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Vaccine nationalism among the public: A cross-country experimental evidence of own-country bias towards COVID-19 vaccination

Joan Barceló [a,1], Greg Chih-Hsin Sheen [b,*,1], Hans H. Tung [c,1], Wen-Chin Wu [d,1]

[a] Division of Social Science, New York University Abu Dhabi, United Arab Emirates
[b] Department of Political Science, National Cheng Kung University, Taiwan
[c] Department of Political Science and Center for Research in Econometric Theory and Applications, National Taiwan University, Taiwan
[d] Institute of Political Science, Academia Sinica, Taiwan

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ABSTRACT

What types of vaccines are citizens most likely to accept? We argue that citizens' identification with their nation may lead them to prefer vaccines developed and produced within their national borders, to the exclusion and/or detriment of vaccines from other nations. We administered a conjoint experiment requesting 15,000 adult citizens across 14 individual countries from around the world to assess 450,000 profiles of vaccines that randomly varied on seven attributes. Beyond vaccine fundamentals such as efficacy rate, number of doses, and duration of the protection, we find that citizens systematically favor vaccines developed and produced in their own country of residence. The extent of preference in favor of vaccines developed and produced within the national borders is particularly large among citizens who identify more strongly with their nation, suggesting nationalism plays a role in explaining the bias in favor of vaccines developed and produced locally. This public opinion bias on vaccine preferences has significant theoretical and practical implications.

1. Introduction

The SARS-CoV-2 (also known as COVID-19) has quickly risen to become one of the deadliest pandemics in history producing nearly 4 million confirmed deaths worldwide (Cheng et al., 2020; Dong et al., 2020). In just about eighteen months since the beginning of the pandemic, seven vaccines have been approved by the World Health Organization, 16 vaccines have received emergency-use authorization by at least one country in the world, 102 vaccines are in clinical trials; and 185 in pre-clinical phase trials (World Health Organization, 2021). At the time of writing, several efficacious and safe vaccines have been inoculated in over 2.4 billion citizens across the globe (Mathieu et al., 2021).

While vaccines bring hope for an end to the pandemic, public hesitancy to accept vaccination remains a global challenge. The Imperial College London YouGov Covid 19 Behaviour Tracker indicates that about 64% of the study's sample, which includes 17 countries, would take a vaccine if it was offered to them (YouGov Data, 2020). Similarly, a recent survey of 13,426 people in 19 countries shows that 71.5% of respondents would take a vaccine if offered (Lazarus et al., 2021). Adding 15 additional samples covering countries at varying levels of development, a recent investigation has also revealed an average acceptance rate fell below 70% across all countries (Solis Arce et al., 2021).

However, these figures mask significant heterogeneity. Vaccine acceptance greatly varies from country to country from widespread acceptance in some countries such as Nepal (97%), China (88.6%) and Brazil (85.4%), to significant vaccine hesitancy in countries such as Burkina Faso (67%), France (59%) and Russia (55%) (Solis Arce et al., 2021; Lazarus et al., 2021). Overall, the levels of COVID-19 vaccine acceptance have been insufficient to meet the requirements for herd immunity in many countries as important subgroups self-exclude from the vaccine rollout.

Meanwhile, the growth of vaccine hesitancy has long been considered a global concern (Lane et al., 2018) and is currently deemed as one of the major global health threats (World Health Organization, 2019). Substantial literature has attempted to identify political and sociological factors that correlate to vaccine acceptance in general (Hornsey et al., 2018; Karafillakis, Larson et al., 2017; Yaqub et al., 2014), and an increasing number of studies have already focused on the COVID-19

* Corresponding author.
E-mail address: gregcsheen@gs.ncku.edu.tw (G.C.-H. Sheen).
[1] The authors contributed to the manuscript equally.

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vaccine in particular (Callaghan et al., 2021; Kaplan and Milstein, 2021; Murphy et al., 2021). This latter set of studies has provided significant findings into the sociopolitical determinants of vaccine acceptance, ranging from demographics and perceived efficacy (Kaplan and Milstein, 2021), ideological, trust, and religious beliefs (Biswas et al., 2021; Murphy et al., 2021), to vaccine fundamentals (Kaplan and Milstein, 2021). However, less attention has been paid to the role of nationalism on vaccine preferences.

The concept of vaccine nationalism's politics has risen to public debate in the last few months (Kupferschmidt, 2020). The discussion has thus far been dominated by its policy dimension, defining different governments' strategies to become the first to inoculate their citizens (Clarke et al., 2021; Duch et al., 2021). The nationalistic race for vaccination has slowed down vaccine rollout and impacted global vaccine equity with significant implications for global health (Fidler, 2020). Academics and pundits have paid less attention to the sociopolitical dimension of vaccine nationalism whereby citizens' identification with their nation and support for its interests may lead them to prefer vaccines developed and produced within their national borders, to the exclusion and/or detriment of vaccines from other nations.

In this paper, we study how the nation of vaccine development may influence vaccine acceptance as respondents hold an own-country bias when evaluating vaccines. Vaccine nationalism, or the own-country bias that we posit in this paper, leads to the following expectation: people prefer vaccines that are developed/manufactured within the national borders over vaccines developed/manufactured abroad. Vaccine nationalism or own-country bias is a subtype of – or a more precise argument than – a country-of-origin effect, which simply suggests that people's willingness to take a vaccine is a function of the vaccine origin. To clarify this point, note that differences in vaccine uptake by the country of origin of a vaccine such as "French citizens preferred vaccines from the United States over similar vaccines from China" would constitute evidence in favor of a country-of-origin effect, yet it would yield no evidence regarding the own-country bias. By contrast, if "French citizens preferred vaccines from France over similar vaccines from the United States", it would constitute specific evidence in favor of own-country bias, e.g., vaccine nationalism.

Bearing this in mind, some of the previous studies on the determinants of vaccine acceptance have largely neglected the role of vaccine nationalism by focusing on other socio-political correlates or vaccine characteristics (e.g., Callaghan et al., 2021; Kaplan and Arnold, 2021; Murphy et al., 2021). Those studies that have taken the country of origin into account have restricted their analysis to single-country studies (e.g., Motta, 2021; Kreps and Kriner, 2021), employed non-experimental methods (Gramacho and Turgeon, 2021), or not collected the necessary evidence to evaluate the vaccine nationalism argument (Stöckli et al., 2022).

In this regard, Motta (2021) and Kreps and Kriner (2021) find evidence that Americans have strong preferences for vaccine candidates produced in the United States. While these studies offer a first step into our understanding of vaccine nationalism, the single-country design precludes us from assessing whether the preference for hypothetical US-developed vaccines is driven by the objective superiority and greater efficacy of the real-world Pfizer and Moderna vaccines, or even idiosyncratic features of the American public opinion. Further in another study, Gramacho and Turgeon (2021) show that Brazilians are more willing to take a hypothetical vaccine from the United States or England, yet vaccine fundamental were not randomly assign so these effects could stem from people's perception that vaccines' is an indicator of important vaccine fundamentals such as greater efficacy or safety.

In the only cross-country study that, to our knowledge, considers the country-of-origin effect, Stöckli et al. (2022) do not specifically examine the impact of vaccine nationalism. Using survey evidence from three European countries (France, Germany, and Sweden), the authors find that citizens have a preference for hypothetical vaccines developed in Germany, United States, or the United Kingdom relative to those developed in China or Russia. While their experimental design allows them to conclude that Europeans prefer vaccines developed in other developed countries, their design does not systematically evaluate the vaccine nationalism argument as most vaccines included in their experimental setup are foreign. Hence, we still lack a systematic cross-country evaluation of the vaccine nationalism argument that specifically compares the impact of vaccines developed within the national borders on vaccine uptake relative to those developed overseas.

In this paper, we contribute to the literature by providing cross-country experimental evidence to specifically evaluate the vaccine nationalism argument. We evaluate the vaccine nationalism hypothesis by employing a paired profile analysis requesting 15,000 adult citizens across 14 individual country samples to assess 450,000 vaccine profiles. These profiles randomly varied on several vaccine fundamentals, including whether the country where the vaccines was developed and produced was respondents' own country or other countries. Our findings systematically reveal the significance of vaccine nationalism in shaping vaccine uptake. Across most country samples, we find that individuals prefer vaccines developed and produced within their national borders relative to similar vaccines developed and manufactured abroad. Further, we examine the role of psychological affinities for one's home country as a primary psychological driver of the own-country bias. We find that this bias is particularly large among citizens who identify more strongly with their nation, suggesting nationalism plays a role in explaining the bias in favor of vaccines developed and produced locally.

2. Experimental design

We embedded several conjoint experiments in Internet-based surveys fielded in fourteen countries around the world. Table 1 reports a list of all countries selected for the fieldwork, the number of respondents, and the fieldwork period. A survey firm Respondi was responsible for the fieldwork in Brazil, France, Germany, Mexico, Spain, United Kingdom, and United States, and another survey firm Rakuten Insight was in charge of the fieldwork in China, Hong Kong, Japan, the Philippines, Singapore, South Korea, and Taiwan. We selected our sample to reflect a wide array of national attributes, including geographic representation from Europe, South and Central America, Southeast and East Asia, income level, geographical size, geopolitical influence, vaccine acceptance rate – China and Brazil close to or above 80% and France below 60% as previously shown in Lazarus et al. (2021) – level of vaccination at the time of our fieldwork – United Kingdom and United States with over 50% of the population with at least one dose and Japan and South Korea with less than 10% of the population – and the stage of vaccine development – four countries had developed at least one vaccine that had been granted for Emergency Use Authorization (EUA) in at least one country (see Online Appendix D for details on the stage of vaccine development each country). We report more details about survey

Table 1
Fieldwork period and number of respondents per country.

Country	Fieldwork period	N
Brazil	May 6, 2021–May 25, 2021	1016
China	May 3, 2021–May 7, 2021	1001
France	April 20, 2021–May 6, 2021	1048
Germany	April 28, 2021–May 10, 2021	1031
Hong Kong	May 3, 2021–May 7, 2021	1000
Japan	May 17, 2021–May 20, 2021	1000
Mexico	April 5, 2021–April 13, 2021	1175
Philippines	May 17, 2021–May 21, 2021	999
Singapore	May 17, 2021–May 20, 2021	1000
South Korea	May 17, 2021–May 20, 2021	1000
Spain	March 1, 2021–March 10, 2021	2000
Taiwan	March 16, 2021–March 30, 2021	1202
United Kingdom	April 12, 2021–April 19, 2021	1041
United States	May 14, 2021–June 14, 2021	1135
Total	**March 1, 2021 - June 14, 2021**	**15648**

participants in Online Appendix A, the descriptive statistics in Online Appendix B. In Online Appendix C, we report a comparison between the sample and population in each country surveyed on gender and age.

A conjoint analysis evaluates the association of vaccine attributes with the decision over one of the two COVID-19 vaccine choices provided in one task. This experimental design has been widely employed in the marketing research to examine consumer preferences (Green et al., 2001) and increasingly used in the social sciences (Hainmueller et al., 2014; Leeper et al., 2020) and the medical research (Almario et al., 2018). This design is especially effective in minimizing social desirability bias and predicting real-world behavior (Hainmueller et al., 2015). The experimental task presents respondents with a pair of hypothetical vaccine profiles through a random combination of vaccine attributes a citizen may encounter clinically. It then asks them to make a forced binary choice after considering the trade-offs among the vaccine characteristics. This design is equivalent to a paired profile conjoint with forced choice design, which has been shown to successfully recover the structural determinants of similar real-world choices (Hainmueller et al., 2015).

In our conjoint experiment, we asked each of the 15,648 respondents evaluated 15 pairs of vaccine profiles resulting in a total of approximately 469,440 vaccine profiles being evaluated. Each of the vaccine profiles randomly varied on 7 attributes: the vaccine country of development, the vaccine country of production, efficacy rate, number of doses, vaccine technology, duration of the protection, and public endorsements. Table 2 describes the conjoint attributes and attribute used in the conjoint experiments. Fig. 1 displays an example of a pair of vaccine profiles shown to respondents. Specifically, this example comes from the version of the survey shown to the respondents in the United States. For the specific wording of the questions and the construct of variables used in our analysis, please see Online Appendix E. The randomized conjoint employed in this study is therefore a constrained factorial design. The number of attributes and levels in this study generates nearly 16 thousand unique profiles ($(3 \times 4 \times 5 \times 6^2 \times 7) + 2(3 \times 4 \times 5 \times 7)$). While survey satisfaction and respondent fatigue is a concern when using multiple conjoint tasks with the same respondents, scholars have shown that response quality does not decline even after 30 conjoint tasks (Bansak et al., 2018). The order of the attributes was fully randomized for each respondent and conjoint task. The specific attribute levels were randomized between and within respondent groups.

Table 2
Conjoint attributes and levels.

Attributes	Levels
Country of invention/development	Own country (ref. category)
	United States
	Germany
	Russia
	China
	Another country
Country of production	Own country (ref. category)
	United States
	Germany
	Russia
	China
	Another country
Efficacy rate	55% (ref. category)
	65%
	75%
	85%
	95%
Duration of the vaccine protection	6 months (ref. category)
	1 year
	2 years
	5 years
Number of doses	1 injection (ref. category)
	2 injections, at least 21 days apart
	3 injections, at least 21 days apart
Vaccine technology	RNA (ref. category)
	Viral vector
	Whole virus
	Protein subunit
Other vaccines using the same vaccine technology	No other licensed vaccines (ref. category)
	Ebola
	Whooping cough, Rabies, Hepatitis A, etc.
	Hepatitis B
Actors who have publicly endorsed the vaccine	Unspecified (ref. category)
	Government official leaders
	Opposition party leaders
	Famous soccer players
	Famous entertainers
	Leading entrepreneurs
	Medical professionals
Testing Sites	Over 20 countries, including the U.S.
FDA Authorization	Yes

While not all potential combinations can be observed, randomization ensures orthogonality of all attributes, which makes it possible for us to estimate the marginal effect of each of them. Following the standard practice in the literature (Hainmueller et al., 2014), we estimated the average marginal component effects (AMCEs) by using an ordinary least squares (OLS) regression model with standard errors clustered at the respondent level. The AMCE for a particular attribute represents the mean difference in respondents' binary choices between two vaccines differing in its levels—e.g., developed by Germany versus by the US—averaged across all possible combinations. More specifically, this conjoint design allows us to examine how the nation of vaccine development influences respondents' vaccine acceptance vis-à-vis variation in the expected benefits and costs of coronavirus vaccination, as well as how this willingness varies depending on respondents' pre-existing nationalistic feelings.

What is worth noting here is that, to make our experiments more externally valid, there were three unrandomized attributes and one constrained attribute in our design. First of all, in additional to "Vaccine Technology", we also presented another related attribute in a separate row, "Other vaccines using the same vaccine technology," which displayed the pre-existing vaccine using the same technology as the hypothetical COVID-19 vaccine. This item was not randomized since it was linked to a particular vaccine technology. Currently there are no other licensed vaccines using RNA vaccines. Ebola is a pre-existing vaccine using viral vector vaccine technology. Whooping cough, Rabies, and Hepatitis A, etc. use whole virus. Hepatitis B uses protein subunit vaccine technology. As this attribute perfectly covaries with the vaccine technology, we present both with the same coefficient in our results. Second, the other two unrandomized attributes were "Testing Sites" with a single level, "Over 20 countries, including the U.S.," and "FDA Authorization" with a single level, "Yes." These two unvaried attributes were simply included to make our vaccine profile descriptions look more realistic. Since both of them were less familiar in the Asian context, they were only present in our Western samples. Despite this difference between the two samples, as Figure S10 in Appendix shows, our results are robust to the absence and presence of these two attributes in profile descriptions. Finally, since the developer of the Chinese vaccines must also be their producer at the same time, "China" in both the attributes of "Developer" and "Producer" was not included in the randomization.

3. Results

Fig. 2 shows the effects of vaccine characteristics on the overall probability of accepting the vaccine across all respondents (the regression model is presented in Table S16 in Online Appendix F). Our experimental results reveal that the specific attributes of a vaccine importantly shape willingness to accept it. Beyond vaccine fundamentals such as duration of protection, vaccine technology, efficacy rates, and the number of doses, we find that a country of vaccine origin significantly affects citizens' willingness to accept a vaccine. Compared to the vaccines developed in their own country, respondents are 8.4

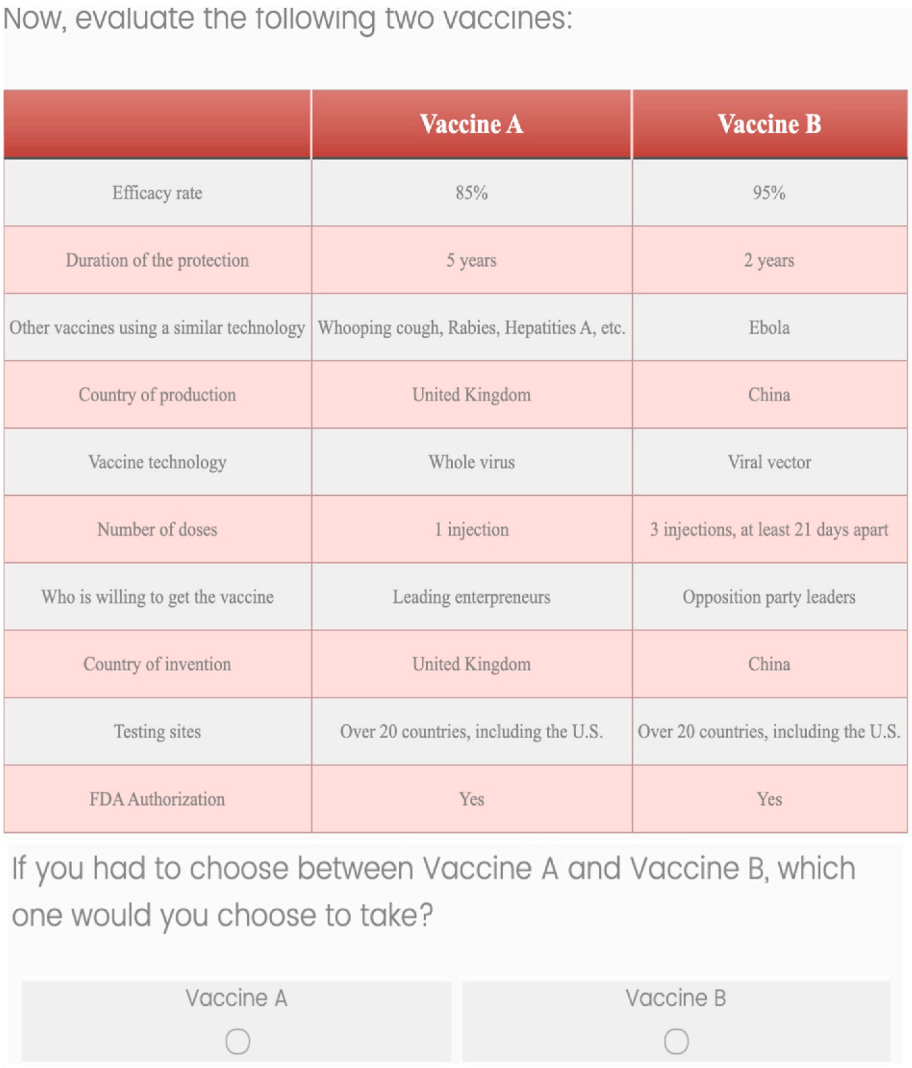

Fig. 1. Example profile pair.

percentage points less likely to accept a vaccine when it is developed in a foreign country ($P < 0.001$) and 4.5 percentage points less likely to accept a vaccine when it is produced in a foreign country ($P < 0.001$) We compute the pooled effect of a "foreign country" vis-à-vis the respondents' own country by aggregating the coefficients of individual countries, and excluding the filler category "Other countries". The difference in the aggregate effects is statistically significant at the $P < 0.001$ level, suggesting that the national bias is stronger with regards to the country of vaccine development rather than the country of vaccine production.

Despite differences in effect magnitude, Fig. 3 shows that the patterns identified from the pooled sample largely remain when we break down the data to 14 individual countries. Respondents systematically report lower preferences for vaccines developed in any of the foreign countries in the study when compared to a vaccine developed locally. While the German and the American vaccines enjoy a great level of popularity across most samples, vaccines developed domestically surpass their popularity even in countries that had not yet shown the capacity to develop a high-quality vaccine such as France, Singapore, South Korea, Spain, and Taiwan (see Online Appendix S9).

However, the general pattern is not without its exceptions. In the Hong Kong and the Filipino samples, people are slightly in favor of the American and the German vaccines compared to similar vaccines developed locally, yet both samples still reveal a bias against the vaccines of Chinese origin – and that of Russian origin in the Hong Kong sample. In the Mexican sample, people showed no significant preference for the locally developed vaccines except for a systematic bias against Chinese vaccines.

What is worth mentioning is that the own-country bias was substantially more pronounced in the Asian samples. For example, compared to homegrown vaccines, vaccines developed in China induced more than 34 percentage points of disapproval in Japan, 27 percentage points in South Korea, and 21 percentage points in Taiwan. Regarding the vaccine production, however, the results are similar between the pooled and the country-specific samples, generally revealing a systematic and significant pattern against vaccines manufactured in Russia and China and negligible effects against those produced in Germany and the United States across most individual country samples.

Fig. 3 also highlights heterogeneity across vaccines' country of origin. While the negative effect is present across all the countries included in our study, vaccines developed in China and Russia stand out for being less favored by 14 percentage points ($P < 0.001$) and 13 percentage points ($P < 0.001$) respectively when compared to locally developed vaccines.

Despite a smaller effect in magnitude, China and Russia are again the least favored producers and dampened the willingness to accept a vaccine by 7 percentage points and 4 percentage points ($P < 0.001$) respectively. The bias against foreign vaccines extends to two of the

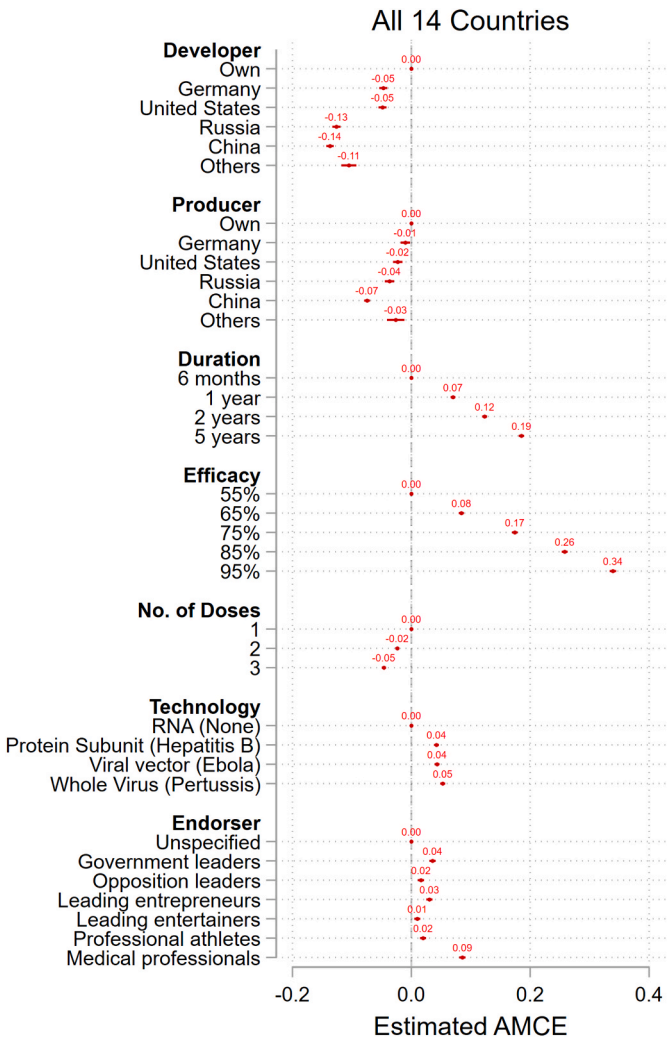

Fig. 2. Effects of vaccine attributes on the probability of accepting the vaccine. Pooled sample across 14 countries.

most technologically advanced countries in the development of vaccines: Germany and the United States. Respondents are more likely to prefer homegrown vaccines than vaccines developed in Germany ($P < 0.001$) or the United States ($P < 0.001$) by 5 percentage points. In contrast, respondents show a small bias against vaccines manufactured in Germany and the United States with a decline in the acceptance of the vaccine by only 1 and 2 percentage points respectively. Fig. 3 also shows that the patterns identified from the pooled sample largely remain when we break down the data to 14 individual countries. Respondents systematically report lower preferences for vaccines developed in any of the foreign countries in the study with the exception of three country samples: Mexico, Hong Kong, and the Philippines. See Online Appendices I and J for more details on the country-by-country results.

Finally, we stratified our main analysis by different subgroups to evaluate the homogeneity and robustness of the estimates. First, we stratified our samples by citizens' gender (see Fig. S7 in Online Appendix K), and age groups (see Tables S51 through S56 in Online Appendix K). Overall, we found that the effects of vaccines' country of development and production remain broadly similar across the different subgroups, which suggests that there is a general consensus among women and men, and young and old on which vaccines are preferred. Second, we estimated the AMCE by pooling the responses from the four countries, i.e., China, Germany, United Kingdom, and the United States, that have successfully developed at least one EUA-granted vaccine and the other AMCE by pooling the responses from the countries that have not yet developed any EUA-granted vaccine by the time of our surveys. As Fig. S9 in Online Appendix K.9 shows, our results remained stable regardless of a country's progress in vaccine develop-ment at the time the survey was conducted. Finally, we split the sample into Asian and European and American countries. A legitimate conjecture is whether the dispreference for Chinese vaccines is a global phenomenon or exclusive to East Asian countries (i.e., South Korea, Japan, and Taiwan) due to political/historical background between them and China. Our subgroup analysis in Online Appendix K.10 indicates that the dispreference for Chinese vaccines was similar across both types of countries, suggesting that this dispreference does not arise from the political/historical background between these countries and China but it is a global phenomenon. Yet, we acknowledge that further research will be needed to establish the regularity and roots of the anti-China bias. Overall, these subgroup analyses reveal that the own-country bias seems to be a widespread, cross-cutting empirical pattern.

Do the country-of-origin estimated effects vary across respondents' strength of national identification? If nationalism drives preference for vaccines, we might expect the nationalistic subgroup of respondents to rely more on the fact that a vaccine is developed domestically rather than abroad – compared to less nationalistic respondents. Fig. 4 reports the pooled regression estimates for those respondents with *Low Nationalism* (25th percentile or lower of the within-country distribution in the Nationalism score) and those with *High Nationalism* (75th percentile or higher of the within-country distribution in the Nationalism score) (the regression models are presented as Table S17 in Online Appendix F). Fig. 4 shows that the preference for the vaccine developed by one's own nation compared to all the others is negative for both high and low nationalistic subgroups, yet the magnitude strongly varies by respondents' nationalism. While respondents who identify more strongly with their nation are about 10 percentage points more likely to choose a vaccine developed in their own country (compared to a similar vaccine developed abroad ($P < 0.001$)), the differential preference reduces to 6 percentage points among low nationalistic respondents ($P < 0.001$). As Figures S2 through S4 in Online Appendix G show, the effect is robust despite different ways of dividing higher and lower nationalism groups.

As Fig. 4 also illustrates, disfavor for foreign vaccines is larger among the high nationalism group across all comparison countries. While the own-country bias is substantively small – i.e., 2 percentage points – when compared to vaccines developed in Germany and the United States among low nationalistic respondents ($P < 0.001$), the effect is threefolded – i.e., 6 percentage points – for both countries among high nationalistic respondents ($P < 0.001$). This subgroups analysis also shows a consistent pattern regarding vaccines developed in Russia and China with low nationalistic subgroups disfavoring them by 10 and 12 percentage points respectively compared to 12 and 15 percentage points respectively among the high nationalistic subgroup. This implies a differential effect of 2 and 3 percentage points between the two subgroups (where both differential effects achieve statistical significance at the $P < 0.001$). Further, the difference in the effect between the high and the low nationalism groups still largely persists in individual national samples, the only exceptions being the samples from Mexico and the Philippines.

As far as vaccine production is concerned, highly nationalistic respondents discriminate against vaccines manufactured in Germany (3 percentage points, $P < 0.001$) and the United States (5 percentage points, $P < 0.001$), which contrasts with the no-bias demonstrated between homegrown vaccines and those produced in Germany (0 percentage points, n.s.) and the United States (1 percentage point, n.s.) among those with less intense nationalistic feelings. By contrast, the bias against vaccines manufactured in Russia and China is homogeneously strong and negative for all nationalism subgroups. To complement these findings, we provide the Marginal means (MMs) estimates in Online Appendix H. Marginal means (MMs) estimates are an important reference for AMCEs' causal interpretation and subgroup comparisons in a context when there are no well-defined baselines in a conjoint

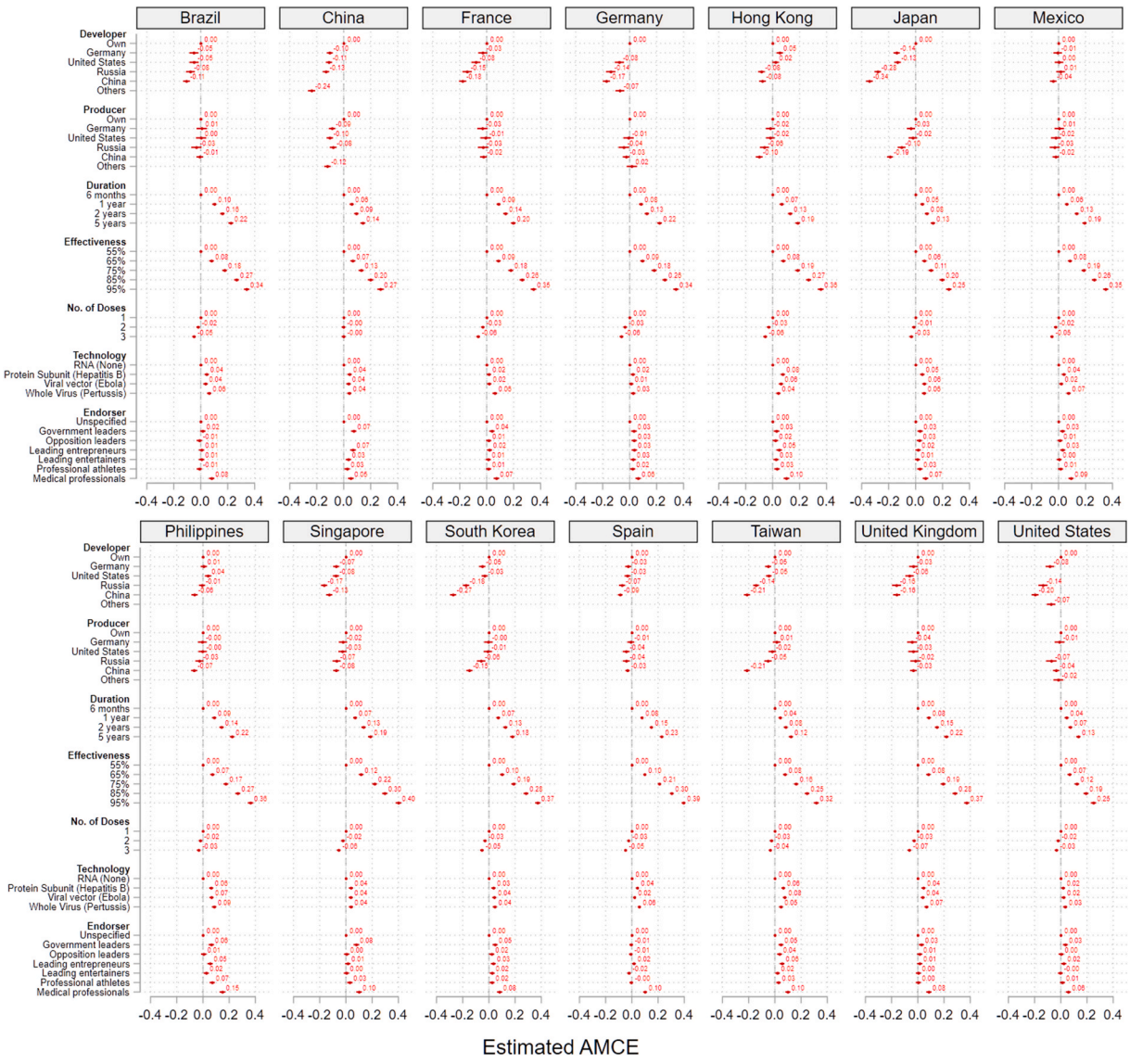

Fig. 3. Effects of vaccine attributes on the probability of accepting the vaccine by country subgroup.

experiment (Leeper et al., 2020). While this is not a concern for our experiment since the homegrown vaccine was a natural choice, we report the results of MMs in Online Appendix H. Figures S5 and S6 show that our results remain unchanged.

4. Robustness checks

We evaluate the robustness of our estimates to shifts in the experimental methodology we use across two dimensions: a) the type of conjoint methodology, whether the paired profile conjoint design involves a forced choice or not; and, b) the impact of experimenter demand effects. To evaluate this, we fielded an additional wave of our conjoint experimental methodology in a sample of citizens of Singapore (N = 1,598). The newly-collected data replicates the same survey methodology described above but it includes three orthogonal experiments by which subjects are randomly assigned: 1) to receive a paired profile conjoint with and without forced choice (see Fig. S11); 2) (not) to respond to the nationalist questions before the conjoint experimental tasks (see Fig. S12); and 3) (not) to see a preamble before the conjoint experimental tasks (see Fig. S13). Please see Online Appendix L for more details on the survey methodology of the robustness data.

First, we originally implemented a paired profile conjoint with forced choice design.

While paired profile conjoint methods have been demonstrated to be superior to all other designs of state preference experiments (Hainmueller et al., 2015), an alternative method could have allowed respondents to choose "neither." Online Appendix M.1 shows that none of the estimates are statistically different across the two study arms, suggesting that the type of conjoint methodology we use is unlikely to influence our findings.

Further, we evaluate whether survey questions before our experiment could have induced experimenter demand effects. When experimental designs employ control or moderator variables, as we do in our research, estimates are valid only if the control and moderator variables are measured *before* the treatment. When researchers measure a moderator *after* the experiment, the moderator is likely to be impacted by the experimental manipulation. If this happens, then the estimates are affected by *post-treatment bias* (see, e.g., Elwert and Winship, 2014; Montgomery et al., 2018; Wooldridge, 2005). Following this, we asked the nationalism questions before the experimental tasks. Online Appendix M.2 shows that none of the estimates are statistically different whether the nationalism questions are asked before the experiment or not.

In addition to this, some country samples included a preamble before

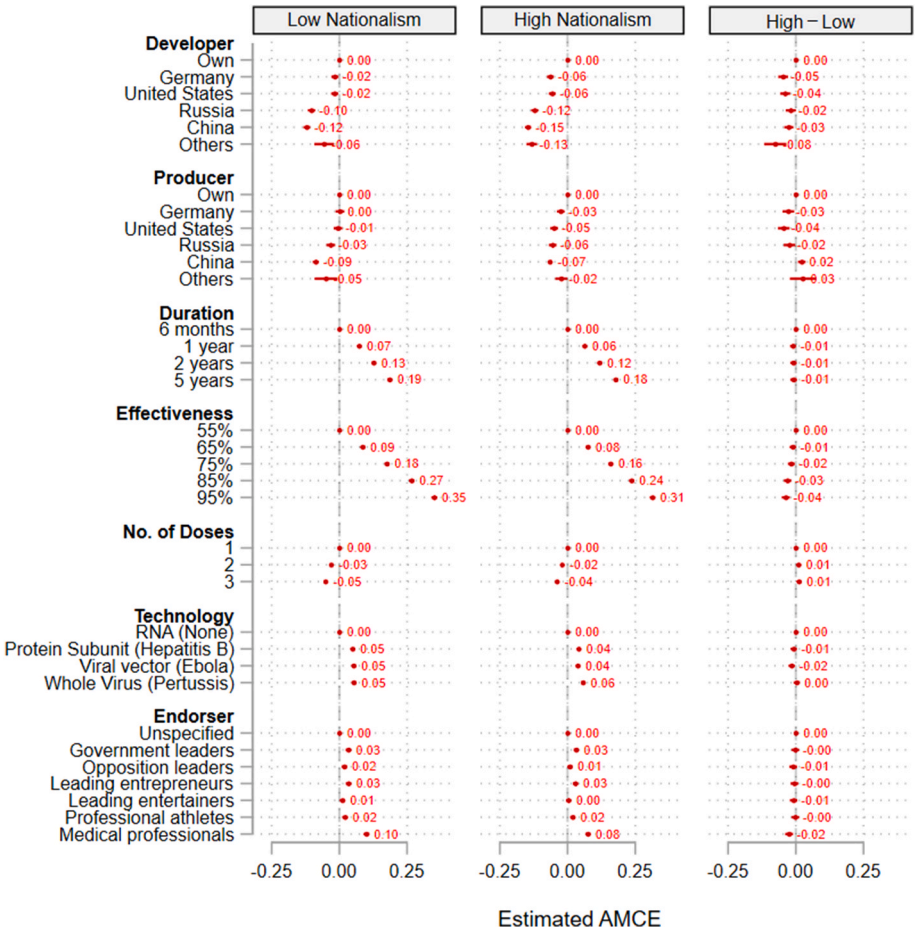

Fig. 4. AMCEs across nationalism (25/75).

the experimental task regarding to the role of the government in purchasing vaccines. More specifically, this preamble was not used in the samples from United States, United Kingdom, Spain, France, Germany, Brazil, and Mexico. While survey experiments are generally robust to experimenter demand effects (Mummolo and Peterson, 2019), some could still believe that the preamble primed respondents to consider the cost to national budget from purchasing vaccine overseas as opposed to developing one locally. Online Appendix M.3 shows that none of the estimates are statistically different whether the preamble is included before the experimental tasks or not.

5. Discussion

We design a large-scale conjoint experiment of 14 countries to assess how vaccine nationalism affects individual's preference over vaccines. From our experiment with over 15,000 respondents, we find a highly robust result that people prefer vaccines developed in their own countries. Overall, our finding suggests that origin of vaccines, especially the nationality of their developers, can significantly affect vaccines acceptance. By comparing this effect with other attributes included in our conjoint design, we find that the effect size is sufficiently large that can even provide compensation for relatively low efficacy of a vaccine. This result suggests that, in order to improve vaccine uptake, it is definitely worthwhile for countries to consider developing own vaccines.

The new empirical evidence brought to light in this paper shows that the public preference for local vaccines is not confounded by the actual objective performance of vaccines from various countries. While it is certainly the case that many individuals around the world (reasonably) believe that safety and validity standards in vaccines developed and/or manufactured in some countries such as Germany, and the United States (i.e., Pfizer/BionTech, Moderna) have better performance, our evidence contradicts the notion that our findings reflect cross-national variation in vaccines' objective performance. If the results simply indicated that citizens around the world preferred vaccines from Germany and the United States and, at the same time, rejected vaccines developed or manufactured elsewhere, vaccines' objective performance would be the most likely explanation for this result. However, our empirical pattern does not show this. Rather, we find that respondents prefer vaccines developed in their own country over vaccines developed elsewhere irrespective of the objective performance of the local versus the overseas vaccines (e.g., Brazilians prefer vaccines developed in Brazil over vaccines developed anywhere else, including the United States, Germany, Russia, and China).

In another vein, while the randomization of attributes ensures the internal validity of the effects we identify, some questions may remain on the external validity of our study. Some components help us alleviate these concerns. Even though our experiment cannot provide direct evidence that people will take one vaccine over another in the real world – conjoint experiments have been systematically found to provide close approximation of people's real-life behavior (Hainmueller et al., 2015) and can help avoid social desirability bias (Horiuchi et al., 2021), which is a common concern of survey studies (Caruso et al., 2009). In this context, field experiments where vaccine attributes are randomly assigned to individuals would likely be unfeasible and unethical. Therefore, we believe that conjoint experiments such as ours provide the most practical and ethical approach for identifying determinants of the public's vaccine preference.

Additionally, the homogeneity of our estimates across gender and

age subgroups (see Online Appendix K) gives us confidence that our findings are close to representing a population-level average treatment effect. Further, we have found the effect to be relatively consistent across 14 countries, which vary greatly on a number of country-level attributes such as economic development, regime type, vaccination acceptance, and vaccination roll-out. However, we acknowledge that our sample of countries includes mostly upper and upper-middle income countries. None of the countries we studied can, in fact, be considered a low-income country. While we admit that it is important to assess whether similar results would hold in low-income countries with a nascent or non-existing national vaccine industry, the reduced penetration of Internet and the impossibility of conducting face-to-face interviews amidst a global pandemic makes it difficult to obtain the sort of high-quality survey data necessary for this type of assessment.

Despite this, our findings have relevance for several theoretical and applied questions. Earlier research has shown that some forms of group identification can shape support for and engagement in protective behavioral measures (Allcott et al., 2020; Gollwitzer et al., 2020; Van Bavel et al., 2022). Contributing to this literature, we underscore the potential danger of vaccine nationalism whereby citizens, especially those strongly identified with their own nation, prefer vaccines developed and produced in their own nations to the exclusion or detriment of equivalent vaccines from other nations. National identification, which might be particularly salient amidst a global health crisis (Bieber, 2020), largely drives biases toward vaccines, which might hamper vaccine uptake. In a context where not all countries have a homegrown vaccine available to their citizens, prejudice and bias against foreign vaccines create an obstacle in the race to inoculate a large portion of the global community to ensure mass immunity to the disease. However, our findings are not all pessimistic.

Uncovering the public's preference for homegrown vaccines can help devise policy for improving vaccine uptake. This paper provides critical evidence in favor of vaccine development and production by local pharmaceutical companies. Our findings also demonstrate a need for international collaboration in the development and production of vaccines – discouraging single-country, single-company efforts – in order to heighten worldwide vaccine acceptance, including multinational joint-ventures and patent-sharing. Third, we show that, even if vaccines are developed abroad, those that are produced locally are more favored. This suggests that the decentralization of vaccine production could boost vaccine acceptance.

Additionally, our findings illuminate the potential benefit of more tailored communication approaches to increase vaccination uptake on a local level. The simplest communication strategies have long proved ineffective to persuade people to inoculate themselves via vaccine (Thomson et al., 2018). This is consistent with our findings that vaccine fundamental attributes only partially determine the public's vac-cine acceptance. Thus far, researchers have named various potentially effective strategies to address vaccine hesitancy, such as combating the spread of false information (Arede et al., 2019), highlighting personal benefits of vaccination in communication materials, leveraging the role of emotion in communication (Chou and Budenz, 2020), improving education of vaccine providers and their interaction with receivers (Leask et al., 2014), and devising culturally tailored promotion strategies (Nagar et al., 2018). However, our findings suggest that it is critical that governments and pundits make efforts to de-bias citizens with regards to the variables of country of development and production. For instance, our data suggests that de-emphasizing, or even removing, the country of origin when communicating about a vaccine could increase its acceptance. Subsequent research should specifically evaluate whether references to the *American vaccine*, the *British vaccine*, or the *Chinese vaccine* might increase vaccine uptake in the United States, the United Kingdom, and China, respectively, at the cost of reducing its acceptance anywhere else.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115278.

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