User-Generated Content, Social Media Bias and Slant Regulation

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Abstract

This paper examines the impact of government regulation in the media market.

In a duopolistic market structure, the intervention of a state-owned media firm without bias will reduce the price of the print version of a newspaper, but will increase its digital subscription fee. Moreover, the government regulation by introducing a third public media outlet without bias will not necessarily reduce the media slanting. The User-Generated Content of a digital version of a newspaper, along with the media bias from both supply-side and the demand-side, make this kind of government regulation much less effective.

However, other regulatory policies such as price regulation and tax can decrease the level of slanting, especially the tax policy, which leads to an average level of slanting even less than the socially optimal level.

Keywords: Social Media, Media Bias, Spatial Model, Government Regulation.

Introduction

Media industry shares many characteristics with other industries: they both have the product suppliers and consumers in the market, the quality and the price of the products are both important attributes for the consumers to make their consumption decisions, the structure of the market can also affect the price and the quality of the products…

However, media markets are also special and different from other markets as the product that they offer, i.e. information, plays a significant role in the political and social life of their consumers. Therefore, the market failures in a media market is more important than its economic impacts. For instance, political economic studies of media market show two stylized extreme, namely, “media power” and “media capture” (Besley and Prat 2006, Prat 2015, Prat 2018,). The former may occur when the media outlets can “control” the government by manipulate information in the elections in a democracy, while the latter implies that the government can “control” the media outlets by censorship and other ways in a dictatorial or autocratic country.

The market failure occurs in the media market when the media outlets can filter and bias information by deciding how much and which information to transmit to their consumers.

This type of market failure that draws the attention of the economists is called “Media Bias”. The increasing importance of the Internet in the social life seems have amplified this market failure. Hence, the need for a more strict regulation of media bias, especially on social media, becomes more urgent in the current context.

On the one hand, the freedom of expression is crucial for the democracy; on the other hand, the full free and liberal public speech, especially on social media, is producing more and more “fake news”, “dangerous or misleading” contents, conspiracy theories...

For example, Facebook was used to provoke a surge in hate for a Muslim minority in Myanmar; a teenager murdered a middle-school teacher after seeing a video online, and even tweeted the victim’s head afterwards; more recently, after the riot on the U.S. Capitol of Donald Trump’s supporters, Facebook and Twitter banned his accounts; the vast conspiracy theories about the vaccine during the COVID-19...

Most of the existing economic (theoretical and empirical) literature about media bias concentrate on the competition theory. Among the few economic studies about the regulatory policy applied to the media bias, they focus on mergers and competition policies. This model fills the gap of the theoretical literature of applying spatial models to the regulation of social media bias.

In this paper, I analyze the regulation of the government in a duopolistic media market by introducing a third public-interest firm and by other regulation policies such as price regulation and tax policy.

This paper is organized as follows:

Section 1 is a brief literature review;

Section 2 presents the basic set-up of model with relevant definitions and hypotheses;

Section 3 and Section 4 analyze the impact of introducing a public media outlet;

Section 5 explores the social welfare analysis as well as the effects of other regulation policies such as price regulation and taxes;

Section 6 concludes.

1. Related Literature

As far as I know, this is the first theoretical microeconomic model that applies the spatial model on government regulation of social media slanting.

This paper contributes to the literature exploring the factors that drive the demand for media bias, see SUTTER (2001), Gentzkow and Shapiro (2008), Prat & Strömberg(2013), SOBBRIO (2014), Gentzkow and Shapiro (2015), MCLEOD *et al.* (2017), S. Robert LICHTER (2017) for reviews.

This strand of literature reckons that media bias comes from the supply or the demand side (or both) in the news market. The media slanting may result from the media companies, for example, from the bias of journalists (e.g. political or ideological bias) (Baron 2006, Puglisi 2008, Kaplan 2009, Hollifield and Becker 2009…), the owners or the editors in a media firm can also impact the media slating (Debs 2007, Anderson & McLaren 2012, Chiang & Knight 2011…).

Not to mention the factors outside the media firms:

The capture of the government and the politicians' interferences during the electoral campaign (Besley and Prat 2006, Prat and Str¨omberg 2011, Prat 2015 &2018..);

The interest groups such as lobbies (Baron 2006, Sobbrio 2011, Petrova 2012…);

The advertisers (Ellman and Germano 2009, Blasco, Pin and Sobbrio 2012, Petrova 2012, Germano and Meier 2013) …

What's more, the media market's structure also influence the level of the media slanting, even though the effects are ambiguous. Some argue that the competition between two media firms will reduce the slanting from the media firms (Anderson & McLaren 2012), while others prove (theoretically) that in a market where the consumers have heterogeneous preferences, competition between the media firms will augment the slanting degree (Mullainthan and Shleifer 2005).

More and more literature has incorporate the bias form the demand side into their models. One of the pioneering prototype models measuring the bias from the consumers, i.e. "the confirmatory bias", a concept psychological, in the microeconomic models, is the Mullainthan and Shleifer's work in 2005. Mullainathan & Shleifer (2005) (MS 2005) integrate both the slanting from the media firms and the confirmative bias from the consumers in a Hotelling model. They show that the competition in the media market will alleviate the slanting of news report if and only if the consumers are homogeneous. In the contrary, if the consumers have heterogeneous preferences for news, to cater to this diversification of demand, the duopolists in news market will slant even more than a monopolist. A series of researches are developed to study the media slants afterwards, with the existence of confirmatory bias (Filistrucchi *et al.* 2015, Stone *et al.* 2018, Gentzkow and Shapiro 2014, Garcia Pires 2014, Guo & Lai 2015, Castañeda& Martinelli 2018, Perego, J., & Yuksel, S. 2018, Kranton & McAdams 2019…). However, most theoretical literature studies the impact of competition or advertising on media bias, or the multi-sided markets with a third agent such as the politicians in the elections.

This paper also contributes to the literature of User-generated content (UGC) in the social media and its impact. A vast of economic literature studies the UGC on social platforms and its economic and social influence. They explores the behavioral incentives behind the UGC (Easley and Ghosh 2013, Anderson *et al.* 2013, Javid & Ghaeli 2019…), social effects of social media in different fields from public health to elections (Bond *et al.* 2012, D'Angelo *et al.* 2013, Jones *et al.* 2017), the competition and network effects (Jackson and Yariv 2005, Ghose *et al.*, 2012, Aral and Walker 2014…)…

2. The model

2.1 The Newspaper Market

The payoff function of a newspaper firm depends on its revenues and the costs. The profits of a media outlet come from the subscription fees, the advertising revenues, or the political rents, or the different combinations of the above three. Here for simplify, suppose that the newspaper firm is an profit-maximizer and its only source of revenue is the subscription fees. In terms of the costs, generally, we consider the returns to scale in the traditional print newspaper industry is increasing, that is, as the production costs (collecting data and writing the news reporting) are fixed, the variable cost equals the reprinting and delivering an additional copy (Reddaway 1963, Rosse 1967).

Consider a market with two newspaper firms, each has a print version and a digital version (a web version or an application version, for example). Suppose that the cost of the production (and operation) of a print version is higher than a digital one, i.e. c for the print version and δc for the digital version, with $0 \leq \delta \leq 1$ as a discount variable.

Consequently, the subscription fees of a digital version of a newspaper are also lower than the print one.

A mass of consumers can subscribe either a print version or the digital version of a newspaper. The only difference (besides the subscription price and the cost) between the two choices is that the consumers can interact with each other on the web or through the applications by their comments or the discussions with each other, i.e. the user-generated content (UGC hereafter). Therefore, the online users' opinions are not influenced by the newspapers' news reporting but also by the UGC online.

2.2 Model Set-up

The model's set-up is borrowed from the model of Esther Gal-or *et al.*'s model in 2013 (hereinafter PET 2013):

The role of a newspaper firm i is to collect some data d about the state of the world t, and then to redact a piece of news n based on the data that it collects. The variable t is supposed to be normally distributed with mean as 0 and deviation as v_t, i.e. $\mathbf{t \sim N(0, v_t)}$, where $1/v_t$ is the precision. The data received by a newspaper firm i is then $\mathbf{d_i = t + \varepsilon_i}$, where ε_i is a random variable of a noise term, with $\mathbf{\varepsilon_i \sim N(0, v_\varepsilon)}$. Therefore, the data d_i also follows normal distribution, i.e. $\mathbf{d_i \sim N(t, v_d)}$, with $\mathbf{v_d = v_t + v_\varepsilon}$.

The news reports ***n*** by a newspaper firm ***i*** is a piece of processed information about the data received, that is, $\mathbf{n_i = d_i + s_i}$, where s_i is a slant of the newspaper ***i***'s news reports. For simplify, suppose there are just two newspapers firms in the market, i.e. i= {1, 2}. To distinguish the digital and print version of a newspaper, suppose that $\mathbf{n_i^o}$ and $\mathbf{n_i^p}$ the digital and print news respectively, and s_i^o and s_i^p their slants online and offline. Hence, $n_i^p = di + s_i^p$, and $\mathbf{n_i^o} = di + s_i^o$.

The consumers, or readers of the newspapers, are uniformly distributed between [-bo, bo]. The total number of readers is normalized to unity. A reader of type ***b*** has prior beliefs about the state of the world, and these beliefs are normally distributed $N\mathbf{(b, v_t)}$, i.e. readers may have biased beliefs about the expected value of t. For instance, ***b*** can be the political opinions of a reader, with b $\in$[-bo,0) is a left-wing-party supporter, b $\in$(0, bo] is a right-wing-party supporter, b=0 a neutralist.

As in PET 2013, we suppose that:

For a rational and unbiased reader, his/her utility from reading a newspaper of i is:

$\mathbf{U^r = \bar{u} - \chi s_i^2 - P_i}$ if he/she subscribes to the print version of i**;**

$\mathbf{U^r = \bar{u} - \chi(s_i^0)^2 - K_i}$ if he/she subscribes to the print version of i**.** (1) [1]

For a biased reader, the bias comes from two sides:

- One called "media slant", comes from the media's side;

- The other named "confirmatory bias", is from the cognitive bias of the readers who prefer the news that are more consistent with their prior beliefs. Both kind of bias will decrease the readers' utility. Therefore, the net utility function of a biased reader of belief ***b*** from reading newspaper ***i*** is:

$\mathbf{U_i = \bar{u} - \chi s_i^2 - \varphi(n_i - b)^2 - P_i}$ if he/she subscribes to the print version of i**;**

$\mathbf{U_i = \bar{u} - \chi(s_i^0)^2 - \varphi(n_i^0 - b)^2 - K_i}$ if he/she subscribes to the print version of i**.** (2)

Where $\mathbf{\bar{u}}$ is the reservation price for the reader, $\boldsymbol{\chi > 0}$ represents the preference for slanting reports, $\phi > 0$ calibrates his preference for hearing confirming news, Ki and Pi are the subscription fees for a digital and print version of a newspaper.

[1] Suppose that the reader is single homing, i.e. the reader can only choose one newspaper and only one version of this newspaper.

Bi is denoted as the reporting location of a newspaper i's print version, satisfying

$s_i(d_i) = \frac{\varphi}{\chi+\varphi}(B_i - d_i)$ and $s_i^{\,o}(d_i) = \frac{\varphi}{\chi+\varphi}(B_i^{\,o} - d_i)$, which implies that $\mathbf{n_i = \gamma_i B_i + (1\text{-}\gamma_i) d_i}$, $\mathbf{n_i^o = \gamma_i B_i^o + (1\text{-}\gamma_i) d_i}$, and $\boldsymbol{\gamma_i = \varphi/(\varphi+\chi)}$.[2] Assume that newspaper 1 is located at the left of newspaper 2, i.e. $B_1 < B_2$.

And the position of its digital version is $\mathbf{B_i^o = B_i + U[bi^o]}$, where $\mathbf{U[bi^o]}$ represents the UGC generated by its online subscribers.

More precisely, we have:

$$B_1^{\,o} = B_1 + \frac{\left(-b_o + \hat{b}_1\right)}{2} \quad (3) \qquad B_2^{\,o} = B_2 + \frac{\left(b_o + \hat{b}_2\right)}{2} \quad (4)$$[3]

As E[di]=0, var[di]=$\mathbf{v_d}$, the prior expected prior utility of a reader of type ***b*** reading a newspaper i, i=1,2, is hence:

$$E[U_i^{\,p}] = \bar{u} - \frac{\varphi^2}{(\chi+\varphi)}(B_i - b)^2 - \frac{\chi\varphi}{(\chi+\varphi)}(b^2 + v_d) - P_i$$ for the print version of newspaper i;

$$E[U_i^{\,o}] = \bar{u} - \frac{\varphi^2}{(\chi+\varphi)}(B_i^{\,o} - b)^2 - \frac{\chi\varphi}{(\chi+\varphi)}(b^2 + v_d) - K_i$$ for the digital version of newspaper i. (5) [4]

2.3 A public-interest newspaper firm as an instrument for slant regulation in an Oligopoly media market

The regulation of the Government is by the introduction of a third public media outlet without slant. What distinguishes a public media outlet from a private one is that the former has no slant from the media side. To simplify, suppose that the public media outlet has no digital version. The intuition behind is also simple: the UGC will generate more bias as the sources online is hard to be verified.

The idea of introducing a public firm as an instrument for regulation is not new (see GIOVANNI and DELBONO 1989, Helmuth CREMER 1989, Helmuth CREMER 1991, Isabel GRILO 1994…). This idea has been applied to many markets, but mostly to mixed

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[2] This transformation is to simplify mathematical analysis and the decision problems.

[3] It equals to the case when α=1 in the PET 2013. However, PET 2013 supposes that 0 < α < 1, here suppose that the Internet has a higher power than the newspaper itself in deciding the online variant of its position.

[4] This expected utility function is taken from the work of Mullainathan and Shleifer (2005), LEMMA A1 in Appendix, P1043-1044. The market for news. American Economic Review, 2005, vol. 95, no 4, p. 1031-1053.

oligopoly markets recently, such as the health and education market where both public and private services exist. This may also be the case of the media market as the ownership of the news media firms can be either public or private.

LEMMA 1. Suppose there exists a public newspaper company, who always reports the "truth" with clarity and objectivity, without slanting any news reports.[5] In the following part, the net utility function of a reader of belief ***b*** from reading a public newspaper (i=3) is noted as

$$\mathbf{E\ (U_3) = u_3 = \bar{u} - E\ [\phi(d-b)^2] - p_3 = \bar{u} - \varphi(v_d + b^2) - p_3} \qquad (6)$$

[5] This is a strong hypothesis as this kind of newspaper is not realistic at all in real life. Not only because of the difficulty of being "objective" and "neutral" in reporting news, but also due to the impact of the public ownership on the news, especially in the elections in a democracy, or the existence of the censorship in an autarchy or a dictatorship.

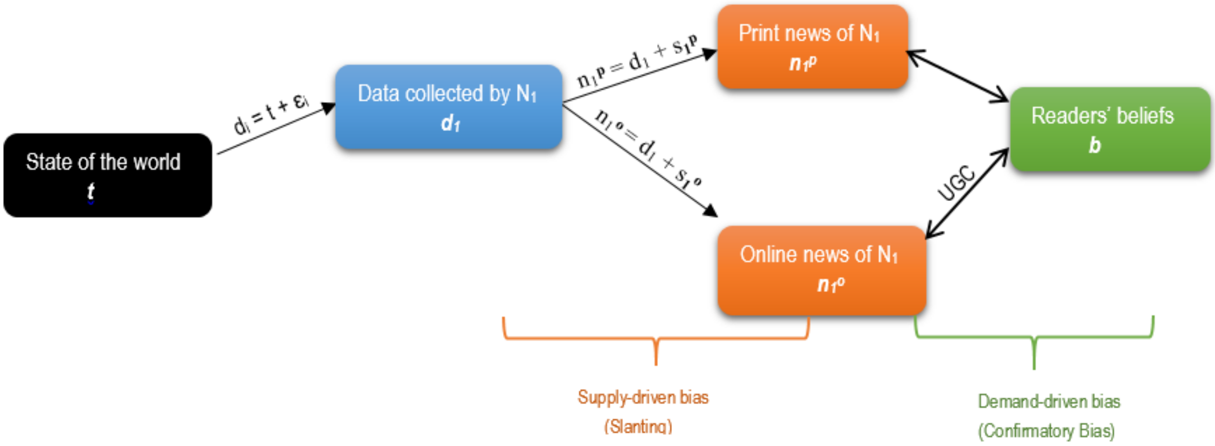
3. The equilibrium analysis of a location-price game

3.1 Timing of the game:

- Stage 1: The newspapers media outlets choose their market decisions of extension their online versions;
- Stage 2: The newspapers announce their political stance of the print version and then their slanting strategy. The third public newspaper without slant is introduced;
- Stage 3: The prices of the print and digital versions of three newspapers are then decided;
- Stage 4: The consumers will make their subscription decisions, the newspapers publish their news, and online readers can interact online with each other via UGC (if they choose the digital versions).

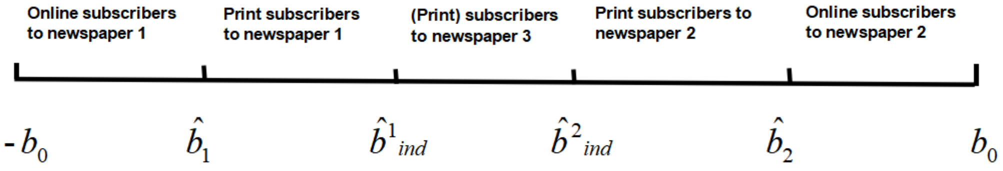
This location-price game is solved by backward induction: we first find the indifferent readers in the stage 4, and then analyze the newspapers' strategic variables such as prices and location choices in stage 2 and 3, and at last see the newspapers' slanting strategies.

Figure 1. Timing of the game in a Duopolostic newspaper market.



3.2 The market shares

Figure 2: Segmentation of the newspaper market share, when a third public newspaper is introduced to a duopoly market of two mixed newspapers.



First, we need to identify the readers that are indifferent between the digital version and the print versions of the two mixed newspapers, noted $\hat{b}_i$:

By E[Ui^o]= E[Ui^p], i=1,2, we have:

$$\hat{b}_i = \frac{(B_1^{o} + B_1)}{2} + \frac{(P_i - K_i)}{2(B_1 - B_1^{o})}\frac{(\varphi+\chi)}{\varphi^2} \qquad (7)$$

Substituting the Bio in (3) and (4) into (7), we can get:[6]

$$\hat{b}_1 = \frac{2B_1 + b_o - 2\sqrt{\Delta_1}}{3}, \Delta_1 = (b_0 - B_1)^2 - 3(P_1 - K_1)\frac{(\varphi+\chi)}{\varphi^2}$$

$$\hat{b}_2 = \frac{2B_2 - b_o + 2\sqrt{\Delta_2}}{3}, \Delta_2 = (b_0 + B_2)^2 - 3(P_2 - K_2)\frac{(\varphi+\chi)}{\varphi^2} \qquad (8)$$

So the readers whose beliefs lying between ($-b_o$) and $\hat{b}_1$ will purchase the digital version of newspaper 1, the readers located between $\hat{b}_2$ and bo will purchase the digital version of newspaper 2, while the readers situated at $[\hat{b}_1, \hat{b}_2]$ will purchase the print version of either one. Then the entry of the third public firm will "steal" one part of the print market:

Denote $\hat{b}^i_{ind}$ as readers who are indifferent between the print versions of the two private newspapers and the public newspaper.

Using $E[U_3]= E[U_i^p]$, we have:

$$\hat{b}^1{}_{ind} = \frac{(B_1{}^2 - v_d)}{2B_1} + \frac{(P_1 - P_3)}{2B_1}\frac{(\varphi+\chi)}{\varphi^2} \qquad \hat{b}^2{}_{ind} = \frac{(B_2{}^2 - v_d)}{2B_2} + \frac{(P_2 - P_3)}{2B_2}\frac{(\varphi+\chi)}{\varphi^2} \qquad (9)$$

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[6] As B_i^o is also the function of $\hat{b}_i$.

3.3 The equilibrium price choices

Given the locations of the indifferent readers in (8), (9), (10), and (11), newspapers make their price choices Pi and Ki to maximize their following profits functions:

$$\Pi_1 = \frac{(\hat{b}_1 + b_0)(K_1 - c\delta) + (\hat{b}^1{}_{ind} - \hat{b}_1)(P_1 - c)}{2b_0}$$

$$\Pi_2 = \frac{(b_0 - \hat{b}_2)(K_2 - c\delta) + (\hat{b}_2 - \hat{b}^2{}_{ind})(P_2 - c)}{2b_0}$$

$$\Pi_3 = \frac{(\hat{b}^2{}_{ind} - \hat{b}^1{}_{ind})(P_3 - c)}{2b_0} \qquad (10)$$

The equilibrium print prices of the three newspapers are given by optimizing the profit functions (10) with respect to Pi, and using the relationship between $\frac{\partial \hat{b}_i}{\partial P_i}$ and $\frac{\partial \hat{b}_i}{\partial K_i}$ derived from (7), and $\frac{\partial \hat{b}^i{}_{ind}}{\partial P_i}$ derived from (9), we get:

$$P_1^{**} = c - \frac{\varphi^2}{(\varphi + \chi)}\left(\frac{B_1{}^2}{2} + b_0 B_1 + \frac{B_1 B_2}{6} - \frac{V_d}{3} + \frac{2}{3} b_0 \frac{1}{\left(\frac{1}{B_1} - \frac{1}{B_2}\right)}\right)$$

$$P_2^{**} = c - \frac{\varphi^2}{(\varphi + \chi)}\left(\frac{B_2{}^2}{2} - b_0 B_2 + \frac{B_1 B_2}{6} - \frac{V_d}{3} + \frac{2}{3} b_0 \frac{1}{\left(\frac{1}{B_1} - \frac{1}{B_2}\right)}\right)$$

$$P_3^{**} = c - \frac{\varphi^2}{(\varphi + \chi)}\left(\frac{(B_1 B_2 + V_d)}{3} + \frac{4}{3}\frac{b_0 B_1 B_2}{(B_2 - B_1)}\right) = c - \frac{\varphi^2}{(\varphi + \chi)}\left(\frac{B_1 B_2}{3} + \frac{V_d}{3} + \frac{4}{3} b_0 \frac{1}{\left(\frac{1}{B_1} - \frac{1}{B_2}\right)}\right) \qquad (11)$$

As for the equilibrium online prices, optimizing again the profit functions (10) with respect to Ki and using $\frac{\partial \hat{b}_i}{\partial K_i}$ derived from (8) we have:

$$K_1^{**} - P_1^{**} = c(\delta - 1) - \frac{\varphi^2}{(\varphi + \chi)}\left(\hat{b}_1^{\,2} - b_0^{\,2}\right) \qquad K_2^{**} - P_2^{**} = c(\delta - 1) - \frac{\varphi^2}{(\varphi + \chi)}\left(\hat{b}_2^{\,2} - b_0^{\,2}\right) \qquad (12)$$

3.4 The equilibrium slanting strategies

Plugging the equilibrium prices P** and K** into the profit functions πi and optimizing the new profit functions with respect to the locations Bi, we get the following:

$$\frac{\partial \Pi}{\partial B_1} = \frac{1}{2b_0}\left\{\left[(K_1 - c\delta) - (P_1 - c)\right]\frac{\partial \hat{b}_1}{\partial B_1} + (P_1 - c)\left(\frac{\partial \hat{b}^1_{ind}}{\partial B_1} + \frac{\partial \hat{b}^1_{ind}}{\partial P_3}\frac{\partial P_3}{\partial B_1}\right)\right\}$$

$$\frac{\partial \Pi}{\partial B_2} = \frac{1}{2b_0}\left\{\left[-(K_2 - c\delta) + (P_2 - c)\right]\frac{\partial \hat{b}_2}{\partial B_2} - (P_2 - c)\left(\frac{\partial \hat{b}^2_{ind}}{\partial B_2} + \frac{\partial \hat{b}^2_{ind}}{\partial P_3}\frac{\partial P_3}{\partial B_2}\right)\right\} \qquad (13)$$

Taking B_2 for example, we get:

$$\frac{\left(\hat{b}_2^{\,2} - b_0^{\,2}\right)\left(\hat{b}_2 + b_0\right)}{\left(b_0 + 3\hat{b}_2 - 2B_2^{**}\right)} +$$

$$\left[\frac{B_2^{**2}}{2} - b_0 B_2^{**} + \frac{B_1 B_2^{**}}{6} - \frac{V_d}{3} + \frac{2}{3}b_0 \frac{1}{\left(\frac{1}{B_1} - \frac{1}{B_2^{**}}\right)}\right]\left[\frac{1}{4} + \frac{V_d}{6B_2^{**2}} - \frac{b_0 B_1}{3\left(B_2^{**} - B_1\right)^2} - \frac{2b_0 B_1^{\,2}}{3B_2^{**}\left(B_2^{**} - B_1\right)^2} + \frac{B_1}{6B_2^{**}}\right] = 0$$

(14)

4 The effects of government regulation

Here to simplify, we only consider the symmetric solutions for slants[7], that is,

$(-B_1) = B_2 = B$, $-B_1{}^o = B_2{}^o$, $(-b^{\wedge}{}_1) = b^{\wedge}{}_2$, $(-b^{\wedge 1}{}_{ind}) = b^{\wedge 2}{}_{ind}$, and suppose that the costs of running a print and a digital newspaper both equal to 0, which leads to:

$$-\hat{b}^1{}_{ind} = \hat{b}^2{}_{ind} = \frac{B^{**} + 2b_0 - V_d}{6} \qquad (9\text{-}1)$$

$$P_1^{**} = P_2^{**} = -\frac{\varphi^2}{3(\varphi+\chi)}\left(\left(B^{**}\right)^2 - 4b_0 B^{**} - V_d\right),$$

$$P_3^{**} = \frac{\varphi^2}{3(\varphi+\chi)}\left(\left(B^{**}\right)^2 + 2b_0 B^{**} - V_d\right) \quad (11\text{-}1)$$

$$P_1^{**} - K_1^{**} = P_2^{**} - K_2^{**} = \frac{\varphi^2}{(\varphi+\chi)}\left(\left(\hat{b}_2^{**}\right)^2 - b_0{}^2\right) \qquad (12\text{-}1)$$

$$-\hat{b}_1 = \hat{b}_2 = \frac{2B^{**} - b_0 + 2\sqrt{\Delta}}{3}, \Delta = \left(B^{**} + b_0\right)^2 - 3c\frac{(\varphi+\chi)}{\varphi^2} - 3\left(\left(\hat{b}_2^{**}\right)^2 - b_0{}^2\right) \qquad (8\text{-}1)$$

$$\frac{\left(\left(\hat{b}_2^{**}\right)^2 - b_0^2\right)\left(\hat{b}_2^{**} + b_0\right)}{\left(b_0 + 3\hat{b}_2^{**} - 2B^{**}\right)} + \frac{1}{36}\left(\left(B^{**}\right)^2 - 5b_0 B^{**} + 4b_0{}^2 + V_d - \frac{7b_0 V_d}{B^{**}} - \frac{2V_d{}^2}{\left(B^{**}\right)^2}\right) = 0 \qquad (14\text{-}1)$$

[7] The asymmetric solutions are either too complicated or may not exist at all.

LEMMA 2. To support the market segmentation in Figure 2 at the symmetric equilibrium, and to guarantee a nonnegative price, the following conditions need to be satisfied:

$$B^{**} \in [-b_0 + \sqrt{b_0^{\ 2} + Vd}, 2b_0 + \sqrt{4b_0^{\ 2} + Vd}] \quad \text{and} \quad B^{**} > \frac{\left(\hat{b}_2^{\ **}\right)^2}{2b_0} \qquad (15)$$[8]

Compare the results from (11-1) and (12-1) (the equilibrium prices under slant regulation) with the following equilibrium prices without slant regulation in PET 2013:

$$P_1^{\ E} = P_2^{\ E} = \frac{\varphi^2}{(\varphi+\chi)} 2b_0 B^E \qquad (11\text{-}2),$$

$$K_1^{\ E} - P_1^{\ E} = K_2^{\ E} - P_2^{\ E} = \frac{\varphi^2}{(\varphi+\chi)} \frac{\left(b_0 - \hat{b}_2^{\ E}\right)\left(b_0 + 3\hat{b}_2^{\ E} - 2B^E\right)}{2}$$

$$K_2^{\ E,E} - P_2^{\ E,E} = \frac{\varphi^2}{(\varphi+\chi)} \frac{\lambda\left(b_0 - \hat{b}_2^{\ E,E}\right)\left[(2-\lambda)b_0 + (4-\lambda)\hat{b}_2^{\ E,E} + 2B_2^{E,E}\right]}{2} \qquad (12\text{-}2)$$[9]

We can observe the following results.

4.1 The effects on equilibrium prices of the print version of a newspaper

Proposition 1.

i) $P_i^E > P_i^{**}$, and $P_i^E > P_3^{**}$, i=1,2. The regulation by introducing a third public newspaper company will reduce the equilibrium prices of the newspapers.

ii) The price of a public newspaper without slanting is not necessarily lower that a private one.

- ✓ When $[(B^{**})^2\text{-}Vd\text{-}boB^{**}] < 0$, the price of a public newspaper without bias is lower;
- ✓ When $[(B^{**})^2\text{-}Vd\text{-}boB^{**}] \geq 0$, the price of a public newspaper without bias is higher than that of a private one with bias.

[8] These are necessary but not sufficient conditions.

[9] To better compare the two equilibria results, we only consider the symmetric scenario, with zero costs, and α=1 based on the model of PET 2013.

Analogous to the market of goods, the new entry of a competing newspaper in the media market decreases the price of the newspaper. As the three newspapers are all profit-maximizers, the effects of competition on equilibrium prices in a media market are similar to that in a market of goods.

However, a public newspaper may offer a more expensive newspaper under some conditions. The institution behind is quite simple:

i) The lack of an online version profits to finance the public newspaper forces it to increase the price to make ends meets;

ii) The high "quality" of the news of the public firm, i.e. news without slanting, increases its "product differentiation", and therefore can release some pressure from the fierce price competition.

4.2 The effects on equilibrium prices of the digital version of a newspaper

Proposition 2.

i) $K_i^{**} > P_i^{**}$, that is, after slant regulation, the digital version of a newspaper is more expensive than its print version.

ii) $K_i^{**} > K_i^{E}$, i.e. the digital subscription fee becomes higher under slant regulation.

The slant regulation by introducing a public newspaper firm without bias has changed the composition of the price, especially that of a digital version. After the entry of a third newspaper firm, the digital subscription fee is much less effected by the position of the print version, as there is no more "B^{**}" in the (12-1) compared with the (12-2).

This result corresponds to the assumption that the Internet has a higher power than the newspaper itself in deciding the online variant of its position at the beginning of this paper.[10] Once the UGC has a higher discretion in deciding the position of the online version of a newspaper, the digital version of a newspaper is no longer a by-product of its print version.

[10] See footnote 3 in the part 2.2.

It may be due to a "Daily-me" effect (Sunstein 2001, Perego & Sevgi 2018…), where UGC helps every user online find information that is consistent with his/her prior beliefs or even catered to his/her beliefs, especially the extremists who can hardly to get approved in their daily life. Therefore, for this segmentation of consumers, they are willing to pay higher prices to digital newspapers.

This also corresponds to the characteristics of UGC: for an online newspaper and its online readers, they try to get higher profits not only by competing on prices, but also by drawing "attention" of consumers (Bordalo Gennaioli& Shleifer 2016, Chen & Suen 2018&2019, Galperti& Trevino 2018…). For example, the more an article is transferred online and is clicked by the online readers, the more it becomes popular and get more readers, no matter how credible it is.[11]

4.3 The effects on the equilibrium slanting strategy of a newspaper

Rewrite the formula of (14) as: (A) + (B) =0, where

$$(A)=\frac{\left(\hat{b}_2^{**}+b_0\right)^2\left(\hat{b}_2^{**}-b_0\right)}{3\hat{b}_2^{**}-2B^{**}+b_o} \qquad (14\text{-}1)$$

$$(B)=\frac{1}{36}\left(\left(B^{**}\right)^2-5b_0B^{**}+4b_0^{\ 2}+V_d-\frac{7b_0V_d}{B^{**}}-\frac{2V_d^{\ 2}}{\left(B^{**}\right)^2}\right) \qquad (14\text{-}2)$$

It's hard to find a simple and direct relationship between the equilibrium slanting strategy (B^{**}) and the equilibrium position of a newspaper $\hat{b}_i^{**}$ by finding the conditions which satisfying (A) + (B) =0.

However, we can at least rule out some hypotheses by observing the two parts (A) and (B) separately.

[11] Sometimes the "Fake News" can get much more attention than the true news, as the former always has a more "eye-catching" title and more astonishing contents.

LEMMA 3.

i) Solutions for the latter part (B) = 0 are:

$$B = \left(\frac{b_0 \pm \sqrt{b_0^2 - 8V_d}}{2}\right), \text{ or } \left(2b_0 \pm \sqrt{4b_0^2 + V_d}\right) \qquad (16)$$

ii) As $(-B_1) = B_2 = B$, $B_1 < B_2$, $Vd = \sigma_d^2 >= 0 \Rightarrow B > 0$, we get

$$2b_0 - \sqrt{4b_0^2 + V_d} < 0 < \frac{b_0 - \sqrt{b_0^2 - 8V_d}}{2} < \frac{b_0}{2} < \frac{b_0 + \sqrt{b_0^2 - 8V_d}}{2} < b_0 < \frac{3b_0}{2} < 2b_0 + \sqrt{4b_0^2 + V_d}$$

and

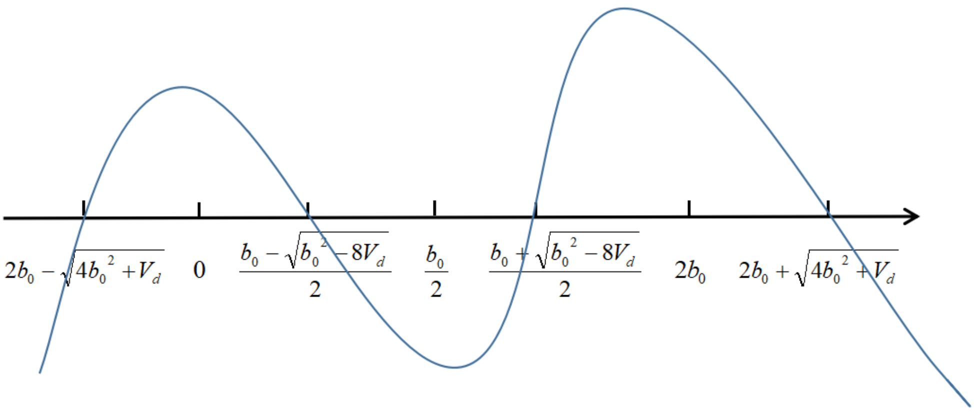
$$2b_0 - \sqrt{4b_0^2 + V_d} < 0 < -b_0 + \sqrt{b_0^2 + V_d} < 2b_0 + \sqrt{4b_0^2 + V_d} \qquad (17)$$

iii) In terms of the former part (A) :

(A)> 0 when $3\hat{b}_2^{**} - 2B^{**} + b_o < 0$, i.e. $B^{**} > \dfrac{3\hat{b}_2^{**} + b_o}{2}$;

(A)< 0 when $3\hat{b}_2^{**} - 2B^{**} + b_o > 0$, i.e. $B^{**} < \dfrac{3\hat{b}_2^{**} + b_o}{2}$. (18)

Figure 3. The ranges of possible values of the equilibrium slanting level of newspaper 2.



Combined w**ith the c**onditions in LEMMA 2, we can draw the following conclusions:

Proposition 3. when $\left(\hat{b}_2^{**}\right)^2 > \frac{2}{3}b_o$, there exists an equilibrium slanting strategy for the private newspapers -taking the newspaper 2 for example- satisfying (A) + (B) =0 and the conditions in LEMMA 2, denoted $B^{**} > \frac{3}{2}b_o$, therefore also above the equilibrium staling level without slant regulation ($B^{E)}$ in PET 2013.

Under slanting regulation, the equilibrium slanting level of the (private) newspapers may be higher than the one without slanting regulation. The two private newspapers may offer more extreme news when a public unbiased newspaper is introduced compared to the scenario when there is no slant regulation in the newspaper market (PET 2013) or the case when there is only print versions of newspapers in the news market (MS 2005).

As we can see from the Figure 3, the equilibrium slanting level increases with the value of Vd and bo, i.e. the variance of the date and the extremist opinions of its readers. The more variant data the newspapers collect, the more exogenous the readers are, the government regulation by introducing a public newspaper without bias has less effect on reducing the slant level of the private newspapers.

5 Implementation of other Regulatory Policies

We have shown that the government regulation of a dupolistic newspaper market by introducing a public newspaper without slant is not as effective as we think.

Now we will see the effects of other alternative regulation policies, such as price regulation and tax, on the level of media bias.

We will return to the original model of PET 2013 in the following analysis, but we assume that the costs are zero.

5.1 Social Welfare

LEMMA 4. Define the social welfare of the Duopolist market in PET 2013 as

$$SW = \int_{-b_0}^{\hat{b}_1} \frac{U_1^o}{2b_0} db + \int_{\hat{b}_1}^{b_{ind}} \frac{U_1^p}{2b_0} db + \int_{b_{ind}}^{\hat{b}_2} \frac{U_2^p}{2b_0} db + \int_{\hat{b}_2}^{b_0} \frac{U_2^o}{2b_0} db + \Pi_1 + \Pi_2$$

$$= \bar{u} - \frac{1}{2b_0}\left\{ \frac{\varphi^2}{(\chi+\varphi)} \begin{pmatrix} \int_{-b_0}^{\hat{b}_1} (B_1^o - b)^2 db + \int_{\hat{b}_1}^{b_{ind}} (B_1 - b)^2 db \\ + \int_{b_{ind}}^{\hat{b}_2} (B_2 - b)^2 db + \int_{\hat{b}_2}^{b_0} (B_2^o - b)^2 db \end{pmatrix} \right\} - \frac{\chi\varphi}{(\chi+\varphi)} \left(\frac{2(b_0)^3}{3} + 2v_d b_0 \right)$$

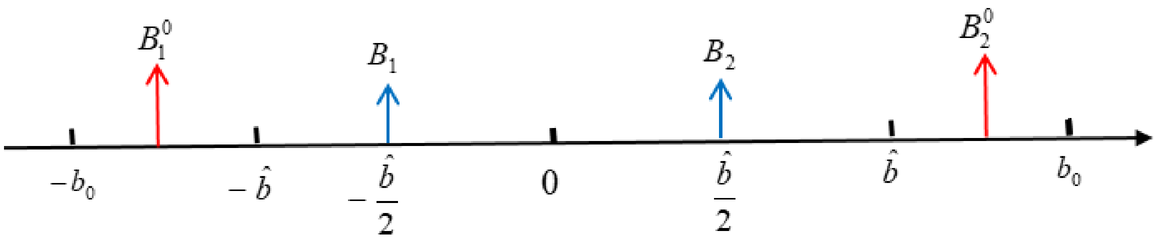
(19)

Optimizing (19) with respect to the (print and digital) location of newspaper i separately, we get:

$$B_1^o = \frac{(\hat{b}_1 - b_o)}{2},\ B_1 = \frac{(b_{ind} + \hat{b}_1)}{2},\ B_2 = \frac{(b_{ind} + \hat{b}_2)}{2},\ B_2^o = \frac{(b_o + \hat{b}_2)}{2} \quad (20)$$

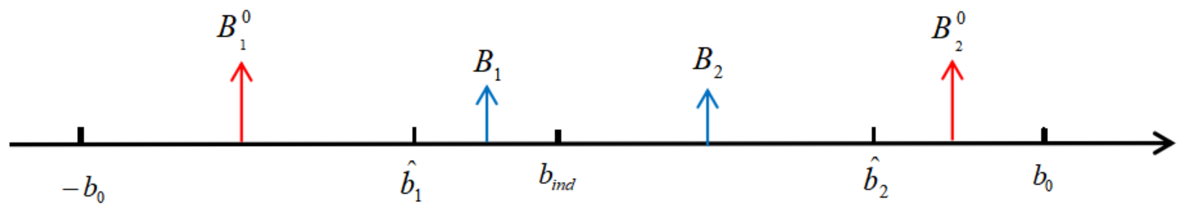
(See Figure 4-1 and Figure 4-2.)

Figure 4-1. The optimal (first-best) reporting location choices (0<α<1).



The socially optimal slanting is the mean value of the opinions of the readers in the print or digital market.

Figure 4-2. The optimal (first-best) reporting location choices (α=1).



Proposition 4.

i) If we follow the assumption of α=1, we can have symmetric solutions for the optimal (first-best) reporting locations as follows:

$$\left(B_1^o, B_1, B_2, B_2^o\right)^{SW} = \left(\frac{-b_o}{2}, 0, 0, \frac{b_o}{2}\right)$$ [12]

ii) And the optimal level of slants is

$$\left(s_1^o(d_1), s_1(d_1), s_2(d_2), s_2^o(d_2)\right)^{SW} = \left(\frac{-\varphi}{\varphi+\chi}\left(\frac{b_o}{2}+d_1\right), \frac{-\varphi d_1}{\varphi+\chi}, \frac{-\varphi d_2}{\varphi+\chi}, \frac{\varphi}{\varphi+\chi}\left(\frac{b_o}{2}-d_2\right)\right)$$ [13]

iii) The socially optimal payoffs for the two newspaper firms are

$$\left(\Pi_1, \Pi_2\right)^{SW} = \left(\frac{K_1}{2}, \frac{K_2}{2}\right) \quad (14)$$

Under the assumption of α=1, i.e., when the UGC plays a more important role than the newspaper itself when deciding the position of its digital version, when the social welfare is maximized, the market are all occupied by the social media (the digital versions of the two newspaper). The "traditional" newspapers are "crowed out" by their digital versions.

The optimal reporting locations for the two newspaper (digital versions) are the same. The social optimal reporting strategy returns to the "Minimum Differentiation Principle" in Hotelling's model (Hotelling 1929). Moreover, the optimal level of slanting for a traditional

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[12] If we don not change the assumption about α in PET 2013, we get

$$\left(B_1^o, B_1, B_2, B_2^o\right) = \left(\frac{\left(\hat{b}_1 - b_o\right)}{2}, \frac{\hat{b}_1}{2}, \frac{\hat{b}_2}{2}, \frac{\left(\hat{b}_2 + b_o\right)}{2}\right)$$

[13] According to the definition in part 2.2 $s_i(d_i) = \frac{\varphi}{\chi+\varphi}(B_i - d_i)$.

newspaper depends only on the data it collects (d_i), and the degree of its readers' preference for confirming news (φ) and their dislike for slanting news (χ).

However, the optimal reporting location of the digital version is different to the print one. The social welfare is maximized when the social media express more diverse but less extreme opinions. The optimal slanting level for a digital newspaper depends not only on its data source, on its readers' preference for confirming news and dislike for slanting news, but also on the extremist readers' opinions.[14]

The more extreme the readers' opinions, the higher the level of the socially optimal slanting. This finding is consistent with the literature shows that the "Echo chamber" Effect, the "Filter bubble" effect, "Dunning–Kruger" effect...

Moreover, as we suppose that the costs of production are zero, the socially optimal payoffs of the two newspapers totally depend on the price of their digital version.

In the original model of PET 2013, as

$$B_1^{o} = B_1 + \frac{\alpha\left(-b_o + \hat{b}_1\right)}{2} \quad \text{and} \quad B_2^{o} = B_2 + \frac{\alpha\left(b_o + \hat{b}_2\right)}{2}$$

Combined with (20), we have :

Proposition 5. The symmetric solutions for optimal (first-best) reporting locations are :

$$\left(B_1^{o}, B_1, B_2, B_2^{o}\right) = \left(\frac{\left(-\hat{b} - b_o\right)}{2}, \frac{-\hat{b}}{2}, \frac{\hat{b}}{2}, \frac{\left(\hat{b} + b_o\right)}{2}\right), with \left(-\hat{b}_1\right) = \hat{b}_2 = \hat{b}$$

iv) And the optimal level of slants is

$$\left(s_1^{o}(d_1), s_1(d_1), s_2(d_2), s_2^{o}(d_2)\right)^{SW} = \left(\frac{-\varphi}{\varphi+\chi}\left(\hat{b} + b_o + d_1\right), \frac{-\varphi}{\varphi+\chi}\left(\frac{\hat{b}}{2} + d_1\right), \frac{\varphi}{\varphi+\chi}\left(\frac{\hat{b}}{2} - d_2\right), \frac{\varphi}{\varphi+\chi}\left(\frac{\hat{b} + b_o}{2} - d_2\right)\right)$$

[15]

[14] That may be due to the assumption that the UGC's effect attends to the maximal level (α=1).

[15] According to the definition in part 2.2.

5.2 Price Regulation

Then we turn to a common regulation policy - price regulation, and see its effects on the level of slanting.

Suppose that government set a unique price $\overline{P} = P_1 = P_2$ for the print newspapers and $\overline{K} = K_1 = K_2$ for the digital versions, the costs are 0, and we only see the symmetric solutions. We can get:

$$\overline{\Pi}_1 = \frac{\left(\hat{b}_1 + b_0\right)\overline{K} + \left(b_{ind} - \hat{b}_1\right)\overline{P}}{2b_0} = \frac{\overline{P}}{2b_0}\left(b_{ind} + \frac{b_0}{2} - \frac{\hat{b}_1}{2}\right),$$

$$\overline{\Pi}_2 = \frac{\left(b_0 - \hat{b}_2\right)\overline{K} + \left(\hat{b}_2 - \hat{b}_{ind}\right)\overline{P}}{2b_0} = \frac{\overline{P}}{2b_0}\left(-\hat{b}_{ind} + \frac{b_0}{2} + \frac{\hat{b}_2}{2}\right),$$

$$\overline{P} = 2\overline{K}$$

And

$$\frac{\partial \overline{\Pi}_1}{\partial B_1} > 0, \frac{\partial \overline{\Pi}_2}{\partial B_2} < 0, \frac{\partial \overline{\Pi}_1}{\partial B_1^0} < 0, \frac{\partial \overline{\Pi}_2}{\partial B_2^0} > 0.$$

Proposition 6. Under price regulation:

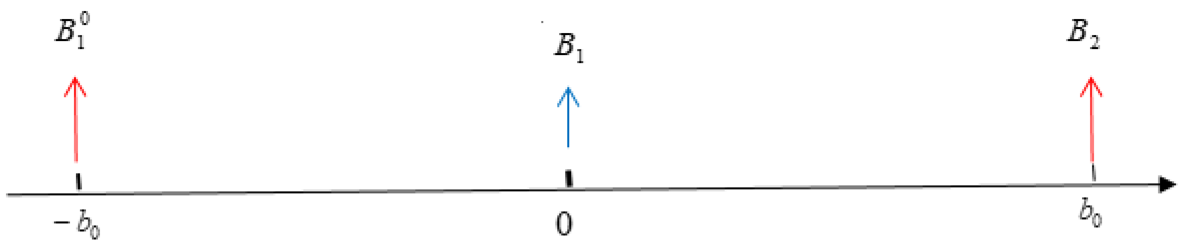
i) When regulated price of the print newspapers is twice that of the digital versions, the two newspapers can maximize their profits;

ii) The equilibrium reporting positions are $\left(\overline{B}_1^{\,o}, \overline{B}_1, \overline{B}_2, \overline{B}_2^{\,o}\right) = \left(-b_o, 0, 0, b_o\right)$;

iii) The level of slants is

$$\bar{s}_1^{o}(d_1), \left(\bar{s}_1(d_1), \bar{s}_2(d_2), \bar{s}_2^{o}(d_2)\right) = \left(\frac{-\varphi}{\varphi+\chi}(b_o + d_1), \frac{-\varphi d_1}{\varphi+\chi}, \frac{-\varphi d_2}{\varphi+\chi}, \frac{\varphi}{\varphi+\chi}(b_o - d_2)\right)$$

Figure 5. The equilibrium reporting location choices under price regulation.



Compared to the social optimal situation, the price regulation has decreased the level of slanting of a print newspaper. While the slant of the digital versions of the newspapers become extremer compared to the socially optimal level.

5.3 Tax for "Fake News"

Consider the government will impose a tax for "Fake News", named ***T***.

The payoffs of the two newspapers turn to:

$$\overline{\Pi}_1 = \frac{\left(\hat{b}_1 + b_0\right)\overline{K} + \left(b_{ind} - \hat{b}_1\right)\overline{P}}{2b_0} - T\left[E_d\left(S_1(d_1)^2\right) + E_d\left(S_1^o(d_1)^2\right)\right]$$

$$= \frac{\left(\hat{b}_1 + b_0\right)\overline{K} + \left(b_{ind} - \hat{b}_1\right)\overline{P}}{2b_0} - T\frac{\varphi^2}{(\varphi+\chi)^2}\left(\left(B_1\right)^2 + \left(B_1^o\right)^2\right)$$

$$\overline{\Pi}_2 = \frac{\left(b_0 - \hat{b}_2\right)\overline{K} + \left(\hat{b}_2 - \hat{b}_{ind}\right)\overline{P}}{2b_0} - T\frac{\varphi^2}{(\varphi+\chi)^2}\left(\left(B_2\right)^2 + \left(B_2^0\right)^2\right)$$

Again we only consider the symmetric scenario when $-B_1=B_2=B$, $-B_1^o=B_2^o=B^o$, and also $c=c\delta=0$, $\alpha=1$.

Optimizing the payoff functions with respect to Pi, we can get the same results of PET 2013. Then replace the equilibrium prices into the payoff function, and optimize with respect to Bi, we have:

Proposition 7. Under tax regulation, the equilibrium reporting positions are:

$$-B_1^T = B_2^T = B^T = \frac{3\left(\left(\hat{b}\right)^2 + \left(b_0\right)^2\right)}{b_0\left(12T+1\right)} \qquad -\left(B_1^o\right)^T = \left(B_2^o\right)^T = \left(B^o\right)^T = \frac{3\left(\left(\hat{b}\right)^2 + \left(b_0\right)^2\right)}{b_0\left(12T+1\right)} + \frac{b_0 + \hat{b}}{2}$$

The equilibrium reporting positions of the newspapers (print and digital versions) become less extreme when the tax level for slanting augments.

5.4 The Average Bias level

Define the average bias level (ARB) for the heterogeneous readers as

$$ARB = \int_b E_d\left[(n_i - d_i)^2\right]$$

$$= \frac{(\hat{b}_1 + b_0)E_d\left[(s_1^o(d_1))^2\right] + (b_{ind} - \hat{b}_1)E_d\left[(s_1(d_1))^2\right] + (\hat{b}_2 - b_{ind})E_d\left[(s_2(d_2))^2\right] + (b_0 - \hat{b}_2)E_d\left[(s_2^o(d_2))^2\right]}{2b_0}$$

$$= \frac{1}{2b_0}\frac{\varphi^2}{(\varphi+\chi)^2}\left\{(\hat{b}_1 + b_0)(B_1^o)^2 + (b_{ind} - \hat{b}_1)(B_1)^2 + (\hat{b}_2 - b_{ind})(B_2)^2 + (b_0 - \hat{b}_2)(B_2^o)^2\right\}$$

We can then compare the average bias level under the above three different regulation policies: (symmetric solutions)

$$(ARB)^{SW} = \frac{1}{2b_0}\frac{\varphi^2}{(\varphi+\chi)^2}\left\{\frac{(\hat{b}_1 + b_0)(b_0)^2 + (b_0 - \hat{b}_2)(b_0)^2}{4} - \right\}$$

$$\xrightarrow{\text{symmetric}} = \frac{\varphi^2}{(\varphi+\chi)^2}\frac{b_0(b_0 - \hat{b})}{4}$$

$$(ARB)^{PR} = \frac{\varphi^2}{(\varphi+\chi)^2}\frac{b_0(2b_0 + \hat{b}_1 - \hat{b}_2)}{2}$$

$$\xrightarrow{\text{symmetric}} = \frac{\varphi^2}{(\varphi+\chi)^2} b_0(b_0 - \hat{b})$$

$$(ARB)^{T} = \left\{\frac{(\hat{b}_1 + b_0)(b_0)^2 + (b_0 - \hat{b}_2)(b_0)^2}{4} - \right\}$$

$$\xrightarrow{\text{symmetric}} = \frac{\varphi^2}{(\varphi+\chi)^2}\left\{(B^T)^2 + \left(\frac{(b_0)^2 - (\hat{b})^2}{b_0}\right)B^T + \frac{(b_0 - \hat{b})(b_0 + \hat{b})^2}{4b_0}\right\}, \quad B^T = \frac{3\left((b_0)^2 + (\hat{b})^2\right)}{(12T+1)}$$

Proposition 8. $(ARB)^{PR} > (ARB)^{SW} > (ARB)^{T}$

The average bias under tax is smaller than the socially optimal average bias. The average bias under the price regulation is the biggest.

6 Conclusion

This paper analyzes the effects of government regulation of social media market.

In a Duopolistic newspaper market, two newspapers offer two versions of their products - a print one and a digital one. The latter is different from the former version of newspaper as the online readers can generate content themselves by interacting with each other. The User-generated content has a non-negligible effect on deciding the positions of a newspaper's online version. Sometimes, UGC is one of the most important reasons for people spreading Fakes News and extremists opinions on the social media.

Introduction of a third public firm without slant seems to be a feasible solution to resolve the growing media bias in news reports, especially on the social media. However, this paper shows that when media bias comes from both supply and demand side, even the government regulation fails to weaken the power of UGC on the social media. Compared to the market without slant regulation, the only positive effect is that the regulation reduces the subscription fee of a print newspaper. On the contrary, the subscription fee of a digital newspaper increases, and the slanting level may get higher under some conditions.

In terms of other regulation policies, compared to the socially optimal level of slanting, the price regulation decreases the level of slanting for a print newspaper, and increase the online slanting level; under tax regulation, the slanting level (both print and digital ones) decreases with the tax level. What's more, the average bias under tax is smaller than the socially optimal average bias, and the average bias under the price regulation is the highest.

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