Optimal Choice of Biased and Neutral News Sources*

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Abstract

This paper examines how individuals with limited attention choose between neutral and biased news sources. I build a theoretical model in which agents select a portfolio of outlets to learn about the true state of the world. Confirmation bias — the tendency to favor sources that reinforce preexisting beliefs — emerges as the default outcome when biased sources are available. Unlike typical behavioral explanations, this pattern arises here purely from rational choice. However, the model also shows that individuals with weak prior beliefs may optimally consume information that is neutral or even contradictory to their beliefs. These choices shape belief formation and polarization: as source error increases, polarization first rises and then falls, forming an inverse-U pattern. Yet, endogenous switching to biased sources can disrupt this dynamic.

JEL classification: D83, L82

Keywords: confirmation bias, information acquisition, media market, media bias, polarization

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1 Introduction

In the contemporary information landscape, both biased and unbiased sources coexist, significantly shaping news consumption patterns. Confirmation bias represents one of the well-documented phenomena related to the choice of information sources in the social sciences literature (e.g., Lord, Ross, & Lepper, 1979; Rabin & Schrag, 1999; Gentzkow & Shapiro, 2006). Individuals exhibiting confirmation bias tend to seek out, prioritize, and more readily recall information that aligns with their pre-existing beliefs. This selective exposure to information can contribute to the creation of echo chambers — environments where individuals predominantly encounter views that reinforce and amplify their initial opinions.

Yet, news outlets rarely provide users with content that merely reinforces their existing beliefs. Instead, they may tend to present a diverse mix of opinions, some of which align with the user's views, while others challenge them. Several studies have documented that consumers can find satisfaction when being presented with contradictory opinions (Bursztyn, Rao, Roth, & Yanagizawa-Drott, 2022; Levy, 2021). While this reaction may partly stem from the emotional impact of opposing opinions (such as inducing anger), my focus is on exploring rational motivations that may underlie this phenomenon.

In this paper, I examine when individuals choose to step outside their echo chambers and consume neutral or even contradictory news. I develop a simple model in which individuals with limited attention select a portfolio of news sources to learn about the true state of the world. The key intuition is that confirmatory sources — those aligned with prior beliefs — are expected to sharpen beliefs, increase confidence, and raise expected payoffs. However, when neutral sources are sufficiently reliable, the highest expected utility comes from consuming neutral news or a mix of neutral and contradictory sources. This combination helps avoid the risk of remaining uncertain and receiving low payoffs. Such behavior deviates from the traditional notion of confirmation bias.

To illustrate the core intuition of my model, consider an agent deciding whether to support a complex policy such as the European Green Deal. The actual effects of the policy are uncertain at the time of decision-making, but media outlets offer cues. Suppose the agent believes the policy is likely beneficial but is not fully confident. She can read only a limited number of news articles due to time constraints. Her options include Green Future Magazine (a source biased in favor of the policy), Our Coal Weekly (opposed to it), and the neutral but still imperfect Daily News.

Reading from Green Future Magazine would likely confirm the agent's views and boost her confidence that the Green Deal is beneficial. If the magazine unexpectedly claimed the policy was harmful, the surprise would be so strong that it could prompt her to fully revise her belief. In both cases, the agent ends up confident. In contrast, reading Our Coal Weekly and encountering a negative report leaves her uncertain — she cannot discern whether the policy is truly flawed or whether the report simply reflects the source's bias. The neutral Daily News is never entirely persuasive due to occasional random errors, but if the agent trusts it, it may still be the best choice.

Notably, for agents who are initially very uncertain, combining Daily News with Our Coal Weekly can be optimal. This portfolio rarely leaves the agent in doubt. An agent who believes the Green Deal is slightly more likely to be good than bad assigns a meaningful probability to Our Coal Weekly publishing a surprisingly positive article. If that happens, the agent becomes confident the policy is beneficial — regardless of what Daily News reports. If Our Coal Weekly claims the policy is harmful, the agent can still cross-check the claim with the more reliable and unbiased Daily News. In either case, the agent ends up with a clearer view of the policy's effects.

While the model primarily focuses on news demand under limited attention, it also has broader implications for policy. In particular, I adopt the perspective of a social planner who is concerned about polarization. I show that polarization follows an inverse-U relationship with the noise of the information source. As a precise source becomes noisier, polarization initially increases. This is driven by some agents receiving incorrect signals, which misaligns their beliefs with those of agents who receive correct signals. However, as noise increases further, agents' trust in the source declines, which limits how far their beliefs can diverge — even when they receive opposing signals. Additionally, because agents endogenously choose their signal portfolios, shifts in portfolio choices can modify or even disrupt this inverse-U pattern.

The key contribution of this paper is a novel description of the role of neutral and biased sources on the media market. It highlights the importance of neutral sources, which can not only become an optimal choice for agents with weak beliefs, but also direct the attention of some agents towards a contradictory source they would otherwise never consume.

The rest of this paper is organized as follows: Section 2 reviews the most relevant literature; Section 3 sets up the theoretical model; Section 4 presents the results and discusses their implications; Section 5 concludes.

2 Related Literature and Contribution

My research contributes to the literature on confirmation bias, which lies in the intersection of psychology and economics. Nickerson (1998) summarizes the earlier literature on this topic. Subsequent contributions from economists have offered various explanations for the phenomenon, including signal misinterpretation (Rabin & Schrag, 1999), reputation concerns (Gentzkow & Shapiro, 2006), preference for consistency (Yariv, 2005), bounded memory (Wilson, 2014), the dimensionality of information (Andreoni & Mylovanov, 2012), and different models of optimal information acquisition (Hu, Li, & Tan, 2024; Jann & Schottmüller, 2023; Allon, Drakopoulos, & Manshadi, 2021; Montanari & Nunnari, 2023; Novák, Matveenko, & Ravaioli, 2024). Among these, the last class of models aligns most closely with the framework I develop in this paper. The primary innovation of my model lies in its ability to describe not only confirmation bias but also behaviors that diverge from it.

In general, theoretical literature describing the circumstances under which agents acquire diverse opinions is quite scarce. Che and Mierendorff (2019) show that such behavior can arise once we introduce a dynamic trade-off between learning the information early and learning it more precisely. The basic features of their model are similar to mine; however, the key innovation of my paper is that I allow for the existence of unbiased news sources, which turn out to induce the demand for contradictory sources, even without assuming any dynamic trade-offs. Moreover, I study the case of simultaneous information source choice and full commitment, where the agents cannot alter their information source choices once they have observed the signals. Therefore, my model is a suitable description of the situations where the agent does not dynamically re-optimize her choices and instead chooses a limited amount of news to consume, and then she sticks to her choice for all future topics she gets informed about. This could, for instance, describe purchasing subscriptions or choosing which accounts to follow on social media. Once the choice is made, there are some monetary, or at least mental costs, associated with rebalancing the source portfolio, which could keep the agent committed to her initial choice.

Several other papers also document the conditions under which consumers may choose contradictory news sources. Charness, Oprea, and Yuksel (2021) derive that this pattern may occur when sources are biased by omission — in case the state of the world is unfavorable for them, they do not send any signal. Jann and Schottmüller (2024) demonstrate the consumption of a contradictory source when deriving utility also from learning the opinions of other agents.

In terms of experimental evidence, Ambuehl and Li (2018) find that when facing biased information sources, agents underrespond to a subjective increase in the informativeness of the source and overvalue sources providing certainty. Calford and Chakraborty (2023) run an experiment with costly biased signals and reports that equal the cost, agents choose a diverse portfolio of signals. In a setting similar to mine, Montanari and Nunnari (2023) experimentally show that even though it would be optimal for a Bayesian agent to always acquire a confirmatory signal, agents sometimes tend to choose the contradicting signal. They also bring many important insights about how agents incorporate the different signals acquired into their decision-making.

Furthermore, my research contributes to the growing literature on media bias, a topic thoroughly described by Gentzkow, Shapiro, and Stone (2015), and related phenomena, including polarization and fake news. For brevity, I focus only on the most recent findings relevant to contemporary media environments. A handful of studies identify the presence of confirmation bias on the side of news outlets (Flaxman, Goel, & Rao, 2013; Budak, Goel, & Rao, 2016). Other studies focus on the demand for media bias under government control (Simonov & Rao, 2022) or when there is an accuracy-confirmation trade-off (Chopra, Haaland, & Roth, 2024). Some studies also evaluate the impact of media coverage on society as a whole, including the support for the current government and polarization of opinions (Enikolopov, Rochlitz, Schoors, & Zakharov, 2022; Martin & Yurukoglu, 2017; DellaVigna & Kaplan, 2007). I contribute to this literature by showing that the realationship between media error and polarization follows an inverse-U shape (disrupted bz endogeneous information choice switches) and discussing related policy implications.

3 Model set-up

Let there be two states of the world $\omega \in \{a, b\}$ ex-ante equally likely to occur. The agent (news consumer) has a prior belief represented by the probability she assigns to the state of the world being a. I denote this prior belief by q. The objective of the agent is to match her action $t \in \{a, b\}$ to the true state of the world, in which case she gets a payoff of one; and a payoff of zero otherwise. That implies a utility function

$$U(t) = \begin{cases} 1, & \text{if } t = \omega \\ 0, & \text{if } t \neq \omega \end{cases} \tag{1}$$

Before taking the action, the agent can consume news articles from three different news sources available — $M \in (\alpha, \nu, \beta)$. These sources send signals $s \in \{A, B\}$ (representing short news articles). Each source, however, is imprecise and sometimes sends a signal that is not in line with the actual state of the world. The probability of the mistake depends on the true state of the world and on the source. There is a source that is biased towards a, a neutral source, and a source biased towards b. Table 1 defines the mistake probabilities for different information sources.[1] I assume that the biases of the biased sources are of equal magnitudes, described by $e \in (0,1)$, whereas the bias of the neutral source $e_\nu \in (0,0.5)$, may differ.

Table 1: The news sources and their biases

news sources		
α	ν	β
biased towards a	neutral	biased towards b
$P(A\|b) = e$	$P(A\|b) = e_\nu$	$P(A\|b) = 0$
$P(B\|a) = 0$	$P(B\|a) = e_\nu$	$P(B\|a) = e$

The agent is exogenously limited with the number of signals n she can consume. Her task is to choose a portfolio of news outlets from which she consumes the signals. Specifically, she chooses

[1] In my notation, I distinguish the source that sent the signal — I denote it with a lower index next to the signal realization. For instance, A_α denotes signal A from source α.

an unordered n-tuple W from elements of the set $M \in (\alpha, \nu, \beta)$ (the portfolio of news outlets) to maximize her expected payoff.

The problem of the agent is

$$\max_{(t, W \in \{\alpha,\nu,\beta\}^n)} \mathbf{E}\left[U(t)|q,W\right], \tag{2}$$

where $U(t)$ and q, n, e, e_ν are defined above.

This problem prescribes that once the realization of all signals S is observed, the optimal action of the agent is

$$t = \begin{cases} a, & \text{if } r_{WqS} > 0.5 \\ b, & \text{if } r_{WqS} < 0.5 \\ a \text{ or } b, & \text{if } r_{WqS} = 0.5 \end{cases}, \tag{3}$$

where $r_{WqS} = \mathbf{E}\left[\mathbf{I}_{\omega=a}|q,S,W\right]$, denotes the posterior belief of the agent induced by the signal received.

The expected payoff, as depicted in Figure 1, is given by:

$$\mathbf{E}\left[U(t)|r_{WqS}\right] = \max\left(r_{WqS}, 1 - r_{WqS}\right) \tag{4}$$

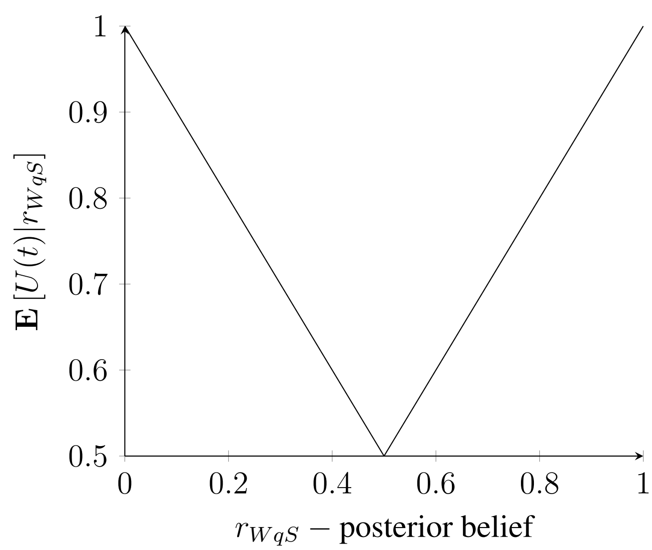


Figure 1: Expected utility as a function of the posterior belief

4 Results

4.1 Demand for One Signal

I begin with a setting in which the agent can consume only one source from the set $\{\alpha, \beta, \nu\}$.

Proposition 1 (Optimal Choice of One Signal)**.** *Let the agent choose one source in* $\{\alpha, \beta, \nu\}$. *Then:*

(i) If the neutral source ν *is not available, the confirmatory source* α *strictly dominates the contradictory source* β *for all prior beliefs* $q \in (0,1)$.

(ii) If the neutral source ν *is available, the optimal choice depends on the prior* q *and the relative precision* e_ν/e*:*

- *If* $e_\nu/e > 0.5$*, the confirmatory source is always optimal.*
- *If* $e_\nu/e < 0.5$*, the neutral source* ν *is optimal for agents with* $q \in \left(\frac{e_\nu}{e}, 1 - \frac{e_\nu}{e}\right)$*; otherwise, the confirmatory source is optimal.*

I illustrate the logic of Proposition 1 by computing the expected utilities for each source. First, I consider source α. An agent with belief q assigns probability $q + e(1-q)$ to this source sending signal A and leading the agent to form a belief of $\frac{q}{q+e(1-q)}$. This posterior belief translates into an expected payoff of max $\left\{\frac{q}{q+e(1-q)}; 1 - \frac{q}{q+e(1-q)}\right\}$. Otherwise, the source sends signal B, and the agent forms a belief of $q = 0$ and gets a payoff of 1. Given that, the expected payoff for source α is

$$\mathbf{E}\left[U|\alpha,q\right] = [q + e(1-q)] \cdot \max\left[\frac{q}{q+e(1-q)}, 1 - \frac{q}{q+e(1-q)}\right] + (1-e)(1-q), \tag{5}$$

which can be simplified to

$$\mathbf{E}\left[U|\alpha, q\right] = \max\left[q, e(1-q)\right] + (1-e)(1-q). \tag{6}$$

Using similar logic, we get

$$\mathbf{E}\left[U|\beta, q\right] = \max\left[eq, (1-q)\right] + (1-e)q, \tag{7}$$

and

$$\mathbf{E}\left[U|\nu, q\right] = \max\left[e_\nu q, (1-e_\nu)(1-q)\right] + \max\left[(1-e_\nu)q, e_\nu(1-q)\right] \tag{8}$$

Figure 2 demonstrates the consideration of the agent. The figure shows the convex mapping between the posterior belief and the payoff of the agent. The agent starts with a prior belief that is associated with a payoff denoted by the black dot. Then, she chooses one of the signals available. The signal shifts her belief according to the rules described above. Here, we get two possible belief shifts corresponding to two possible signal realizations for each source — they are denoted with red, blue, and green dots. Clearly, receiving signal A from any source shifts the belief to the right, and receiving signal B shifts the belief to the left.

Moreover, given that our agent is Bayesian, there is a simple way to illustrate her expected payoff for each source. The lines connecting the two possible realizations of the signal show all the convex linear combinations of these two payoffs. Furthermore, its intersection with the vertical line drawn at the prior belief of the agent (dashed) determines the overall expected payoff for that source and agent with the given prior belief. This yields from the fact that the expected posterior belief is equal to the prior belief of the agent. Therefore, it is easy to illustrate the intuition behind optimal source choice by comparing the vertical coordinates of intersections with the dashed line denoting the prior belief.

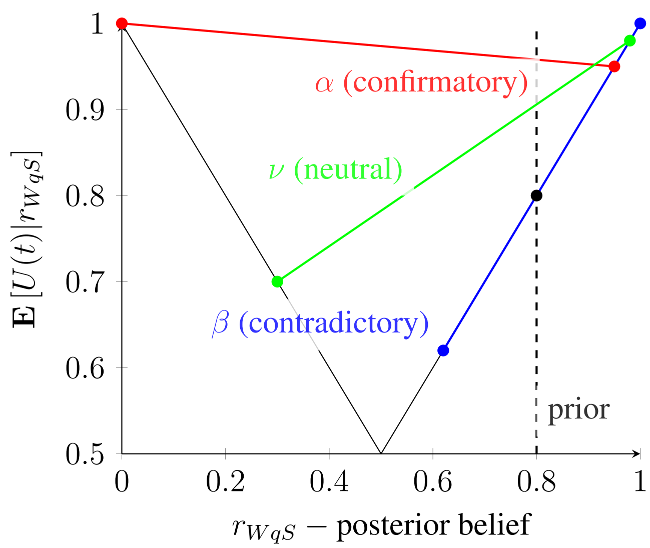
For the confirmatory source α, there is always a chance that it reveals the state of the world being b and sets the belief to 0. If not, it at least always increases the belief of the agent to a value close to 1. In both cases, the expected payoff increases substantially, leading to a high expectation of the payoff when consuming this source.

The contradictory source β instead either sets the belief to be equal to 1 (by sending signal A) or lowers it (by sending signal B). In the latter case (which the agent considers to be more likely), the belief of the agent could either end up still being > 0.5, which does not change the action of the agent and therefore does not improve her payoff, or it could end up slightly below the threshold of 0.5, which, however, is associated with a low payoff. Therefore, the contradictory source is always dominated by the confirmatory source and is never an optimal choice.

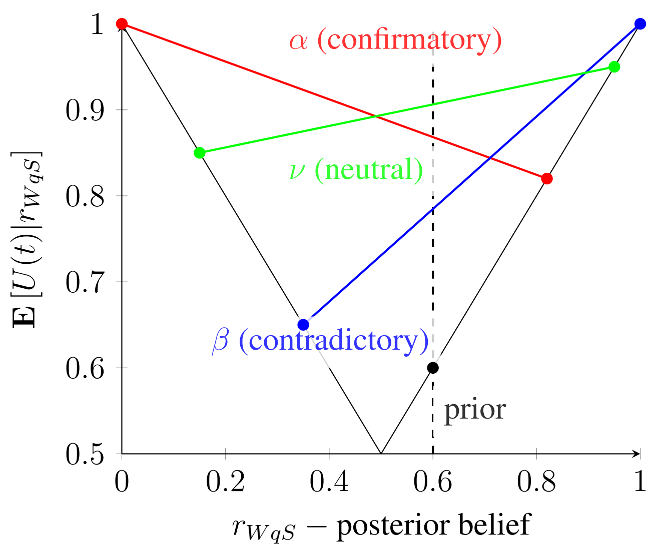
Furthermore, adding the neutral source into consideration, receiving signal A sets the belief to be higher than the prior (and thus associated with a higher payoff), whereas signal B leads to a posterior close to 0.5. The exact posterior beliefs depend on the quality of the neutral source and the prior of the agent. If the agent is sufficiently close to $q = 0.5$, and the source is sufficiently precise, it induces strong posterior beliefs that, in terms of the expected payoff, overrule the confirmatory source.

Panel (a) of Figure 2 illustrates the case of an agent with a strong prior belief. For her, the highest payoff is achieved by the confirmatory source since the other two sources could result in a weaker belief and lower expected payoff.

Conversely, an agent with a weak prior belief benefits the most from choosing source ν, as demonstrated in Panel (b). Here, the confirmatory source is unable to convince the agent about the



(a) strong prior ($q = 0.8$), optimal choice: α



(b) weak prior ($q = 0.6$), optimal choice: ν

Figure 2: Posterior beliefs and expected payoffs for the case of one signal.

Note: For both figures $e_\nu = 0.1$ and $e = 0.4$. The prior of the agent is expressed with a black dot and a dashed black line. The solid black line plots the expected utility as a function of posterior belief. The points demonstrate the potential posterior beliefs and the payoffs associated with them. The intersection of the lines with the dashed line shows the expected payoff for a given source.

state of the world being a as much as the neutral source is.

To describe the optimal signal choices for different configurations of e, and e_ν, I compare the expected utilities computed above. The intuition suggests that agents would never opt for their contradictory signal. Instead, depending on the strength of their prior belief and the quality of the sources available, they might seek out the neutral source. It turns out that the optimal signal choice is completely determined by q (the prior belief) and the ratio of e_ν and e (capturing the relative bias of the neutral source). Figure 3 shows the relation between these parameters and the optimal signal choice. For $e_\nu/e > 0.5$ it is never optimal to choose the neutral source. However, below this threshold, there is always a band of agents around $q = 0.5$ who find it optimal to choose the neutral source. The width of this band increases with decreasing relative bias of the neutral source.

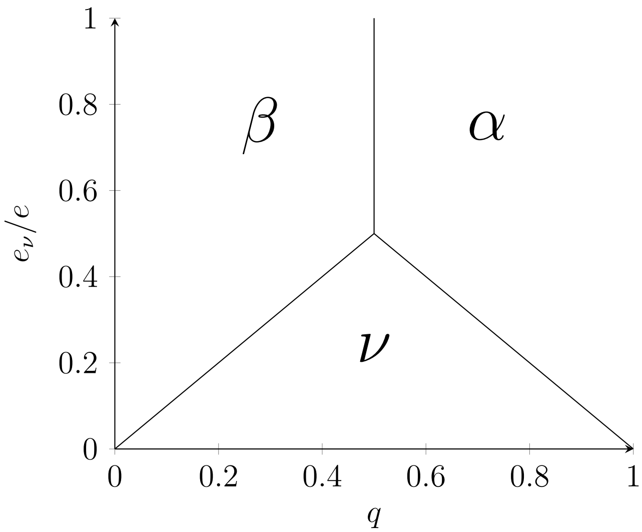


Figure 3: Optimal signal choice for different parameter combinations

This result suggests that, absent the neutral media and assuming that the agent pays only a minimal amount of attention, confirmation bias arises even from the simple objective of guessing the true state of the world, given that the agents already have some preexisting beliefs. However, when neutral sources of sufficient quality are introduced, some agents with weak prior beliefs may prefer them over biased sources. Nevertheless, this basic result takes an interesting twist when I allow the agents to choose two signals instead of one, which I show in the following section.

4.2 Demand for Two Signals

Now, suppose the agent chooses a portfolio of two sources, possibly from the same source. The portfolio choice affects the possible signal realizations and thereby posterior beliefs. I assume that the agent can distinguish which source sent which signal.

Proposition 2 (Two Source Portfolio Choice)**.** *Depending on the values of e and e_ν, three distinct regimes emerge:*

(i) The confirmatory-confirmatory portfolio is optimal for all q.

(ii) Agents with strong priors choose a confirmatory-confirmatory portfolio. Agents with weak beliefs choose a neutral-contradictory portfolio.

(iii) Agents with strong priors choose a confirmatory-confirmatory portfolio. Agents with weak beliefs choose a neutral-contradictory portfolio. Agents with moderate beliefs choose $\nu\nu$.

In general, case (i) arises for high e_ν and low e, where the neutral source is too imprecise compared to the biased one. Cases (ii)-(iii) occur for low e_ν, but high e.

I derive the belief updates and probabilities for each of the six source portfolios in Table 2. The intuition follows in Figures 4 and 5.

The offer to read from two sources introduces novel trade-offs into the consideration of the agent. To illustrate the intuition, assume an agent with belief $q > 0.5$. The one-sided biased source portfolios $\alpha\alpha$ and $\beta\beta$ follow similar logic to the case of one signal; either the source reveals the state of the world completely, or shifts the belief in the direction of its own bias. If the agent chooses $\nu\nu$, she faces some probability that she will end up with a posterior equal to her prior and learn nothing (when she gets two signals contradicting each other). A similar threat is associated with portfolio $\alpha\beta$, which only rarely helps the agent improve her belief.

Figure 4 demonstrates the choice between source portfolios using similar plots as in the case of one signal. Since some of the source portfolios offer three different payoff-relevant signal realizations, it is no longer possible to illustrate the expected payoff as a simple intersection of two lines. However, the logic remains the same — the expected payoff of a given source is the weighted average of the three potential payoffs and is shown at the vertical dashed line representing the prior belief.

Panel (a) demonstrates that for agents with a strong prior belief, no other source can overrule the one-sided confirmatory portfolio $\alpha\alpha$ as it always induces a sharp posterior belief.

Nevertheless, as the prior beliefs of the agents get weaker, portfolios capturing the neutral source become appealing. For some agents with moderate belief, source $\nu\nu$ might become the most convenient, as shown in panel (b). This choice is always associated with some probability of receiving two opposing signals and being left with the prior belief, but if it is of sufficient quality, this option happens only with a little probability, and at the same time, the beliefs when the signals are aligned are sufficiently sharp for this portfolio to still be the optimal choice.

Panel (c) shows perhaps the most surprising result of this exercise. If the belief of the agent is very weak, $\beta\nu$ becomes the optimal choice. That implies that some agents may opt for a contradictory source along with a neutral source, violating the general confirmation bias pattern. This

Table 2: The payoff-relevant signal realizations and corresponding posterior beliefs r_{WqS} for different information sources when obtaining two signals

		$\alpha\alpha$	
S	$A_\alpha A_\alpha$	$A_\alpha B_\alpha, B_\alpha A_\alpha, B_\alpha B_\alpha$	
$P[S\|q, W]$	$q + e^2(1-q)$	$1 - q - e^2(1-q)$	
r_{WqS}	$\frac{q}{q+e^2(1-q)}$	0	
		$\alpha\beta$	
S	$A_\alpha A_\beta$	$A_\alpha B_\beta$	$B_\alpha B_\beta$
$P[S\|q, W]$	$(1-e)q$	e	$(1-e)(1-q)$
r_{WqS}	1	q	0
		$\beta\beta$	
S	$A_\beta A_\beta, A_\beta B_\beta, B_\beta A_\beta$	$B_\beta B_\beta$	
$P[S\|q, W]$	$1 - e^2 q - (1-q)$	$e^2 q + (1-q)$	
r_{WqS}	1	$\frac{e^2 q}{e^2 q+(1-q)}$	
		$\nu\nu$	
S	$A_\nu A_\nu$	$A_\nu B_\nu, B_\nu A_\nu$	$B_\nu B_\nu$
$P[S\|q, W]$	$(1-e_\nu)^2 q + e_\nu^2(1-q)$	$2(1-e_\nu)e_\nu$	$e_\nu^2 q + (1-e_\nu)^2(1-q)$
r_{WqS}	$\frac{(1-e_\nu)^2 q}{(1-e_\nu)^2 q+e_\nu^2(1-q)}$	q	$\frac{e_\nu^2 q}{e_\nu^2 q+(1-e_\nu)^2(1-q)}$
		$\alpha\nu$	
S	$A_\alpha A_\nu$	$A_\alpha B_\nu$	$B_\alpha A_\nu, B_\alpha B_\nu$
$P[S\|q, W]$	$(1-e_\nu)q + ee_\nu(1-q)$	$e_\nu q + e(1-e_\nu)(1-q)$	$(1-e)e_\nu(1-q) + (1-e_\nu)(1-e)(1-q)$
r_{WqS}	$\frac{(1-e_\nu)q}{(1-e_\nu)q+ee_\nu(1-q)}$	$\frac{e_\nu q}{e_\nu q+e(1-e_\nu)(1-q)}$	0
		$\beta\nu$	
S	$A_\beta A_\nu, A_\beta B_\nu$	$B_\beta A_\nu$	$B_\beta B_\nu$
$P\left[S\|q\right]$	$(1-e)(1-e_\nu)q + (1-e)e_\nu q$	$(1-e_\nu)eq + (1-q)e_\nu$	$ee_\nu q + (1-q)(1-e_\nu)$
r_{WqS}	1	$\frac{e(1-e_\nu)q}{(1-e_\nu)eq+(1-q)e_\nu}$	$\frac{ee_\nu q}{ee_\nu q+(1-q)(1-e_\nu)}$

Note: For clarity, I indicate the source that sent the signal with a subscript next to the signal realization.

source portfolio offers three payoff-relevant signal realizations, each of them quite convenient. Either by sending signal A, the source β reveals the true state of the world completely. If not (and the agent gets B from β), she can benefit from the signal acquired from the neutral source, which has quite a substantial impact on her belief, as has already been demonstrated in the previous chapter. The posterior belief will, in all cases, be quite close to either 0 or 1, which makes this combination an optimal portfolio choice. Interestingly, $\beta\nu$ overrules even the confirmatory-neutral combination $\alpha\nu$. This is mainly driven by the threat of receiving signal $A_\alpha B_\nu$. This signal does not provide certainty regarding the true state of the world; moreover, it always decreases the belief of the agent since source ν is, in general, more trusted than source α for around-the-middle agents. Consequently, the belief ends up being close to 0.5, substantially decreasing the expected payoff. At the same time, no similar threat is associated with portfolio $\beta\nu$. To see this, notice that even when the signals from β and ν contradict each other, and the state of the world is not revealed (that means signal $B_\beta A_\nu$ is sent), the belief of the agent increases, since source ν is, in general, more trusted. That results in a sufficiently high payoff for all three potential signal realizations.

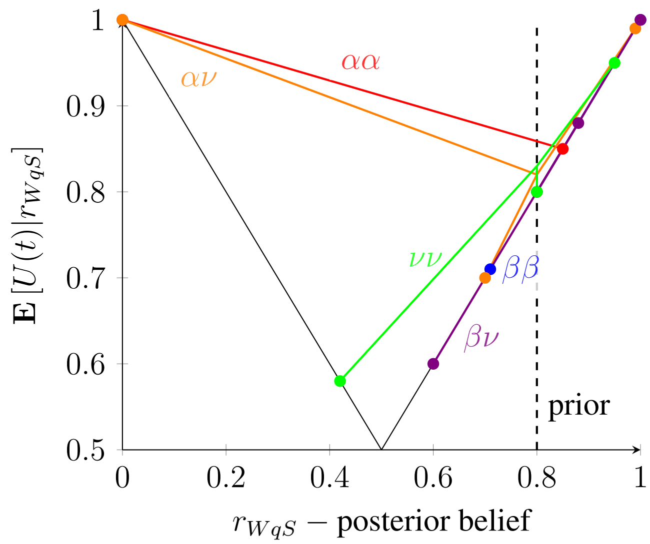
In the case of one signal, the optimal choice of sources was completely determined by the combination of q and e_ν/e. For two signals, the optimal signal choice depends on the particular values of all three parameters — e, e_ν, and q. Therefore, the relationship is difficult to visualize. Figure 5 shows the optimal choices of sources for different parameter configurations.

For low values of e, we get the classical confirmation bias result — it is always optimal to choose two signals from the confirmatory source. Nevertheless, once e reaches a certain threshold, and e_ν remains sufficiently small, for q around 0.5, it is optimal to choose the contradictory source along with the neutral one. As e further increases, two signals from the neutral source become optimal for medium priors. However, some agents with weak beliefs are always left with a combination of neutral and contradictory sources.

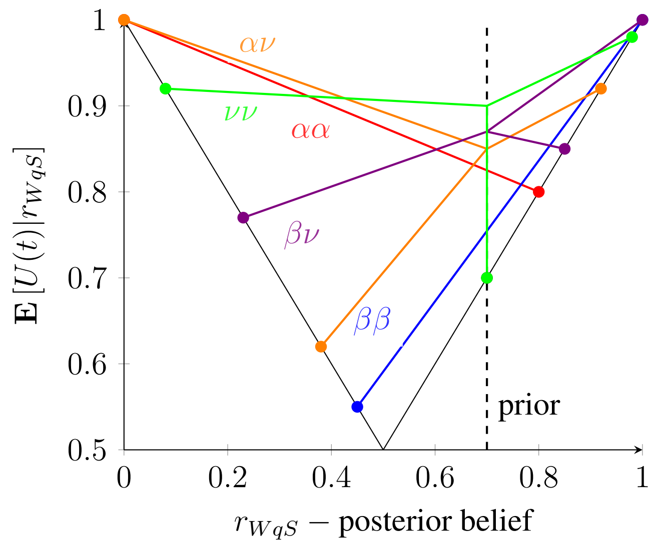
The results for two signals suggest that if neutral sources of sufficient quality are available, the baseline tendency to consume confirmatory sources is violated. The mechanism of this violation is twofold. The first intuitive mechanism is the generally higher precision of the neutral source compared to the biased sources, which works similarly to the case of one source described in the previous subsection.

The second mechanism operates through the complementarity of neutral sources with the contradictory source and may lead some agents with weak prior beliefs to choose the contradictory source along with the neutral one. This combination offers a considerable probability of immediate uncertainty resolution (provided by the contradictory source) and a reliable way to establish a strong belief if the contradictory source does not reveal the state of the world (provided by the neutral source).

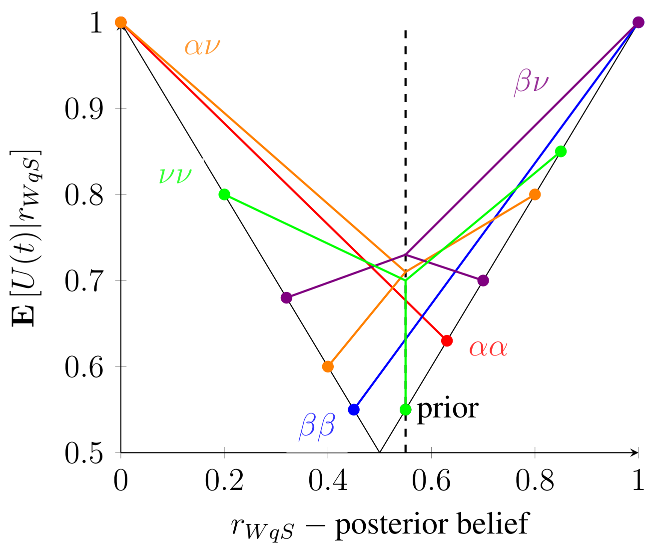
A similar approach could be used to study the demand for a general number of signals k.



(a) strong prior ($q = 0.8$), optimal choice: $\alpha\alpha$



(b) medium prior ($q = 0.7$), optimal choice: $\nu\nu$



(c) weak prior ($q = 0.55$), optimal choice: $\beta\nu$

Figure 4: Posterior beliefs and expected payoffs for the case of two signals.

Note: For both figures $e_\nu = 0.3$ and $e = 0.8$. The prior of the agent is expressed with a black dot and a dashed black line. The solid black line plots the relation between belief and expected utility. Points show the potential belief shifts achieved by consuming the given source. The intersection of the colorful lines with the dashed line shows the expected payoff for a given source. For clarity, I omit the never optimal signal combination $\alpha\beta$.

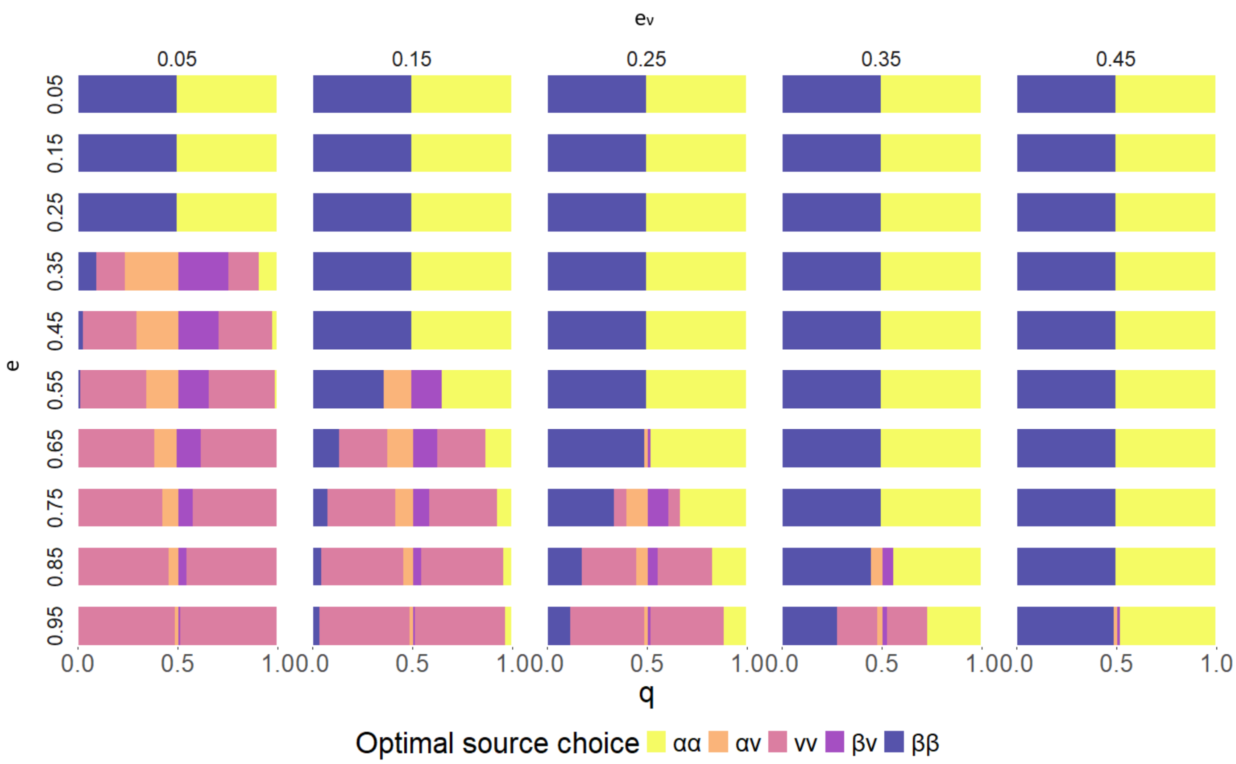


Figure 5: Optimal choice of two sources for different parameter combinations

Note: The rows represent different values of the biased sources error, the columns represent different values of the neutral source error. The horizontal axis of each subplot denotes the prior belief of the agent.

However, with increasing k, the number of source portfolios to consider grows rapidly, which impairs their comparison in terms of expected utilities. In Appendix Section A.1, I derive that in the absence of neutral sources, it is always optimal to choose only the one-sided confirmatory portfolio and present the general formulation of the news consumer problem, which could be further solved using numerical methods.

4.3 Polarization

Finally, I use the model to study polarization. As a measure of polarization, I define ideological distance as the expected difference in beliefs of two otherwise identical agents who consume different news portfolios.

For simplicity, I assume that there are two agents (I denote them as high and low) with a flat prior belief ($q_H = q_L = 0.5$). The agents consume news in line with my model. Depending on the parameters determining the error of media sources, it might be that the agent is indifferent between two different sources. Therefore, I assume that the high agent always consumes the source portfolio that an agent with a slightly higher belief would consume, and the low agent always consumes the source that an agent with a slightly lower belief would consume. For instance, in the case of one source and $e_\nu/e > 0.5$ (which means that only biased sources are chosen), the high agent chooses α, and the low agent chooses β.

Furthermore, there is a social planner who cares about the ideological distance between the two agents. I define the ideological distance (ID) as the absolute value of the expected distance between the posterior beliefs r_{Wq_LS} and r_{Wq_HS}.

$$\mathbf{E}\left[ID\right] = \mathbf{E}\left[\left|r_{Wq_HS} - r_{Wq_LS}\right|\right]. \tag{9}$$

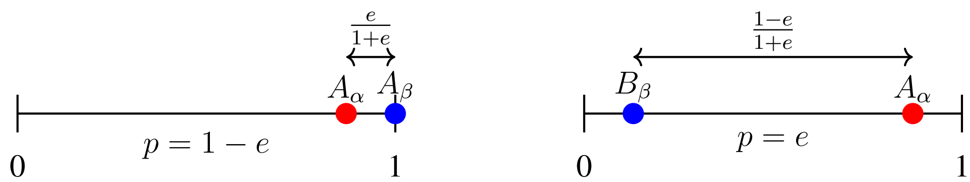
The social planner does not know the true state of the world or the realizations of the signals. Nevertheless, she assumes that the agents consume media following the pattern described above. She may control e or e_ν by media policy tools.

Proposition 3 (Ideological Distance and Source Choice)**.** *Polarization represented by expected ideological distance* $\mathbf{E}[ID]$ *is:*

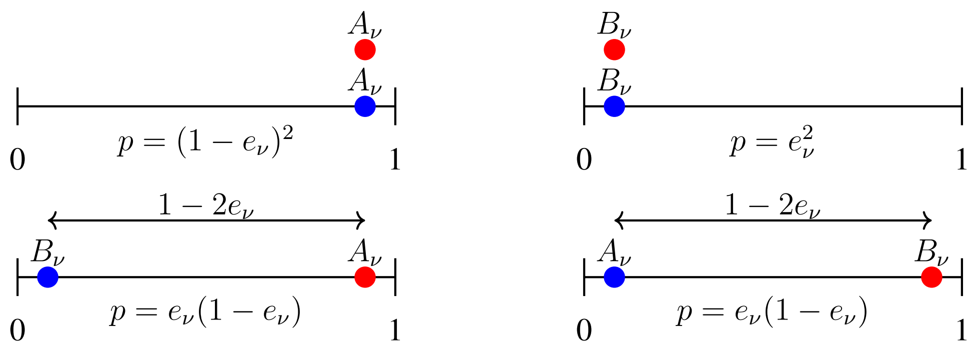
$$\mathbf{E}[ID] = \begin{cases} \frac{2e(1-e)}{1+e}, & \textit{if } e_\nu/e > 0.5 \ (\textit{biased sources chosen}) \\ 2e_\nu(1-e_\nu)(1-2e_\nu), & \textit{if } e_\nu/e < 0.5 \ (\textit{neutral source chosen}) \end{cases}$$

This distance follows a nonmonotonic pattern with respect to both e *and* e_ν*, forming an inverse-U shape on either side of the* $e_\nu/e = 0.5$ *threshold. At this threshold, ideological distance exhibits a jump.*

I demonstrate the consideration of the social planner using the case of the agents acquiring one signal. There, the demand for news sources is quite clear — if the neutral sources are too imprecise ($e_\nu/e > 0.5$), the high agent chooses α, whereas the low agent chooses β, whereas if the neutral sources are sufficiently precise ($e_\nu/e < 0.5$, both choose ν). Figure 6 demonstrates the posterior beliefs in both cases. This Figure assumes that the state of the world is a with no loss of generality, as the social planner considers both states of the world to be equally likely.



(a) $e_\nu/e > 0.5$, optimal choice: α or β



(b) $e_\nu/e > 0.5$, optimal choice: ν

Figure 6: Posterior beliefs and ideological distances for two agents with a flat prior

Note: The red dot denotes the belief of the high agent, and the blue dot denotes the belief of the low agent. Without loss of generality, I assume that the state of the world is a. The arrow denotes the ideological distance between the agents, and p is the probability of this signal realization from the perspective of the social planner.

Panel (a) shows the posterior beliefs for the case when agents consume only from biased sources. There, either both agents get the same signal, and their ideological distance is quite small, or they get opposing signals, where each source sends the signal aligned with its bias. The case that a low agent gets signal B and at the same time, the high agent gets A has zero probability since this result could not be supported by either state of the world.

Panel (b) shows that if both agents choose the neutral source, then either they get the same signal (true or false), form identical beliefs, and the ideological distance is zero, or they get opposing signals, and their beliefs end up being different.

The impact of the error of the source on the expected ideological distance is twofold. First, since the error of the sources is known to the agents, the degree to which it affects their posterior

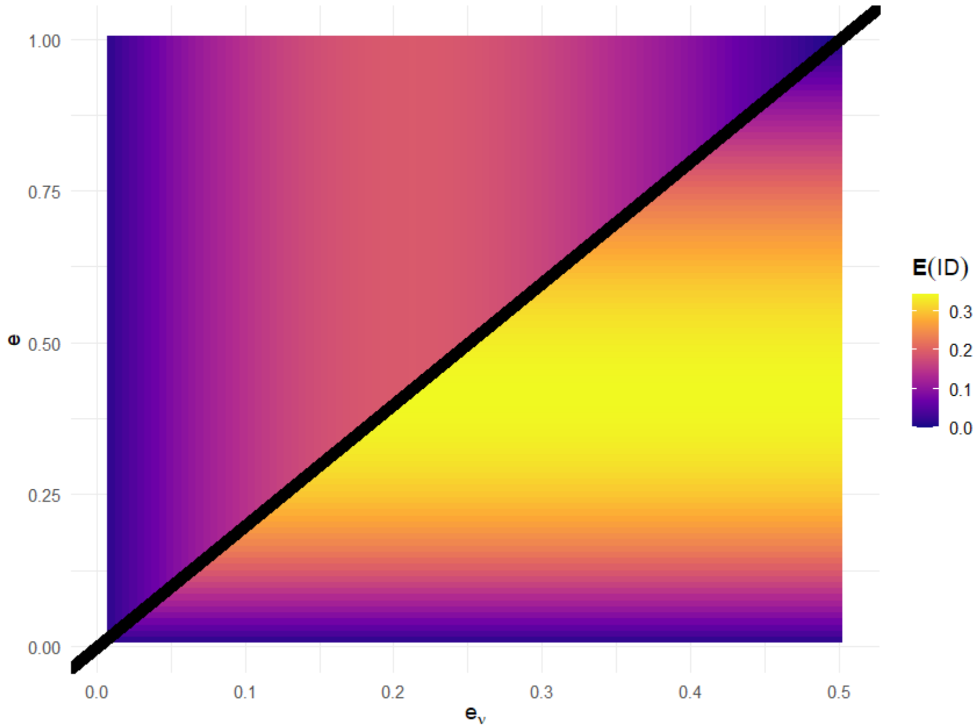


Figure 7: The expected ideological distance of two agents with flat beliefs for different parameter combinations.

beliefs decreases with the error. If the given source has a high probability of error, the agents assign less weight to it, and it has lower power to polarize them. However, the error of the source also decreases the correlation between the two signals that the agents receive. If the error is high, the chance that the agents get opposing signals is quite substantive, which could, in the end, increase polarization. As a result, the relation between the error of the source and polarization is nonmonotonic and has an inverse U-shape.

Figure 7 illustrates the expected ideological distance as a function of e and e_ν. The plot is separated into two triangular areas by the line $e_\nu/e = 0.5$ representing the threshold where agents change their news consumption patterns. The ideological distance has a substantive upward jump at this threshold when going from the top-left part (where the neutral source is chosen) to the bottom-right part (where biased sources are chosen). On both sides of the threshold, the relation between the error and ideological distance is non-monotonic and has an inverse-U shape. Figures 8 and 9 further illustrate this relation by fixing one of the errors in question and plotting the relationship between the other error and the expected ideological distance.

This relationship between the errors and a measure of polarization could have interesting implications for the role of neutral sources in the media market. Assume that the social planner aims to achieve a low level of polarization and that she can only control the error of the neutral source,

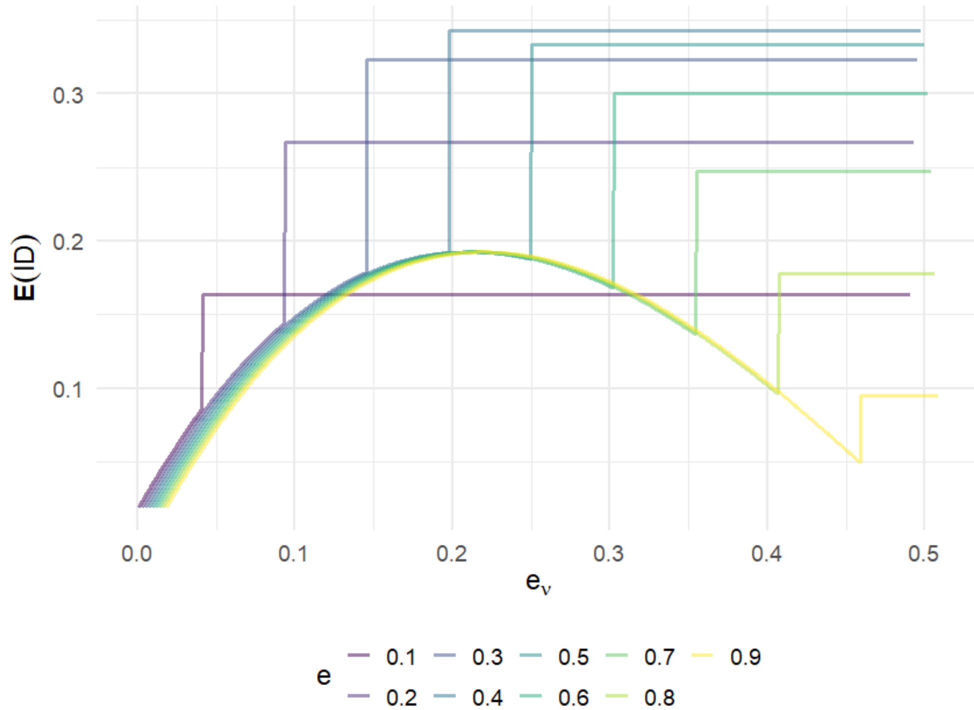


Figure 8: Expected ideological distance as a function of the error of the neutral source.

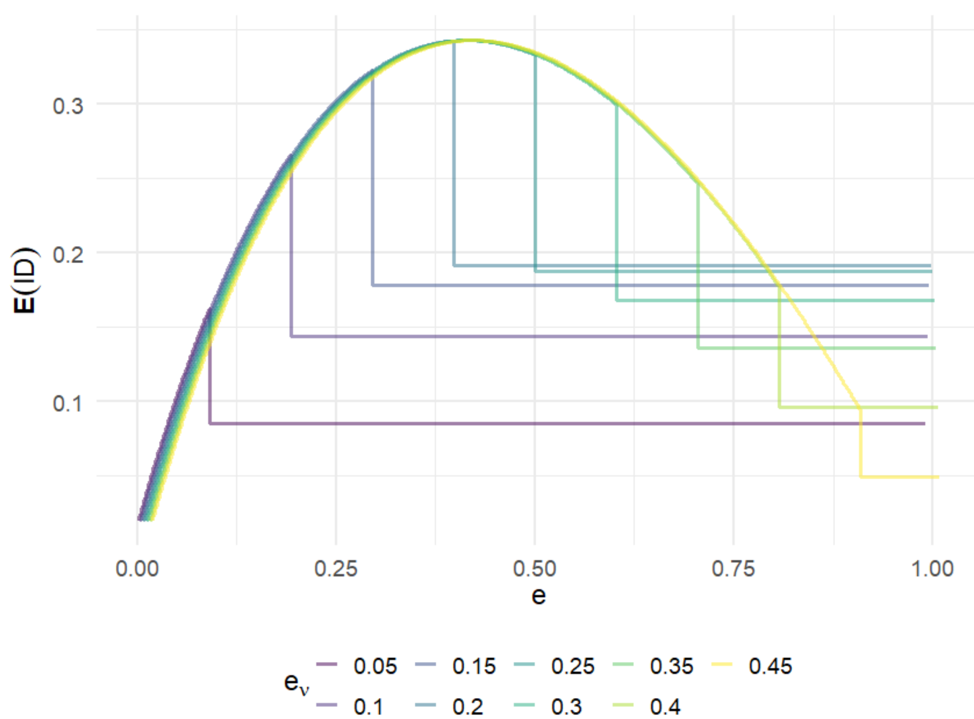


Figure 9: Expected ideological distance as a function of the error of the biased sources.

the error of biased sources is set exogenously. Given the non-monotonic relationship between the error of the neutral source and polarization, she has two options. First, she can push the error to be as low as possible. However, that might be associated with large investments in the quality of the media. Second, she can try to increase the error to get over the peak into the are where the polarization is low enough. However, if she overdoes it, the agents may switch to biased sources, causing an upward jump in polarization and not paying attention to neutral media at all.

Alternatively, I could assume that the social planner takes the quality of neutral media as given and tries to calibrate the error of the biased media. There, again, two strategies are available. Either she can push the error of the biased media to be as low as possible (which can again be too costly or difficult), or she can decrease the polarization by increasing the error, which either results in getting to the decreasing part of the error-polarization function or changing the news consumption patterns in favor of neutral sources and an instant downward jump in polarization.

Similar intuition also holds for the case when agents consume two signals. There, agents with $q = 0.5$ either consume from the confirmatory source $\alpha\alpha$ and $\beta\beta$, or the contradictory source along with the neutral source $\alpha\nu$ and $\beta\nu$. This, in general, smooths out the relation between error and polarization but, at the same time, preserves the inverse-U shape presented above and the direction of the jumps (see Appendix Section A.2).

5 Conclusion

This paper examines the role of biased and neutral sources in the media market. It describes the conditions under which consumers engage with news articles that contradict their prior beliefs — a behavior that contrasts with the traditional confirmation bias extensively studied in the literature.

I develop a model where agents choose between media sources with different error structures. The model shows that while confirmation bias remains the dominant behavior, agents with weaker prior beliefs may choose to consume exclusively neutral sources or even combine neutral and contradictory sources, which exhibit strong mutual complementarity.

Additionally, I discuss the implications of these consumption patterns for polarization. I demonstrate that the relationship between source error and polarization follows an inverse U shape. This is mainly driven by two opposing effects of increasing source error: a decrease in its power to shift posterior beliefs and a decrease in the correlation of signals sent to different agents. However, given the relative errors of respective sources, agents may reoptimize their news portfolios, disrupting this pattern.

My research could be relevant to policymakers seeking to understand the dynamics of media consumption and its impact on public opinion, highlighting the potential for interventions aimed at encouraging the consumption of diverse news sources and mitigating polarization

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A Appendix

A.1 Demand for More Signals

In this section I examine the case where the agent can receive $n > 2$ signals. Her problem would be to choose source portfolio represented by an ordered triplet $(k_\alpha, k_\nu, k_\beta)$, where $k_\alpha \geq 0, k_\nu \geq 0, k_\beta \geq 0$, and $k_\alpha + k_\nu + k_\beta = n$. That brings $\binom{3+n-1}{n}$ options for a given n.

No neutral source

I start by showing that when a neutral source is unavailable (or very imprecise), and the agent chooses only from sources α and β, it is never optimal to choose a combination of these sources. Conversely, the agent always chooses to acquire all signals from her confirmatory source, which means α for agents with $q > 0.5$ and β for agents with $q < 0.5$

In this simplified problem, the agent chooses k_α, and k_β such that $k_\alpha + k_\beta = n$. Then, she gets k_α signals from source α and k_β signals from source β. Let me denote by $k_{\alpha B}$ the number of signals B sent by source α, and by $k_{\beta A}$ the number of signals A sent by source β. Given the design of our sources, we can use these two numbers to classify all the possible signal realizations the agent might get.

There are, in principle, four different cases. First, the case when $k_{\alpha B} > 0$, and $k_{\beta A} = 0$ completely reveals that the state of the world is B. Symmetrically, the case when $k_{\beta A} > 0$, and $k_{\alpha B} = 0$ completely reveals the state of the world is A. Given the structure of our sources, we can easily compute the probabilities the agent assigns to these signal realizations.

The case when both $k_{\beta A}$ and $k_{\alpha B}$ are non-zero has probability zero since no state of the world could support this signal realization.

Only when $k_{\beta A}$ and $k_{\alpha B}$ are equal to zero (which means that both sources sent only the signals in line with their bias), the posterior beliefs of the agents could end up being non-trivial.

Table A.1 presents the probabilities of these signal realizations, the posterior beliefs, and expected payoffs.

Table A.1: Clasification of all possible signal realizations using $k_{\alpha B}$ and $k_{\beta A}$

$k_{\alpha B}$	$k_{\beta A}$	$P[S\|q, W]$	r_{WqS}	$\mathbf{E}[U\|q, W, S]$
> 0	$= 0$	$(1 - e^{k_\alpha})(1 - q)$	0	1
$= 0$	> 0	$(1 - e^{k_\beta})q$	1	1
> 0	> 0	0	—	—
$= 0$	$= 0$	$e^{k_\beta} q + e^{k_\alpha}(1 - q)$	$\frac{e^{k_\beta} q}{e^{k_\beta} q + e^{k_\alpha}(1-q)}$	$\max\left[\frac{e^{k_\beta} q}{e^{k_\beta} q + e^{k_\alpha}(1-q)}, \frac{e^{k_\alpha}(1-q)}{e^{k_\beta} q + e^{k_\alpha}(1-q)}\right]$

Given this, and noticing that it has to be that $k_\alpha + k_\beta = n$, the problem of the agent can be rewritten as

$$\max_{k_\alpha \in [0,n]} \left\{ \max \left[e^{n-k_\alpha} q, e^{k_\alpha}(1-q) \right] + (1-q)(1-e^{k_\alpha}) + q(1-e^{n-k_\alpha}) \right\}. \tag{A.1}$$

Here, for a while, I abstract from the fact that k_α should be an integer and handle it as a real number. I first show that there is no interior solution; therefore, for any n, e, and q, it is optimal to choose $k_\alpha = 0$ or $k_\alpha = n$

I proceed by taking the first derivative of the expected payoff. Since the objective function contains a maximum operator, the derivative of the function for $k_\alpha = log_e \left(\sqrt{\frac{qe^n}{1-q}} \right)$ does not exist. Otherwise, it can be expressed as

$$\text{if} \quad k_\alpha < log_e \left(\sqrt{\frac{qe^n}{1-q}} \right): \quad -(1-q)e^{k_\alpha}, \tag{A.2}$$

$$\text{if} \quad k_\alpha > log_e \left(\sqrt{\frac{qe^n}{1-q}} \right): \quad qe^{n-k_\alpha}. \tag{A.3}$$

This shows that for $k_\alpha < log_e \left(\sqrt{\frac{qe^n}{1-q}} \right)$, the function is strictly decreasing, reaches a local minimum in $k_\alpha = log_e \left(\sqrt{\frac{qe^n}{1-q}} \right)$ and then increases again. Therefore, no interior k_α maximizes the objective function.

This implies that the only optimal choice could be $k_\alpha = n$, or $k_\alpha = 0$. Let me now derive conditions for the optimality of each choice. The expected utilities equal

$$\mathbf{E}\left[U|q, W, (k_\alpha = 0)\right] = \max\left[e^n q, (1-q)\right] + q(1-e^n) \tag{A.4}$$

$$\mathbf{E}\left[U|q, W, (k_\alpha = n)\right] = \max\left[q, e^n(1-q)\right] + (1-q)(1-e^n) \tag{A.5}$$

The agent always chooses the k_α that delivers higher expected utility. It turns out that

- for $q < 0.5$: $\mathbf{E}\left[U|q, W, (k_\alpha = 0)\right] > \mathbf{E}\left[U|q, W, (k_\alpha = n)\right]$, and the optimal choice is $k_\alpha = 0$,
- for $q > 0.5$: $\mathbf{E}\left[U|q, W, (k_\alpha = n)\right] > \mathbf{E}\left[U|q, W, (k_\alpha = 0)\right]$, and the optimal choice is $k_\alpha = n$.

That means that all agents that initially believed a is more likely to be the state of the world consume only signals from source α, and all agents who initially believed b is more likely to be the true state of the world consume only from source β.

These results show that confirmation bias is the phenomenon that governs the demand for media even when agents are allowed to choose a higher (but still limited) number of confirmation sources. This opens up a space for examining how the addition of neutral sources into this problem shapes the choices of agents.

Including the neutral source

Now, I perform a similar analysis for the original case, where the neutral source is available. Here, the agent chooses k_α, k_ν, k_β. Again, I will denote by $k_{\alpha B}$ the number of signals B received from source α, and similarly by $k_{\beta A}$ the number of signals A received from source β. These numbers can be again used to classify the realizations of signals into 4 different cases. Table A.2 summarizes them assuming that the agent chose to consume k_ν signals from the neutral source and received $k_{\nu A}$ signals A from it

Table A.2: Clasification of all possible signal realizations using $k_{\alpha B}$ and $k_{\beta A}$, and $k_{\nu A}$

$k_{\alpha B}$	$k_{\beta A}$	$P[S\|q,W]$	r_{WqS}
>0	$=0$	$(1-e^{k_\alpha})(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}$	0
$=0$	>0	$(1-e^{k_\beta})qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}$	1
>0	>0	—	—
$=0$	$=0$	$e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}$	$\frac{e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}}{e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}}$

The expected utility for a particular choice of k_α,k_ν, and k_β can be computed by taking an expectation of the expected utilities over all possible realizations of $k_{\nu A}$ — the combination of signals delivered by the neutral source. That yields

$$\begin{aligned}
\mathbf{E}[U|q,W] = \mathbf{E}[\mathbf{E}[U|q,W,S]|S] = \\
\sum_{k_{\nu A}=0}^{k_\nu}\binom{k_\nu}{k_{\nu A}}(1-e^{k_\alpha})(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}+ \\
\sum_{k_{\nu A}=0}^{k_\nu}\binom{k_\nu}{k_{\nu A}}(1-e^{k_\beta})qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+ \\
\sum_{k_{\nu A}=0}^{k_\nu}\binom{k_\nu}{k_{\nu A}}\left[e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}\right]\cdot \\
\max\left(\frac{e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}}{e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}},\right. \\
\left.\frac{e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}}{e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}}+e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}}\right)
\end{aligned} \tag{A.6}$$

The first two sums can be modified using the binomial theorem yielding

$$\begin{aligned}
\mathbf{E}[U|q,W] = (1-e^{k_\alpha})(1-q)+(1-e^{k_\beta})q+ \\
+\sum_{k_{\nu A}=0}^{k_\nu}\binom{k_\nu}{k_{\nu A}}\cdot\max\left[e^{k_\beta}qe_\nu^{k_\nu-k_{\nu A}}(1-e_\nu)^{k_{\nu A}},e^{k_\alpha}(1-q)e_\nu^{k_{\nu A}}(1-e_\nu)^{k_\nu-k_{\nu A}}\right].
\end{aligned} \tag{A.7}$$

The general problem of the agent could thus be formulated as

$$\begin{aligned} & \max_{k_\alpha, k_\beta, k_\nu} \Bigg\{ (1 - e^{k_\alpha})(1-q) + (1 - e^{k_\beta})q + \\ & + \sum_{k_{\nu A}=0}^{k_\nu} \binom{k_\nu}{k_{\nu A}} \cdot \max\left[e^{k_\beta} q e_\nu^{k_\nu - k_{\nu A}} (1-e_\nu)^{k_{\nu A}}, e^{k_\alpha}(1-q) e_\nu^{k_{\nu A}} (1-e_\nu)^{k_\nu - k_{\nu A}} \right] \Bigg\}, \end{aligned} \tag{A.8}$$

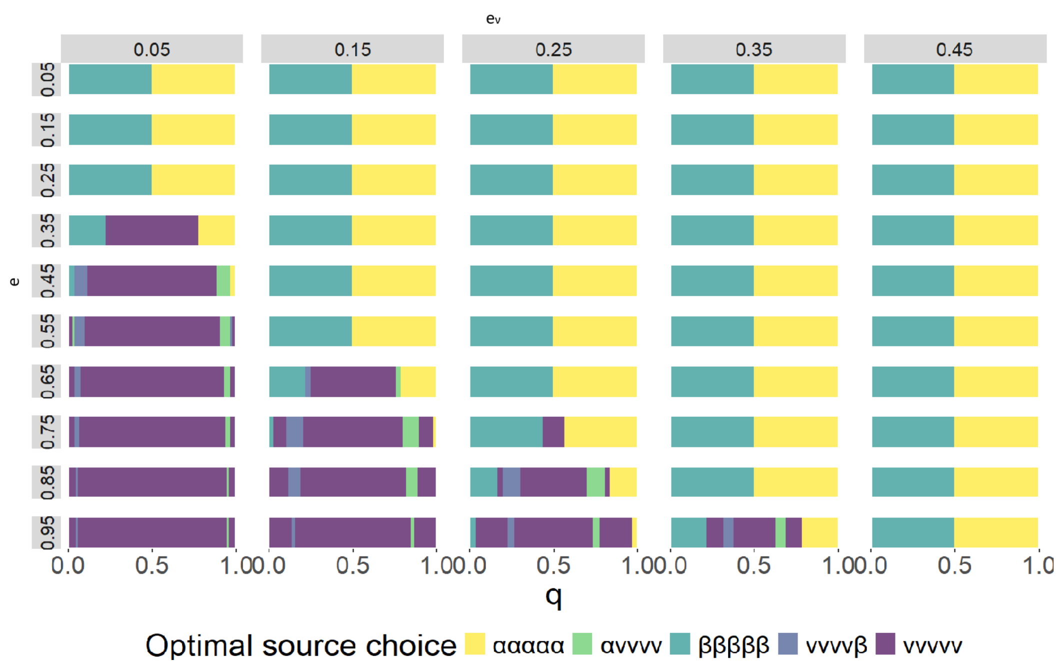
$$k_\alpha + k_\beta + k_\nu = n, \tag{A.9}$$

$$k_\alpha, k_\beta, k_\nu \geq 0. \tag{A.10}$$

Unfortunately, due to the complexity of this function, solving this problem in a closed form for general n is not possible. However, the optimal source portfolios could be determined using numerical methods. Figure A.1 shows the numerically computed optimal source choices for 3 and 5 signals.

These computations suggest that the main pattern described for two signals generalizes also for the case of more signals. Again, the dominant pattern for low relative bias of biased sources is to stick with a completely confirmatory source portfolio. However, as the neutral source gets more precise, it might be optimal to consume only from that source, or to combine signals from the neutral source with a signal from the contradictory source. The optimal combination of neutral and contradictory source always composes of $n-1$ neutral signals, and one contradictory signal. Moreover, the band where this choice is optimal, moves further away from flat prior belief.

(a) Optimal choice of three signals ($n = 3$)



(b) Optimal choice of five signals ($n = 5$)

Figure A.1: Optimal source choices for different values of q, e, and e_ν, and n.

A.2 Expected ideological distance for two sources

I derive the expression for the expected ideological distance after consuming two signals and plot it for different values of e and e_ν. In the paper, I have already demonstrated that the agents with a flat belief of $q = 0.5$ either

- choose the one-sided confirmatory source portfolios — that means $\alpha\alpha$ for the high agent and $\beta\beta$ for the low agent, or
- choose the neutral-contradictory source combination — that means $\beta\nu$ for the high agent and $\alpha\nu$ for the low agent.

The threshold where the news consumption pattern switches is where the agent is indifferent between the expected utility delivered by the choices in question. That means that the threshold is characterized by

$$1 - \frac{e^2}{2} = 1 - \frac{e_\nu + e}{2} + \max\left[e_\nu, (1-e_\nu)e\right]. \tag{A.11}$$

The expected ideological distance can then be computed using logic similar to that of one signal. After simplification, the expected ideological distance could be expressed as

$$\mathbf{E}\left[ID\right] = \begin{cases} \frac{2e^2(1-e^2)}{1+e^2}, & \text{if } \frac{e^2}{2} < \frac{e_\nu + e}{2} + \max\left[e_\nu, (1-e_\nu)e\right], \\ ee_\nu \dfrac{(1-e_\nu)^2(1-e) + (1-e_\nu)(1-e)e_\nu}{1 - e_\nu + ee_\nu} + \\ + (1-e_\nu)^2 e \left(\dfrac{1-e_\nu}{1-e_\nu+ee_\nu} - - - \dfrac{e(1-e_\nu)}{(1-e_\nu)e + e_\nu} \right) + \\ + (1-e_\nu)ee_\nu \dfrac{1-e_\nu-ee_\nu}{1-e_\nu+ee_\nu} + \\ + e(1-e_\nu)\dfrac{e_\nu(1-e)(1-e_\nu) + e_\nu^2(1-e)}{e_\nu + e(1-e_\nu)} + \\ + e_\nu e(1-e_\nu)\dfrac{e(1-e_\nu) - e_\nu}{e(1-e_\nu) + e_\nu} + \\ + e_\nu^2 e \left(\dfrac{e_\nu}{e_\nu + e(1-e_\nu)} - - - \dfrac{ee_\nu}{ee_\nu + 1 - e_\nu} \right), & \text{if } \dfrac{e^2}{2} > \dfrac{e_\nu + e}{2} \end{cases}. \tag{A.12}$$

Even though the formula seems to be a bit more complex, the main patterns (non-monotonicity, in general, higher polarization for consuming the biased sources only) remain the same as in the case of one signal. Figures A.2, A.3 and A.4 document the relation.

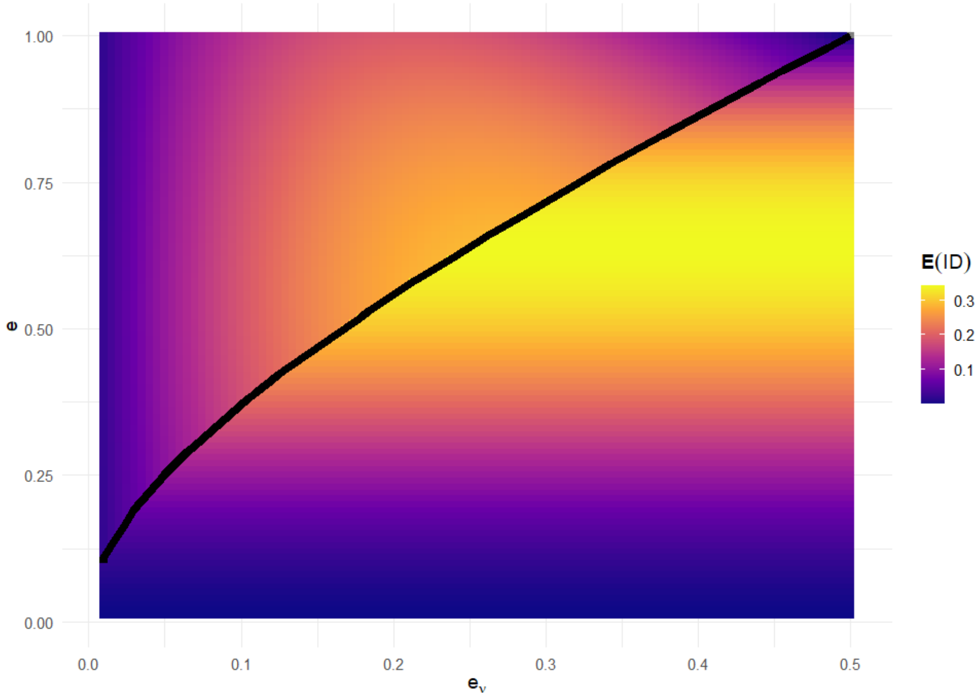


Figure A.2: The expected ideological distance of two agents with flat beliefs for different parameter combinations.

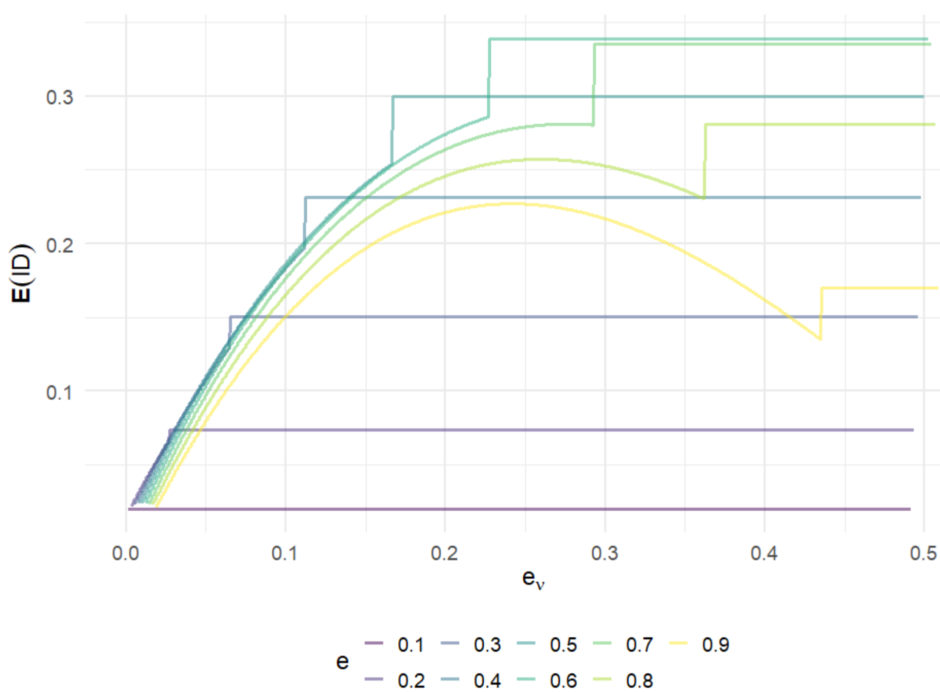


Figure A.3: Expected ideological distance as a function of the error of the neutral source.

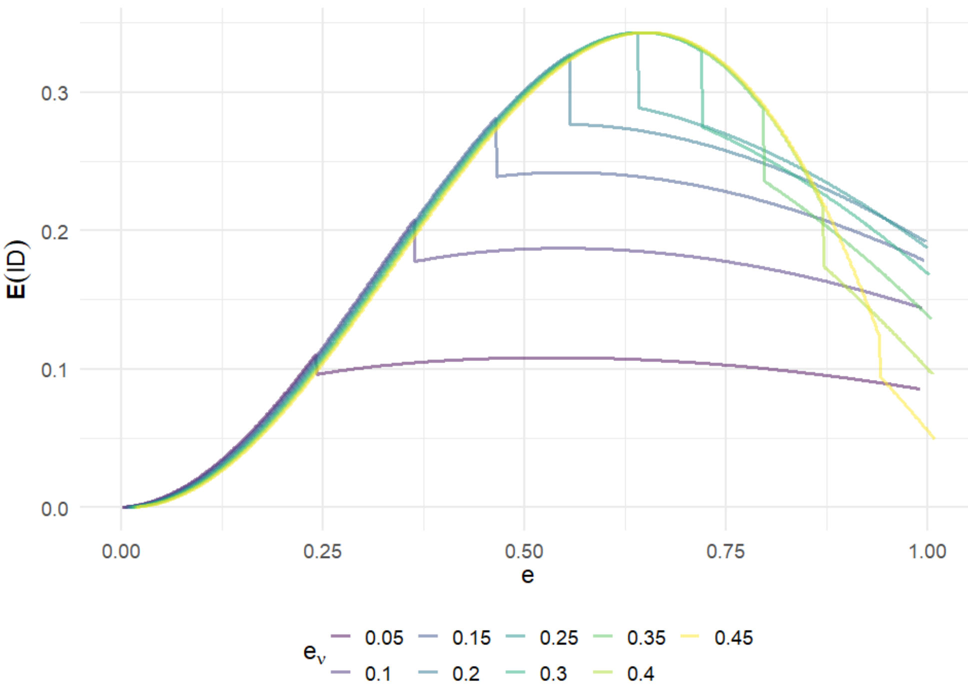


Figure A.4: Expected ideological distance as a function of the error of the biased sources.