

Lost in Transmission*

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Abstract

Much of the information we absorb is not obtained directly from the source but is passed along by others through word of mouth. How does human transmission of economic information alter or filter different dimensions of the information, and does imperfect transmission result in downstream belief distortions? In this paper, we experimentally study oral information transmission. Participants listen to audio recordings discussing qualitative expectations about economic variables and are paid to accurately relay the information via voice messages. Other participants then listen to the original or transmitted recordings and report beliefs about the economic variables discussed. While information that influences the first moment of beliefs is fully preserved by oral transmission, variation in the second moment (uncertainty) is largely lost in transmission. We investigate the cognitive mechanisms underlying the differential loss of information about uncertainty, and the downstream consequences of loss of second-moment information.

Keywords: Communication, Uncertainty, Speech, Information Loss, Beliefs, Narratives.

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1 Introduction

Much of the information we consume is not gathered directly from its source but transmitted by others before reaching us. When absorbing news, stock market insights, or political and economic trends, we often depend on information that is conveyed to us verbally by others through conversations, media coverage, or podcast discussions. At every step of the human transmission chain, the content of information may be altered: pieces get lost, modified, or accidentally added. As the classic game of Telephone illustrates, information is often transformed in surprising and drastic ways even when transmitters are doing their best to pass it on accurately.

If oral transmission tends to alter information content in systematic yet unnoticed ways, this could have dramatic consequences for downstream belief formation. A vast body of research in economics studies distortions in people’s beliefs, focusing on the information sources we choose to consume and on how we interpret and update from information. Yet, little is known about a potentially first-order determinant of the kinds of information we receive: conditional on choosing a given media source or peer to listen to, what are the consequences of the fact that this source is usually relaying a second- or third-hand oral account of some original piece of information? Which attributes of economically-relevant information are preserved by oral transmission, and which attributes tend to be compromised? A better understanding of the nature of transmission loss may help shed light on the origins of well-documented belief distortions in practice.

In this paper, we study the nature and economic consequences of verbal information transmission. We examine (i) how oral transmission alters or filters out different dimensions of economically-relevant information content, and (ii) the systematic implications of oral transmission for downstream beliefs. To address these questions, we conduct a series of experiments that allow us to dissect the transmission process in a highly controlled fashion.

We focus on oral information transmission because, first, it is the main source of information in our daily lives through conversations with friends, family, and colleagues, and consumption of spoken content from TV, radio, or podcasts. Second, unlike written commu-

nication, it provides a natural testing ground for analyzing how cognitive constraints affect transmission. People cannot directly copy and paste information they overhear, and must often verbalize it spontaneously.

To systematize and quantify transmission effects, we analyze the first moment (mean) and the second moment (variance or uncertainty) of subjective beliefs formed based on original versus transmitted information. This way we can cast our findings in terms of the standard features of beliefs examined in the literature and directly speak to evidence on biased beliefs.

We start with a transmitter experiment: participants listen to a short recording of an opinion piece providing a qualitative narrative about the future path of an economic, financial or political variable. Then, they record their own verbalization of the article content. The “transmitter” participants are incentivized to pass on the contained information to a “listener” with maximum accuracy. Specifically, transmitters are told they will be paid a bonus according to the listener’s accuracy in answering questions about the *beliefs* and *confidence* of the person who wrote the original opinion piece (henceforth “the originator”). Each transmitter does this for narratives about five variables: the stock market, inflation, the Euro-US Dollar exchange rate, the price of Bitcoin, and the war in Ukraine.

Within each topic, we randomize two features of the original opinion piece. First, we randomize whether the piece argues for a positive or a negative outlook; we keep the factors discussed the same but flip whether the piece interprets them positively or negatively. For example, the stock market piece always discusses supply chain disruptions, but we flip whether it claims they will resolve soon or persist. Second, we randomize whether the original recording expresses a high degree of certainty or a high degree of uncertainty. We do so both by varying certainty- or uncertainty-expressing prefixes (e.g., “will definitely” versus “may possibly”) and by adding or omitting sentences expressing caveats. We use standard dictionaries for uncertainty classification to validate our text manipulations. By measuring the beliefs of respondents exposed to the original recordings, we show that these cross-randomizations indeed create systematic variation in beliefs about the originator’s quantitative expectations and uncertainty.

In a subsequent listener experiment, a separate sample of respondents listen either to the original recording or a transmitted recording, for each of the five topics. Respondents are incentivized to guess the quantitative belief and the level of uncertainty of the originator of the opinion piece.

The listener survey results show that information about the direction and extremity of the original author’s first-order beliefs is fully preserved by the oral transmission process. Listeners who hear the original opinion piece, and listeners who hear a transmitted version, give on average identical answers when asked to guess the quantitative beliefs of the author of the original opinion piece (for example, by what percent the author thinks the value of the S&P 500 will change in 2023; what probability the author assigns to the war in Ukraine ending in 2023; and so on). Our cross-randomizations shift quantitative beliefs by 1.1 standard deviations on average and this magnitude is identical in the “original recording” and “transmitted” recording groups. There is also no difference in the dispersion of responses between the two groups.

By contrast, oral transmission results in the loss of about half of the variation in uncertainty communicated in the original opinion pieces. Specifically, among listeners who hear the original opinion pieces, moving from a high-certainty to a low-certainty piece reduces beliefs about the author’s certainty by 20 percentage points on a 0-100 percent scale. By contrast, among listeners who hear *transmitted* versions, moving from a high-certainty to low-certainty original piece moves beliefs about certainty by only 10 percentage points. Information loss about uncertainty is largest in the case of probabilistic forecasts about binary events.

Moreover, across all versions of the original text, listeners who hear a transmitted recording believe the original orator to be about 11 percentage points less certain. This likely reflects listeners (mis)interpreting pauses and disfluencies introduced in the transmitted recordings as cues indicative of the subjective uncertainty of the original orator.

To shed light on what drives the loss of uncertainty-conveying information, we characterize how the transcripts of orators’ transmissions differ from the original opinion pieces that

our orators listened to. We document that the share of both uncertainty- and certainty-denoting words is significantly lower in the transmitted scripts compared to the scripts from the original recordings. Moreover, a transcript’s share of uncertainty- or certainty-denoting words is strongly predictive of the second-order beliefs listeners form on the basis of the transcript, so the loss of these words mechanically explains a large part of the loss of information about uncertainty.

Our paper ties into various literatures. First, it relates to work on how cognitive constraints affect belief formation (Enke and Zimmermann, 2019; Graeber, 2022; Enke, 2020) and to an emerging literature on complexity and belief formation (Oprea, 2020; Enke and Graeber, 2023; Enke et al., 2023). Oral transmission is subject to strong cognitive constraints and we provide suggestive evidence that better-educated and higher-IQ participants are better able to pass on information. Our paper offers a new perspective by analyzing how constraints on the process of transmitting qualitative information shapes downstream beliefs. We introduce the concept of *transmission complexity*, which characterizes the complexity of a piece of information through the degree of average information loss in human transmission.

Our focus on qualitative stories about economic variables allows us to shed light on the forces underlying narrative transmission of information (Shiller, 2017, 2020). We thereby contribute to a new emerging literature on narratives and belief formation (Andre et al., 2022; Kendall and Charles, 2022; Barron and Fries, 2023) and a strand of work on learning from qualitative information (Graeber et al., 2022).¹ Our experiments identify which aspects of information are more likely to be successfully passed on from one person to another.²

Our paper relates to a large literature on cultural transmission in experiments (e.g, Mesoudi and Whiten, 2008) as well as theoretical and empirical literatures on communication in strategic games (Cooper et al., 1992; Crawford and Sobel, 1982). We differ from

¹Our measurement of transmitted information relates to a growing literature on the measurement of attention (Bordalo et al., 2021c) and the role of memory constraints as a force shaping economic expectations (Bordalo et al., 2021b,a). In our context, short-term memory constraints are likely a key channel constraining people’s capacity to transmit all of the original information (Miller, 1956).

²Conlon et al. (2022) show that people are much less sensitive to information others discover compared to equally-relevant information they discover themselves.

this literature in our focus on (i) non-strategic settings, (ii) the transmission of qualitative information in the form of narratives, and (iii) the role of verbalization constraints as a source for information loss.³

Methodologically, our work also relates to a small literature on analyzing speech data, mostly outside of economics (Qin and Yang, 2019; Hajek, 2022; Gómez-Cram and Grotteria, 2022; Gennaro and Ash, 2022). Graeber and Roth (2023) use speech data to study how paralanguage – the way people say things – affects social learning and thereby the virality of misbeliefs in the context of financial decision making. We use speech data as a tool to study whether and how oral communication induces information loss.

Our paper proceeds as follows: Section 2 describes the experimental design of our orator and listener experiment. Section 3 provides results from both experiments. Section 4 concludes with a summary and an outlook for next steps.

2 Experimental Design

2.1 Transmission Experiment

Sample We conducted our transmission experiments on Prolific, a widely used online platform to conduct social science experiments (Eyal et al., 2021). The experiments were run with 500 US respondents in March 2023. In order to participate in our experiments, respondents needed to have a working microphone enabling them to record their voice.

Design In the transmission experiment, respondents work through five blocks, in a random order, covering the following economic variables: the S&P 500 in 2023, the US inflation rate in 2023, the Euro-Dollar exchange rate in 2023, the price of Bitcoin in 2023, and the likelihood of the war in Ukraine ending in 2023. Within each block, respondents listen to a 1-minute recording of an opinion piece providing a narrative about future development of the

³Our paper relates to foundational work in psychology on verbal reports as data (Ericsson and Simon, 1980, 1984). As opposed to our focus on speech data as a tool to study information transmission, this previous literature considered both the potential and limitations of verbal data as a lens into cognitive processes.

variable. They then complete two Raven’s Matrices (a standard puzzle format used on IQ tests) and are subsequently asked to record their own verbalization of the original recording.⁴ Respondents are incentivized to pass on the contained information to a “listener” with maximum accuracy. Specifically, transmitters are told they will be paid a bonus according to the listener’s performance on questions about the *beliefs* and *uncertainty* of the person who wrote the original opinion piece. The full set of experimental instructions can be found in Appendix C.1.

Within each topic, we randomize two features of the original opinion piece. First, we randomize whether the piece argues for a positive or a negative outlook; we keep the factors discussed the same but flip whether the piece interprets them positively or negatively. For example, the stock market piece always discusses supply chain disruptions, but we flip whether it claims they will resolve soon or persist. Second, we randomize whether the original recording expresses a high degree of certainty or a high degree of uncertainty, both by varying certainty- or uncertainty-expressing prefixes (e.g., “will definitely” versus “may possibly”) and by adding or omitting sentences expressing caveats. We show, by measuring the beliefs of respondents exposed to the original recordings, that these cross-randomizations create systematic variation in beliefs about the originator’s quantitative expectations and confidence. The full scripts for each of the conditions are shown in Appendix D. These treatments allow us to create systematic variation in beliefs about the originator’s beliefs about the expected values as well as about their level of uncertainty about the future value of the variable of interest.

2.2 Listener Experiment

Sample We conducted these experiments on Prolific in March 2023. The experiments were run with 390 US respondents.

⁴We implement the recording of speech data through Phonic (<https://www.phonic.ai>, which we embed in our Qualtrics survey.)

Design In our listener experiments, respondents listen to five recordings about the future development of the same variables described in the transmission experiment. As before, the order of the topics is fully randomized. Respondents are asked to guess the originator’s beliefs. For any given variable, they are randomized either to an original recording (original recording treatment) or a recording transmitted from a respondent in the transmission experiment (transmitted recording treatment).

Our core interest lies in understanding people’s guesses about the beliefs of the originator of the opinion piece. We first ask our respondents to guess the originator’s estimate of the variable of interest. For example, in the context of inflation, our respondents receive the following instructions:

Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person estimates the inflation rate in 2023 will be?

To reduce noise in the stated beliefs we fix all respondents’ prior beliefs about the current inflation rate.⁵

To measure beliefs about the originator’s level of uncertainty we ask our respondents how certain they think the originator is about their estimate. In particular, we ask them about the percent chance that the originator believes that their estimate is within a given interval around their estimate. Participants respond on a quantitative scale ranging from 0 to 100%. To enhance comprehension our quantitative slider ranges from “0%: not at all certain” to “100%: Fully certain.” In the context of inflation, a respondent who guessed the originator expects a 1% inflation rate is provided with the following instructions:

How certain do you think this person is about their inflation estimate?

More specifically, what do you think this person believes is the percentage chance that inflation in 2023 will be between -1% and 3%? [i.e. a $\pm 2\%$ interval around the respondent’s first-order guess]

The full set of experimental instructions can be found in Appendix C.3.

⁵We provide anchors in all of our belief elicitation to ensure that respondents are reasonably familiar with the scale across all five topics.

3 Experimental Results

3.1 Listener Experiment

We begin by using data from the listener experiment to examine how the process of transmission affects perceptions of the originator’s first- and second-moment beliefs.

3.1.1 Transmission of the First Moment

Empirical Specification Our main specification of interest takes the following form:

$$\text{Belief}_i = \alpha_0 + \alpha_1 \text{Neg}_i + \alpha_2 \text{Transm}_i + \alpha_3 \text{Neg}_i \times \text{Transm}_i + \alpha_4 \text{Uncert}_i + \alpha_5 \text{Uncert}_i \times \text{Transm}_i + \varepsilon_i \quad (1)$$

where Belief_i is respondent i ’s belief about the originator’s estimate or her belief about the originator’s uncertainty. Neg_i takes value one if the opinion piece of the original transcript suggests bad news and value zero if it suggests good news. Transm_i takes value one if the respondent listens to a transmitted recording and takes value zero if they listen to an original recording. Uncert_i takes value one if the original recording expressed high levels of uncertainty and value zero if it expressed low levels of uncertainty. Standard errors are clustered at the respondent level.

In this specification, α_1 represents the effect on first-order beliefs of switching from a narrative arguing in one direction to a narrative arguing in the other direction, *for listeners who hear the original recording*. Meanwhile, $\alpha_1 + \alpha_2$ represents this effect *for listeners who hear a transmitted recording*. If α_2 has the same sign as α_1 , this suggests transmission *extremifies* information contained in the original. If α_2 has the opposite sign to α_1 , this suggests some information is lost or watered down through transmission.

Results Table 1 and Panel (a) of Figure 1 describe respondents’ beliefs about the expectations of the originator of the script. We first start by describing differences in beliefs among

respondents exposed to original transcripts.

α_1 captures differences in beliefs induced by receiving a transcript indicating bad news rather than good news among respondents exposed to original transcripts. Column 1 shows the pooled estimate based on a z-scored measure.⁶ The difference across treatment groups for the pooled measure corresponds to 1.07 standard deviations ($p < 0.01$). Columns (2) to (6) show disaggregated treatment effects for each of the topics. Respondents in the negated treatment have a 24 percentage point lower annual return expectation for the stock market, have a 3 percentage point higher inflation expectation ($p < 0.01$), do not expect the Ukraine war to end with a 53 p.p. higher likelihood ($p < 0.01$), expect an 11 percent higher USD exchange rate ($p < 0.01$), and expect a 53 p.p. more negative change in the price of Bitcoin ($p < 0.01$).

α_2 captures whether differences in beliefs about the originator’s estimates induced by the negation treatment are affected by the transmission process. All of the coefficients are very small and none of them are statistically significant. The pooled coefficient is also relatively tightly estimated, suggesting no systematic loss of information for the variation induced by the negation treatment through the process of information transmission.

α_3 captures differences in beliefs about the originator’s estimates induced by the transmission process alone, irrespective of any interaction of the transmission process with content differences in the original script. It therefore captures whether the transmission process per se shifts guesses about the orator’s point beliefs. The coefficient is close to zero and precisely estimated in the pooled regression. This indicates that the transmission process per se did not induce any changes in beliefs.⁷ Our first main result, based on the evidence presented in this section, can be summarized as follows:

Result 1. *Information about the expected future value of economic variables is fully preserved*

⁶We z-score the first order beliefs by topic *and* flip the signs of the inflation and Ukraine beliefs so that negating the recording will *decrease* the magnitude of the belief.

⁷ α_4 captures the effects of the uncertainty treatment on beliefs about the orator’s estimate, and α_5 captures the interaction effect between this uncertainty treatment and the transmission process. As expected, this treatment, which is designed to only shift beliefs about the orator’s uncertainty, does not affect beliefs about the orator’s expected value.

by oral transmission.

3.1.2 The Transmission of Uncertainty

We next turn to the transmission of uncertainty in the orator’s beliefs.

Empirical specification Our main empirical specification of interest takes the following form:

$$\text{BeliefUncertainty}_i = \beta_0 + \beta_1 \text{Uncertain}_i + \beta_2 \text{Transm}_i + \beta_3 \mathbf{v}_i \times \text{Transm}_i + \beta_4 \text{Neg}_i + \beta_5 \text{Neg}_i \times \text{Transm}_i + \varepsilon_i \quad (2)$$

The specification is identical to the one used in the previous section, except that our outcome variable of interest is now $\text{BeliefUncertainty}_i$, respondents’ beliefs about the orator’s uncertainty and that our main right-hand side coefficient of interest is now β_1 and concerns the effects of the uncertainty treatment, Uncertain_i . Standard errors are clustered at the respondent level.

Again, β_1 indicates the effect of varying the uncertainty in the original text *for respondents who hear the original recording* and $\beta_1 + \beta_2$ represents the same effect *for respondents who hear a transmitted recording*.

Results Table 2 and Panel (b) of Figure 1 describe respondents’ beliefs about the uncertainty of the original orator of the script. We first start by describing differences in beliefs among respondents exposed to original rather than transmitted transcripts.

β_1 captures differences in beliefs about the orator’s certainty induced by receiving a transcript with high *uncertainty* rather than high certainty among respondents exposed to original transcripts. Column 1 of Table 2 shows the estimate pooled across all five different topics. Respondents in the *Uncertain* treatment expect the orator to be 20 p.p. less certain on average ($p < 0.01$). This effect size is sizable and corresponds to 0.74 of a standard deviation. Columns (2) to (6) show disaggregated treatment effects for each of the topics.

Respondents in the *Uncertain* treatment expect the orator to be 18.47 p.p. less certain about their stock market expectation ($p < 0.01$), 21.09 p.p. less certain about their inflation expectation ($p < 0.01$), 28.88 p.p. less certain about the orator’s prediction about the future development of the Ukraine war ($p < 0.01$), 21.49 p.p. less certain about the orator’s prediction about the future USD-Euro exchange rate ($p < 0.01$) and 12.93 p.p. less certain about the orator’s Bitcoin expectations ($p < 0.01$).

β_2 captures whether differences in beliefs about the original orator’s uncertainty induced by the uncertainty treatment are affected by the transmission process. The pooled results indicate that there is substantial and highly significant information loss induced by the process of information transmission. Oral transmission results in the loss of about half of the variation in uncertainty communicated in the original opinion pieces. Specifically, among listeners who hear the original opinion pieces, moving from a high-certainty to a low-certainty piece reduces beliefs about the author’s certainty by 20 percentage points on a 0-100 percent scale. By contrast, among listeners who hear *transmitted* versions, moving from a high-certainty to low-certainty original piece moves beliefs about certainty by only 10 percentage points. The table also shows that information loss about uncertainty is largest in the case of predictions about the Ukraine war. We are currently working on follow-up experiments examining the sources of this strong effect.

β_3 captures differences in beliefs about the original orator’s uncertainty induced by the transmission process alone, irrespective of any interaction of the transmission process with content differences in the original scripts. Table 2 reveals that listeners perceive more uncertainty when they are exposed to a transmitted recording irrespective of the treatment condition. This effect of 11.29 p.p. is sizable in magnitude and highly statistically significant ($p < 0.01$) and robustly emerges across all topics. This likely reflects that people use cues indicative of subjective uncertainty of the transmitter as a signal about the original orator’s extent of uncertainty.⁸ Taken together, our second main result can be summarized

⁸ β_4 captures the effects of the negation treatment on beliefs about orator’s uncertainty, and β_5 captures the interaction effect between this negation treatment and the transmission process. As expected, this treatment, which is designed to only shift beliefs about the orator’s expected value, does not affect beliefs about the orator’s uncertainty.

as follows:

Result 2. *Variation in uncertainty induced by content differences in the original transcripts is to a large degree lost through information transmission. Moreover, listeners perceive more uncertainty when they are exposed to a transmitted recording irrespective of the treatment condition.*

3.1.3 Heterogeneity in Information Transmission

Heterogeneity by Transmitter Characteristics Certain kinds of transmitters might be predictably better at communicating the uncertainty contained in the original text. For example, if information about uncertainty is complex or difficult to clearly articulate, better-educated or higher-IQ respondents might be more successful at passing it on. Appendix Tables A.1 and A.2 test this hypothesis by checking whether variations in the uncertainty of the original text have larger impacts on listener beliefs when the transmitter is highly educated (reports having at least a college degree) or above-median IQ (measured by the share of correct responses to the ten Raven’s Matrix questions our transmitters complete during the course of the experiment⁹). A negative coefficient on the Intelligence \times Uncertain measure constitutes evidence for this hypothesis.

These tables show suggestive but noisy evidence for the idea that better-educated or higher-IQ are better able to pass on uncertainty. Most of the coefficients are negative and have reasonably strong magnitudes, suggesting that more intelligent participants pass on 20-50% more of the original variation in uncertainty. However, most of these coefficients are statistically insignificant and a few have the opposite sign.

Individual Heterogeneity in Information Transmission Regardless of observable characteristics like IQ or education, are certain individuals predictably better at transmitting uncertainty, or is the amount of uncertainty conveyed in a particular instance just a random variable with no stable individual-level component?

⁹Respondents on average spend 90 seconds on each Raven’s Matrix, and performance on the questions is uncorrelated with time spent, validating performance as a measure of IQ rather than effort choices.

We can get at this question by calculating transmitter-level measures of uncertainty preservation. Because each transmitter records 5 orations, each of which is heard by 5 or 6 listeners, we have 25-30 listener observations per transmitter. Moreover, because each transmitter receives original texts that are independently randomly assigned to high-uncertainty or low-uncertainty conditions, we have variations within (most) transmitters, across topics, in whether they are exposed to high-uncertainty or low-uncertainty original texts. We can therefore calculate a transmitter-level measure of uncertainty preservation by running the following regression within each transmitter j :

$$\text{BeliefUncertainty}_{ijt} = \beta_0 + \beta_1 \text{Uncertain}_{it} + \varepsilon_i \quad (3)$$

where i indexes listeners and t indexes topics. Figure 2 plots transmitters’ individual uncertainty-transmission coefficients; it reveals substantial individual heterogeneity in the degree of information transmission, with a left-hand tail of transmitters who are clearly statistically distinguishable from the null of zero uncertainty transmission, and a majority for whom we cannot reject the hypothesis that no uncertainty information is transmitted at all. Individual transmitters’ effects are weakly correlated with IQ in the expected direction.

3.2 Mechanisms Driving Loss of Uncertainty Information

3.2.1 Loss of Uncertainty-Denoting Words

To shed light on what drives the loss of information about the originator’s uncertainty, we characterize how the transcripts of orators’ transmissions differ from the original opinion pieces that transmitters listened to. Our analysis focuses on the preservation of uncertainty-denoting words such as “may,” “might,” “possibly,” or “sometimes” and certainty-denoting words such as “clearly,” “definitely,” and “always.” We devised the original transcripts so that high-certainty versions of the texts contain many certainty-denoting words and few uncertainty-denoting ones, and vice versa for the high-uncertainty versions.

Inclusion or omission of these words has strong impacts on listeners’ assessments of

originators’ uncertainty: Appendix Figure A.5 shows that, pooling original and transmitted recordings, listeners’ evaluations of the originator’s confidence are strongly increasing in the share of transmitted words that are certainty-denoting, and weakly decreasing in the share that are uncertainty-denoting.

Figure 3 provides structured evidence that certainty- and uncertainty-denoting words are partially lost in translation. Looking at high-uncertainty versions of the original texts, shifting from the original transcript to a transmitted transcript causes the share of uncertainty-denoting words in the transcript to drop by roughly half (comparing the red and orange bars in Panel (a)). Similarly, looking at high-certainty versions of the original texts (blue and orange bars in Panel (b)), shifting from original to transmitted loses more than half of the certainty-denoting words.

An unstructured analysis of the texts also highlights the loss of uncertainty-denoting prefixes. Comparing the original texts to their transmitted versions, we use the Gentzkow and Shapiro (2010) method to extract the words that are most characteristic of original (as opposed to transmitted) transcripts. Panel (a) shows that when we apply this method to original and transmitted versions of the high-uncertainty texts, several of the words that are uniquely characteristic of the original transcripts are uncertainty-prefixes: “potentially,” “suggests,” “unclear,” “possibly,” and “uncertain.” This is indicative of *loss* of these words in the transmitted transcripts. Similarly, applying this to high-certainty texts, multiple words characteristic of the original transcripts are certainty-denoting prefixes: “definitely” and “strongly.”

In both cases, the word most predictive of transmitted texts is a disfluency, “um,” which provides a convenient bridge to the next mechanism we explore.

3.2.2 Transmission-Induced Garbling

Two patterns suggest that transmitted recordings are more “garbled” and harder for listeners to follow than the original recordings. First, as just noted, the transmitted recordings contain many pauses and disfluencies like “um” or “uh,” unlike the original recordings. Second, after

hearing each recording, listeners are asked how difficult it was to follow the reasoning in the recording. On average, listeners find it 16% harder to follow transmitter recordings.

One potential explanation of our results is that garbling does not disrupt transmission of first-order beliefs, but does disrupt transmission of uncertainty.

Garbling might disrupt the transmission of uncertainty in two ways. First, the addition of disfluencies might make transmitted recordings seem more uncertain *across the board*, obscuring the variations in uncertainty in the original texts. This mechanism is consistent with the fact that there is a “main effect” of transmission in our regressions in Table 1: transmitted recordings cause listeners to believe the originator is 12 percentage points less certain, regardless of whether the original recording is certain or uncertain. There is no such main effect for the first-order beliefs of the originator.

Second, more garbled recordings might confuse respondents and make it more difficult to discern subtle variations in uncertainty. To test this hypothesis, we check whether variations in original-text uncertainty are preserved more strongly among transmissions that listeners rate as easier to follow. Table A.5 shows that this is indeed the case: among transmitted recordings that are above the median “ease of following” rating, variations in uncertainty in the original text shift listeners’ uncertainty assessments by 14 percentage points (nearly the full 20 induced by the original recordings). By contrast, in below-median recordings this is only 7 percentage points.

However, this is not unique to the transmission of information about uncertainty: Table A.6 shows that easier-to-follow recordings also transmit information about first-order beliefs 50% more strongly than hard-to-follow recordings. This second mechanism therefore does not seem able to explain the differential loss of information about uncertainty.

4 Conclusion

Our research investigates the transmission of narratives through oral communication and the impact of information loss on belief formation. Through the study of speech data, we have

found that while information about expected future economic variables is fully preserved through oral transmission, uncertainty is largely lost in translation. Orators tend to drop uncertainty-denoting prefixes and focus on first-order narratives rather than caveats and discussions of aleatory uncertainty. We have proposed several potential explanations for this phenomenon, including cognitive complexity, vocabulary limitations, and demand-side considerations, and plan to use mechanism experiments to empirically distinguish between these explanations. Our findings highlight the importance of understanding the limitations of oral communication in shaping beliefs and decision-making.

We formulate several potential explanations for people’s neglect of information about uncertainty: cognitive complexity, vocabulary limitations, and demand-side considerations. In ongoing work, we use mechanism experiments to distinguish these explanations empirically.

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5 Main exhibits

Figure 1: Listener Experiment: First- and Second-Order Beliefs (Pooled)

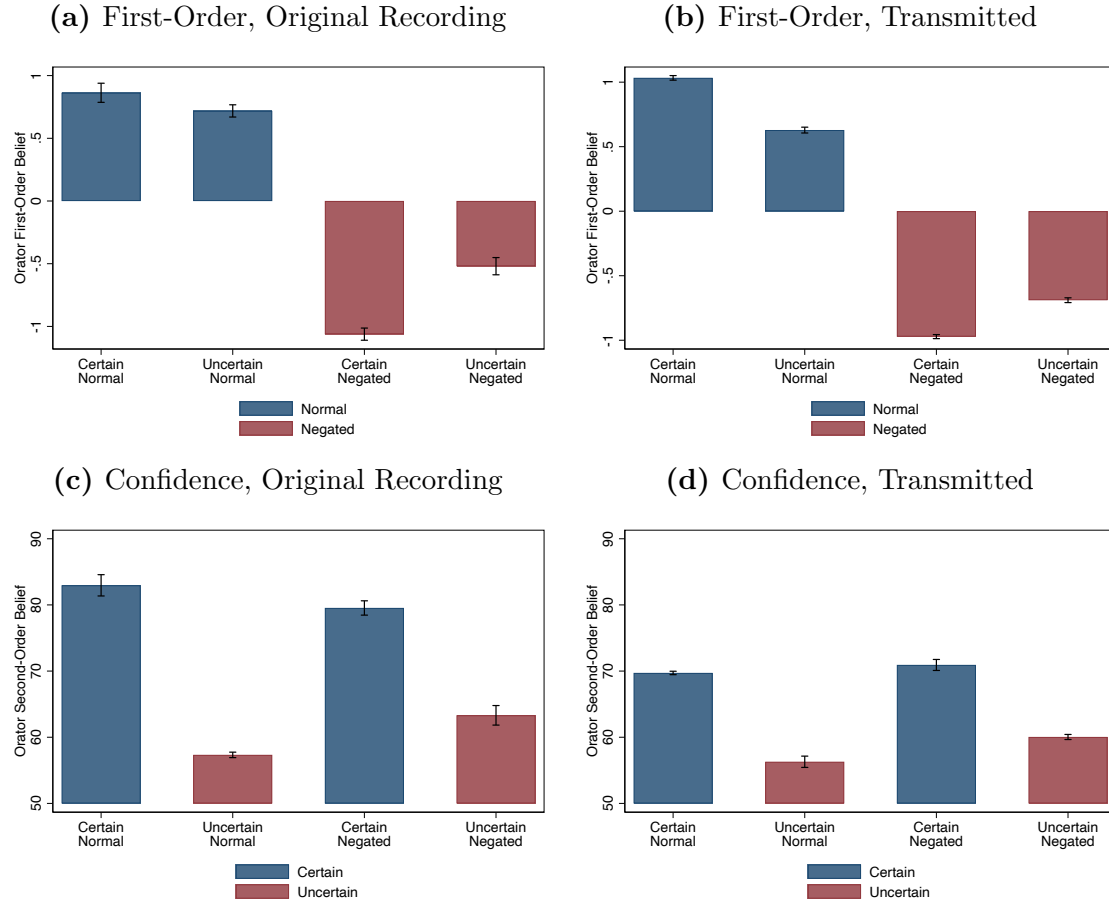


Figure 2: Transmitter-Level Heterogeneity in Information Transmission

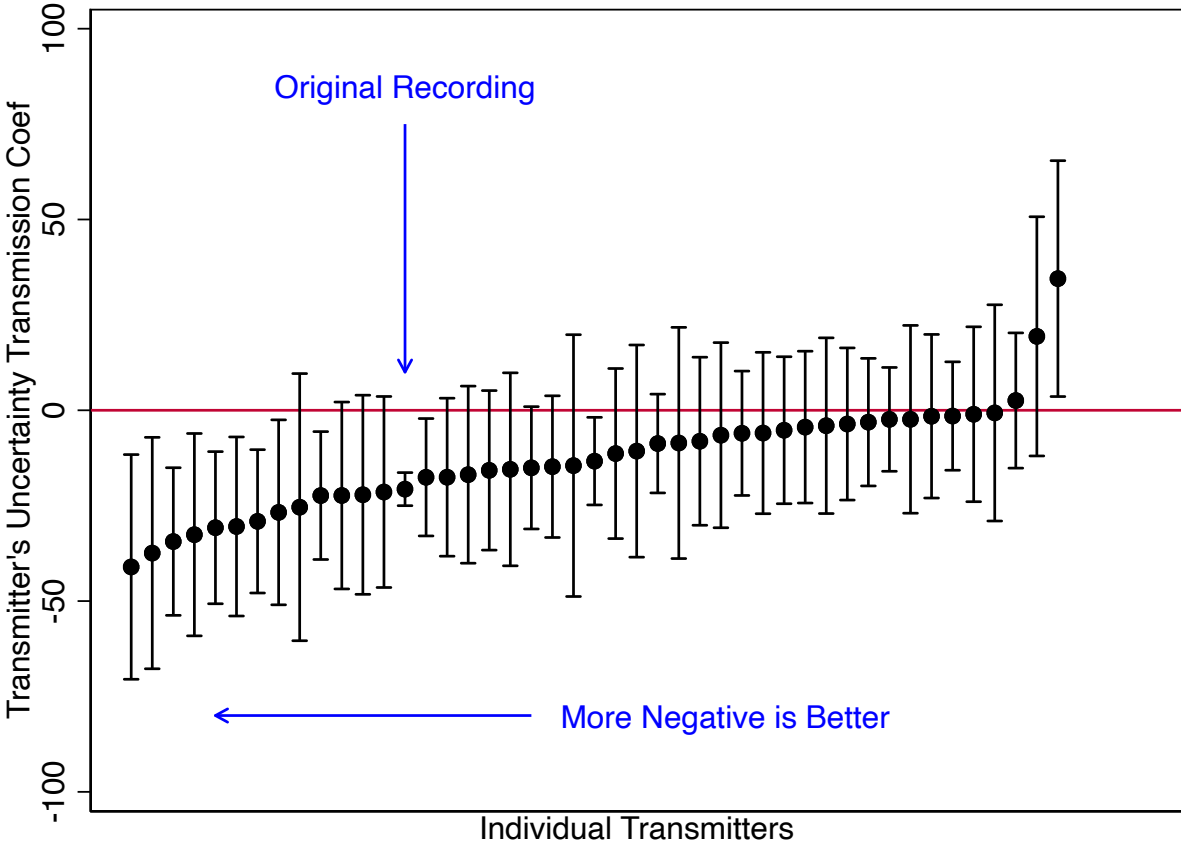
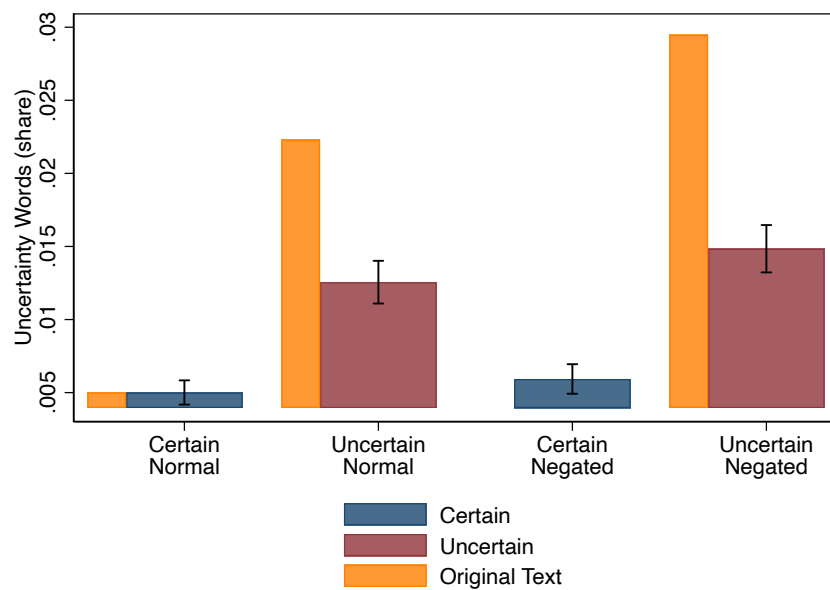


Figure 3: Uncertainty Words: Original Texts vs Transmitted Texts

(a) Uncertainty-Denoting Words (Share of Total Words)



(b) Certainty-Denoting Words (Share of Total Words)

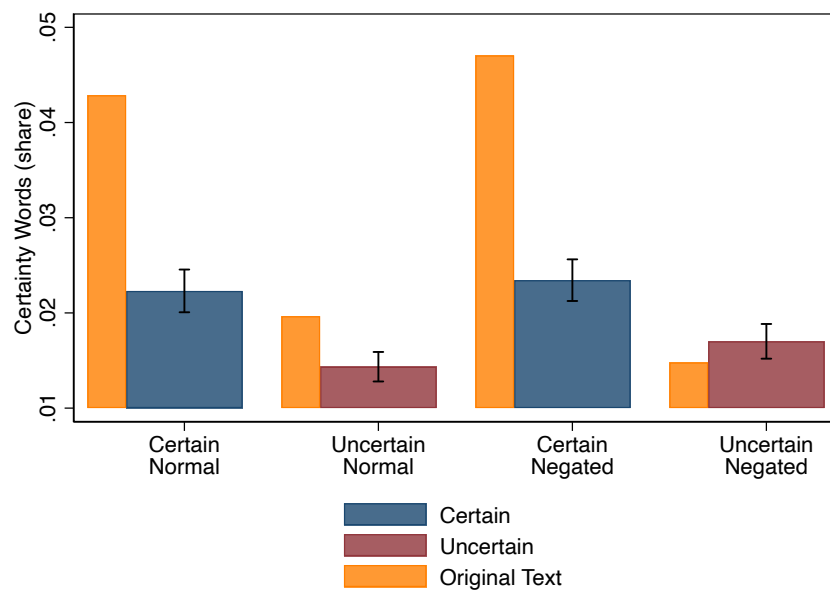
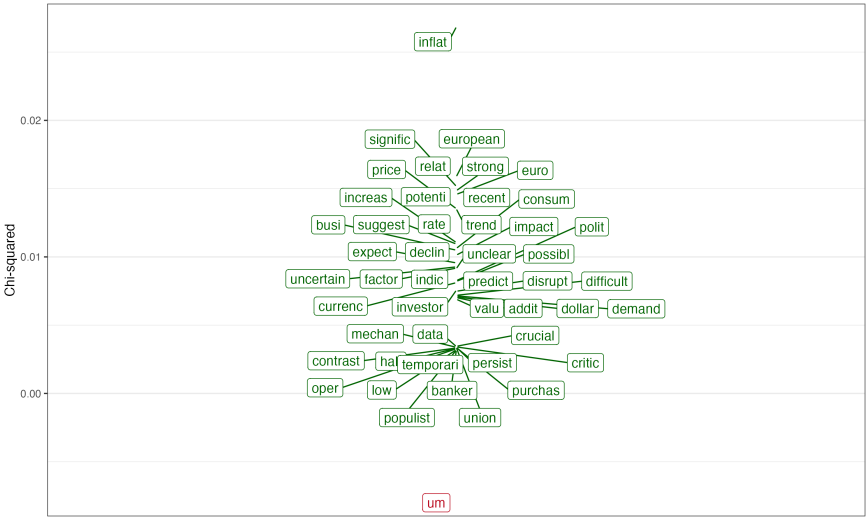


Figure 4: Words Predictive of Original (Green) vs Transmitted (Red) Transcripts

(a) Uncertain Original Transcript



(b) Certain Original Transcript

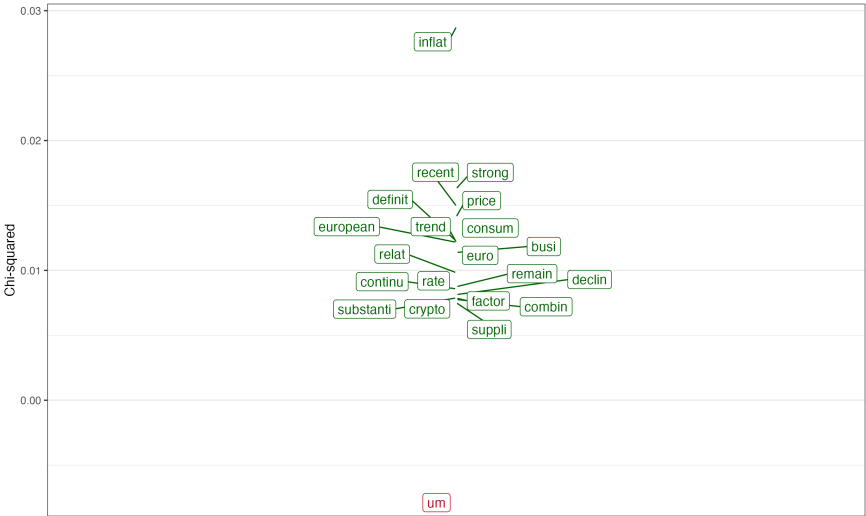


Table 1: Listener Experiment: Beliefs about Orator's Estimate

| | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------------------|----------------------|-----------------------|---------------------|----------------------|--------------------|-----------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Negated | -1.073*** (0.084) | -24.045*** (3.150) | 2.984*** (0.481) | 53.070*** (5.680) | 0.114** (0.040) | -53.046*** (8.205) |
| Negated \times Transmitted | 0.028 (0.090) | 2.516 (3.552) | -0.406 (0.622) | -4.127 (6.414) | 0.027 (0.047) | -4.122 (8.921) |
| Transmitted | -0.018 (0.080) | -5.006* (2.315) | 0.231 (0.517) | 1.887 (4.882) | -0.046 (0.053) | 0.360 (6.054) |
| Uncertain | 0.071 (0.083) | -6.025 (3.070) | -0.532 (0.479) | 1.068 (5.573) | -0.099* (0.041) | 3.280 (8.892) |
| Uncertain \times Transmitted | -0.108 (0.092) | 1.507 (3.444) | 0.888 (0.623) | -10.159 (6.329) | 0.093 (0.048) | -9.186 (9.551) |
| Nb. obs | 1,950 | 390 | 390 | 390 | 390 | 390 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Listener Experiment: Beliefs about the Orator's Uncertainty

| | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -20.666*** (2.241) | -18.474*** (5.072) | -21.091*** (4.582) | -28.876*** (4.550) | -21.488*** (4.263) | -12.929** (4.727) |
| Uncertain \times Transmitted | 9.039*** (2.655) | 1.550 (5.863) | 4.876 (5.415) | 21.243*** (5.784) | 7.877 (5.183) | 6.112 (5.422) |
| Transmitted | -11.293*** (2.019) | -6.098 (4.669) | -16.869*** (4.148) | -15.805*** (4.419) | -11.085** (3.826) | -6.395 (4.274) |
| Negated | 1.883 (2.264) | -2.480 (5.179) | -1.313 (4.780) | 4.283 (4.979) | 1.410 (4.307) | 6.246 (4.719) |
| Negated \times Transmitted | 0.035 (2.640) | 4.662 (5.983) | 11.271* (5.618) | -2.759 (6.028) | -1.548 (5.240) | -9.204 (5.429) |
| Nb. obs | 1,950 | 390 | 390 | 390 | 390 | 390 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A Additional exhibits from Transmission Experiment

Figure A.1: Orator: First-Order Beliefs

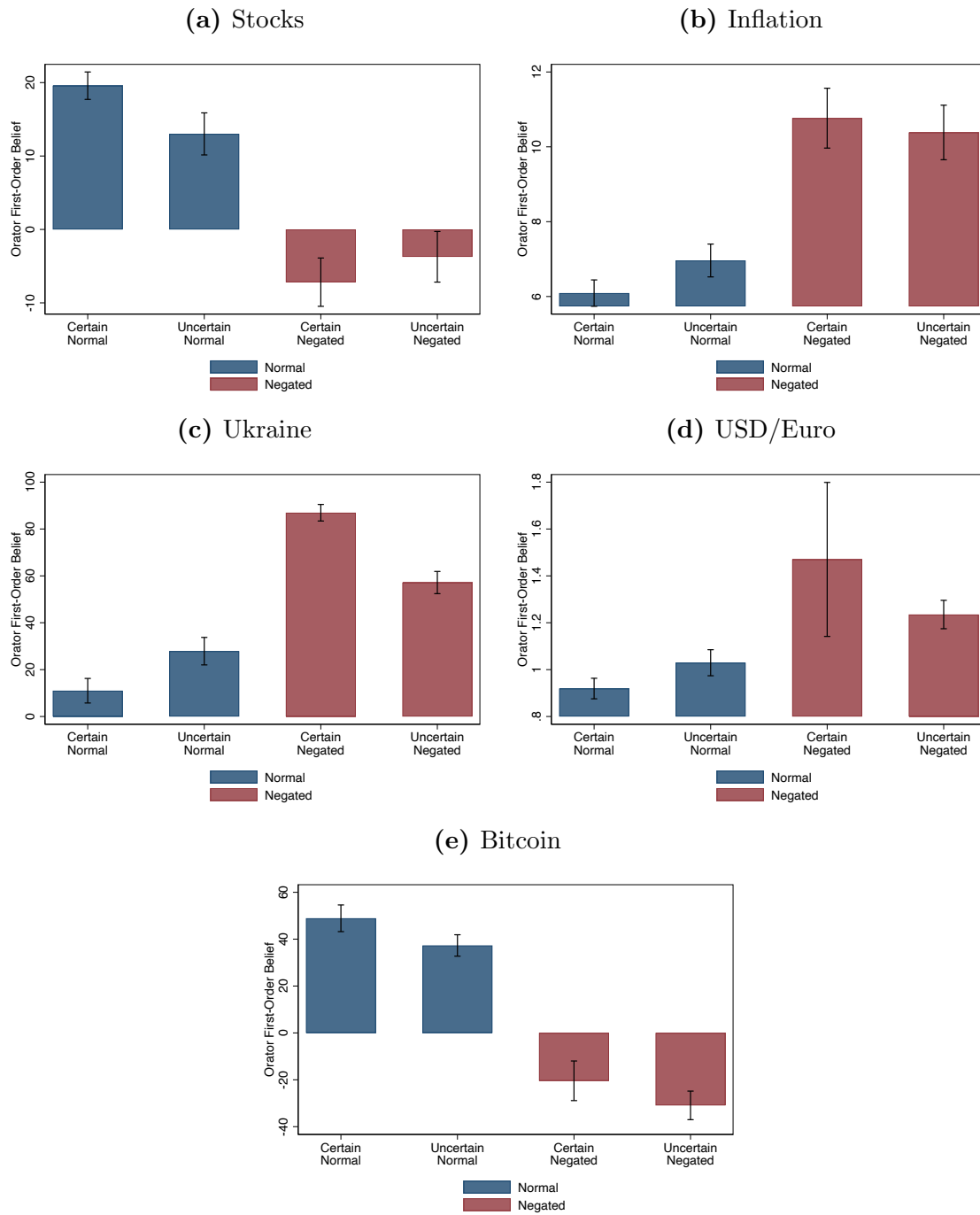
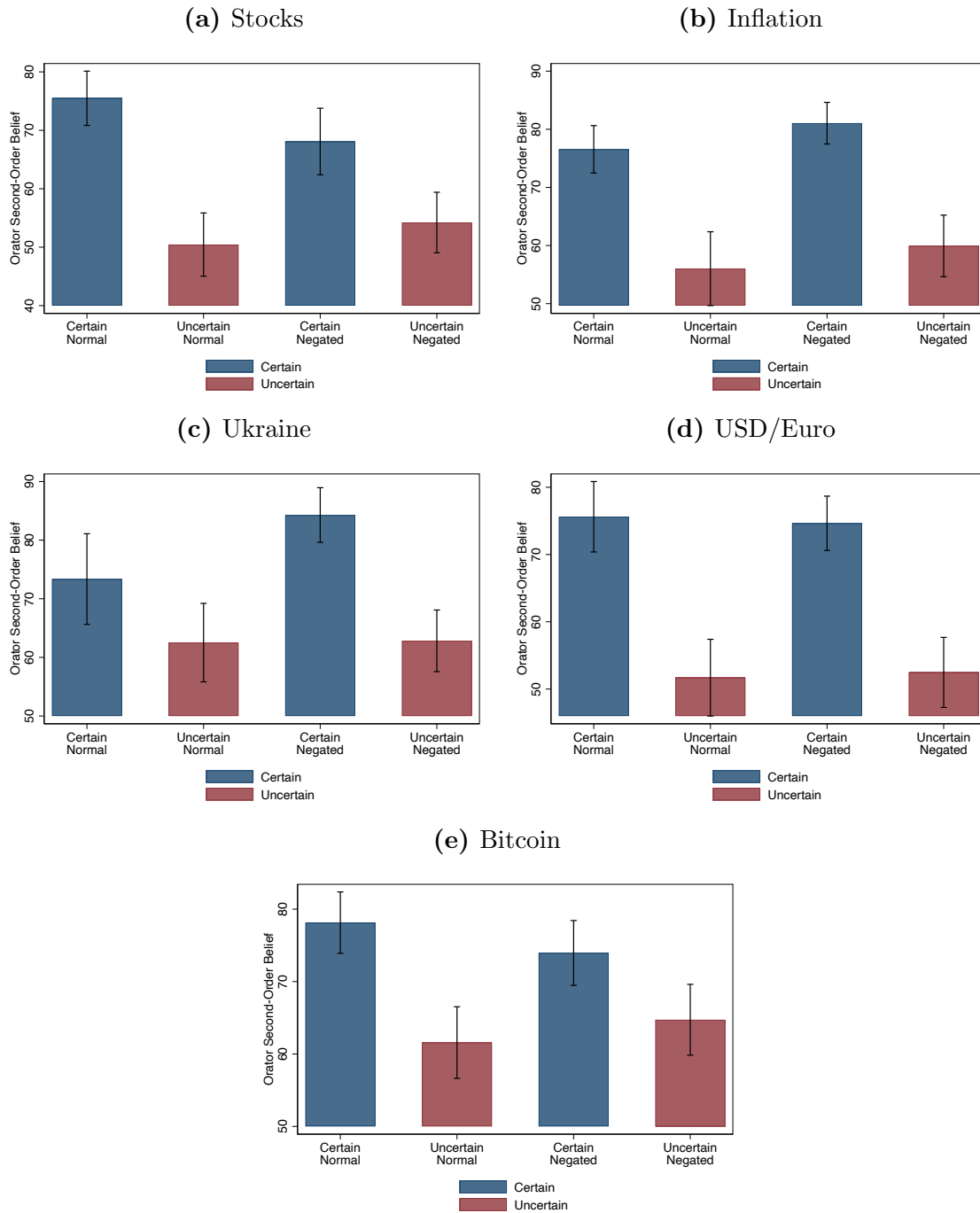


Figure A.2: Orator: Second-Order Beliefs



B Additional Exhibits from Listener Experiment

Figure A.3: Listener Experiment: Beliefs about the Orator's Estimate, By Topic

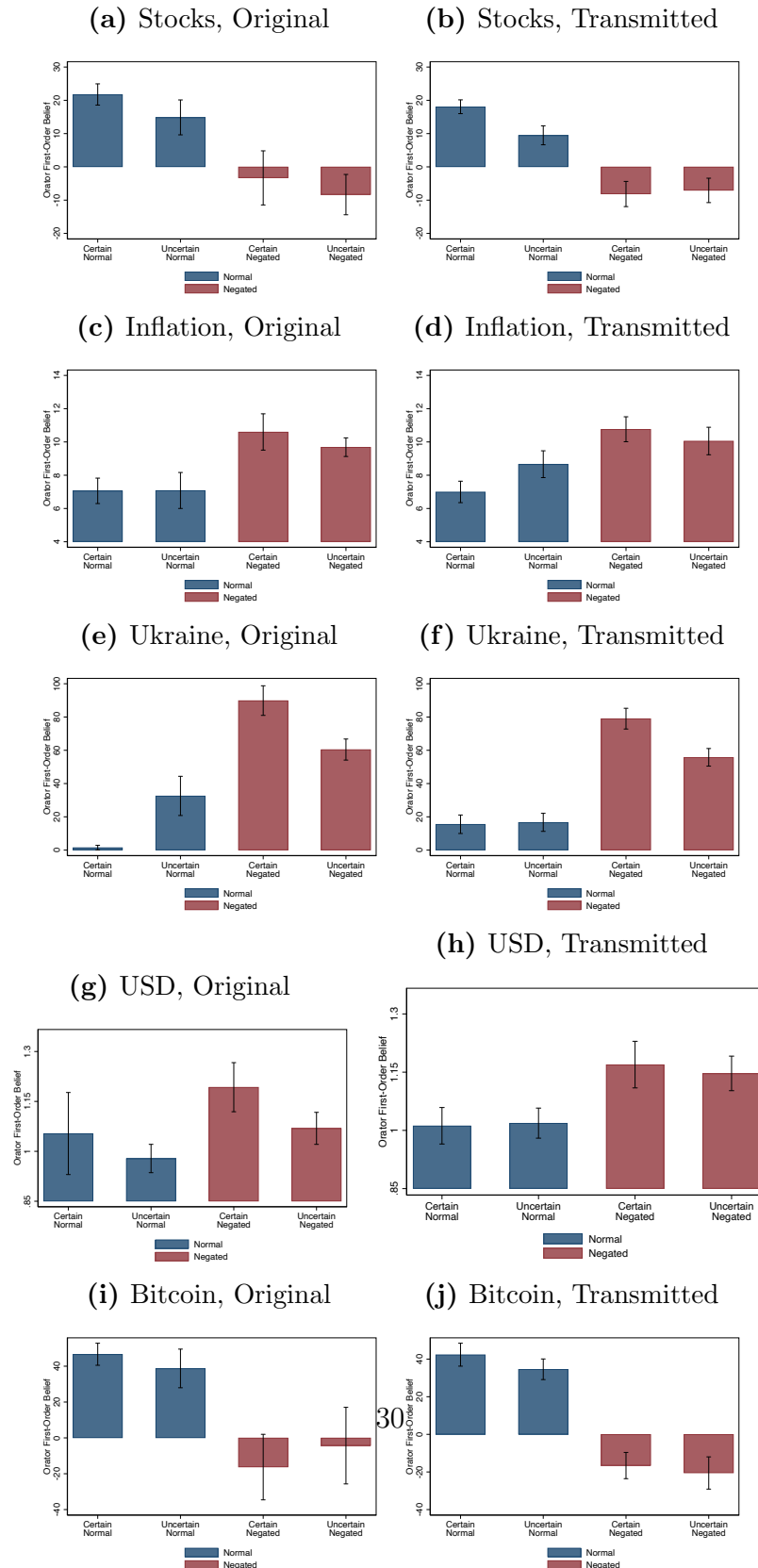


Figure A.4: Listener Experiment: Beliefs about Orator Uncertainty, By Topic

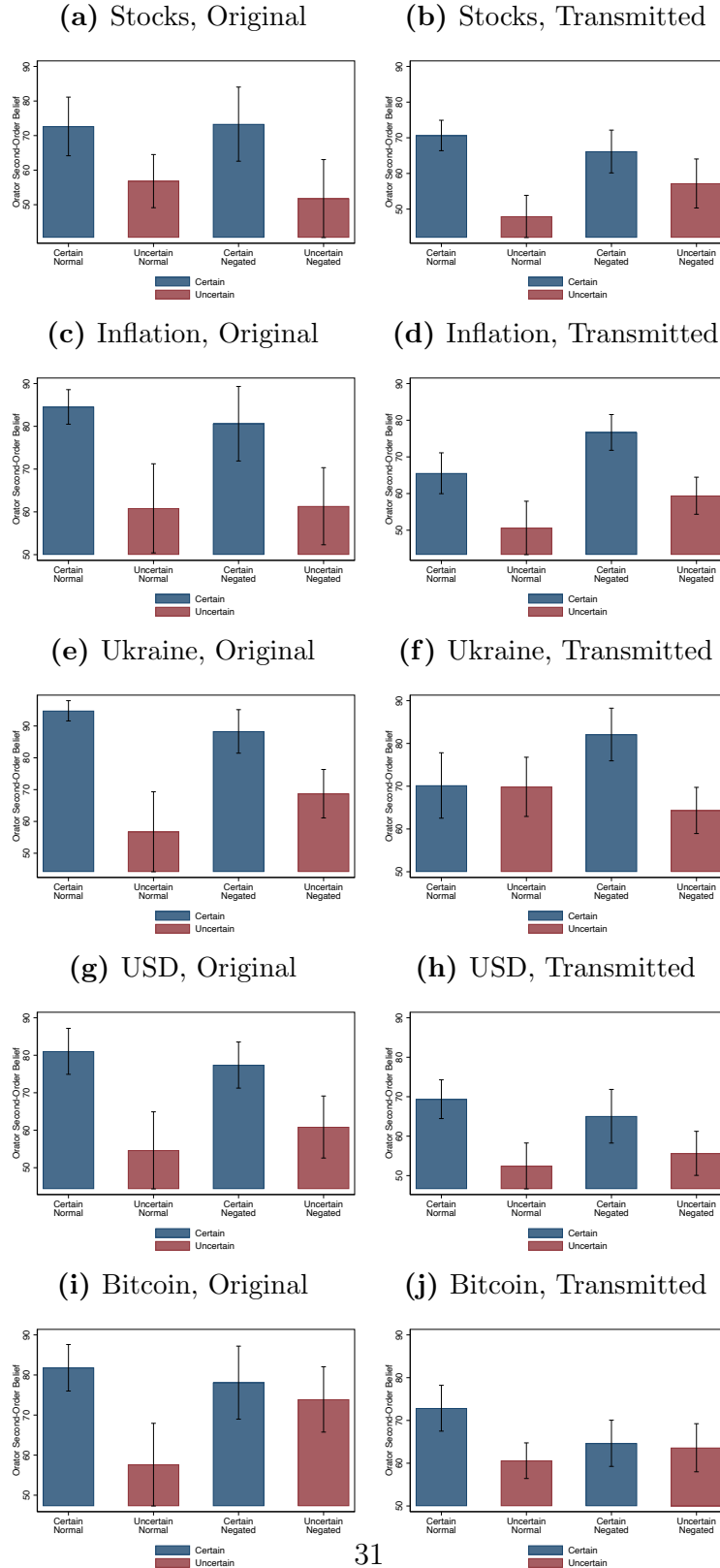
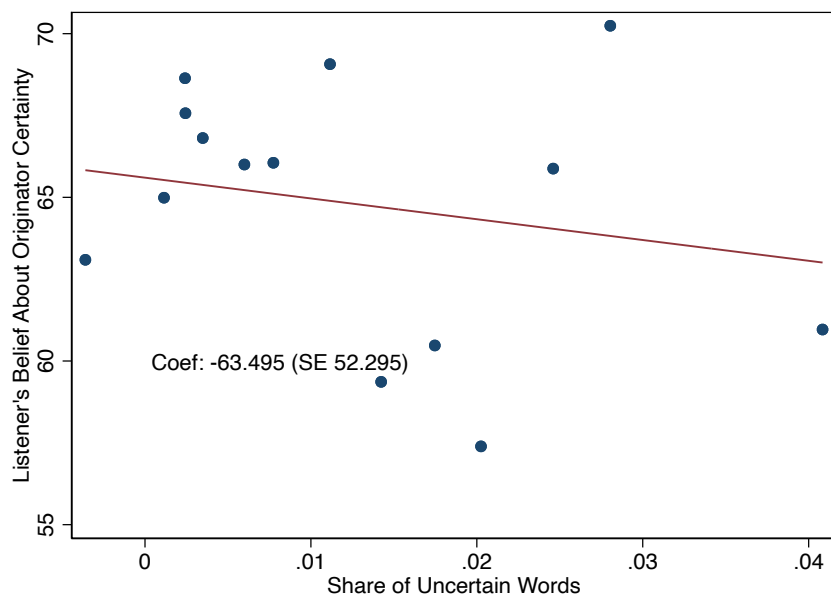


Figure A.5: Share of Uncertain or Certain Words in Transcript Predicts Listener's Belief About Originator Certainty

(a) Certainty Belief on Uncertain Word Share



(b) Certainty Belief on Certain Word Share

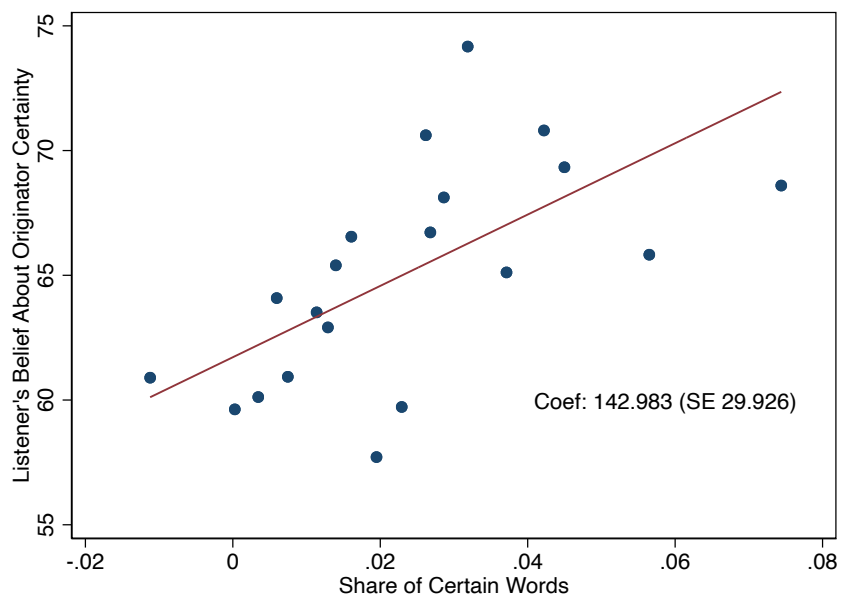


Table A.1: Listener Experiment: Beliefs about the Originator's Confidence, by Transmitter Education

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------------------------------------------------|----------------------|-----------------------|---------------------|--------------------|---------------------|-------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -9.973*** (2.088) | -20.865*** (4.048) | -9.675* (4.441) | -3.886 (5.620) | -11.390* (4.514) | -6.639 (3.766) |
| Uncertain \times College Degree | -3.200 (2.794) | 7.892 (5.929) | -12.659* (5.764) | -6.740 (7.110) | -4.469 (5.936) | 0.397 (5.471) |
| College Degree | 2.674 (2.480) | -5.647 (4.140) | 8.549 (4.963) | 15.524* (6.587) | -2.129 (4.687) | -2.284 (4.849) |
| Negated | 2.421 (2.086) | 3.249 (3.875) | 12.107** (4.568) | 3.750 (5.223) | -2.067 (4.565) | -4.953 (3.869) |
| Negated \times College Degree | -1.059 (2.796) | -2.472 (5.943) | -4.779 (5.887) | -4.710 (6.751) | 3.916 (6.005) | 4.112 (5.541) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.2: Listener Experiment: Beliefs about the Orator's Confidence, by Transmitter IQ

| | (1) | (2) | (3) | (4) | (5) | (6) |
|----------------------------------------------------|-----------------------|-----------------------|-----------------------|-------------------|---------------------|----------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -10.984*** (1.702) | -16.444*** (3.405) | -12.319*** (3.409) | -6.580 (4.525) | -9.310* (3.754) | -10.000** (3.353) |
| Uncertain \times Above Med: IQ | -2.074 (2.870) | -9.122 (6.682) | -15.671** (5.844) | -3.611 (6.921) | -11.701 (6.759) | 9.692 (5.427) |
| Above Med: IQ | 1.258 (2.301) | -8.114 (4.387) | -0.149 (6.009) | 10.998 (5.981) | 12.492** (4.283) | -5.919 (4.935) |
| Negated | 2.481 (1.679) | 0.717 (3.607) | 10.084** (3.382) | 1.871 (4.219) | 3.891 (3.678) | -4.278 (3.460) |
| Negated \times Above Med: IQ | -1.469 (2.987) | 4.888 (6.313) | 7.989 (6.477) | -5.424 (7.077) | -11.921 (6.217) | 3.745 (5.368) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Listener Experiment: Beliefs about the Orator's Confidence, by Transmitter's Confidence in Their Transmission

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------------------------------------|-----------------------|---------------------|-----------------------|---------------------|-----------------------|-------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -11.009*** (1.924) | -8.331 (4.408) | -18.109*** (4.166) | -8.882 (5.223) | -20.636*** (3.989) | -3.928 (3.958) |
| Uncertain \times Above Med: Orator Confidence | -1.128 (2.822) | -14.481* (5.990) | 5.492 (5.785) | 3.491 (7.314) | 11.587 (6.129) | -5.013 (5.473) |
| Above Med: Orator Confidence | -1.401 (2.378) | 7.082 (4.046) | 0.017 (4.965) | -13.919* (6.609) | -6.211 (4.536) | 1.969 (4.861) |
| Negated | -1.808 (1.962) | -5.302 (4.615) | 7.473 (4.220) | -6.745 (4.898) | -5.867 (4.065) | -1.776 (3.980) |
| Negated \times Above Med: Orator Confidence | 7.508** (2.719) | 9.810 (6.185) | 4.770 (5.852) | 17.746* (6.931) | 7.504 (6.203) | -1.545 (5.519) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.4: Listener Experiment: Beliefs about the Orator's Confidence, by Transmitter's Disfluency

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------------------------------------|----------------------|-----------------------|-----------------------|--------------------|---------------------|----------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -9.546*** (1.974) | -19.258*** (4.391) | -16.086*** (3.839) | -1.779 (5.774) | -9.139* (4.117) | -4.390 (3.695) |
| Uncertain \times Above Med: Orator Disfluency | -4.286 (2.742) | 5.029 (5.859) | 0.751 (5.780) | -12.740 (7.390) | -7.803 (5.938) | -0.578 (5.344) |
| Above Med: Orator Disfluency | 2.678 (2.329) | -8.214* (4.041) | 4.861 (5.099) | 13.893* (6.744) | 11.040* (4.658) | -1.732 (4.985) |
| Negated | 2.379 (1.900) | -4.479 (4.536) | 16.201*** (4.238) | 8.088 (4.896) | 6.722 (4.065) | -10.285** (3.921) |
| Negated \times Above Med: Orator Disfluency | -1.069 (2.757) | 13.386* (5.981) | -12.714* (6.095) | -13.645 (7.084) | -13.599* (6.016) | 14.021* (5.594) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.5: Listener Experiment: Beliefs about the Orator's Confidence, by Listener's Ease of Following

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------------------------------------|----------------------|----------------------|-----------------------|--------------------|----------------------|---------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Uncertain | -7.970*** (1.900) | -12.734** (4.016) | -14.365*** (4.107) | -2.984 (5.675) | -11.800** (3.892) | -1.075 (3.529) |
| Uncertain \times Above Med: Ease of Following | -7.457** (2.663) | -8.134 (5.567) | -3.660 (5.681) | -8.215 (7.297) | -5.070 (5.828) | -12.179* (5.172) |
| Above Med: Ease of Following | 13.977*** (2.252) | 20.254*** (3.783) | 11.808* (4.812) | 4.438 (6.991) | 14.682** (4.473) | 13.443** (4.565) |
| Negated | 0.790 (2.004) | 1.353 (4.124) | 10.121* (4.141) | -6.416 (5.417) | 0.721 (3.917) | -3.934 (3.579) |
| Negated \times Above Med: Ease of Following | 3.621 (2.563) | 2.592 (5.599) | -1.831 (5.803) | 15.113* (6.832) | 0.843 (5.959) | 4.018 (5.195) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.6: Listener Experiment: Beliefs about the Orator's First-Order Beliefs, by Listener's Ease of Following

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------------------------------------|----------------------|-----------------------|---------------------|----------------------|--------------------|-----------------------|
| | Pooled | Stocks | Inflation | Ukraine | USD | Bitcoin |
| Negated | -0.832*** (0.065) | -17.975*** (2.293) | 2.386*** (0.660) | 35.596*** (5.045) | 0.101** (0.035) | -46.095*** (5.043) |
| Negated \times Above Med: Ease of Following | -0.434*** (0.085) | -7.590* (3.219) | 0.470 (0.774) | 22.657*** (6.058) | 0.098* (0.047) | -22.562** (6.950) |
| Above Med: Ease of Following | 0.177** (0.068) | 0.334 (2.094) | -0.527 (0.599) | -10.694 (5.443) | -0.024 (0.042) | 12.354* (5.650) |
| Uncertain | -0.050 (0.071) | -5.592* (2.217) | 0.514 (0.662) | -14.055** (5.117) | 0.019 (0.035) | -1.548 (5.047) |
| Uncertain \times Above Med: Ease of Following | 0.058 (0.089) | 2.606 (3.079) | -0.335 (0.778) | 6.661 (6.196) | -0.067 (0.047) | -6.839 (6.893) |
| Nb. obs | 1,566 | 316 | 313 | 306 | 312 | 319 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C Experimental Instructions

C.1 Transmission Experiment

Inflation When you click onto the next page, a recording will start playing automatically. This recording expresses beliefs about the outlook for inflation in 2023.

Your payment is determined by how accurately the receiver of your voice message guesses (i) how the person in the recording played to you thinks inflation will develop in 2023 and (ii) how confident that person is about their prediction.

After the recording finishes playing, you will have to answer two questions. You will then be taken to another page where a recording of you will start automatically and you will have to start talking. Include as much information and detail as possible from the article you just heard. You'll click "Stop Recording" when you finish talking. You can only record yourself once.

PAGEBREAK

[page with 2 raven matrices]

PAGEBREAK

When you click onto the next page, a recording of you will start automatically and you will have to start talking. Include as much information and detail as possible from the article you just heard. You'll click "Stop Recording" when you finish talking. You can only record yourself once.

PAGEBREAK

[page with recording]

PAGEBREAK

Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person estimates the inflation rate in 2023 will be?

For context, the inflation rate in 2022 was 9.1%.

PAGEBREAK

How certain do you think this person is about their inflation estimate?

More specifically, what do you think this person believes is the percentage chance that inflation in 2023 will be between $X-2\%$ and $X+2\%$? [X is the guess about the person's estimate of the inflation rate in 2023].

C.2 Predictions instructions for other domains

Stock market Think about the beliefs of the person who wrote the opinion piece you just heard.

By what percent do you think this person believes the S&P 500 index will change in 2023? Use positive numbers to indicate growth in stock prices and negative numbers to indicate falls in stock prices.

For context, historically, annual changes in the S&P 500 are usually between -30% and 30%.

PAGEBREAK

How certain do you think this person is about their S&P 500 estimate?

More specifically, what do you think this person believes is the percentage chance that the change in the stock market in 2023 will be between $X - 5\%$ and $X + 5\%$?

Ukraine War Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person believes is the percent chance that the war in Ukraine will end in 2023? Your answer should be a number between 0% and 100%.

PAGEBREAK

How certain do you think this person is about the probability that the war in Ukraine will end?

More specifically, what do you think this person believes is the percentage chance that the probability of the war in Ukraine ending in 2023 is between $X - 5\%$ and $X + 5\%$?

Euro-Dollar Exchange Rate Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person believes the exchange rate between the Euro and US Dollar will be at the end of 2023?

For context, in December 2022 the exchange rate was 1.05, meaning 1 Euro bought 1.05 US Dollars. Over the past 20 years, the exchange rate has varied between 0.85 and 1.60. Values below 1 mean the Euro is weaker than the US Dollar, while values above 1 mean it is stronger.

PAGEBREAK

How certain do you think this person is about the exchange rate between the Euro and US Dollar at the end of 2023?

More specifically, what do you think this person believes is the percentage chance that the exchange rate at the end of 2023 will be between $X-0.05$ and $X+0.05$?

Bitcoin Think about the beliefs of the person who wrote the opinion piece you just heard.

By what percent do you think this person believes the price of Bitcoin will change in 2023? Use positive numbers to indicate growth in Bitcoin prices and negative numbers to indicate falls in Bitcoin prices.

For context, historically, annual changes in the price of Bitcoin are usually between -70% and 70%.

PAGEBREAK

How certain do you think this person is about the change in the price of Bitcoin at the end of 2023?

More specifically, what do you think this person believes is the percentage chance that the change in the price of Bitcoin in 2023 will be between $X-10\%$ and $X+10\%$?

[Slider from 0% (not at all certain) to 100% (fully certain)]

C.3 Listener Experiment

On the next page, a recording will start playing automatically. The recording is an opinion piece or a summary of an opinion piece about the outlook for inflation in 2023.

Please pay close attention to the recording.

You will be asked some questions about the recording. Your payment is determined by how accurately you answer the questions.

[Respondents then listen to a recording about inflation]

Inflation Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person estimates the inflation rate in 2023 will be?

For context, the inflation rate in 2022 was 9.1%.

PAGEBREAK

How certain do you think this person is about their inflation estimate?

More specifically, what do you think this person believes is the percentage chance that inflation in 2023 will be between $X-2\%$ and $X+2\%$? [X is the guess about the person's estimate of the inflation rate in 2023].

C.3.1 Instructions for other prediction questions

Stock market Think about the beliefs of the person who wrote the opinion piece you just heard.

By what percent do you think this person believes the S&P 500 index will change in 2023?
Use positive numbers to indicate growth in stock prices and negative numbers to indicate falls in stock prices.

For context, historically, annual changes in the S&P 500 are usually between -30% and 30%.

PAGEBREAK

How certain do you think this person is about their S&P 500 estimate?

More specifically, what do you think this person believes is the percentage chance that the change in the stock market in 2023 will be between $X - 5\%$ and $X + 5\%$?

Ukraine War Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person believes is the percent chance that the war in Ukraine will end in 2023? Your answer should be a number between 0% and 100%.

PAGEBREAK

How certain do you think this person is about the probability that the war in Ukraine will end?

More specifically, what do you think this person believes is the percentage chance that the probability of the war in Ukraine ending in 2023 is between $X - 5\%$ and $X + 5\%$?

Euro-Dollar Exchange Rate Think about the beliefs of the person who wrote the opinion piece you just heard.

What do you think this person believes the exchange rate between the Euro and US Dollar will be at the end of 2023?

For context, in December 2022 the exchange rate was 1.05, meaning 1 Euro bought 1.05 US Dollars. Over the past 20 years, the exchange rate has varied between 0.85 and 1.60. Values below 1 mean the Euro is weaker than the US Dollar, while values above 1 mean it is stronger.

PAGEBREAK

How certain do you think this person is about the exchange rate between the Euro and US Dollar at the end of 2023?

More specifically, what do you think this person believes is the percentage chance that the exchange rate at the end of 2023 will be between $X-0.05$ and $X+0.05$?

Bitcoin Think about the beliefs of the person who wrote the opinion piece you just heard.

By what percent do you think this person believes the price of Bitcoin will change in 2023? Use positive numbers to indicate growth in Bitcoin prices and negative numbers to indicate falls in Bitcoin prices.

For context, historically, annual changes in the price of Bitcoin are usually between -70% and 70%.

PAGEBREAK

How certain do you think this person is about the change in the price of Bitcoin at the end of 2023?

More specifically, what do you think this person believes is the percentage chance that the

change in the price of Bitcoin in 2023 will be between $X-10\%$ and $X+10\%$?

[Slider from 0% (not at all certain) to 100% (fully certain)]

D Scripts for original recordings: Transmission Experiment

Stocks

Stocks 1: Increase + certain

After a catastrophic year for investors in 2022, the stock market will strongly rebound in 2023 and we will see large growth in the S&P 500 Index. There are a few reasons why this substantial rebound will definitely happen. First, stock markets always strongly rebound after bad years. In the long run, stock markets inevitably trend upwards, so temporary deviations from trend are always quickly reversed. Second, recent statistics confirm that inflation will undoubtedly continue to drastically decline throughout 2023, in which case the Federal Reserve can ease off on its interest rate increases. Early data show inflation quickly dropping as business expectations adjust and the temporary shocks of 2020-2022 subside. This means the Federal Reserve can stop raising interest rates and businesses can continue to access cheap loans to finance expansions, which helps the stock market. Third, supply chain difficulties caused by Covid and the war in Ukraine will certainly begin to resolve themselves. This will significantly boost business activity and stock prices. Fourth, investor confidence, which took a beating in 2022, will recover as a recession fails to materialize. The combination of these factors will definitely create a major boom in stock prices this year.

Stocks 2: Increase + uncertain

The year 2022 was catastrophic for investors, but it's possible that the stock market could strongly rebound in 2023, leading to potential substantial growth in the S&P 500 Index. Some experts suggest that stock markets tend to strongly rebound after poor years. While this may be true in the long run, it's difficult to predict short-term market trends with certainty. Recent statistics also suggest that inflation could drastically decline throughout 2023, which could lead to a reduction in interest rate increases from the Federal Reserve,

driving strong increases in business activity. However, it's difficult to say whether this trend will continue, as the economy is complex and unpredictable. Additionally, while supply chain difficulties caused by Covid and the war in Ukraine might start to resolve themselves, it's uncertain how quickly this will happen and to what extent it will improve stock market performance. Lastly, investor confidence is a critical factor in the stock market's performance, and while it may recover in 2023, it's impossible to predict with certainty. Ultimately, a combination of these and other factors may strongly improve the stock market's performance in 2023, but it's difficult to make definitive predictions about short-term market trends.

Stocks 3: Decrease + certain

Despite a difficult year for investors in 2022, the stock market will face significant challenges in 2023 and we will certainly see further significant declines in the S&P 500 Index. There are a few reasons why this will clearly happen. First, stock markets do not typically strongly rebound after bad years, and there is no evidence that last year's downward trend will be quickly reversed. Second, recent statistics confirm that inflation will continue to rise throughout 2023, which means the Federal Reserve will need to increase interest rates further to keep prices under control. This will make it more difficult for businesses to access affordable loans to finance expansions, negatively impacting the stock market. Third, supply chain difficulties caused by Covid and the war in Ukraine will certainly persist throughout 2023, which will impede business activity and put downward pressure on stock prices. Fourth, investor confidence, which took a beating in 2022, will continue to decline as the global economic downturn persists. The combination of these factors will definitely create a challenging environment for the stock market this year.

Stocks 4: Decrease + uncertain

The year 2022 was difficult for investors, and it is possible that the stock market will face significant challenges in 2023, perhaps leading to further significant declines in the S&P 500 Index. There are several reasons why this could happen, though it is worth noting

that stock prices are very hard to forecast. First, historical trends show that stock markets do not always rebound strongly after a bad year, and it is uncertain whether last year's downward trend will be quickly reversed. Second, recent statistics suggest that inflation may continue to rise throughout 2023, which might prompt the Federal Reserve to maintain or even increase interest rates to manage prices. This could make it more difficult for businesses to access affordable loans to finance expansions, potentially impacting the stock market. Early data also indicate businesses could continue to struggle with supply chain difficulties and pandemic-related disruptions. This might impede business activity and put downward pressure on stock prices. Fourth, investor confidence, which was negatively affected in 2022, might continue to decline due to global economic uncertainty. The combination of these factors may create a challenging environment for the stock market this year, but it is highly uncertain how significant the impact will be.

Inflation

Inflation 1: Decrease + certain

Painfully high inflation throughout 2022 substantially eroded consumers' purchasing power. Luckily, the rate of inflation will certainly slow substantially in 2023, giving consumers much-needed relief. Economists say that inflation will undoubtedly slow strongly in 2023 for several reasons. First, the Federal Reserve is predicted to continue raising interest rates throughout 2023. Interest rate increases are a crucial tool for containing inflation: when interest rates go up, businesses and consumers always spend and invest much less, which slows down economic activity and hence strongly reduces inflationary pressures. This is an extremely reliable dynamic, so the Fed's continued hikes will certainly reduce inflation. Second, recent statistics paint an encouraging picture: inflation in recent months has been much lower than the 2022 average. Economists believe recent inflation trends definitively provide a very confident signal about inflation through the rest of this year. Third, consumer and business expectations will adjust as panic over inflation decreases. When people expect inflation, this becomes a self-fulfilling prophecy; so as people stop expecting inflation, inflation will actually decrease. These facts therefore bode well for the rest of 2023, heralding a world of certainly much lower inflation.

Inflation 2: Decrease + uncertain

Painfully high inflation throughout 2022 substantially eroded consumers' purchasing power. However, there are indications that inflation could slow down in 2023, providing some relief to consumers. Economists suggest that there are several factors that might possibly contribute to the reduction in inflation. For instance, the Federal Reserve is expected to continue raising interest rates throughout the year, which could help contain inflation. Interest rate increases have historically slowed down economic activity and reduced inflationary pressures, though they are not guaranteed to work at reducing inflation. Additionally, recent statistics indicate that inflation has been lower in recent months than the 2022 average, which could

be an encouraging sign for the rest of the year, though there is substantial uncertainty about the reliability of this data. Moreover, it's unclear if these trends are reliable indicators of what will happen in the future. Finally, consumer and business expectations could also play a role in inflation. As panic over inflation decreases, people may stop expecting inflation, which could contribute to a decrease in inflation. However, it's uncertain how quickly or significantly expectations will adjust, as there exists no comparable historical data on these issues. Therefore, while these factors may suggest a lower inflation rate for the rest of 2023, it's impossible to predict with certainty what will happen.

Inflation 3: Increase + certain

Painfully high inflation throughout 2022 substantially eroded consumers' purchasing power. Unfortunately, the rate of inflation will certainly increase in 2023, withholding much-needed relief from consumers. Economists point to several factors confirming even higher inflation through 2023. First, they point to evidence that the Federal Reserve will soon pause its interest rate hikes. Interest rate increases are a crucial tool for containing inflation, so when they are paused, inflation will definitely accelerate again. Additionally, recent statistics confirm that inflation in recent months has been close to or even higher than the average in 2022, which is very concerning given that economists confidently believe recent inflation trends provide a definitive signal about inflation throughout the rest of this year. Moreover, consumers and businesses continue to expect high inflation. Expectations of inflation lead to a self-fulfilling prophecy, so these expectations will lead to cycles of further inflation. The combination of these facts bodes badly for the rest of 2023, heralding a world of certainly much higher inflation.

Inflation 4: Increase + uncertain

Painfully high inflation throughout 2022 substantially eroded consumers' purchasing power. Unfortunately, it seems like inflation might increase significantly in 2023, though inflation is very hard to forecast. Economists suggest that the Federal Reserve may soon pause its

interest rate hikes. Interest rate increases are often considered a crucial tool for containing inflation, so if they are paused, inflation might increase again. Additionally, recent statistics appear to indicate that inflation in recent months has been close to or even higher than the average in 2022, a concerning sign given that recent inflation is probably mildly predictive of future inflation. However, it is important to note that inflation trends can and often do deviate significantly from recent trends. Moreover, it is not clear to what extent consumer and business expectations will adjust over the next year. People's expectations can have a significant impact on inflation, and currently people expect very high inflation. High inflation expectations could be a self-fulfilling prophecy, though it is difficult to predict how and when expectations will change. Overall, there are indications that inflation will increase significantly throughout 2023, but there is no certainty in these assessments.

Ukraine

Ukraine 1: Low + certain

The war in Ukraine is extremely unlikely to end in 2023. The leaders of both countries are refusing to back down: Putin maintains his goal of conquering Ukraine and toppling its government, while Zelensky aims to regain all of the Ukrainian territory annexed by the Russians. As long as both leaders stick to these goals, it is impossible for the conflict to come to a negotiated solution. Neither leader is likely to be replaced anytime soon; Zelensky remains overwhelmingly popular among the Ukrainian public, and Putin faces no serious threats to his dictatorial rule, as his crowd of oligarchs remain loyal to him. Finally, both countries have the supplies to maintain an extended engagement. Ukraine can certainly rely on a continuous supply of weaponry and vehicles from Western democracies, while foreign fighters flock to its cause. Russia, meanwhile, is a huge country that has engaged in a massive mobilization effort to conscript soldiers and resources for the war. Neither side is going to run out of fighting material anytime soon, meaning there is no pressure to end the war quickly. Overall, this demonstrates that the war in Ukraine will certainly not end in 2023.

Ukraine 2: Low + uncertain

The war in Ukraine may be unlikely to end in 2023, though the situation remains highly uncertain and therefore mostly unpredictable. Both countries' leaders appear to be committed to their positions: Putin seeks to annex Ukraine and overthrow its government, while Zelensky aims to regain all of Ukraine's territory. This could make it difficult to reach a negotiated settlement. It seems unlikely that either leader will be replaced in the near future, with Zelensky still enjoying strong support among the Ukrainian public, and Putin's grip on power appearing firm. Additionally, as far as international observers can tell, both sides have ample supplies to continue the fight. Ukraine can count on a steady stream of weapons and vehicles from Western democracies, and has attracted foreign fighters to its

cause. That said, it is possible that foreign aid to Ukraine will dry up if isolationist leaders begin to win elections in Western democracies. Meanwhile, Russia has mobilized significant resources and conscripted soldiers to support its efforts, though its conscription efforts have faced resistance and it is unclear how much Russia has left to draw on. With neither side appearing to face immediate shortages of military materials, there may be little incentive to end the conflict quickly. This suggests that the war in Ukraine might potentially extend beyond 2023.

Ukraine 3: High + certain

The war in Ukraine is extremely likely to end in 2023. The leaders of both countries are beginning to relax their goals, with Putin backing off from the ambition of full control of Ukraine and Zelensky conceding that regaining all annexed Ukrainian territory is unrealistic. This relaxation of goals means a negotiated solution will be able to happen. Moreover, Putin's dictatorial rule will continue to be threatened by both internal and external factors, either resulting in his deposition and the immediate end of the war, or causing him to change his approach to avoid becoming even more unpopular. Additionally, the ongoing engagement in the war will soon become unsustainable for both sides, as their supplies of weaponry and resources dwindle over time. Western democracies will become reluctant to continue supplying Ukraine with weapons and vehicles, while foreign fighters who were previously flocking to Ukraine have already lost interest in the conflict. Meanwhile, Russia's mobilization effort has become too costly to sustain and is dropping off quickly. Both sides will soon face shortages of military materials, forcing the conflict to its conclusion. Ultimately, the war in Ukraine will certainly end within the next year.

Ukraine 4: High + uncertain

The war in Ukraine may be likely to end in 2023, though the situation remains highly uncertain and mostly unpredictable. The leaders of both countries may be showing some willingness to compromise, with Putin appearing to back off from his former ambition of full

control of Ukraine, and Zelensky possibly conceding that regaining all annexed Ukrainian territory is unrealistic. This willingness to compromise may translate into a negotiated solution to the war, though it is unclear whether both leaders will be able to overcome the deep-seated political and territorial divisions that have fueled the conflict. Putin's grip on power may also continue to be challenged, leading to the end of the war, but predicting the timing and outcome of any potential political upheaval is difficult. Similarly, while both sides seem to face imminent resource constraints that will cause them to run out of soldiers and weapons, it is uncertain when or how these shortages will impact the war effort, and there may be unforeseen factors that could mitigate or exacerbate these challenges. While it is therefore very likely that the war will come to an end in the near future, the complex and dynamic nature of the conflict means that any predictions about its resolution must be considered tentative and subject to change.

USD/EUR Exchange Rate

USD/EUR Exchange Rate 1: Decrease + certain

In 2022, the Euro reached historic lows relative to the US Dollar. In the mid-2000s, one Euro bought about one and a half US dollars. In 2022, the currencies reached parity: one Euro bought only one US dollar. This decline in the relative value of the Euro will certainly continue and even accelerate in 2023, due to many factors. The war in Ukraine has disrupted energy supplies to most European countries, which previously relied on pipelines of gas from Russia. This huge blow to energy supply substantially raises operating costs for European businesses and impoverishes European consumers, making Europe a less attractive location for investment and strongly reducing demand for the Euro. Meanwhile, US energy supplies have remained unaffected. Moreover, the American Federal Reserve has acted much more aggressively than the European Central Bank in raising interest rates to tame inflation. Persistently higher inflation in Europe will also sharply reduce demand for the Euro, while demand for the US dollar remains highly robust. Finally, the European Union is deeply divided politically. Brexit and the rise of anti-EU populist leaders in many countries threaten to break up the union, which would also destroy the free movement of people and capital that are so essential to the economic success of Europe. The combination of these factors will certainly continue to make Europe less profitable for investors than the US, which will strongly exacerbate the decline of the Euro relative to the US dollar.

USD/EUR Exchange Rate 2: Decrease + Uncertain

In 2022, the Euro reached historic lows relative to the US Dollar. In the mid-2000s, one Euro bought about one and a half US dollars. In 2022, the currencies reached parity: one Euro bought only one US dollar. This decline in the relative value of the Euro may possibly continue and even accelerate in 2023, due to many factors. However, predicting the future value of a currency is inherently uncertain, and various mechanisms may impact the exchange rates in unpredictable ways. The war in Ukraine has disrupted energy supplies to

most European countries that previously relied on pipelines of gas from Russia. This has raised concerns about increases in the operating costs of European businesses and decreases in the purchasing power of European consumers, which may translate into a reduced demand for the Euro, though it is unclear to what extent this will happen. Similarly, the American Federal Reserve has acted more aggressively than the European Central Bank in raising interest rates to tame inflation. This may reduce demand for the Euro, though it is unclear how this will affect the demand for the Euro in the long run, or how persistently higher inflation in Europe might impact the Euro's value relative to the US dollar. Moreover, the European Union is politically divided and faces various challenges, such as Brexit and the rise of anti-EU populist leaders in many countries. While these developments may create uncertainty and risk for investors, it is unclear how likely it is that the European Union will experience significant political disruption. Therefore, while it is possible that the decline of the Euro relative to the US dollar will continue in 2023, it is important to acknowledge the inherent uncertainty of such predictions and the complexity of the various factors that may affect currency exchange rates.

USD/EUR 3: Increase + certain

In 2022, the Euro reached historic lows relative to the US Dollar. In the mid-2000s, one Euro bought about one and a half US dollars. In 2022, the currencies reached parity: one Euro bought only one US dollar. However, in 2023, the decline in the relative value of the Euro will certainly reverse and the relative value of the Euro will strongly increase, due to many factors. Disruptions to European energy supplies from the war in Ukraine are easing as Europe finds alternative sources of cheap energy. Cheaper energy will lower operating costs for European businesses and enrich European consumers, making Europe a more attractive location for investment and increasing demand for the Euro. Meanwhile, US energy supplies will be threatened by continued political instability in key producing regions and by climate change. Moreover, the European Central Bank has begun catching up to the American Federal Reserve in raising interest rates to tame inflation. This will

reduce European inflation relative to the US and increase demand for the Euro. Finally, the European Union is politically robust. The disaster of Brexit and the electoral defeats of anti-EU populist leaders in many countries show that the union is stronger than ever. The free movement of people and capital that are so essential to the economic success of Europe are therefore highly robust, in contrast to political divisions in the US. The combination of these factors will certainly strongly reverse the decline of the Euro relative to the US dollar in the coming year.

USD/EUR 4: Increase + Uncertain

In 2022, the Euro reached historic lows relative to the US Dollar. In the mid-2000s, one Euro bought about one and a half US dollars. In 2022, the currencies reached parity: one Euro bought only one US dollar. Looking forward, in 2023, the decline in the relative value of the Euro might reverse due to various factors, potentially causing its relative value to strongly increase. However, predicting the future value of a currency is inherently uncertain, and various mechanisms may impact the exchange rates in unpredictable ways. Disruptions to European energy supplies from the war in Ukraine seem to be easing as Europe searches for alternative sources of energy. Cheaper energy could potentially lower operating costs for European businesses and enrich European consumers, which could make Europe a more attractive location for investment and increase demand for the Euro. In contrast, US energy supplies might be vulnerable to political instability in critical producing regions or climate change. Additionally, the European Central Bank appears to have started catching up to the American Federal Reserve in raising interest rates to curb inflation. This could reduce European inflation relative to the US and increase demand for the Euro. Finally, the European Union appears to be politically robust, as the disaster of Brexit and the electoral defeats of anti-EU populist leaders in many countries indicate political strength. The free movement of people and capital that are crucial to the economic success of Europe appears stable, in contrast to political divisions in the US. The combination of these factors may potentially reverse the decline of the Euro relative to the US dollar in the coming year, but

the outcome is highly uncertain.

Bitcoin

Bitcoin 1: Increase + certain

The price of Bitcoin fell by more than 50% across 2022, thanks to the TerraLuna collapse in June and the FTX crisis in November. However, the price of Bitcoin will definitely bounce back strongly in 2023 as consumer and investor confidence recovers and money flows back into the crypto ecosystem. The 2022 crashes purged out unstable and fragile crypto companies, meaning the companies that remain all have robust business plans. These companies provide a solid base from which to rebuild. Recent events have also made the value of crypto clearer. Rampant inflation, and central bankers' manipulation of interest rates, have made the unpredictability and instability of paper currencies all too clear, raising demand for cryptocurrencies that are immune to centralized control. Finally, in the long run, bitcoin prices have been trending strongly upwards over the last 10 years despite temporary fluctuations upwards or downwards. This is a clear signal that the fundamental value of bitcoin is growing over time and becoming more highly recognized, a trend that will continue in the future. Occasional disturbances like TerraLuna or FTX will change short-run prices but don't interfere with the baseline trend, which will reassert itself in 2023. Overall, this means the price of Bitcoin will certainly recover strongly in 2023.

Bitcoin 2: Increase + uncertain

The price of Bitcoin fell by more than 50% across 2022, thanks to the TerraLuna collapse in June and the FTX crisis in November. It is possible that the price of Bitcoin will rebound in 2023 as consumer and investor confidence potentially improves, and money flows back into the crypto ecosystem. It is worth noting that the 2022 crashes may have helped to eliminate some of the unstable and fragile crypto companies, which could potentially leave behind more resilient companies with strong business plans. Recent events have highlighted the potential benefits of cryptocurrencies, as paper currencies may be vulnerable to inflation and central bankers' manipulation of interest rates. While bitcoin prices have exhibited strong upward

trends over the last 10 years, there have also been temporary fluctuations that may have contributed to price changes. Therefore, while it seems that the fundamental value of bitcoin will continue to increase over time, it is possible that short-term disturbances like TerraLuna or FTX could have a more significant impact. Overall, it seems like the price of Bitcoin will strongly recover in 2023 but there is plenty of uncertainty.

Bitcoin 3: Decrease + certain

The price of Bitcoin fell by more than 50% across 2022, thanks to the TerraLuna collapse in June and the FTX crisis in November. The price of Bitcoin will definitely decrease further in 2023 as consumer and investor confidence remains low, and money continues to flow away from the crypto ecosystem. The 2022 crashes revealed the instability and fragility of crypto companies, and many unstable companies certainly remain in the ecosystem. Recent events have highlighted that both paper currencies and cryptocurrencies are vulnerable to inflation and central bankers' manipulation of interest rates, dispelling one of the major arguments in favor of crypto. This will definitely cause confidence in bitcoin to plummet further. While bitcoin prices have exhibited upward trends over part of the last 10 years, there have also been fluctuations that have contributed to persistent price declines. Therefore, the fundamental value of Bitcoin does not trend upwards over time, and short-term disturbances like FTX and TerraLuna have long-run negative impacts. Overall, the price of Bitcoin will certainly decline further in 2023.

Bitcoin 4: Decrease +uncertain

The price of Bitcoin fell by more than 50% across 2022, thanks to the TerraLuna collapse in June and the FTX crisis in November. It seems like the price of Bitcoin will potentially fall further in 2023 as consumer and investor confidence probably remains low, and it is unclear if money will flow back into the crypto ecosystem. The 2022 crashes might have revealed the considerable fragility and instability of crypto companies, and there may still be many unstable companies within the ecosystem. Recent events have suggested that both paper

currencies and cryptocurrencies are probably susceptible to inflation and central bankers' manipulation of interest rates, which challenges one of the major arguments in favor of crypto. While bitcoin prices have demonstrated strong upward trends over the last decade, there have also been temporary fluctuations that have contributed to persistent price declines. Hence, it appears that the fundamental value of Bitcoin does not consistently trend upwards over time, and short-term disruptions like FTX and TerraLuna may have long-term negative effects. Overall, it seems like the price of Bitcoin will further decline in 2023 but there is plenty of uncertainty.