Country-of-Origin Bias towards COVID-19 Vaccination

CEYHUN ELGIN
Bogazici University
Department of Economics
Natuk Birkan Kat 2 Bebek
34342 Istanbul Turkey

ALISON P. GALVANI
Yale University
Center for Infectious Disease Modeling and Analysis
Yale School of Public Health,
New Haven, CT, 06520, USA

HATİME KAMİLÇELEBİ
Kirklareli University
Faculty of Applied Sciences
Luleburgaz, Kirklareli 39750, Turkey

Rapid vaccination against COVID-19 is viewed to be the only way to exit from the current pandemic. In addition to the difficulties in the production and global distribution of the vaccines, one major barrier behind this is the vaccine hesitancy, and particularly biases to vaccines of different countries of origin among the public. In this study We conducted a cross-sectional vignette study and designed five online surveys, where the participants were given some information about the efficacy of vaccines from different countries of origin. We then used standard mean comparison tests and (ordered) logistic regressions to provide evidence for the country-of-origin bias of the COVID-19 vaccines. 1615 participants answered our five surveys. Even though the two vaccines are reported to have the same efficacy, participants' subjective evaluation of the vaccine's efficacy as well as their willingness to get vaccinated is significantly higher when the vaccine is from Germany rather than from China. Ordered logistic regressions also support the existence of a bias in favor of a vaccine from Germany rather than from China. This study underscores that manufacturing origin plays a significant role in people's perceptions about the vaccine as well as their intentions to get vaccinated. Public health officials and scientists should take this into account, particularly due to the fact that the vaccination rates in the next few months will play a key role to control the pandemic.

Introduction

Vaccination has been perceived as one of the "medicine's greatest lifesaver" due to its impact against infections (1). On March 11, 2020, following the declaration of the epidemic as a pandemic by the WHO,

vaccination studies against the SARS-CoV2 infection had been initiated in various countries. As of April 2021, there are currently about 90 vaccines against the SARS-CoV2 in Phase 1, 2, 3, and 4 clinical trials (2), six vaccines in early/limited use, and seven fully approved vaccines for full use (3). In this study, we design a vignette study where the aim is to see whether the country of origin of a COVID-19 vaccine plays a role in the reflection of the efficacy of the vaccine and in the acceptance/hesitancy of/towards getting vaccinated. To this end, we designed a survey that a group of participants randomly selected among the undergraduate students of Bogazici, Kirklareli, and Eskisehir Osmangazi Universities as well as the general public in Turkey were asked to complete after reading some hypothetical vaccine-related news designed as vignettes. In this regard, the efficacy rates and side effects of an anonymous vaccine, as well as the vaccines of Chinese and German origins, were presented to the participants using vignettes before the surveys were administered. Next, the participants were asked questions regarding their subjective evaluation about the efficacy of the vaccines, as well as their willingness to get them.

Moreover, the survey also asked several demographic questions such as the education levels of the participants and their parents, their age, gender, and household income. These questions were then followed by some COVID-19 related questions, such as whether they and their families have had COVID-19 infection, whether they have had any other underlying conditions, whether they have been vaccinated against COVID-19, and whether they have ever wished to get vaccinated, as well as, about their overall attitude towards a vaccine and the amount of money they would be willing to pay for another vaccine originating from a different country. Using different statistical methods, we then have analyzed whether the country of origin of a vaccine is crucial in determining subjective efficacy and the acceptance of a vaccine.

The first COVID-19 case in Turkey was detected on March 11, 2020. Before applying the survey, a mass vaccination campaign has been initiated as of January 2021 in Turkey for vaccination of the prioritized groups consisting of healthcare workers. All pharmacy workers, social care workers, and adult residents at elderly care homes, rehabilitation centers for disabled, and women and children protection/foster homes, all individuals 65 aged and older, and some teachers through the administration of the CoronaVac (Chinese origin) vaccine with ongoing Phase 3 clinical trials (4). However, there is plenty of anecdotal evidence and news reported in the media that there is significant hesitancy towards COVID-19 vaccines and especially towards the vaccine freely offered by the government.

Despite the various vaccine development efforts, the WHO included vaccine hesitancy among the top-10 global health threats in 2019 (5). If vaccine hesitancy is common for the SARS-CoV2 infection, it is crucial to identify the motives and causes underlying such vaccination hesitancy (6). While the effectiveness and preference rate of the SARS-CoV2 vaccine are interrelated (7), public confidence in the SARS-CoV2

vaccine is also affected by the approval of the vaccines by political leaders (8). However, many possible factors affect preferences and vaccine hesitancy. The country of the manufacturing of the vaccine, being among the countries in which the COVID-19 cases first occurred, or the countries that are known for their cold storage, logistics, and mass vaccination units, as well as, high prevalence of the companies that make high profits from the vaccines, may be associated with increasing hesitancy (9). For example, people who may perceive the vaccines in the clinical process developed in a rush may not base their decisions entirely on vaccine efficacy (10, 11). In this regard, a hypothetical rapid Covid-19 vaccine development process reduced its acceptance (12).

Moreover, in a study with Americans, a vaccine that originated from a non-US country (China and UK) is less likely to be preferred by individuals (13). The same study also found that the US Centers for Disease Control and Prevention and WHO approvals are more likely to choose a vaccine when compared with President Trump's approval. Identifying factors for vaccine hesitancy and addressing them before initiating a vaccination program can improve vaccination incentive policies and vaccination decisions.

To correctly manage the pandemic, it is essential to determine the prevalence and causes of vaccine hesitancy. As seen in Table 1, several previous studies investigated the vaccine's acceptance in different countries. Although individuals who claim that they would not be vaccinated vary by country, this ratio ranges between 5% and 30%. However, the percentage of those who are neutral or indifferent regarding their vaccination decisions (between 7% and 32%) is also substantial. Studies conducted worldwide indicate that more reliable or higher-efficacy vaccines or the existence of other vaccinated individuals are associated with a reduction in vaccine hesitancy (10, 14).

Table 1. Intention to vaccinate against COVID-19: Literature Summary

Public, place, time	Intention to vaccinate against COVID-19 (%) (When a vaccine for the SARS-CoV2 becomes available, will you get vaccinated?)			References
	Yes	Neutral/Not Sure	No	
Australian adults (n=1143) March 18-24, 2020	80.5	13.7	5.8	15
Australian adults (n=4362) April 17–21, 2020	85	9.4	4.9	16
Australian parents (n=2018) June 15–23, 2020	75.8	16.7	7.5	17
French adults (n=1012) March 27-29, 2020	-	-	26	18
French adults, (n=5018) April 2020	76	16.1	7.9	11

French working-age adults (n=1942) July 2020	71.2	-	28.8	19
Italian adults (n=1004) 2020	59	41		20
Italian university students (n=735) 2020	86.1	13.9		21
US adults (n=991) April 16-20, 2020	57.6	31.6	10.8	22
Canadian adults (n=1902) May 6–19, 2020	-	-	20	23
American adults (n=1772) May 6-19, 2020	-	-	25	
Brazilian adults (n=717) June 2020	85.4	7.9	6.6	24
Canadian adults (n=707) June 2020	68.7	15.0	16.3	
Chinese adults (n=712) June 2020	88.6	10.7	0.7	
Ecuadorian adults (n=741) June 2020	71.9	12.7	15.4	
French adults (n=669) June 2020	58.9	22.7	18.4	
German adults (n=722) June 2020	68.4	15.4	16.2	
Indian adult (n=742) June 2020	74.5	14.2	11.4	
Italian adults (n=736) June 2020	70.8	14.8	14.4	
Mexican adults (n=699) June 2020	76.2	11.9	11.8	
Nigerian adults (n=670) June 2020	65.3	14.0	20.7	
Polish adults (n=666) June 2020	56.3	16.4	27.3	
Russian adults (n=680) June 2020	54.8	18.8	25.3	
Singapore adults (n=655) June 2020	67.9	11.1	20.9	
South African adults (n=619) June 2020	81.6	13.6	4.9	
South Korean adults (n=752) June 2020	79.8	15.2	5.1	
Spanish adults (n=748) June 2020	74.4	12.3	13.4	
Swedish adults (n=650) June 2020	65.2	18.0	16.8	
UK adults (n=768) June 2020	71.5	13.7	14.8	
US adults (n=773) June 2020	75.4	13.3	11.3	
UK adults (n=4000) September 2020	54.1	39.9	6	25
US adults (n=4001) September 2020	42.5	42.4	15	

Methods

Study Design and Participants

We did a cross-sectional study across a relatively large number of individuals. To this end, we designed five surveys, which were all conducted online. Participants were recruited mainly from two sources: 1) Undergraduate students at three large public universities which the authors are affiliated with: Bogazici University, Eskisehir Osmangazi University, and Kirklareli University 2) General public. People younger than age 18 years or unwilling or unable to consent to the study were excluded from participation. In total, we ended up with 1615 responses to all of our five surveys. 876 of these responses are from university students and 739 from the general public. This study was approved by the Bogazici University Social Science Research Ethics Review Board (2021-11) and the Ministry of Health Scientific Research Platform. All participants were provided written informed consent.

Procedures

Surveys were written in Turkish and conducted online in late March 2021. English translations of the surveys are provided in the appendix. The questionnaire covered a vignette giving some hypothetical news about the efficacy of different COVID-19 vaccines followed by questions directly related to the vignette and some demographic and COVID-19 related questions. The questionnaire was pre-tested during a pilot phase and adapted accordingly. Responses were recorded electronically via Google Surveys. In addition to different demographic and COVID-19 related measures, our primary variables are 1) the subjective reflection about the efficacy of the vaccine measured in an ordered scale from 1 to 5 based on the question ‘‘How effective does this vaccine seem to you?’’ and then 2) a measure about the acceptance of the vaccine constructed again in an ordered scale from 1 to 5 after the following question: ‘’Would you get this vaccine?’’ We repeat this latter question after mentioning a hypothetical endorsement by the WHO and after increasing or reducing its reported efficacy, to 95% and 75%, from the benchmark rate of 85%. Survey 1 conducts the survey with a vaccine that originated from China; Survey 2 applies the same survey with a vaccine from Germany, and Survey 3 does not mention the source country. Finally, Surveys 4 and 5 include information about two vaccines in the same survey. The vaccine from China has an 85% efficacy in the former one, and the German vaccine has 80%. In the latter one, these rates are 85% and 75%, respectively.

Statistical Analysis

We calculate means and standard deviations of several key variables (related to the subjective efficacy of the vaccine and its acceptance) in different surveys and compare these means against each other using standard mean comparison t-tests in a pairwise comparison and the Kruskal-Wallis test when all the means are compared against each other.

Moreover, we also run several regressions to identify the existence of potential bias towards the vaccine. We do this by combining all the survey responses from the first three surveys and then regressing the subjective efficacy and acceptance, both ordered variables, to a number of variables, including dummy variables for each of the three surveys. Since both of our dependent variables are ordered variables, we run ordered logistic regressions with robust standard errors. Moreover, to see the predictors of the bias, we also run several logistic regressions of a dummy variable that serves as a proxy for the bias for efficacy and acceptance.

Results

Table 2. Efficacy and Acceptance in Surveys 1 to 3

	Survey 1 (Chinese 85%) 314 Responses	**Survey 2 (German 85%) 398 Responses**	**Survey 3 (Anonymous) 315 Responses**	**Kruskal-Wallis Test**
Efficacy	3.15±0.98	3.41±0.88	3.21±0.95	0.0002
Taking the Vaccine	3.14±1.33	3.43±1.34	3.17±1.30	0.0038
Taking the Vaccine after WHO Endorsement	3.22±1.35	3.56±1.27	3.39±1.31	0.0044
Taking the Vaccine if Efficacy is 95%	3.91±1.24	4.14±1.14	3.96±1.20	0.0145
Taking the Vaccine if Efficacy is 75%	2.67±1.35	3.02±1.37	2.75±1.26	0.0014

Table 2 illustrates the means and standard deviations of the five variables (subjective efficacy and attitude to take the vaccine with the given information, i.e. 85% efficacy, additionally with WHO endorsement, and finally when the efficacy reduces to 75% and increases to 95%) in the first three surveys. The table also presents the p-value associated with the Kruskal-Wallis test for the equality of the means of variables in three surveys. The test results suggest that there is a significant difference when all means are compared against each other.

Table 3. Relative Efficacy and Acceptance in Surveys 4 and 5

	Survey 4 **287 Responses**	**Survey 5** **301 Responses**
Efficacy of the German Vaccine	3.22±0.86	3.07±0.94

Taking the German Vaccine	3.28±1.32	3.18±1.38
Efficacy of the Chinese Vaccine	3.32±0.95	3.44±1.06
Taking the Chinese Vaccine	3.22±1.32	3.31±1.40

Moreover, when the means of all the five variables in survey 1 mentioning that the 85% efficient vaccine originated from China and survey 2, where the vaccine is said to be originated from Germany are compared against each other using mean comparison t-tests, we observe that the efficacy (p-value=0.0002), taking the vaccine (p-value=0.0041), after WHO endorsement (p-value=0.0006), with 95% efficacy (p-value=0.0103) and with 75% efficacy (p-value=0.0007) are all significantly different from each other, where all the averages in survey 2 are higher than the ones in the survey 1.

Next, in Table 3 we present the means and standard deviations of some key variables from the surveys 4 and 5. In these surveys, the vignette includes information about two vaccines. In survey 4, the vaccine originating from China has 85% efficacy whereas the one from Germany has 80% efficacy. In survey 5, the efficacy of the German vaccine is reduced to 75%. In survey 4, the subjective efficacy of the German vaccine is at 3.22(±0.86) and the Chinese vaccine is at 3.32(±0.95), and there is no significant difference in between these two means (p-value=0.1867) Similarly, when asked about the likelihood of getting either vaccine, the average for the German vaccine, 3.28(±1.32), is not significantly different from the Chinese vaccine ,3.22±1.32 (p-value=0.5863). However, in survey 5, when the efficacy differences in the vignette are further increased at the expense of the German vaccine, the subjective efficacy of the German vaccine drops to 3.07±0.94, whereas the one of the Chinese vaccine increases to 3.44±1.06, their difference becomes significant. (p-value<0.0001). However, still, when asked whether they would take the vaccine, there is still no significant difference between the German (3.18±1.38) and the Chinese (3.31±1.40 vaccines (p-value=0.2517) In fact in survey 4, 35 respondents out of 301 in total respond that the efficacy of the Chinese vaccine is strictly less than the one of the German vaccine and 81 indicate that they will strictly prefer to get the German vaccine over the Chinese one. When the efficacy differences are increased to 10% in survey 5, these numbers drop down to 19 and 29, respectively but are still substantial.

Table 4: Descriptive Statistics

	Survey 1	**Survey 2**	**Survey 3**	**Survey 4**	**Survey 5**
Age (years)	30.30±12.12	28.19±16.70	26.26±9.27	28.51±11.49	24.19±6.77

Female (%)	46.82%	53.27%	51.11%	63.07%	49.17%
Mother's education (1=incomplete elementary education, 2= elementary eeducation, 3=secondary education 4= higher education 5=graduate education)	13.06% 50.32% 21.97% 12.74% 1.91%	11.31% 34.17% 25.38% 24.87% 4.27%	12.70% 41.90% 21.59% 20% 3.81%	13.24% 45.99% 23.69% 15.33% 1.74%	9.63% 33.55% 26.91% 25.91% 3.99%
Monthly Household Income (1=less than 3000 TRY, 2=between 3000 and 6000 TRY, 3= between 6000 and 9000 TRY, 4=above 9000 TRY	18.15% 27.71% 20.38% 33.76%	7.79% 31.16% 17.34% 43.72%	15.24% 28.25% 27.94% 28.57%	17.07% 32.06% 21.95% 28.92%	14.95% 30.56% 22.59% 31.89%
Had Covid-19 Vaccine (YES)	4.78%	2.51%	5.40%	3.83%	1.99%
Will you get the vaccine? (Yes/No/Unknown)	53.50% / 19.43% /27.07%	61.06% 17.09% 21.86%	54.92% 14.92% 30.16%	55.75% 17.07% 27.18%	58.80% 17.28% 24.25%
Presence of Underlying Conditions (Yes/No/Unknown)	12.10% 83.12% 4.78%	7.79% 88.69% 3.52%	7.30% 89.21% 3.49%	6.27% 89.20% 4.53%	5.98% 88.70% 5.32%
Did you get Covid-19? (Yes/No/Unknown)	11.46% 82.17% 6.37%	12.31% 79.90% 7.79%	10.48% 80.00% 9.52%	7.67% 86.06% 6.27%	10.63% 81.06% 8.31%
Had Covid-19 Vaccine in the Family (Yes/No/Unknown)	44.90% 54.14% 0.96%	56.53% 43.47% 0.00%	41.90% 57.14% 0.95%	47.39% 52.26% 0.35%	39.20% 58.47% 2.33%
Covid-19 Death in the Family (Yes/No/Unknown)	8.28% 91.40% 0.32%	6.03% 93.72% 0.25%	6.67 92.30% 0.95%	8.01% 90.59% 1.39%	6.31% 93.02% 0.66%
Ready to Pay for a Vaccine	68.15%	71.36%	62.54%	58.19%	64.45%

General Attitude towards the Vaccin (1=against any vaccine/2=not against all vaccine but unsure about COVID-19 /3=in favor of any vaccine)	3.18% 64.97% 31.85%	3.52% 54.02% 42.46%	6.67% 66.03% 27.30%	3.83% 65.16% 31.01%	5.65% 59.14% 35.22%

Before proceeding with the ordered logistic regression results, Table 4 presents some summary statistics across all surveys. In addition to the dummy variables for different surveys, we include age, a dummy variable for females, a categorical variable for the education of the mother[1] (of the survey respondent), a categorical variable for the household income, dummies for already having the COVID-19 vaccine, intention to get the vaccine, presence of underlying conditions, having got the COVID-19 disease, having someone getting the vaccine in the immediately family as well as presence of a death in the immediate family due to COVID-19, being willing to pay for the COVID-19 vaccine and a categorical variable to measure general attitude towards vaccinations.

Table 5: Regressions of the Benchmark Efficacy and Acceptance in Surveys 1 to 3

VARIABLES	Efficiency	Efficiency	Efficiency	Acceptance	Acceptance	Acceptance
German Vaccine (Survey 2)	0.39***	0.42***	0.42***	0.30**	0.37**	0.38**
	(0.16)	(0.16)	(0.16)	(0.15)	(0.16)	(0.16)
Anon.Vaccine (Survey 3)	-0.02	-0.02	0.15	-0.02	0.28	0.30
	(0.17)	(0.17)	(0.18)	(0.15)	(0.16)	(0.16)
Age	-0.002	-0.002	-0.003	0.004	0.003	0.003
	(0.004)	(0.004)	(0.005)	(0.003)	(0.003)	(0.003)
Female	-0.52***	-0.44***	-0.43***	-0.20	-0.09	-0.11
	(0.13)	(0.13)	(0.13)	(0.12)	(0.12)	(0.12)
Had Covid Vaccine	0.73	0.65	0.68	1.44***	1.37***	1.43***

[1] We also ask for the education level of the father, however, this variable is very highly correlated with household income. That is why we only include the mother's education among the predictors.

	(0.41)	(0.45)	(0.44)	(0.44)	(0.50)	(0.50)
Will Have Covid Vaccine	1.86***	1.25***	1.26***	3.32***	2.62***	2.64***
	(0.14)	(0.15)	(0.16)	(0.17)	(0.18)	(0.18)
Covid Vaccine in Family		-0.10	-0.11		0.10	0.07
		(0.13)	(0.13)		(0.12)	(0.13)
Underlying Condition		-0.33	-0.33		-0.29	-0.27
		(0.23)	(0.23)		(0.22)	(0.23)
Got Covid 19		-0.23	-0.24		-0.23	-0.24
		(0.20)	(0.20)		(0.18)	(0.18)
Fatality in Family		-0.02	-0.02		0.16	0.14
		(0.25)	(0.26)		(0.24)	(0.24)
Will Pay for the Vaccine		0.51***	0.50***		0.76***	0.73***
		(0.15)	(0.15)		(0.14)	(0.14)
General Attitude 2			0.36		0.76**	0.73
			(0.37)		(0.39)	(0.39)
General Attitude 3			1.47***		2.26***	2.25***
			(0.40)		(0.42)	(0.43)
Income 2			-0.08			-0.03
			(0.19)			(0.19)
Income 3			0.05			0.16
			(0.21)			(0.21)
Income 4			0.02			0.18
			(0.22)			(0.22)
Mother’s Education 2			-0.17			0.31
			(0.21)			(0.20)
Mothers Education 3			0.03			0.55***
			(0.23)			(0.22)
Mothers Education 4			-0.16			0.50**
			(0.25)			(0.23)
Mother’s Education 5			-0.31			-0.66
			(0.42)			(0.37)
Observations	1026	1026	1026	1026	1026	1026

Pseudo R-squared	0.11	0.14	0.14	0.20	0.24	0.25
Wald chi-test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00

Robust standard errors in parentheses. All regression include dummies for colleges of the respondents. The Wald test is the p-value associated with the test that at least one of the predictor's coefficient is not equal to zero

*** p<0.01, ** p<0.05

Table 5 presents regressions of the subjective efficacy and acceptance on a number of variables. In the first three regressions the dependent variable is the efficacy, whereas in the last three regressions it is the acceptance variable. All regressions are ordered logistic regressions. Here, results presented in the first row are of particular interest. The significantly positive estimated coefficient of the dummy associated with the second survey (with a vaccine originating from Germany) indicates that, after controlling for several different factors that might be associated with the subjective efficacy or acceptance, the respondents report that the efficacy of the German vaccine is higher and are also more likely to accept the German vaccine compared to the Chinese vaccine. Particularly, when the marginal effects are calculated, after controlling for various related predictor we observe that the likelihood of choosing the choice 4 or 5 for the vaccine efficacy and acceptance are 4 to 5% higher for the German vaccine compared to the Chinese one. On the other hand, we do not observe a significant different between the Chinese and anonymous vaccine.

Other variables that are significantly associated with the subjective efficacy of the vaccines are gender, willingness to get the vaccine, willingness to pay for the vaccine and general attitude towards vaccination. Particularly, Table 5 indicates that the subjective efficacy is lower for females and higher for those who indicate that they will get a vaccine, those who are ready to pay for a vaccine and those who are in favor of any vaccination. As for the acceptance towards the vaccine described in the vignette significant factors are already having a vaccine, willingness to get the vaccine, willingness to pay for the vaccine, general attitude towards vaccinations and the education of the mother of the respondent. Specifically, those who already had a vaccine and those who are willing to get one or pay as well as are in favor of any vaccine indicate a higher level of acceptance. Moreover, those whose mothers have secondary or higher education (relative to elementary education) show a higher level of acceptance.

Table 6. Regressions of the Acceptance under Different Scenarios

VARIABLES	**75% Efficacy**	**95% Efficacy**	**WHO Endorsement**
German Vaccine	0.35**	0.43***	0.34**
	(0.16)	(0.17)	(0.17)
Anonymous Vaccine	0.35**	0.39**	0.31

	(0.17)	(0.18)	(0.17)
Age	0.001	-0.0004	-0.001
	(0.003)	(0.003)	(0.005)
Female	0.07	-0.05	-0.001
	(0.12)	(0.13)	(0.12)
Had Covid Vaccine	1.31***	1.50***	1.25***
	(0.38)	(0.58)	(0.39)
Will Have Covid Vaccine	1.36***	1.59***	1.52***
	(0.15)	(0.17)	(0.15)
Covid Vaccine in Family	0.23	0.13	0.16
	(0.12)	(0.13)	(0.12)
Underlying Condition	-0.09	0.01	-0.44**
	(0.24)	(0.25)	(0.22)
Got Covid 19	-0.17	-0.14	0.13
	(0.18)	(0.21)	(0.17)
Fatality in Family	0.67***	0.08	0.01
	(0.20)	(0.26)	(0.22)
Will Pay for the Vaccine	0.72***	0.85***	0.64***
	(0.14)	(0.15)	(0.14)
General Attitude 2	1.00***	1.12***	0.88***
	(0.38)	(0.30)	(0.31)
General Attitude 3	2.40***	1.98***	1.77***
	(0.41)	(0.36)	(0.35)
Income 2	0.11	0.22	-0.01
	(0.19)	(0.21)	(0.19)
Income 3	0.18	0.18	0.33
	(0.21)	(0.23)	(0.21)
Income 4	0.33	0.05	0.11
	(0.21)	(0.24)	(0.22)
Mother’s Education 2	-0.07	0.31	0.27
	(0.20)	(0.21)	(0.22)
Mothers Education 3	0.13	0.08	0.15

	(0.22)	(0.22)	(0.23)
Mothers Education 4	0.04	0.32	0.35
	(0.23)	(0.26)	(0.25)
Mother's Education 5	-0.54	-0.42	-0.43
	(0.44)	(0.36)	(0.34)
Observations	1026	1026	1026
Pseudo R-squared	0.17	0.16	0.14
Wald chi-test (p-value)	0.00	0.00	0.00

Robust standard errors in parentheses. All regression include dummies for colleges of the respondents. The Wald test is the p-value associated with the test that at least one of the predictor's coefficient is not equal to zero

*** p<0.01, ** p<0.05

Next, in Table 6 we report the results of three similar regressions using the same combined dataset from three surveys. Here we only run the sixth regression of Table 5 with the same set of predictors. However, this time the dependent variables are acceptance towards the vaccine when the vaccine in the vignette has 75% or 95% of efficacy or endorsed by a hypothetical representative of the WHO. The results are essentially highly similar to the ones reported in Table 5. Particularly, independent of whether the vaccine efficacy drops down to 75% or increases to 95% or endorsed by a representative of the WHO, the estimated coefficient of the German vaccine is significantly positive. Additionally, already having the vaccine, willingness to have the vaccine, willingness to pay for the vaccine and general attitude towards vaccines again are significantly associated with acceptance.

Finally, Table 7, using data from survey 4 and survey 5, respectively, presents logistic regressions of two variables that aim to measure the bias towards country of origin of vaccines. These two variables are constructed in the following way. The first dependent variable, Efficacy Bias, takes the value of 1 if the subjective efficacy of the Chinese vaccine is strictly smaller than the one of the German vaccine. The second one, Acceptance Bias, is similarly constructed when the acceptance of the Chinese vaccine is strictly smaller than the one of the German vaccine. Since in both surveys the efficacy of the Chinese vaccine, as reported in the vignette, is strictly larger (the difference is 5% for Survey 4 and 10% for Survey 5) than the efficacy of the German vaccine, these variables are used to proxy the level of the bias. In Table 7, we have results of four such logistic regressions. In the first one of the efficacy bias, we observe that those who mention that they will get a COVID-19 vaccine and those whose mothers have completed at least higher education have a lower probability to have a bias. On the other hand, those who are ready to pay for the vaccine are associated with a larger probability of having a efficacy bias. As for

the acceptance of getting the vaccine, predictors that are associated a bias are gender and income. Accordingly, females and those in the third income category have a lower bias towards the acceptance of the vaccine. Next, when we increase the efficacy differences between the two vaccines to 10 % in Survey 5, the regressions reported in the last two columns suggest that none of the predictors we have included in our survey are significantly associated with any of the bias types.

Table 7. Regressions of the Efficacy and Acceptance Biases in Surveys 4 and 5

VARIABLES	**Survey 4 Efficacy Bias**	**Survey 4 Acceptance Bias**	**Survey 5 Efficacy Bias**	**Survey 5 Acceptance Bias**
Age	-0.003	-0.003	0.003	-0.004
	(0.002)	(0.003)	(0.004)	(0.004)
Female	-0.03	-0.09**	0.01	0.01
	(0.04)	(0.04)	(0.03)	(0.03)
Had Covid Vaccine	0.11	0.13	NA	0.07
	(0.08)	(0.10)	NA	(0.12)
Will Have Covid Vaccine	-0.09**	-0.05	0.02	-0.008
	(0.04)	(0.05)	(0.04)	(0.04)
Covid Vaccine in Family	0.008	0.02	0.02	-0.01
	(0.05)	(0.05)	(0.03)	(0.03)
Got Covid 19	-0.02	0.08	-0.03	0.04
	(0.07)	(0.07)	(0.06)	(0.05)
Fatality in Family	-0.02	-0.02	-0.007	-0.009
	(0.08)	(0.08)	(0.05)	(0.06)
Will Pay for the Vaccine	0.10**	0.07	-0.04	-0.007
	(0.05)	(0.05)	(0.04)	(0.05)
Income 2	-0.006	0.005	-0.02	-0.04
	(0.05)	(0.07)	(0.06)	(0.05)
Income 3	-0.03	-0.13**	-0.05	-0.05
	(0.06)	(0.07)	(0.07)	(0.07)
Income 4	0.01	-0.05	-0.11	-0.001
	(0.07)	(0.08)	(0.06)	(0.09)
Mother's Education 2	-0.07	-0.01	0.02	0.009

	(0.09)	(0.07)	(0.04)	(0.06)
Mothers Education 3	-0.12	-0.03	0.005	-0.02
	(0.09)	(0.08)	(0.04)	(0.07)
Mothers Education 4	-0.18**	-0.07	0.04	-0.04
	(0.08)	(0.08)	(0.06)	(0.07)
Mother's Education 5	-0.07	-0.07	NA	-0.02
	(0.13)	(0.12)	NA	(0.09)
Observations	287	287	283	301
Pseudo R-squared	0.08	0.07	0.12	0.04

The presented values are average marginal effects on the bias. Robust standard errors in parentheses. All regression include dummies for colleges of the respondents. The Wald test is the p-value associated with the test that at least one of the predictor's coefficient is not equal to zero

*** p<0.01, ** p<0.05

Discussion

To the best of our knowledge, this study is the first to evaluate the subjective evaluation of the efficacy and acceptance of the COVID-19 vaccines. Our results generally show that the manufacturing origin of the vaccine plays a significant role in people's perceptions about the vaccine. Specifically, even though the objective efficacy of the vaccine is the same, people may have a bias/preference towards a vaccine originating from a particular source. More importantly, however, even though a vaccine has a lower efficacy, it may not be the preferred choice of individuals due to its source of origin. This is an important result that the public health officials and scientists should take into account, particularly due to the fact that the vaccination rates in the next few months will play a key role to control the pandemic.

Our results are also related to the country-of-origin literature in economic and management/marketing sciences. The main finding in that literature, as summarized by a thorough reviews and meta-analyses (26, 27, 28) the country of origin may play a very crucial role in perceived quality and attributes for product. On the other hand, the effect on purchase intentions is less than the effect on perceived quality. In our study, as illustrated by the results presented in Table 5, country of origin plays a role in both the perceived quality (subjective efficacy) as well as vaccination intentions (acceptance). However, the marginal effects are somewhat lower for the acceptance.

In another related paper (29) the authors provide evidence from Iranian social media users that the country of origin matters for people's choices on COVID-19 vaccines. Specifically, they show that for the participants of their survey conducted in Iran German vaccines are the most trusted, followed by the US and then Russia and China.

Nevertheless, we should also yield that our results might have several limitations. First, even though we made every effort to have samples representative of the overall population in several different dimension, the weight of the college students in our sample is higher than the overall population. Moreover, the colleges, in which the surveys were conducted, were not randomly selected but were mainly a convenience as they are the institutions which the authors are affiliated with. Information bias could have also affected results, since answers to all questions were self-reported. Our efforts to mitigate information bias included the use of pre-tested questionnaires and training of the study team.

References

1- Allen A, Fitzpatrick M. (2007). Vaccine: The Controversial Story of Medicine's Greatest Lifesaver. Journal of the Royal Society of Medicine. 100(5):241. doi:10.1177/014107680710000515
2- World Health Organization. (2021). Draft landscape of COVID-19 candidate vaccines. https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines) Accessed 4 April 2021.
3- Zimmer, C., Corum, J., Wee, S. (2021). Coronavirus vaccine tracker. NY Times (2021). https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html Accessed 4 April 2021.
4- Republic Of Turkey Ministry Of Health Covid-19 Vaccination Information Platform. (2021). https://covid19asi.saglik.gov.tr/EN-80295/list-of-covid-19-vaccination-groups.html Accessed 4 April 2021.
5- World Health Organization. (2019). Ten threats to global health in 2019. https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019 Accessed 4 April 2021.
6- Hornsey, M. J., Harris, E. A., Fielding, K. S. (2018). The psychological roots of anti-vaccination attitudes: a 24-nation investigation. Health Psychology. 37:307–315. doi: 10.1037/hea0000586
7- Kaplan, R.M., Milstein, A. (2021). Influence of a COVID-19 vaccine's effectiveness and safety profile on vaccination acceptance. Proceedings of the National Academy of Sciences USA. 118(10):e2021726118. doi: 10.1073/pnas.2021726118.
8- Bokemper, S. E., Huber, G. A., Gerber, A. S., James, E. K., Omer, S. B. (2021). Timing of COVID-19 vaccine approval and endorsement by public figures. Vaccine. 39(5):825-829, doi: 10.1016/j.vaccine.2020.12.048.
9- Schwarzinger, M., Flicoteaux, R., Cortarenoda, S., Obadia, Y., Moatti, J. P. (2010) Low acceptability of A/H1N1 pandemic vaccination in French adult population: did public health policy fuel public dissonance?. PLoS One. 5e10199
10- Lin, C., Tu, P., Beitsch, L.M. (2021). Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. Vaccines. 9(1):16.

11- Ward, J.K., Alleaume, C., Peretti-Watel, P., the COCONEL Group (2020). The French public's attitudes to a future COVID-19 vaccine: The politicization of a public health issue. Social Science & Medicine. 265, 113414.
12- Hursh, S. R., Strickland, J. C., Schwartz, L. P., Reed D. D. (2020). Quantifying the Impact of Public Perceptions on Vaccine Acceptance Using Behavioral Economics. Frontiers in Public Health, 8: 877. doi: 10.3389/fpubh.2020.608852
13- Kreps, S., Prasad, S., Brownstein, J. S., Hswen, Y., Garibaldi, B. T., Zhang, B., Kriner, D. L. (2020). Factors Associated With US Adults' Likelihood of Accepting COVID-19 Vaccination. JAMA Netw Open. 3(10): e2025594.
14- de Figueiredo, A., Simas, C., Karafillakis, E., Paterson, P., Larson, H. J. (2020). Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. Lancet. 396: 898–908
15- Seale, H., Heywood, A.E., Leask, J., Sheel, M., Durrheim, D.N., Bolsewicz, K., Kaur, R. (2021). Examining Australian public perceptions and behaviors towards a future COVID-19 vaccine. BMC Infectious Disease. 21(1):120. doi: 10.1186/s12879-021-05833-1.
16- Dodd, R.H., Cvejic, E., Bonner, C., Pickles, K., McCaffery, K.J., Sydney Health Literacy Lab COVID-19 group. (2021). Willingness to vaccinate against COVID-19 in Australia. Lancet Infectious Diseases. 21(3):318-319. doi: 10.1016/S1473-3099(20)30559-4.
17- Rhodes, A., Hoq, M., Measey, M.A., Danchin, M. (2020). Intention to vaccinate against COVID-19 in Australia. Lancet Infectious Diseases. S1473–3099(20):30724–6.
18- The COCONEL Group. (2020). A future vaccination campaign against COVID-19 at risk of vaccine hesitancy and politicisation. Lancet Infectious Diseases. 20: 769-770. doi: 10.1016/S1473-3099(20)30426-6
19- Schwarzinger, M., Watson, V., Arwidson, P., Alla, F., Luchini, S. (2021). COVID-19 vaccine hesitancy in a representative working-age population in France: a survey experiment based on vaccine characteristics. Lancet Public Health. 6(4):e220-e221. doi: 10.1016/S2468-2667(21)00012-8
20- Palamenghi, L., Barello, S., Boccia, S., Graffigna, G. (2020). Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. European Journal of Epidemiology. 35:785–788. doi: 10.1007/s10654-020-00675-8.
21- Barello, S., Nania, T., Dellafiore, F., Graffigna, G., Caruso, R. (2020). "Vaccine hesitancy" among university students in Italy during the COVID-19 pandemic. European Journal of Epidemiology. 35:781–783. doi: 10.1007/s10654-020-00670-z.
22- Fisher, K.A., Bloomstone, S.J., Walder J., Crawford, S., Fouayzi, H., Mazor, K.M. (2020). Attitudes Toward a Potential SARS-CoV-2 Vaccine: A Survey of U.S. Adults. Ann Intern Med. 173(12):964-973. doi: 10.7326/M20-3569.
23- Taylor, S., Landry, C. A., Paluszek, M. M., Groenewoud, R., Rachor, G. S., Asmundson, G. J. G. (2020). A Proactive Approach for Managing COVID-19: The Importance of Understanding the Motivational Roots of Vaccination Hesitancy for SARS-CoV2, Frontiers in Psychology, 11:2890, doi: 10.3389/fpsyg.2020.575950
24- Lazarus, J. V., Scott, C. R., Adam, P., Lawrence O. G., Heidi J. L., Kenneth, R, Spencer, K., Ayman E.. (2021). A global survey of potential acceptance of a COVID-19 vaccine. Nature Medicine. 27:225–228. doi: 10.1038/s41591-020-1124-9.
25- Loomba, S., de Figueiredo, A., Piatek, de Graaf, S.J.K., Larson, H. J. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nature Human Behavior. 5:337–348. doi: 10.1038/s41562-021-01056-1.
26- Verlegh, P. W., Steenkamp, J-B E. M. (1999) A review and meta-analysis of country-or-origin research. Journal of Economic Psychology. 20, 521-546.
27- Wilcox, D. (2005). Country-of-Origin Bias: A Literature Review and Prescription for the Global World. Developments in Marketing Science, 28 (3), 87–97.

28- Wilcox, D. (2015). Country-of-origin bias: a literature review and prescription for the global world H.E. Spotts (Ed.), Marketing, Technology and Customer Commitment in the New Economy, Springer International Publishing, Basel, Switzerland, 86-96.
29- Mirzaee, S., Jalalinejad, R., George, B. (2021) Country of Origin, COVID-19 Vaccine and the Future of Travel: A Preliminary Study in Iran. Revista Anais Brasileiros de Estudos Turisticos. 11, 1-6.

Appendix:

Below is the English translation of the Survey 1

Below is some information about a vaccine developed against coronavirus. Please read carefully. The efficacy results of the vaccine developed by the Chinese biotech company Biogtigs against the coronavirus were announced in a press release. A total of 22,000 people between the ages of 18-65 participated in the clinical trials of the vaccine, which was given as two doses with 28 days apart. According to the results of the study, the efficacy of the vaccine was announced as 85 percent. This rate was calculated as follows: In the vaccine group with 11 thousand people, only 25 people got coronavirus disease, while in the control group with 11 thousand people, 170 people became sick. Antibodies that protect against the disease were observed in the vaccinated individuals. Again, in individuals who were vaccinated, side effects such as weakness, headache and muscle pain were observed.

How effective does this vaccine seem to you? Please give a score from 1 to 5.

1 (not effective at all) 2 3 (moderately effective) 4 5 (very effective)

Would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

If, you saw on television that Dr. Richard Taylor from the World Health Organization (WHO) say that Biogtigs is an effective vaccine and they recommend it to be applied worldwide, would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

If the vaccine had an efficiency rate of 95 percent would you get this vaccine?

Would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

If the efficacy of the vaccine had dropped to 75 percent, would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

Survey 2 is the literally the same as survey 1, except that we mention that the Biogtigs is a German biotechnology firm. Next, in Survey 3, we just mention that Biogtigs is a biotechnology name without naming the country origin.

Survey 4

The efficacy results of the vaccine developed by the German biotech company Vacinart against coronavirus were announced in a press release. A total of 22,000 people between the ages of 18-65 participated in the clinical trials of the vaccine, which was given as two doses with 28 days apart. According to the results of the study, the efficacy of the vaccine was announced to be 80 percent. This rate was calculated as follows: In the vaccine group with 11 thousand people, only 34 people got coronavirus disease, while in the control group with 11 thousand people, 170 people became sick. Antibodies that protect against the disease were observed in the vaccinated individuals. Also, individuals who were vaccinated had side effects such as muscle pain and fatigue.

Would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

If the efficacy of the vaccine had dropped to 75 percent, would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

The efficacy results of the vaccine developed by Pinkenac, a Chinese biotech company, against coronavirus, have been announced. According to the results of the study in which 22 thousand people between the ages of 18-65 participated in two doses with an interval of 28 days, the efficacy of the vaccine was 85 percent. In the vaccine group, which included 11 thousand people, only 25 people got coronavirus disease, while 170 people became sick in the control group with 11 thousand people. Antibodies that protect against the disease were observed in the vaccinated individuals. Also, individuals who were vaccinated had side effects such as muscle pain and fatigue.

Would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

If the efficacy of the vaccine had dropped to 75 percent, would you get this vaccine? Please give a score from 1 to 5.

1 (definitely not) 2 3 (undecided) 4 5 (definitely would)

Finally, Survey 5 is the same as the Survey 4 with the exception that the reported efficacy of the German vaccine Vacinart is reduced to further down to 75%.