^{E,E}}{2b_0}\frac{\partial \hat{b}^{E,E}}{\partial b_0} > 0$.

Again from (16), $\frac{\partial B^{E,E}}{\partial \alpha} = \frac{3}{4b_0}\left(2\alpha\hat{b}^{E,E}\frac{\partial \hat{b}^{E,E}}{\partial \alpha} + \left(\hat{b}^{E,E}\right)^2 - {b_0}^2\right)$, which implies: $\frac{\partial B^{E,E}}{\partial \alpha} = \frac{3}{4b_0}\left(-\frac{2\alpha\hat{b}^{E,E}\frac{\partial H\left(\hat{b}^{E,E}\right)}{\partial \alpha}}{\frac{\partial H(\hat{b}^{E,E})}{\partial \hat{b}^{E,E}}} + \left(\left(\hat{b}^{E,E}\right)^2 - {b_0}^2\right)\right)$. Substituting for $\frac{\partial H(\hat{b}^{E,E})}{\partial \hat{b}^{E,E}}$ and $\frac{\partial H(\hat{b}^{E,E})}{\partial \alpha}$ into this expression, we obtain:

$$\frac{\partial B^{E,E}}{\partial \alpha} = -\frac{3}{4b_0}\left(\frac{3\alpha\left(\hat{b}^{E,E}\right)^4 + 3\alpha\left(\hat{b}^{E,E}\right)^3 b_0 + \left(3(2+\alpha)\hat{b}^{E,E} - (2+\alpha)b_0\right)\hat{b}^{E,E}{b_0}^2 + 2(3-\alpha){b_0}^3\left(b_0-\hat{b}^{E,E}\right)}{9\alpha\left(\hat{b}^{E,E}\right)^2 - 3(4-\alpha)\hat{b}^{E,E}b_0 + 2(3-\alpha){b_0}^2}\right). \quad \text{(A.18)}$$

Notice that the denominator in (A.18) is negative since $\frac{\partial H(\hat{b}^{E,E})}{\partial \hat{b}^{E,E}} < 0$. In the numerator, $3(2+\alpha)\hat{b}^{E,E} - (2+\alpha)b_0 > 0$ since $\hat{b}^{E,E} > \frac{b_0}{2}$. Thus, $\frac{\partial B^{E,E}}{\partial \alpha} > 0$. As well, $sgn\left\{\frac{\partial \hat{b}^{E,E}}{\partial \alpha}\right\} = sgn\left\{\frac{\partial H(\hat{b}^{E,E})}{\partial \alpha}\right\} > 0$ in the region $\hat{b}^{E,E} \in (\frac{b_0}{2}, b_0)$.

Finally, $\frac{\partial {\pi_2}^{E,E}}{\partial \alpha} = \frac{1}{2b_0}\left(-\frac{\partial \hat{b}_2^{E,E}}{\partial \alpha}\left(\left({K_2}^{E,E} - c\delta\right) - \left({P_2}^{E,E} - c\right)\right)\right) < 0$ since $\frac{\partial \hat{b}_2^{E,E}}{\partial \alpha} > 0$ and $\left({K_2}^{E,E} - c\delta\right) - \left({P_2}^{E,E} - c\right) = \frac{\phi^2}{(\phi+\chi)}\frac{\alpha\left(b_0 - \hat{b}_2^{E,E}\right)\left((2-\alpha)b_0 + \hat{b}_2^{E,E}(4-\alpha) - 2\,{B_2}^{E,E}\right)}{2} > 0$ given that $\hat{b}_2^{E,E} > \frac{b_0}{2}$.

Proof of Proposition 3: From (19) and (20) optimizing with respect to ${P_i}^{NE,E}, i = 1,2,$ and ${K_2}^{NE,E}$, yields expressions similar to those derived when both newspapers extend their product lines. Specifically, similar expressions to (11) and (A.12), as follows:

$${P_1}^{NE,E} - c = \frac{\phi^2}{(\phi+\chi)}\left({B_2}^{NE,E} - {B_1}^{NE,E}\right)\left(\frac{\left({B_1}^{NE,E} + {B_2}^{NE,E}\right)}{3} + 2b_0\right), \quad \text{(A.19)}$$

$${P_2}^{NE,E} - c = \frac{\phi^2}{(\phi+\chi)}\left({B_2}^{NE,E} - {B_1}^{NE,E}\right)\left(-\frac{\left({B_1}^{NE,E} + {B_2}^{NE,E}\right)}{3} + 2b_0\right), \text{ and} \quad \text{(A.20)}$$

$$\left({K_2}^{NE,E} - c\delta\right) - \left({P_2}^{NE,E} - c\right) = \frac{\phi^2}{(\phi+\chi)}\frac{\alpha\left(b_0 - \hat{b}_2^{NE,E}\right)\left((2-\alpha)b_0 + \hat{b}_2^{NE,E}(4-\alpha) - 2\,{B_2}^{NE,E}\right)}{2}. \quad \text{(A.21)}$$

Substituting the equilibrium strategies back into the profit functions (19) and (20), we obtain the second stage profit function $V_i^{NE,E}({B_i}^{NE,E}, {B_j}^{NE,E})$. Differentiating with respect to the locations yields from the Envelope Theorem that: $\frac{\partial {V_1}^{NE,E}}{\partial {B_1}^{NE,E}} = \frac{\partial {\pi_1}^{NE,E}}{\partial {B_1}^{NE,E}} + \frac{\partial {\pi_1}^{NE,E}}{\partial {P_2}^{P,S}}\frac{\partial {P_2}^{NE,E}}{\partial {B_1}^{NE,E}} =$

$$\frac{1}{2b_0}\left(\frac{\partial {b_{indif}}^{NE,E}}{\partial {B_1}^{NE,E}} + \frac{\partial {b_{indif}}^{NE,E}}{\partial {P_2}^{NE,E}}\frac{\partial {P_2}^{NE,E}}{\partial {B_1}^{NE,E}}\right)\left({P_1}^{NE,E} - c\right) = 0, \text{ and} \quad \text{(A.22)}$$

$$\frac{\partial {V_2}^{NE,E}}{\partial {B_2}^{NE,E}} = \frac{\partial {\pi_2}^{NE,E}}{\partial {B_2}^{NE,E}} + \frac{\partial {\pi_2}^{NE,E}}{\partial {P_1}^{NE,E}}\frac{\partial {P_1}^{NE,E}}{\partial {B_2}^{NE,E}} = \frac{1}{2b_0}\left(-\frac{\partial \hat{b}_2^{NE,E}}{\partial {B_2}^{NE,E}}\left(\left({K_2}^{NE,E} - c\delta\right) - \left({P_2}^{NE,E} - c\right)\right) -$$

$$\left(\frac{\partial {b_{indif}}^{NE,E}}{\partial {B_2}^{NE,E}} + \frac{\partial {b_{indif}}^{NE,E}}{\partial {P_1}^{NE,E}}\frac{\partial {P_1}^{NE,E}}{\partial {B_2}^{NE,E}}\right)\left({P_2}^{NE,E} - c\right)\right) = 0. \quad \text{(A.23)}$$

Substituting (A.19) and (A.20) in (17) yields:

$$\frac{\partial {b_{indif}}^{NE,E}}{\partial {B_1}^{NE,E}} = \frac{\left(-5{B_1}^{NE,E} + {B_2}^{NE,E}\right)}{6\left({B_2}^{NE,E} - {B_1}^{NE,E}\right)}. \quad \text{(A.24)}$$

From (A.20):

$$\frac{\partial {P_2}^{NE,E}}{\partial {B_1}^{NE,E}} = \frac{\phi^2}{(\phi+\chi)}\left(\frac{2{B_1}^{NE,E}}{3} - 2b_0\right). \quad \text{(A.25)}$$

Substituting (A.19), (A.24) and (A.25) into (A.22) we obtain:

$${B_1}^{NE,E} = \frac{{B_2}^{NE,E}}{3} - 2b_0. \quad \text{(A.26)}$$

According to (17) $\frac{\partial {b_{indif}}^{NE,E}}{\partial {P_2}^{NE,E}} = -\frac{\partial {b_{indif}}^{NE,E}}{\partial {P_1}^{NE,E}}$. Substituting in (A.23) the last relation, (A.20), (A.21), the fact that from (17) $\frac{\partial {b_{indif}}^{NE,E}}{\partial {B_2}^{NE,E}} = \frac{\left(5{B_2}^{NE,E} - {B_1}^{NE,E}\right)}{6\left({B_2}^{NE,E} - {B_1}^{NE,E}\right)}$ and $\frac{\partial {b_{indif}}^{NE,E}}{\partial {P_1}^{NE,E}} = -\frac{\phi+\chi}{2\phi^2}\frac{1}{\left({B_2}^{NE,E} - {B_1}^{NE,E}\right)}$, and from (A.19) $\frac{\partial {P_1}^{NE,E}}{\partial {B_2}^{NE,E}} = \frac{2\phi^2}{(\phi+\chi)}\left(\frac{{B_2}^{NE,E}+3b_0}{3}\right)$ yields a quadratic equation in ${B_2}^{NE,E}$ as follows:

$$-\frac{1}{162b_0}\frac{\phi^2}{(\phi+\chi)}\left((16\left({B_2}^{NE,E}\right)^2 - 120{B_2}^{NE,E}b_0 + 81\alpha\left({\hat{b}_2}^{NE,E}\right)^2 + 9(16-9\alpha){b_0}^2)\right) = 0. \quad \text{(A.27)}$$

Solving (A.27) for ${B_2}^{NE,E}$ and choosing the root to ensure that $\frac{\partial {B_2}^{NE,E}}{\partial {\hat{b}_2}^{NE,E}} > 0$, we obtain ${B_2}^{NE,E}$ as given in (23). Substituting (23) in (A.26), we obtain ${B_1}^{NE,E}$ as expressed in (22). From these solutions, it follows that ${B_1}^{NE,E} < -\frac{3}{2}b_0$, and ${B_2}^{NE,E} < \frac{3}{2}b_0$, since ${\hat{b}_2}^{NE,E} < \mathrm{b}_0$.

In order to demonstrate that ${B_2}^{NE,E} < B^{E,E}$, we will first show that ${\hat{b}_2}^{NE,E} < \hat{b}^{E,E}$. Note that the solution for ${\hat{b}_2}^{NE,E}$ can be obtained implicitly as in the proof of Lemma 1 as follows:

$$G\left({\hat{b}_2}^{NE,E}\right) \stackrel{\text{def}}{=} \frac{\alpha}{8}\left(2{\hat{b}_2}^{NE,E}\left(4{B_2}^{NE,E} + \alpha b_0\right) + (4-\alpha)\left(-3\left({\hat{b}_2}^{NE,E}\right)^2 + b_0^2\right)\right) - T = 0, \quad \text{(A.28)}$$

where ${B_2}^{NE,E}$ is expressed in terms of ${\hat{b}_2}^{NE,E}$ in (23). Notice that

$$B^{E,E} = \frac{3}{4b_0}\left(\alpha\left(\hat{b}^{E,E}\right)^2 + (2-\alpha)b_0^2\right) > \frac{3}{4}\left(5b_0 - 3\sqrt{-\alpha\left({\hat{b}_2}^{E,E}\right)^2 + (1+\alpha){b_0}^2}\right).$$

Hence using the definition of function $H(\cdot)$ from the proof of Lemma 1, $0 = H\left(\hat{b}^{E,E}\right) > G\left(\hat{b}^{E,E}\right)$. Since the function defined in (A.28) is negative when evaluated at $\hat{b}^{E,E}$ and it should be equal to zero at ${\hat{b}_2}^{NE,E}$, it follows that ${\hat{b}_2}^{NE,E} < \hat{b}^{E,E}$. As a result, from (23) ${B_2}^{NE,E} < \frac{3}{4}\left(5b_0 - 3\sqrt{-\alpha\left({\hat{b}_2}^{E,E}\right)^2 + (1+\alpha){b_0}^2}\right) < B^{E,E} < \frac{3}{2}b_0$.

Finally, substituting (22), (23), (A.19) and (A.20) into (17) yields:

$${b_{indif}}^{NE,E} = \frac{1}{2}\left(b_0 - \sqrt{-\alpha\left({\hat{b}_2}^{NE,E}\right)^2 + (1+\alpha){b_0}^2}\right) < 0. \quad \text{(A.29)}$$

Proof of Proposition 4: Substituting (22), (23), (A.19), and (A.29) into (19) yields:

$$\pi_1{}^{NE,E} = \frac{3\phi^2}{8b_0(\phi+\chi)}\left(3b_0 - \sqrt{-\alpha\left(\hat{b}_2{}^{NE,E}\right)^2 + (1+\alpha){b_0}^2}\right)^3. \quad \text{(A.30)}$$

Similarly, substituting (14) and (16) into (9) we get:

$$\pi_1{}^{E,E} = \frac{\phi^2}{(\phi+\chi)}\left(3{b_0}^2 - \frac{\alpha(b_0-\hat{b}^{E,E})(-3\alpha\left(\hat{b}^{E,E}\right)^3+(8+\alpha)b_0\left(\hat{b}^{E,E}\right)^2+(2+3\alpha){b_0}^2\hat{b}^{E,E}+(14-\alpha){b_0}^3)}{8{b_0}^2}\right) \quad \text{(A.31)}$$

From (A.31) $\pi_1{}^{E,E} < \pi_1{}^{NE,NE} = \frac{\phi^2}{(\phi+\chi)}3\,{b_0}^2$, and since the firms are symmetric $\pi_2{}^{E,E} < \pi_2{}^{NE,NE}$ as well. Since from the proof of Proposition 3, $\hat{b}_2{}^{NE,E} < \hat{b}^{E,E}$, it follows that:

$$\pi_1{}^{E,E} - \pi_1{}^{NE,E} > \frac{\phi^2\left(3{b_0}^2 - \left(\frac{\alpha\left(b_0-\hat{b}^{E,E}\right)\left(-3\alpha\left(\hat{b}^{E,E}\right)^3+(8+\alpha)b_0\left(\hat{b}^{E,E}\right)^2+(2+3\alpha){b_0}^2\hat{b}^{E,E}+(14-\alpha){b_0}^3\right)+3b_0\left(3b_0-\sqrt{-\alpha\left(\hat{b}^{E,E}\right)^2+(1+\alpha){b_0}^2}\right)^3}{8{b_0}^2}\right)\right)}{(\phi+\chi)}. \quad \text{(A.32)}$$

The second term subtracted inside the parenthesis of (A.32) is:

$$\frac{\alpha(b_0-\hat{b}^{E,E})(-3\alpha\left(\hat{b}^{E,E}\right)^3+(8+\alpha)b_0\left(\hat{b}^{E,E}\right)^2+(2+3\alpha){b_0}^2\hat{b}^{E,E}+(14-\alpha){b_0}^3)+3b_0\left(3b_0-\sqrt{-\alpha\left(\hat{b}^{E,E}\right)^2+(1+\alpha){b_0}^2}\right)^3}{8{b_0}^2}. \quad \text{(A.33)}$$

(A.33) decreases with $\hat{b}^{E,E}$. Therefore at $\hat{b}^{E,E} = 0$, it obtains its maximum value of $\frac{\alpha(14-\alpha)+3\left(3-\sqrt{(1+\alpha)}\right)^3}{8}{b_0}^2$ which is less than $3{b_0}^2$ when $\alpha < 0.376$. Thus, $\pi_1{}^{E,E} - \pi_1{}^{NE,E} > 0$.

Note that $\pi_2{}^{NE,E} = \frac{\left(b_0-\hat{b}_2{}^{NE,E}\right)}{2b_0}\left(K_2{}^{NE,E} - c\delta\right) + \frac{\left(\hat{b}_2{}^{NE,E}-b_{indif}{}^{NE,E}\right)}{2b_0}\left(P_2{}^{NE,E} - c\right)$

$$> \frac{\left(b_0-\hat{b}_2{}^{NE,E}\right)}{2b_0}\left(P_2{}^{NE,E} - c\right) + \frac{\left(\hat{b}_2{}^{NE,E}-b_{indif}{}^{NE,E}\right)}{2b_0}\left(P_2{}^{NE,E} - c\right) = \frac{\left(b_0-b_{indif}{}^{NE,E}\right)}{2b_0}\left(P_2{}^{NE,E} - c\right)$$

Substituting (22), (23), (A.20), and (A.29) into $\frac{\left(b_0-b_{indif}{}^{NE,E}\right)}{2b_0}\left(P_2{}^{NE,E} - c\right)$ implies $\pi_2{}^{NE,E} >$

$$\frac{\phi^2}{(\phi+\chi)}\frac{3\left(3b_0-\sqrt{-\alpha\left(\hat{b}_2{}^{NE,E}\right)^2+(1+\alpha){b_0}^2}\right)\left(b_0+\sqrt{-\alpha\left(\hat{b}_2{}^{NE,E}\right)^2+(1+\alpha){b_0}^2}\right)^2}{8b_0} > \pi_2{}^{NE,NE} = \frac{\phi^2}{(\phi+\chi)}3{b_0}^2.$$

Proof of Proposition 5: For ease of exposition we drop the superscript *E,E* in all the variables. When newspaper *i* chooses $B_i{}^o$, the cutoff points $\hat{b}_i$ are still given as in (6). However, because readers have no ability to affect $B_i{}^o$ via UGC, they consider $B_i{}^o$ exogenous. Specifically,

$$\hat{b}_i = \frac{{B_i}^o + B_i}{2} + \frac{P_i - K_i}{B_i - {B_i}^o}\frac{(\phi+\chi)}{2\,\phi^2}\,. \tag{A.34}$$

The expression for b_{indif} remains as in (5) and the objectives of the firms are still given in (9) and (10). Optimizing with respect to P_i and K_i in Stage 3 and solving in terms of B_i and ${B_i}^o$ yields for P_i a solution identical to (11) and for K_i:

$$K_1 - c\delta = P_1 - c + \left[\frac{c(1-\delta)}{2} + \frac{\phi^2}{(\phi+\chi)}(B_1 - {B_1}^o)\left(b_0 + \frac{B_1 + {B_1}^o}{2}\right)\right],$$

$$K_2 - c\delta = P_2 - c + \left[\frac{c(1-\delta)}{2} + \frac{\phi^2}{(\phi+\chi)}({B_2}^o - B_2)\left(b_0 - \frac{B_2 + {B_2}^o}{2}\right)\right]. \tag{A.35}$$

Substituting the expressions for P_i and K_i back into the expression for $\hat{b}_i$ in (A.34), yields that segmentation is feasible at the symmetric equilibrium, specifically at $0 < \hat{b}_2 < b_0$ if:

$$\frac{\phi^2}{(\phi+\chi)}({B_2}^o - B_2)\left(-b_0 + \frac{{B_2}^o + B_2}{2}\right) < \frac{c(1-\delta)}{2} < \frac{\phi^2}{(\phi+\chi)}({B_2}^o - B_2)\left(b_0 + \frac{{B_2}^o + B_2}{2}\right). \tag{A.36}$$

This implies from (A.35) that: $K_i - c\delta > P_i - c$. In the second stage, each newspaper chooses B_i and ${B_i}^o$. For Newspaper *1*, differentiating (9) with respect to B_1 and ${B_1}^o$ yields:

$$\frac{d\pi_1}{dB_1} = \frac{1}{2b_0}\left\{\left[\frac{\partial b_{indif}}{\partial B_1} + \frac{\partial b_{indif}}{\partial P_2}\frac{\partial P_2}{\partial B_1}\right](P_1 - c) + [(K_1 - c\delta) - (P_1 - c)]\frac{\partial \hat{b}_1}{\partial B_1}\right\}, \tag{A.37}$$

$$\frac{d\pi_1}{d{B_1}^o} = \frac{1}{2b_0}[(K_1 - c\delta) - (P_1 - c)]\frac{\partial \hat{b}_1}{\partial {B_1}^o}\,, \tag{A.38}$$

where b_{indif} is given in (5) and $\hat{b}_1$ in (A.34). Evaluating (A.37) and (A.38) at the symmetric equilibrium where $-B_1 = B_2$, $-{B_1}^o = {B_2}^o$, $b_{indif} = 0$, $-\hat{b}_1 = \hat{b}_2$, while using the equilibrium expressions for P_i and K_i from (11) and (A.35) yields:

$$\frac{d\pi_1}{dB_1} = \frac{1}{2b_0}\left\{\left[\left(\frac{4}{3}B_2 b_0 - 2{b_0}^2\right) + \frac{1}{2}\left(b_0 - \frac{{B_2}^o + B_2}{2}\right)\left(\frac{{B_2}^o}{2} - \frac{3}{2}B_2 + b_0\right)\right]\frac{\phi^2}{(\phi+\chi)} + \frac{c(1-\delta)}{2} - \frac{c^2(1-\delta)(\phi+\chi)}{8({B_2}^o - B_2)^2\phi^2}\right\}\,, \tag{A.39}$$

$$\frac{d\pi_1}{d{B_1}^o} = \frac{1}{2b_0}[(K_1 - c\delta) - (P_1 - c)]\left[\frac{(\phi+\chi)c(1-\delta)}{4\phi^2({B_2}^o - B_2)^2} + \frac{\left(\frac{3}{2}{B_2}^o - \frac{B_2}{2} - b_0\right)}{2({B_2}^o - B_2)}\right].$$

Assuming an interior equilibrium with ${B_1}^o < B_1 < 0$ implies that $\frac{d\pi_1}{d{B_1}^o} = 0$, and since $(K_1 - c\delta) > (P_1 - c)$,

$$\frac{c(1-\delta)}{2} = \left(b_0 + \frac{B_2}{2} - \frac{3}{2}{B_2}^o\right)({B_2}^o - B_2)\frac{\phi^2}{(\phi+\chi)}\,. \tag{A.40}$$

Substituting (A.40) into (A.39) yields that:

$$\frac{d\pi_1}{dB_1} = \frac{1}{2b_0}\left[2{B_2}^o b_0 - \frac{3}{2}B_2 b_0 - 2({B_2}^o)^2 + 2B_2{B_2}^o - 2{b_0}^2\right]\frac{\phi^2}{(\phi+\chi)}\,. \tag{A.41}$$

To ensure segmentation, the lower bound on $\frac{c(1-\delta)}{2}$ from (A.36) should hold, which combined with (A.40) implies that ${B_2}^{o} < b_0$. Using the last inequality in (A.41) implies that $\frac{d\pi_1}{dB_1} < 0$ for all values of B_2 and ${B_2}^{o}$. Hence, Newspaper *1* will choose the lowest bias consistent with ${B_1}^{o} \leq B_1 < 0$, implying that ${B_1}^{o} = B_1$ and no segmentation arises. A similar argument holds also for Newspaper *2*.

Proof of Proposition 6: We drop the superscript *E,E* to simplify the notation, and write the objective of Newspaper *2* as:

$$\pi_2 = \frac{q}{2b_0}\left\{\left(\left(\hat{b}_2{}^{old} - b_{indif}\right)(P_2 - c) + \left(b_0 - \hat{b}_2{}^{old}\right)(K_2 - c\delta)\right)\right\}$$
$$+\frac{(1-q)}{2b_0}\left\{\left(\left(\hat{b}_2{}^{young} - b_{indif}\right)(P_2 - c) + \left(b_0 - \hat{b}_2{}^{young}\right)(K_2 - c\delta)\right)\right\}.$$

A similar expression can be derived for the objective of Newspaper *1*. Using an approach similar to that leading to the first order condition (A.16), yields that the optimization with respect to B_2 in the second stage can be expressed as:

$$\left.\frac{dV_2}{dB_2}\right|_{symmetry} =$$
$$-\frac{\phi^2}{2b_0(\phi+\chi)}\left[\alpha\left({b_0}^2 - E\left[\hat{b}_2\right]^2\right) + \frac{4B_2b_0}{3} - 2{b_0}^2\right] +$$
$$\frac{\phi^2}{2b_0(\phi+\chi)}\left[\frac{\alpha(b_0 - E[\hat{b}_2])q(1-q)\left(\hat{b}_2{}^{old} - \hat{b}_2{}^{young}\right)^2(4-\alpha)}{(2-\alpha)b_0 - 2B_2 + (4-\alpha)\left(q\hat{b}_2{}^{young} + (1-q)\hat{b}_2{}^{old}\right)}\right] = 0\,, \qquad \text{(A.42)}$$

where $E\left[\hat{b}_2\right] = q\hat{b}_2{}^{old} + (1-q)\hat{b}_2{}^{young}$. The first term of (A.42) coincides with the first order condition (A.16) that was derived when politics was the only differentiating attribute among readers, with the only difference being that $E\left[\hat{b}_2\right]$ replaces $\hat{b}_2{}^{E,E}$ in (A.16). The second term is positive, and measures the extent of heterogeneity between the young and old populations. This second term is bigger when the variance due to the different ages in the general population is bigger (the product $q(1-q)$) and when the difference $\left(\hat{b}_2{}^{old} - \hat{b}_2{}^{young}\right)$ is more significant (as implied by the different values of ξ^{young} and ξ^{old}.) Evaluating (A.42) at the point when $E\left[\hat{b}_2\right] = \hat{b}_2{}^{E,E}$ implies that $\frac{dV_2}{dB_2} > 0$, hence Newspaper *2* has to increase B_2 beyond ${B_2}^{E,E}$ in order to satisfy the first order condition (A.42). Hence, bias intensifies, and since B_2 and $E\left[\hat{b}_2\right]$ move in the same direction, $E\left[\hat{b}_2\right] > \hat{b}_2{}^{E,E}$.

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WEB APPENDIX

A. MODEL EXTENSIONS

Expansion of Readership Facilitated by Online Editions

In this section we demonstrate that the profits of each newspaper may rise with the introduction of an online edition, if in the absence of offering such editions the market of readers is not fully covered. In Figure WA.1 we depict this possibility.

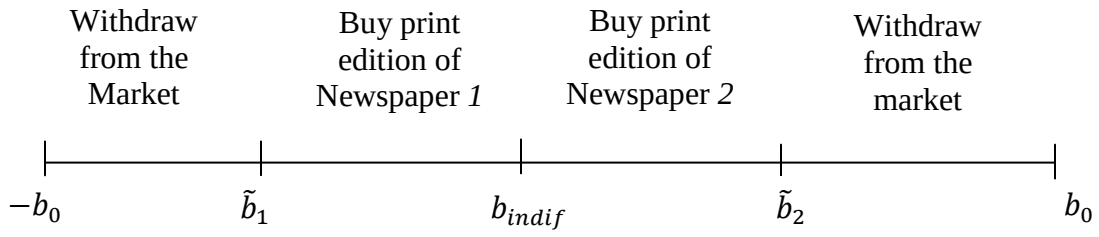

Figure WA.1: Market Less Than Fully Covered When Only the Print Version is Offered

Less than full coverage implies that the expected utility of readers with very extreme political opinions is negative when newspapers offer only print editions, namely $E[U_b] < 0$ for $b < \tilde{b}_1$ and $> \tilde{b}_2$, and $E[U_b] > 0$ for $\tilde{b}_1 < b < \tilde{b}_2$. Readers located at $\tilde{b}_1$ and $\tilde{b}_2$ are just indifferent between buying the print edition of newspapers *1* and *2*, respectively, and withdrawing from the market. Solving for $\tilde{b}_1$ and $\tilde{b}_2$ yields:

$$\tilde{b}_1 = \frac{\phi\, B_1}{(\phi+\chi)} - \sqrt{\frac{\phi^2\, {B_1}^2}{(\phi+\chi)^2} + \left[\frac{\bar{u}-P_1}{\phi} - \frac{\phi {B_1}^2}{(\phi+\chi)^2} - \frac{\sigma^2\chi}{(\phi+\chi)}\right]}\ ,$$

$$\tilde{b}_2 = \frac{\phi\, B_2}{(\phi+\chi)} + \sqrt{\frac{\phi^2\, {B_2}^2}{(\phi+\chi)^2} + \left[\frac{\bar{u}-P_2}{\phi} - \frac{\phi {B_2}^2}{(\phi+\chi)^2} - \frac{\sigma^2\chi}{(\phi+\chi)}\right]}\ . \qquad \text{(WA.1)}$$

Note that the expressions in the brackets included in the radicals of (WA.1) are positive, since the expected utility of a reader located at *b*=0 is positive according to Figure WA.1. Hence, $\tilde{b}_1 < \frac{2\phi\, B_1}{(\phi+\chi)}$ and $\tilde{b}_2 > \frac{2\,\phi\, B_2}{(\phi+\chi)}$. The objectives of the two newspapers are:

$$\max_{P_1,\, B_1} \pi_1 = \frac{(b_{indif}-\tilde{b}_1)(\,P_1-c)}{2b_0}\,; \quad \max_{P_2,\, B_2} \pi_2 = \frac{(\tilde{b}_2-b_{indif})(\,P_2-c)}{2b_0}. \qquad \text{(WA.2)}$$

Optimizing with respect to P_i yields at the symmetric equilibrium when $P_1 = P_2 = P$, $-B_1 = B_2 = B$, $b_{indif} = 0$, and $-\tilde{b}_1 = \tilde{b}_2 = \tilde{b}$ that:

$$P_{less}^{NE,NE} - c = \frac{4\phi^2 B\tilde{b}\left(\tilde{b} - \frac{\phi B}{(\phi+\chi)}\right)}{(\phi+\chi)^2\left(\tilde{b} + \frac{\phi B}{(\phi+\chi)}\right)} \text{ and } \pi_{less}^{NE,NE} = \frac{(P_{less}^{NE,NE} - c)\tilde{b}}{2b_0}, \quad \text{(WA.3)}$$

where the subscript *less* in (WA.3) indicates that the market is less than fully covered. It is possible to find an upper bound on the equilibrium profits in (WA.3). Specifically,

$$\pi_{less}^{NE,NE} < 0.343\phi\, {b_0}^2. \quad \text{(WA.4)}$$

Now, assume that extending the product mix by introducing the online edition allows the newspapers to cover the entire market. Specifically, the expected utility of readers located at $-b_0$ and b_0 is strictly positive at the $\{E, E\}$ equilibrium. Hence, $E[U_{b_0}] > 0$ when reader b_0 is exposed to the bias $(B^o)^{E,E}$ and pays the fee $K^{E,E}$. From (A31), it is possible to derive a lower bound on the expected profits of each newspaper for the region of α values that support segmentation, as specified in Lemma 1. Specifically,

$$\pi^{E,E} > \frac{2.6\,\phi^2}{(\phi+\chi)}\, {b_0}^2. \quad \text{(WA.5)}$$

A comparison of (WA.5) with (WA.4) implies that the expansion of the readership that is facilitated by the extension of the product mix will definitely increase the profits of each newspaper provided that $\chi < 6.58\phi$, namely that readers are not overly concerned about inaccurate reporting. Note that this condition does not contradict the requirement for less than full coverage in the absence of segmentation. A necessary condition for the latter is that $\chi > 2\phi$. Hence, there is a nonempty interval of values for the ratio $\frac{\chi}{\phi}$ that is consistent with the result that introducing the online edition may increase the profits of the newspapers. This increase in profits is different from the result reported in Proposition 4, when the market was fully covered even in the absence of segmentation.

Advertising the Only Source of Revenue of the Online Edition

In this section we assume that readers have free access to the online edition (namely, $K_i = 0$) and that the only source of revenue for the online edition accrues from advertisers who choose to place ads on the online edition. We still maintain the assumption that revenues from the print edition accrue from subscribers. We designate by A_i the fee charged from an advertiser who chooses to place an ad with newspaper *i*, and by η the unit cost of serving an advertiser.

We assume that advertisers are differentiated according to their location *x*. It measures the relative appeal of the newspapers to the advertisers, with *x* uniformly distributed on [0,1]. Advertisers located closer to zero prefer to place ads with Newspaper *1* and those closer to one prefer Newspaper *2*. This relative preference may relate to the type of readership of each newspaper, with this type not necessarily determined exclusively by political opinions. Thus, the product advertised by a certain advertiser may appeal more strongly to the tastes of the readers who choose one newspaper over the other. Using a Hotelling model to formulate this horizontal differentiation from the perspective of advertisers, we designate by *t* the unit transportation cost. We also assume that the gross benefit an advertiser derives from placing an ad with a newspaper is proportional to the size of the readership of this newspaper. Specifically, when placing an ad, the net benefit of an advertiser located at *x* is:

$$E_1 = h_0\left(b_0 + \hat{b}_1\right) - A_1 - tx,\ E_2 = h_0\left(b_0 - \hat{b}_2\right) - A_2 - t(1-x). \quad \text{(WA.6)}$$

The first term of E_i is tied to the size of the readership of the newspaper ($\left(b_0 + \hat{b}_1\right)$ for Newspaper *1* and $\left(b_0 - \hat{b}_2\right)$ for Newspaper *2*), where $h_0 > 0$ is a coefficient measuring the importance of the size of readership on the benefit from advertising. The second term is the advertising fee charged by the newspaper, and the last term is the transportation cost incurred by the advertiser located at $x \in [0,1]$. From (WA.6), we can derive the location of the advertiser that is indifferent between the two newspapers as follows:

$$x^* = \frac{1}{2} + \frac{A_2 - A_1}{2t} + \frac{h_0\left(\hat{b}_1 + \hat{b}_2\right)}{2t}\ , \quad \text{(WA.7)}$$

where the expression for $\hat{b}_1$ and $\hat{b}_2$ are given by (7) and (8) upon substituting $K_1 = K_2 = 0$. The objectives of the newspapers can be written as:

$$\pi_1 = \frac{\left(b_{indif} - \hat{b}_1\right)(P_1 - c)}{2b_0} + x^*(A_1 - \eta),$$

$$\pi_2 = \frac{\left(\hat{b}_2 - b_{indif}\right)(P_2 - c)}{2b_0} + (1 - x^*)(A_2 - \eta). \quad \text{(WA.8)}$$

With the above specification of the advertising market, in Proposition WA.1 we demonstrate that when advertising fees replace subscription fees as a source of revenue to support the online editions, the equilibrium profits of the newspapers decline.

Proposition WA.1

When readers have free access to the online editions and advertising fees replace subscription fees as a source of revenue to support the online editions, the equilibrium profits of the newspapers are lower than $\pi_i^{E,E}$.

Proof: We illustrate the optimization for Newspaper *2*. Optimizing π_2 with respect to P_2 and A_2 in (WA.8) yields at the symmetry that:

$$A_2 - \eta = t \text{ and } P_2 - c = \frac{\hat{b}_2 - b_0 h_0 \frac{\partial \hat{b}_2}{\partial P_2}}{\left(\frac{(\phi+\chi)}{4\,B_2\phi^2} - \frac{\partial \hat{b}_2}{\partial P_2}\right)} = \frac{\hat{b}_2 + b_0 h_0 \frac{(\phi+\chi)}{\phi^2} \frac{2}{\alpha\left(-2\,B_2 + (4-\alpha)\hat{b}_2 + b_0(2-\alpha)\right)}}{\left(\frac{(\phi+\chi)}{4\,B_2\phi^2} + \frac{(\phi+\chi)}{\phi^2} \frac{2}{\alpha\left(-2\,B_2 + (4-\alpha)\hat{b}_2 + b_0(2-\alpha)\right)}\right)}.$$

As well, to ensure that the net benefit to each advertiser is strictly positive $E_2 = h_0\left(b_0 - \hat{b}_2\right) - A_2 - \frac{t}{2} > 0$, thus implying $h_0 > \frac{3t}{2b_0}$. Using (WA.8) and ensuring that segmentation is feasible ($b_{indif} < \hat{b}_2 < b_0$) yields an upper bound on the profits of the newspaper as follows:

$$\pi_2 < \left(\frac{\alpha^2(4-\alpha)}{12} + \frac{\alpha(4-\alpha)^2}{12} + \frac{\alpha\hat{b}_2(4-\alpha)}{2b_0}\right)\frac{\phi^2 {b_0}^2}{(\phi+\chi)}.$$

For the region of α values supporting segmentation in Lemma 1 ($\alpha < 0.376$), the RHS of the above inequality implies that $\pi_2 < 0.83\frac{\phi^2 {b_0}^2}{(\phi+\chi)}$. However, from (A.31) for the same region of α values ${\pi_2}^{E,E} > \frac{2.6\,\phi^2 {b_0}^2}{(\phi+\chi)}$. Hence, replacing subscription fees with advertising fees reduces the newspaper's profits.

The main reason for the result reported in Proposition WA.1 is the value advertisers place on the size of the readership of the newspapers. In order to deliver a larger readership to advertisers, newspapers have a stronger incentive to moderate their positions, thus leading to reduced differentiation between them. As the print editions become less differentiated, subscription fees and profits decline. The implication of this "readership effect" on the bias selected by the newspapers is discussed in detail in Gal-Or, Geylani, Yildirim (2010). To illustrate the existence of this effect in our setting, note that when a newspaper chooses its location an additional term arises that leads to the moderation of the newspapers' positions. For Newspaper *2*, for instance, this additional term arises when differentiating with respect to B_2 the second term of π_2 that measures the profits from advertisers (in WA.8). Specifically, $\frac{\partial(1-x^*)(A_2-\eta)}{\partial B_2} = -\frac{h_0}{2t}\frac{\partial \hat{b}_2}{\partial B_2}(A_2 - \eta) < 0$. Hence, this term provides an extra incentive for Newspaper *2* to reduce bias in order to offer a larger readership to advertisers.

B. SAMPLE COMMENTS FROM READERS OF ONLINE EDITIONS

On News about the Health Care Reform

Wall Street Journal Online:

"I agree, there should be low-cost catastrophic insurance available for young and healthy people. But then who is going to pay for all the deadbeat sickos who can't afford to care for themselves? What we have now is 80% of the healthy people paying for the 20% of the sickos. That's how insurance works. But it is not fair to the young and the healthy..."

"Health insurance works like Marxism. It promises: "To each according to his needs". But everyone takes as much as he can, because hey, the insurance company is paying for it. So everyone loses. These systems are not honest (and not efficient) almost by design."

"I think the problem with liberals is that they point at people who are making a rational argument and call them stupid because they lack a rational response to the argument. Now, since it makes sense to you that there are a country full of stupid people who believe in a free lunch (is self-survival really "stupid"?), and your argument is that you are not one of them (the "stupid" people) and that you, via the government, have to protect these stupid people from themselves, you highlight the difference between liberals and some conservatives…"

"…Poor people who can't afford the best medical care should get whatever they can. It is wrong to lie to them and tell them they can get the best medical care, no matter how poor they are. Poor people have to be told the truth--they can't get whatever the middle class or the wealthy are getting. They can't get the same food, the same homes, the same cars, the same vacations, the same clothes, the same education, why should they expect to get the same health care? Beggars can't be choosers."

New York Times Online:

"The best way to get Medicare under control is to stop the fraud and put everyone under a national health care system which allows ZERO profits."

"The best way to get health care spending under control is to take over the entire system federally and effect broad cost controls. Medicare Part D is an expensive subsidy to senior citizens that goes on because senior citizens are better represented in Washington than working class people, who have been falling into uninsurance for at least a generation."

"As a rule, distrust "advice" given by free market 501 (c) (3)
organizations that rely on very rich backers and industry to churn out "research" that always agrees with the economic incentives of the funders."

"I understand subsidies and Federal programs for the poor, but then why does Medicare cover the wealthy? Even at the middle class level, Medicare has to be an exercise in taking people's money and giving it back to them, minus friction costs. Cut Medicare for the top 80% of households, leave it for the poor."

On News about Renewable Energy and Offshore Drilling

Wall Street Journal Online:

"You have it backwards. Government, throughout history, has acted as a puppet of existing industry and has been active in suppressing new, nascent industries…You find that governments have been, thoughout history, pretty nasty entities. They are not to be trusted with anything."

"…Please, to recommend that Courtney be reduced to reading History would be a violation of the Eighth Amendment's prohibition of "cruel and unusual punishment". You know very well that History is filled with those evil Facts, and that "Facts to a Leftist, are as Kryptonite to Superman".

"…Isn't it timely to see our socialist, ideological leader allow the ban to end? That illegimate garbage will do anything for a vote. Once again he shows just how little he thinks of America and its citizens by ending the ban now instead of after the election. What an absolute piece of garbage!"

"Oh – don't worry - the ban will come back one way or another. Brazil can drill with our money but we cannot - since we should be punished and we should lose our standard of living ... except Obama of course."

New York Times Online:

"…If the oil companies are entitled to charge motorists for the value of the fuel, so is the general citizenry entitled to be reimbursed for the pollution costs those fuels exacts from the public… Making oil producers responsible for the true cost of their product would double and triple the price at the pump and allow alternative fuels a level field on which to compete. Moreover, such additional environmental charges at the pump would not be a tax, they would be the removal of what now amounts to a gigantic subsidy to oil companies."

"Gee I thought I heard the death rattle of Big Oil at the end of the Bush administration. Guess I was wrong. Must've been a hallucination. Cause Big Oil is certainly not dead (nor big Coal). The current Congress will never fund renewables. Rebublithugs and their Tea Party pawns don't believe in global warming, remember? Big, old, dirty and entrenched business interests rule the day. Hope and Change has been stomped upon."

"Republicans and Tea Partiers in the pockets of people like the Koch brothers just call environmental bills "red tape" and will do everything they can to block it. Unfortunately, there are also Democrats, those often referred to as "blue dogs" who back the oil corporatocracy as well…"

"…No, such thoughts rise from the deep dark wells of pignut Republicans who side step the Constitution with contracts and promises that in the past have continued trading in Democracy for Privatization; for global business agreements that trump the Constitution, Bill of Rights and Laws of the Land. The Republicans care for one thing and one thing only: Power to do as they wish. "They," it turns out, are fewer than one half of a dozen of the richest pignuts that pay the party hacks the majority of money necessary to buy votes and Congress People to do their will but also to American jobs now in India or Communist China or the ever enlarging Banana Belt…".