The path towards herd immunity: predicting COVID-19 vaccination uptake through results from a stated choice study across six continents

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A team effort

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Context

- Need for understanding COVID-19 vaccine uptake remains even given initial success of vaccine campaigns
- Share of population vaccinated remain low in developing countries
- And need for COVID-19 vaccination will likely not go away
  - new variants may emerge
  - resistance built up by vaccines will reduce, and boosters will be needed
- Important to gain an understanding of the drivers of vaccine acceptance
- Can also provide insights for future non-Covid pandemics

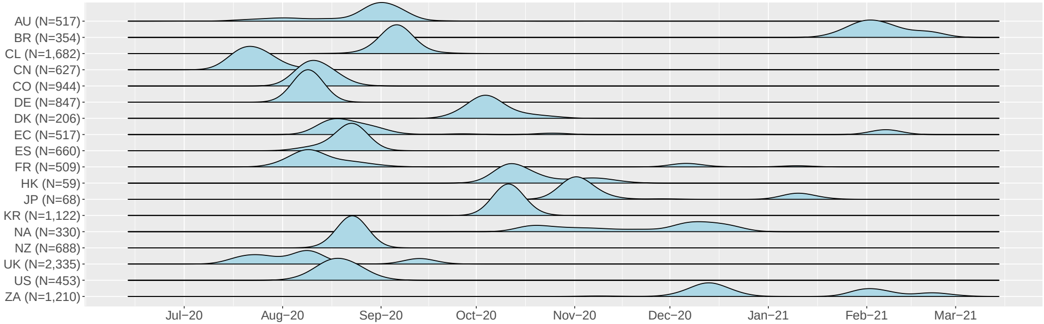
Past work

- Much attention paid to what share of people intend to get vaccinated
  - But often just answers to simple yes/no question
- Or statistics on what share of a population have been vaccinated
  - But without details on who refused vaccination by what vaccine
- A major question remains as to how much vaccine characteristics matter for uptake
- Especially relevant given differences across vaccines in efficacy and risk

Stated choice as a tool

- Some limited work looking at vaccine acceptance using stated choice (SC) surveys
- Almost always limited to a single country, and often without focus on vaccine characteristics
- This study is different
  - Apply a consistent stated choice survey across 18 countries/territories
  - Understand likely impact of vaccine characteristics on uptake
  - Make predictions of uptake in possible future vaccine scenarios

Surveyed >13K individuals in 18 countries/territories



- Mix of sources, primarily survey companies and social media
- Corrected for age and gender distribution in model application

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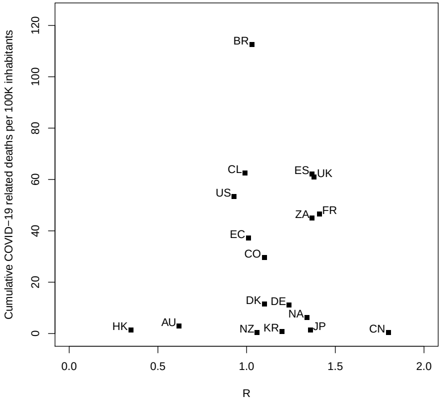
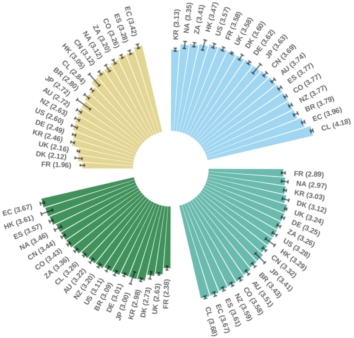
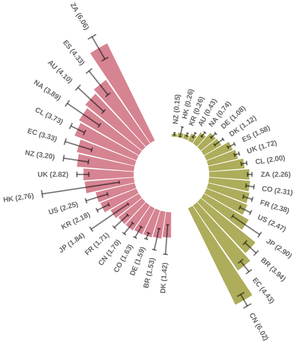
Differences in pandemic (at time of sampling)

- Major differences across study areas
- Some of these differences remained (e.g. AU/NZ have kept numbers low)
- But DE, DK and NA data collected at a time with comparatively lower pandemic impact
- Controlled for later in model recalibration



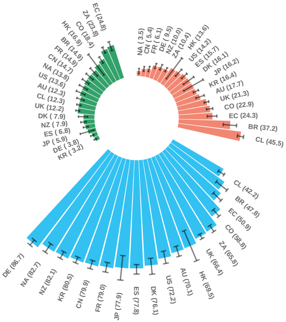
People take COVID-19 quite seriously

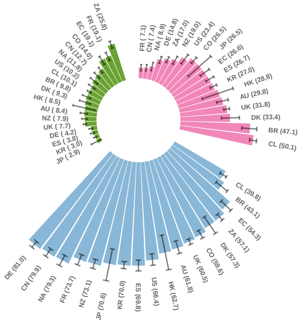




	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Likelihood of infection leading to symptoms	5−point Likert	3.74	3.79	4.18	3.69	3.77	3.62	3.60	3.96	3.77	3.58	3.47	3.63	3.13	3.35	3.77	3.58	3.57	3.41
Likelihood of infection leading to serious illness	5−point Likert	3.51	3.43	3.68	3.32	3.58	3.25	3.12	3.67	3.61	2.89	3.29	3.41	3.03	2.97	3.59	3.24	3.28	3.26
Likelihood of infection leading to hospitalisation	5−point Likert	3.22	3.09	3.26	3.44	3.43	3.01	2.73	3.67	3.57	2.38	3.61	3.00	2.98	3.46	3.20	2.63	3.11	3.36
Likelihood of infection leading to death	5−point Likert	2.72	2.80	2.84	3.12	3.26	2.49	2.12	3.42	3.28	1.96	3.05	2.72	2.46	3.12	2.63	2.16	2.60	3.20
	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Estimated share of infected people	%	0.43	3.94	2.00	6.02	2.31	1.08	1.12	4.43	1.58	2.38	0.26	2.90	0.26	0.74	0.15	1.72	2.47	2.26
Estimated risk of death if infected yourself	%	4.10	1.53	3.73	1.70	1.63	1.59	1.42	3.33	4.33	1.71	2.76	1.84	2.18	3.89	3.20	2.82	2.25	6.06

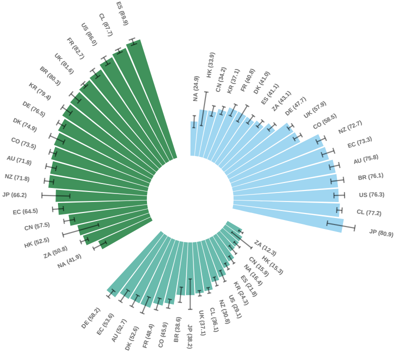
Impact of restrictions





	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Physical health worse than before COVID−19	%	17.65	37.21	45.54	5.36	22.85	9.51	16.06	24.29	15.68	6.10	13.56	16.18	16.36	3.48	10.01	21.32	14.22	10.42
Physical health same as before COVID−19	%	70.09	47.84	42.21	79.93	58.79	86.66	76.08	50.88	77.82	79.02	69.49	77.94	80.47	82.75	82.13	66.45	72.15	65.78
Physical health better than before COVID−19	%	12.26	14.94	12.25	14.71	18.36	3.83	7.86	24.83	6.83	14.87	16.95	5.88	3.17	13.77	7.86	12.23	13.62	23.80
	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Mental health worse than before COVID−19	%	29.79	47.10	50.08	7.37	26.46	14.81	33.41	26.59	26.74	7.14	28.81	26.47	27.03	8.93	18.98	31.80	23.37	17.05
Mental health same as before COVID−19	%	61.77	43.09	39.80	79.92	59.57	81.04	57.26	54.29	69.80	73.72	62.71	70.59	69.96	79.31	73.14	60.45	66.44	57.12
Mental health better than before COVID−19	%	8.45	9.81	10.12	12.71	13.96	4.15	9.34	19.12	3.79	19.14	8.47	2.94	3.01	11.76	7.89	7.75	10.19	25.83

Differences in past vaccine uptake



	Past influenza vaccination (%)	Other elective vaccines (%)	All recommended vaccines (%)
AU	75.75	52.66	71.77
BR	76.12	38.55	80.30
CL	77.18	36.09	87.69
CN	34.17	15.85	57.52
CO	58.52	45.94	73.48
DE	47.68	58.20	76.54
DK	41.05	52.60	74.89
EC	73.27	53.64	64.54
ES	41.06	21.77	89.88
FR	40.82	48.39	82.71
HK	33.90	15.25	52.54
JP	80.88	38.24	66.18
KR	37.06	24.28	79.39
NA	24.91	16.43	41.92
NZ	72.68	30.79	71.76
UK	57.92	37.07	81.59
US	76.27	29.11	85.99
ZA	43.13	12.28	50.78

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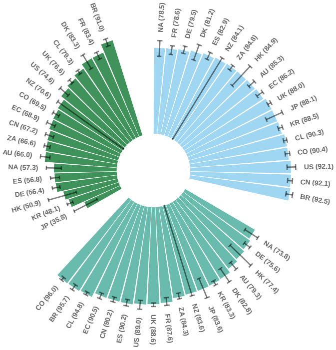
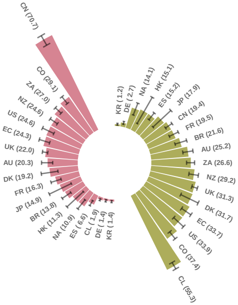
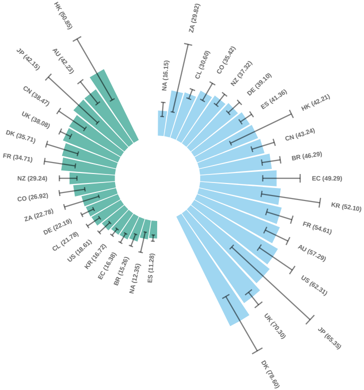
Differences in reasons for vaccination





	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
To protect myself	%	85.30	92.51	90.35	92.11	90.37	79.55	81.24	86.18	82.87	78.60	84.91	88.06	88.48	78.45	84.10	88.03	92.07	84.81
To protect my family	%	79.30	95.71	94.81	90.22	96.04	75.58	82.84	90.49	90.20	87.58	77.36	83.58	83.29	73.75	83.59	88.57	89.00	84.34
To protect the public	%	65.97	91.02	79.29	67.16	69.50	56.42	83.34	68.89	56.80	83.41	50.94	35.82	48.14	57.29	70.61	76.65	74.56	66.55
	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Due to contact with an infected person	%	25.16	21.61	55.33	19.38	37.41	2.69	31.75	33.69	15.18	19.48	15.09	17.91	1.17	14.07	29.21	31.30	33.87	26.57
Due to appearance of symptoms	%	20.29	13.85	1.87	70.68	29.07	1.45	19.16	24.34	6.63	16.26	11.32	14.93	1.38	10.92	24.63	21.99	24.61	27.04

Willingness to pay for faster access



	WTP for avoiding 6 month wait (£)	Additional WTP for travel restriction exemption (£)
AU	57.29	42.23
BR	46.29	15.26
CL	30.60	21.78
CN	43.24	38.47
CO	35.42	26.92
DE	39.10	22.19
DK	78.60	35.71
EC	49.29	16.38
ES	41.36	11.28
FR	54.61	34.71
HK	42.21	50.85
JP	65.35	42.15
KR	52.10	16.72
NA	16.15	12.35
NZ	37.32	29.24
UK	70.30	38.08
US	62.31	18.61
ZA	29.82	22.78

SC component

- Six tasks per respondent
- Choice between two vaccines or no vaccine, and additionally choice between free (with wait) or paid (no wait) access
- Paid access could come into play in future
  - already happens in Pakistan
  - and vaccine tourism from Latin America to the US
- Efficacy presented as remaining risk of infection to give respondents a baseline (for no vaccine)

Scenario 1:

Please consider the following vaccination options and make your choice as if they happened in the current environment. Please remember there is no right or wrong answer.

	Vaccine A		Vaccine B		No vaccine
Risk of infection (out of 100,000 people coming in contact with infected person):	4,000 (4%)		3,000 (3%)		7,500 (7.5%)
Risk of serious illness (out of 100,000 people who become infected):	2,000 (2%)		4,000 (4%)		20,000 (20%)
Estimated protection duration:	five years		two years		
Risk of mild side effects (out of 100,000 vaccinated people):	100 (0.1%)		500 (0.5%)		
Risk of severe side effects (out of 100,000 vaccinated people):	1 (0.001%)		5 (0.005%)		
Population coverage:	60%				
Exemption from international travel restrictions:	restrictions apply				restrictions apply
Waiting time (free vaccination):	1 months		3 months		
Fee (no waiting time):		£100		£50	

	Vaccine A free	Vaccine A paid	Vaccine B free	Vaccine B paid	No vaccine
Your preferred choice is:	○	○	○	○	○

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SC *vs* real-world

- Real-world situation in many countries will be one where a single vaccine is offered to individuals and they choose to accept vaccination or not
- Although some countries offer a choice between different vaccines, or vaccine available depends on which location people choose for vaccination
- Similarly, paying for faster access is not an option at present in study areas
- SC scenarios need not mimic the real-world situation, as long as they present respondents with choices that could reasonably arise in the future
- Aim of data collection is not to understand vaccine acceptance in a specific scenario but to elicit sensitivities to individual vaccine characteristics
- This includes the sensitivity to cost, which can be used to understand the willingness to accept out-of-pocket expenses for faster vaccination, where this could include, for example, travel costs to a nearby country with easier access to vaccines

Within household choices and longitudinal

- After facing scenarios for themselves, respondents were shown the same scenarios for their entire household (without having been told about this before)
- The survey was then repeated two more times several months later, again using the same scenarios

Scenario 1:

Please consider the following vaccination options and make your choice as if they happened in the current environment. Please remember there is no right or wrong answer.

	Vaccine A		Vaccine B		No vaccine
Risk of infection (out of 100,000 people coming in contact with infected person):	4,000 (4%)		4,000 (4%)		7,500 (7.5%)
Risk of serious illness (out of 100,000 people who become infected):	15,000 (15%)		4,000 (4%)		20,000 (20%)
Estimated protection duration:	one year		one year		
Risk of mild side effects (out of 100,000 vaccinated people):	5,000 (5%)		10,000 (10%)		
Risk of severe side effects (out of 100,000 vaccinated people):	15 (0.015%)		15 (0.015%)		
Population coverage:	Fewer than 10%				
Exemption from international travel restrictions:	restrictions apply				restrictions apply
Waiting time (free vaccination):	3 months		2 months		
Fee (no waiting time):		£100		£100	

	Vaccine A free	Vaccine A paid	Vaccine B free	Vaccine B paid	No vaccine
Yourself:	○	○	○	○	○
Your partner/spouse:	○	○	○	○	○
Dependent children:	○	○	○	○	○

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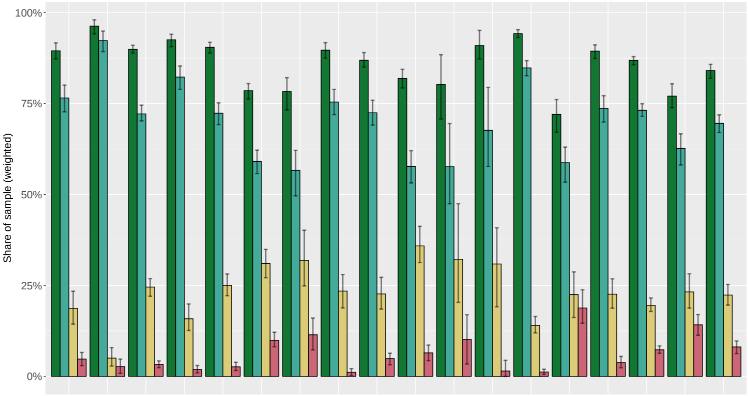
Vaccine hesitance and resistance

- Respondents either always choose a vaccine, sometimes do, or never do
- Follow-up question for this latter group
    - All those not answering *"The options presented to me were not good enough compared to not being vaccinated"* were classed as vaccine resistant
- The people who will accept any reasonable vaccine are not sufficient to achieve herd immunity
- Key importance for success of vaccine campaigns is the group that make choices dependent on vaccine characteristics, which can be termed as vaccine hesitant

Vaccine uptake



	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
Overall vaccine uptake	%	89.5	96.3	89.9	92.5	90.5	78.5	78.3	89.7	86.9	81.9	80.2	90.9	94.2	72.0	89.4	86.9	77.1	84.1
Share likely to accept any reasonable vaccine	%	76.5	92.3	72.1	82.3	72.3	59.1	56.7	75.4	72.5	57.7	57.6	67.6	84.8	58.7	73.6	73.1	62.6	69.6
Share open to vaccination depending on characteristics	%	18.7	5.0	24.5	15.8	25.0	31.0	31.9	23.4	22.7	35.8	32.2	30.9	14.0	22.5	22.6	19.5	23.2	22.3
Share of vaccine−resistant individuals	%	4.8	2.7	3.3	1.9	2.6	9.9	11.4	1.1	4.9	6.5	10.2	1.5	1.2	18.8	3.8	7.3	14.2	8.1

Step 1 of analysis of SC data: ordered logit

- Dependent variable is vaccine uptake at the person level (from $\frac{0}{6}$ to $\frac{6}{6}$)
- Used to understand role of country/territory characteristics (q) and person characteristics (z) in explaining heterogeneity
- Crucial for recalibration of models in prediction later on
- Dependent variable turned into continuous uptake for prediction

$$Y_{n,c} = \sum_{t=1}^{6} \frac{Y_{n,c,t}}{6}$$

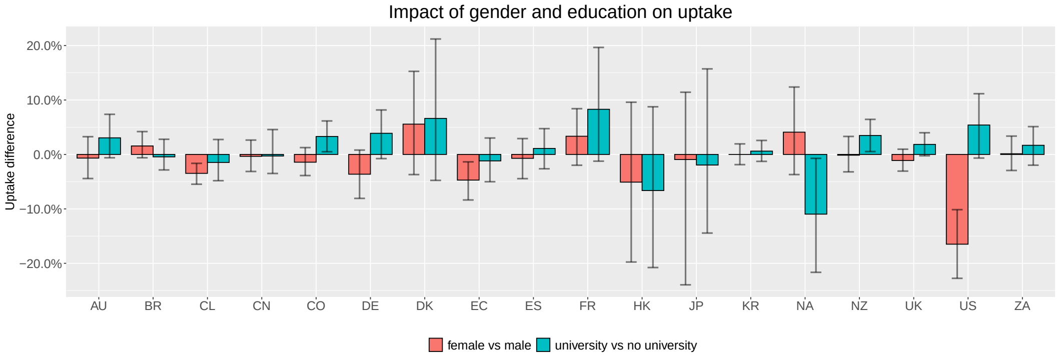
$$V_{n,c} = \delta_c + \sum_{l=1}^{L} \kappa_l q_{n,c,l} + \sum_{m=1}^{M} \gamma_{m,c} z_{n,c,m}$$

$$L(\Omega_{OL}) = \prod_{c=1}^{C} \prod_{n=1}^{N_c} \sum_{s=0}^{S} I\left(Y_{n,c} = \frac{s}{6}\right) \left[\frac{e^{\tau_{s+1} - V_{n,c}}}{1 + e^{\tau_{s+1} - V_{n,c}}} - \frac{e^{\tau_s - V_{n,c}}}{1 + e^{\tau_s - V_{n,c}}}\right]$$

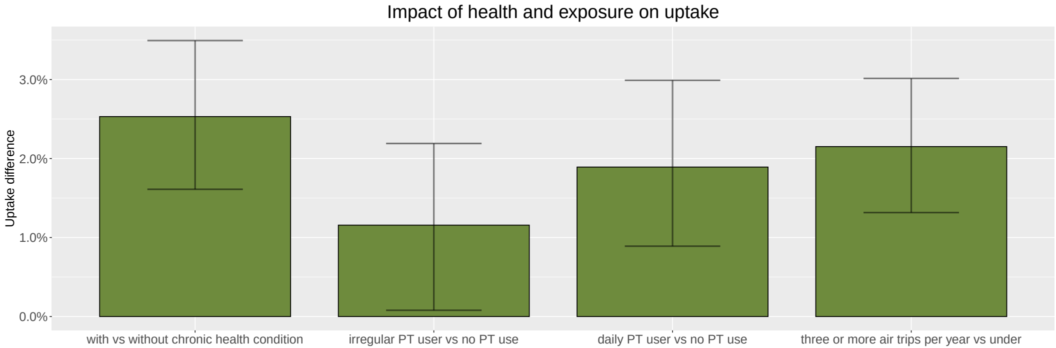
$$Y_{n,c}\left(\widehat{\Omega}_{OL}, q_{n,c}, z_{n,c}\right) = \sum_{s=0}^{S} \frac{s}{6} \left[\frac{e^{\widehat{\tau}_{s+1} - \widehat{V}_{n,c}}}{1 + e^{\widehat{\tau}_{s+1} - \widehat{V}_{n,c}}} - \frac{e^{\widehat{\tau}_s - \widehat{V}_{n,c}}}{1 + e^{\widehat{\tau}_s - \widehat{V}_{n,c}}}\right]$$

$$Y_c\left(\widehat{\Omega}_{OL}, Q_c, Z_c\right) = \frac{\sum_{n=1}^{N_c} Y_{n,c}\left(\widehat{\Omega}_{OL}, q_{n,c}, z_{n,c}\right)}{N_c}$$

Person effects: gender and education



Person effects: health and exposure



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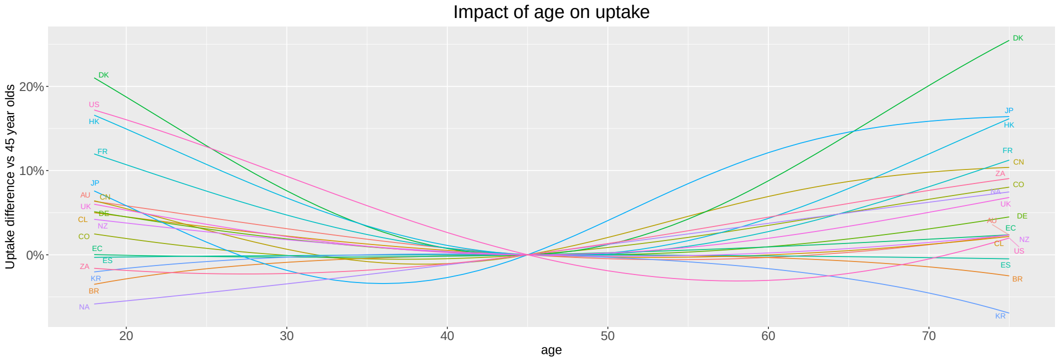
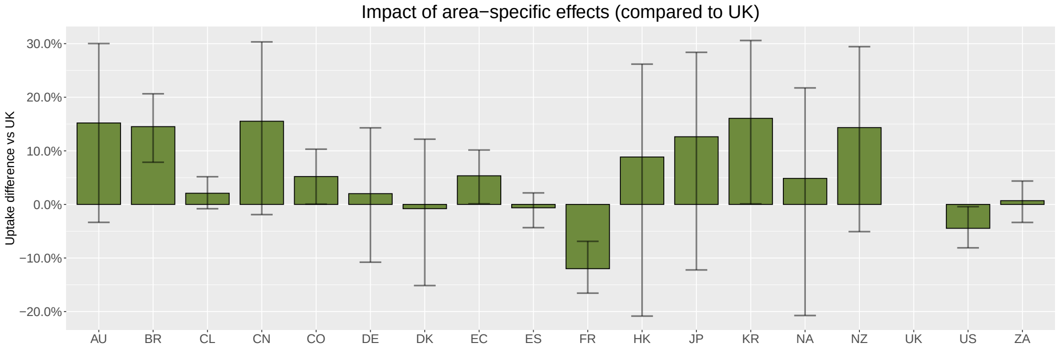
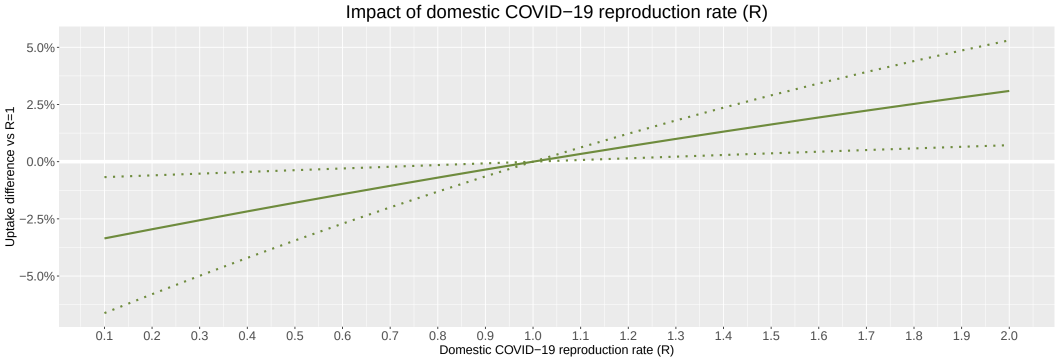
Person effects: age



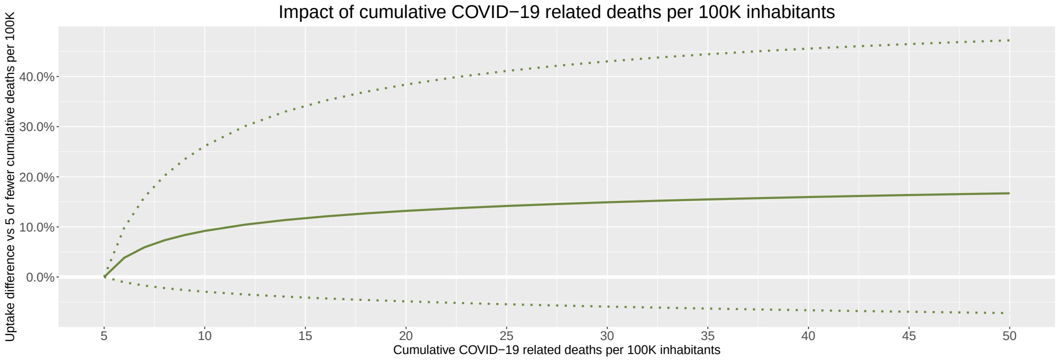
Country effects



Pandemic state effects



Pandemic evolution effects



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Step 2 of analysis of SC data: latent class

- Country-specific latent class nested logit models
- No covariates in class allocation
- Predictions combine posterior class allocation probabilities with reweighting by age and gender
- Vaccine hesitant people added back in during predictions

$$V_{n,c,i,t,s} = \delta_{c,i,s} + \beta_{c,s}{}' x_{n,c,i,t}$$

$$P_{n,c,t,s} = \frac{\sum_{j=1}^{4} Y_{n,c,t,j} \cdot e^{\frac{V_{n,c,j,t,s}}{\lambda_s}} \left(\sum_{k=1}^{4} e^{\frac{V_{n,c,k,t,s}}{\lambda_s}} \right)^{\lambda_s - 1} + Y_{n,c,t,5} \cdot e^{V_{n,c,5,t,s}}}{\left(\sum_{j=1}^{4} e^{\frac{V_{n,c,j,t,s}}{\lambda_s}} \right)^{\lambda_s} + e^{V_{n,c,5,t,s}}}$$

$$\pi_{n,c,s} = \frac{e^{\alpha_{c,s}}}{\sum_{k=1}^{S_c} e^{\alpha_{c,k}}}$$

$$L\left(\Omega_{LC}\right) = \prod_{n=1}^{N_c} \left[\sum_{s=1}^{S_c} \pi_{n,c,s} \prod_{t=1}^{6} P_{n,c,t,s}\left(\Omega_{LC,s}\right) \right]^{1 - vr_{n,c}}$$

$$\widetilde{\pi}_{n,c,s} = \frac{\widehat{\pi}_{n,c,s} \prod_{t=1}^{6} \widehat{P}_{n,c,t,s}}{\sum_{k=1}^{S_c} \widehat{\pi}_{n,c,k} \prod_{t=1}^{6} \widehat{P}_{n,c,t,k}}$$

$$\widetilde{P}_{c,i} = \frac{\sum_{n=1}^{N_c} w_{n,c} \left(1 - vr_{n,c}\right) \sum_{s=1}^{S_c} \widetilde{\pi}_{n,c,s} \widehat{P}_{n,c,s,i}}{\sum_{n=1}^{N_c} w_{n,c}}$$

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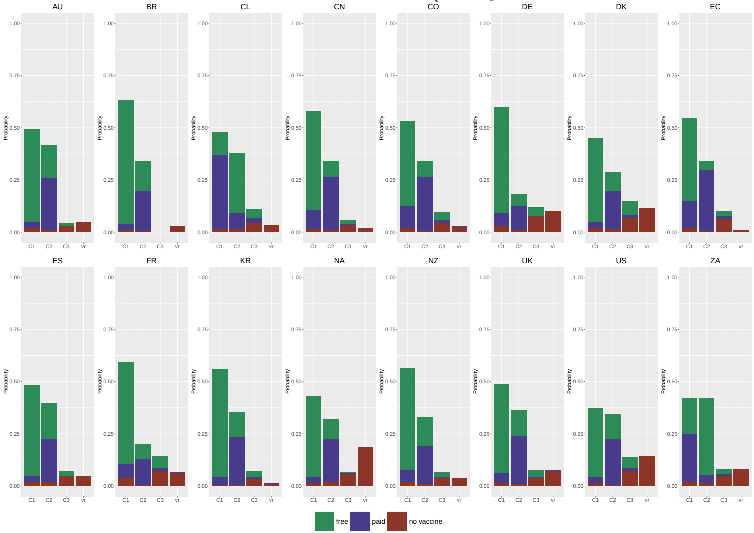
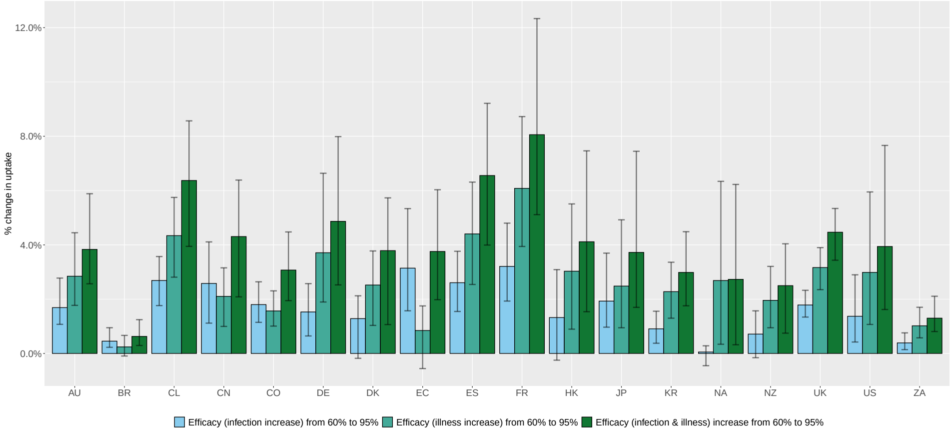
Class structure (single class for JP & HK)



Understanding results

- To understand role of vaccine characteristics, we look at marginal effects
- Two scenarios
- Single vaccine case
  - low efficacy vaccine (60% efficacy for both infection and illness), with unknown protection duration and low levels of mild (0.1%) and severe (0.001%) side effects
- Two vaccine case
  - addition of high efficacy vaccine (95% efficacy for both infection and illness), but with a 3 month wait

Efficacy matters



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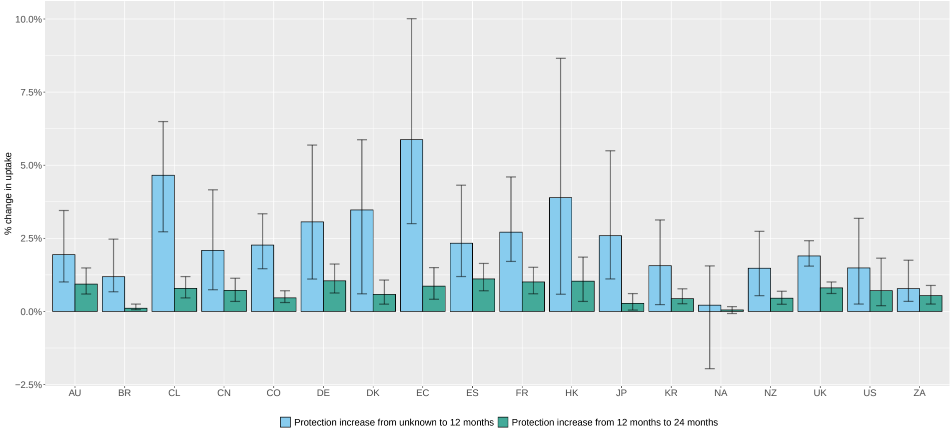
Some knowledge about protection duration is key



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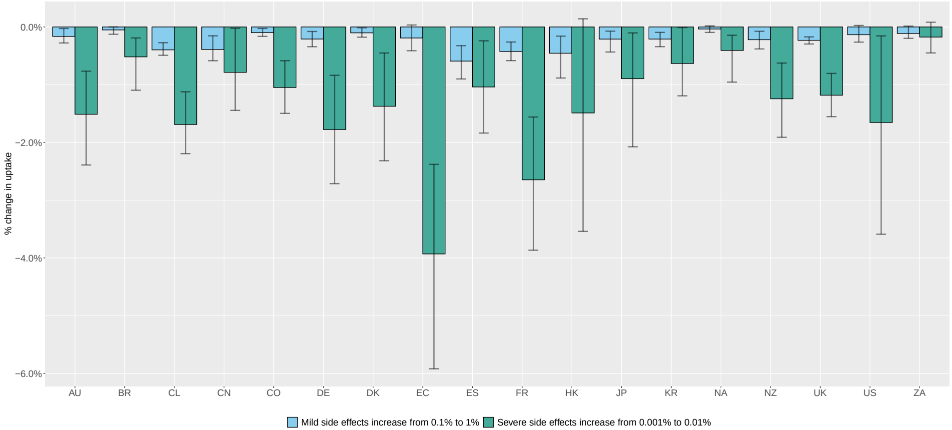
Severe side effects matter much more than mild ones



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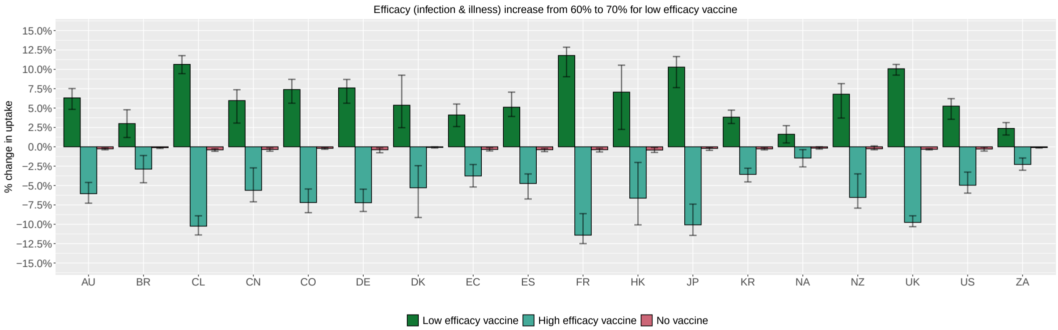
Bigger impact of efficacy in choice between vaccines



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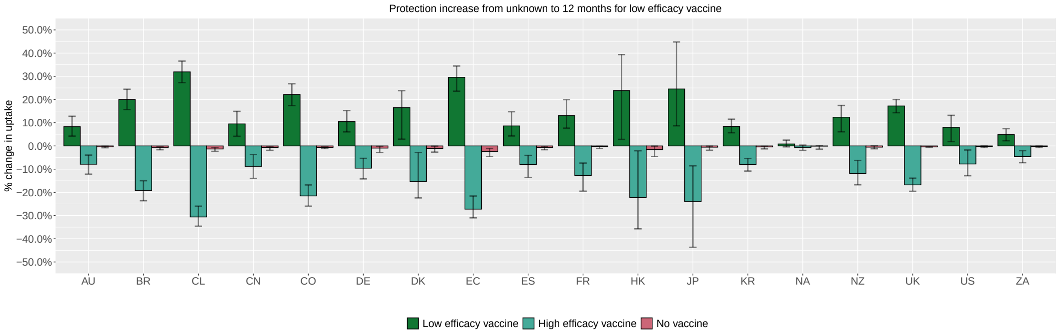
Lower efficacy but certainty about protection?



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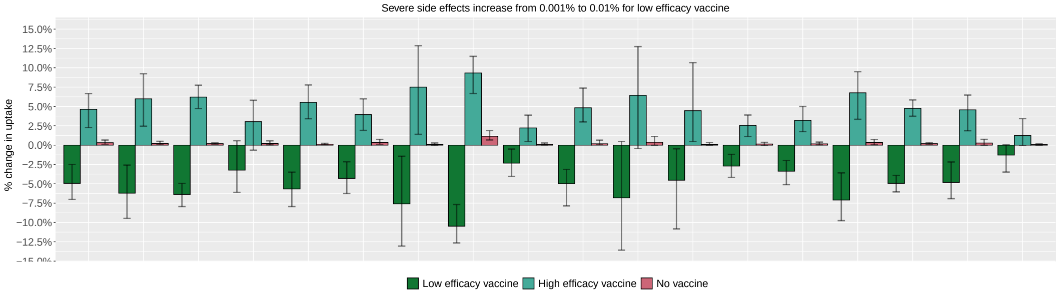
Severe side effects matter in choice between vaccines



- Supported by evidence in some countries of people waiting for Pfizer-BioNTech vaccine and refusing Oxford-AstraZeneca

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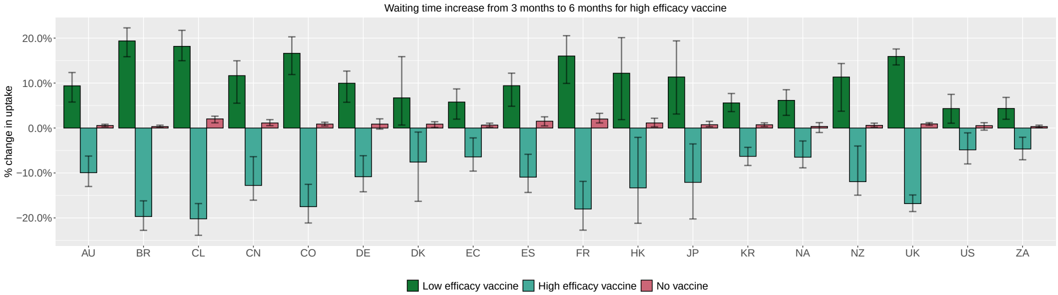
But people only want to wait for so long



Recalibration to account for differences in timing

Step 1: OL predictions for base data, and for $R = 1$ and January 2022 cumulative COVID-19 related deaths, followed by calculation of correction factor

Step 2: Adjust rate of no vaccine choice for non vaccine resistant sample

Step 3: Baseline LC predictions for non vaccine resistant sample

Step 4: Iterative correction approach to no vaccine constant to match baseline with adjusted

$$CF_c = \frac{1 - P_{OL-uptake,c,current}}{1 - P_{OL-uptake,c,base}}$$

$$NV_c = \frac{\sum_{n=1}^{N_c} w_{n,c}\left(1 - vr_{n,c}\right)\sum_{t=1}^{6}\frac{1-Y_{n,c,t}}{6}}{\sum_{n=1}^{N_c} w_{n,c}\left(1 - vr_{n,c}\right)}$$

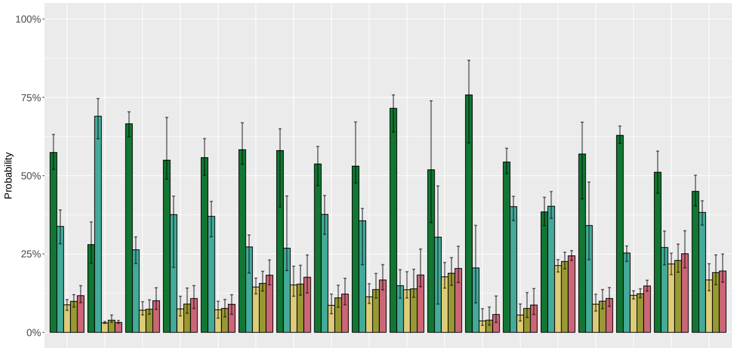
$$NV_{c,adjusted} = CF_c \cdot NV_c$$

$$P_{LC-nv,c,base} = \frac{\sum_{n=1}^{N_c} w_{n,c}\left(1 - vr_{n,c}\right)\sum_{s=1}^{S_c}\widetilde{\pi}_{n,c,s}\sum_{t=1}^{6}\widehat{P}_{n,c,t,s,5}}{\sum_{n=1}^{N_c} w_{n,c}\left(1 - vr_{n,c}\right)}$$

$$\delta_{c,5,adjusted} = \delta_{c,5,base} + \ln\left(\frac{NV_c}{P_{LC-nv,c,base}}\right)$$

Scenario 1

High efficacy (90%) with 3 month wait vs low efficacy (60%) vaccine with immediate access, both with low risk of side effects



	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
High efficacy, low risk of side effects, wait 3 months	%	57.4	28.0	66.6	54.9	55.8	58.3	58.0	53.7	53.1	71.5	51.9	75.8	54.4	38.4	56.9	62.9	51.1	45.0
Low efficacy, low risk of side effects, no wait	%	33.8	69.0	26.4	37.6	37.0	27.3	26.9	37.6	35.6	14.9	30.4	20.6	40.1	40.2	34.1	25.3	27.1	38.3
No vaccine	%	8.8	3.0	7.1	7.5	7.2	14.4	15.1	8.6	11.3	13.6	17.7	3.7	5.5	21.3	9.0	11.8	21.8	16.7
No vaccine if only high efficacy available	%	9.9	3.9	7.4	9.0	7.6	15.6	15.4	11.0	13.7	13.9	18.9	3.9	7.6	22.6	10.0	12.3	22.9	19.1
No vaccine if only low efficacy available	%	11.7	3.2	10.1	10.8	9.0	18.2	17.6	12.2	16.7	18.3	20.4	5.7	8.7	24.4	10.8	14.8	25.1	19.6

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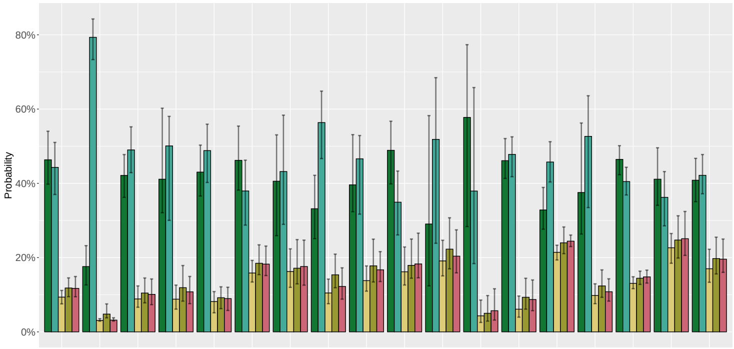
Scenario 2

High efficacy (90%) with 3 month wait and high risk of side effects vs low efficacy (60%) vaccine with immediate access



	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
High efficacy, high risk of side effects, wait 3 months	%	46.3	17.6	42.1	41.1	43.0	46.2	40.6	33.2	39.6	48.9	29.1	57.8	46.1	32.8	37.5	46.4	41.1	40.8
Low efficacy, low risk of side effects, no wait	%	44.3	79.3	49.0	50.1	48.8	37.9	43.2	56.4	46.6	34.9	51.8	37.9	47.8	45.7	52.7	40.5	36.2	42.2
No vaccine	%	9.4	3.1	8.9	8.8	8.2	15.9	16.2	10.5	13.8	16.2	19.1	4.3	6.1	21.4	9.8	13.1	22.6	17.0
No vaccine if only high efficacy available	%	11.8	4.8	10.5	11.9	9.2	18.5	17.1	15.4	17.8	17.9	22.3	5.0	9.3	24.0	12.4	14.4	24.7	19.7
No vaccine if only low efficacy available	%	11.7	3.2	10.1	10.8	9.0	18.2	17.6	12.2	16.7	18.3	20.4	5.7	8.7	24.4	10.8	14.8	25.1	19.6

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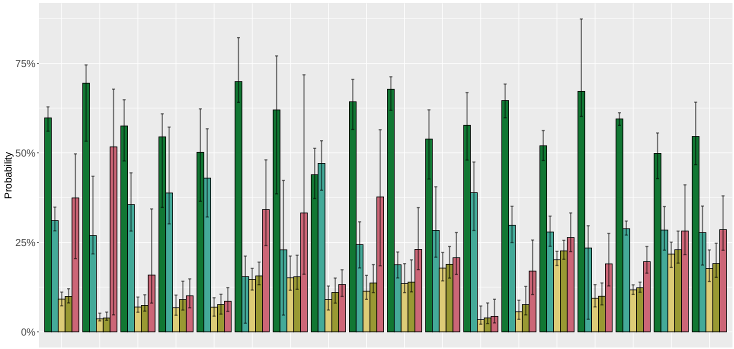
Scenario 3

High efficacy (90%) with 3 month wait or paid access (£100) without wait, low risk of side effects

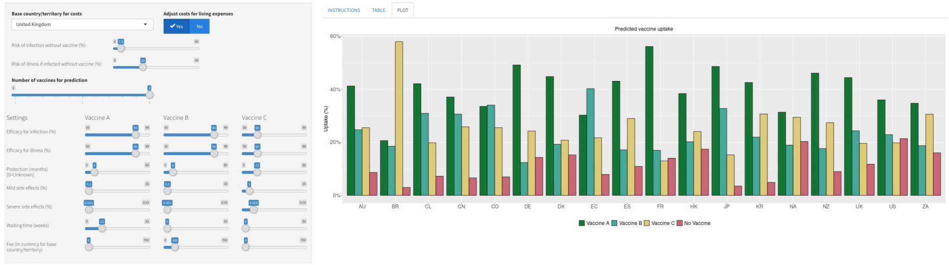


	units	AU	BR	CL	CN	CO	DE	DK	EC	ES	FR	HK	JP	KR	NA	NZ	UK	US	ZA
High efficacy, wait 3 months, no fee	%	59.8	69.5	57.5	54.5	50.2	69.9	62.0	43.9	64.3	67.8	53.8	57.7	64.6	52.0	67.2	59.5	49.8	54.6
High efficacy, no wait, pay £100	%	31.1	26.9	35.6	38.8	42.9	15.4	22.9	47.1	24.4	18.8	28.3	38.9	29.8	27.9	23.4	28.8	28.4	27.7
No vaccine	%	9.2	3.6	6.9	6.7	6.9	14.7	15.1	9.0	11.4	13.5	17.8	3.4	5.6	20.1	9.4	11.7	21.7	17.7
No vaccine if only option with wait available	%	9.9	3.9	7.4	9.0	7.6	15.6	15.4	11.0	13.7	13.9	18.9	3.9	7.6	22.6	10.0	12.3	22.9	19.1
No vaccine if only paid option available	%	37.4	51.7	15.9	10.1	8.6	34.2	33.2	13.2	37.7	23.0	20.7	4.3	17.0	26.4	19.0	19.6	28.2	28.6

Try it yourself

- Online scenario tool, available at
  https://stephanehess.shinyapps.io/COVID19_Shiny/

COVID-19 vaccine uptake prediction



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- Characteristics of vaccines matter for a sizeable share of individuals
- Large share will accept any reasonable vaccine, small share will not accept any
- Substantial amounts of heterogeneity across and within countries, but also with regional similarities
- No single vaccine is likely to be acceptable to all individuals, and availability of more than one vaccine at the same time may lead to a further small increase in overall vaccine uptake
- Non-trivial share of the population would be willing to pay for faster access, but with little benefit in terms of overall vaccine uptake

Initial findings from household and longitudinal part

- People choose differently for children and their partners
- They also (but less often) change their own choice when faced with scenarios where they choose for the whole household
- Choices are VERY stable across the three waves, with only small changes in the sensitivity to side effects

Policy relevance

- For herd immunity, need to convince the group of people who are open to vaccination only if the characteristics of the vaccine are right for them
- Should the lower efficacy/higher side effect vaccines which are in higher supply and acceptable to a large proportion be used first?
- With more *appealing* vaccines reserved to encourage uptake by those people who are more hesitant, as others are likely to accept any vaccine?
- Ignores policy response in many countries to reserve higher efficacy/lower side effects vaccine for younger people who are more exposed to side effects
- There are also international implications, with the optimal distribution of vaccines not being in line with domestic policy and vaccine protectionism, which has led to the higher quality vaccines not being accessible to areas where they may make a greater contribution to achieving herd immunity

Thank you