A Gamble of Life and Death: Ambiguity Aversion, Risk Preferences, and Parental Influenza Vaccination Decisions in Rural America

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May 13, 2022

Acknowledgements: We acknowledge generous funding from the Mountain West NIH-CTRIN. We also thank research assistants including Madelyn Lundblad, Stephen Frimpong, and Kendall Cogley-Huntington.

Disclaimer: The findings and conclusions in this publication are those of the authors and should not be construed to represent any official Federal Reserve Board of Governors, USDA or U.S. Government determination or policy. The research was conducted prior to Mr. Marchal's work with the Federal Reserve and Dr. Ehmke's work with USDA-ERS.

Abstract

Vaccine hesitancy in rural communities contributes to outbreaks of vaccine preventable diseases like influenza, burdening healthcare systems with hospitalizations and deaths. Research in metropolitan areas has shown that parents who mistrust the healthcare system perceive uncertainty on information related to vaccine efficacy and risks (i.e. side effects), leading to a decline in vaccine uptake. Our research objective is to test the role of parents' economic risk preferences and vaccine information ambiguity in their decision to forego influenza vaccinations for their children and themselves. We collected data using a lab-in-field economic experiment to measure parents' constant relative risk aversion coefficient (CRRA) and a survey to obtain data on their vaccine beliefs, practices, and information sources. The data were then analyzed using a logit model regression to test the role of economic risk preferences and vaccine information ambiguity in their influenza vaccination decisions. We control for trust in the healthcare system, community characteristics, and personal demographic information in the model estimation. We find parents' influenza vaccination decisions are significantly dependent on their ambiguity aversion, but not their risk aversion CRRA measurements. Parents who perceive greater uncertainty in vaccines risks relative to the risks of diseases tend to vaccinate their children for the flu at lower rates. This relationship exists after controlling for trust in the healthcare system, suggesting that policies addressing the perceived ambiguity in the vaccination decision independent of healthcare trust may be most effective to reduce hesitancy.

***Keywords**:* Vaccination, Influenza, Ambiguity, Risk, Economic experiment, Children

JEL Codes: D11 • D81 • I12

Statements and Declarations:

1 Introduction

In 2019, vaccine hesitancy made the WHO's list of top ten threats to global health (World Health Organization, 2019). Vaccine hesitancy has played a significant role in suppressing vaccination rates, leading to outbreaks of vaccine-preventable diseases like influenza (Phadke et al., 2016; Kempe et al., 2015). Only 58.6 percent of children from six months to seventeen years old in the United States received a flu vaccine during the 2020-2021 flu season, and vaccine hesitancy is at the center of this low vaccination rate (Center for Disease Control and Prevention, 2021; Phadke et al., 2016). Rural communities tend to have lower vaccination rates than their urban counterparts (Zhai et al., 2020). The state of Wyoming, a predominately rural state, had the third-lowest influenza vaccination rate (46.3 percent) in the United States for children during the 2020-2021 influenza season (Center for Disease Control and Prevention, 2021). Rural communities also have higher rates of pre-existing conditions and worse healthcare quality, meaning that outbreaks of vaccine-preventable diseases are particularly damaging in those areas (Dorn et al., 2020).

Vaccine hesitancy refers to the "delay in acceptance or refusal of vaccination despite availability of vaccination services" (Macdonald, 2015, p. 1). Perceptions of vaccine safety and efficacy are at the core of vaccine hesitancy. These concerns still persist despite extensive medical research proving the risk of severe adverse side effects to vaccines and vaccine effectiveness in reducing the risks of illness or death from contagious diseases (McKee & Bohannon, 2016; Facciola et al., 2019; Blaisdell et al., 2015). Policy interventions to address vaccine hesitancy, like educational interventions, have been ineffective at improving vaccination rates, particularly for parents of young children (Serpell & Green, 2006; Nyhan et al., 2014).

Parental decisions to vaccinate children against the flu can be framed as a decision between two risky alternatives—to get a vaccine and potentially incurring a side effect or forgoing a vaccine and increasing diseases-related risks (Binder & Nuscheler, 2017; Reyna, 2016). Vaccine preferences are, thus, often discussed in relation with risk preferences (Blaisdell et al., 2016). To our knowledge, only Trueblood et al. (2021) correlated monetary risk preferences to vaccination decisions. They asked subjects to decide between hypothetical monetary gambles in a survey. While the authors found that monetary risk preferences are correlated with COVID-19 vaccine uptake, the hypothetical nature of their work means the results may be influenced by hypothetical bias-related inaccuracy.

Ambiguity aversion may also influence parental vaccination decision making for children. Hesitant parents often perceive uncertainty on the probabilities of having severe adverse reactions to vaccines or getting sick after being vaccinated, contradicting the consensus of medical researchers (Bond & Nolan, 2011; Blaisdell et al. 2016). Uncertainty in the distribution of outcomes may also drive decisions, depending on if the uncertainty is in disease risks or vaccine risks (Courbage & Peter, 2021; Han et al., 2018; Ritov & Baron, 1990). However, to our knowledge, previous researchers have not tested whether explicitly ranking vaccine risks as "more uncertain" than disease risks is associated with lower vaccine uptake.

Our research focuses on the interaction between risk preferences, perceived uncertainty, and vaccine hesitancy. We study whether parents follow flu vaccine recommendations for their child and themselves. We do not find evidence supporting a relationship between degrees of risk aversion and vaccination decisions. However, we do find that parents who believe the risks of vaccinations are more uncertain than risks of diseases tend to vaccinate their children for the flu at a lower rate, even after controlling for trust in the healthcare system. This finding is important in the context of policy solutions to increase education about the outcome distribution because healthcare mistrust is typically assumed to be the cause for perceived uncertainty in the distribution of outcomes (Braun et al. 2020).

The rest of the paper is organized as follows. Section 2 highlights the experiment design and implementation. Section 3 describes our experiment results, while section 4 provides concluding remarks.

2 Design

Between November 2017 and April 2018, we administered experiments to parents across Wyoming, the state with the lowest flu vaccination rate in the country during the data collection period (Center for Disease Control and Prevention, 2021). Participants included residents from four different counties with low vaccination rates: Albany, Natrona, Park, and Sheridan. Table 1 describes basic information on each location. We employed the Wyoming Survey and Analysis Center to recruit parents in each location. They used Facebook ads and random calls to find participants. Parents were promised a $100 show-up fee to cover their travel costs and time opportunities for additional earnings. Child-care services were also provided for free to incentivize participation. The experiment was approved by the University of Wyoming Internal Review Board.

	Albany	Natrona	Park	Sheridan
Population	38,102	80,610	29,121	30,012
Participants in Study	57	47	39	47
2019 Flu Vaccination Rate (%)*	64	51	40	72
Median Household Income ($)	46,865	60,550	62,666	58,521
Poverty rate (%)	26.6	9.6	7.7	6.2
High School Completion (% of adults)	96.7	92.1	93.8	94.8
White (%)	90.1	94.1	94.4	95.1
Population Density (pop. per square mile)	8.9	15.1	4.2	11.9

Table 1

2018 County-level demographic data

*Flu vaccination rate for children under age 5. Data not available in 2018 for children under age 5. Wyoming statewide vaccination rate during 2018-19 and 2019-20 flu seasons for children under 5 were 50.3% and 77.3%, respectively

Sources: Center for Disease Control, 2021; U.S. Census Bureau, 2018; Wyoming Department of Health, 2020.

In total, 198 parents with children aged one to five participated in the experiment. All of our adult subjects claimed to be the primary caregivers for their children. Each participant completed a series of experiments as well as a survey. The experiments took place in classrooms and were manually administered in sessions of 10-16 participants. Parents only knew the experiment was about health decision making when they were recruited.

We estimate risk preferences using an experiment with gambles similar to those in previous literature (Ball et al., 2010; Dave et al., 2010; Eckel et al., 2012). Every participant chose one of six gambles with real monetary payoffs. Each gamble had a high and low payoff with a P = 0.5 chance of occurring. At the end of the session, subjects were paid based on the result of a coin flip. The six gambles they were allowed to choose from are available in appendix A.2. Beginning with gamble one, each subsequent gamble reflected a decreasing level of risk aversion. As the standard deviation of the gambles increased, so did the expected value of each gamble. For each gamble, we estimate a constant relative risk aversion (CRRA) coefficient using a second-order Taylor series expansion (see appendix A).[1] The frequency of each gamble being chosen, as well as the potential payoffs, expected value, standard deviation, and the CRRA range are given in table two (see the results section).

The participants also completed a survey at the end of each session with questions on personal demographic information, history of health decisions, and vaccination opinions. We measure current vaccination opinions by asking flu vaccination decisions or intentions for both the participant and their youngest child for the 2017-18 flu season. To analyze ambiguity as it pertains to vaccines, we use two survey questions that were given to all participants. These questions asked individuals to state on a Likert scale how strongly they agreed with each statement. The two statements were: “The risks of contagious diseases are generally known,” and “The risks of vaccination are unknown.” Note a differentiator in our survey compared to many previous studies is that these questions ask whether the risks of vaccines and diseases are known, not if they are high.

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[1] The constant relative risk aversion (CRRA) coefficient is the ρ in the utility function $u(x) = x^{(1-\rho)}/(1-\rho)$. In our calculations, we only include potential winnings from the game and not the show-up fee

3 Results

3.1 Model

For the regressions, our vaccination decision variables, ambiguity variables and controls come directly from the survey. We also create a relative uncertainty dummy variable that compares how people viewed the perceived uncertainty in the risks of vaccines in relation to diseases to indicate if an individual viewed the risks of vaccines as more uncertain than the risks of diseases. We model risk preferences using the mid-point estimate of the CRRA coefficients and as individual indicator variables.

Our controls fall into three categories: healthcare trust, community characteristics, and demographic characteristics. Previous literature has linked trust in pharmaceutical institutions and research with parental vaccine hesitancy, which has been frequently highlighted during the COVID-19 pandemic (Palamenghi et al., 2020; Reuben et al., 2020; Jamison et al. 2020). Mistrusting medical data directly influences perceptions about vaccine safety and efficacy (Sundaram et al. 2018), as does mistrust in physician vaccine recommendations (Luttrell-Freeman et al., 2021).

These results are motivation to incorporate three non-demographic controls to address potential bias. The "Pharmaceutical Lobbying" variable asked, on a Likert scale, how much each subject agreed with the idea that recommended immunizations were the result of pharmaceutical companies lobbying government officials. "Trust in Health Care Providers" similarly asked if the subject believed that their child's health care provider acts in the best interest of their child. Finally, we surveyed if subjects believed that lifestyle measures, like cleaning and nutrition, could prevent their child from catching contagious diseases in the "Lifestyle Measures Can Prevent Disease" variable.

We also consider community fixed effects - like the prevalence of a disease in a community - that may influence willingness to vaccinate (Baumgaertner et al., 2020). Vaccine hesitancy beliefs may be institutionalized at the community level, and these beliefs may be circulated locally (Dubé et al., 2018). The "Minutes of Travel to Health Care Provider" asked subjects how far (in minutes) they lived from their child's health care provider to measure physical connectedness to a community. To control for intrapersonal effects, we also include social network characteristics that might influence beliefs, i.e. if individuals knew someone who previously had the flu. The "Social Network" variable asked where each subject sought information on vaccinations from. If they ranked two of "social media friends," "family members," or "friends of other parents" among their top five sources for vaccination information, they have been given a value of one.

Finally, we control for standard demographic characteristics, many of which have been linked with vaccination patterns. This includes lower education, lower incomes, and religious beliefs all being associated with vaccine hesitancy (Kempe et al., 2020; Kawai & Kawai et al., 2019; Smith et al. 2017). However, we did not control for race because our sample was over 95% white, a statistic consistent with rural Wyoming demographics. The religious variable is zero if the subject said that they were "atheist" or "agnostic" on the survey. Income was included in our regressions in logarithmic form.

3.2: Summary Statistics

Choice	N	Percent	Low Payoff	High Payoff	EV	SD	CRRA Range
1	16	8.79	7	7	7	0	3.11, ∞
2	12	6.59	6	9	7.5	1.5	1.75, 3.11
3	47	25.82	5	13	9	4	0.87, 1.75
4	37	20.33	3	20	11.5	8.5	0.58, 0.87
5	9	4.95	1	25	13	12	0.37, 0.58
6	61	33.52	0	30	15	15	−∞, 0.37

Table 2
Gamble selection options and estimated CRRA coefficient.

	N	mean	sd	min	max
Contagious Disease Uncertainty	182	1.93	1.03	1	5
Vaccine Uncertainty	182	2.52	1.19	1	5
Relative Uncertainty Dummy	182	0.50	0.50	0	1

Table 3
Uncertainty Metrics[2]

Summary statistics for our risk preferences metrics and ambiguity metrics are depicted in table two and three, respectively.[3] Sixty-three, or 35% of the sample, said they neither got a flu vaccine for their youngest child nor did they plan to. Gamble six, the gamble associated with lowest degree of risk aversion, had the highest number of selections by subjects (61, or 33%). However, approximately 40% of our sample chose one of the three gambles with the lowest standard deviation. The mean value on our vaccine uncertainty metric was 2.52, meaning that the average person in our sample roughly agreed with the statement that the risks of vaccines are unknown. Exactly half of our subjects viewed the risks of vaccines as more uncertain than the risks of diseases.

[2] Contagious Disease Uncertainty and Vaccine Uncertainty deal with subjects' perceptions of uncertainty for disease risks and vaccine risks, respectively, on a Likert scale of 1-5.

[3] In total, 182 subjects were included in our analysis. We omitted eight subjects based on if they reported that their child has a medical risk of flu vaccination or are missing demographic information.

	N	sd	mean	Min	max
Pharmaceutical Lobbying	182	1.18	2.44	1	5
Trust in Health Care Providers	182	0.71	4.65	1	5
Lifestyle Measures Can Prevent Disease	182	1.32	3.65	1	5
Know Someone Who Had the Flu	182	0.46	0.70	0	1
Social Network	182	0.47	0.32	0	1
Minutes of Travel to Health Care Provider	182	10.4	11.1	5	45
Female	182	0.28	0.92	0	1
Parent Age	182	6.55	32.1	19	59
Income	182	49,049	70,406	0	430,601
Years of Education	182	1.92	16.0	11	22
Religious	182	0.38	0.82	0	1

Table 4
Summary statistics for controls used in the main model

Table four provides summary statistics of our control variables included in our regressions. 16% of subjects believed that immunization recommendations are influenced by pharmaceutical companies lobbying government.[4] Only four subjects in our sample did not believe health care providers act in the best interest of their child.[5] 63% of our sample believed that maintaining a healthy lifestyle can help build immunity against contagious diseases.[6] 70% of respondents knew someone who has had the flu. 32% of subjects received significant vaccination information from two of the following sources: family members, friends of other parents, or social media friends.[7] Most of our respondents (88%) lived within 20 minutes of

[4] From responding with a four or a five on "Pharmaceutical Lobbying"
[5] From responding with a one or a two on "Trust in Health Care Provider", meaning that that they either partially or strongly disagree with the idea that healthcare providers act in their child's best interest.
[6] From responding with a four or five on "Lifestyle Measures Can Prevent Disease"
[7] From the "Social Network" variable.

their health care provider. The average individual in our experiment was female, over 30 years old, had an income of around $70,000, had some college education, and was religious.

3.3: Regression Analysis

We use logit models to estimate the parents' vaccination decisions as a function of the experiment and survey variables. Coefficient estimates are presented in tables at the end of this section. Results for the logit model estimation on the youngest child's flu vaccination intentions are given in table five, and those for each parent's personal vaccination decisions are given in table six. In columns one through four for each table, we regress the respective influenza vaccination decision on both gamble selection as a dummy variable and the mid-point of the CRRA range as a continuous variable. Ambiguity aversion metrics were left out of these regressions. The coefficients on both the CRRA midpoints and the individual indicator variables are mostly negative, implying that parents who selected the riskless investment tended to vaccinate their children at higher rates. However, we have no evidence of a statistically significant relationship in these regressions.

We do have two statistically significant control variables: parent age ($p < .05$ in the child models) and pharmaceutical lobbying ($p < .01$ in all models). The marginal effects of both models show that increasing the "Pharmaceutical Lobbying" variable response by one (on the Likert scale) is associated with a drop in the probability of vaccinating their children by 12 percentage points and themselves by 11-12 percentage points. This is consistent with previous literature linking health care trust with vaccine hesitancy. Similarly, increasing parent age by one year is associated with a one percentage point decrease in the probability of vaccinating their child. Parent age was not associated with a statistically significant change in the probability of the subject personally getting vaccinated. We do not find a statistically significant relationship between income and vaccination decisions, despite prior research demonstrating a relationship (Kempe et al. 2020). This may be partly because our sample does not have many people with lower incomes.

All of our regressions of perceived vaccine ambiguity have both economic and statistical significance, given in columns five through ten of tables five and six. These regressions did not include risk preferences metrics. In the "Vaccine Uncertainty" model (columns five and six), people who see more uncertainty in vaccine risks are less likely to vaccinate themselves ($p < .01$) and their children ($p < .05$). Marginal effects indicate increasing the perception of uncertainty on vaccination risks on the Likert Scale by one is associated with a seven and nine percentage point drop in the probability of the subject getting their child and themselves vaccinated. Our disease uncertainty model (columns seven and eight) generally reported negative coefficients, indicating that people who perceive less uncertainty in the risks of diseases generally vaccinated at a lower rate. This model had no statistical significance, though. In the Relative Uncertainty model (columns nine and ten), we find that people who view the risks of vaccines as *more uncertain* than the risks of diseases, on average, have an 11 and 15 percentage point lower probability of vaccinating their child ($p < .1$) and themselves ($p < .05$). Parent age was insignificant in the parent vaccination models and decreased ($p < .1$ from $p < .05$) in the child vaccination models. Pharmaceutical lobbying ($p < .01$) remains statistically significant in our uncertainty models.

In our final set of results, we combine the risk and uncertainty models. The trends previously discussed continue in this model; monetary risk preferences do not have a statistically significant relationship with vaccine decisions, while our relative uncertainty variable does ($p < .1$ for child vaccination, $p < .05$ for adults). Additionally, the marginal effect for the relative uncertainty of vaccines does not change in magnitude or direction when we include risk aversion, accentuating that monetary risk aversion is a) not correlated with vaccination decisions and b) is not a confounding variable with perceived uncertainty. None of our control coefficients changed in significance or direction in this last set of regressions.

The result that risk preferences are not linked with decisions to vaccinate could be due to a variety of causes. First, vaccine-hesitant people may view vaccine payoffs as uncertain, as we find in our study (Blaisdell et al., 2016). Some hesitant people may also view the payoffs of the vaccine decision incorrectly, making risk preferences irrelevant (viewing safety concerns as large as opposed to uncertain) (Mckee and Bohannon, 2016). Vaccine preferences may reflect prudence, where people tend to avoid the worst payoff of a gamble, causing rare side effects to be overweighted by people (Mayrhofer and Schmitz, 2020; Costa-Font et al., 2021). Finally, vaccine hesitancy may reflect loss aversion, where people exhibit "risk-seeking behavior" when dealing with gambles involving losses (Chen and Stevens, 2017).

Both healthcare provider trust and our uncertainty variables remain significant when used in the same model, a result that disentangles the causality in why people view uncertainty in vaccine risks. This finding is noteworthy because previous literature in some cases does not differentiate between the two, even as it links uncertainty about vaccines to distrust in the healthcare system (Braun and O'Leary, 2020; Jamison et al. 2020). As a robustness check, in appendix B, we run regressions that do not include trust variables. Tables B1 and B2 show regression results when the "Pharmaceutical Lobbying" variable is left out for both the child vaccine and personal vaccine decision, respectively. Tables B3 and B4 include regressions that removed the other two trust variables ("Trust in Healthcare Providers" and "Lifestyle Measures Can Prevent Disease") in addition to pharmaceutical lobbying. When only "Pharmaceutical Lobbying" is removed, the significance on the marginal effects of the uncertainty dummy in the combined model (columns 11 and 12 of tables B1 and B2) jumps ($p < .01$ in both models). Additionally, the magnitude of the marginal effects increases by six and five percentage points for the child and parent models, respectively, when compared to the original models containing the pharmaceutical lobbying variables. Additionally, in the full models, "Trust in Health Care Providers" and "Lifestyle Measures Can Prevent Diseases" do not have statistically significant coefficients. When Pharmaceutical Lobbying is removed, the significance on both of these variables increases to 5% in the child, combined model (columns 11 and 12 of table B1).

When the other two healthcare variables are removed (tables B3 and B4), the trends for the relative uncertainty variable continue. It remains statistically significant ($p < .01$), and the magnitude of the marginal effects coefficient for both the child and parent models are respectively eleven and ten percentage points higher than the full models with all control variables. In the child regression, the CRRA midpoint also becomes statistically significant in the regression without uncertainty metrics, all this significance is eliminated in the combined model (columns 11 and 12 of table B3). Altogether, this robustness check provides evidence of coefficient stability for the relative uncertainty dummy, providing more evidence for its importance in the vaccination decision.

These results suggest parents still see uncertainty in vaccine risks that beyond this, and that mending the doctor-patient relationship can only address part of the problem. One hypothesis for this could be that if parents initially believe false information that the safety of vaccines is unknown, they may exhibit confirmation bias and seek out information that supports this view (Meppelink et al., 2019; Casara et al., 2019; Jacobson et al., 2007). In any case, these results suggest that disentangling trust in the healthcare system with perceived ambiguity in vaccine risks is crucial when analyzing vaccine hesitancy.

VARIABLES	(1) Gamble Logit	(2) Gamble Marginal Effects	(3) CRRA Logit	(4) CRRA Marginal Effects	(5) Vaccine Uncertainty Logit	(6) Vaccine Uncertainty Marginal Effects	(7) Disease Uncertainty Logit	(8) Disease Uncertainty Marginal Effects	(9) Relative Uncertainty Logit	(10) Relative Uncertainty Marginal Effects	(11) Combined Model Logit	(12) Combined Model Marginal Effects
Relative Uncertainty Dummy									**-0.62***	**-0.11***	**-0.64***	**-0.11***
									(0.37)	**(0.06)**	**(0.37)**	**(0.06)**
CRRA			**-0.07**	**-0.01**							**-0.08**	**-0.01**
			(0.09)	**(0.02)**							**(0.09)**	**(0.02)**
Vaccine Uncertainty					-0.41**	-0.07**						
					(0.18)	(0.03)						
Contagious Disease Uncertainty							-0.19	-0.03				
							(0.17)	(0.03)				
Risk = 2	-1.17	-0.22										
	(0.92)	(0.17)										
Risk = 3	-0.18	-0.03										
	(0.72)	(0.12)										
Risk = 4	-0.38	-0.06										
	(0.72)	(0.12)										
Risk = 5	-0.42	-0.07										
	(1.08)	(0.19)										
Risk = 6	-0.66	-0.12										
	(0.68)	(0.11)										
Pharmaceutical Lobbying	-0.66***	-0.12***	-0.64***	-0.12***	-0.55***	-0.10***	-0.69***	-0.12***	-0.61***	-0.11***	-0.58***	-0.10***
	(0.18)	(0.03)	(0.18)	(0.03)	(0.18)	(0.03)	(0.18)	(0.03)	(0.18)	(0.03)	(0.18)	(0.03)
Trust in Health Care Providers	0.52	0.09	0.55	0.10	0.42	0.07	0.53	0.09	0.49	0.09	0.48	0.09
	(0.38)	(0.06)	(0.35)	(0.06)	(0.35)	(0.06)	(0.36)	(0.06)	(0.36)	(0.06)	(0.35)	(0.06)
Lifestyle Measures Can Prevent Disease	-0.21	-0.04	-0.21	-0.04	-0.16	-0.03	-0.20	-0.04	-0.21	-0.04	-0.20	-0.04
	(0.14)	(0.03)	(0.14)	(0.02)	(0.15)	(0.03)	(0.14)	(0.02)	(0.14)	(0.03)	(0.15)	(0.03)
Know Someone Who Had the Flu	-0.05	-0.01	-0.03	-0.00	-0.05	-0.01	-0.00	-0.00	-0.07	-0.01	-0.09	-0.02
	(0.40)	(0.07)	(0.38)	(0.07)	(0.41)	(0.07)	(0.39)	(0.07)	(0.39)	(0.07)	(0.39)	(0.07)
Social Network	-0.01	-0.00	0.02	0.00	0.11	0.02	0.04	0.01	-0.04	-0.01	-0.03	-0.00
	(0.37)	(0.07)	(0.37)	(0.07)	(0.39)	(0.07)	(0.37)	(0.07)	(0.38)	(0.07)	(0.38)	(0.07)
Minutes of Travel to Health Care Provider	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00
	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)
Female	-0.52	-0.09	-0.44	-0.08	-0.34	-0.06	-0.46	-0.08	-0.26	-0.05	-0.32	-0.06
	(0.67)	(0.12)	(0.64)	(0.12)	(0.57)	(0.10)	(0.66)	(0.12)	(0.61)	(0.11)	(0.61)	(0.11)
Parent Age	-0.06**	-0.01**	-0.06*	-0.01**	-0.05*	-0.01*	-0.05*	-0.01**	-0.05*	-0.01*	-0.05*	-0.01*
	(0.03)	(0.01)	(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.01)
Log of Income	0.08	0.01	0.08	0.01	0.01	0.00	-0.00	-0.00	0.05	0.01	0.10	0.02
	(0.25)	(0.04)	(0.24)	(0.04)	(0.24)	(0.04)	(0.24)	(0.04)	(0.24)	(0.04)	(0.24)	(0.04)
Years of Education	-0.01	-0.00	0.02	0.00	0.02	0.00	0.03	0.01	0.02	0.00	0.01	0.00
	(0.11)	(0.02)	(0.10)	(0.02)	(0.11)	(0.02)	(0.10)	(0.02)	(0.11)	(0.02)	(0.11)	(0.02)
Religious	-0.01	-0.00	0.05	0.01	0.02	0.00	0.08	0.01	-0.04	-0.01	-0.06	-0.01
	(0.47)	(0.08)	(0.47)	(0.08)	(0.51)	(0.09)	(0.48)	(0.09)	(0.49)	(0.09)	(0.48)	(0.09)
Constant	2.66		1.40		3.11		2.42		2.05		1.92	
	(3.68)		(3.46)		(3.33)		(3.55)		(3.39)		(3.37)	
Observations	182	182	182	182	182	182	182	182	182	182	182	182

Table 5: Child Flu Vaccination on Risk and Perceived Uncertainty

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) Gamble Logit	(2) Gamble Marginal Effects	(3) CRRA Logit	(4) CRRA Marginal Effects	(5) Vaccine Uncertainty Logit	(6) Vaccine Uncertainty Marginal Effects	(7) Disease Uncertainty Logit	(8) Disease Uncertainty Marginal Effects	(9) Relative Uncertainty Logit	(10) Relative Uncertainty Marginal Effects	(11) Combined Model Logit	(12) Combined Model Marginal Effects
Relative Uncertainty Dummy									**-0.76****	**-0.15****	**-0.77****	**-0.15****
									(0.34)	**(0.06)**	**(0.34)**	**(0.06)**
CRRA			**-0.01**	**0.00**							**-0.03**	**-0.01**
			(0.08)	**(0.02)**							**(0.09)**	**(0.02)**
Vaccine Uncertainty					-0.44***	-0.09***						
					(0.16)	(0.03)						
Contagious Disease Uncertainty							0.03	0.01				
							(0.16)	(0.03)				
Risk = 2	-0.14	-0.03										
	(0.81)	(0.16)										
Risk = 3	0.01	0.00										
	(0.66)	(0.13)										
Risk = 4	-0.22	-0.04										
	(0.66)	(0.13)										
Risk = 5	-0.90	-0.18										
	(1.03)	(0.21)										
Risk = 6	-0.25	-0.05										
	(0.61)	(0.12)										
Pharmaceutical Lobbying	-0.58***	-0.12***	-0.56***	-0.11***	-0.44***	-0.09***	-0.56***	-0.11***	-0.49***	-0.10***	-0.48***	-0.10***
	(0.16)	(0.03)	(0.16)	(0.03)	(0.16)	(0.03)	(0.16)	(0.03)	(0.16)	(0.03)	(0.16)	(0.03)
Trust in Health Care Providers	0.40	0.08	0.39	0.08	0.23	0.05	0.40	0.08	0.31	0.06	0.30	0.06
	(0.31)	(0.06)	(0.29)	(0.06)	(0.30)	(0.06)	(0.30)	(0.06)	(0.29)	(0.06)	(0.29)	(0.06)
Lifestyle Measures Can Prevent Disease	-0.21	-0.04	-0.21	-0.04	-0.17	-0.03	-0.22	-0.04	-0.22	-0.04	-0.22	-0.04
	(0.14)	(0.03)	(0.14)	(0.03)	(0.15)	(0.03)	(0.14)	(0.03)	(0.15)	(0.03)	(0.15)	(0.03)
Know Someone Who Had the Flu	0.10	0.02	0.06	0.01	0.05	0.01	0.06	0.01	-0.01	-0.00	-0.02	-0.00
	(0.38)	(0.08)	(0.37)	(0.08)	(0.38)	(0.07)	(0.37)	(0.07)	(0.38)	(0.07)	(0.38)	(0.08)
Social Network	-0.08	-0.02	-0.07	-0.01	0.03	0.01	-0.07	-0.02	-0.11	-0.02	-0.10	-0.02
	(0.36)	(0.07)	(0.36)	(0.07)	(0.38)	(0.07)	(0.37)	(0.07)	(0.37)	(0.07)	(0.38)	(0.07)
Minutes of Travel to Health Care Provider	0.02	0.00	0.02	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00
	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)
Female	0.61	0.12	0.62	0.13	0.65	0.13	0.63	0.13	0.68	0.14	0.67	0.13
	(0.56)	(0.11)	(0.55)	(0.11)	(0.52)	(0.10)	(0.56)	(0.11)	(0.56)	(0.11)	(0.56)	(0.11)
Parent Age	-0.02	-0.00	-0.02	-0.00	-0.01	-0.00	-0.02	-0.00	-0.01	-0.00	-0.01	-0.00
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.00)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Log of Income	0.32	0.06	0.29	0.06	0.29	0.06	0.29	0.06	0.32	0.06	0.34	0.07
	(0.22)	(0.04)	(0.22)	(0.04)	(0.21)	(0.04)	(0.21)	(0.04)	(0.21)	(0.04)	(0.22)	(0.04)
Years of Education	-0.06	-0.01	-0.04	-0.01	-0.06	-0.01	-0.04	-0.01	-0.06	-0.01	-0.07	-0.01
	(0.10)	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.10)	(0.02)
Religious	0.09	0.02	0.10	0.02	0.07	0.01	0.10	0.02	-0.03	-0.01	-0.04	-0.01
	(0.46)	(0.09)	(0.43)	(0.09)	(0.47)	(0.09)	(0.43)	(0.09)	(0.46)	(0.09)	(0.46)	(0.09)
Constant	-2.04		-2.15		-0.61		-2.27		-1.46		-1.50	
	(3.11)		(2.85)		(2.82)		(2.93)		(2.74)		(2.75)	
Observations	182	182	182	182	182	182	182	182	182	182	182	182

Table 6: Parent Flu Vaccination on Risk and Perceived Uncertainty

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4 Conclusion

This research addresses the gap in literature on vaccine hesitancy research in rural communities, and unlike previous literature, we control for healthcare trust when understanding perceptions of vaccine uncertainty. We do not find any evidence of a relationship between vaccine uptake and monetary risk preferences (measured in an economic experiment). However, there is a statistically significant relationship between vaccine uptake and perceptions of relative uncertainty between vaccine risks and diseases. Importantly, this relationship remains even after controlling for trust in the healthcare system.

This research has important policy implications. Addressing trust in health care providers has been frequently cited as a crucial way to address vaccine hesitancy (Rozek et al. 2021; Siddiqui et al. 2013). As a result, previous literature has identified pediatricians as playing an important role in addressing perceived vaccine uncertainty (Braun et al. 2020). However, addressing healthcare trust may not lead to changes in the perceptions of vaccine uncertainty for some parents. Additionally, large-scale communication is an essential part of combatting viral diseases in order to share information quickly and effectively with the public about medical interventions like vaccines (Hanafiah et al., 2021). Communication strategies need to address perceived ambiguity on vaccines independently of healthcare trust to be most effective. Additionally, strategies to help parents sort through information may be useful in combating the spread of vaccine misinformation and reducing perceived ambiguity.

There are several limitations of our research. Our risk preferences experiment does not include a gamble that only risk-seeking people would take, so our findings about risk preferences cannot be applied to them. This experiment does not address topics like loss aversion or prudence that may influence the vaccination decision. Our uncertainty metric focuses on if people perceive ambiguity in vaccine risks. Thus, we do not assess how degrees of ambiguity aversion may influence vaccination preferences. Finally, all of the data in our experiment was collected before the COVID-19 pandemic and changing health perceptions about vaccines may bias our results.

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A CRRA Coefficient Estimation with Taylor Series Expansion

A.1 Estimate Derivation

We use a second-order Taylor series expansion to estimate the CRRA coefficients for individuals based off the gamble they selected. We asked participants to select one of six gambles with real monetary payoffs. For a given gamble, define:

x = 7 := return of the gamble with no risk (gamble 1).

x1 := lower possible winnings in the given gamble

x2 := upper possible winnings of the gamble

xμ := mean return of gamble

πc := the compensatory premium (the premium for taking a gamble with higher variance)

ρ := CRRA coefficient

We assume that subjects' preferences take the functional form of a CRRA utility function:

$u(y) = \frac{y^{1-\rho}}{1-\rho}$.

Consequently, the first and second derivatives of the utility function are

$$u'(y) = y^{-\rho}$$

and

$u''(y) = -\rho y^{-\rho-1}$.

Assume that the mean expectation of error is 0: $E[\epsilon] = 0$. Consequently, we can assume that the expectation of error squared is the standard error:

$$E[\epsilon^2] = \sigma^2 = \sum_i p_i (x_i - x_\mu)^2 = \frac{1}{2}\left((x_1 - x_\mu)^2 + (x_2 - x_\mu)^2\right).$$

By definition, the utility obtained through the gamble with no risk, x, is

$u(x) \;=\; E[u((x + \pi_c) + \epsilon).$

We now write the right-hand-side second-order Taylor series expansion and find the expectation of the expansion. Note that we stop at the second moment because there is no skewness, implying that the third moment would be 0.

$$RHS \approx u\left(x + \pi_c\right) + u'\left(x + \pi_c\right)\epsilon + \frac{1}{2}u''\left(x + \pi_c\right)\epsilon^2.$$

$$E[RHS] \approx u\left(x + \pi_c\right) + \frac{1}{2}u\left(x + \pi_c\right)\sigma^2.$$

The left-hand-side first-order Taylor series expansion is

$$LHS \approx u\left(x - \pi_i\right) \approx u(x) - u'(x)\pi_i.$$

We can then expand this equation:

$$u(x) \approx u\left(x + \pi_c\right) + \frac{1}{2}u\left(x + \pi_c\right)\sigma^2.$$

If we assume that $\pi_c \approx \pi_i$, then $u\left(x - \pi_i\right) \approx u(x) + \frac{1}{2}u''(x)\sigma^2$. With this information,

$$u(x) - u'(x)\pi \approx u(x) + \frac{1}{2}u''(x)\sigma^2$$

and

$$\pi \approx \left(\frac{1}{2}\right)\frac{-u''(x)}{2u'(x)}\sigma^2 \approx \left(\frac{-1}{2}\right)\frac{-\rho x^{-\rho-1}}{x^{-\rho}}\sigma^2.$$

Recall the x = 7. Substituting this in, we get

$$\pi = \frac{\rho}{14}\sigma^2.$$

Therefore,

$$\rho = \frac{14\pi}{\sigma^2}$$

for all gambles with $\sigma^2 > 0$. This is the estimate for the CRRA coefficient.

A.2 Estimates Based on Our Gambles

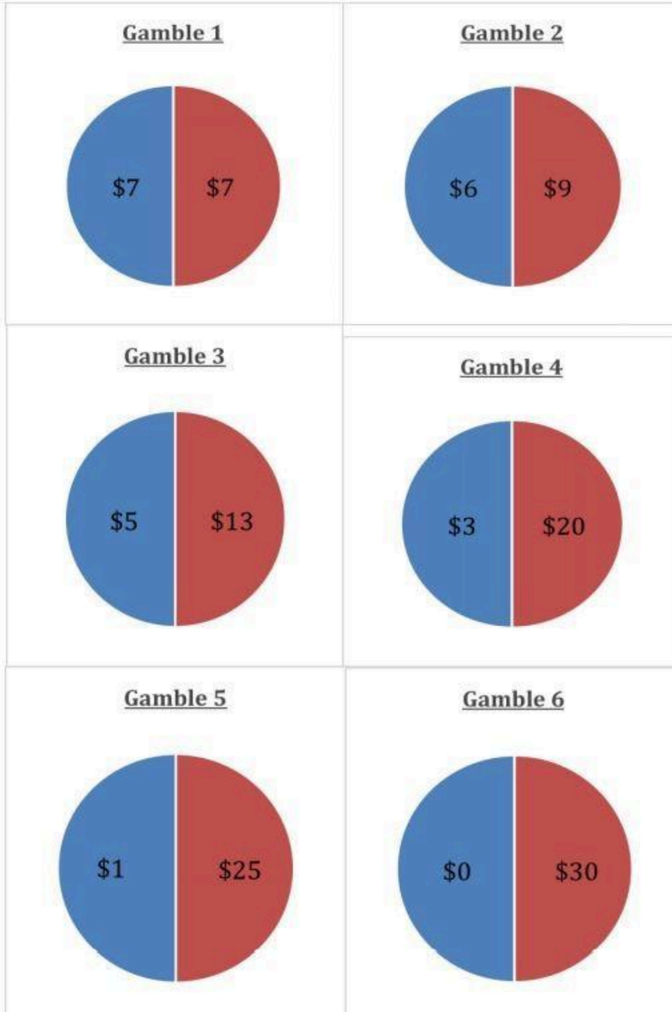

Figure 1: Gamble Choices

We now estimate CRRA coefficients from the gambles in our experiment using the estimate of the CRRA coefficient for a given gamble: $\rho = \frac{14\pi}{\sigma^2}$. Gamble one has a guaranteed return of 7. As there is a standard deviation of zero, we know the CRRA of gamble one is greater than that for gamble two: $\rho_1 > \rho_2$. For gamble two, $x_\mu = 7.5, \pi = 7.5 - 7 =.5$, and $\sigma^2 = 2.25$. Thus, $\rho_2 \leq \frac{14(.5)}{2.25} = 3..11$, and $\rho_2 > \rho_3$. Using similar logic, we can calculate the upper bounds on the CRRA coefficients for the rest of the gambles.

Gamble 3: $x_{\mu} = 9, \pi = 2, \sigma^{2} = 16, \rho_{3} \leq 1.75$

Gamble 4: $x_{\mu} = 11.5, \pi = 4.5, \sigma^{2} = 72.25, \rho_{4} \leq .87$

Gamble 5: $x_{\mu} = 13, \pi = 6, \sigma^{2} = 144, \rho_{5} \leq .58$

Gamble 6: $x_{\mu} = 15, \pi = 8, \sigma^{2} = 225, \rho_{6} \leq .37$

From these findings, we can estimate that

$\rho_{1} \geq 3.11, \rho_{2} \in (1.75, 3.11], \rho_{3} \in (.87, 1.75], \rho_{4} \in (.58, .87], \rho_{5} \in (.37, .58],$ and $\rho_{6} \leq .37$

.

B Regressions without Trust Variables

In this appendix, we include regressions that do not contain control variables on trust in the healthcare system. Tables B1 and B2 do not include the pharmaceutical lobbying variable, while tables B3 and B4 to not include any trust variables.

VARIABLES	(1) Gamble Logit	*(2) Gamble Marginal Effects*	(3) CRRA Logit	*(4) CRRA Marginal Effects*	(5) Vaccine Uncertainty Logit	*(6) Vaccine Uncertainty Marginal Effects*	(7) Disease Uncertainty Logit	*(8) Disease Uncertainty Marginal Effects*	(9) Relative Uncertainty Logit	*(10) Relative Uncertainty Marginal Effects*	(11) Combined Model Logit	*(12) Combined Model Marginal Effects*
Relative Uncertainty Dummy									**-0.87****	***-0.17******	**-0.89****	***-0.17******
									(0.34)	***(0.06)***	**(0.35)**	***(0.06)***
CRRA			**-0.13**	***-0.03***							**-0.13**	***-0.03***
			(0.09)	***(0.02)***							**(0.09)**	***(0.02)***
Vaccine Uncertainty					-0.55***	*-0.10****						
					(0.17)	*(0.03)*						
Contagious Disease Uncertainty							-0.11	*-0.02*				
							(0.16)	*(0.03)*				
Risk = 2	-0.69	*-0.14*										
	(0.85)	*(0.17)*										
Risk = 3	0.20	*0.04*										
	(0.71)	*(0.13)*										
Risk = 4	-0.06	*-0.01*										
	(0.72)	*(0.14)*										
Risk = 5	0.15	*0.03*										
	(1.01)	*(0.18)*										
Risk = 6	-0.55	*-0.11*										
	(0.68)	*(0.13)*										
Trust in Health Care Providers	0.83**	*0.16****	0.82***	*0.16****	0.61*	*0.11**	0.84***	*0.17****	0.74**	*0.14***	0.71**	*0.13***
	(0.34)	*(0.06)*	(0.32)	*(0.06)*	(0.33)	*(0.06)*	(0.32)	*(0.06)*	(0.33)	*(0.06)*	(0.33)	*(0.06)*
Lifestyle Measures Can Prevent Disease	-0.31**	*-0.06***	-0.31**	*-0.06***	-0.23	*-0.04*	-0.33**	*-0.07***	-0.32**	*-0.06***	-0.29**	*-0.06***
	(0.15)	*(0.03)*	(0.14)	*(0.03)*	(0.15)	*(0.03)*	(0.14)	*(0.03)*	(0.15)	*(0.03)*	(0.15)	*(0.03)*
Know Someone Who Had the Flu	0.06	*0.01*	0.05	*0.01*	0.06	*0.01*	0.11	*0.02*	0.00	*0.00*	-0.05	*-0.01*
	(0.37)	*(0.07)*	(0.36)	*(0.07)*	(0.39)	*(0.07)*	(0.36)	*(0.07)*	(0.36)	*(0.07)*	(0.36)	*(0.07)*
Social Network	-0.13	*-0.03*	-0.12	*-0.02*	-0.00	*-0.00*	-0.15	*-0.03*	-0.21	*-0.04*	-0.16	*-0.03*
	(0.35)	*(0.07)*	(0.36)	*(0.07)*	(0.37)	*(0.07)*	(0.36)	*(0.07)*	(0.36)	*(0.07)*	(0.36)	*(0.07)*
Minutes of Travel to Health Care Provider	0.01	*0.00*	0.02	*0.00*	0.01	*0.00*	0.02	*0.00*	0.01	*0.00*	0.01	*0.00*
	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*
Female	-0.42	*-0.08*	-0.33	*-0.06*	-0.27	*-0.05*	-0.26	*-0.05*	-0.13	*-0.02*	-0.22	*-0.04*
	(0.62)	*(0.12)*	(0.60)	*(0.12)*	(0.52)	*(0.10)*	(0.58)	*(0.12)*	(0.58)	*(0.11)*	(0.59)	*(0.11)*
Parent Age	-0.06*	*-0.01***	-0.06*	*-0.01**	-0.05*	*-0.01**	-0.05*	*-0.01**	-0.05*	*-0.01**	-0.05*	*-0.01**
	(0.03)	*(0.01)*	(0.03)	*(0.01)*	(0.03)	*(0.01)*	(0.03)	*(0.01)*	(0.03)	*(0.01)*	(0.03)	*(0.01)*
Log of Income	0.23	*0.05*	0.23	*0.05*	0.10	*0.02*	0.12	*0.02*	0.16	*0.03*	0.25	*0.05*
	(0.21)	*(0.04)*	(0.21)	*(0.04)*	(0.21)	*(0.04)*	(0.21)	*(0.04)*	(0.21)	*(0.04)*	(0.21)	*(0.04)*
Years of Education	0.01	*0.00*	0.03	*0.00*	0.02	*0.00*	0.04	*0.01*	0.02	*0.00*	0.01	*0.00*
	(0.11)	*(0.02)*	(0.11)	*(0.02)*	(0.11)	*(0.02)*	(0.10)	*(0.02)*	(0.11)	*(0.02)*	(0.11)	*(0.02)*
Religious	0.21	*0.04*	0.28	*0.05*	0.21	*0.04*	0.33	*0.07*	0.16	*0.03*	0.12	*0.02*
	(0.46)	*(0.09)*	(0.45)	*(0.09)*	(0.48)	*(0.09)*	(0.45)	*(0.09)*	(0.45)	*(0.09)*	(0.46)	*(0.09)*
Constant	-2.48		-2.94		0.14		-2.39		-1.76		-1.78	
	(2.93)		(2.76)		(2.85)		(2.78)		(2.77)		(2.82)	
Observations	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*

Table B1: Child Flu Vaccination, No Pharmaceutical Lobbying Variable

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) Gamble Logit	(2) Gamble Marginal Effects	(3) CRRA Logit	(4) CRRA Marginal Effects	(5) Vaccine Uncertainty Logit	(6) Vaccine Uncertainty Marginal Effects	(7) Disease Uncertainty Logit	(8) Disease Uncertainty Marginal Effects	(9) Relative Uncertainty Logit	(10) Relative Uncertainty Marginal Effects	(11) Combined Model Logit	(12) Combined Model Marginal Effects
Relative Uncertainty Dummy									**-0.97*** **	**-0.20*** **	**-0.98*** **	**-0.20*** **
									(0.33)	**(0.06)**	**(0.33)**	**(0.06)**
CRRA			**-0.07**	**-0.02**							**-0.08**	**-0.02**
			(0.08)	**(0.02)**							**(0.08)**	**(0.02)**
Vaccine Uncertainty					-0.56***	-0.11***						
					(0.15)	(0.03)						
Contagious Disease Uncertainty							0.08	0.02				
							(0.15)	(0.03)				
Risk = 2	0.24	0.05										
	(0.79)	(0.17)										
Risk = 3	0.33	0.07										
	(0.66)	(0.14)										
Risk = 4	0.05	0.01										
	(0.66)	(0.14)										
Risk = 5	-0.34	-0.08										
	(0.89)	(0.20)										
Risk = 6	-0.19	-0.04										
	(0.61)	(0.14)										
Trust in Health Care Providers	0.68**	0.15***	0.65**	0.14***	0.40	0.08	0.68**	0.15***	0.54*	0.11**	0.52*	0.11*
	(0.28)	(0.06)	(0.26)	(0.05)	(0.29)	(0.06)	(0.27)	(0.05)	(0.28)	(0.06)	(0.28)	(0.06)
Lifestyle Measures Can Prevent Disease	-0.30**	-0.06**	-0.30**	-0.07**	-0.22	-0.04	-0.32**	-0.07**	-0.31**	-0.06**	-0.29**	-0.06**
	(0.14)	(0.03)	(0.14)	(0.03)	(0.14)	(0.03)	(0.14)	(0.03)	(0.14)	(0.03)	(0.15)	(0.03)
Know Someone Who Had the Flu	0.15	0.03	0.10	0.02	0.10	0.02	0.12	0.03	0.01	0.00	-0.02	-0.00
	(0.38)	(0.08)	(0.36)	(0.08)	(0.38)	(0.08)	(0.36)	(0.08)	(0.37)	(0.08)	(0.37)	(0.08)
Social Network	-0.15	-0.03	-0.15	-0.03	-0.00	-0.00	-0.19	-0.04	-0.20	-0.04	-0.17	-0.04
	(0.34)	(0.07)	(0.35)	(0.08)	(0.37)	(0.07)	(0.35)	(0.08)	(0.36)	(0.07)	(0.36)	(0.08)
Minutes of Travel to Health Care Provider	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)
Female	0.61	0.13	0.63	0.14	0.66	0.13	0.68	0.15	0.74	0.15	0.70	0.15
	(0.51)	(0.11)	(0.50)	(0.11)	(0.51)	(0.10)	(0.51)	(0.11)	(0.56)	(0.12)	(0.55)	(0.11)
Parent Age	-0.02	-0.00	-0.02	-0.00	-0.01	-0.00	-0.02	-0.00	-0.01	-0.00	-0.01	-0.00
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Log of Income	0.43**	0.09**	0.40*	0.09**	0.34*	0.07*	0.37*	0.08*	0.39*	0.08**	0.44**	0.09**
	(0.21)	(0.04)	(0.21)	(0.04)	(0.20)	(0.04)	(0.21)	(0.04)	(0.20)	(0.04)	(0.21)	(0.04)
Years of Education	-0.04	-0.01	-0.03	-0.01	-0.05	-0.01	-0.02	-0.01	-0.05	-0.01	-0.06	-0.01
	(0.10)	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.10)	(0.02)
Religious	0.28	0.06	0.26	0.06	0.17	0.04	0.27	0.06	0.11	0.02	0.07	0.02
	(0.43)	(0.09)	(0.42)	(0.09)	(0.46)	(0.09)	(0.42)	(0.09)	(0.44)	(0.09)	(0.44)	(0.09)
Constant	-6.18**		-5.63**		-2.86		-5.97**		-4.44*		-4.42*	
	(2.78)		(2.52)		(2.68)		(2.60)		(2.53)		(2.56)	
Observations	182	182	182	182	182	182	182	182	182	182	182	182

Table B2: Parent Flu Vaccination, No Pharmaceutical Lobbying Variable

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) Gamble Logit	*(2) Gamble Marginal Effects*	(3) CRRA Logit	*(4) CRRA Marginal Effects*	(5) Vaccine Uncertainty Logit	*(6) Vaccine Uncertainty Marginal Effects*	(7) Disease Uncertainty Logit	*(8) Disease Uncertainty Marginal Effects*	(9) Relative Uncertainty Logit	*(10) Relative Uncertainty Marginal Effects*	(11) Combined Model Logit	*(12) Combined Model Marginal Effects*
Relative Uncertainty Dummy									**-1.09***** **(0.33)**	***-0.23******* ***(0.06)***	**-1.10***** **(0.34)**	***-0.22******* ***(0.06)***
CRRA			**-0.17**** **(0.08)**	***-0.04***** ***(0.02)***							**-0.18**** **(0.09)**	***-0.04***** ***(0.02)***
Vaccine Uncertainty					-0.70*** (0.16)	*-0.13**** *(0.02)*						
Contagious Disease Uncertainty							-0.19 (0.14)	*-0.04* *(0.03)*				
Risk = 2	-0.88 (0.83)	*-0.19* *(0.18)*										
Risk = 3	-0.14 (0.69)	*-0.03* *(0.13)*										
Risk = 4	-0.20 (0.70)	*-0.04* *(0.13)*										
Risk = 5	0.12 (1.03)	*0.02* *(0.18)*										
Risk = 6	-0.97 (0.67)	*-0.21* *(0.13)*										
Know Someone Who Had the Flu	-0.10 (0.37)	*-0.02* *(0.08)*	-0.07 (0.36)	*-0.01* *(0.08)*	-0.02 (0.40)	*-0.00* *(0.08)*	0.01 (0.36)	*0.00* *(0.08)*	-0.11 (0.37)	*-0.02* *(0.08)*	-0.15 (0.37)	*-0.03* *(0.08)*
Social Network	-0.29 (0.34)	*-0.06* *(0.07)*	-0.27 (0.34)	*-0.06* *(0.07)*	-0.07 (0.36)	*-0.01* *(0.07)*	-0.30 (0.34)	*-0.07* *(0.07)*	-0.34 (0.35)	*-0.07* *(0.07)*	-0.28 (0.36)	*-0.06* *(0.07)*
Minutes of Travel to Health Care Provider	0.01 (0.02)	*0.00* *(0.00)*	0.01 (0.02)	*0.00* *(0.00)*	0.01 (0.02)	*0.00* *(0.00)*	0.01 (0.02)	*0.00* *(0.00)*	0.01 (0.02)	*0.00* *(0.00)*	0.00 (0.02)	*0.00* *(0.00)*
Female	-0.38 (0.59)	*-0.08* *(0.13)*	-0.31 (0.56)	*-0.07* *(0.12)*	-0.23 (0.49)	*-0.04* *(0.09)*	-0.24 (0.55)	*-0.05* *(0.12)*	-0.12 (0.60)	*-0.03* *(0.13)*	-0.22 (0.59)	*-0.05* *(0.12)*
Parent Age	-0.04 (0.03)	*-0.01* *(0.01)*	-0.04 (0.03)	*-0.01* *(0.01)*	-0.04 (0.03)	*-0.01* *(0.00)*	-0.04 (0.03)	*-0.01* *(0.01)*	-0.04 (0.03)	*-0.01* *(0.01)*	-0.04 (0.03)	*-0.01* *(0.01)*
Log of Income	0.23 (0.22)	*0.05* *(0.05)*	0.25 (0.22)	*0.05* *(0.05)*	0.08 (0.20)	*0.01* *(0.04)*	0.10 (0.21)	*0.02* *(0.05)*	0.16 (0.21)	*0.03* *(0.04)*	0.28 (0.22)	*0.06* *(0.04)*
Years of Education	-0.03 (0.10)	*-0.01* *(0.02)*	-0.02 (0.10)	*-0.00* *(0.02)*	-0.01 (0.10)	*-0.00* *(0.02)*	0.01 (0.09)	*0.00* *(0.02)*	-0.01 (0.10)	*-0.00* *(0.02)*	-0.03 (0.10)	*-0.01* *(0.02)*
Religious	-0.01 (0.47)	*-0.00* *(0.10)*	0.07 (0.44)	*0.02* *(0.10)*	0.06 (0.49)	*0.01* *(0.09)*	0.14 (0.44)	*0.03* *(0.10)*	-0.07 (0.45)	*-0.02* *(0.09)*	-0.12 (0.46)	*-0.02* *(0.09)*
Constant	0.90 (2.41)		0.26 (2.34)		3.07 (2.34)		1.04 (2.26)		1.06 (2.23)		0.98 (2.39)	
Observations	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*

Table B3: Child Flu Vaccination, No Trust Variables

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) Gamble Logit	*(2) Gamble Marginal Effects*	(3) CRRA Logit	*(4) CRRA Marginal Effects*	(5) Vaccine Uncertainty Logit	*(6) Vaccine Uncertainty Marginal Effects*	(7) Disease Uncertainty Logit	*(8) Disease Uncertainty Marginal Effects*	(9) Relative Uncertainty Logit	*(10) Relative Uncertainty Marginal Effects*	(11) Combined Model Logit	*(12) Combined Model Marginal Effects*
Relative Uncertainty Dummy									**-1.12*** **	***-0.25****	**-1.13*** **	***-0.25****
									(0.32)	***(0.06)***	**(0.32)**	***(0.06)***
CRRA			**-0.12**	***-0.03***							**-0.12**	***-0.03***
			(0.08)	***(0.02)***							**(0.08)**	***(0.02)***
Vaccine Uncertainty					-0.67***	*-0.14****						
					(0.15)	*(0.02)*						
Contagious Disease Uncertainty							-0.01	*-0.00*				
							(0.15)	*(0.03)*				
Risk = 2	0.09	*0.02*										
	(0.83)	*(0.19)*										
Risk = 3	0.09	*0.02*										
	(0.65)	*(0.15)*										
Risk = 4	-0.03	*-0.01*										
	(0.65)	*(0.15)*										
Risk = 5	-0.36	*-0.08*										
	(0.85)	*(0.20)*										
Risk = 6	-0.55	*-0.13*										
	(0.61)	*(0.14)*										
Know Someone Who Had the Flu	0.01	*0.00*	-0.01	*-0.00*	0.04	*0.01*	0.03	*0.01*	-0.05	*-0.01*	-0.09	*-0.02*
	(0.37)	*(0.09)*	(0.35)	*(0.08)*	(0.39)	*(0.08)*	(0.35)	*(0.08)*	(0.37)	*(0.08)*	(0.37)	*(0.08)*
Social Network	-0.27	*-0.06*	-0.26	*-0.06*	-0.04	*-0.01*	-0.30	*-0.07*	-0.31	*-0.07*	-0.27	*-0.06*
	(0.33)	*(0.08)*	(0.33)	*(0.08)*	(0.36)	*(0.07)*	(0.34)	*(0.08)*	(0.35)	*(0.08)*	(0.36)	*(0.08)*
Minutes of Travel to Health Care Provider	0.01	*0.00*	0.01	*0.00*	0.00	*0.00*	0.01	*0.00*	0.00	*0.00*	0.00	*0.00*
	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*	(0.01)	*(0.00)*	(0.02)	*(0.00)*	(0.02)	*(0.00)*
Female	0.55	*0.13*	0.55	*0.13*	0.65	*0.14*	0.62	*0.15*	0.71	*0.16*	0.64	*0.14*
	(0.55)	*(0.13)*	(0.55)	*(0.13)*	(0.55)	*(0.11)*	(0.57)	*(0.14)*	(0.65)	*(0.14)*	(0.63)	*(0.14)*
Parent Age	-0.01	*-0.00*	-0.01	*-0.00*	-0.00	*-0.00*	-0.01	*-0.00*	-0.00	*-0.00*	-0.01	*-0.00*
	(0.02)	*(0.01)*	(0.02)	*(0.01)*	(0.02)	*(0.01)*	(0.02)	*(0.01)*	(0.02)	*(0.01)*	(0.03)	*(0.01)*
Log of Income	0.41*	*0.10***	0.39*	*0.09***	0.30	*0.06*	0.31	*0.07*	0.35*	*0.08**	0.44**	*0.10***
	(0.21)	*(0.05)*	(0.21)	*(0.05)*	(0.19)	*(0.04)*	(0.19)	*(0.05)*	(0.19)	*(0.04)*	(0.20)	*(0.04)*
Years of Education	-0.06	*-0.01*	-0.05	*-0.01*	-0.06	*-0.01*	-0.04	*-0.01*	-0.05	*-0.01*	-0.07	*-0.02*
	(0.09)	*(0.02)*	(0.09)	*(0.02)*	(0.09)	*(0.02)*	(0.09)	*(0.02)*	(0.09)	*(0.02)*	(0.09)	*(0.02)*
Religious	0.08	*0.02*	0.06	*0.01*	0.04	*0.01*	0.08	*0.02*	-0.11	*-0.02*	-0.13	*-0.03*
	(0.43)	*(0.10)*	(0.42)	*(0.10)*	(0.47)	*(0.10)*	(0.42)	*(0.10)*	(0.45)	*(0.10)*	(0.45)	*(0.10)*
Constant	-3.37		-3.14		-1.03		-2.99		-2.46		-2.57	
	(2.45)		(2.25)		(2.29)		(2.25)		(2.18)		(2.26)	
Observations	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*	182	*182*

Table B4: Parent Flu Vaccination, No Trust Variables

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1