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# Cueing quality: Unpacking country-of-origin effects on intentions to vaccinate against COVID-19 in Taiwan

Chun-Fang Chiang [a], Jason Kuo [b,*], Jin-Tan Liu [a]

[a] Department of Economics, National Taiwan University, Taiwan
[b] Department of Political Science, National Taiwan University, Taiwan

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ABSTRACT

While existing studies have reported and recognized country-of-origin effects on the intentions to vaccinate against COVID-19 among individual citizens in some countries, the causal mechanism behind such effects to inform public health policymakers remain unexplored. Adding up a quality cue explanation for such effects to the existing literature, the authors argue that individual consumers are less willing to get a vaccine designed and manufactured by a country with a significantly lower quality perception than other countries. A survey experiment that recruited a nationally representative sample of Taiwanese adults (n = 1951) between December 13, 2020 and January 11, 2021 was designed and conducted to test the argument. We find that all else equal, Taiwanese respondents were on average less likely to express stronger willingness to take a vaccine from China than from the US, Germany, and Taiwan. Furthermore, even when the intrinsic quality of the vaccine was held constant by the experimental design, respondents still had a significantly lower quality perception of the vaccine from China, both in terms of perceived protection and severe side effects. Further evidence from casual mediation analyses shows that about 33% and 11% of the total average causal effects of the "China" country-of-origin label on vaccine uptake intention were respectively mediated through the perceived efficacy of protection and perceived risk of experiencing severe side effects. We conclude that quality cue constitutes one of many casual mechanisms behind widely reported country-of-origin effects on intention to vaccinate against COVID-19.

## 1. Introduction

Vaccinations are important public health policy instruments to contain and eradicate emerging infectious diseases among humans (Anderson and May, 1992). According to estimates from the World Health Origination (WHO), at least 10 million deaths between 2010 and 2015 were prevented worldwide by vaccines (World Health Organization, 2020). The worldwide-threatening global pandemic of the novel coronavirus (COVID-19) has been no exception. Even though mass vaccinations cannot establish global herd immunity unless a significant proportion of individual citizens are willing to get vaccinated, some citizens remain hesitant to get vaccinated against COVID-19 than others.

While the well-established demand-side literature attributes vaccine intake intent to assorted personal traits of individuals, a growing line of supply-side research suggests that attributes of the vaccine candidate matter. One widely reported and recognized attribute of a COVID-19 vaccine that affects the intentions to get it among participants in public opinion surveys is the "designed-in" and "made-in" country-of-origin. However, the causal mechanism behind country-of-origin effects to inform public health policymakers remain empirically unexplored.

This study attempts to fill the gap. Borrowing insights from the marketing research on country-of-origin effects (Verlegh and Steenkamp, 1999), we argue that the "designed-in" and "made-in" country-of-origin labels cognitively function as quality cues that help consumers judge the unobserved intrinsic quality of the newly developed and produced COVID-19 vaccines and in turn shape their intentions to vaccinate against COVID-19. More substantively, we find that consumers in Taiwan tend to avoid vaccines from a country, which is China in the survey experiment, associated with significantly lower perceived quality. We also conduct casual mediation analyses to show that about 33% and 11% of the total average treatment effects of the "China" country-of-origin label on vaccine uptake intention are mediated respectively through the perceived efficacy of protection and perceived risk of severe side effects. This new set of evidence suggests that quality cue is indeed one of many potential casual mechanisms behind country-of-origin effects.

* Corresponding author.
*E-mail addresses:* chunfang@ntu.edu.tw (C.-F. Chiang), jasonkuo@ntu.edu.tw (J. Kuo), liujt@ntu.edu.tw (J.-T. Liu).

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Our study is consistent with some other survey experiments implemented in the US and China around the same time (Dong et al., 2020; Kreps et al., 2020; Motta, 2021). It also points to a promising research avenue in search for other potential causal mechanisms behind country-of-origin effects beyond quality cue, such as the politicization of vaccines in the emerging literature (e.g. Bokemper et al., 2021; Callaghan et al., 2021; Gadarian et al., 2021).

### 1.1. Explaining the COVID-19 vaccine hesitancy

Two strands of research have proliferated to explain the COVID-19 vaccine hesitancy at the individual level. The demand-side literature has attributed vaccine intake intent to assorted individuals' traits from studies conducted in various countries over the past two years (Cerda and García, 2021; Detoc et al., 2020; Ditekemena et al., 2021; Faasse and Newby, 2020; Gadarian et al., 2021; Graffigna et al., 2020; Guidry et al., 2021; Harapan et al., 2020; Jiang et al., 2020; Kourlaba et al., 2021; Karlsson et al. 2021; Lin et al., 2020; Machida et al., 2021; Muqattash et al., 2020; Paul et al., 2021; Reiter et al., 2020; Robertson et al., 2021; Sarasty et al., 2020; Sherman et al., 2020; Tobin et al., 2021; Wang et al., 2021; Wong et al., 2020; Zhang et al., 2021). Grounded in the well-established Health Belief Model (Rosenstock, 1974) and Theory of Planned Behavior (Ajzen, 1985, 1991), these studies explain why some people have been more willing than others to vaccinate against COVID-19 by personal traits. Nevertheless, these studies cannot explain why some vaccine candidates are more popular to be vaccinated than others.

This leads to the supply-side strand of experimental research on the effects of various vaccine attributes on willingness to receive vaccination among individual citizens. In Australia, Borriello et al. (2021) find that utilities of individuals increased with the effectiveness of a vaccine and yet decreased with the number of cases reporting mild and severe side effects, time until the vaccine was available, and price using a stated preference discrete choice experiment. In China, Dong et al. (2020) conduct a similar discrete choice experiment online and find a strong preference for a vaccine that was more effective, with longer protective duration, with very few adverse events, and being manufactured abroad. Administering a conjoint experiment in a demographically representative sample of adults in the United States, Motta (2021) finds that respondents preferred vaccines that were domestically produced, over 90% effective, and carried a less than 1% risk of minor side effects. Furthermore, vaccines that were politically endorsed by public figures could undermine beliefs about their safety and efficacy as well as the willingness to receive them among adult respondents in a pair of endorsement survey experiments in the US, as Bokemper et al. (2021) show.

### 1.2. Country-of-origin labels as quality cues

This article engages proliferating research cited above, with a focus on the country of origin. In this line of research, country of origin is a widely reported and recognized attribute of vaccine. Yet, it produces mixed empirical evidence. For example, Motta (2021) finds that US adults preferred the vaccine produced by a domestic company to a foreign one. However, Dong et al. (2020) find that the Chinese adults preferred imported vaccines to their domestic counterparts. While the country-of-origin label matters, it remains unclear how it works.

Marketing research has established that country-of-origin label is a crucial factor for a company's brand positioning strategy (Verlegh and Steenkamp, 1999). Such new pharmaceutical products as COVID-19 vaccines entering the global market during the global pandemic are no exception. Since consumers cannot directly observe the intrinsic quality attributes of any newly developed vaccine, its extrinsic country-of-origin labels provide them a cognitively helpful shortcut to evaluate the competing vaccine candidates and to avoid the one with the least perceived quality of protecting them from being infected with the coronavirus or bringing about severe side effects. In other words, the "made-in" and "designed-in" country-of-origin labels function as *quality cues* to mediate differential preferences for COVID-19 vaccines by their country-of-origin labels among consumers. Below this study tests this quality cue explanation for country-of-origin effects on the intention for COVID-19 vaccination against empirical data.

## 2. Methods

### 2.1. Recruitment of respondents

Two waves of online surveys were conducted first between December 13 and 19 in 2020 and then between January 11 and 17 in 2021 through two separate opt-in panels managed by two marketing research companies, Pollster and Chinese Marketing Information Service Inc., respectively. The two companies used quota sampling to ensure representativeness for the adult population that included men and women, aged between 20 and 55, and resided in the four geographic regions of Taiwan. The two waves of survey shared the same study design approved by National Taiwan University's Research Ethics Committee (NTU-REC No.: 202011HS024) despite the difference in the sample size: 1200 for the December 2020 wave and 751 for the January 2021 follow-up. Hence, data from the two waves of survey could be pooled together as a full sample for empirical analysis.

Since WHO officially declared COVID-19 a Public Health Emergency of International Concern (PHEIC) on February 12, 2020, governments around the world have mainly relied on a variety of non-pharmaceutical interventions (NPIs) to contain the spread of the novel coronavirus. Meanwhile, vaccine manufacturers have sped up the development of COVID-19 vaccine candidates to meet the urgent worldwide demand. As of the time of conducting the survey, the first emergency use authorization of a COVID-19 vaccine to the Pfizer/BioNTech was just issued by the US Food and Drug Administration (FDA) and WHO, respectively on December 11 and 31, 2020. In other words, the quality of COVID-19 vaccine candidates remained highly uncertain for Taiwanese respondents recruited in the two waves of survey.

### 2.2. Experimental vignettes

The identical experimental protocol was built in each wave of survey and administered by the corresponding company in charge. Each recruited respondent was randomly assigned to one of the five experimental vignettes describing assorted attributes of a hypothetical vaccine through the company's own Qualtrics-like online survey platform. Before being exposed to the experimental vignette, each respondent was asked for demographic backgrounds, personal health status, and past health behaviors. These pre-treatment questions were included to check if the random assignment succeeded.

The five experimental vignettes were identical in describing all attributes of the hypothetical vaccine except this study's primary focus: country-of-origin. At the time of designing and implementing this experiment, pharmaceutical companies leading the vaccine development and being covered by local media were mostly from the following three countries—China, the US, and Germany. Hence, these foreign country labels were included with respondents' home country label—Taiwan—as the four country-of-origin treatments in this randomized experiment. Unlike the other four, the fifth experimental vignette did not specify the country of origin at all. Doing so made it the benchmark to be compared with the other four treatment groups.

To avoid losing experimental control of some widely recognized attributes of the vaccine other than country-of-origin in respondents' minds, we intentionally held them constant in the experiment. More specifically, the Phase of clinical trials was set at III, the efficacy rate of protection was 95%, period of protection 12 months, severe side effects on humans non-existent, and availability for global market distribution mid-2021 no matter which country-of-origin treatment—China, the US,

Germany, Taiwan, or unspecified—was given to respondents in vignettes across experimental groups. The exact wordings of the experiment vignettes translated from Chinese to English read as follows:

> *Imagine a vaccine designed and manufactured by a company [Control] (from China [Country 1], the US [Country 2], Germany [Country 3] or Taiwan [Country 4]) against COVID-19 that will be available in the mid-2021: the vaccine already passed Phase III trials, believed to protect people from getting infected with COVID-19 in 12 months with the 95% efficacy rate, and nearly no evidence showing its severe side effects on humans.*

### 2.3. Measuring vaccine uptake intention

Immediately after the experimental vignettes describing the vaccine, the respondent was asked the following question:

> *"If this is the only vaccine that Taiwan can have by the end of 2021, will you be willing to take the COVID-19 vaccine?"*

Since progress in COVID-19 vaccine development has been constantly updated and covered by the local media, the question was carefully worded to direct respondents to think about the vaccine described in the randomly assigned experimental vignette only. Initial responses to this question were on a six-point scale, with the value of 1 for "completely unwilling," 2 ″very unwilling," 3 ″somewhat unwilling," 4 ″somewhat willing," "very willing," and 6 ″completely willing." Hence, the main outcome variable of vaccine uptake intention, or *Intended*, is ordinal.

### 2.4. Measuring quality perception

Two follow-up questions about the quality perception of the vaccine were put right after the outcome question. One asked each respondent for the subjective probability that he or she would *not* get infected with COVID-19 within 12 months after getting the randomly assigned vaccine, and the other for the counterpart that he or she would experience severe side effects after getting the randomly assigned vaccine. When answering each question, respondents were able to rate on a percentage scale from 0 to 100 with a fixed interval of 10. The two questions were intentionally designed to validate the causal mechanism such that each specific country-of-origin label cues the quality of the newly developed COVID-19 vaccine under a low-information environment for vaccination. Thus, the two outcome variables for quality perception, or *Protected* and *Side Effects*, are ordinal as well.

### 2.5. Hypotheses

The authors expect differential preferences for the newly developed pharmaceutical product of the COVID-19 vaccine by country-of-origin among individuals. If the quality cue explanation is correct, such a cross-national product differentiation should occur among respondents not only to the vaccine uptake intention (H1) but also to the quality perception of the vaccine measured by the subjective probability of risking severe side effects and that of being protected by the vaccine (H2). Furthermore, because the intention to get a vaccine follows its quality perception, we also expect that respondents are less likely to express their stronger willingness to get the vaccine from a country with a lower quality perception than the others (H3).

### 2.6. Estimation strategy

To test the three hypotheses, we created five experimentally manipulated country-of-origin treatment indicators, respectively for China (Country 1), Germany (Country 2), the US (Country 3), Taiwan (Country 4), and unspecified (Control). For each hypothesis, we regressed each corresponding ordinal outcome variables on these country-of-origin treatment indicators using the method of ordered probit with robust standard errors in the full sample (Liao, 1994: 25–41; Long, 1997: 114–145). Since the randomization slightly failed to produce a balanced distribution of some demographical covariates across randomly assigned experimental groups (as shown in Table A1 of the appendix), we included an extensive set of pre-treatment demographical covariates in all regression models to obtain relatively conservative estimates of the average treatment effects for these country-of-origin labels.

Table 1 presents the summary statistics for our outcome variable of vaccine uptake intention, quality percetion measures, treatment indicators, and demographical covariates in this study. At the end of this article also provides detailed description of how each of these variables was operationalized.

## 3. Primary results

### 3.1. Average treatment effects

Results from statistical analyses of the survey experiment (N = 1951) support all three hypotheses. Column (1) of Table 2 reports ordered probit coefficient estimates of the average treatment effects on vaccine uptake intention. As expected in H1, there are differential responses among respondents to these randomly assigned country labels. Estimated coefficient of "China" country label is significantly negative while its "Germany," "US," and "Taiwan" counterparts respectively fail to be statistically distinguished from zero. In other words, other things being equal, respondents are significantly *less* likely to express their stronger willingness to get the vaccine designed and manufactured by a company from China than from Germany, the US, and Taiwan.

Columns (2) and (3) of Table 2 report ordered probit coefficient estimates of the average treatment effects on perceived severe side effects and perceived protection, respectively. Again, estimated coefficient of "China" country label is significantly positive for perceived severe side effects and yet significantly negative for perceived protection. Meanwhile, "Germany," "US," and "Taiwan" counterparts respectively fail to

**Table 1**
Summary statistics.

| VARIABLES | Obs | Mean | Sd | Min | Max |
|---|---|---|---|---|---|
| **Outcomes** | | | | | |
| *Intended* | 1951 | 3.637 | 1.317 | 0 | 6 |
| *Protected* | 1951 | 56.80 | 24.89 | 0 | 100 |
| *Side Effect* | 1951 | 44.25 | 24.68 | 0 | 100 |
| **Treatments** | | | | | |
| China | 1951 | 0.195 | 0.396 | 0 | 1 |
| Germany | 1951 | 0.200 | 0.400 | 0 | 1 |
| US | 1951 | 0.195 | 0.396 | 0 | 1 |
| Taiwan | 1951 | 0.209 | 0.406 | 0 | 1 |
| **Covariates** | | | | | |
| Age | 1951 | 38.38 | 9.719 | 20 | 55 |
| Male | 1951 | 0.484 | 0.500 | 0 | 1 |
| Job | 1951 | 0.777 | 0.417 | 0 | 1 |
| College | 1951 | 0.737 | 0.441 | 0 | 1 |
| Risk taker | 1951 | 2.285 | 1.070 | 1 | 5 |
| Flu shot | 1951 | 0.196 | 0.397 | 0 | 1 |
| Chronic illness | 1951 | 0.138 | 0.345 | 0 | 1 |
| Conservative ideology | 1951 | 2.718 | 0.678 | 1 | 5 |
| Having a child | 1951 | 0.319 | 0.466 | 0 | 1 |
| Having an elder | 1951 | 0.279 | 0.449 | 0 | 1 |
| Family income level 0 | 1951 | 0.067 | 0.251 | 0 | 1 |
| Family income level 1 | 1951 | 0.162 | 0.369 | 0 | 1 |
| Family income level 2 | 1951 | 0.330 | 0.470 | 0 | 1 |
| Family income level 3 | 1951 | 0.331 | 0.471 | 0 | 1 |
| Family income level 4 | 1951 | 0.110 | 0.313 | 0 | 1 |
| North | 1951 | 0.460 | 0.499 | 0 | 1 |
| Central | 1951 | 0.244 | 0.430 | 0 | 1 |
| South | 1951 | 0.266 | 0.442 | 0 | 1 |
| 2021 sample | 1951 | 0.385 | 0.487 | 0 | 1 |
| Trust in Chinese govt | 1951 | 2.274 | 2.45 | 0 | 10 |

**Table 2**
Primary results from the full sample, ordered probit estimates.

| Outcome | (1) | (2) | (3) |
|---|---|---|---|
| | *Intended* | *Side Effects* | *Protected* |
| **Treatments** | | | |
| China | −0.553*** | 0.263*** | −0.447*** |
| | (0.788) | (0.075) | (0.073) |
| Germany | −0.043 | 0.091 | 0.021 |
| | (0.073) | (0.071) | (0.072) |
| US | −0.059 | 0.135 | −0.025 |
| | (0.073) | (0.074) | (0.071) |
| Taiwan | −0.112 | −0.003 | 0.105 |
| | (0.073) | (0.070) | (0.072) |
| **Covariates** | Yes | Yes | Yes |
| **Cutoffs** | | | |
| Cutoff 1 | −1.329*** | −1.986*** | −1.690*** |
| | (0.242) | (0.241) | (0.226) |
| Cutoff 2 | −1.019*** | −0.943*** | −1.337*** |
| | (0.241) | (0.234) | (0.226) |
| Cutoff 3 | −0.262 | −0.562** | −1.150*** |
| | (0.239) | (0.234) | (0.225) |
| Cutoff 4 | 0.934*** | −0.258 | −0.895*** |
| | (0.240) | (0.234) | (0.223) |
| Cutoff 5 | 1.537*** | −0.076 | −0.703*** |
| | (0.242) | (0.234) | (0.224) |
| Cutoff 6 | | 0.644*** | −0.033 |
| | | (0.235) | (0.224) |
| Cutoff 7 | | 0.937*** | 0.275 |
| | | (0.235) | (0.224) |
| Cutoff 8 | | 1.267*** | 0.729*** |
| | | (0.235) | (0.225) |
| Cutoff 9 | | 1.675*** | 1.303*** |
| | | (0.238) | (0.226) |
| Cutoff 10 | | 1.93*** | 2.164*** |
| | | (0.239) | (0.236) |
| Observations | 1951 | 1951 | 1951 |
| Pseudo R-Squared | 0.049 | 0.009 | 0.023 |
| Log pseudolikelihood | −2920.913 | −4182.619 | −4161.833 |

Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.
For the full results that include estimates for covariates, please see appendix Table A2.

be statistically distinguished from zero for both outcome measures for quality perception. These results suggest that all else equal, the vaccine from China is more likely to be perceived by respondents with a greater chance of having severe side effects and a fewer chance of being protected than from Germany, the US, and Taiwan. Overall, these results support H2.

### 3.2. Substantive interpretations

To interpret such average treatment effects of "China" country label on ordinal vaccine uptake intention more substantively, the authors further compute changes in predicted probabilities of random assignment to "China" treatment across six ordinal outcomes of willingness to be vaccinated by setting the other variables at their mean values. Point estimates of these marginal effects and their corresponding 95% confidence intervals, as Fig. 1 shows, are all *above* zero for "completely unwilling," "very unwilling," and "somewhat unwilling" and all *below* zero for "somewhat willing," "very willing," and completely willing." In other words, centris paribus, respondents are *less* likely to have stronger willingness to get a vaccine from China.

We take similar steps to make substantive interpretations of how "China" country label may affect the two ordinally measured quality perception. Point estimates of marginal effects of "China" treatment and their corresponding 95% confidence intervals on the perceived chance of having severe side effects are plotted in Fig. 2. All else equal, respondents are *more* likely to worry about severe side effects with a greater subjective chance for the vaccine from China than otherwise. Likewise, Fig. 3 plots point estimates of marginal effects of "China" country label and their corresponding 95% confidence intervals on the perceived probability of being protected. Other things being equal, respondents are *less* likely to have a greater subjective chance of being protected by the vaccine from China.

Taken together, our primary results from a series of ordered probit analyses are consistent with H3 in a joint venture. That is, Taiwanese respondents are indeed less likely to express their stronger willingness to get the vaccine from a country with a lower quality perception than the others; and China was such a country shown in this study.

### 3.3. Robustness checks

One potential threat to this study's internal validity is that survey respondents may have reacted to the treatment of "China" country label simply because of their familiarity with COVID-19 vaccine development at the time of survey.[1] To empirically rule this alternative explanation out, the authors use the word count (each Chinese character was a word) of open-ended responses to the question of why they were willing or unwilling to vaccinate against COVID-19 as a proxy for respondent attentiveness to the treatment. We regard this a proper proxy for respondent attentiveness to the experimental treatment for two reasons. First, this open-ended question was put right after the outcome and quality perception questions for the experiment in each wave of the survey. Second, respondents who typed in more word counts to answer the open-ended question had to spend more time on the survey experiment. While not as perfect as the exact time spent on reading the experimental vignette, this is the best proxy we could come up with from this study.

In the full sample, there are 182 respondents who typed in "no" or "NA" for this open-ended question. These are clearly the respondents *inattentive* to the treatment. Thus, we do *not* expect to find any country-of-origin effects among them at all. By contrast, the remaining 1769 respondents who typed in meaningful answers should have been *attentive* to the treatment. Thus, we expect to find country-of-origin effects in this attentive subsample.

Fig. 4 further plots the word count distribution of the 1769 attentive respondents. The horizonal axis represented word count and the vertical one the frequency of Chinese character. The median word count is six. Thus, we can further split the 1769 attentive respondents into two groups, with the "less attentive" respondents whose typed in fewer than six in the word count distribution and the "more attentive" more than it. Doing so results in 897 less attentive respondents and 872 more attentive. If our experimental treatments of country labels were more effective among the more attentive respondents than the less attentive, as the alternative explanation suggests, we would expect stronger conditional average treatment effect of the "China" country label on vaccine uptake intention among the more attentive than the less attentive. Otherwise, the alternative explanation can be rejected.

Table 3 reports ordered probit estimates for split-sample analyses of country-of-origin effects on vaccine uptake intention. As expected, we find little cross-national product differentiation in vaccine uptake intention across randomly assigned groups of country labels among the 182 inattentive respondents in column (1). By contrast, the 1769 attentive respondents are significantly less likely to express stronger willingness to get vaccinated against COVID-19 as shown in column (2). Furthermore, "China" country label remains the only country-of-origin treatment that has a negative coefficient on vaccine uptake intention in columns (3) and (4), respectively.

To interpret the effect of "China" treatment substantively, we compute its marginal effects on probabilities for each of the six ordinal willingness to be vaccinated across four subsamples by setting the other variables at their mean values. As shown in Table 4, estimated substantive effects of "China" treatment on predicted probabilities for six

[1] The authors thank the reviewer to point this out.

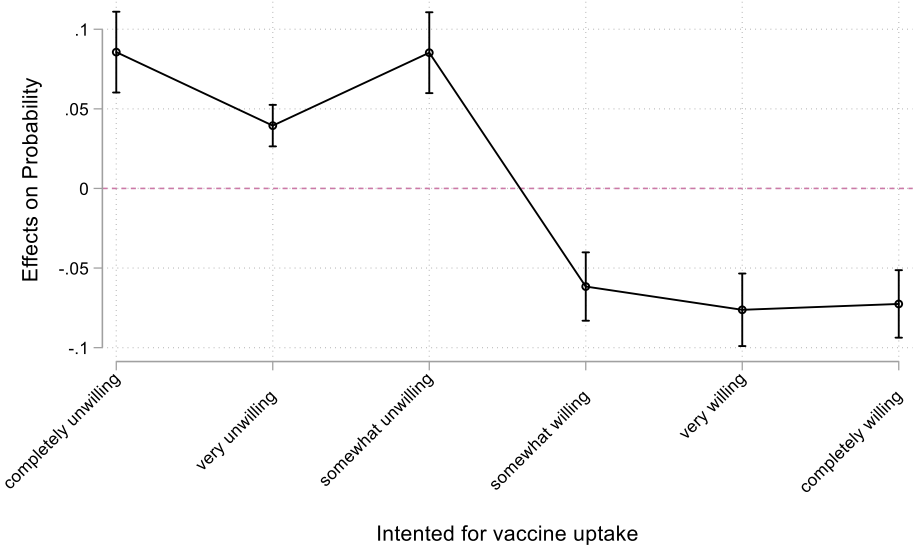


**Fig. 1.** Substantive effects of "China" treatment on vaccine uptake intention.

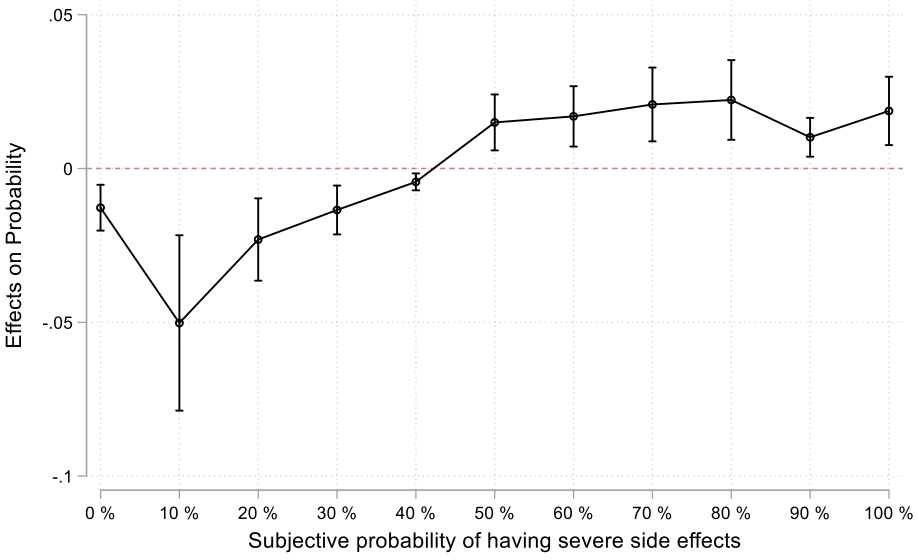


**Fig. 2.** Substantive effects of "China" treatment on perceived side effects.

ordinal outcomes are consistent among the 1769 attentive respondents no matter how attentive they were in the experiment. It is unlikely that our respondents reacted to the experimental treatment of "China" country label simply due to their past exposures to information about COVID-19 vaccine development at the time of entering our sample. Instead, the reported average treatment effects are not sensitive to the attentiveness of respondents.

### 3.4. Average causal mediation effects

While we have already demonstrated primary results in support of the three hypotheses above, whether the quality perception of the vaccine could mediate the average causal effects of the "China" treatment on vaccine uptake intention remains untested. To show the complete causal chain of how quality cue matters, we follow Motta, Callaghan, and Sylvester's (2018) empirical strategy of mediation analyses. That is, we document the degree to which the "China" country-of-origin label reduces vaccine uptake intention through perceived efficacy rate of protection and perceived risk of severe side effects using the STATA mediation package developed by Hicks and Tingley (2012). Because the available link function of the package is either continuous or binary, we recode the ordinal measures of vaccine uptake intention, perceived protection, and perceived side effects as binary alternatives base on substantive effects of "China" treatment on predicted probabilities in Figs. 1–3. Thus, we obtain an alternative dichotomous outcome variable of vaccine uptake intention, *D_Intended*, with the value of one for "completely willing," "very willing," and "somewhat willing," as well as zero for "somewhat unwilling," "very unwilling," and "completely unwilling." Likewise, we obtain one dichotomous mediating variable of perceived protection, *D_Protected*, with the value of one for any rated subjective probability of being protected equivalent to 60% or above; and the other dichotomous mediating variable of perceived severe side effects, *D_Side Effects*, with the value of one for any rated subjective probability of having severe side effects equal to 50% or above. With these dichotomous variables, we are able to estimate average casual mediation effects using the probit link function in the package.

Results from causal mediation analyses of the "China" country label are reported in Table 5. Column (1) shows that the treatment of "China" country label significantly reduces the perceived protection of the vaccine. Column (2) further shows that the same treatment significantly

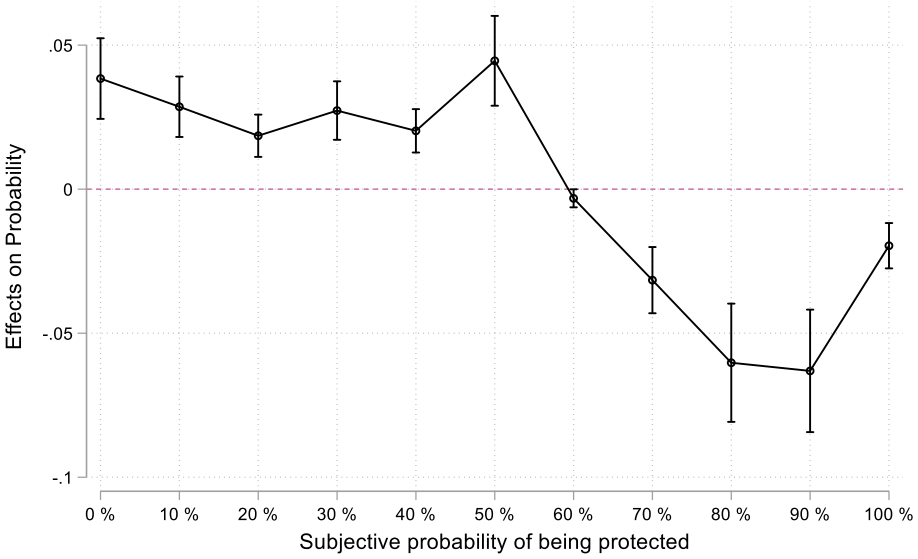


**Fig. 3.** Substantive effects of "China" treatment on perceived protection.

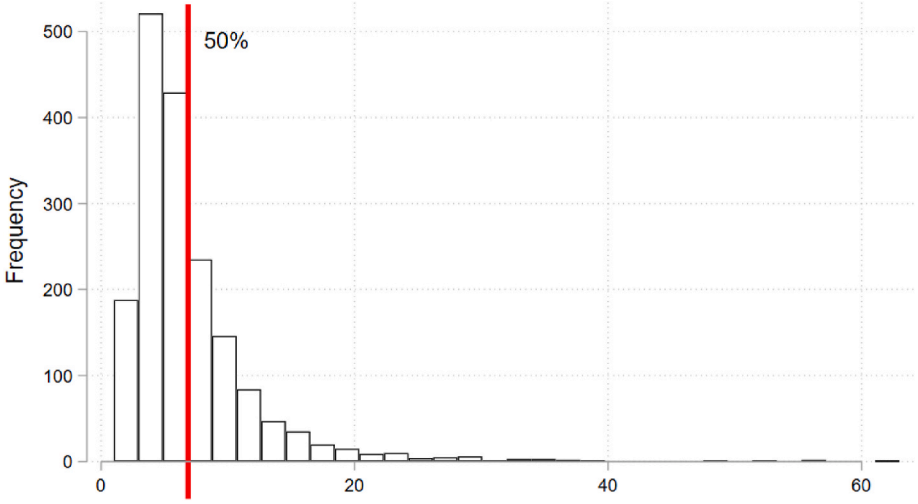


**Fig. 4.** The Distribution of Respondent Attentiveness by Word Count. (The inattentive are excluded; N = 1769).

reduces vaccine uptake intention not only directly by 14 percentage points *but also indirectly* through the perceived protection by 7 percentage points. Substantively speaking, about 33% of the total average treatment effect of "China" country-of-origin label on vaccine uptake intention is mediated through the perceived protection. Likewise, Column (3) shows that the same "China" country label treatment significantly reduces the perceived risk of experiencing severe side effects; and column (4) further demonstrates that such a treatment significantly reduces vaccine uptake intention not only directly by 16 percentage points *but also indirectly* through the perceived risk of experiencing severe side effects by 2 percentage points. More specifically, around 11% of the total average treatment effect of "China" country-of-origin label on vaccine uptake intention is mediated through the perceived risk of experiencing severe side effects. These results are consistent with our argument that country-of-origin labels function as quality cues to mediate the willingness to take a COVID-19 vaccine among individuals.

## 4. Discussions

The country-of-origin label matters in a way of generating public backlashes against the COVID-19 vaccine from a country with lower perceived quality in Taiwan. China is such a country that would significantly reduce public willingness to vaccinate against COVID-19 than its counterparts. This is in line with some other survey experiments implemented in the US around the same time (Motta, 2021; Kreps et al., 2020). It is also consistent with new experimental evidence of public preference for COVID-19 vaccines imported from abroad rather than produced domestically among Chinese consumers (Dong et al., 2020). In other words, our study shows that the internal validity of the country-of-origin effects on the intention to vaccinate against COVID-19 is well beyond the existing US and Chinese sample.

More importantly, this study unpacks the causal mechanism of quality cue behind widely recognized and reported country-of-origin effects. Our casual mediation analyses show that about 33% and 11% of the total effect of "China" country label on vaccine uptake intention are respectively mediated through the perceived efficacy rate of protection and risk of severe side effects. This new set of findings suggests that quality cue is indeed one of many potential casual mechanisms behind such effects.

So far Taiwan's Central Epidemic Command Center has not authorized the two internationally well-known vaccines designed and manufactured in China, namely Sinopharm and Sinovac, for domestic

**Table 3**
Split-sample analyses by respondent attentiveness, ordered probit estimates.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Outcome: *Intended* | The inattentive: with no reason | The attentive: with a reason | Less attentive: with a reason below median word count | More attentive: with a reason above median word count |
| **Treatments** | | | | |
| China | −0.301 | −0.563*** | −0.558*** | −0.539*** |
| | (0.270) | (0.0826) | (0.119) | (0.117) |
| Germany | 0.334 | −0.030 | −0.0615 | 0.123 |
| | (0.263) | (0.077) | (0.106) | (0.112) |
| US | 0.217 | −0.067 | −0.009 | −0.099 |
| | (0.287) | (0.076) | (0.106) | (0.109) |
| Taiwan | 0.406 | 0.099 | 0.076 | 0.157 |
| | (0.246) | (0.077) | (0.109) | (0.111) |
| **Cutoffs** | | | | |
| Cutoff 1 | −1.269* | −1.399*** | −1.488*** | −1.354*** |
| | (0.738) | (0.255) | (0.341) | (0.399) |
| Cutoff 2 | −0.822 | −1.101*** | −1.180*** | −1.055*** |
| | (0.735) | (0.253) | (0.339) | (0.396) |
| Cutoff 3 | 0.113 | −0.355 | −0.462 | −0.264 |
| | (0.734) | (0.252) | (0.337) | (0.396) |
| Cutoff 4 | 1.409* | 0.846*** | 0.812** | 0.895** |
| | (0.741) | (0.252) | (0.336) | (0.396) |
| Cutoff 5 | 1.948* | 1.460*** | 1.381*** | 1.577*** |
| | (0.760) | (0.254) | (0.341) | (0.398) |
| Observations | 182 | 1769 | 897 | 872 |
| Pseudo R-squared | 0.092 | 0.049 | 0.068 | 0.047 |
| Log pseudolikelihood | −256.526 | −2644.755 | −1311.952 | −1308.592 |

Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; The median word count for open-ended question about the reason of willingness or unwillingness to get vaccinated is about six Chinese characters. For the full results that include estimates for covariates, please see appendix Table A3.

**Table 4**
Substantive effects of "China" treatment on predicted probabilities from split-sample analyses.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | The inattentive: with no reason | The attentive: with a reason | Less attentive: with a reason below median word count | More attentive: with a reason above median word count |
| **Outcome** | | | | |
| completely unwilling | 0.048 | 0.086*** | 0.080*** | 0.082*** |
| | (0.042) | (0.013) | (0.018) | (0.019) |
| very unwilling | 0.031 | 0.038*** | 0.039*** | 0.037*** |
| | (0.029) | (0.007) | (0.009) | (0.009) |
| somewhat unwilling | 0.041 | 0.087*** | 0.086*** | 0.087*** |
| | (0.038) | (0.013) | (0.019) | (0.020) |
| somewhat willing | −0.069 | −0.056*** | −0.053*** | −0.058*** |
| | (0.064) | (0.011) | (0.015) | (0.015) |
| very willing | −0.029 | −0.079*** | −0.073*** | −0.082*** |
| | (0.027) | (0.012) | (0.016) | (0.019) |
| completely willing | −0.021 | −0.076*** | −0.079*** | −0.065*** |
| | (0.019) | (0.012) | (0.017) | (0.015) |
| Observations | 182 | 1769 | 897 | 872 |

Marginal effects on predicted probabilities are computed based on ordered probit models in Table 3. Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; The median word count for open-ended question about the reason of willingness or unwillingness to get vaccinated is about six Chinese characters.

**Table 5**
Causal mediation analyses, probit estimates.

| Outcome | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *D_Protected* | *D_Intended* | *D_Side Effects* | *D_Intended* |
| **Treatment** | | | | |
| China | −0.397*** | −0.508*** | 0.314*** | −0.525*** |
| | (0.094) | (0.106) | (0.093) | (0.099) |
| **Mediator** | | | | |
| *D_Protected* | | 1.384*** | | |
| | | (0.108) | | |
| *D_Side Effects* | | | | −0.772*** |
| | | | | (0101) |
| **Covariates** | Yes | Yes | Yes | Yes |
| Observations | 774 | 774 | 774 | 774 |
| Pseudo R-squared | 0.071 | 0.283 | 0.028 | 0.173 |
| Log likelihood | −495.359 | −382.793 | −511.637 | −441.773 |
| **Mediation** | | | | |
| ACM Effect | - | −0.07 | - | −0.02 |
| Direct Effect | - | −0.14 | - | −0.16 |
| Total Effect | - | −0.21 | - | −0.18 |
| % Mediated | - | 33% | - | 11% |

Simulated standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; For the full results that include estimates for covariates, please see appendix Table A4.

emergency use even if many other countries in the world and WHO have done so.[2] Our empirical evidence suggests a plausible reason for this intriguing public health policy phenomenon: The prevention of public backlashes against Chinese vaccines due to quality concerns. Yet, we believe that this needs not be the sole reason. Searching for other casual mechanisms behind country-of-origin effects beyond the quality cue explanation that we theoretically developed and empirically tested here may be a promising research avenue in the future as the literature on the politicization of vaccines has been emerging (e.g. Bokemper et al., 2021; Gadarian et al., 2021; Callaghan et al., 2021).

## Author credit statements

Chun-Fang Chiang: Conceptualization, Methodology, Investigation, Supervision; Jason Kuo: Conceptualization, Methodology, Investigation, Validation, Visualization, Writing; Jin-Tan Liu: Conceptualization,

[2] As of March 2022, only four COVID-19 vaccines were approved for use in Taiwan by its Central Epidemic Command Center. See https://covid19.trackvaccines.org/country/taiwan/.

Supervision, Funding acquisition, Project administration.

## The operationalization of variables

Below is the complete list of variables used in the paper with details on specific definition and measurement. The variables appear in the order of summary statistics.

**Intended:** An ordinal variable that takes the value of one if the respondent is "completely unwilling" to be vaccinated against COVID-19, two "very unwilling", three "somewhat unwilling", four "somewhat willing", five "very willing", and six "completely willing". It ranges from 1 to 6 with the internal of 1. *Scale:* 1, 2, …, 6.

**Protected:** An ordinal variable that measures the respondent's subjective efficacy rate of the COVID-19 vaccine. It ranges from 0 to 100 with the interval of 10. *Scale:* 0, 10, …, 100.

**Side effects:** An ordinal variable that measures the respondent's subjective probability of having serious side effects after taking the COVID-19 vaccine. Each point indicates the corresponding percentage of the probability of side effects. It ranges from 0 to 100 with the interval of 10. *Scale:* 0, 10, …, 100.

**China:** A treatment indicator variable that takes the value of one if the respondent is randomly assigned to the treatment vignette with the country of origin label of "China"; and zero otherwise. *Scale:* 0, 1.

**Germany:** A treatment indicator variable that takes the value of one if the respondent is randomly assigned to the treatment vignette with the country of origin label of "Germany"; and zero otherwise. *Scale:* 0, 1.

**US:** A treatment indicator variable that takes the value of one if the respondent is randomly assigned to the treatment vignette with the country of origin label of "US"; and zero otherwise. *Scale:* 0, 1.

**Taiwan:** A treatment indicator variable that takes the value of one if the respondent is randomly assigned to the treatment vignette with the country of origin label of "Taiwan"; and zero otherwise. *Scale:* 0, 1.

**Age:** A continuous variable that represents the respondent's age.

**Male:** An indicator variable that takes the value of one if the respondent is male; and zero otherwise. *Scale:* 0, 1.

**Job:** An indicator variable that takes the value of one if the respondent has a job; and zero otherwise. *Scale:* 0, 1.

**College:** An indicator variable that takes the value of one if the respondent has a bachelor degree or above; and zero otherwise. *Scale:* 0, 1.

**Risk taker:** An ordinal variable measuring the respondent's risk attitude. It ranges 1 one to 5. The higher value of this variable, the more the respondent is against saving money in case of future financial emergencies. *Scale:* 1, 2, …, 5.

**Flu shot:** An indicator variable that takes the value of one if the respondent has ever taken any flu shot before; and zero otherwise. *Scale:* 0, 1.

**Chronic illness:** An indicator variable that takes the value one if the respondent has any chronic illness; and zero otherwise. *Scale:* 0, 1.

**Conservative ideology:** An ordinal variable measuring the respondent's view on the responsibility of government in tackling with the pandemic. It ranges from 1 to 5. The higher value of this variable, the more the respondent is to believe that each citizen should not count on the government during the pandemic. *Scale:* 1, 2, …, 5.

**Having a child:** An indicator variable that takes the value one if there is any child aged 12 years old or below in the respondent's family; zero otherwise. *Scale:* 0, 1.

**Having an elder:** An indicator variable that takes the value one if there is any elder aged 70 years old or above in the respondent's family; zero otherwise. *Scale:* 0.

**Family income level 0:** An indicator variable that takes the value one if the respondent's family income per month is below 20,001 NTD; zero otherwise. *Scale:* 0.

**Family income level 1:** An indicator variable that takes the value one if the respondent's family income per month is between 20,001 and 40,000 NTD; zero otherwise. *Scale:* 0, 1.

**Family income level 2:** An indicator variable that takes the value one if the respondent's family income per month is between 40,001 and 80,000 NTD; zero otherwise. *Scale:* 0, 1.

**Family income level 3:** An indicator variable that takes the value one if the respondent's family income per month is between 80,001 and 150,000 NTD; zero otherwise. *Scale:* 0, 1.

**Family income level 4:** An indicator variable that takes the value of one if the respondent's family income per month is above 150,001 NTD; zero otherwise. *Scale:* 0, 1.

**North:** An indicator variable that takes the value of one if the respondent is living in the northern region of Taiwan; zero otherwise. *Scale:* 0, 1.

**Central:** Indicator variable that takes the value of one if the respondent is living in the central region of Taiwan; zero otherwise. *Scale:* 0, 1.

**South:** Indicator variable that takes the value of one if the respondent is living in the southern region of Taiwan; zero otherwise. *Scale:* 0, 1.

**2021 sample:** Indicator variable that takes the value of one if the respondent is from the January 2021 sample; zero otherwise. *Scale:* 0, 1.

**Trust in Chinese govt**: An ordinal variable measuring the respondent's trust in the Chinese government. It ranges from 1 to 10. The higher value of this variable, the more the respondent trust the Chinese government. *Scale:* 1, 2, …, 10.

## Data availability

Data will be made available on request.

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## Appendix

**Table A1**
Demographic Balance Across Randomly Assigned Treatment Groups, Difference-in-Means Estimates

| VARIABLES | China | Germany | US | Taiwan | Control Mean | Observations |
|---|---|---|---|---|---|---|
| Age | −0.0106 (−0.699) | 0.489 (−0.695) | 0.376 (−0.699) | 0.327 (−0.687) | 38.14 | 1951 |
| Male | 0.0326 (−0.036) | 0.0226 (−0.0357) | 0.0379 (−0.036) | 0.0444 (−0.0353) | 0.457 | 1951 |
| College | −0.0768** (−0.0317) | −0.01 (−0.0314) | −0.0453 (−0.0317) | −0.0443 (−0.0311) | 0.772 | 1951 |
| Job | −0.0242 (−0.03) | 0.0233 (−0.0298) | 0.00737 (−0.03) | 0.0171 (−0.0295) | 0.772 | 1951 |
| Having a child | 0.0521 (−0.0335) | 0.031 (−0.0333) | 0.0600* (−0.0335) | 0.0921*** (−0.0329) | 0.272 | 1951 |

(*continued on next page*)

**Table A1** (*continued*)

| VARIABLES | China | Germany | US | Taiwan | Control Mean | Observations |
|---|---|---|---|---|---|---|
| Having an elder | 0.0154 (−0.0323) | −0.0151 (−0.0321) | 0.0233 (−0.0323) | 0.00107 (−0.0317) | 0.274 | 1951 |
| Risk taker | −0.0398 (−0.0769) | −0.081 (−0.0764) | −0.0635 (−0.0769) | −0.124 (−0.0756) | 2.348 | 1951 |
| Flu shot | −0.0007 (−0.0285) | 0.02 (−0.0284) | −0.0296 (−0.0285) | 0.011 (−0.0281) | 0.195 | 1951 |
| Chronic illness | −0.0264 (−0.0248) | 0.0194 (−0.0246) | −0.0238 (−0.0248) | 0.0201 (−0.0244) | 0.140 | 1951 |
| Conservative ideology | 0.0898* (−0.0487) | 0.0503 (−0.0484) | 0.0846* (−0.0487) | 0.104** (−0.0479) | 2.652 | 1951 |
| 2021 sample | 0.014 (−0.035) | 0.00647 (−0.0348) | 0.014 (−0.035) | −0.0122 (−0.0344) | 0.381 | 1951 |
| North | 0.000574 (−0.0359) | 0.0353 (−0.0356) | 0.0453 (−0.0359) | −0.0019 (−0.0352) | 0.444 | 1951 |
| Central | 0.0659** (−0.0309) | 0.0228 (−0.0307) | 0.000147 (−0.0309) | 0.0397 (−0.0303) | 0.218 | 1951 |
| South | −0.0518 (−0.0318) | −0.0584* (−0.0315) | −0.0518 (−0.0318) | −0.0467 (−0.0312) | 0.307 | 1951 |
| East | −0.0147 (−0.0124) | 0.000312 (−0.0123) | 0.00639 (−0.0124) | 0.00886 (−0.0122) | 0.0305 | 1951 |
| Family income level 0 | −0.0002 (0.0180) | 0.01606 (0.0179) | −0.00020 (0.018073) | −0.007021 (0.017765) | 0.659 | 1951 |
| Family income level 1 | 0.0269 (−0.0265) | −0.00349 (−0.0263) | 0.0112 (−0.0265) | −0.0223 (−0.026) | 0.160 | 1951 |
| Family income level 2 | −0.0541 (−0.0337) | −0.0678** (−0.0335) | −0.0594* (−0.0337) | −0.111*** (−0.0332) | 0.388 | 1951 |
| Family income level 3 | −0.028 (−0.0337) | 0.00577 (−0.0335) | 0.000975 (−0.0337) | 0.108*** (−0.0331) | 0.312 | 1951 |
| Family income level 4 | 0.0553** (−0.0225) | 0.0495** (−0.0224) | 0.0474** (−0.0225) | 0.032 (−0.0221) | 0.0736 | 1951 |
| Trust in Chinese govt | −0.12018 (0.17656)( | −0.06019 (0.01795) | −0.00020 (0.01807) | −0.00702 (0.01776) | 0.0659 | 1951 |

Standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

**Table A2**
Full Results from the Pooled Sample, Ordered Probit Estimates

| Outcome | (1) | (2 | (3) |
|---|---|---|---|
| | *Intended* | *Side Effects* | *Protected* |
| **Treatments** | | | |
| China | −0.553*** | 0.263*** | −0.447*** |
| | (0.078) | (0.075) | (0.073) |
| Germany | 0.0435 | 0.091 | 0.022 |
| | (0.073) | (0.071) | (0.072) |
| US | −0.059 | 0.135 | −0.025 |
| | (0.073) | (0.074) | (0.071) |
| Taiwan | 0.112 | −0.003 | 0.105 |
| | (0.073) | (0.070) | (0.072) |
| **Covariates** | | | |
| Age | 0.0007 | −0.003 | 0.001 |
| | (0.002) | (0.002) | (0.002) |
| Gender | 0.196*** | −0.146*** | 0.188*** |
| | (0.049) | (0.048) | (0.048) |
| Job | 0.026 | −0.048 | −0.039 |
| | (0.060) | (0.058) | (0.056) |
| Risk taker | −0.087*** | 0.032 | −0.0617*** |
| | (0.0247) | (0.024) | (0.024) |
| Flu shot | 0.486*** | −0.154*** | 0.193*** |
| | (0.062) | (0.057) | (0.058) |
| Chronic illness | 0.101 | 0.045 | −0.009 |
| | (0.074) | (0.069) | (0.071) |
| Conservative ideology | 0.014 | −0.102*** | 0.038 |
| | (0.038) | (0.038) | (0.039) |
| Having a child | 0.006 | 0.050 | −0.006 |
| | (0.052) | (0.049) | (0.050) |
| Having an elder | −0.041 | 0.180*** | −0.028 |
| | (0.054) | (0.053) | (0.052) |
| Family income level 1 | 0.066 | 0.176 | 0.065 |
| | (0.116) | (0.107) | (0.103) |
| Family income level 2 | 0.058 | 0.096 | 0.079 |
| | (0.108) | (0.099) | (0.097) |
| Family income level 3 | 0.187 | 0.062 | 0.277*** |
| | (0.109) | (0.102) | (0.099) |
| Family income level 4 | 0.529*** | −0.039 | 0.441*** |
| | (0.131) | (0.122) | (0.121) |
| North | −0.329* | 0.297* | −0.237 |
| | (0.144) | (0.144) | (0.135) |
| Central | −0.256 | 0.196 | −0.190 |
| | (0.149) | (0.148) | (0.139) |
| South | −0.336* | 0.255 | −0.240 |
| | (0.148) | (0.147) | (0.139) |
| 2021 Sample | 0.184*** | 0.0133 | −0.100** |
| | (0.053) | (0.0492) | (0.049) |
| Trust in Chinese govt | 0.058*** | 0.008 | 0.0532*** |
| | (0.010) | (0.010) | (0.009) |
| **Cutoffs** | Yes | Yes | Yes |
| Observations | 1951 | 1951 | 1951 |

Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; Coefficient estimates for cutoffs are reported in Table 2 of the main texts.

**Table A3**
Full Results for Respondent Attentiveness, Ordered Probit Estimates

| Outcome: *Intended* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | The inattentive | The attentive | Less attentive | More attentive |
| **Treatments** | | | | |
| China | −0.301 | −0.563*** | −0.558*** | −0.539*** |
| | (0.270) | (0.0826) | (0.119) | (0.117) |
| Germany | 0.334 | 0.0304 | −0.0615 | 0.123 |
| | (0.263) | (0.0766) | (0.106) | (0.112) |
| US | 0.217 | −0.0672 | −0.00896 | −0.0996 |
| | (0.287) | (0.0755) | (0.106) | (0.109) |
| Taiwan | 0.406* | 0.0993 | 0.0755 | 0.157 |
| | (0.246) | (0.0772) | (0.109) | (0.111) |
| **Covariates** | | | | |
| Age | −0.000499 | 0.000716 | 0.000116 | 0.000368 |
| | (0.00957) | (0.00266) | (0.00391) | (0.00370) |
| Gender | −0.00962 | 0.207*** | 0.283*** | 0.101 |
| | (0.186) | (0.0515) | (0.0726) | (0.0749) |
| Job | 0.353* | 0.00950 | 0.0829 | −0.0441 |
| | (0.196) | (0.0633) | (0.0939) | (0.0877) |
| Risk taker | −0.0341 | −0.0942*** | −0.158*** | −0.0471 |
| | (0.0901) | (0.0259) | (0.0392) | (0.0353) |
| Flu shot | 0.536** | 0.471*** | 0.514*** | 0.446*** |
| | (0.240) | (0.0642) | (0.0895) | (0.0926) |
| Chronic illness | −0.0343 | 0.135* | −0.0168 | 0.241** |
| | (0.226) | (0.0790) | (0.117) | (0.106) |
| Conservative ideology | −0.124 | 0.0258 | 0.0668 | −0.0103 |
| | (0.123) | (0.0396) | (0.0541) | (0.0593) |
| Having a child | −0.167 | 0.0305 | 0.0179 | 0.0457 |
| | (0.177) | (0.0547) | (0.0767) | (0.0802) |
| Having an elder | 0.0972 | −0.0408 | −0.130 | 0.0667 |
| | (0.181) | (0.0568) | (0.0840) | (0.0786) |
| Family income level 1 | 0.306 | 0.00590 | −0.276 | 0.310* |
| | (0.350) | (0.123) | (0.170) | (0.181) |
| Family income level 2 | 0.289 | −0.00424 | −0.185 | 0.215 |
| | (0.391) | (0.113) | (0.155) | (0.167) |
| Family income level 3 | 0.704* | 0.105 | −0.0453 | 0.257 |
| | (0.407) | (0.114) | (0.158) | (0.170) |
| Family income level 4 | 0.556 | 0.495*** | 0.122 | 0.881*** |
| | (0.424) | (0.138) | (0.193) | (0.204) |
| North | −0.933** | −0.309** | −0.287 | −0.307 |
| | (0.462) | (0.152) | (0.195) | (0.253) |
| Central | −0.449 | −0.275* | −0.271 | −0.297 |
| | (0.472) | (0.157) | (0.200) | (0.260) |
| South | −0.631 | −0.335** | −0.300 | −0.360 |
| | (0.475) | (0.156) | (0.201) | (0.257) |
| 2021 Sample | 0.126 | 0.188*** | 0.371*** | 0.0267 |
| | (0.186) | (0.0552) | (0.0834) | (0.0767) |
| Trust in Chinese govt | 0.117*** | 0.0538*** | 0.0779*** | 0.0271* |
| | (0.0349) | (0.0107) | (0.0155) | (0.0154) |
| **Cutoffs** | Yes | Yes | Yes | Yes |
| Observations | 182 | 1769 | 897 | 872 |

Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; Coefficient estimates for cutoffs are reported in Table 3 of the main texts.

**Table A4**
Full Results for Causal Mediation Analyses, Probit Estimates

| Outcome | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *D_Protected* | *D_Intended* | *D_Side Effects* | *D_Intended* |
| **Treatment** | | | | |
| China | −0.397*** | −0.508*** | 0.314*** | −0.525*** |
| | (0.094) | (0.106) | (0.093) | (0.099) |
| **Mediator** | | | | |
| *D_Protected* | | 1.384*** | | |
| | | (0.108) | | |
| *D_Side Effects* | | | | −0.772*** |
| | | | | (0101) |
| **Covariates** | | | | |
| Age | −0.004 | −0.001 | 0.002 | −0.001 |
| | (0.005) | (0.005) | (0.004) | (0.005) |
| Gender | 0.222** | 0.011 | −0.051 | 0.106 |
| | (0.096) | (0.107) | (0.094) | (0.101) |

(*continued on next page*)

**Table A4** (*continued*)

| Outcome | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *D_Protected* | *D_Intended* | *D_Side Effects* | *D_Intended* |
| Job | −0.064 | −0.075 | −0.185 | −0.147 |
| | (0.116) | (0.128) | (0.116) | (0.121) |
| Risk taker | −0.115** | −0.009 | −0.009 | −0.064 |
| | (0.045) | (0.049) | (0.044) | (0.046) |
| Flu shot | −0.040 | 0.354** | −0.067 | 0.394** |
| | (0.119) | (0.136) | (0.118) | (0.129) |
| Chronic illness | −0.040 | −0.047 | 0.136 | −0.013 |
| | (0.145) | (0.162) | (0.143) | (0.152) |
| Conservative ideology | −0.091 | −0.030 | −0.098 | −0.092 |
| | (0.069) | (0.078) | (0.069) | (0.073) |
| Having a child | 0.104 | 0.046 | −0.098 | 0.072 |
| | (0.105) | (0.117) | (0.104) | (0.110) |
| Having an elder | −0.171 | −0.220 | 0.268** | −0.209 |
| | (0.106) | (0.118) | (0.105) | (0.111) |
| Family income level 1 | −0.090 | 0.011 | 0.290 | 0.059 |
| | (0.216) | (0.242) | (0.213) | (0.228) |
| Family income level 2 | −0.105 | −0.079 | 0.260 | −0.034 |
| | (0.202) | (0.228) | (0.200) | (0.214) |
| Family income level 3 | 0.124 | 0.228 | 0.114 | 0.296 |
| | (0.212) | (0.240) | (0.209) | (0.225) |
| Family income level 4 | 0.239 | 0.477 | 0.066 | 0.577** |
| | (0.101) | (0.282) | (0.243) | (0.268) |
| North | −0.189 | −0.705 | 0.189 | −0.586 |
| | (0.318) | (0.389) | (0.309) | (0.357) |
| Central | −0.277 | −0.525 | 0.162 | −0.506 |
| | (0.324) | (0.395) | (0.316) | (0.363) |
| South | −0.307 | −0.599 | 0.230 | −0.560 |
| | (0.321) | (0.393) | (0.313) | (0.360) |
| 2021 Sample | 0.029 | 0.500*** | −0.081 | 0.442*** |
| | (0.029) | (0.113) | (0.100) | (0.107) |
| Trust in Chinese govt | 0.098*** | 0.086*** | −0.013 | 0.123*** |
| | (0.019) | (0.022) | (0.019) | (0.020) |
| Constant | 0.665 | 0.077 | 0.024 | 1.253** |
| | (0.464) | (0.550) | (0.455) | (0.510) |
| Observations | 774 | 774 | 774 | 774 |
| Pseudo R-squared | 0.071 | 0.283 | 0.028 | 0.173 |
| Log likelihood | −495.359 | −382.793 | −511.637 | −441.773 |
| **Mediation** | | | | |
| ACM Effect | - | −0.07 | - | −0.02 |
| Direct Effect | - | −0.14 | - | −0.16 |
| Total Effect | - | −0.21 | - | −0.18 |
| % Mediated | - | 33% | - | 11% |

Simulated standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

## References


Ajzen, I., 1985. From intentions to actions: a theory of planned behavior. In: Kuhl, J., Beckman, J. (Eds.), Action-Control: from Cognition to Behavior. Springer, Heidelberg, pp. 11–39.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Anderson, Roy M., May, Robert M., 1992. Infectious Diseases of Humans: Dynamics and Control. Oxford University Press.

Bokemper, S.E., Huber, G.A., Gerber, A.S., James, E.K., Omer, S.B., 2021. Timing of COVID-19 vaccine approval and endorsement by public figures. Vaccine 39 (5), 825–829. https://doi.org/10.1016/j.vaccine.2020.12.048.

Borriello, A., Master, D., Pellegrini, A., Rose, J.M., 2021. Preferences for a COVID-19 vaccine in Australia. Vaccine 39 (3), 473–479. https://doi.org/10.1016/j.vaccine.2020.12.032.

Callaghan, T., Moghtaderi, A., Lueck, J.A., Hotez, P., Strych, U., Dor, A., Fowler, E.F., Motta, M., 2021. Correlates and disparities of intention to vaccinate against COVID-19. Soc. Sci. Med. 272, 113638 https://doi.org/10.1016/j.socscimed.2020.113638.

Cerda, A.A., García, L.Y., 2021. Willingness to pay for a COVID-19 vaccine. Appl. Health Econ. Health Pol. 19 (3), 343–351. https://doi.org/10.1007/s40258-021-00644-6.

Detoc, M., Bruel, S., Frappe, P., Tardy, B., Botelho-Nevers, E., Gagneux-Brunon, A., 2020. Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic. Vaccine 38 (45), 7002–7006. https://doi.org/10.1016/j.vaccine.2020.09.041.

Ditekemena, J.D., Nkamba, D.M., Mutwadi, A., Mavoko, H.M., Siewe Fodjo, J.N., Luhata, C., Obimpeh, M., Van Hees, S., Nachega, J.B., Colebunders, R., 2021. Covid-19 vaccine acceptance in the Democratic Republic of Congo: a cross-sectional survey. Vaccines 9 (2), 153. https://doi.org/10.3390/vaccines9020153.

Dong, D., Xu, R.H., Wong, E.L., Hung, C.T., Feng, D., Feng, Z., Yeoh, E.K., Wong, S.Y., 2020. Public preference for COVID-19 vaccines in China: a discrete choice experiment. Health Expect. 23 (6), 1543–1578. https://doi.org/10.1111/hex.13140.

Faasse, K., Newby, J., 2020. Public perceptions of COVID-19 in Australia: perceived risk, knowledge, health-protective behaviors, and vaccine intentions. Front. Psychol. 551004 https://doi.org/10.3389/fpsyg.2020.551004.

Gadarian, S.K., Goodman, S.W., Pepinsky, T.B., 2021. Partisanship, health behavior, and policy attitudes in the early stages of the COVID-19 pandemic. PLoS One 16 (4), E0249596. https://doi.org/10.1371/journal.pone.0249596.

Graffigna, G., Palamenghi, L., Boccia, S., Barello, S., 2020. Relationship between citizens' health engagement and intention to take the Covid-19 vaccine in Italy: a mediation analysis. Vaccines 8 (4), 576. https://doi.org/10.3390/vaccines8040576.

Guidry, J., Laestadius, L.I., Vraga, E.K., Miller, C.A., Perrin, P.B., Burton, C.W., Ryan, M., Fuemmeler, B.F., Carlyle, K.E., 2021. Willingness to get the COVID-19 vaccine with and without emergency use authorization. Am. J. Infect. Control 49 (2), 137–142. https://doi.org/10.1016/j.ajic.2020.11.018.

Harapan, H., Wagner, A.L., Yufika, A., Winardi, W., Anwar, S., Gan, A.K., Setiawan, A.M., Rajamoorthy, Y., Sofyan, H., Vo, T.Q., Hadisoemarto, P.F., Müller, R., Groneberg, D. A., Mudatsir, M., 2020. Willingness-to-pay for a COVID-19 vaccine and its associated determinants in Indonesia. Hum. Vaccines Immunother. 16 (12), 3074–3080. https://doi.org/10.1080/21645515.2020.1819741.

Hicks, R., Tingley, D., 2012. Causal mediation analysis. STATA J. 14 (4), 605–619. https://doi.org/10.1177/1536867X1201100407.

Jiang, M., Feng, L., Wang, W., Gong, Y., Ming, W.K., Hayat, K., Li, P., Gillani, A.H., Yao, X., Fang, Y., 2020. Knowledge, attitudes, and practices towards influenza among Chinese adults during the epidemic of COVID-19: a cross-sectional online survey. Hum. Vaccines Immunother. 17 (5), 1412–1419. https://doi.org/10.1080/21645515.2020.1812312.

Karlsson, Linda C., Soveri, Anna, Lewandowsky, Stephan, Karlsson, Linnea, Karlsson, Hasse, Nolvi, Saara, Karukivi, Max, Lindfelt, Mikael, Antfolk, Jan, 2021. Fearing the disease or the vaccine: the case of COVID-19. Pers. Indiv. Differ. 172 https://doi.org/10.1016/j.paid.2020.110590.

Kourlaba, G., Kourkouni, E., Maistreli, S., Tsopela, C.G., Molocha, N.M., Triantafyllou, C., Koniordou, M., Kopsidas, I., Chorianopoulou, E., Maroudi-Manta, S., Filippou, D., Zaoutis, T.E., 2021. Willingness of Greek general population

to get a COVID-19 vaccine. Global Health Res. Pol. 6 (1), 3. https://doi.org/10.1186/s41256-021-00188-1.
Kreps, S., Prasad, S., Brownstein, J.S., Hswen, Y., Garibaldi, B.T., Zhang, B., Kriner, D.L., 2020. Factors associated with US adults' likelihood of accepting COVID-19 vaccination. JAMA Netw. Open 3 (10), e2025594. https://doi.org/10.1001/jamanetworkopen.2020.25594.
Liao, T.F., 1994. Interpreting Probability Models: Logit, Probit and Other Generalized Linear Models. Sage, Thousand Oaks, CA.
Lin, Y., Hu, Z., Zhao, Q., Alias, H., Danaee, M., Wong, L.P., 2020. Understanding COVID-19 vaccine demand and hesitancy: a nationwide online survey in China. PLoS Neglected Trop. Dis. 14 (12), e0008961 https://doi.org/10.1371/journal.pntd.0008961.
Long, J.S., 1997. Regression Models for Categorical and Limited Dependent Variables. Thousand Oaks, CA: Sage.
Machida, M., Nakamura, I., Kojima, T., Saito, R., Nakaya, T., Hanibuchi, T., Takamiya, T., Odagiri, Y., Fukushima, N., Kikuchi, H., Amagasa, S., Watanabe, H., Inoue, S., 2021. Acceptance of a covid-19 vaccine in Japan during the covid-19 pandemic. Vaccines 9 (3), 210. https://doi.org/10.3390/vaccines9030210.
Motta, Matthew, Callaghan, T., Sylvester, S., 2018. Knowing less but presuming more: dunning-Kruger effects and the endorsement of anti-vaccine policy attitudes. Soc. Sci. Med. 211, 274–281. https://doi.org/10.1016/j.socscimed.2018.06.032.
Motta, Matt, 2021. Can a COVID-19 vaccine live up to Americans' expectations? a conjoint analysis of how vaccine characteristics influence vaccination intentions. Soc. Sci. Med. 272, 113642 https://doi.org/10.1016/j.socscimed.2020.113642.
Muqattash, R., Niankara, I., Traoret, R.I., 2020. Survey data for COVID-19 vaccine preference analysis in the United Arab Emirates. Data Brief 33, 106446. https://doi.org/10.1016/j.dib.2020.106446.
Paul, E., Steptoe, A., Fancourt, D., 2021. Attitudes towards vaccines and intention to vaccinate against COVID-19: implications for public health communications. The Lancet Regional Health - Europe 1, 100012. https://doi.org/10.1016/j.lanepe.2020.100012.
Reiter, P.L., Pennell, M.L., Katz, M.L., 2020. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? Vaccine 38 (42), 6500–6507. https://doi.org/10.1016/j.vaccine.2020.08.043.
Robertson, E., Reeve, K.S., Niedzwiedz, C.L., Moore, J., Blake, M., Green, M., Katikireddi, S.V., Benzeval, M.J., 2021. Predictors of COVID-19 vaccine hesitancy in the UK household longitudinal study. Brain Behav. Immun. 94, 41–50. https://doi.org/10.1016/j.bbi.2021.03.008.
Rosenstock, I.M., 1974. The health belief model and preventive health behavior. Health Educ. Behav. 2 (4), 354–386. https://doi.org/10.1177/109019817400200405.
Sarasty, O., Carpio, C.E., Hudson, D., Guerrero-Ochoa, P.A., Borja, I., 2020. The demand for a COVID-19 vaccine in Ecuador. Vaccine 38 (51), 8090–8098. https://doi.org/10.1016/j.vaccine.2020.11.013.
Sherman, S.M., Smith, L.E., Sim, J., Amlôt, R., Cutts, M., Dasch, H., Rubin, G.J., Sevdalis, N., 2020. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-Sectional survey. Hum. Vaccines Immunother. 17 (6), 1612–1621. https://doi.org/10.1080/21645515.2020.1846397.
Tobin, Ekaete Alice, Okonofua, Martha, Azeke, Azuka, Ajekweneh, Vivian, George, Akpede, 2021. Willingness to acceptance a covid-19 vaccine in Nigeria: a population-based cross-sectional study. J. Media Res. 5 (2).
Verlegh, P.W.J., Steenkamp, J.B.E.M., 1999. A review and meta-analysis of coutnry-of-origin research. J. Econ. Psychol. 20, 521–546. https://doi.org/10.1016/S0167-4870(99)00023-9.
Wang, J., Lyu, Y., Zhang, H., Jing, R., Lai, X., Feng, H., Knoll, M.D., Fang, H., 2021. Willingness to pay and financing preferences for COVID-19 vaccination in China. Vaccine 39 (14). https://doi.org/10.1016/j.vaccine.2021.02.060.
Wong, L.P., Alias, H., Wong, P.F., Lee, H.Y., AbuBakar, Sazaly, 2020. The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay. Hum. Vaccines Immunother. 16 (9), 2204–2214. https://doi.org/10.1080/21645515.2020.1790279.
World Health Organization, 2020. The Power of Vaccines: Still Not Fully Utilized. WHO. https://www.who.int/publications/10-year-review/chapter-vaccines.pdf.
Zhang, Y., Luo, X., Ma, Z.F., 2021. Willingness of the general population to accept and pay for COVID-19 vaccination during the early stages of COVID-19 pandemic: a nationally representative survey in Mainland China. Hum. Vaccines Immunother. 17 (6), 1622–1627. https://doi.org/10.1080/21645515.2020.1847585.