CALIFORNIA STATE UNIVERSITY
FULLERTON
MIHAYLO COLLEGE
OF BUSINESS AND ECONOMICS

Department of Economics
Working Paper Series

2020/014

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December 2020

CALIFORNIA STATE UNIVERSITY, FULLERTON

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Stay-at-Home Orders and the Willingness to Stay Home During the COVID-19 Pandemic: A Stated-Preference Discrete Choice Experiment

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Abstract

The spread of COVID-19 in the Spring of 2020 prompted state and local governments to implement a variety of policies, including stay-at-home (SAH) orders and mandatory mask requirements, aimed at reducing infection rates and the severity of the pandemic's impact. We implement a discrete choice experiment survey in three major U.S. States - California, Georgia, and Illinois - to empirically quantify individuals' willingness to stay (WTS) home, measured as the number of weeks of a potential new SAH order, to prevent the spread of the COVID-19 disease and explore factors leading to their heterogeneous WTS. Our results demonstrate broad support for statewide mask mandates. In addition, the estimate of WTS to lower new positive cases is quite large, approximately five and half weeks, even though staying home lowers utility. We also find that individuals recognize the trade-offs between case reduction and economic slowdown stemming from SAH orders when they decide to stay home or not. Finally, pandemic related factors such as age, ability to work from home, and unemployment status are the main drivers of the heterogeneity in individuals' WTS.

Introduction

The spread of COVID-19 across the United States in the Spring of 2020 prompted state and local governments to implement a variety of policies, including stay-at-home (SAH) orders and mandatory mask requirements, aimed at reducing infection rates and the severity of the pandemic's impacts. As the pandemic continues to spread, several state governments have re-implemented SAH orders, while others are considering re-implementing them. For example, Oregon has imposed a one-week "freeze" under which businesses are required to close their offices and mandate work-from-home starting November 18. New Mexico has also re-implemented a two-week SAH order effective November 16 through November 30. While such policies lower the transmission rate [1, 2, 3], reduced economic activities and human interaction due to the lockdown result in economic and psychological costs [4, 5, 6, 7].

Existing literature in economics has extensively examined the costs and benefits of national-level lockdowns applying modified Susceptible-Infectious-Recovered models to incorporate varying individual behaviors and demographic compositions [1, 8, 9, 10, 11, 12, 13, 14, 15]. These existing studies have focused on the trade-offs

from the policy-makers' perspective and shown that lockdowns, especially those that differentially target older and riskier groups, can generate benefits that exceed the costs of such programs. However, how the general public values the costs and benefits of these policies remains unclear. On the one hand, individuals face different levels of economic vulnerability and thus heterogeneous costs of the economic downturn. On the other hand, the benefits they receive from disease prevention differ depending on how susceptible they are towards the virus. Measuring individuals' willingness to stay (WTS) home, and examining in particular how heterogeneous socio-economic status and personal characteristics affect their SAH decisions, provides important insight for evaluating and implementing public policy during the pandemic.

In this paper, we examine individuals' WTS home to prevent the spread of the COVID-19 disease and factors driving their heterogeneous WTS. We implement a discrete choice experiment (DCE) survey to quantify respondents' WTS depending on five attributes: the length of a new SAH order, state-level increases in the number of newly confirmed cases, increases in the number of unemployment insurance claims, the probability of school opening, and whether a mask wearing mandate is implemented. To capture state-level heterogeneity, our survey targets three states in the U.S.: California, Georgia, and Illinois. These three states are drastically different in the number of infections and deaths per capita, timing of surges in positive cases, and most importantly, policy responses towards the COVID-19 pandemic including the implementation of the SAH order, school reopening, and mask wearing mandate.

The survey was implemented during the final week of August, 2020. All three states have gradually lifted the SAH mandates during the end of April and through May. At the time of the survey, California had experienced its deadliest month since the pandemic started with the highest number of new cases in the nation [16, 17]. At the same time, the number of newly confirmed cases was relatively stable in Illinois, while Georgia's number of infections had slowly tapered as shown in Figure 1.

Fig 1 caption. 7-day moving average of number of cases across the three states. Dashed lines show the beginning and end of the survey period. Data source: `https://covid.cdc.gov/covid-data-tracker`

This paper makes three major contributions. First, to the best of our knowledge, this is the first study that explicitly measures individual's WTS home during the COVID-19 pandemic. In particular, we conduct a DCE survey to investigate how individuals perceive trade-offs between the benefits such as disease prevention and the costs including both economic and mental health costs of a SAH order. Previous studies have mainly focused on the trade-offs from a social planner's point of view and suggest that SAH policies, especially targeted ones based on age and other risk factors can be effective [8, 9, 10, 11, 12, 13, 14, 15]. However, successful policy implementation depends on individuals' preferences and WTS home. Existing research has investigated the extensive margin of individuals' preferences towards SAH orders; that is, whether individuals are willing to comply with mandatory SAH orders. Our analysis contributes to the literature by measuring individuals' WTS at the intensive margin - how long they are willing to stay home. We show that individuals are willing to stay home for additional five and half weeks to lower the increase in new cases by 100%. Previous literature indicates that individuals are less willing to obey SAH policies when presented with a longer SAH length than expected [27]. Our findings provide suggestive evidence that the general public's support for SAH policies is still strong as the pandemic progresses.

Second, our survey design limits the impact of free-riding when quantifying individuals' WTS. Staying home lowers the possibility of getting sick for not only the person himself/herself but also everyone else in the community. These unintentional and uncompensated benefits are identified as positive externalities in economics. Economic theory predicts that free-riding is likely to occur with public goods like staying-at-home behavior when the benefits are both non-excludable and non-rival; that is, nobody can be excluded from receiving the benefit and one person's consumption does not reduce others' utility [28]. In our DCE survey, instead of asking respondents how many weeks they are willing to stay home directly as in existing surveys (e.g. [29]), we use "the length of a SAH order" to measure their WTS. We also reminded respondents multiple times that the SAH mandate is strictly imposed by the government and will severely limit their daily activities if in place. By emphasizing the presence of government enforcement, our survey design limits the effect of free riding and provides an estimate closer to the socially optimal level.

Third, we contribute to the stated preference valuation literature. Recent stated preference studies have adopted non-monetary payment modes to elicit respondents' preferences for non-market goods and services. For example, [30] have estimated respondents' willingness to volunteer their time in stormwater management. [31] has investigated individuals' willingness to work. We further expand the literature by quantifying individuals' WTS home during an unprecedented pandemic.

Materials and methods

Survey design

We conduct a stated-preference DCE survey to estimate residents' WTS home during the COVID-19 pandemic in California, Georgia, and Illinois. The DCE method provides us with flexibility to estimate marginal values for each attribute included in the survey design [32]. Our survey design was examined by Clemson University and California State University Institutional Review Board in 2020, and received a notice of exemption (Clemson University Proposal number 2020-160; California State University Proposal number 21-008). There was no deception used in the survey design. Participants have provided written consent at the beginning of the survey. There was no deception used in the survey design. Our survey was administered electronically through the online survey platform Qualtrics, and it took respondents an average of 20 minutes to finish. Web-based survey tools like Qualtrics provide flexibility to randomize question order and cost-effectively select targeted populations. We acknowledge that volunteer survey takers might have higher than average willingness to pay (WTP) for market or non-market goods, but it is unclear whether the selection bias has similar effect on WTS that is evaluated in our study.

We first have the respondents read important background information on the COVID-19 pandemic to contextualize them with the issue. Specifically, we include information on effective preventative measures (i.e., social distancing), public policy that has been implemented (i.e., SAH orders), the positive and negative consequences of this policy (i.e., case reduction and economic and psychological cost), and the possibility of a new round of SAH orders given the new outbreaks in many states after the reopening. We then present respondents a description of the status quo scenario without a SAH order when states are partially open. Next, we show the fixed and variable attributes if a new SAH order is implemented. The fixed features include what activities and businesses are open and closed under a SAH order. The variable features of SAH scenarios include the length of SAH order, mask wearing policy, increase in newly confirmed COVID-19 cases (daily), increase in weekly initial unemployment

insurance claims, and school opening possibility. Descriptions and levels of variable attributes used in the survey is given in Fig 2.

Fig 2 caption. Attribute levels in the discrete choice experiment survey.

The background and fixed and variable attributes information are followed by a total of six discrete-choice questions. Within each question, we ask respondents to choose between a pair of hypothetical SAH scenarios with different variable attribute levels and a status quo scenario (i.e. No new SAH policy is implemented and the state remains partially reopen). A sample choice card is available in Fig 3. After the discrete-choice questions, we ask respondents for information on their demographics. Some pandemic related information (e.g. whether respondents are health or essential workers, if they have family members who are health workers, and if respondents can work from home) are also surveyed.

Fig 3 caption. Sample choice card.

To elicit individuals' WTS, we develop a set of realistic SAH scenarios, including a status quo scenario when respondents choose not to have a new state-level SAH policy. The length of a SAH order is the first attribute in each choice question - 0 weeks, 4 weeks, 6 weeks, 8 weeks, or 10 weeks, which serves as the non-monetary payment vehicle similar to the monetary cost in a traditional WTP study. Levels of the other choice attributes vary depending on the lengths of the SAH order. Zero weeks (no SAH order) is the baseline and is presented as the status quo option in each choice question. We choose 10 weeks (2.5 months) as the maximum SAH order lengths given that the medical community is pushing forward with the COVID-19 vaccine development, and studies have shown it is likely to be available 12-18 months from the start of the pandemic [33, 34].

The second attribute, having a mask mandate or not having a mask mandate, indicates whether the government imposes a statewide mask wearing mandate so that respondents are required to wear masks or face coverings when they leave home or are unable to social distance (i.e., stay 6-feet apart) over the next ten weeks (2.5 months) from the day the survey was taken. The third attribute is the increase in daily newly confirmed COVID-19 cases. The attribute levels are presented as percentage increase in the next ten weeks from the day the respondents answer the survey - 0.5 times (50%), 1 time (100%), 1.5 times (150%), and 2 times (200%). In the attribute description, we provide respondents the number of newly confirmed cases in their state on August 20, which was ten days before the survey was taken, as a reference to help them quantify the attribute levels. This attribute captures the benefits, "low increase" (reduction) of newly positive COVID-19 cases, from staying home.

We also introduce the increase in weekly initial unemployment insurance claims - 2 times, 4 times, 6 times, and 8 times the pre-pandemic level ten weeks from the day the survey was taken, as the forth attribute. Similarly, in the attribute description, we present respondents the number of pre-pandemic (defined as March 14, 2020) weekly initial unemployment insurance claims in their corresponding states.

The final attribute is the possibility of school reopening four weeks from the date when the survey was taken - 20%, 40%, 60%, and 80% chance. Some schools in the nation have started in-person instruction at the time the survey was distributed and

already observed outbreaks of cases among students [35]. While some schools continue to conduct in-person teaching, others quickly switch to virtual learning mode given the spikes in infection. Whether school will remain open largely depends on whether individuals are willing to stay home and practice social distancing. Using percentages relative to a baseline instead of absolute numbers help respondents comprehend and compare the attribute levels since it is difficult to put large numbers into scale.

Various survey drafts were shown to faculty members, graduate and undergraduate students, survey design specialists, and other members of the general public to solicit their opinions of the survey. Feedback gathered have lead to numerous changes in the survey, particularly clarity of information presented such as background information and the descriptions of the choice attributes and the layout of the choice questions. We have also adjusted the amount of questions and the presentations of attribute levels. Due to the fast development of the pandemic and the consequent time constraint, we were not able to conduct formal focus groups to test the survey. However, the feedback we solicited from this diverse group of audience helped us improve the survey substantially.

A pilot version of the survey was sent out in mid August through Qualtrics. After the pilot survey pre-launch, we obtained 51 complete and usable surveys. The pilot survey results allowed us to: 1) evaluate whether respondents are responsive to the lengths of the SAH order. For example, whether extremely long SAH periods deter respondents from choosing to stay home. 2) modify any problems or issues with the survey; 3) evaluate whether respondents understand the survey questions. We refined the final survey based on the pilot study results by increasing the lengths of stay from 0, 2, 4, 6, 8 weeks to 0, 4, 6, 8, 10 weeks. In addition, we reminded the respondents multiple times in the survey that the SAH order is strict, implying that individuals' daily activities will be severely restricted under the mandate.

To ensure the validity and reliability of the value estimates in a DCE study, survey questions need to be consequential. In particular, participants must perceive that their responses can potentially affect policy implementation [36]. We first include a policy consequentiality script in the introduction to convince respondents that their answers can possibly affect COVID-19 public policy implementation. In addition, choice questions are followed by a consequentiality question asking respondents to what extent they believe their answers will be considered by policymakers.

Following the standard practice in DCE, We use a D_0-optimal design [37] with multiple restrictions to allocate attribute levels to non status-quo options in choice questions. For example, long SAH lengths are more likely to lead to reduction in newly confirmed COVID-19 cases, high increase in weekly unemployment insurance claims, and high probability of school opening. Our experimental design ensures that no options dominate or to be dominated within or across choice questions. The final design consists of a total of 18 choice questions with three blocks of six questions in each block. Both the order of choice questions and blocks are randomized to minimize bias due to learning from earlier questions and survey fatigue. We also prevent respondents from going back and change their answers to previous questions.

Data

We collected a total of 731 complete and usable responses. We only include individuals who choose "I will read carefully and provide my best answers" in the consent questions. This resulted in us dropping 71 responses. To ensure within state variation and representation of both urban and rural areas, we weighted the number of surveys collected by the share of the state population residing in urban and rural counties. In the end, we have a total of 479 responses from urban counties, and 192 responses from rural counties.

To investigate the demographics of our respondents further, we present the summary statistics of our survey sample in Table 1, columns 1 through 3. Alongside these, we also report the actual demographics of each state, derived from the American Community Survey (ACS) obtained from the Census Bureau, in columns 4 though 6. Table 1 shows that the respondents have a higher proportion of whites, with lower proportions of minorities. They are also more likely to be female, younger, and from lower income brackets. Overall, the respondents' demographics are generally representative of the adult population (18+ years old) in each of their respective states.

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Table 1. Distribution of demographic characteristics of survey participants and the 2019 state-level population.

Category	Variable	Population			
		(1) California	(2) Georgia	(3) Illinois	(4 Calif
Age	18-24	9.30	9.70	9.20	11.67
	25-34	15.30	13.80	13.80	25.83
	35-44	13.40	13.20	13.00	22.92
	45-54	12.60	13.10	12.60	13.33
	55-64	12.10	12.30	13.00	12.92
	65+	14.80	14.40	16.20	13.33
Gender	Male	49.71	48.69	49.06	46.25
Race/Ethnicity	White	63.60	59.90	73.80	62.50
	Black or African American	7.00	33.50	15.40	4.58
	American Indian and Alaska Native	2.00	0.90	0.80	1.67
	Asian	17.10	4.90	6.60	12.08
	Native Hawaiian and Other Pacific Islander	0.80	0.20	0.10	0.42
	Hispanic	39.40	9.80	17.50	17.08
	Other	14.94	3.50	6.30	1.67
Marital Status	Single	37.35	34.74	35.74	40.83
	Married	46.54	46.24	47.05	47.92
	Divorced	9.28	11.34	9.89	7.92
	Widow(er)	4.93	5.44	5.74	3.33
Education Level	Less than high school graduate	15.97	12.09	10.15	2.08
	High school graduate or GED	20.59	27.40	25.94	15.42
	Some college or associate's degree	28.44	28.00	28.15	32.92
	Bachelor's degree	21.86	19.92	21.69	31.25
	Graduate or professional degree	13.14	12.59	14.06	18.33
Income Level	Less than $25,000	14.90	19.30	17.60	16.25
	$25,000 to $49,999	16.70	21.30	19.40	21.25
	$50,000 to $74,999	15.30	18.30	16.50	19.58
	$75,000 to $99,999	12.50	12.70	12.80	13.33
	$100,000 to $149,999	17.40	14.80	16.90	14.17
	$150,000 to $199,999	9.40	6.30	7.80	7.50
	$200,000 or more	13.70	7.30	9.00	7.92

Methods

We examine individuals' preferences towards a SAH policy using the DCE method. Our empirical model is based on the discrete choice random-utility maximization (RUM)

framework discussed in [38]. Individuals choose from a set of SAH scenarios with varying attributes to maximize their utility. The utility of individual n choosing option i in choice scenario t can be written as:

$$U_{nit} = \beta'_{\mathbf{n}}\mathbf{X_{nit}} + \epsilon_{nit} \tag{1}$$

$\mathbf{X_{nit}}$ here is an observed component, which is a vector of alternative-specific attributes including number of daily newly confirmed cases, number of weekly unemployment insurance claims, statewide mask mandate, probability of school reopening, and non-monetary cost measured as the length of a strict SAH mandate. β_n is a vector of individual-specific random coefficients. ϵ_{nit} is an unobserved random component that captures individual's idiosyncratic tastes and is i.i.d extreme value type-one distributed [39].

The chosen alternative can be specified as y_n. Conditional on β_n, the probability of individual n choosing alternative i over t scenarios where i $\neq$ j is:

$$L(y_n|\beta_n) = \prod_t \frac{e^{\beta_{ni}x_{it}}}{\sum_j e^{\beta_{nj}x_{jt}}} \tag{2}$$

Since β_n is a random coefficient, integrating over all possibilities of β_n gives us the unconditional probability of choosing alternative j for individual n as:

$$P_n(y_n|\theta) = \int L(y_n|\beta_n) f(\beta|\theta) d\beta \tag{3}$$

where θ are the underlying parameters defining β, and $f(\beta|\theta)$ is the probability density of β.

We estimate a mixed multinomial logit (MMNL) model to account for respondents' preference heterogeneity by allowing the parameter coefficients to vary across individuals. In addition, we include an alternative specific constant (ASC) in the model so that parameter coefficients vary across choice scenarios, which allows us to differentiate the status quo option and the other two alternatives and accommodate the differences in substitutability between option pairs [40].

We first estimate the MMNL model, allowing the coefficients to be independent (not correlated). The justification of this no-correlation assumption will be further explained in the result section. The coefficient for the number of weeks of staying home is assumed to be log-normally distributed, while the coefficients for all the other attributes are normally distributed. Standard errors are clustered at the individual level.

There are two ways to obtain respondents' WTS. First, WTS can be calculated using the ratio of coefficients in the utility function as specified in Equation 1 in what is known as preference space estimation [41]. Second, WTS can be estimated directly in the WTP space, known as WTP space estimation. The advantage of WTP space estimation is that we can specify the distribution of the WTS directly instead of deriving it indirectly using the distribution of coefficients in the utility function. As noted in previous literature, the WTP estimates in the preference space estimation tend to be unrealistically high with less realistic distributions [41, 42]. Another advantage of the estimation in the WTP space is that it accounts for scale heterogeneity among individuals even without a fully correlated model. Hence, we estimate individuals' WTS home in the WTP space following [41].

In the WTP space estimation, we assume WTS for increase in daily number of new cases and unemployment insurance claims to be log-normally distributed with a negative sign, while WTS for school opening follows a log-normal distribution with a positive sign. We make these distribution assumptions since WTS home is likely to incur a diminishing marginal return. Therefore, the longer people stay home, the lower their WTS will be. The WTS for mask mandate is assumed to be normally distributed.

To further investigate the relationship between respondents' characteristics and their WTS, we first recover the average conditional individual-attribute-specific marginal WTS [43]. We then regress individual's WTS for each attribute on their socioeconomic and pandemic related characteristics. The estimated results provide insight on heterogeneity in WTS and particularly how individual-specific characteristics affect their WTS.

Results

Main MMNL results

The preference space MMNL estimation results are in Table 2. The first column presents the results for the full sample including all respondents in the three states. We have 59 (8.07%) respondents always choose the status quo option of no SAH orders. It is possible that these respondents are protesting the SAH policy, or the complexity of the choice experiment leads to their choice [44, 45, 46]. While our survey includes multiple attributes that may make the selection a complex task, we believe the main reason that a few respondents always selected the status quo option is their lack of trust in the SAH policy. First, the number of respondents constantly choosing the status quo option is relatively low compared to other studies, such as [44]. In addition, among those who always choose the status quo, 48 (81.35%) of them also state that they don't believe in the effectiveness of the SAH policy. As a result, we construct a main sample by dropping respondents who always choose the status quo option of no SAH orders and do not believe that SAH policies are effective in preventing the spread of the virus.

Column (1) and Column (2) compare the MMNL results using the full sample and the main sample separately. In both specifications, all coefficients are highly significant with expected signs. Respondents prefer to have SAH orders with a shorter length. Longer staying home period lowers utility. Not surprisingly, an increase in the number of cases and unemployment insurance claims reduces utility. On the contrary, people gain utility from an increase in the probability of school opening and a statewide mask mandate. The ratio of the coefficients for the increase in the number of daily new cases and weekly unemployment insurance claims provides essential insight. If we assume that the change in utility with respect to the change in the number of cases and weekly unemployment insurance claims is linear, the ratio of the two coefficients shows us the trade-off between an increase in the number of cases and an increase in the number of weekly unemployment insurance claims.

While controversial like a SAH mandate, it is notable that a statewide mask mandate has an opposite impact on individuals' utility compared to a SAH order. Specifically, mask-wearing improves utility. This can be potentially attributed to the fact that the inconvenience of wearing masks is relatively low against its extensive benefits, while the cost involved in staying home is much higher. Wearing a mask, like staying home, generates positive externalities. It not only lowers an individual's probability of getting sick, but also generates external benefits to everyone else by preventing the spread of the virus. These results suggest, in general, mitigation policies such as mask mandates are more favorable than strict suppression policies like lockdown orders. Our findings are consistent with the existing literature findings that there is widespread support for mitigation policies such as mask or face covering mandates [47].

Column (3) shows the MMNL results of an extended model when we include interactions between choice attributes and a dummy variable indicating if a respondent believes in the effectiveness of SAH orders in curbing the spread of COVID-19. The highly significant coefficients (0.05% level) demonstrate that there is a substantial difference in how each attribute affects respondents' utility depending on whether they

Table 2. The MMNL results estimated in preference space.

	(1) Full sample	(2) Main sample	(3) × SAH
Alternative specific constant	-2.329*** (0.438)	-2.183*** (0.239)	-1.799*** (0.198)
Number of daily cases	-0.453*** (0.067)	-0.489*** (0.079)	0.296* (0.168)
Weekly unemployment benefit claims	-0.127*** (0.017)	-0.139*** (0.019)	-0.269*** (0.049)
Probability of school opening	0.007*** (0.002)	0.008*** (0.002)	-0.007 (0.005)
Mask wearing mandate = 1	1.356*** (0.096)	1.673*** (0.123)	-0.210 (0.235)
Stay-at-home (weeks)	-3.723*** (0.691)	-3.991*** (0.412)	-18.573*** (4.286)
Number of daily cases × SAH effective			-0.934*** (0.189)
Weekly unemployment benefit claims × SAH effective			0.159*** (0.048)
Probability of school opening × SAH effective			0.016*** (0.005)
Mask wearing mandate = 1 × SAH effective			2.094*** (0.275)
N	13104	12240	13104
LR chi2	386.238	633.342	531.641
Prob >chi2	0.000	0.000	0.000
Log lik.	-3076.578	-2894.033	-3001.180

Standard errors in parentheses

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

The table shows the MMNL model estimated in the preference space. Column (1) presents the results for the full sample, including all respondents. Column (2) presents the results for the main sample. We construct the main sample by dropping respondents who always choose the status quo option and do not believe in SAH policy. Column (3) shows the MMNL results when including interactions between choice attributes and a dummy indicating if an individual believes in a SAH order.

are a believer of the policy or not. The probability of school opening, and a mask-wearing mandate do not significantly change the utility of non-believers of SAH orders. In contrast, individuals who believe in the SAH orders' effectiveness lose greater utility from an increase in the number of positive cases, face less utility reduction from an increase in weekly unemployment insurance claims, and gain more utility from an increase in the probability of school opening and from a mask-wearing mandate than non-believers. The coefficients for the length of a SAH order are negatively significant at the 5% level in all three model specifications. This indicates that staying home is indeed a non-monetary "cost" that reduces respondents' utility. We also want to acknowledge that though we assume staying home is a cost, being home brings benefits for some individuals, such as more family time, flexible work schedule, and avoided commuting costs. Considering this, the estimates of WTS for the number of new cases and weekly unemployment insurance claims are likely biased upward. In other words, our estimated WTS might be larger than they are in reality. The negative coefficient can be interpreted as the "net cost" of staying home.

Willingness to stay home

We estimate individuals' WTS in the WTP space. Table 3 presents the mean and median WTS estimates from the WTP space model. All attributes are assumed to be random and independent of each other. Given that we assume the WTS for an increase in daily new cases, unemployment insurance claims, and the probability of school opening are distributed log-normally, median WTS estimates are more informative than mean WTS. In addition, the WTS results on mask mandate are not easily interpretable since the mask mandate is added as an attribute to improve the flexibility of the choice alternatives and ensure the choice scenarios are realistic. Therefore, we focus our discussion mainly on median WTS for an increase in daily new cases, unemployment insurance claims, and the probability of school opening.

Table 3. Estimated WTS for different attributes in the WTP Space.

	Mean	Median	SD
Number of daily cases	-21.624**	-5.488*	82.416
	(10.117)	(3.110)	(53.888)
Weekly unemployment benefit claims	-4.667**	-1.997**	9.858*
	(2.156)	(0.996)	(5.252)
Probability of school opening	0.208**	0.191*	0.090
	(0.104)	(0.101)	(0.100)
Mask wearing mandate = 1	45.671**	45.671**	56.901**
	(20.469)	(20.469)	(25.410)
Alternative specific constant	-61.166**	-61.166**	-65.801**
	(25.728)	(25.728)	(29.647)
N	12,240	12,240	12,240

Standard errors in parentheses

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

This table shows the estimated mean, median, and standard deviation of WTS for four choice attributes. The model is estimated in WTP space. WTS of attribute "Mask wearing mandate" is assumed to be normally distributed, while the WTS for the other attributes are assumed to be log-normally distributedf. The WTS for alternative specific constant is included and assumed to be normally distributed.

Consistent with previous literature, we confirm individuals' strong support for the SAH orders [20]. Our results suggest that respondents are willing to stay home for additional five and half weeks to lower the increase of new cases by 100%. Their WTS to reduce the increase in the unemployment insurance claims by 100% is approximately two weeks, which is much lower than the WTS for case reduction. The fact that individuals are less willing to stay home to reduce unemployment insurance claims than to prevent disease infection indicates that they recognize the trade-off between infection prevention and economic development slowdown caused by SAH orders. While a SAH mandate generates benefits by reducing the spread of the virus, it seizes businesses and reduces economic activity, which leads to job losses and increase in the number of weekly unemployment insurance claims, resulting in large economic cost [49] and mental health costs [6, 7].

Individuals' WTS to increase the probability of schools opening in the fall is relatively large. Specifically, respondents are willing to stay home for about nine and half weeks to increase the probability of school opening by 50%. Given that school reopening may affect the number of positive cases when students gather, this WTS estimate highlights the importance of school reopening to the general public.

We note that our estimated WTS coefficients are based on the uncorrelated model.

To justify this assumption and properly specify the correlation structure between the choice attributes, we compare the results of the uncorrelated and the fully correlated model. We find that the uncorrelated model has a favorable Bayesian Information Criterion (BIC). In addition, we test the correlation between the choice attributes in the uncorrelated model. As shown in Table 4, the correlations between the four choice attributes are low. We have also tested the correlation in a fully correlated model as a robustness check, and the results are comparable to these in the uncorrelated model. We, therefore, decide to estimate individuals' WTS in the WTP space with an uncorrelated MMNL model. As noted earlier, the uncorrelated model accounts for scale heterogeneity. The scale parameter captures all sources of variation that exist for the coefficients in the utility function even when only scale heterogeneity is controlled. Hence, our uncorrelated model captures other variations among utility coefficients as well.

Table 4. Correlation between WTS for the main attributes.

	Number of daily cases
Weekly unemployment benefit claims	-0.057
Probability of school opening	-0.007
Mask wearing mandate = 1	0.092
N	680

This table shows the correlation between the choice attributes in the uncorrelated model estimated in the WTS space. We use the main WTP-space specification (Table 3) to recover conditional individual-specific WTS.

Absent a SAH mandate, unmitigated spread of COVID-19 can also reduce economic activity due to the reduced human interactions stemming from individuals' defensive behavior [12]. Thus, while individuals perceive a trade-off between costs and benefits of a SAH mandate at the levels observed in August and exhibit certain preference towards the SAH order, this outcome does not necessarily hold across different stages of the pandemic when the transmission rates and economic conditions vary.

Heterogeneity in WTS

We may expect individuals to display heterogeneous WTS for two main reasons. First, individuals experience different costs and benefits from a statewide SAH policy. Those who are more vulnerable to the disease, like the old, may be more willing to advocate for such mandates than the young. On the other hand, those who rely on jobs requiring human interactions may be less willing to support a stay-at-home policy. Second, staying home and wearing masks both provide positive externalities to society. As a result, the extent to which individuals internalize the externalities affects their WTS.

The high standard deviations of the WTS estimates as shown in Table 3 provides support for our hypothesis that there is a significant amount of heterogeneity in individuals' preferences and WTS home.

Table 5 presents the estimation results when we regress respondents' WTS for each attribute on their demographics like age, gender, income, and pandemic-related characteristics such as wether they can work from home or whether they are health or essential workers.

Results are generally consistent with our expectations and follow intuition. Seniors who are 65 or older have substantially higher WTS, over 6 weeks, to a lower number of cases than younger individuals. This finding also confirms our hypothesis that older respondents are warier about the disease. In contrast, seniors have slightly lower WTS to increase the probability of school opening. Additionally, individuals who have applied for unemployment insurance claims are willing to stay home 6 fewer weeks to bring down

-2.25in0in

Table 5. Heterogeneity in WTS for different attributes.

	Number of daily case	Weekly unemployment benefit claims	Probablity school opening
Believe SAH effective	-6.605	2.087***	0.002
	(4.132)	(0.595)	(0.001)
Work from home	-3.571	0.765*	0.001
	(3.165)	(0.456)	(0.001)
Active employment	0.417	0.126	-0.001
	(3.317)	(0.478)	(0.001)
Senior (above 65)	6.117*	-0.135	-0.002*
	(3.376)	(0.486)	(0.001)
Bachelor degree	-1.044	0.158	0.001
and above	(3.017)	(0.434)	(0.001)
Believe free-riding	-5.934	0.386	-0.001
exits[a]	(4.138)	(0.596)	(0.001)
Not envious[b]	-1.497	-0.600	0.001
	(3.229)	(0.465)	(0.001)
Envious[b]	0.615	0.685	-0.001
	(3.003)	(0.432)	(0.001)
Republican	0.608	0.012	0.001
	(3.316)	(0.478)	(0.001)
Received unemployment	-6.128*	0.469	0.000
insurance	(3.691)	(0.532)	(0.001)
Health worker	-4.998	0.090	-0.001
	(3.174)	(0.457)	(0.001)
Essential worker	0.038	0.060	0.001
	(3.113)	(0.448)	(0.001)
Experienced wage cut	4.000	-0.511	0.000
	(3.288)	(0.474)	(0.001)
Female	0.764	-0.397	-0.000
	(2.918)	(0.420)	(0.001)
Income >100K	5.251	-0.460	-0.001
	(3.550)	(0.511)	(0.001)
Conservative for	1.917	-0.412	0.000
economic issues[c]	(3.363)	(0.484)	(0.001)
Constant	-13.539**	-6.361***	0.207***
	(5.490)	(0.791)	(0.002)
N	673	673	673

Standard errors in parentheses

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

This table shows the OLS regression results when we regress individual-attribute-specific WTS on individual characteristics. [a]We ask respondents what the percentage of people in their community they believe are not wearing masks to measure if they believe there exists free-riding. [b]We ask respondents about how the wealth of others impacts their own happiness. The two question reads as: "Using the provided scale (1 "strongly disagree" to 5 "strongly agree"), please indicate to what extent you agree or disagree with the following statement: "Regardless of how much money I have, I am concerned that there are people who have more (less) money than me". A selection of 5 or 4 in these two questions would indicate that the respondent identifies as being envious (not envious) of the wealth of others. [c]We ask respondents their political ideology for economic issues. Choices include conservative, middle of the road, and liberal.

positive cases than those who do not. Given that staying home results in stagnation in the labor market, this result is not surprising. We find that respondents who can work from home are willing to stay home for 0.8 additional weeks to increase the number of unemployment insurance claims than those who cannot. In other words, their WTS to reduce unemployment is lower than their counterparts. A possible explanation is that people who have the option to work from home are not concerned about losing their jobs, leading to lower WTS for reducing unemployment. Together, these results validate our hypothesis that individuals bear different costs and benefits from the SAH policy, and as a result, have a heterogeneous WTS to reduce the spread of the virus.

Discussion

This paper empirically quantifies individuals' WTS home during the COVID-19 pandemic by conducting a stated-preference DCE survey and further explored factors driving the heterogeneity in individuals' WTS. Our findings can provide critical information needed for effective and efficient policy responses during the COVID-19 pandemic and future pandemics.

With winter approaching and individuals gathering and spending more time indoors, countries worldwide are experiencing another COVID-19 outbreak with surging cases. We find that staying home results in a net cost to individuals and lowers their utility. However, the magnitude of respondents' WTS to reduce the number of cases and increase the probability of school opening is still quite large even when the net cost is considered. Specifically, we find that by keeping the number of unemployment benefits claims fixed, individuals are willing to stay home for approximately an additional five weeks to reduce the number of positive COVID-19 cases. However,if a SAH order would increase the number of unemployment benefits claims, our results suggest that people do consider the raise in unemployment and shorten their WTS length. [27] show that individuals are more willing to obey SAH policies if the length of a SAH order is not longer than they expected. Our findings provide insight into the potential length of SAH policies if the re-implementation of lockdown is considered.

There are continuing heated debates and deeply divided views on the mask mandate across the country, though mask-wearing has been recognized as one of the most effective tools to curb the pandemic in the public health community. Overall, we present evidence showing that average respondent gains utility from mask and face-covering mandates. Policymakers may consider leveraging such support to utilize mask mandates as an effective preventative measure limiting the further spread of the virus.

In addition, we find that several pandemic related characteristics, including age, ability to work from home, and employment status are factors determining individuals' heterogeneous WTS. Targeted policies that differentiate the population by age and risk groups have been found to outperform uniform lockdown policies in theory. Based on the results of this study, specific suggestions on how potential targeted policies could be implemented are offered.

We recognize one limitation in our study regarding the magnitudes of our estimates. Even though we have reminded the strictness of a SAH order in our survey, respondents might choose longer lengths of SAH orders than they would have accepted in reality since the SAH orders are not easily enforceable. In other words, this brings a potentially upward biased into our estimates.

There are several avenues to expand the work and advance our understanding of people's WTS home during pandemics. For instance, conducting a retrospective survey evaluating what individuals now believe would have been optimal at the beginning of the pandemic may inform policy given that individuals become more informed over time. In addition, future studies may examine more nuanced SAH policies, for example, with

varying degrees and types of closures (e.g., park closures versus bar closures). A study that examines methods and levels of enforcing SAH orders and mask-wearing mandates may also add additional insight into the policy implementation.

Acknowledgments

We would like to thank M. Sloggy for his helpful comments.

Author Contributions

Conceptualization, Survey design, Data curation: LL, DL, MR. Formal Analysis, Methodology: LL. Writing - original draft: DL. Writing - review& editing: LL, DL, MR.

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Figures

Fig 1. 7-day moving average of number of cases across the three states. Dashed lines show the beginning and end of the survey period. Data source: https://covid.cdc.gov/covid-data-tracker.

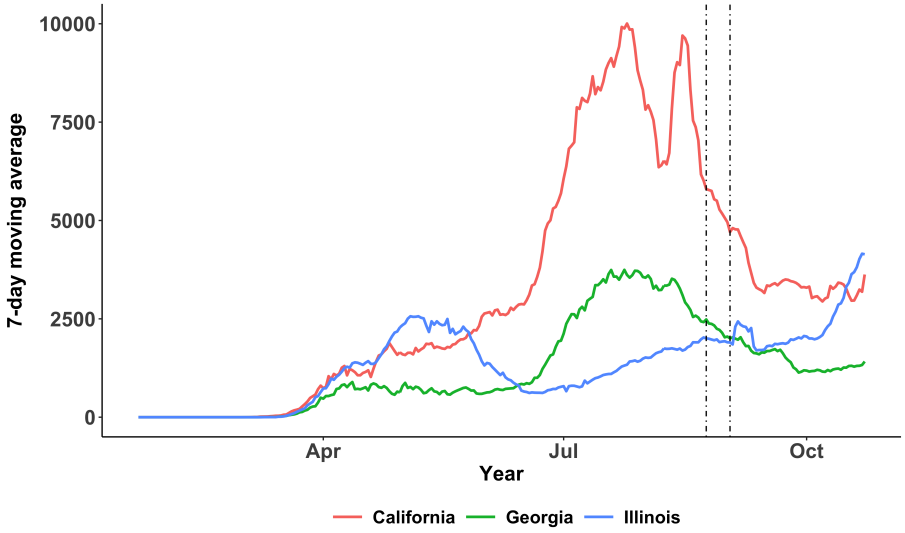

Fig 2. Attribute levels in the discrete choice experiment survey.

Attribute and Description	Attribute Levels
Length of a state-wide stay-at-home order	4 weeks 6 weeks 8 weeks 10 weeks
Mask Wearing Policy: Whether the public is required to wear a mask or face covering when they leave home and are unable to socially distance (6 feet) over the next **TEN weeks (2.5 months)**.	Wearing a mask or face covering is required. Wearing a mask or face covering is not required.
Increase in newly confirmed COVID-19 cases (daily): Increase in newly confirmed COVID-19 cases **every day** in your state **TEN weeks (2.5 months) from today**. A higher number means more people are infected by the coronavirus every day. Note: The number of newly confirmed COVID-19 cases in California is 5,920 as of August 20th.	0.5 times (50%) increase from today 1 time (100%) increase from today 1.5 times (150%) increase from today 2 times (200%) increase from today
Increase in weekly *initial* unemployment insurance claims: Increase in weekly emerging unemployment insurance claims in your state **TEN weeks (2.5 months) from today**. A higher number means more people have filed unemployment insurance claims. Note: The *Unemployment Insurance* program pays benefits to workers who have lost their jobs and meet the program's eligibility requirements. The number of pre-pandemic (03/14/2020) weekly initial unemployment insurance claims is 57,606 in California.	2 times the pre-pandemic level 4 times the pre-pandemic level 6 times the pre-pandemic level 8 times the pre-pandemic level
School Opening Possibility: Probability of schools being open **FOUR weeks from today**.	20% chance that schools are open 40% chance that schools are open 60% chance that schools are open 80% chance that schools are open

Fig 3. Sample choice card.

Suppose Option A and Option B are the **only** two scenarios under the pandemic you could choose. Which **one** would you choose? Please read **all** the features of **each** option and then **check the box that represents your choice**. If you do not like either option A or option B, then please choose "Do not stay at home for additional weeks".

Option / Attribute	Option A	Option B	Do not stay at home for additional weeks
Number of Weeks to Stay at Home	6 weeks	4 weeks	0 weeks
Mask Wearing/ face covering over the next TEN weeks (2.5 months)	Not Required 	Required 	Not Required 
Increase in newly confirmed COVID-19 cases (daily) TEN weeks (2.5 months) from today	0.5 times 	1.5 times 	2 times 
Increase in weekly initial unemployment insurance claims TEN weeks (2.5 months) from today	4 times 	6 times 	2 times 
Probability of schools being open FOUR weeks from today	60% 	20% 	20%