SNF Working Paper No 07/20

Some Economics of Echo Chambers

by

Martin Richardson
Frank Stähler

SNF project no 10052

"Media Competition and Media Policy"

The project is financed by the Research Council of Norway

CENTRE FOR APPLIED RESEARCH AT NHH
BERGEN, OCTOBER 2020
ISSN 1503-2140

Some Economics of Echo Chambers

Martin Richardson[1] and Frank Stähler[2]

Version of October 5, 2020

[1]Research School of Economics, The Australian National University, Canberra ACT 2601, Australia. Email: martin.richardson@anu.edu.au.

[2]School of Business and Economics, University of Tübingen, University of Adelaide, CESifo and NoCeT, Tübingen, Germany. Email: frank.staehler@uni-tuebingen.de.

Abstract

This paper analyzes competition between a media firm providing true information (news) and two "fake news" providers that create echo chambers. Information from the media firm is uncertain but truthful, and consumers enjoy confirmation of their prior beliefs due to cognitive dissonances. We show that, even if real news is more valued than fake news, entry by fake news providers becomes more profitable with the variance of information. Furthermore, a public news provider makes entry for fake news providers harder compared to a profit-maximizing media firm.

JEL Classification: D21, L15, L82

Keywords: media, fake news, echo chamber

1 Introduction

> *Most men's conscience, habits, and opinions are borrowed from convention and gather continually comforting assurances from the same social consensus that originally suggested them.*
> George Santayana (1905)

Santayana's 1905 insight was offered as a positive remark - an explanation for hysteresis and sluggishness in the evolution of social mores and norms. But this phenomenon has a normative side to it as well: when people take comfort from the continual confirmation of their views, they are likely to actively seek that confirmation out. In recent parlance, people might enjoy "echo chambers" in which they simply hear their own views reflected back to them, rather than information or opinions that might challenge them. Since the pioneering work by Festinger (1957), psychology labels the discomfort originating from the difference between beliefs and evidence a cognitive dissonance. Echo chambers are able to reduce cognitive dissonances by apparently confirming extreme prior beliefs and sharing prejudices.

But if consumers also derive some value from being accurately informed then there will be some tension between the value of information and the comfort of having one's views validated. This tension has been examined extensively by economists (see Gentzkow *et al* (2015) for a thorough survey and treatment) but this paper explores it in a setting in which there is a known reliable news provider, where consumers are fully aware of what an "echo chamber" is doing and in which the basic value of information exceeds the comforting value of reassurance.

Borrowing from Mullainathan and Shleifer (2005) (MS henceforth) we construct a very simple model to illustrate that "fake news" providers can be profitable if the aversion of consumers to disconfirmation of their views is sufficiently strong and if uncertainty around the nature of the truth is sufficiently high. An implication of the model is that fake news is more likely to flourish in domains where the true state of the world is less certain but people have strong views about it. Furthermore, fake news inevitably caters to those with relatively extreme views.

The remainder of this paper is organized as follows. Section 2 summarized the growing literature on echo chambers. Section 3 sets up the model, and section 4 shows how the media firm competes against echo chamber rivals. Section 5 concludes.

2 Related literature

The literature on echo chambers is growing rapidly, in economics as well as in other fields. The reason is that digitization changed the distribution and perception of new information substantially. Digitization has made access to information, reliable or not, much easier. The emergence of so-called Online Content-Sharing Service Providers as platforms that allow users to share information has led to an abundance of information offered to consumers. Since these platforms create social networks and live on targeted social network advertising, the algorithm of these platforms is designed to maximize usage, and this can be done best if viewers receive "news" that confirm their views.[1] Thus, these platforms do not only offer users to share information provided by media firms,[2] but also to create echo chambers. Furthermore, since echo chambers allow the like-minded to re-confirm their views, they also allow their consumers to escape from a permanent challenge to manage the complexity of new information.

Levy and Razin (2019) break down the term echo chamber into two aspects: "Chambers: Individuals segregate with those who are like-minded in terms of preferences, beliefs, or attitudes. 2. Echo: Individuals are influenced in a nonrational manner by the beliefs of those with whom they communicate in their chamber." They note that segregation into chambers of like-minded agents can be unwitting, or quite conscious; in our model it is the latter. In particular, it is not only the users of content sharing platforms who share their views or selected news from media firms, but echo chambers are also served by fake news providers who offer specific "information" and receive revenue through advertising. Thus, these fake news providers are able to run an information business and compete against traditional media firms like TV stations or classic newspapers.

The evidence for the existence of echo chambers and their perceived value to users is overwhelming. Gorodnichenko *et al* (2018) look at Twitter users in response to two recent significant events (Brexit and the 2016 U.S. Presidential election) and find that,

[1] Since social media collect information on the socio-economic background, the geographic location and many preferences of their users, they are able to target advertising in a way that is not possible for media firms like TV stations and newspapers.

[2] Sharing content on these platforms is now under scrutiny in Australia, Europe and the US. The European Directive on Copyright in the Digital Single Market is the first legal framework which requires that platforms must have a license agreement with collective management organizations that control the content platform users may (or must not) upload to or share on the platform. See Stähler and Stähler (2020) for details.

for example, users respond more rapidly and more positively to news that affirms their views and do so whether the source of information is a bot or a human. They conclude that their results are, "consistent with the "echo chambers" effect in social media; that is, people tend to select themselves into groups of like-minded people so that their beliefs are reinforced while information from outsiders might be ignored" (p.3). Similarly, Chiou and Tucker (2018) find that groups such as the anti-vaccine community form echo chambers on Facebook.

The consequences of echo chambers can be extensive. Del Vicario *et al* (2016) show that increased engagement with echo chambers on Facebook affects users' emotional behaviour in a negative way and Levy and Razin (2018) suggest that echo chamber effects in migrant communities in prejudiced societies can polarize and lead to lower societal trust and welfare. Grossman and Helpman (2019) construct a model of electoral competition in which the ability of political parties to reach echo chamber groups of supporters can lead to greater policy divergence across parties with consequent welfare losses. Levy and Razin (2019) catalogue many ways in which segregation affects both political and economic outcomes in societies.

Not all views of echo chambers are negative, however. Jann and Schottmüller (2018) assume that information transmission is easier in "segregated, homogeneous cliques", perhaps because senders and receivers trust each other more and, as a consequence, echo chambers can serve to increase information transmission and can be an efficient outcome for society. As Levy and Razin (2019) note with respect to the literature that finds positive effects of segregation and biases, "[t]he key ... is that the political system, even without taking into consideration cognitive biases, is already flawed .... When there are other types of inefficiencies in the political system, it is sometimes useful for voters to be overconfident or for voters to ignore in some way their information and therefore induce less distortive behavior by politicians" (p.320).

While our model shares some similarities with that of MS – particularly the idea that a consumer's utility is decreasing in the difference between her beliefs and what she reads – their focus is on comparing monopoly versus competition amongst media providers and the endogenous choice of 'slant' in presenting the news. We should also note up front that, while we have a similar information structure to that in Anderson and McLaren (2012) in that, "[o]ne must [access a media provider] ... to learn what its publisher is making public about x [an underlying random variable in which one is interested]", their focus, like MS,

is also on competition versus monopoly (two providers versus one) so they consider media mergers in a model in which there is bias that serves the political motives of media owners. They note that competition between media firms can solve this problem but note further that media mergers can undermine this solution.

There is also a growing literature on how information may or may not change beliefs. Azzimonti and Fernandes (2018) model accurate information about the true state of the world as an unbiased private signal received by all agents, but their agents are boundedly rational actors whose posteriors are not simply Bayesian updates based on this signal but are also affected by information – which may be false – received by neighbours in their social network. This is in contrast to our model in which agents are fully aware that the true state of the world can be learned from a particular media source. Thaler (2020) runs an experiment which shows that individuals revise their belief if this revision is in line with their fundamental beliefs. Our model does not consider belief updates, but we focus on the choice of individuals whether they would prefer to learn the potentially inconvenient truth or not.

3 The model

We suppose that the news-consuming public is interested in some underlying random variable, x, which we assume to lie on [0,1]. *Ex ante*, the cdf of x is given by $F(x)$ and its pdf is given by $f(x) = F'(x)$. (In our example below, we assume a uniform distribution such that $x \sim U[0,1]$.) A media firm can and is committed to establish the true value of this realization for its consumers.[3] Fake news providers, however, have no interest in the true value but are highly predictable such that they will always claim that x is either equal to 0 or 1. Consumers are aware of this, so the fake news provider operates to confirm beliefs of their consumers and can be thought of as offering a "comforting reassurance" value of size α to its consumers. Note carefully that fake news consumers do not regard the confirmation of their beliefs as uninformative, as the very nature of the echo chamber

[3]The assumption of establishing the true value is a simplification, but not important for our analysis. Nothing changes in our model if the media firm established an expected x instead of its exact and true value, for example, because the evidence is not (yet) completely clear. In this case, the media firm is able to update consumers on $F(x)$, and the model we use assumes that this update implies a degenerate distribution.

guarantees that any other information is considered fake news.[4] On the contrary, the media news provider offers an information value of size β to its consumers where $\beta \geq \alpha$, but this provider does not appease any cognitive dissonance. Their business is set up such that it is committed to reveal x whatever small or large it turns out to be.

Without any prior beliefs and cognitive dissonances, fake news providers would not have a market since $\beta \geq \alpha$. However, all consumers have a prior $y \in [0, 1]$, and this prior also represents their preferred outcome of the realization. This prior could be due to a first assessment of the relevant issue by the consumer, for example, or to a political orientation of the consumer. Furthermore, consumers may strongly believe that their prior is a correct assessment, and given this conviction, any revision creates a cognitive dissonance. *Ex ante*, y is distributed according to the cdf $\Phi(y)$ and its pdf is $\phi(y) = \Phi'(y)$. $\Phi(y)$ does not have to be the same as $F(y)$ (but for our example, we assume $F(y) = \Phi(y)$ and $y \sim U[0, 1]$.) Although we consider only a single issue here, y could be a political orientation that will be important for many issues. A consumer either accesses her news *via* the media firm to learn (and accept) the true value of x or receives the comforting assurances of her worldview from a fake news provider in its echo chamber. Finally, the information provided by the media firm is uncertain: *ex ante*, the consumer does not know what the media firm will find out on x.

The main difference of our model to that of Anderson and McLaren (2012), which explicitly models the source of private valuations of news, is that we allow information values to be equal, because consumers of fake news do not seem to dislike biases, but are willing to believe in "alternative facts". Furthermore, compared to MS, $\beta = \alpha$ allows consumers not to be interested in the truth in order to make better private decisions. For example, there is no direct private cost to believe that the Earth is flat, that the moon landing did not take place, that 9/11 was an inside job, that Bill Gates is responsible for the Covid-19-crisis or to believe in white supremacy, as most of these beliefs do not have immediate economic costs that may imply a rational revision of beliefs.[5] In this

[4] In fact, debunking fake news may even lead to an apparently stronger belief in fake news. One of the most prominent examples was the theory that presidential candidate Hillary Clinton was involved in a child-abuse ring run out of a certain pizza place in suburban Washington, D.C. After this theory was quickly debunked by media firms, the pizza place was subject to a gun attack. See New York Times, 'In Washington Pizzeria Attack, Fake News Brought Real Guns', December 5, 2016. For a model of debunking and fake news, see Long *et al* (2019).

[5] This is also consistent with Oskar Morgenstern's notion of theory absorption (see Morgenstern, 1972): an agent knowing the theory we develop here does not make fake news consumers vulnerable to exploitation

sense, it does not matter for those consumers whether the information signal they buy is informative or uninformative; all they care about is minimizing their expected dissonance costs. But our model can also accommodate the case that the signals have a different quality: if $\beta > \alpha$, each consumer knows that the echo chamber is re-confirming her view, and the difference in quality of the information values is taken into account.[6]

Consequently, the utility of a consumer will depend on the true value of x (and her prior y) only if she buys the information from the media firm. Let the price set by the media firm be denoted by p_m, and the price set by the fake news provider serving the echo chamber on the left (on the right) be given by p_0 (p_1). These prices can be interpreted as direct monetary costs or as disutility from advertising or the use of a consumer's data.[7] If she buys from the media firm, her utility when being informed that the true realization is given by x is equal to $u(x, y) = \beta - \gamma(x - y)^2 - p_m$, where the second term is the cost of dislike due to the difference in accepting that the true value is different from the prior (see MS for a similar setup); this term represents the cost of overcoming cognitive dissonance and aligning belief and evidence. Since information provided by the media firm is uncertain, the expected utility of a consumer with prior y is given by

$$\hat{u}(y) = \beta - \gamma \int_0^1 (x - y)^2 dF(x) - p_m. \tag{1}$$

If the consumer turns to the fake news providers, she knows exactly what they will offer, and her utility is equal to

$$u_0(y) = \alpha - \gamma y^2 - p_0, u_1(y) = \alpha - \gamma(1 - y)^2 - p_1,$$

respectively, where the subscript 0 (1) denotes the utility realized by buying from the fake news provider on the left (right). If a consumer buys from a fake news provider, she knows the (extreme) signal that this provider will offer and, while it may not match her prior, it may still be desirable for its certainty and confirming her (and others') beliefs to some extent.

---

by that agent, as those consumers' beliefs do not imply economic losses compared to any alternative formation of beliefs.

[6] The difference $\beta - \alpha$ can also reflect the economic cost of deliberately choosing misinformation, and thus out model can also accommodate a setting in which misinformation has a direct cost for a consumer.

[7] A well-known aphorism of uncertain origin has it that if the price is zero, "you are not the consumer; you are the product."

4 Competition between echo chambers and the media firm

We now explore how the media news firm competes against echo chambers. Let $\underline{y}$ ($\overline{y}$) denote the consumer who is indifferent between consuming the information from the media news firm and enjoying the echo chamber on the left (right) extreme. In case of interior solutions, $\underline{y}$ and $\overline{y}$ are respectively determined by

$$\begin{aligned} g(\underline{y}, p_m, p_0) &= \beta - \alpha - p_m + p_0 - \gamma \left(\int_0^1 (\underline{y} - x)^2 dF(x) - \underline{y}^2 \right) = 0, \\ h(\overline{y}, p_m, p_1) &= \beta - \alpha - p_m + p_1 - \gamma \left(\int_0^1 (\overline{y} - x)^2 dF(x) - (1 - \overline{y})^2 \right) = 0, \end{aligned} \tag{2}$$

for which

$$\frac{\partial \underline{y}}{\partial p_m} = \frac{1}{2\gamma \hat{x}} = -\frac{\partial \underline{y}}{\partial p_0}, \frac{\partial \overline{y}}{\partial p_m} = -\frac{1}{2\gamma(1-\hat{x})} = -\frac{\partial \overline{y}}{\partial p_1}$$

holds, where $\hat{x} = E(x)$. Information and "comfort" provision are fixed costs and do not depend on the market share, so the media firm maximizes $\pi_m = [\Phi(\overline{y}(p_m, p_1))) - \Phi\left(\underline{y}(p_m, p_0)\right)]p_m$ w.r.t. p_m, and the fake news providers maximize $\pi_0 = \Phi\left(\underline{y}(p_m, p_0)\right) p_0$ w.r.t. p_0 and $\pi_1 = [1 - \Phi(\overline{y}(p_m, p_1))] p_1$ w.r.t. p_1. In what follows, we assume that the market share of the media firm is always strictly positive and that its operating profit covers any fixed cost.[8]

In this case, the media firm has two options: (i) setting the price sufficiently low such that the fake news provider has no market share, or (ii) accommodating entry of one or both fake news providers. The fake news provider will not enter if its market share is zero even if it charges a zero price. In general, the the optimal prices p_m^*, p_o^*, p_1^* of all firms are determined by the Kuhn-Tucker conditions

$$\begin{aligned} \frac{\partial \pi_0(p_m^*, p_0^*)}{\partial p_0} &= -\frac{\phi\left(\underline{y}(p_m^*, p_0^*)\right) p_0^*}{2\gamma \hat{x}} + \Phi\left(\underline{y}(p_m^*, p_0^*)\right) \leq 0, p_0^* \geq 0, \\ \frac{\partial \pi_0(p_m^*, p_0^*)}{\partial p_0} p_0^* &= 0, \end{aligned} \tag{3}$$

[8] Otherwise, both fake news providers simply compete against each other according to a standard Hotelling duopoly model.

$$\begin{aligned}
\frac{\partial \pi_1(p_m^*, p_1^*)}{\partial p_1} &= -\frac{\phi\left(\overline{y}(p_m^*, p_1^*)\right) p_1^*}{2\gamma(1-\hat{x})} + 1 - \Phi\left(\overline{y}(p_m^*, p_1^*)\right) \leq 0, p_1^* \geq 0, \\
\frac{\partial \pi_1(p_m^*, p_1^*)}{\partial p_1} p_1^* &= 0, \\
\frac{\partial \pi_m(p_m^*, p_0^*, p_1^*)}{\partial p_m} &= -\frac{p_m^*}{2\gamma}\left[\frac{\phi\left(\overline{y}(p_m^*, p_1^*)\right)}{1-\hat{x}} + \frac{\phi\left(\underline{y}(p_m^*, p_0^*)\right)}{\hat{x}}\right] \\
&+ \Phi\left(\overline{y}(p_m^*, p_1^*)\right) - \Phi\left(\underline{y}(p_m^*, p_0^*)\right) = 0.
\end{aligned}$$

We are interested in the emergence and profitability of fake news providers serving echo chambers. As discussed in section 2, digitization has reduced the entry costs of these providers substantially or even eliminated them, and since (re-)confirming extreme views has no cost, we assume that fake news providers do not have to carry any (substantial) entry cost. In particular, we want to learn how an increase in the *ex ante* uncertainty of information affects the equilibrium. In this sense, in a world that has, in general, become more complex, the emergence of echo chambers may result (i) from an increase in the costs of overcoming cognitive dissonances due to the increased marginal cost of understanding a more complex world and (ii) from an increase in complexity itself, leading to more uncertainty about outcomes.

Echo chambers served by fake news providers will not exist if their profit is zero even if they charge a zero price. Let $\tilde{p}_m^0$ and $\tilde{p}_m^1$ denote the highest price for which no consumer will buy information from fake news provider 0 and 1, respectively. We find:

Lemma 1.

$$\tilde{p}_m^0 = \beta - \alpha - \gamma\left(Var(x) + \hat{x}^2\right), \tilde{p}_m^1 = \beta - \alpha - \gamma\left(Var(x) + 1 - 2\hat{x} + \hat{x}^2\right).$$

Proof. The largest price that will keep fake news provider 0 (1) out of the market makes the consumer with prior $y = 1 (y = 0)$ indifferent between accepting $\tilde{p}_m^0(\tilde{p}_m^1)$ and enjoying the echo chamber at $y = 1 (y = 0)$ for free. Thus,

$$\tilde{p}_m^0 = \beta - \alpha - \gamma \int_0^1 x^2 dF(x) \text{ and } \tilde{p}_m^1 = \beta - \alpha - \gamma \int_0^1 (1-x)^2 dF(x)$$

Since

$$\text{Var}(x) = \int_0^1 x^2 dF(x) - \hat{x}^2, \text{Var}(1-x) = \int_0^1 (1-x)^2 dF(x) - (1-\hat{x})^2 \text{ and } \text{Var}(x) = \text{Var}(1-x),$$

from which Lemma 1 follows. □

Lemma 1 shows that the entry-deterring prices decrease with the variance of information for a given average $\hat{x}$. Since dissonance costs are marginally increasing, a larger variance of information, revealing a potentially inconvenient truth, increases the expected cost for a consumer with prior $y = 1$ or prior $y = 0$. This increase in dissonance cost must be compensated by a lower price to keep this extreme consumer with the media firm. Furthermore, if $\hat{x} > (<)1/2$, that is, if the pdf $f(x)$ is skewed to the right (left), $\tilde{p}_m^0 > (<)\tilde{p}_m^1$, that is, the largest price of the media firm that gives fake news provider 0 no market is larger (smaller) than the one that gives fake news provider 1 no market. The media firm will do better by a higher price, thus allowing entry by a fake news provider, if

$$-\frac{p_m}{2\gamma}\left[\frac{\phi(1)}{1-\hat{x}}+\frac{\phi(0)}{\hat{x}}\right]+1>0 \Leftrightarrow p_m < \frac{2\gamma}{\frac{\phi(1)}{1-\hat{x}}+\frac{\phi(0)}{\hat{x}}}$$

so entry by a fake news provider occurs if

$$\frac{\beta-\alpha}{\gamma} - \left(\text{Var}(x)+\hat{x}^2+z\right) < \frac{2\hat{x}(1-\hat{x})}{\phi(1)\hat{x}+\phi(0)(1-\hat{x})}, \tag{4}$$

where $z = \max\{0, 1-2\hat{x}\}$. Eq. (4) proves:

Proposition 1. *The profitability of market entry by fake news providers increases with the variance of x and the consumer's loss from disconfirmation (γ) and decreases with $\beta - \alpha$.*

Proposition 1 shows that both an increase in the cost of overcoming cognitive dissonances and an increase in complexity, measured by an increase in the variance of information, supports the emergence of echo chambers. Our analysis also shows that entry is less likely for a fake news producer that is closer to the expected outcome $\hat{x}$. If the pdf $f(x)$ is skewed to the right (left), the largest price of the media firm to keep a fake news provider out of the market is larger for fake news provider 0 (1) compared to fake news provider 1 (0). Thus, deterring entry is harder when targeting the fake news provider that is closer to $\hat{x}$.

In order to shed more light on the potential dominance of echo chambers, we now illustrate our results with an identical uniform distribution for both x and y and for

which $\hat{u}(y) = \beta - \gamma\left(1/3 - (1-y)y\right) - p_m$. Furthermore, due to symmetry, $\hat{x} = \hat{y} = 1/2$ and both fake news providers are equidistant from $\hat{x} = \hat{y}$. For the case of entry, setting $\hat{u}(y) = u_0(y)$ and $\hat{u}(y) = u_1(y)$ yields the market shares

$$\begin{aligned} s_0(p_m, p_0) &= \max\left\{0, \frac{1}{3} - \frac{\beta - \alpha + p_0 - p_m}{\gamma}\right\}, \\ s_1(p_m, p_m) &= \max\left\{0, \frac{1}{3} - \frac{\beta - \alpha + p_1 - p_m}{\gamma}\right\}, \\ s_m(p_m, p_0, p_1) &= \min\left\{\frac{1}{3} - \frac{2p_m - p_0 - p_1 - 2(\beta - \alpha)}{\gamma}, 1\right\}. \end{aligned}$$

In equilibrium,

$$p_m^* = \frac{3(\beta - \alpha) + 2\gamma}{9}, p_0^* = p_1^* = \max\left\{0, \frac{5\gamma - 6(\beta - \alpha)}{18}\right\},$$

and

$$s_m(p_m^*, p_1^*, p_1^*) = \min\left\{\frac{4}{9} + \frac{2(\beta - \alpha)}{3\gamma}, 1\right\}, s_0(p_m^*, p_0^*) = s_1(p_m^*, p_1^*) = \max\left\{0, \frac{5}{18} - \frac{\beta - \alpha}{3\gamma}\right\}.$$

We observe that $\beta - \alpha < (\geq) 5\gamma/6$ implies that fake news providers have a strictly positive (no) market share. Of course, with an increase in α, the market share of the media firm shrinks and the market share of both fake news providers increases. Note that $s_m(p_m^*, p_0^*, p_1^*) < s_0(p_m^*, p_0^*) + s_1(p_m^*, p_1^*)$ for $\beta - \alpha < \gamma/9$. Thus, there is a range of sufficiently high comfort value in the echo chambers (α), still lower than the value of information (β), such that fake news providers will even dominate the market, and they definitely dominate the market if $\beta = \alpha$.

In many countries, one form of media provider that is required to report news in a balanced and unbiased way is a public broadcaster. Frequently, such broadcasters are also free to consumers (both in direct monetary terms and with respect to any disutility from advertising, when such providers are commercial-free); does this make any difference here? We find:

Proposition 2. *If a public provider offers information for free, the profitability of market entry by fake news providers increases with the variance of x and the consumer's loss from disconfirmation (γ) and it decreases with $\beta - \alpha$. The profitability of market entry is smaller compared to a profit-maximizing media firm.*

Proof. A fake news provider will consider entry if $\partial\pi_0(p_m = p_1 = 0)/\partial p_1 = \Phi\left(\underline{y}(0,0)\right) > 0$, that is when the provider can gain a strictly positive market share for $p_1 = 0$, requiring that $\underline{y}(0,0) > 0$. This is true if

$$\frac{\beta - \alpha}{\gamma} - \left(\text{Var}(x) + \hat{x}^2 + z\right) < 0. \tag{5}$$

Comparing (5) with (4) shows that condition (4) is less demanding than condition (5). □

For the uniform distribution, we find that fake news providers have a positive market share *iff* $\beta - \alpha < \gamma/3$. While the profitability of market entry is determined by the variance of information and the loss from disconformation in a similar way, it will be harder for fake news providers to win market share against a public provider charging a zero price. Thus, a public provider is in a better position to deter entry by fake news providers.[9]

What happens when the locations of providers are endogenous to begin with? Note that only the fake news providers have a definite location in our model, but the media firm has not, as it is committed to establish the true value of information in an unbiased fashion. The appendix shows – for a profit-maximizing media firm – the condition under which the Principle of Maximal Differentiation holds. When the media firm will respond with a sufficient price cut when any fake news provider will move away from the extremes, the fake news providers have no interest in becoming more moderate. Thus, the extreme positioning of fake news providers is also possible in case of endogenous locations. An interesting qualification to this applies in the case of a public provider. In that case there is no price response from the real media provider so maximal differentiation cannot apply. Indeed, it is optimal for the echo chamber firms to moderate their positions and move closer to the centre such that their location choice is also their marginal consumer and they serve only consumers to their left (for x_0) or right (for x_1.) If $(\beta - \alpha)$ is small then this will also bring down their prices. Thus a public provider can not only moderate the extreme positions of fake news providers, but it can also make them more competitive.

[9]Note that Bertrand competition between two or more media firms will lead to the same result.

5 Concluding remarks

This paper presents a simple model of a consumer's trade-off between valuable real news and "news" known to be fake but which confirms a consumer's priors: an echo chamber. We demonstrate that such providers can coexist with genuine news media even if, in a sense made clear in the paper, consumers value real news more highly than the comfort they receive from fake news that confirms their beliefs about the world. They are more likely to be profitable the more consumers value confirmation, of course, but also the less certain is the news environment. Furthermore, they will appeal more to consumers with extreme views than to moderates. Since the echo chambers' market shares increase with the variance of possible outcomes, it is no surprise that they have become more influential in a world that is perceived to have become more complex.

While echo chambers do not do any harm to their consumers, this does not mean that they do not cause social damage. Extreme views may imply that violence and unrest will replace debate to some extent and thus undermine democratic institutions that rely on well-informed citizens. Our paper shows that a public media provider can mitigate this danger, as it will reduce the market share of echo chambers and will make them less extreme. Furthermore, media education could reduce the costs of overcoming cognitive dissonances. Echo chambers will have no place in a society in which curiosity beats prejudices. Echo chambers have won market shares as digitization has reduced their operating costs substantially, but this does not mean that digitization could not be used in media education to reduce their influence. Furthermore, competition policy could regulate or even break up firms that have monopoly power in social media markets and whose algorithms support the confirmation of extreme views, so as to make the operation of fake news providers more expensive.

Appendix

We demonstrate the conditions for the Principle of Maximum Differentiation to hold for the fake news firm that is located to the left and considers to locate at x_0 instead of 0. $\underline{y}$ is then determined by

$$g(\underline{y}, p_m, p_0, x_0) = \beta - \alpha - p_m + p_0 - \gamma \left(\int_0^1 (\underline{y} - x)^2 dF(x) - (\underline{y} - x_0)^2 \right), \qquad \text{(A.1)}$$

for which

$$\frac{\partial \underline{y}}{\partial p_m} = \frac{1}{2\gamma(\hat{x} - x_0)} = -\frac{\partial \underline{y}}{\partial p_0}, \frac{\partial \underline{y}}{\partial x_0} = \frac{\underline{y} - x_0}{\hat{x} - x_0} > 0.$$

Indifference condition (A.1) replaces condition (2), and the first-order conditions now read for interior solutions as

$$\begin{aligned}
\frac{\partial \pi_0(p_m^*, p_0^*, x_0)}{\partial p_0} &= -\frac{\phi\left(\underline{y}(p_m^*, p_0^*, x_0)\right) p_0^*}{2\gamma(\hat{x} - x_0)} + \Phi\left(\underline{y}(p_m^*, p_0^*, x_0)\right) = 0, \\
\frac{\partial \pi_1(p_m^*, p_1^*)}{\partial p_1} &= -\frac{\phi\left(\overline{y}(p_m^*, p_0^*)\right) p_0^*}{2\gamma(1 - \hat{x})} + 1 - \Phi\left(\overline{y}(p_m^*, p_1^*)\right) = 0, \\
\frac{\partial \pi_m(p_m^*, p_0^*, p_1^*, x_0)}{\partial p_m} &= -\frac{p_m^*}{2\gamma}\left[\frac{\phi\left(\overline{y}(p_m^*, p_1^*)\right)}{1 - \hat{x}} + \frac{\phi\left(\underline{y}(p_m^*, p_0^*, x_0)\right)}{(\hat{x} - x_0)}\right] \\
&+ \Phi\left(\overline{y}(p_m^*, p_1^*)\right) - \Phi\left(\underline{y}(p_m^*, p_0^*, x_0)\right) = 0, \qquad \text{(A.2)}
\end{aligned}$$

where the fake news provider 1 continues to be located at $x_1 = 1$. The second-order condition implies that $\partial^2 \pi_m(p_m^*, p_0^*, p_1^*, x_0)/\partial p_m^2 < 0$, and

$$\begin{aligned}
\frac{\partial^2 \pi_m(p_m^*, p_0^*, p_1^*, x_0)}{\partial p_m \partial x_0} &= -\frac{p_m^*}{2\gamma}\left[\frac{\partial \underline{y}}{\partial x_0}\frac{\phi'\left(\underline{y}(p_m^*, p_0^*, x_0)\right)}{(\hat{x} - x_0)} + \frac{\phi\left(\underline{y}(p_m^*, P_0^*, x_0)\right)}{(\hat{x} - x_0)^2}\right] \\
&- \frac{\partial \underline{y}}{\partial x_0} f\left(\underline{y}(p_m^*, p_0^*, x_0)\right) < 0
\end{aligned}$$

if $\phi'\left(\underline{y}(p_m^*, p_0^*, x_0)\right) \geq 0$. $\partial^2 \pi_m(p_m^*, p_0^*, p_1^*, x_0)/\partial p_m \partial x_0 < 0$ implies $dp_m^*/dx_0 < 0$ such that the media firm will lower its price in response to a closer location of its fake news rival. Let $\pi_0^*(x_0) = \pi_0(p_0^*(x_0), p_m^*(x_0), x_0)$ denote the maximized profit of the fake news firm. Differentiation and the envelope theorem imply that

$$\begin{aligned}
\frac{d\pi_0^*}{dx_0} &= \frac{\partial \pi_0(p_0^*(x_0), p_m^*(x_0), x_0)}{\partial p_m}\frac{dp_m^*(x_0)}{dx_0} + \frac{\partial \pi_0(p_0^*(x_0), p_m^*(x_0), x_0)}{\partial x_0} \\
&= \frac{p_0^*(x_0)}{2\gamma(\hat{x} - x_0)}\left[\frac{dp_m^*(x_0)}{dx_0} + 2\gamma(\underline{y} - x_0)\right],
\end{aligned}$$

and thus the optimal location is the extreme location $x_0^* = 0$ if the price reduction is sufficiently strong such that $dp_m^*(x_0)/dx_0 < -2\gamma\underline{y}$ holds.

References

[1] Anderson, S.P., McLaren, J. (2012), Media mergers and media bias with rational consumers, *Journal of the European Economic Association*, 10: 831-859.

[2] Azzimonti, M., Fernandes, M. (2018), Social Media Networks, Fake News, and Polarization, *NBER Working Paper No. 24462*, March 2018.

[3] Chiou, L., Catherine Tucker, C. (2018), Fake News and Advertising on Social Media: A Study of the Anti-Vaccination Movement, *NBER Working Paper No. 25223*, November 2018.

[4] Del Vicario, M., Vivaldo, G., Bessi, A., Zollo, F., Scala, A., Caldarelli, G., Quattrociocchi, W. (2016), Echo Chambers: Emotional Contagion and Group Polarization on Facebook, *Scientific Reports*, 6:37825. DOI: 10.1038/srep37825.

[5] Feistinger, L. (1957), A Theory of Cognitive Dissonance, Stanford University Press.

[6] Gentzkow, M., Shapiro, J.M., Stone, D.F. (2015), Media bias in the marketplace: theory. In Simon Anderson, David Strömberg and Joel Waldfogel (eds), *Handbook of Media Economics*. Elsevier: Amsterdam. Chapter 14: 623-645.

[7] Gorodnichenko, Y., Pham, T., Talavera, O. (2018), Social Media, Sentiment and Public Opinions: Evidence from # Brexit and # USElection, *NBER Working Paper No. 24631*, May 2018 .

[8] Grossman, G.M., Helpman, E. (2019), Electoral Competition with Fake News, *NBER Working Paper No. 26409*, October 2019.

[9] Jann, O., Schottmüller, C. (2018), Why Echo Chambers are Useful, mimeo. Available at `https://olejann.net/wp-content/uploads/echo_chambers.pdf`. Accessed 24 June 2020.

[10] Levy, G., Razin, R. (2018), Immigration into prejudiced societies: segregation and echo chambers effects, *CEPR Discussion Paper DP12630*, 22 January 2018.

[11] Levy, G., Razin, R. (2019), Echo Chambers and Their Effects on Economic and Political Outcomes, *Annual Review of Economics*, 11: 303-28.

[12] Long, N.V., Richardson, M., Stähler, F. (2019), Media, fake news, and debunking, *The Economic Record*, 95: 312-324.

[13] Morgenstern, O. (1972), Descriptive, Predictive and Normative Theory, *Kyklos*, 25: 699-714.

[14] Mullainathan, S., Shleifer, A. (2005), The market for news, *American Economic Review*, 95: 1031-1053.

[15] Stähler, F., Stähler, L. (2020), Copyright Protection in the Digital Single Market, *SNF Working Paper No 04/20*, Norwegian School of Economics, Available at `https://www.snf.no/Files/Filer/Publications/A04_20.pdf`.

[16] Thaler, M. (2020), The "Fake News" Effect: Experimentally Identifying Motivated Reasoning Using Trust in News, mimeo. Available at `https://scholar.harvard.edu/mthaler/publications/fake-news-effect`. Accessed 30 June 2020.