

Shots and Shocks: How Vaccine-related Media Coverage Changed During COVID-19

Evidence from Utah Media Outlets

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Introduction

Background — Vaccine Hesitancy & Media

- Hesitancy not new; now more identity-based
- Social media → misinformation & echo chambers
- Trust in institutions affects message credibility
- Political media framing shapes attitudes
- Health vs. economic frames affect different groups

Utah-Specific Context

- Strong trust in religious/local leaders
- LDS beliefs shape vaccine attitudes
- Myths tied to religious identity
- Deseret News & KSL are Church-affiliated
- Possible post-COVID shift toward economic framing

Research Question & Expectations

- **Research Question:** Did Utah church affiliated news outlets shift from health to economic framing after COVID?
- **Expectation:** More economic framing post-COVID
- **Method** 2017–2024 data from two major Utah news online outlets (Deseret News, KSL).

Methodology

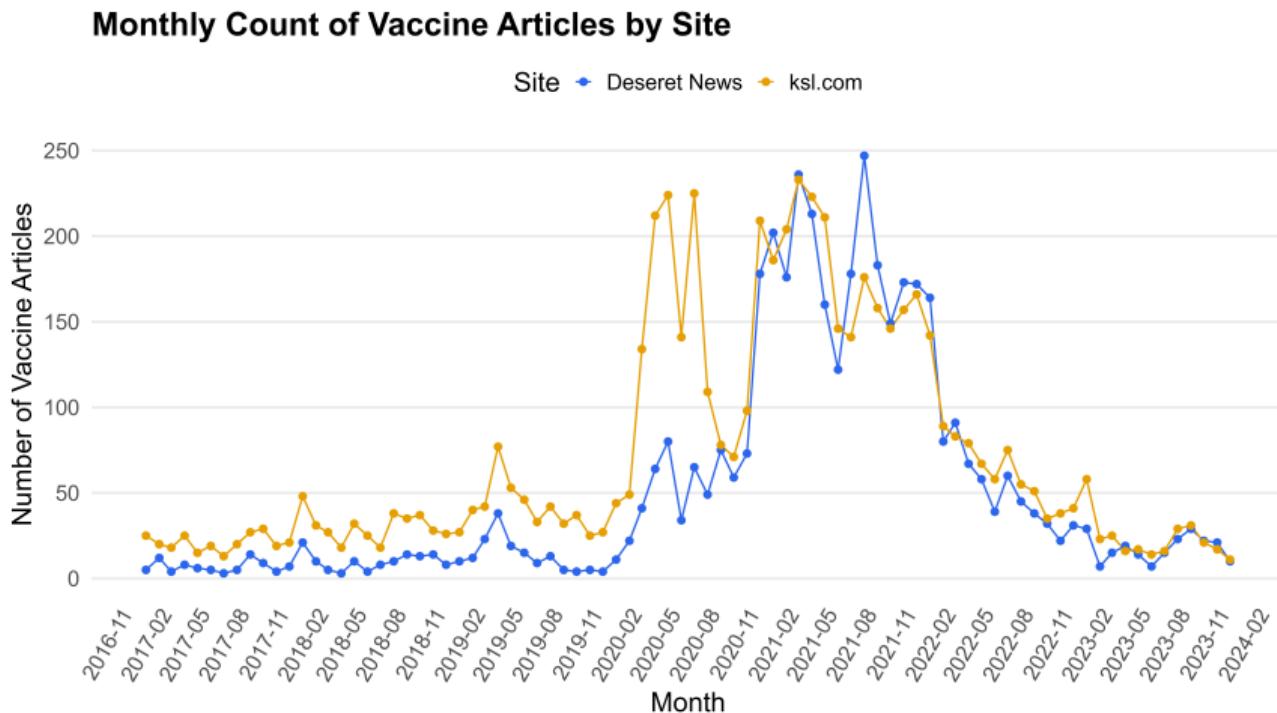
Sampling Methodology Overview

- ① Sampling Frame Construction
- ② Stratification Design
- ③ Preliminary Sample
- ④ Power Simulation w/ Neyman Allocation
- ⑤ Full Sample w/ LLM Coding

Sampling Frame Construction

- Scrape public sitemap data from KSL and Deseret News
 - 2,606,491 published article URLs
- Filter between January 1, 2017 to January 1, 2024
- Find all published vaccine-related articles through a pre-defined vaccine lexicon
 - 4,259 DN articles
 - 5,927 KSL articles
 - 10,186 total

Vaccine Media Over Time



LLM Coding

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Zero-shot LLM coding with Google Gemma

- ① 'A' = health framing
- ② 'B' = economic framing
- ③ 'C' = balanced health/economy
- ④ 'D' = unrelated to health or economy

LLM Coding - Prompt Example

You are coding media articles for their dominant framing motive.

Return a single code from {A,B,C,D}.

A = Highlights public health consequences or solutions

B = Highlights economic consequences or solutions

C = Presents both health and economic consequences equally

D = Discussion is unrelated to health or economy

Guidelines:

- Determine which dimension--health or economy--anchors the author's reasoning.
- If focus is tangential or absent, choose D.

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LLM Coding

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- **Problem:** Previous literature shows that Zero-shot LLM can be unstable/highly variable
- **One Solution:** Decrease variance by using multiple prompts!
 - Five different independent prompt variants
 - Take mode classification

Stratification Design

- ① Stratify by site/domain (KSL, DN)
- ② Stratify by time
 - Stratify by year for sparse years (2017, 2018, 2019, 2022, 2023)
 - Stratify by quarter for dense years (2020Q1, ..., 2020Q4, 2021Q1, ..., 2021Q4)
- ③ $2 \text{ sites} \times (5 + 8) \text{ temporally partitioned strata} = 26 \text{ total strata}$

Neyman Allocation for Full Sample

- Use Neyman allocation with estimated population variances for each strata ($n = 1,000$)

$$n_h = n \frac{N_h S_h}{\sum_{j=1}^H N_j S_j}, \quad S_h = \sqrt{p_h^{(B)}(1 - p_h^{(B)})}$$

Preliminary Sample

- Is proportional Neyman allocation appropriate?
- Use small sample to estimate per stratum variance in response

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Table: Preliminary stance proportions by COVID period

	Before COVID	During COVID	After COVID
strata	1–3, 14–16	4–11, 17–24	12–13, 25–26
$\hat{p}^{(A)}$	0.809 (0.393)	0.680 (0.467)	0.703 (0.457)
$\hat{p}^{(B)}$	0.0588 (0.235)	0.133 (0.339)	0.0110 (0.104)
$\hat{p}^{(C)}$	0.0735 (0.261)	0.155 (0.362)	0.187 (0.390)

Results from a preliminary sample using $n = 468$ total samples from proportional allocation relative to stratum size. Estimates $\hat{p}^{(A)}$, $\hat{p}^{(B)}$, $\hat{p}^{(C)}$, correspond to the estimate probability of an article being coded stances A–C, respectively, within each strata. Standard errors of Bernoulli variances (e.g. $\sqrt{\hat{p}(1 - \hat{p})}$) are shown in parentheses.

Power Simulation

- How many articles should we sample?

Power Simulation

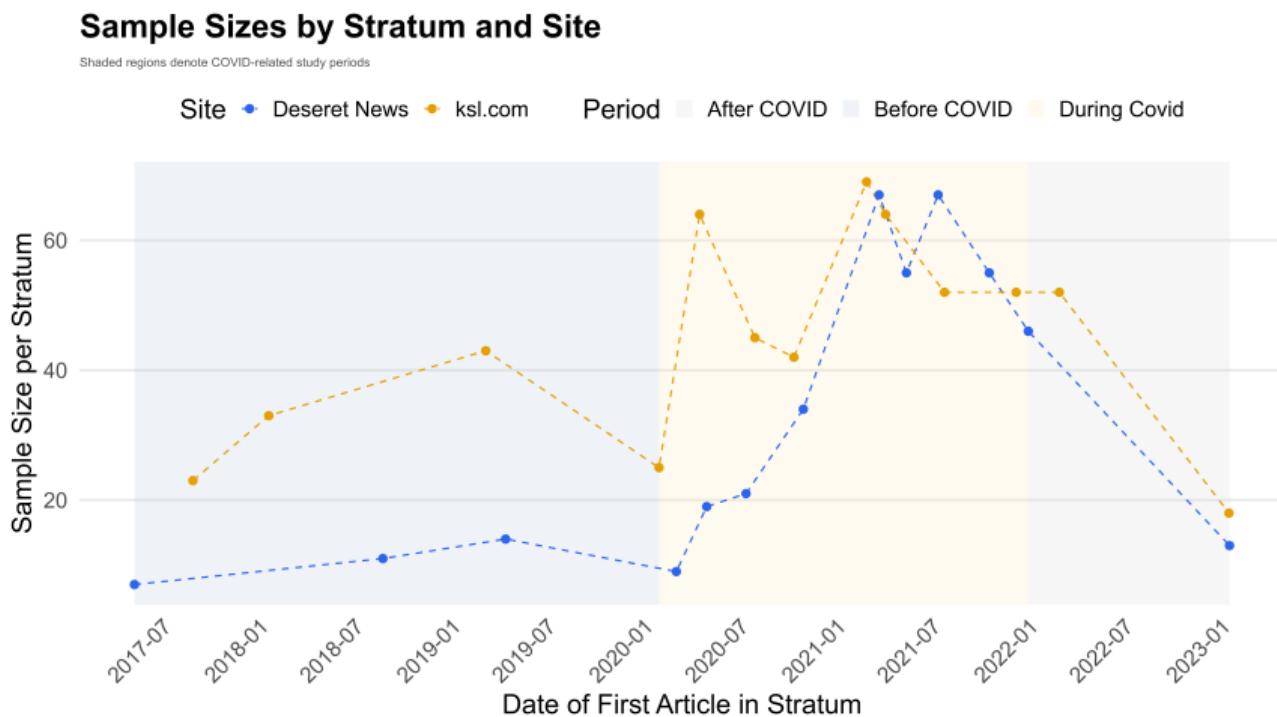
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⇒ 746 total observations needed (round up to 1,000)

Allocated Sample Sizes



Why Sample at All?

- Census is expensive (lots of API calls to LLM!)
- Time constraints
- Sampling may be sufficient for research question

Inference

- How do we measure the *shock* in how media frames vaccine-related articles?

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- How do we measure the *shock* in how media frames vaccine-related articles?
- **One Solution:** model the framing sentiment parametrically! (see Lohr (2019) pg. 95)

Model: Bayesian Interrupted Time Series (ITS) Model

For an article j in stratum h ,

$$Y_{hj} = \mathbb{1}(\text{Stance}_{hj} = B) \sim \text{Bern}(p_{hj})$$

$$g(p_{hj}) = \beta_0 + \mu_h + x'_{hj}\beta + \mathbb{1}(t_{hj} < 0)f^{(\text{pre})}(t_{hj}) + \mathbb{1}(t_{hj} \geq 0)[\gamma + f^{(\text{post})}(t_{hj})],$$

where $f^{(\text{pre})}(t_{hj}) = \alpha_1^{(1)} t_{hj} + \alpha_2^{(1)} t_{hj}^2$,

$$f^{(\text{post})}(t_{hj}) = \alpha_1^{(2)} t_{hj} + \alpha_2^{(2)} t_{hj}^2,$$

and $g(\cdot) = \Phi^{-1}(\cdot)$ is the standard Normal inverse CDF

Parameter of Interest

- We want to measure the *shock* in framing sentiment exactly at the time of COVID-19 to measure the effect the pandemic had on how sentiment changed
- Use January 20, 2020 as COVID-19 threshold
- Mathematically,

$$\begin{aligned}\Delta &:= \lim_{t \rightarrow t_0^+} p_{hj}(t) - \lim_{t \rightarrow t_0^-} p_{hj}(t), \\ p_{hj}(t) &= \Phi\left(\beta_0 + \mu_h + x'_{hj}\beta + \mathbb{1}(t < 0)f^{(\text{pre})}(t) + \mathbb{1}(t \geq 0)[\gamma + f^{(\text{post})}(t)]\right) \\ \implies \Delta &= \Phi\left(\beta_0 + \mu_h + x'_{hj}\beta + \gamma\right) - \Phi\left(\beta_0 + \mu_h + x'_{hj}\beta\right)\end{aligned}$$

Results

Recorded Data

Table: Observed first ten sampled articles by site, date, and stance classification.

Obs.	Title	Site	Date	Stratum	A	B	C	D	Main Stance
1	Nation of Islam jewelry, clothing and documents slated for auction	Deseret News	2017-05-10	1	0	2	0	3	D
2	Letter: Vaccinate children	Deseret News	2017-05-15	1	5	0	0	0	A
3	Two human cases of West Nile virus reported in Utah	Deseret News	2017-08-24	1	5	0	0	0	A
4	Peter Morici: America is on the cusp of a golden age	Deseret News	2017-12-29	1	0	0	5	0	C
5	Suicide bomber strikes Damascus justice building, killing 30	Deseret News	2017-03-15	1	4	0	1	0	A
6	Jay Evensen: Think the U.S. should cut foreign aid? Think again	Deseret News	2017-09-21	1	5	0	0	0	A
7	BLM plans removal, treatment for wild horses	Deseret News	2017-01-10	1	1	0	1	3	D
8	Ay Chihuahua! Taylorsville home condemned after up to 125 dogs found living inside	Deseret News	2018-08-24	2	5	0	0	0	A
9	Protests as Congo leader warns of Ebola election 'disaster'	Deseret News	2018-12-29	2	5	0	0	0	A
10	Canyons School District to begin online registration Aug. 2	Deseret News	2018-07-05	2	0	0	1	4	D

Examples of B-coded Articles

USA TODAY

Global economy will suffer worst year since Depression, IMF projects

Published: April 14, 2020, 7:07 a.m. MDT



The buildings of the banking district are seen in Frankfurt, Germany, early Tuesday, April 14, 2020, as the economy expects worldwide heavy losses. (Michael Probst, Associated Press)

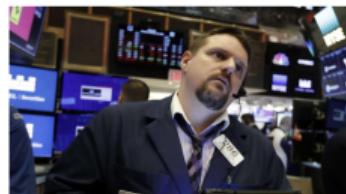
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Most Popular

- 1 Meet the new Presiding Bishopric of the Church of Jesus Christ.
- 2 Inspired BYU takes its post-Texas Tech frustrations out on old rival.
- 3 AJ Dabani's religion class at BYU might surprise you.
- 4 It's been an amazing year for this BYU legend — and he's just getting going.

Dow down 616 points, 10% below record high they set two weeks ago

By The Associated Press | Posted: Feb. 27, 2020 at 5:35 a.m.



US hiring slows amid signs of longer-lasting economic damage

By CHRISTOPHER PLUMMER, Associated Press | Updated: Aug. 7, 2020 at 7:28 p.m. | Posted: Aug. 7, 2020 at 7:13 a.m.


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MOST VIEWED

- 1 Dive teams to search Jordan River in Saratoga Springs double-murder investigation
- 2 Another winter weather advisory issued as storms linger in Utah
- 3 Idaho grand jury indicts 4 in alleged murder cover-up near local boat dock
- 4 Driver gets rear-ended then arrested
- 5 New book shows how Harry Reid's team celebrated false claims about Mitt Romney's taxes

Commercial construction in Utah at strong pace despite pandemic

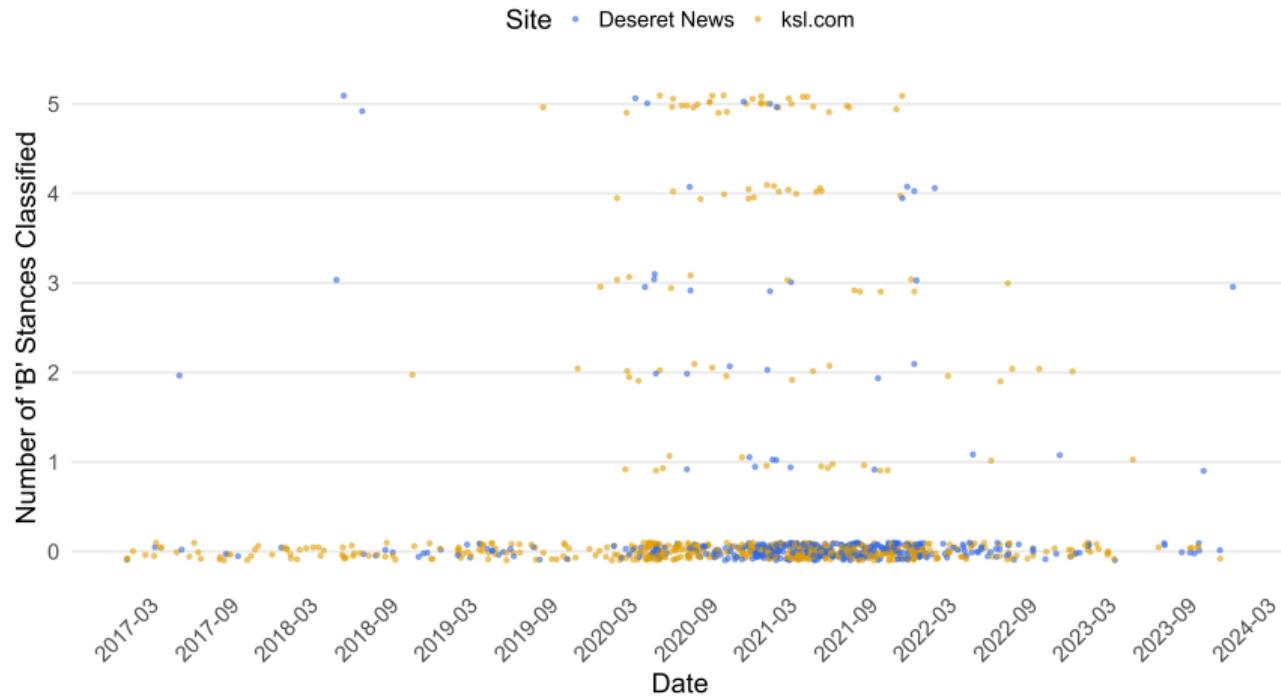
Published: Nov 29, 2020, 10:00 p.m. MST


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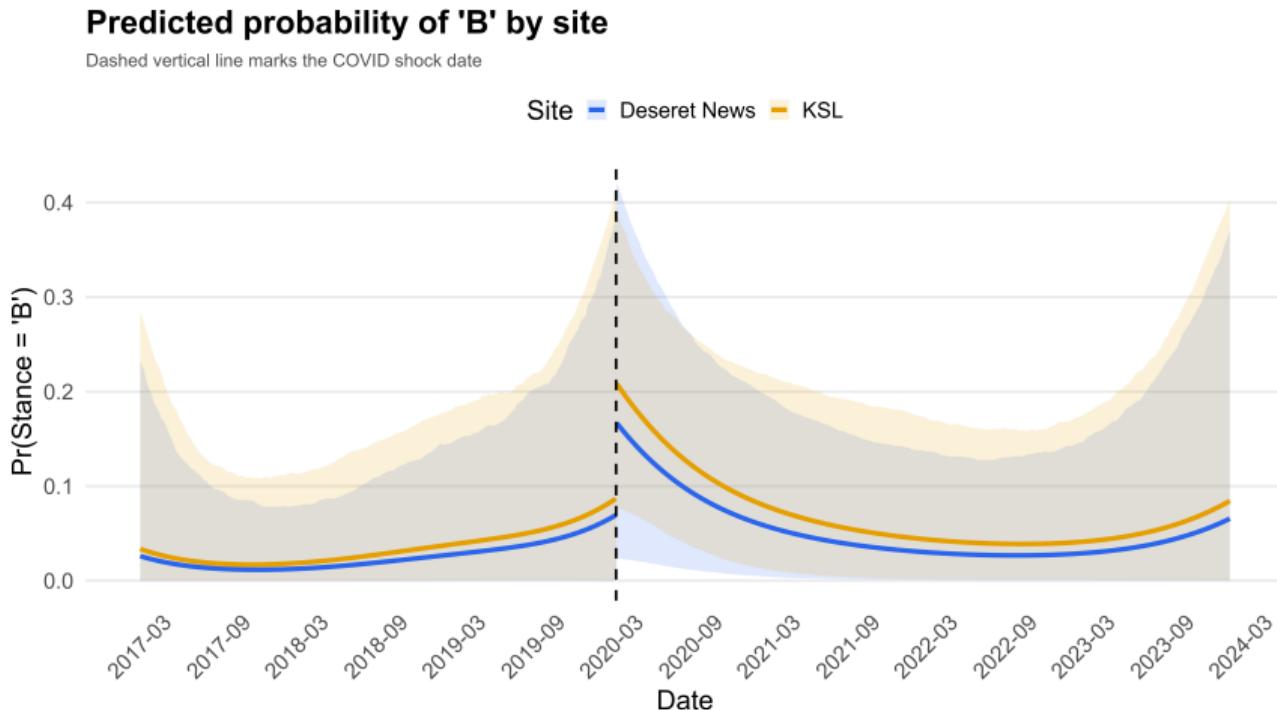
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- 5 BYU basketball player Kennard Davis Jr. arrested on suspicion of DUI after crash in Peoa on Thursday

Observed Economic Framing Over Time



Fitted Probabilities Over Time



Posterior means with 95% CrI; dashed line at $t = 0$.

Posterior Jump (Δ) at COVID-19 Shock

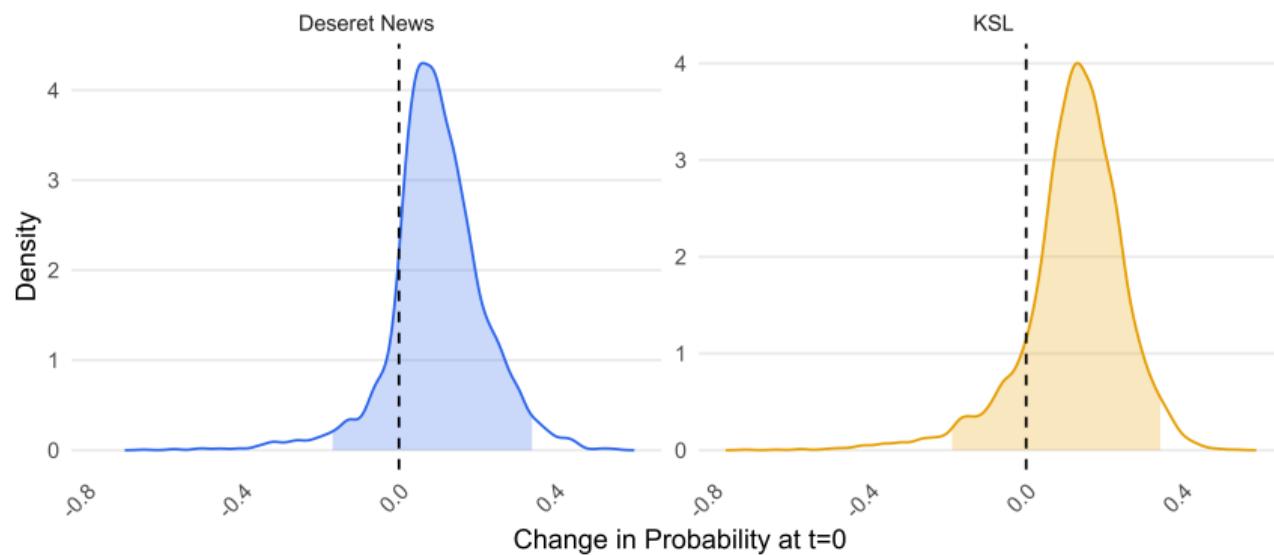
Site	$\mathbb{E}[\Delta \mathcal{D}]$	Median	95% Crl	$\Pr(\Delta > 0 \mathcal{D})$
Deseret News	0.110	0.105	[-0.193, 0.373]	0.860
KSL	0.123	0.130	[-0.144, 0.329]	0.877
Pooled	0.117	0.118	[-0.161, 0.350]	0.868

Posterior Densities of Δ

Posterior Probability Jump at COVID shock

Shaded area is the 95% credible interval

Site ■ Deseret News ■ KSL



Summary

Conclusion

- We used a **stratified random sample** of 1,000 Utah news articles to study how vaccine coverage changed during COVID-19
- Articles stratified by news outlet and time period using **Neyman allocation** w/ minimum sample size determined by **power simulation**
- After COVID began, news stories were about **11-12% more likely** to focus on economic impacts
- This increase was non-negligible (\approx **87% chance** of a positive shift) but gradually faded over time

Possible Explanations

- **Engagement Incentives:** Articles highlighting financial impacts likely drew higher readership and engagement, encouraging this framing

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- **Audience Tailoring:** Economic framing may resonate with Utah's largely conservative population, who may respond better to pragmatic or financial appeals than institutional authority or scientific evidence
- **Institutional Influence:** The Church of Jesus Christ's ownership of Deseret News and KSL may have promoted pro-vaccine narratives emphasizing community welfare and economic stability

Appendix

Data & Code

Repository: <https://github.com/SamLeeBYU/vaccine-sentiment-utah>

References I

| Lohr, S. L. (2019). *Sampling: Design and analysis* (2nd ed.). Chapman; Hall/CRC.