Public Views on Vaccine Pricing: Pre-analysis Plan

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Abstract

Global pricing of vaccines against infectious diseases is an important determinant of global public health outcomes as it affects the production and distribution of vaccines across countries. Pricing of vaccines remains a contentious issue because there is a dilemma: ensuring vaccines are affordable to poorer countries which have a relatively high burden of disease compared to richer countries, while also providing pharmaceutical firms with sufficient incentives for the research, development and innovation of vaccines. As a result, there have been calls for *equity-based* pricing, where prices are based on a country's ability to pay. Using an online randomised controlled survey experiment, we will analyse the relative effects of providing different types of information on public support for equity-based pricing of vaccines.

Keywords: vaccines; equity-based pricing; randomised controlled survey experiment; information

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1. Introduction

Global vaccine pricing is a contentious issue that has attracted attention from governments, donors, global institutions, and researchers. One major reason is that there are two potentially conflicting goals which need to be considered in the pricing of vaccines across countries: affordability by poorer countries vis-à-vis innovation incentives for pharmaceutical firms. This tension has been highlighted by the COVID-19 global pandemic. The World Health Organization (WHO) Director-General recently stated that the failure to ensure global equitable access of vaccines during the COVID-19 global pandemic would be "a catastrophic moral failure – and the price of this failure will be paid with lives and livelihoods in the world's poorest countries" (Ghebreyesus 2021). However, in July 2020, some pharmaceutical firms told a US Congress Committee that they planned to sell their COVID-19 vaccines at profit rather than at cost (United States Congress 2020). Similarly, Pascal Soriot, the CEO of AstraZeneca, a British-Swedish pharmaceutical firm, argued that "…if you don't protect IP [intellectual property], then essentially there is no incentive for anybody to innovate" (Newey 2020).

Equity-based pricing has long been proposed and supported by numerous global institutions and donors as the preferred model for global vaccine pricing (for example, GAVI (2020), the Bill and Melinda Gates Foundation (2020a) and UNICEF (2019)). Equity-based pricing is based on a country's ability to pay, and can therefore be regarded as a form of progressive pricing. Under this model, poor countries pay the least, while rich countries pay the most for the same vaccines, and firms can potentially make higher profits than under uniform pricing. Bill Gates, a prominent advocate of equity-based pricing, has suggested that "…drugs companies should support a system whereby rich countries subsidise vaccines so that poor countries pay less than $3 or less a dose. The price needs three tiers where rich countries are paying back a lot of the fixed costs, middle-income countries are paying some of the fixed costs and the poorer countries are paying a true marginal cost" (Peel et al. 2020).

Many governments of high-income countries have given in-principle support to equity-based pricing of vaccines by their participation in the WHO-backed COVID-19 Vaccines Global Access (COVAX) Facility, the global pooled procurement mechanism for COVID-19 vaccines (WHO 2021). Notably, the COVAX Facility is negotiating equity-based pricing with pharmaceutical firms on behalf of its 190 participating countries (Kelland and Streenhuysen 2020). In addition, in order to improve access to vaccines, the facility aims to provide financial

support to eligible low and middle-income countries with funding provided by higher-income countries (WHO 2021).

The implementation of equity-based pricing critically depends on public support for such pricing in high-income countries, which would face the highest price of vaccines. Greater public support for equity-based pricing in these countries would make democratically-elected governments in high-income countries more committed to participating in the COVAX facility, and to helping poorer countries access vaccines more generally. However, the extent of public support for equity-based pricing in high-income countries remains an open empirical question. Support may partly depend on whether the public has sufficient and accurate information about the facts relevant to global vaccine pricing. It may also depend on public awareness and deliberation of the relevant competing considerations.

This study aims to answer the following research questions: (a) the extent of public support for equity-based vaccine pricing in high-income countries (b) the relative effects of different types of information on public support, and (c) the sensitivity of these findings to the total cost of producing vaccines. The study will involve a randomised controlled survey experiment containing multiple treatment arms. Each treatment arm will contain several stages, but the primary difference will be whether and what type of information is provided to participants before they make their pricing decisions.

Participants will be randomly allocated to one out of the following four groups: (1) *control* group (2) *facts* only group (3) *competing considerations* only group, and (4) *facts plus considerations* group. Participants in the control group will not be provided any information. Participants in the facts only group will be provided facts relevant to global vaccine pricing. The participants in the competing considerations only group will be informed about the competing considerations relevant to vaccine pricing but no facts. The facts plus considerations group will be provided information about both the facts and the competing considerations.

Our study relates to the literature on the effect of information provision on support for government policy, particularly those that involve competing considerations, and draws on the large literature on the role of facts and values in information processing and public opinions (Chong and Druckman 2007; Druckman and Bolsen 2011; Dietz 2013). It also touches on the broader literature in political science and philosophy on the principle of public justification and

public reason liberalism. To ensure legitimacy and political stability in a democratic society, rules and policies should be publicly justifiable by appealing to facts or arguments that reasonable citizens can accept (Rawls 1996; Quong 2004; Hadfield and Macedo 2012; Kogelmann and Sitch 2016; Chung 2020).

2. Experimental design and sample

The main goal of this study is to assess the effects of providing different types of information on public support for equity-based pricing of vaccines. We will conduct an online randomised controlled survey experiment. Participants will be recruited via Prolific, a UK-based crowdsourcing survey and research platform. The survey will be programmed using Qualtrics.

The experiment will involve a target sample of 720 participants in the United States. The experiment is expected to begin in April 2021 and end by May 2021. To increase external validity, we will use the 2019 American Community Survey to create a stratified sample that is representative of the US adult population in terms of age, sex, race and education. We estimate participants will take about 30 minutes to complete the experiment. Each participant will be paid GBP 2.10 for completing the experiment and earn a bonus of up to GBP 2.90 depending on their responses. Table 1 provides an overview of the various steps in the experiment.

Table 1 – Summary of the experimental design

Step	Description
1	Pre-experiment questions
2	Pre-experiment knowledge quiz
3	Background information
4	Information treatment
5	Main survey: Stage 1 (Personal choice)
6	Main survey: Stage 2 (Co-ordination game)
7	Demographic questionnaire
8	Cognitive Reflection Test

2.1 Pre-experiment questions

Participants will be asked a series of questions about their views towards income inequality and world poverty, their experience with COVID-19, intention to receive a COVID-19 vaccine, and familiarity with the factors relevant to the pricing of vaccines. As some of these questions

may be uncomfortable for some participants, it will also give them an opportunity to withdraw early from the survey if they wish to do so.

2.2 Pre-experiment knowledge quiz

In the knowledge quiz, participants will be asked some questions to assess their knowledge of facts about low-income countries and lower middle-income countries that are relevant to global vaccine pricing. Participants will first be introduced to the World Bank's income-based country classification: low-income country, lower middle-income country, upper middle-income country, and high-income country. They will then be asked to answer questions about some statistics and facts related to the objectives of affordability and need of vaccines, such as the average income and share of the world's population in each type of country (Figure 1). The knowledge quiz will consist of a multiple-choice test, with the options presented in random order. We will incentivize correct answers with a bonus of GBP 0.10 per answer to encourage participants to think carefully before answering.

2.3 Background information

All participants will be provided with necessary background information about vaccine pricing before they make their pricing decisions in the main survey experiment. The information will cover key concepts, such as marginal costs, fixed costs, uniform pricing and price discrimination. We will include some questions about the information to encourage participants to read the information carefully. These questions will be incentivized (bonus of GBP 0.10 per correct answer). To help improve participants' understanding of the choice experiment, participants will be provided with feedback on their answers (including an explanation of the correct answer), regardless of whether their answer is correct or not. We may also use performance on the background information questions to identify participants who are relatively more likely to provide reliable responses in the choice experiment (see section 3.2).

2.4 Intervention: Information treatment

The survey experiment will involve randomisation at two levels: at the participant level and at the group level. To analyse the effect of different types of information on support for equity-based pricing, we will first randomise the type of information at the participant level using a between-group design. Participants will be randomly allocated to one of four groups: control, facts only, competing objectives only, facts and competing objectives. Although participants across the different groups will receive different types of information, they will have to answer

the same questions about vaccine pricing in the main survey experiment. The structure of the treatment arms is summarised in Table 2, and is described in more detail in the following sections.

Table 2 – Information treatments

Group	Type of information provided	Description
Control	No information	No statistics or competing objectives
Treatment 1	Facts only	Statistics
Treatment 2	Competing objectives only	Competing objectives without reference to facts and statistics
Treatment 3	Facts and competing objectives	Competing objectives with reference to facts and statistics

To test whether pricing choices are sensitive to the total costs of vaccine production, we then randomise the total costs (low vs. high) at the group level. Within each of the four groups, participants will be randomly assigned to make choices in one of two possible scenarios: *low* total cost per dose (USD 10) or *high* total cost per dose (USD 50). In both scenarios, the marginal cost per dose will be fixed at 30 per cent of the total cost per dose (USD 3 and USD 15 respectively). The two cost scenarios are designed to reflect the variation in the price of vaccines observed in practice.

2.4.1 Intervention: No information (Control)

The control group will not be given any information that may be relevant to global vaccine pricing and go directly from the background information to the main survey. The control group will provide a baseline measure of support for equity-based pricing in the absence of information.

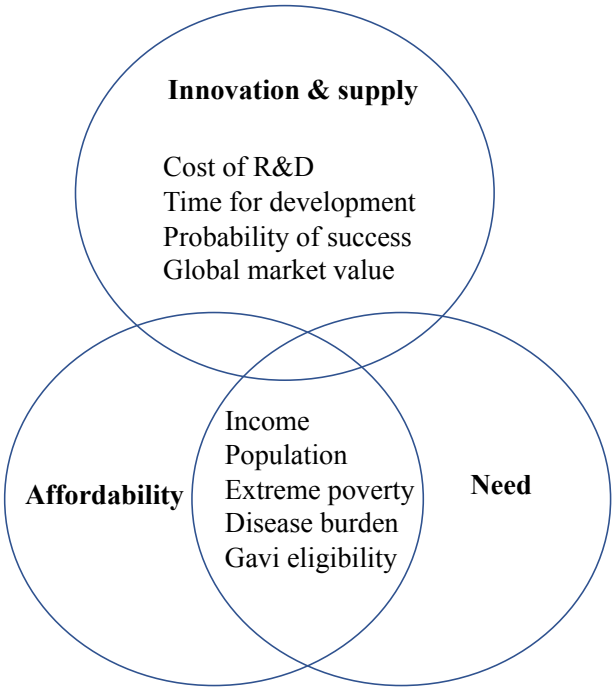
2.4.2 Intervention: Facts only (Treatment 1)

To analyse the effect of providing factual information on support for equity-based pricing, participants will be given a set of facts that are relevant to global vaccine pricing (Figure 1). The facts will be mainly presented in the form of tables of statistics and in random order on the same page. These statistics are based on facts typically used to justify actual arguments made in favour of equity-based vaccine pricing, and to justify pricing approaches or objectives more generally (Berkley 2014, 2019; Bill & Melinda Gates Foundation (2020b); GSK 2019). We

will include statistics about lower middle-income countries and upper middle-income countries because there is some survey evidence to suggest that the public may lack information or have misperceptions about middle-income countries (Gapminder 2017).

We will also ask participants factual questions about the statistics and provide feedback containing the correct answers, regardless of whether the participant's answer is correct or not. The question is designed to check whether participants have paid attention to the facts. The facts will be drawn from various sources, including the World Bank, Institute for Health Metrics and Evaluation, World Health Organization, research studies and industry.

Figure 1 – Facts and competing objectives relevant to global vaccine pricing



2.4.3 Intervention: Competing objectives only (Treatment 2)

In the competing objectives only group, participants will be provided information about the three main competing objectives of global vaccine pricing: (i) affordability (ability to pay) (ii) need for vaccines, and (iii) providing incentives for continued innovation and supply (Figure 1). These objectives are actually cited as being relevant considerations, and in many instances, are drawn from the pricing policies and materials produced by many of the largest vaccine manufacturers in the US (Pfizer 2018, GSK 2019, Merck 2019, Sanofi 2020, Janssen 2021). The objectives will be presented in random order on the same page.

The competing objectives will be presented as arguments without any supporting facts or statistics. This is designed to isolate the effect of framing the decision in terms of the relevant competing values (which typically lack factual content) on support for equity-based pricing, such as fairness or equity and reward for innovation. Providing this information will also help participants understand that there exist competing considerations that can have different implications for pricing and profits.

To minimise priming and experimenter demand effects, we will frame each objective and elicit participants' views about them in a neutral manner. Participants will first be provided with a basic description of an objective, followed by an argument based on the objective using neutral language. For example, in relation to the objective of affordability, participants will first read the following:

> **Factor:** The overall pricing strategy of vaccines across different countries should aim to make the vaccine affordable for all countries and be based on a country's **ability to pay**.
>
> It has been argued that vaccine pricing should ensure that low-income countries pay the lowest price.

Participants will then be asked about the extent to which they agree or disagree with a statement based on the objective. For example, participants will be asked to indicate their views in relation the following statement about the objective of affordability:

> How strongly do you agree or disagree with the following statement?
>
> "High-income countries should pay the most for vaccines."

Participants will be asked to respond using to a 5-point Likert scale (from "Strongly agree" to "Strongly disagree"). The aim is to encourage participants to think critically about the arguments on their own. Information on the two other objectives will be presented to participants using a similar structure.

2.4.3 Intervention: Facts and competing objectives (Treatment 3)

Participants in the facts plus competing objectives group will be provided information about both the facts and competing objectives relevant to global vaccine pricing. Participants will first be shown the facts and statistics provided to participants in the facts only group, followed by the competing objectives provided to participants in the competing objectives only group. The objectives will be presented in random order on the same page.

However, there is one important difference – the arguments for each of the competing objectives will now be justified by the facts. Therefore, Treatment 3 will provide reasons for supporting the competing objectives and contain references to the relevant statistics. For example, in relation to the objective of affordability, participants will be asked to read the following:

> **Factor:** The overall pricing strategy of vaccines across different countries should aim to make the vaccine affordable for all countries and be based on a country's **ability to pay**.
>
> It has been argued that vaccine pricing should ensure that low-income countries pay the lowest price because they have the lowest average income.

The argument will link the objective to the relevant facts in order to increase the salience of the facts and offer an interpretation of them. The purpose is twofold: (1) to make it easier for participants to connect the given objective (or value) to the relevant facts and to provide a way to think about the facts, and (2) to provide a fact-based reasoning of the competing objectives and encourage deliberation by participants, which may involve weighing up the arguments against one other and determining which factor is more important.

Main survey experiment

The main experiment consists of two stages: a personal choice experiment and a co-ordination game. The structure of each stage is outlined below.

2.5 Main survey experiment Stage 1: Personal choice

In Stage 1, participants will be asked to make decisions about pricing and overall profits across different countries during a global pandemic. Participants will be informed a firm has

developed a safe and effective vaccine that has been approved by health authorities, and developed the manufacturing capacity to supply the whole world. This is to remove the influence of any concerns participants may have about the safety, effectiveness or supply of vaccines.

Participants will need to choose a price per dose they think the firm should charge each of the four types of countries as defined by the World Bank (low income, lower-middle income, upper-middle income and high income). To avoid calculation errors by participants, prices are fixed as six categorical variables, rather than continuous variables based on prices chosen by participants themselves. We will also present the firm's profits associated with each pricing category, together with the pricing categories themselves. For example, when we present the last pricing category where the price exceeds the total cost, it will also be noted alongside this pricing category that the firm will make a profit.

Participants will also be asked whether they think the firm should make some overall profit from its pricing across different types of countries (Yes, No, Unsure). Among other things, this will allow us to infer what prices the participants intended to choose. For example, if a participant chooses a price greater than total cost for one country type only, and decides that the firm should make some overall profit across all types of countries, then it may be inferred the participant intended to charge a price that is sufficiently greater than total cost for that country type to enable cross-subsidisation.

2.6 Main survey experiment Stage 2: Co-ordination game

The second part of the main survey experiment will involve a static co-ordination game. Participants will be asked to make the same choices as before (price per dose for each of the four types of countries and firm's overall profit), except they will now earn a bonus if their choice is the same as that most frequently chosen by all participants in a given cost scenario. Therefore, participants will be given an incentive to co-ordinate on the *same* choice of price or overall profits. Before they are asked to make their choices, participants will be asked an attention check question designed to check that they understand the payment structure of the co-ordination game, and that they are paying attention during the experiment.

The participants' choices in stage 2 will allow us to infer which price or overall profit is socially focal (most likely to be agreed upon), even though this social choice may differ from an

individual's personal choice in stage 1. As such, the choices made by participants in the co-ordination game may be regarded as representing the socially agreed choice with respect to prices and profits.

2.7 Demographic questionnaire

We will ask participants to complete a questionnaire on their demographic, socioeconomic and attitudinal characteristics, such as age, sex, state, race, educational attainment, religion and political leaning. The information will be used to construct control variables and for subgroup analysis.

2.8 CRT questions

The final part of the experiment will require participants to answer some Cognitive Reflection Test (CRT) questions. These are numerical-based questions which are designed to measure a person's cognitive style (Frederick 2005). Participants will earn a bonus of GBP 0.10 for each correct answer to encourage them to think carefully about their answers and pay attention to the questions, which will provide a more accurate measure of their cognitive style.

2.9 Attrition

Some participants may start the survey but not complete it, which can lead to a smaller sample size than planned and selection bias. Where possible, for each of the treatment groups, we will test whether differences between the baseline characteristics of the participants who dropped out of the study and those who completed the survey are individually and jointly statistically significant. We will also check whether the attrition rate in the treatment group is significantly different to the attrition rate in the control group.

To detect whether treatment status is driving non-response (i.e. whether non-response is random), we will estimate the following equation:

$$A_i = \pi_0 + \pi_1 Treatment1_i + \pi_2 Treatment2_i + \pi_3 Treatment3_i + \varepsilon_i \qquad (1)$$

where

- A_i is a binary indicator equal to 1 if a participant began the survey but did not finish the survey, and 0 otherwise.

- $Treatment1_i$, $Treatment2_i$ and $Treatment3_i$ are binary indicators that equal 1 if the participant is assigned to Information Treatment 1 group (facts only), Information Treatment 2 group (competing objectives only) and Information Treatment 3 group (facts and competing objectives) respectively, and 0 otherwise. The omitted category is the control group.
- ε_i is the idiosyncratic person-specific error term. We will use robust standard errors.

We will test whether the coefficients π_1, π_1 and π_1 are statistically different from zero at the 5 per cent significance level.

3. Analysis

3.1 Outcome measures

The two primary outcomes of interest are:

1. A binary variable that is equal to 1 if the participant chooses prices consistent with "equity-based" pricing, and 0 otherwise.
2. A binary variable that is equal to 1 if the participant responds "Yes" to the question "Should the firm make some overall profit from its pricing across different countries?", and 0 otherwise.

The outcome measures will be defined at the participant-cost scenario level, and at the personal choice or co-ordination stage level. This study will primarily focus on the results at the personal choice stage level.

We will use multiple definitions of "equity-based pricing" to reflect the many different conceptions of equity, and the different ways it can be measured. The definitions will consist of different combinations of the conditions shown in Table 3. For simplicity, we will focus on six definitions of equity-based pricing (from strictest to weakest).

Condition (1) is a basic ordinal condition that requires price discrimination (progressive pricing) to ensure equitable access, such that poorer countries pay strictly *less* than high-income countries. Importantly, condition (1) does not make any assumptions about the relative price of vaccines between low-income countries and lower middle-income countries. It allows for the possibility that the price paid by lower middle-income countries is less than, more than or

equal to the price paid by low-income countries (i.e. Low-income country $\lneqq$ Lower middle-income country).

Equity-based pricing may also require imposing some additional "reference point" restrictions on prices to achieve specific objectives because progressive pricing by itself does not guarantee that vaccines are affordable for poorer countries which have a relatively high burden of disease compared to richer countries. Conditions (2a) – (3c) could be justified on the grounds of affordability and need. Condition (2a) is consistent with Bill Gates' suggestion (Peel et al. 2020), and the actual prices negotiated by Gavi for low-income countries (GAVI 2020). Conditions (2b) and (2c) are weaker variants of condition (2a). Similarly, condition (3) reflects the concern that lower middle-income countries cannot afford to pay all of the fixed costs of vaccine production. By contrast, condition (4) ensures that pharmaceutical firms have a (profit) incentive to innovate and supply vaccines, and that pricing is based on a country's ability to pay. This also means that rich countries cross-subsidise poorer countries.

Table 3 – Conditions and definitions of equity-based pricing

Condition	Prices	Definition	Conditions
1	Low-income country ≤ Upper middle-income country ≤ High-income country AND Low-income country < High-income country; OR Lower middle-income country ≤ Upper middle-income ≤ High-income country AND Lower-middle income country < High-income country	v. 1	1 + 2a + 3
2a	Low-income country ≤ marginal cost	v. 2	1 + 2b + 3
2b	Low-income country ≤ marginal cost + (0.5 × fixed cost)	v. 3	1 + 2c + 3
2c	Low-income country < total cost	v. 4	1 + 2b + 3 + 4
3	Lower-middle country < total cost	v. 5	1 + 2b + 3 + 4
4	High-income country ≥ total cost	v. 6	1 + 2c + 3 + 4

Conditions (1) and (3) apply in all definitions because they capture the minimum requirements of equity-based pricing. The only difference between the definitions are *which* condition for

the low-income country applies (condition 2a, 2b or 2c), and *whether* the condition for the high-income country (condition 4) applies. However, there may be some concern that conditions (2a) and (2c) are too extreme or strict and therefore not feasible in practice because they require low-income countries to pay a very low or very high price. As a result, this study will primarily focus on definitions v. 2 and v. 5 that use condition (2b).

Secondary outcome measures may include the mean and variance of prices by country and treatment group using the midpoint approach. For simplicity, we will take the midpoint of each of the six price categories to generate continuous variables. As the upper bound of the last category (price > total cost) is unbounded, we will use the most conservative measure by ensuring the midpoint is the same distance from the lower bound as the first category (price < marginal cost). For example, in the low total cost scenario where total cost = $10 (marginal cost = $3), the midpoint of the first category (price < marginal cost) is $1.50, so the midpoint of the last category (price > total cost) is taken to be $11.50. For robustness, we will check and report whether the results are sensitive to alternative widths of the interval for the last category.

3.2 Sample selection for analysis

The responses of some participants may not be reliable. Some participants may not pay attention to the background information or read the questions carefully, despite the incentive payment and attention check questions. To examine if the data are sensitive to unreliable responses, we may exclude participants who incorrectly answer the background information questions that test whether a participant understands how marginal and fixed costs can be recovered from prices. Specifically, we require participants to understand three key concepts: (i) prices that recover only some of the marginal cost (ii) prices that recover all of the marginal cost, and (iii) prices that recover all of the marginal cost but only some of the fixed cost. Understanding these points is necessary to understand the six pricing categories in the choice experiment.

In our sensitivity analysis, we may also restrict the sample to participants who: (1) meet a certain threshold of understanding the problem based on their overall performance in the background information questions, and/or (2) correctly answer the attention check question before the co-ordination game.

3.3 Baseline balance in covariates

We will check for baseline differences in participants' observable characteristics between the treatment and control groups. The baseline covariates will include those variables used for stratification (age, sex, race and education). We will do a series of t-tests that check for significant differences in the means of treatment and control groups variable-by-variable by regressing each of the variables on a treatment indicator.

If there is imperfect balance between the treatment groups and control group in some covariates, they will be added as additional controls in the analysis to control for selection bias. If there is significant imbalance, we will use propensity score matching to make treatment and control groups observationally similar.

3.4 Treatment effects – Main specification

The main specification is a linear probability model, where we will estimate the average treatment effects of the two stages (personal choice and co-ordination game) separately. We will compare the behaviour of participants in the treatment group with participants in the control group.

To capture the effects of the information treatments at the personal choice stage, we will estimate the following equation using OLS:

$$y_{ij}^{p} = \beta_0 + \beta_1 Treatment1_i + \beta_2 Treatment2_i + \beta_3 Treatment3_i + \varepsilon_{ij} \qquad (2p)$$

where

- y_{ij}^{p} is the outcome of interest for participant i in total cost scenario j (low or high) in the personal choice stage.
- $Treatment1_i$, $Treatment2_i$ and $Treatment3_i$ are binary indicators that equal 1 if the participant is assigned to Information Treatment 1 group (facts only), Information Treatment 2 group (information on competing objectives only) and Information Treatment 3 group (information on both facts and competing objectives) respectively, and 0 otherwise. The omitted category is the control group.

- ε_{ij} is an idiosyncratic individual-specific error term. Heteroskedasticity-robust standard errors will be clustered by participant. We will use p-values adjusted for multiple hypotheses testing.

Similarly, to capture the effects of the information treatments at the co-ordination stage, we will estimate equation (1p) again, but this time restrict the sample to choices made by participants in the co-ordination game:

$$y_{ij}^{c} = \beta_0 + \beta_1 Treatment1_i + \beta_2 Treatment2_i + \beta_3 Treatment3_i + \varepsilon_{ij} \qquad (2c)$$

As our primary outcome of interest is support for equity-based pricing, y_{ij} is a dummy variable that equals 1 if the prices chosen by participant i in total cost scenario j is consistent with equity-based pricing. The constant β_0 measures the share of participants whose price decisions are consistent with equity-based pricing when they are not provided with any information. The key coefficients of interest are β_1, β_2 and β_3, which measure the effect of providing information on facts only, competing objectives only, and both, on the probability of participants choosing equity-based pricing respectively.

If $\beta_1 > 0$, $\beta_2 > 0$ or $\beta_3 > 0$, then the relevant information treatment increases the probability of participants choosing prices consistent with equity-based pricing. If $\beta_1 < 0$, $\beta_2 < 0$ or $\beta_3 < 0$, the information treatment decreases the probability of participants choosing prices consistent with equity-based pricing.

We will conduct several robustness checks. Results will be reported with and without the inclusion of controls for covariates (especially participant characteristics not perfectly balanced at baseline) and strata dummies. The regression results will also be checked against results from alternative specifications, such as logit or probit models.

3.5 Subgroup analysis

Treatment effects may vary by observed participant characteristics. We will explore heterogeneity along the following three dimensions:

1. cognitive style (as measured by CRT scores)
2. political affiliation (Democrat or Republican)

3. willingness to be vaccinated

Since our treatment involves providing information, we expect treatment effects to depend on how individuals process and respond to information. Therefore, treatment effects may differ by participants' cognitive style and self-reported political affiliation. Furthermore, participants' vaccine pricing decisions may depend on attitudes towards taking vaccines.

Participants will be asked specific questions on each dimension and will be split into two groups based on their responses. We will use a classification that aims to ensure there is roughly an equal number of participants in each group. For example, we will code participants as having low or high CRT scores based on the number of CRT questions they get correct. Political affiliation will be self-reported by participants, who will be classified as either Republican or Democrat. We will also ask a question on willingness to be vaccinated, with participants classified as either "vaccine hesitant" or "vaccine confident" based on their responses.

We will check for heterogeneous treatment effects by adding both the relevant covariate and interaction terms between the covariate and treatment status as additional regressors in equations (2p) and (2c). The following equation will be estimated, where $subgroup$ refers to the subgroup of interest:

$$\begin{aligned} y_{ij} = \beta_0 + \beta_1 Treatment1_i + \beta_2 Treatment2_i + \beta_3 Treatment3_i + \beta_4 subgroup \\ + \beta_5 (subgroup \times Treatment1_i) + \beta_6 (subgroup \times Treatment2_i) \\ + \beta_7 (subgroup \times Treatment3_i) + \varepsilon_{ij} \qquad (3) \end{aligned}$$

We will focus on β_4, which measures whether there are differences in outcomes between subgroups in the control group. We will test whether β_4 is statistically different from zero at the 5 per cent significance level. Additional key coefficients of interest are β_5, β_6 and β_7, which estimate the differential responses to the information treatment based on the subgroup. We will also do a F-test of joint significance. Standard errors will be adjusted for heteroskedasticity and clustered by participant, and p-values will be corrected for multiple hypotheses testing.

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