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Vaccine attributes and vaccine uptake in Hungary: evidence from a conjoint experiment

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Background: In an ongoing public health crisis, the question of why some people are unwilling to take vaccines with particular attributes is an especially pertinent one, since low rates of vaccination mean that it will take longer for many nations to exit the coronavirus disease 2019 (COVID-19) pandemic. **Methods:** In this article, we conduct a pre-registered conjoint experiment in Hungary ($N = 2512$), where respondents were asked about their attitudes towards hypothetical COVID-19 vaccines whose characteristics varied across a number of attributes. **Results:** Results indicate that vaccine attributes matter for the likelihood of uptake when it comes to the prevalence of severe side effects, efficacy and country of origin. Moreover, we find that our pre-treatment measure of institutional trust moderates the effect of our treatment, as differences in vaccine attributes are larger for those with robust levels of institutional trust compared to those with weaker levels. **Conclusion:** Our findings suggest that institutional trust matters when it comes to understanding the relationship between vaccine attributes and likelihood of uptake.

Introduction

The development of safe and effective vaccines against the SARS-CoV-2 virus that causes coronavirus disease 2019 (COVID-19) has been labeled a 'game changer' in the global fight against the pandemic—but only if people actually get vaccinated. Recent research demonstrates that vaccine-specific attributes such as side effects, effectiveness and country of origin can all affect people's willingness to take a given vaccine.[1–8] In addition to these works, research has examined the role of institutional trust (e.g. in doctors, the scientific community and elected politicians) in shaping health-related behaviors during the COVID-19 pandemic. Higher levels of institutional trust facilitated greater compliance with protective behaviors during the early stages of the pandemic.[9] Elsewhere, research indicates that individuals with higher levels of trust in scientists are more likely to adopt health-related behavioral adjustments such as hand washing and social distancing than those with lower trust.[10] Studies from previous epidemics likewise provide evidence that individuals who exhibit high levels of institutional trust are more likely to take precautions and modify their behavior during health crises.[11,12]

In this article, we build on these existing works in three ways. First, we consider how additional attributes (e.g. the technology used to develop the vaccine or how different vaccines cost the government) affect vaccination intent. Second, we add data from an additional country (Hungary) near the beginning of the national vaccination campaign when whether or not to accept a vaccine was highly salient. Third, we examine how a measure of incumbent trust is associated with willingness to vaccinate. Institutional trust is associated with a variety of vaccine-related behaviors[9–12] but is lower in Hungary than most western European countries.[13]

Methods

Sample

We pre-registered our hypotheses as well as primary, and secondary analyses on OSF prior to collecting any data. Data were collected by the survey sampling company YouGov, who recruited $N = 2512$ adults living in Hungary. YouGov constructed general population weights, benchmarking our sample to Census estimates on demographic factors including age, sex and region. Section D of the Supplementary information file provides an overview of the demographic composition of our sample compared to estimates derived from the most recent Hungarian Census. As indicated here, a typical respondent is slightly more likely to be female than male, be 55 or older, and reside in Central Hungary.

Procedure and conjoint experimental research design

Prior to the experiment, respondents completed basic demographic information and information on institutional trust. Afterward, respondents were taken to a conjoint choice task. In each of the five scenarios, respondents were presented with two different hypothetical vaccines (vaccines A and B), which varied across seven dimensions (see table 1). In each scenario, respondents indicated on a scale ranging between 0 and 10 the raw likelihood of taking

Table 1 Conjoint experimental design

Attribute	Level 1	Level 2	Level 3	Level 4	Level 5
Side effects	1 in 10 000	1 in 100 000	1 in 1 000 000		
Effectiveness (%)	55	75	95		
Country of origin	China	Russia	UK	USA	Germany
Vaccine type	Live virus vaccine	Viral vector vaccine	Subunit vaccine	mRNA vaccine	
Vaccinated people	1 million	10 million	100 million		
Vaccine coverage	In 3 months	In 6 months	In 9 months		
Costs	10× population EUR/SEK	50× population EUR/SEK	100× population EUR/SEK		

such a vaccine (likelihood of uptake), and also indicated which of the two vaccines they preferred (vaccine choice). This design resulted in 10 uptake-likelihoods and 5 vaccine choices per respondent, totaling 25 089 uptake-likelihoods 9816 vaccine choices after listwise deletion of missing data.

Measures

Vaccine attributes

Table 1 provides an overview of the attributes and attribute levels used in the experiment. These attribute levels are meant to reflect the range of COVID-19 vaccines available at the time our study fielded. For instance, the levels for the country-of-origin attribute are informed by regulator-approved vaccines such as Sinovac (China), Sputnik V (Russia), AstraZeneca (UK), Moderna (USA) and Pfizer-BioNTech (Germany). Efficacy rates of 75% and 95% mirror results from clinical trials for the AstraZeneca and Moderna/Pfizer-BioNTech vaccines. Similarly, the vaccine costs are informed by available price information of COVID-19 vaccines.

Likelihood of vaccine uptake and vaccine choice

Our focal dependent variables measure a respondent's self-reported likelihood of vaccine uptake and vaccine choice. For each pair of vaccines, respondents were asked which vaccine they would prefer to take. They are also asked 'how likely would you be to choose each of the vaccines?' on a scale ranging between 0 = 'not at all likely', to 10 = 'extremely likely'.

Institutional trust

Our key moderator of interest is institutional trust. To measure institutional trust, we rely on a series of four items. In these items, respondents were asked on a five-point scale (1 = 'strongly agree', 5 = 'strongly disagree') to their extent of agreement or disagreement with the following statements: 'Those we elect to public office usually try to keep the promises they make during the election', 'Most public officials can be trusted to do what is right without our having to constantly check on them', 'You can generally trust the people in our government to do what is right' and 'Quite a few of the people running our government are not as honest as the voters have a right to expect'. All items are coded so that higher values were indicative of higher levels of trust. These items formed a highly reliable scale (Cronbach's $\alpha = 0.89$), and we took the average of them as a measure of institutional trust. For the subgroup analysis, we use tercile binning to define respondents by low trust, mid-trust and high trust.

Analytical strategy

In line with prior work,[8] we expect preferences for less common side effects, higher rates of vaccine efficacy and country of origin (i.e. Western vaccines vs. Russia and China), to exert a positive effect on vaccine acceptance among respondents. In addition, we expect to observe heterogeneous treatment effects through institutional trust. Therefore, we also conduct subgroup analyses by grouping respondents based on their levels of institutional trust (low, mid and high) and test for asymmetric responses to treatment.

To facilitate the interpretation of our results, we compute marginal means (MMs) for the effects of vaccine attributes on the likelihood of uptake and vaccine choice. MMs describe the average self-reported likelihood of a vaccine being accepted on a scale ranging between 0 and 10 when a vaccine has an attribute at a particular level (for instance, mRNA vaccine type). MMs are useful because they provide an estimate for the baseline level of vaccine uptake between the full sample and the subgroups binned by their levels of institutional trust.

Our analysis was pre-registered as average marginal component effects (AMCEs), which estimate treatment effects when vaccine attributes are altered to a reference level (for instance, Germany relative to China).[14–18] We deviate from our preregistration to present MMs in the main text to aid interpretation that is not predicated upon a specific reference category[15,18] (full pre-registered AMCE results are available in the Supplementary information and are substantively identical to MM results).

Results

Figure 1 depicts the MMs from self-reports of how likely the full sample of respondents would be to receive a vaccine with a particular attribute level. The vertical dashed line represents the grand mean (i.e. the overall mean across all vaccine attributes). Points to the right of the line indicate attribute levels that increase vaccine favorability. Conversely, points to the left of the line indicate attribute levels that decrease vaccine favorability. For brevity, we focus our attention on vaccine attributes which exhibited the strongest effects on an individual's likelihood of taking a vaccine—namely, side effects, effectiveness, a vaccine's country of origin and the type of vaccine.

We begin by unpacking the results for side effects. The MMs for side effects indicate that respondents are more willing to take a vaccine where side effects only occur in 1 in 1 000 000 people (MM = 5.15, 95% CI [5.04–5.26]), are less likely to take a vaccine where side effects occur in 1 in 10 000 people (4.48, [4.38–4.58]), while the likelihood of taking a vaccine where side effects occur in 1 in 100 000 people was average (4.79, [4.68–4.89]). Moving onto effectiveness, respondents are more likely to take a vaccine with a 95% efficacy rate (5.31, [5.20–5.43]) than they are to take one with an efficacy rate of just 55% (4.30, [4.19–4.40]). In contrast, individuals are no more likely than average to take a vaccine with an efficacy rate of 75%. Turning to country of origin, individuals are more likely than average to take a vaccine if it originates from Germany (5.06, [4.94–5.18]), the USA (5.05, [4.92–5.17]) and the UK (4.97, [4.84–5.09]). Conversely, individuals are less likely than average to take a vaccine if it originates from Russia (4.72, [4.59–4.85]) or China (4.21, [4.08–4.34]). When considering the type of vaccine, respondents are more likely than average to take a vaccine if it is an mRNA type (5.06, [4.95–5.18]) or a viral vector type (4.84, [4.72–4.95]), are less likely than average to take a live virus vaccine (4.59, [4/47–4.71]), and are no more likely than average to take a subunit vaccine (4.72, [4.60–4.83]). In contrast, the remaining vaccine attributes exhibit little effect on the likelihood of an individual's willingness to take a vaccine. There was however a very modest effect with the number of people already inoculated with a vaccine; people were slightly more likely to

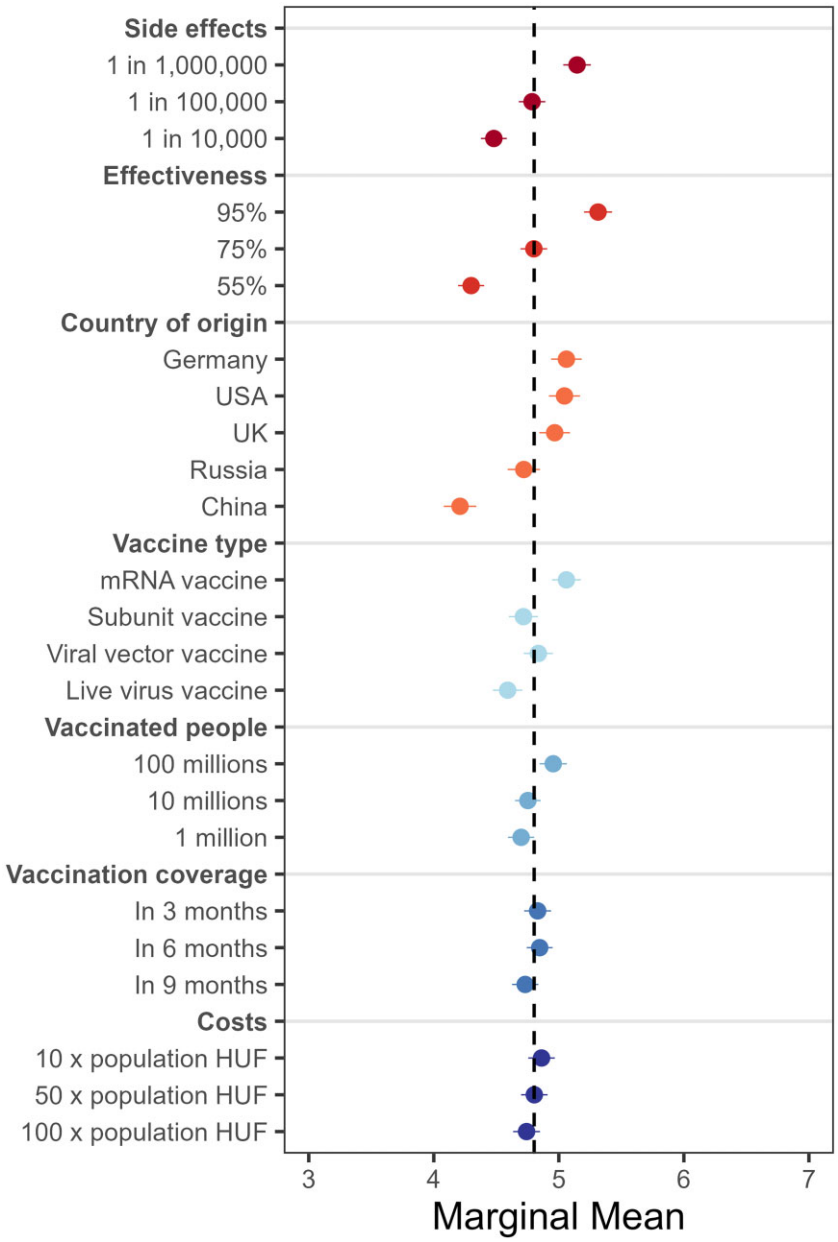

Figure 1 MMs for self-reported likelihood of uptake. Notes: The figure reports the MM point estimates are plotted with 95% CIs, representing the average likelihood of uptake at each vaccine attribute level. The dashed line represents the grand mean (4.80)

be willing to take a vaccine that had already been used to vaccinate 100 000 000 people.

Subgroup analyses: institutional trust

We conduct additional subgroup analyses to determine whether the effect of different vaccine attributes varies with individual levels of institutional trust. We present MMs, as these estimates provide insight into both the absolute and relative favorability of vaccines with particular attribute levels across different subgroups. The MMs for the three subgroups are depicted in figure 2. The dashed vertical line represents the grand mean. Points to the right of the reference line indicate attribute levels that increase profile favorability, while points to the left indicate attribute levels that decrease favorability.

In absolute terms, those with high levels of institutional trust are consistently more favorable towards vaccines than those with lower levels of institutional trust. In some instances, the high-trust group is more favorable toward the least optimal vaccine attribute than the low-trust group is toward the most optimal vaccine attribute. For example, individuals in the high trust subgroup are far more likely to be willing to take a vaccine where side effects occur in 1 in 10 000 people (5.35, [5.15–5.55]) than those in the low trust subgroup are willing to take a vaccine where side effects occur in 1 in 1 000 000 people (4.58, [4.39–4.77]). Similarly, individuals in the high trust subgroup are more likely to be willing to take a vaccine with only 55% efficacy (5.15, [4.94–5.35]) than individuals in the low trust subgroup are to take a vaccine with 95% efficacy (4.81, [4.61–5.01]).

When it comes to country of origin, differences in the likelihood of uptake across the different subgroups are small when it comes to preferences for a vaccine originating from Germany, the USA or the UK. However, individuals in the high-trust subgroup are highly willing to take a vaccine from Russia (5.96, [5.73–6.19]) or China (5.49, [5.24–5.74]) than the low-trust group would (Russia: 3.83 [3.63–4.06]; China: 3.35 [3.14–3.57]).

Moving beyond side effects, effectiveness and a vaccine's country of origin, we see that differences in the likelihood of an individual's willingness to take a vaccine become more smaller and more uniform across the remaining attributes. Nevertheless, it is important to note that the pattern of those with higher levels of institutional trust

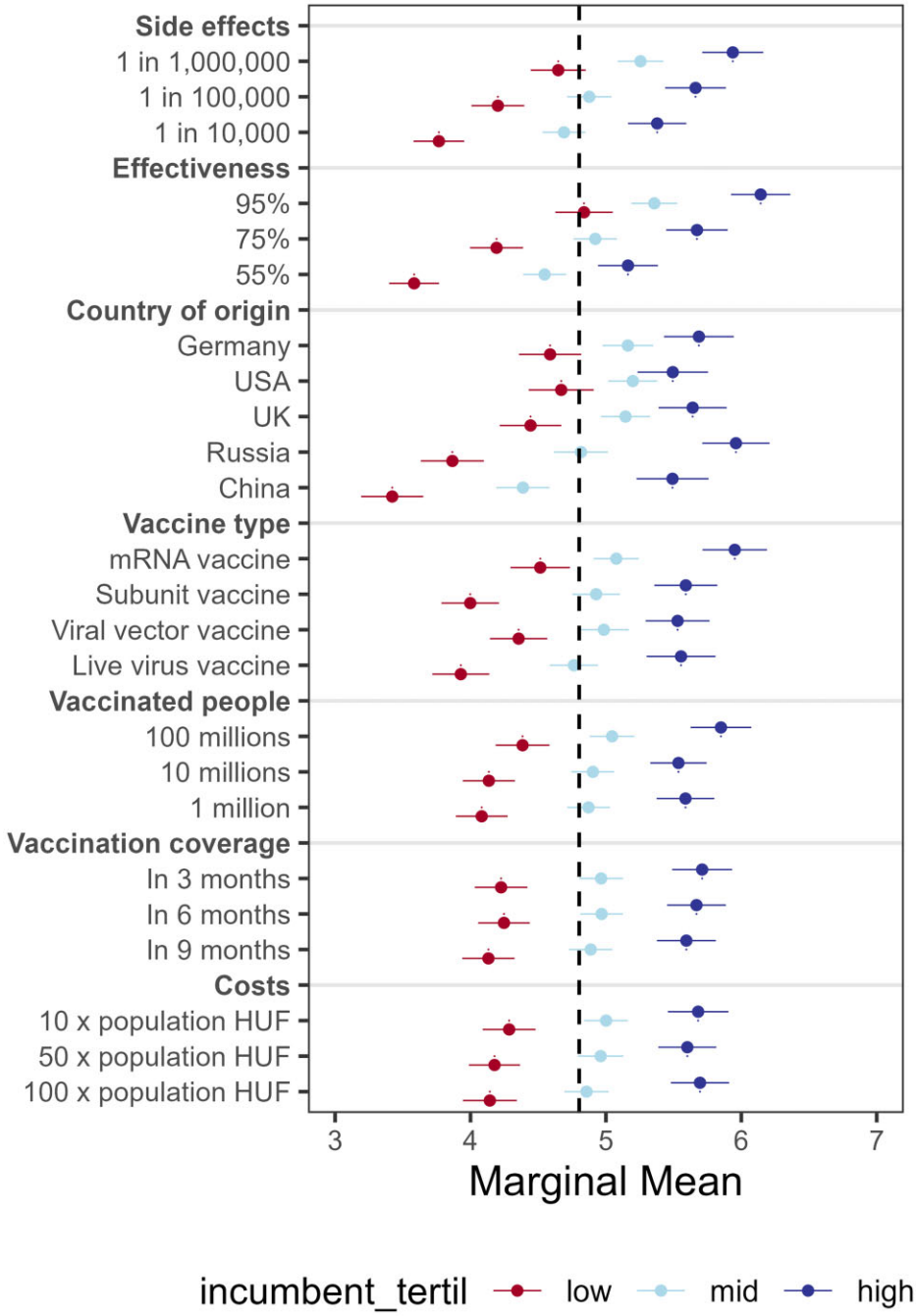

Figure 2 *Subgroup analysis: differences across different trust groups* (MMs *for likelihood of uptake*). Notes: The figure reports the MM point estimates are plotted with 95% CIs, representing the average vaccine choice at each vaccine attribute level. The dashed line represents the grand mean (4.80)

exhibiting greater rates of favorability towards vaccines than those with lower institutional trust holds constant.

Discussion

The question of why individuals prefer one vaccine over another, and how these preferences feed into the likelihood of taking a vaccine, is especially pertinent during an ongoing global public health crisis. Our findings replicate previous work which finds that individuals exhibit robust preferences for vaccines with a low prevalence of severe side effects, as well as a high rate of efficacy.[6–8,19,20] The present study also expands on recent work which analyses how vaccine preferences shape vaccine uptake albeit in a Western European context.[21] For instance, Stöckli et al.[22] find that citizens of France, Germany and Sweden, are more willing to take a vaccine if it comes from a Western nation (Germany, the USA and the UK). Here, we also find that respondents from Hungary are also highly likely to prefer a vaccine from a Western nation (Germany, the USA and the UK), as opposed to Russia or China. This finding is important because Hungary actually used vaccines from all of these different countries during their vaccination efforts,[23] whereas countries such as France, Germany and Sweden, did not order vaccines from Russia or China. This finding is also interesting given the national context. As a semi-authoritarian post-Soviet state, we might expect Hungarian respondents to exhibit stronger preferences for a hypothetical vaccine manufactured in Russia. However, this is not what we find here. Our findings may also be unique to the particular national context where we ran our survey given Hungary's aging population, with 39.90% of the population being 55 or older.[24] This demographic includes those who are of an age where the

likelihood of contracting and experiencing worse symptoms of COVID-19 is higher, meaning that they ought to have a greater incentive to get vaccinated than younger cohorts.

The implications of our study are threefold. First, our study expands on extant work concerning the relationship between trust and the willingness to be vaccinated. Prior work in the Italian context finds that individuals with lower levels of trust in the scientistic community are more likely to view vaccines as harmful.[16,17] However, a limitation of these works is that they only test attitudes towards generic vaccines and *not* attitudes towards specific vaccine attributes. It is possible that low-trust individuals are reluctant to take a vaccine *regardless* of its attributes. Yet, we find that the likelihood of uptake among those with lower levels of trust varies depending on the attributes of a hypothetical vaccine. While we find that low-trust individuals are less likely to take a vaccine regardless of many of its attributes, this is not the case for *every* attribute. For instance, those with low levels of institutional trust appear to be mildly favorable towards a hypothetical vaccine with an efficacy rate of 95% (figure 2). In this respect, our results underscore the importance of asking about specific vaccine attributes. Future works on the relationship between trust and vaccine uptake should thus include items reflecting specific attributes where available, as it is possible that low-trust subgroups are willing to take vaccines if they have certain attributes (e.g. a high rate of efficacy).

Second, the results can inform policymakers and public health experts about which vaccine attributes should be emphasized in order to maximize the likelihood of vaccine uptake among citizens. For instance, we find Hungarian respondents prefer a vaccine with a lower prevalence of severe side effects, increased efficacy and vaccines developed in Western nations. However, citizens choices of *actual* vaccines may not meet all of these criteria, meaning there is a gap between their preferences and what vaccines are available to them in a real-world scenario. Policymakers should therefore communicate that the benefits of currently available vaccines outweigh any risks that might be correlated with citizens' vaccine preferences.

Third, our findings underscore the necessity of micro-targeted public health messaging to different sections of the public, particularly among those with varying levels of trust in institutions. Our findings indicate that individuals with high levels of institutional trust are broadly accepting of hypothetical vaccines *irrespective* of their various attributes. Conversely, for those with low-to-middling levels of institutional trust, public health messaging might need to emphasize the attributes of vaccines that such individuals not only find appealing but might subsequently influence their choice to get vaccinated.

Limitations

All studies have limitations, so it is important to highlight those of the current study. One limitation of the current study is a potential lack of external validity. For instance, the vaccine choices respondents were presented with in conjoint experiment were purely hypothetical (though specific levels within the attributes were informed, where possible, by real-world vaccines). We also measure general attitudes towards hypothetical vaccines as opposed to directly observing vaccine behavior. Similarly, the survey context may differ from in situ vaccine decisions (which might be observable in a field experiment). Notwithstanding, some evidence suggests that vaccine intentions (i.e. self-reports) are strongly related to vaccine behavior.[8] While vaccine attributes mirror real-world values where possible, some levels are less plausible. For instance, the hypothetical cost per unit of vaccine was set at €10 per unit, €50 per unit or €100 per unit. However, the *actual* price per unit of COVID-19 vaccine was close to €20 in the EU. While price per dose played a role in elite-level discourse within the EU, this did not seem to affect broader national-level discussions of vaccines (especially as the cost was not directly borne by patients). Despite these concerns, we believe that the description of our hypothetical vaccines reflects real-world choices quite well.

A second limitation relates to our measure of trust. In this article, we use measures of institutional trust to test for gradations in vaccine preferences. However, trust in medical professionals and in the scientific community may be more influential in shaping individuals' vaccine preferences. For instance, work indicates that patients who have lower trust in doctors have negative attitudes towards vaccines.[18] Elsewhere, scholars find that individuals with low levels of trust in the scientific community are more likely to see vaccines as harmful.[16,17] Given these findings, it is possible that we omit some factors that are important to individuals' vaccine preferences, such as their trust in doctors and scientists.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Conflicts of interest: None declared.

Data availability

The data underlying this article are available at: https://osf.io/9k8yv/.

Key points

- We conducted a pre-registered conjoint experiment in Hungary to test how vaccine attributes affect vaccine acceptance. Respondents were given pairs of hypothetical vaccine profiles which varied across several dimensions.
- Vaccine effectiveness, the prevalence of side effects and country of origin affect vaccine preferences, while differences across other dimensions (e.g. the number of people who have received the vaccine globally, per-unit vaccine cost to the government) matter less.
- Institutional trust is important in explaining vaccine attitudes. Across all of our vaccine attributes, we find that those with the lowest levels of institutional trust are less likely to be willing to take a vaccine with the most favorable attributes than those with high trust are to take vaccine with the least favorable attributes.

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