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Abstract

Peoples' willingness to vaccinate is critical to combating the COVID-19 pandemic. We devise a representative experiment to study how the design of the vaccine approval procedure affects public attitudes towards vaccination. Compared to an *Emergency Use Authorization*, choosing the more thorough *Accelerated Authorization* approval procedure increases vaccination intentions by 13 percentage points. Effects of increased duration of the approval procedure are positive and significant only for *Emergency Use Authorization*. Treatment effects are homogenous across population subgroups. Increased trust in the vaccine is the key mediator of treatment effects on vaccination intentions.

JEL-Codes: I120, I180, C930, D830.

Keywords: vaccination, Covid-19, approval procedure, experiment.

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1. Introduction

Vaccination is the most promising exit strategy out of the COVID-19 pandemic (WHO, 2020). While global vaccination supply accelerated in the first half of 2021, many countries have been struggling with the refusal of COVID-19 vaccination in sizeable shares of their populations. For instance, in Germany, the country we study, 75 % of the population received their first dose by January 2022 and only 9% of the vaccine-eligible but unvaccinated population reported they are willing to be vaccinated against COVID-19 if the vaccine were available to them (Jones, 2020).[1] The high incidence of vaccination refusal is a first-order public health issue, since it undermines efforts to eventually overcome one of the most detrimental pandemics of the past century. The vaccine approval procedure is a critical step in vaccination campaigns. Not only does the design of the procedure determine when the vaccination campaign can begin, but it may also affect people's trust in the efficacy and safety of vaccines and, ultimately, their vaccination readiness (e.g., Quinn et al., 2021). However, the causal relationship between characteristics of the approval procedure and vaccination readiness have not yet been studied. This is the research gap we address in this paper.

Against the backdrop of unprecedented rapid vaccine development, people's distrust in the quality and safety of COVID-19 vaccines has emerged as a major barrier to vaccination readiness (Steinert et al., 2021). An important institution to ensure the efficacy and safety of vaccines is approval by a health authority such as the European Medicines Agency (EMA) or the US Food and Drug Administration (FDA) (see Section 2 for institutional background). Policymakers must choose among alternative approval procedures that may differ in duration and the scope of the evaluation. Thus, they face an important tradeoff whenever vaccines are about to be introduced, adapted, or authorized for at-risk groups: on the one hand, faster approval facilitates an earlier start of the vaccination rollout; on the other hand, it could undermine people's trust in the vaccine and their vaccination readiness.

We study how characteristics of the approval procedure of COVID-19 vaccines affect attitudes towards vaccination. Identifying this causal relationship with naturally occurring data is nearly impossible, because exogenous variation in approval procedures is usually missing. We circumvent this identification problem by conducting a pre-registered vignette experiment in a representative sample of the German population (N = 2,030) in March 2021, when the vast majority of the population was still unvaccinated. The vignettes describe hypothetical but realistic vaccines that differ along two dimensions: type of approval procedure (*Emergency Use Authorization (EUA)* or the more thorough

[1] This share was similarly low in other countries, e.g., 7% in the UK or 11% in the US for the last available data. Respondents were asked for their agreement with the statement "If a COVID-19 vaccine were made available to me this week, I would definitely get it" on a 5-point scale from "Strongly agree" (1) to "Strongly disagree" (5). Respondents who indicate a "1" or "2" are considered to agree with the statement. See https://ourworldindata.org/grapher/covid-vaccine-willingness [accessed 20 January 2022].

Accelerated Authorization (AA))[2] and duration of approval (*5*, *20*, or *150* days between application and authorization). We consider four type-duration combinations: *EUA-5*, *EUA-20*, *AA-20* and *AA-150*. Our outcomes of interest are respondents' intentions to vaccinate, trust in the vaccine, and stated willingness to pay for the vaccine.

We find that the type of approval procedure substantially affects attitudes towards vaccination: compared to *Emergency Use Authorization*, intentions to vaccinate are 13 percentage points higher with *Accelerated Authorization* (*EUA-20* versus *AA-20*). Similarly, the share of respondents trusting in the vaccine, and their willingness to pay, significantly increase by 12 percentage points and 8-9 Euros, respectively. The effects of the admission duration are smaller and depend on the type of authorization: while increasing the duration of *Emergency Use Authorization* from 5 to 20 days (marginally) significantly increases vaccination intentions and trust by 5-6 percentage points (*EUA-5* versus *EUA-20*), increasing *Accelerated Authorization* duration from 20 to 150 days has no significant effect. Thus, increasing approval duration improves attitudes towards vaccination when requirements for the vaccine approval are relatively low and when the approval duration is very short.

Our detailed subgroup analysis reveals that – while average attitudes towards vaccination vary meaningfully along respondents' background characteristics – treatment effects hardly differ across subgroups of respondents defined by sociodemographic characteristics, political preferences, and economic preferences. Thus, our experimental estimates are rather universal and not driven by extreme reactions of certain population subgroups. Turning to the interpretation of our intention-to-vaccinate measure (i.e., our main outcome variable of interest), we show that treatment effects on intentions are largely attributable to altered trust in the vaccine. Finally, while our main outcomes of interest are (as in most other papers) necessarily *hypothetical* COVID-19 vaccination intentions, we discuss several pieces of evidence suggesting a tight link between vaccination intentions and actual vaccination decisions.

In summary, we provide the first causal and representative evidence that the design of the vaccine approval procedure has economically and statistically significant effects on attitudes towards COVID-19 vaccination – a critical factor for the success of vaccination campaigns. Thereby, we contribute to several strands of the literature.

First, we contribute to the literature on vaccination intentions and their determinants in the context of the COVID-19 pandemic. Several descriptive studies investigate predictors of vaccination intentions, like safety concerns, concerns about side effects, about the reliability of clinical trials, or distrust in government and public health authorities (see Li et al., 2021; Lin et al., 2020; Robinson et al., 2021;

[2] The main difference between the two types is that *Emergency Use Authorization* has lower requirements for the data that needs to be submitted for review, and lower scope of the evaluation.

Wake, 2021 for reviews).[3] Recent experimental studies scrutinize how intentions to vaccinate against COVID-19 are affected by factors like defaults, monetary, legal, and social incentives (Klüver et al., 2021; Serra-Garcia & Szech, 2022; Sprengholz et al., 2021a; Sprengholz et al., 2021b), communication and framing of vaccine features (Petersen et al., 2021; Sudharsanan et al., 2021), or online misinformation (Loomba et al., 2021).[4] We contribute to this literature by studying how the type and duration of the approval procedure –factors neglected so far in the literature –causally affect attitudes towards vaccination.[5]

Second, our study relates to the literature on trust in science during pandemics. Some studies investigate the pandemics themselves as determinants of trust in science (e.g., Agley, 2020; Eichengreen et al., 2021). Others use trust in science as an explanatory variable and show a positive association with self-reported compliance with non-pharmaceutical interventions (e.g., mask wearing) and attitudes towards vaccination (e.g., Algan et al., 2021; Bicchieri et al., 2021).[6] We advance this strand of literature by demonstrating that (*i*) the admission procedure chosen by public health authorities causally affects trust in vaccines, and (*ii*) changes in trust mediates treatment effects on vaccination intentions.

Third, at a more general level, we extend the recent literature in economics that implements experiments in large-scale surveys to study public attitudes and policy preferences. Most of these papers have focused on the effects of correcting public misperceptions through information provision on attitudes (see Haaland et al., 2020, for a review). In contrast, the question how the design of public policies affects public attitudes has received little attention in this literature (an exception is Lergetporer and Woessmann (2019), who study the effects of the design of university tuition repayment schemes on public preferences for tuition). We extend this literature by studying how the design of the vaccine approval procedure affects public attitudes towards vaccination.

The remainder of the paper is organized as follows. Section 2 provides institutional background information on vaccination approval procedures and on the vaccination rollout in Germany. Section 3

[3] In their descriptive study, Guidry et al. (2021) show that concerns about rushed vaccine development correlate negatively with vaccination intent under emergency use authorization . We advance this evidence by studying the *causal* effect of the vaccine approval procedure on attitudes towards vaccination.

[4] While these studies also rely on self-reported vaccination intentions as outcomes of interest, we are only aware of two papers that study treatment effects on actual COVID-19 vaccination rates: Campos-Mercade et al. (2021) leverage a large-scale field experiment in Sweden to show that modest monetary incentives increase actual vaccination rates by 4 percentage points. Dai et al. (2021) show that text-based reminders can increase vaccination appointment and vaccination rates by up to 6 and 4 percentage points, respectively.

[5] Beyond the context of COVID-19, there is a larger literature studying the determinants of vaccination intentions and take-up (see Brewer et al. (2017) for a review, and Milkman et al. (2021) and Milkman et al. (2022) for recent megastudies). These studies find that interventions are most effective when they build on positive intentions or reduce barriers to vaccination. Like the recent studies on COVID-19 vaccination, this literature has not studied the effects of the vaccine approval procedure on vaccination intentions as we do.

[6] Relatedly, several studies investigate trust in science and its relationship to vaccination intentions pre-COVID-19. For instance, Gauchat (2012) shows that trust in science in the US differs by social class, ethnicity, gender, church attendance, and region, and Sturgis et al. (2021) investigate the relationship between trust in science and vaccination confidence.

describes the data and the experimental design. Section 4 presents our results. Section 5 provides a discussion and concludes.

2. Institutional background

In this section, we first discuss different types of vaccination approval procedures, and then present information on the vaccination rollout in Germany.

2.1 Vaccination approval procedures

In the development of a new vaccine, a vaccine candidate goes through several stages. First, preclinical trials with animals are conducted to select the best vaccine candidates. Afterward, three phases of clinical trials in humans follow to assess the efficacy and safety of the vaccine. After Phase III trials, producers can apply for approval from the appropriate regulatory agencies. After approval, post-marketing surveillance starts, in which the long-term safety and effectiveness of the vaccine are monitored (Van Norman, 2016).

The regulatory agencies responsible for the approval of new vaccines are, for instance, the European Medicines Agency (EMA) in the European Union, the Food and Drug Administration (FDA) in the United States, or the Medicines and Healthcare products Regulatory Agency (MHRA) in the United Kingdom.[7,8] The regulatory agencies evaluate the quality, safety, and efficacy of the vaccines by reviewing all the scientific data the applicants are legally obliged to provide from the clinical trials. In case of an emergency, such as in the context of COVID-19, the development of vaccines is compressed in time and approval is obtained through a fast-track evaluation. Thereby, the EMA chose to implement a different authorization procedure than the FDA and the MHRA. Whereas the EMA used a *Conditional Marketing Authorization* (in the context of our study we call it an *"Accelerated Authorization"*), the FDA and also the MHRA applied an *Emergency Use Authorization* for COVID-19 vaccines (European Medicinces Agency, 2021d).

Compared to a standard marketing authorization, *Conditional Marketing Authorization* is based on less comprehensive clinical data to speed up the evaluation process from a maximum of 210 days to a maximum of 150 days. To receive approval, the applicant has to provide sufficient data to demonstrate

[7] Note that in the EU, the EMA only provides a recommendation for approval. The authority responsible for granting marketing authorization in case of a centralized authorization procedure in the EU is the European Commission which provides the decision after receipt of EMA's recommendation (European Medicinces Agency, 2019). Besides the centralized authorization, which is mainly applied for new and innovative medicines (e.g., COVID-19 vaccines), there exists also the national authorization procedure where medicines (mostly generic medicines and medicines without prescription) are assessed and authorized by national authorities maintained by EU member states. However, the data requirements and standards for authorization are the same for both centralized and national authorization procedures (European Medicinces Agency, 2021a).

[8] Even though the UK was still in the transition period of leaving the EU at the time of the authorization of COVID-19 vaccines, changes made to the Human Medicines Regulations 2012 on October 16 2020, allowed the MHRA to grant temporary authorization without relying on the EMA (Mahase, 2020).

that the medicine's benefits outweigh the risks. As such, the *Conditional Marketing Authorization* guarantees that approved medicines meet the standards for safety, efficacy, and quality set by the EU. In addition, all the missing data has to be provided post-authorization (European Medicinces Agency, 2021c). In the context of COVID-19, the EMA used a rolling review procedure in which data is delivered by the applicant and assessed by the EMA as soon as it is available, already previous to the application for marketing authorization (European Medicinces Agency, 2021d).

Unlike the *Conditional Marketing Authorization*, the *Emergency Use Authorization* is no marketing authorization. Instead, it enables the use of unapproved medical products (or unapproved uses of approved medical products) in cases of emergency. For an *Emergency Use Authorization*, the FDA requires that known or potential benefits outweigh known or potential risks and that the medical product "may be effective". Applicants need to deliver additional data for continuous monitoring of the safety and efficacy of the medical product after the emergency authorization to pursue approval (i.e., marketing authorization) (US Food and Drug Administration, 2017).

During the field phase of our survey from March to April 2021, four (three) COVID-19 vaccines were authorized by the EMA for the EU (FDA for the US). The first authorization was given to the mRNA vaccine Comirnaty by BioNTech (Pfizer), followed by the mRNA vaccine Spikevax by Moderna, the vector vaccine Vaxzevria by AstraZeneca (not in the US), and finally to the vector vaccine Janssen (Johnson & Johnson). The timeline from application to the authorization for the mRNA vaccine Comirnaty from BioNTech (Pfizer) is shown in Figure 1 for the three regulatory agencies of the EU, US, and the UK. The time span between application and authorization is 21 days for both the US and the EU, and 8 days for the UK (European Medicinces Agency, 2021b; Medicines and Healthcare products Regulatory Agency, 2020; US Food and Drug Administration, 2020).

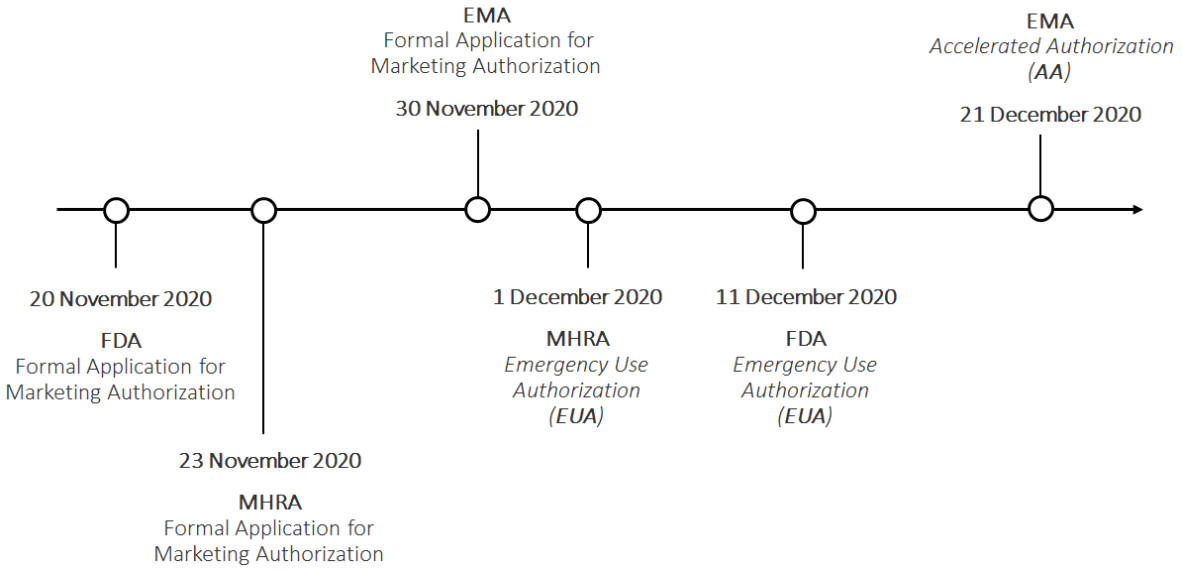

Figure 1: Timeline of authorization procedure applied by three different agencies, the *European Medicines Agency* (EMA), the *U.S. Food and Drug Administration* (FDA), and the *Medicines and Healthcare products Regulatory Agency* (MHRA) in the UK for the COVID-19 vaccine Comirnaty by Biontech (Pfizer). Above the timeline, we see the *Accelerated Authorization* (*AA*) applied by the EMA, while below we depict the *Emergency Use Authorization* (*EUA*) applied by the FDA and MHRA.

2.2 Vaccination rollout in Germany

The vaccination rollout in Germany started with the EU authorization of the mRNA vaccine Comirnaty from BioNTech on December 21, 2020, and the consecutive batch release for Germany by the Paul-Ehrlich-Institut, Federal Institute for Vaccines and Biomedicines, on December 22, 2020. By the end of 2021, almost 74% of the population received at least one dose of a COVID-19 vaccine. Figure 2 shows the development of vaccination rates in Germany from the start of the rollout until the end of December 2021. Due to supply shortages and logistical challenges, the rollout progressed only slowly until the end of March. At the start of our survey phase on March 24, 2021, only a small proportion of 9.8% of the German population had been vaccinated at least once. These were mainly elderly people and healthcare professionals who were prioritized based on the vaccine prioritization plan (Bundesministerium für Gesundheit, 2021; Bundesregierung, 2021).

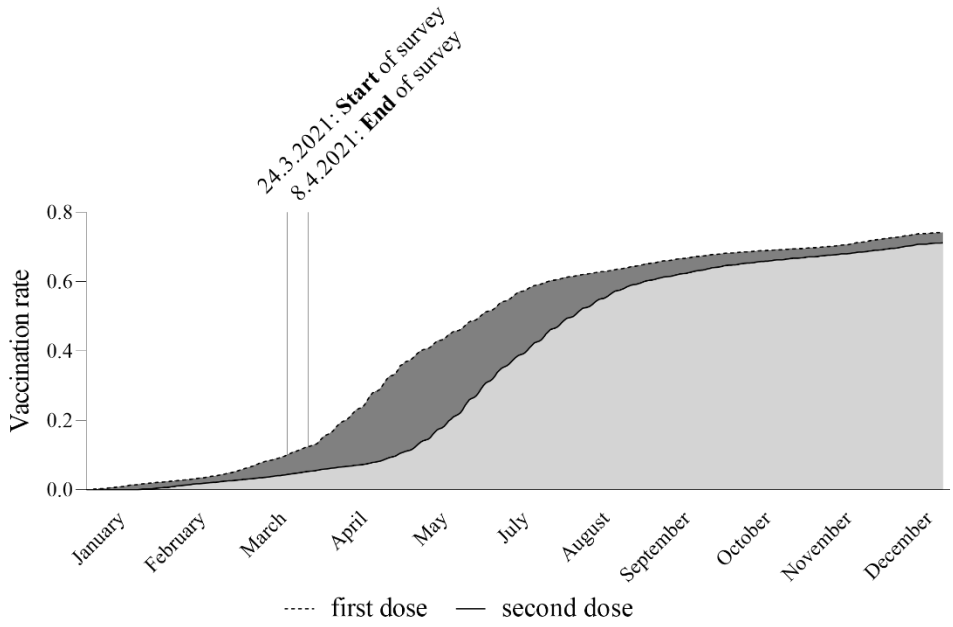

Figure 2: Vaccination rates of the German adult population (Bundesministerium für Gesundheit, 2021).

3. Data and experimental design

In this section, we describe the data collection, the experimental design, the empirical model, and the test of randomization.

3.1 Data collection and sample

The online survey was conducted between March 24, and April 2, 2021 with adults in Germany.[9] In total, 2,030 respondents were sampled and surveyed by the polling company Respondi.[10] The sample was drawn to match official population statistics with respect to age, gender, educational attainment, and federal state.[11] Our sample comprises respondents aged between 18 to 70 years. We consider this age group particularly relevant because vaccination hesitancy is much more pronounced among relatively younger compared to older individuals (see e.g., Robinson et al., 2021 for a review). Furthermore, as a result of the prioritization plan, at the time of the data collection the share vaccinated

[9] The experiment was pre-registered in the AEA RCT registry as trial 7388 (https://www.socialscienceregistry.org/trials/7388). IRB approval was obtained by the Ludwig-University of Munich (Project 2021-06).

[10] In total, Respondi sent a link to the survey to 11,252 people, from which 9,653 (86%) opened the link. From those, 2,296 (24%) started the survey, and 2,182 (23%) finished it. Respondi adjusted the sample to match official population statistics by deleting 152 observations, which leaves a final sample of 2,030 respondents.

[11] Reassuringly, Grewenig et al. (2018) show that online surveys that are drawn to match population characteristics represents the entire population (onliners and offliners) well. Furthermore, Peyton et al. (2021) show that pre-pandemic online experiments replicate well during the COVID-19 pandemic, demonstrating that the pandemic does not threaten the generalizability of online experiments.

among adults aged above 70 years was much higher at 28% compared to only 6% among those below age 70 years (Timcke et al., 2021).

Respondents complete the survey online on their own digital devices, without any assistance by a surveyor. Median response time was 6 minutes 40 seconds. The survey comprised a total of 28 questions including respondents' sociodemographic characteristics, political and economic preferences, and a question testing survey inattention (see Appendix B for the survey and column 1 of Table 1 for descriptive statistics of respondent characteristics).

Table 1: Summary statistics and balancing tests

		Difference			
	Overall Mean	***AA-20***	***AA-150***	***EUA-5***	***EUA-20***
	(1)	(2)	(3)	(4)	(5)
Sociodemographic characteristics					
Female	0.495	-0.02	0.01	-0.01	0.02
Age in years	45	-0.17	0.66	0.26	-0.74
Born in Germany	0.945	-0.00	0.01	-0.01	0.01
Living in the East of Germany	0.190	-0.02	0.03	0.00	-0.02
Equivalized household size	1.6	0.03	-0.03	0.01	-0.00
Equivalized household income [in Euros]	1703	-11.11	-40.71	34.50	16.60
University degree	0.102	-0.00	0.00	0.00	-0.00
Highest school degree					
No degree/basic degree	0.279	0.01	-0.00	-0.00	-0.00
Middle school degree	0.333	-0.02	0.03	-0.01	-0.01
University entrance qualification	0.387	0.01	-0.03	0.01	0.01
Work					
Currently works	0.614	-0.01	0.02	0.01	-0.02
Work in health sector	0.082	-0.04**	0.02	-0.01	0.03
Work in system-relevant job	0.171	-0.03	0.02	0.00	0.01
Political party preferences					
AfD§	0.095	-0.00	-0.00	0.01	-0.01
CDU / CSU§	0.185	0.03	-0.02	-0.02	0.02
FDP§	0.066	-0.00	0.00	0.00	-0.00
SPD	0.131	0.01	-0.04*	0.03	-0.00
Die Gruenen	0.165	-0.03	-0.00	0.02	0.02
Linke	0.071	0.02	-0.00	0.00	0.02*
Other	0.031	-0.01	0.01	0.01	-0.01
None	0.258	-0.00	0.06*	-0.07**	0.02
COVID-19 related information					
Already vaccinated	0.810	-0.01	0.01	-0.00	0.00
Already had COVID-19	0.067	0.01	0.00	0.02	-0.03**
Economic preferences					
Risk-taking	4.071	-0.10	0.05	-0.01	0.05
Patience	6.471	-0.04	-0.05	0.09	0.01
Altruism	7.227	-0.08	0.14	-0.02	-0.04
Trust in other people	2.403	-0.01	-0.02	0.05	-0.02
Trust in government	2.019	0.08	-0.02	-0.06	0.01
Trust in science	2.808	0.06	0.01	-0.06	-0.01
Experiment					
Attentive subj.	0.718	-0.04	-0.01	0.03	0.03
Non-response	0.003	0.00	-0.00	-0.00	-0.00
Observations (in respective treatment)	2,030	503	503	511	513

Notes: Column 1 shows means over all treatments. Columns 2-5 show differences in means between the respective treatment and the other three treatments. Each cell is the coefficient stemming from a simple OLS-regression, where we regress the respective background variable on a treatment dummy. ***Covariates***: **Equivalized household size** is a measure of household size using a standard (equivalence) scale, the so-called modified OECD scale. This scale gives a weight of 1 to the first adult in the household, 0.5 to each other person in the household aged 14 years or older, and 0.3 to each child under the age of 14 years and adds them up. **Equivalized household income** corresponds to the reported household income (in Euros) divided by the equalized household size. **University degree** takes on the value one if respondents report having graduated from university. **Currently works** takes on the value 1 if respondents report being employed or self-employed. Additionally, respondents answered whether they work in the **health sector** and/or in a **system relevant job** (e.g., health professions including elder care, public health office, police, and fire brigade). **Political party preference** was elicited asking respondents which party they generally sympathize with. We elicited whether respondents are **already vaccinated** (i.e., if they already received their first dose of some COVID-19-vaccine). Additionally, we asked whether respondents have **already had COVID-19** using a 4-point Likert scale (1 "*Yes, sure*"; 2 "*Probably Yes*"; 3 "*Probably No*"; 4 "*No, sure*") and transformed it into a binary indicator where *one* corresponds to "*Yes*" and *zero* to "*No*". **Risk-taking, patience,** and **altruism** were measured on 11-point Likert scales (1 "no agreement"; 11 "total agreement") following (Falk et al., 2018). **Trust** was measured using a 4-point Likert scale ranging from "*very high trust*" (1) to "*no trust at all*" (4). We included an **attention check** in the middle of the experiment to test if respondents are reading the questions carefully or not. **Non-response** takes the value 1 if respondents did not answer at least one of our six main outcome variables. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.
§ Leaning towards any of these political parties is classified as conservative political orientation.

3.2 Experimental design

To identify the effect of different aspects of the vaccination approval procedure on attitudes towards vaccination, we administered an experimental vignette study in which respondents were randomly assigned to one of four vignettes. All vignettes described the same hypothetical vaccine against COVID-19 but differed in details of the approval procedure. The vaccine described is based on mRNA technology and has an efficacy of 90%, with one dose required for complete immunization. Two aspects of the approval procedure were systematically varied across vignettes. First, the *type* of the approval procedure was either *Emergency Use Authorization* (*EUA*) or *Accelerated Authorization* (*AA*). Second, the *duration* from application to authorization was varied within each approval procedure. For the *EUA*, the duration was either 5 days (*EUA-5*) or 20 days (*EUA-20*). For the *AA* it was either 20 days (*AA-20*) or 150 days (*AA-150*).

Comparing vaccination attitudes between *EUA-20* and *AA-20* allows us to estimate the causal effect of the type of approval procedure while holding the duration constant at 20 days. We chose a time span of 20 days because this roughly corresponds to the duration of the actual authorization of the vaccine Comirnaty by both the FDA and EMA (see Figure 1). Comparing *EUA-5* and *EUA-20* (*AA-20* and *AA-150*) facilitates estimating the causal effect of approval duration while holding the approval type constant. Naturally, given that the *EUA* is less thorough than the *AA*, the investigated time spans differ across approval type. We chose 5 days as a plausible lower limit for the duration of the *EUA*, and 150 days as the upper limit of the *AA*, because it represents the legal maximum duration for *Conditional Marketing Authorization*. The vignettes, which describe the hypothetical vaccine and the approval procedures in detail, are presented in Appendix C.

After presenting the vignettes, we elicited three sets of outcomes to capture different dimensions of attitudes towards the use of the described vaccine: (*i*) intention to vaccinate (ITV), (*ii*) trust in the vaccine, and (*iii*) the willingness to pay for the vaccine (WTP). To elicit ITV and trust, we used a 5-point Likert scale measuring agreement to the following statements: *"I would get vaccinated with the vaccine"*; *"All in all, I trust the vaccine"*; *"I trust that the vaccine is effective"*; and *"I trust that the vaccine is safe"*.[12] We measured respondents' WTP for their own vaccination (WTP me) and for the vaccination of a person of their choice (WTP other) using open number input fields. In the main analysis, we consider a binary measure for ITV (coded *one* if the respondent "fully" or "rather" agrees to get vaccinated, *zero* otherwise), a trust index computed as the mean of dichotomized answers to the three

[12] Answer categories: "I fully agree", "I rather agree", "Neither nor", "I rather disagree", "I fully disagree". To minimize the error of central tendency, the category "neither nor" was placed below the other four answer categories. In methodological experiments, Lergetporer and Woessmann (2019) confirm that this reduces the error of central tendency without affecting the relative frequency of the other answer categories.

trust questions, and an WTP index computed as the mean of both WTP questions.[13] In Appendix Table A1, we show that the results are robust when using the original scale for ITV and trust, and when considering each of the six outcome variables separately.

3.3 Econometric model

Because of the random assignment of respondents to the four experimental conditions, we can use the following simple regression model to estimate the causal effect of our treatments:

$$y_i = \alpha_0 + \alpha_1 T_{ji} + \delta X_i + \varepsilon_i \quad (1)$$

where y_i is the outcome of interest for individual i, T_{ji} is an indicator for the vignette $j \in$ *AA-20, AA-150, EUA-5, EUA-20* an individual i received, X_i is a vector of control variables, and ε_i is an error term. The average treatment effects, estimated as coefficients α_1, are identified because of the random assignment of treatment status. Therefore, adding control variables, X_i, should not alter the estimates of the treatment effects, though it might increase precision.[14] Thus, we present estimation results with and without additional covariates.

To analyze heterogeneous treatment effects across subgroups (defined over respondents' characteristics) we extend our basic regression model to:

$$y_i = \beta_0 + \beta_1 T_{ji} + \beta_2 S_{ki} + \beta_3 T_{ji} S_{ki} + \varepsilon_i \quad (2)$$

where S_{ki} equals one if respondent i is a member of the respective subgroup k, zero otherwise. The treatment effect for non-members of the subgroup is given by β_1, and β_3 measures the additional effect on the subgroup.

3.4 Test of randomization

To test whether randomization successfully balanced the characteristics of the respondents in the different treatments, we examine whether our rich set of covariates differ by treatment status. The first column of Table 1 depicts mean values of the observable characteristics over all our four treatments. The remaining columns (2-5) report the coefficients γ_1 of regressions of the form:

$$C_i = \gamma_0 + \gamma_1 T_{ji} + \varepsilon_i \quad (3)$$

[13] To build the trust index, we first transformed the three ordinal categorical trust variables into binary variables indicating that respondents "fully" or "rather" agree with the respective statement. Then, we computed the index as the mean of the three binary variables. Before computing the WTP index, we winsorized answers to both WTP questions at the 99-percentile to account for outliers.

[14] See table notes for list of included covariates. In our sample, the share of missing covariate data is very low (below 1%, on average). Throughout this paper, we impute missing covariates by a constant and include dummies indicating imputed values for each covariate. Our results hold when instead dropping observations with missing covariates (see Appendix Table A2).

for each observable characteristic C_i. It is reassuring that only 3 out of 124 comparisons (2%) yield a significant coefficient at the 5 percent level. Hence, the balancing test shows that random assignment worked as intended.

4. Results

4.1 Main treatment effects

Figure 3 depicts effects of the randomized vignettes on intentions to vaccinate (ITV), trust, and willingness to pay (WTP). All three outcomes of interest strongly differ by the type of the approval procedure: holding the approval duration constant at 20 days, *Accelerated Authorization* (*AA-20*) yields significantly higher ITV (65% versus 52%; $p < 0.01$, χ^2 test), trust (68% versus 56%, $p < 0.01$, t-test) and WTP (34 Euros versus 26 Euros; $p < 0.10$, t-test), than *Emergency Use Authorization* (*EUA-20*). Next, we turn to the effects of approval duration. Focusing on *Emergency Use Authorization*, we find significantly higher levels of ITV (52% versus 46%; $p < 0.10$, χ^2 test) and trust (56% versus 50%; $p < 0.10$, t-test) for a duration of 20 days (*EUA-20*) compared to 5 days (*EUA-5*). The effect on WTP goes in the same direction but is not statistically significant. For *Accelerated Authorization*, we find no statistically significant treatment effects of admission duration (*AA-20* versus *AA-150*). Interestingly, attitudes towards vaccination tend to decrease when increasing duration from 20 to 150 days. Taken together, our findings suggest that approval duration increases willingness to vaccinate when approval requirements are relatively low and when the approval duration is very short.

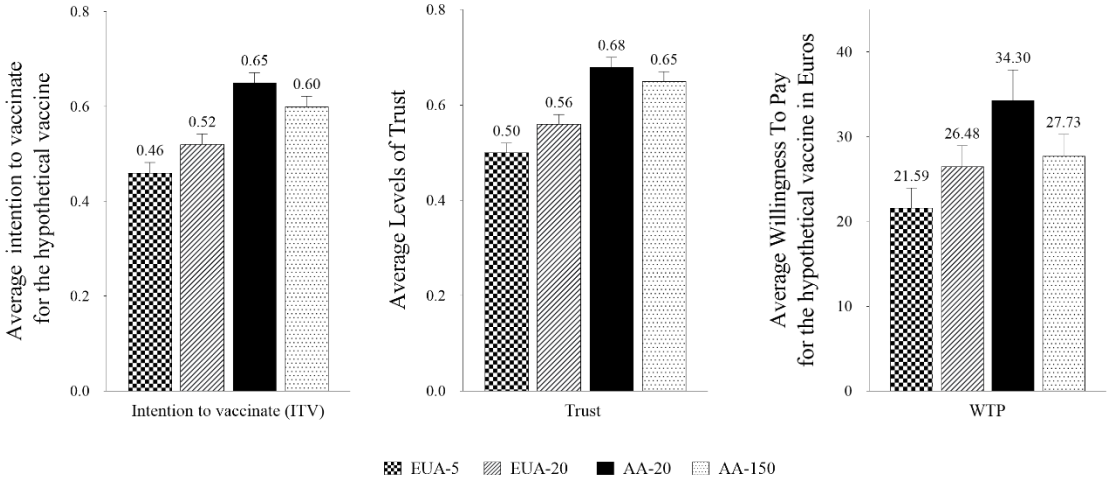

Figure 3: Attitudes towards vaccination by approval procedure. Mean values and standard errors (error bars) of our main outcome variables. The outcome variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** is the binary variable for the intention to vaccinate. **Trust** is the mean of the three binary trust outcomes. **WTP** is the mean of the two WTP outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days.

Table 2 presents OLS regressions of ITV (columns 1-2), trust (columns 3-4), and WTP (columns 5-6) on the treatment indicators. *EUA-20* is the omitted baseline condition. Odd-numbered columns do not include any covariates, whereas even-numbered columns include basic covariates as indicated in the table notes. As the table reveals, adding covariates does not affect any of our results. In line with the results reported above, the coefficients on *AA-20* show that - compared to *Emergency Use Authorization - Accelerated Authorization* increases ITV by 13 percentage points, trust by 12 percentage points, and WTP by 8-9 Euros when holding approval duration constant at 20 days. The negative coefficients on *EUA-5* again show that the shorter approval duration of 5 days decreases ITV and trust significantly by 5-6 percentage points, and WTP insignificantly by 5 Euros. In contrast, the effects of increasing approval duration within AA tend to go into the opposite direction but are not statistically significant (see post-estimation Wald tests).

Table 2: Effects of approval procedure on attitudes towards vaccination

	ITV		Trust		WTP	
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.134***	0.131***	0.117***	0.117***	7.819*	8.565**
	(0.031)	(0.029)	(0.028)	(0.026)	(4.362)	(4.202)
AA-150	0.088***	0.090***	0.093***	0.095***	1.247	2.662
	(0.031)	(0.029)	(0.028)	(0.026)	(3.563)	(3.449)
EUA 5	-0.053*	-0.058**	-0.056*	-0.062**	-4.887	-4.598
	(0.031)	(0.029)	(0.029)	(0.026)	(3.405)	(3.231)
add. Covariates	no	yes	no	yes	no	yes
EUA-20 Mean[1]	0.517		0.559		26.479	
R^2	0.021	0.169	0.024	0.189	0.005	0.089
Obs.	2030		2029		2024	
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - AA-20	-0.046	-0.041	-0.025	-0.022	-6.572	-5.903

Notes: ***EUA-20*** serves as the baseline. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** (column 1 & 2) is the binary variable for the intention to vaccinate. **Trust** (column 3 & 4) is the mean of the three binary trust outcomes. **WTP** (column 5 & 6) is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *"Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** E*mergency Ese Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Our main results are confirmed in a series of robustness tests. In Appendix Table A1 we consider each component of the trust and WTP indices separately and consider ordinal 5-point scale measures of ITV and trust instead of dichotomized outcomes. Results are qualitatively identical with this alternative coding of outcome variables.[15] One potential concern with survey data is that respondents may not react to the treatment manipulations because they do not pay enough attention when completing the survey. Therefore, we implemented an attention check in the survey which allows us to differentiate between attentive and inattentive respondents.[16] Appendix Table A3 presents regression results separately for the

[15] The analysis discussed so far follows exactly our pre-registration plan. The following robustness checks, heterogeneity analysis, and mediation analysis however, was not pre-registered prior to the start of the survey. Hence, these rather explorative results must be interpreted with caution.

[16] The attention check read as follows: *"It sometimes happens that survey participants do not read individual questions accurately. To ensure that you read the questions accurately, we ask you to ignore the following question and enter the number twenty-two in the text box.*

subgroup of attentive respondents. Coefficient estimates are very similar to the results in Table 2, which suggests that inattention does not severely attenuate our treatment-effect estimates. While we did not select survey respondents based on their vaccination status, people who were neither vaccinated nor recovered at the time of the survey are particularly relevant because they still had the vaccination decision ahead of them. Therefore, we next restrict our sample to unvaccinated respondents (Appendix Table A4), and to those who have not already had COVID-19 (Appendix Table A5). Reassuringly, treatment effects are again very similar among these subgroups compared to the overall sample.[17] Finally, in Appendix Table A6 we estimate treatment effects on ITV and trust using Probit regressions instead of OLS regressions, which does not affect our results.

4.2 Subgroup analysis: sociodemographic characteristics, political and economic preferences

The described analyses so far focused on average treatment effects. Next, we analyze effect heterogeneity across various subgroups to explore the generality of our findings across sociodemographic characteristics, political and economic preferences.

As background, we first provide descriptive evidence on how intentions to vaccinate (ITV), trust in the vaccine, and willingness to pay (WTP) vary with respondents' characteristics. Table A7 presents OLS regressions of our outcome variables on respondents' characteristics. Each cell in the odd-numbered columns present the coefficient of a bivariate regression of our outcomes on the respective characteristic, while even-numbered columns present a multivariate regression including all characteristics simultaneously. We find robust evidence that females, younger respondents, people living in the East of Germany, supporters of the right-wing party AfD, and unvaccinated respondents exhibit lower ITV and trust in the vaccine (results go in the same direction when considering WTP, but are less clear-cut). Attitudes towards vaccination also tend to be more positive for respondents with higher education levels and income, though these relationships are somewhat less robust across specifications. These patterns are highly consistent with previous evidence on the relationship between individual characteristics and COVID-19 vaccination intentions and status.[18] Furthermore, economic

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The federal states are responsible for organizing vaccination against Corona. In how many states do you estimate that primary care physicians are already providing vaccination nationwide? In _____ of the total of 16 federal states"

We classify respondents who answered the question with "22" as attentive (72%), and the rest as inattentive.

[17] Interestingly, those who are vaccinated against COVID-19 exhibit more positive average attitudes towards vaccination, whereas attitudes do not differ by previous COVID-19 infections (see Appendix Table A7).

[18] Huebener and Wagner (2021) find that respondents who are female, younger, poorer, and less educated exhibit higher vaccine hesitancy. Similar patterns are reported by Galanis et al. (2021), Galasso et al. (2021), Campos-Mercade et al. (2021), and Steinert et al. (2021). While Betsch et al. (2021) find no significant association between gender or education and vaccination status, they report that vaccination rates are lower in East Germany (a result in line with official statistics by the Robert Koch Institut (RKI, 2021)). In line with the negative coefficient on AfD-supporters, more recent surveys show that two-thirds of unvaccinated adults in Germany support right-wing parties, especially the AfD (Der Spiegel, 11 November, 2021,

preferences turn out to be strong and robust predictors: attitudes towards vaccination are higher for more risk-taking, patient, and altruistic respondents, and those who exhibit higher levels of generalized trust in people, the government and science. In sum, respondents' attitudes towards vaccination vary meaningfully with their sociodemographic characteristics and political and economic preferences.

These differences in attitudes towards vaccination raise the question whether treatment effects also differ across subgroups. Therefore, Appendix Tables A8, A9, and A10 report heterogeneous treatment effect estimates on ITV, trust, and WTP, respectively, for different subgroups of respondents. Based on Equation (2), the tables depict the main treatment effect for the respective omitted subgroup (β_1 in columns 1-3) and coefficients on the treatment-subgroup interaction terms (β_3 in columns 4-6) measure the additional effect on the subgroup.

Treatment effects turn out very homogeneous across subgroups: we only find eight out of 171 treatment-subgroup interactions (4.7%) are significant at the 5%-level, which may be expected by pure chance. The most robust heterogeneity seems to be that respondents not born in Germany react stronger to using an *Accelerated Authorization* versus an *Emergency Use Authorization* (*AA-20* versus *EUA-20*). These differences need to be interpreted with caution, however, given the large number of comparisons made. In sum, this analysis reveals that the effects of the vaccination approval procedure on attitudes towards vaccination reported above are rather general and not driven by extreme treatment reactions of some subgroups of respondents.

4.3 Trust as mediating factor

In this section, we scrutinize the interplay between two of our main outcomes of interest, namely intention to vaccinate and trust in the vaccine. The literature generally considers trust in science as a means to promote COVID-19 control measures, such as adherence to non-pharmaceutical interventions or getting vaccinated (e.g., Algan et al., 2021; Bicchieri et al., 2021). At the same time, the vaccine approval procedure may primarily affect people's trust in the vaccine, which has likely been undermined by the unprecedented pace of COVID-19 vaccine development (Quinn et al., 2021; Steinert et al., 2021).

Therefore, we next perform a mediation analysis in the spirit of Pearl (2012) and Heckman et al. (2013). Therefore, we re-estimate treatment effects on ITV using the following extension of our basic regression model from Equation (1):

$$y_i = \alpha_0 + \alpha_1^{residual} T_{ji} + \alpha_2 \text{trust} + \delta X_i + \varepsilon_i \quad (3)$$

By accounting for trust in the regression, $\alpha_1^{residual}$ represents the treatment effect on ITV not explained by changes in trust, and $1 - \alpha_1^{residual}/\alpha_1$ (with α_1 from equation (1)) is the share of the

https://www.spiegel.de/politik/deutschland/corona-und-die-afd-zwei-von-drei-ungeimpften-waehlen-rechte-parteien-a-da3157d2-c123-4796-898a-9f6bb35ee918 [accessed 17 December 2021]).

treatment effect on ITV explained by the changes in the observed mediators.[19] The regression results of equation (3) are depicted in columns 2 and 3 in Appendix Table A11. Compared to the basic model that does not account for trust (columns 1 and 3), coefficient estimates of $\alpha_1^{residual}$ are much smaller and insignificant. Concerning the effect of the type of the approval procedure (i.e., the coefficient on *AA-20*) we find that roughly 82% of the treatment effect on intention to vaccinate can be attributed to increased trust in the vaccine. Turning to the treatment effect of decreasing the duration of the *Emergency Use Authorization* from 20 to 5 days (i.e., the coefficient on *EUA-5*), we find that even 97% of the effect on intention to vaccinate is attributable to changes in trust. Thus, while this analysis is inherently descriptive, it suggests that treatment effects on ITV largely operate through altered trust in the vaccine.

5. Discussion and conclusion

We conducted a representative online survey experiment with more than 2,000 adults in Germany to study the effect of type and duration of the COVID-19 vaccine approval procedure on vaccination intentions, trust in the vaccine, and willingness to pay for it. Respondents were randomly assigned to one of four different vignettes that all describe a hypothetical vaccine against COVID-19 but differ in the described vaccine approval procedure in two dimensions: *type* of the approval procedure (*Emergency Use Authorization (EUA)* or *Accelerated Authorization (AA)*) and *duration* of approval (5, 20, or 150 days). We consider the following type-duration combinations *EUA-5*, *EUA-20*, *AA-20*, *AA-150*. The type of approval has large effects on attitudes towards vaccination: keeping approval duration constant at 20 days, the more thorough *Accelerated Authorization* increases vaccination intentions (+13 percentage points), trust (+ 12 percentage points), and willingness to pay (+ 8-9 Euros) compared to *Emergency Use Authorization* (*EUA-20* versus *AA-20*). Increasing *EUA* approval duration from 5 to 20 days increases attitudes towards vaccination, whereas increased duration of *AA* from 20 to 150 days has no significant effects (if anything, they are slightly negative). We provide first causal and representative evidence that the design of the vaccination approval procedure has important effects on peoples' attitudes towards vaccination. Results are confirmed in a series of robustness tests, and hardly differ across subgroups of respondents, which underlines their generality.

Since decisions about vaccine approval procedures are made at the national or supranational level, exogenous variation in actual vaccine approval procedure is lacking. This undermines studying the first-order question how the approval procedure affects vaccination rates. The main virtue of vignette experiments as ours is that it facilitates sidestepping these identification challenges. However, one potential interpretational concern with our vignette experiments is that outcomes are hypothetical, and

[19] See, for instance, Hermes et al. (2021), for a recent application of this approach, and a detailed discussion of the underlying assumptions.

that the experimental variation affects behavior differently from intentions. As with almost all other studies on the determinants of COVID-19 vaccination decisions, the hypothetical nature of our outcome variable warrants some caution in interpreting our results. At the same time, several pieces of evidence suggest the relevance and validity of our outcome measures. First, as reported in Section 4.2, the association between our outcome measures and respondent characteristics closely resembles not only correlation patterns in other surveys on vaccination intentions, but also variation in actual vaccination rates (e.g., by gender, age, or residence). Second, Klüver et al. (2021) report a strong within-person correlation between vaccination intentions against COVID-19 in hypothetical vignettes and actual subsequent vaccination decisions in German adults. Similarly, in Angerer et al. (2022) we show that survey-reported intentions to vaccinate strongly correlate with revealed preferences for COVID-19 vaccination (i.e., acquiring information on how to sign up for a vaccination appointment). Third, Campos-Mercade et al. (2021) show that the reaction towards the experimental variation is similar between intentions and actual behavior. Fourth, more generally, Hainmueller et al. (2015) validate vignette survey experiments by showing that the factors that drive hypothetical choices also predict real-world choices in referenda. Finally, public opinions and preferences elicited in large-scale surveys are in themselves politically relevant, as politicians invest huge resources to assessing public opinions and preferences, and adapt their policy positions accordingly (Blinder & Krueger, 2004; Hager & Hilbig, 2020).

While we show that certain aspects of the vaccine approval procedure strongly affect attitudes towards the COVID-19 vaccination, our results open up several new questions for future research. For instance, what is the tradeoff between sooner availability and lower trust towards the vaccine with respect to public health? How does the availability of a medical treatment or alternative vaccine affect our results? How do our findings for adults in Germany carry over to other countries or subjects (e.g., adolescents and children)? Do our results extend to other combinations of approval duration and type of approval? How do disagreements in vaccination recommendations between national agencies (e.g., the Standing Vaccination Commission in Germany) and the European Medicine Agency (EMA) affect vaccination intentions? How do vaccination approval procedures affect public support for the introduction of universal COVID-19 vaccination obligations? We consider the study of these questions to be very important for the further management of the pandemic.

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Appendix A: Additional Tables and Figures

Table A1: Effects of approval procedure on attitudes towards vaccination (alternative outcomes)

		Trust …				
	ITV	Overall	Effectiveness	Safety	**WTP** me	**WTP** other
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.360***	0.358***	0.342***	0.325***	10.259**	6.838
	-0.085	(0.076)	(0.075)	(0.080)	(4.005)	(4.954)
AA-150	0.266***	0.297***	0.274***	0.234***	3.659	1.661
	-0.085	(0.077)	(0.077)	(0.080)	(3.338)	(4.271)
EUA-5	-0.196**	-0.170**	-0.135*	-0.205**	-2.286	-6.909*
	-0.087	(0.077)	(0.079)	(0.082)	(3.030)	(4.073)
Covariates	yes	yes	yes	yes	yes	yes
EUA-20 Mean[1]	1.931	1.839	2.008	1.763	-3.271	1.939
R^2	0.183	0.195	0.163	0.181	0.075	0.086
Obs.	2030	2030	2029	2030	2025	2026
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - AA-20	-0.062	-0.069	-0.091		-6.600	-5.178

Notes: ***EUA-20*** serves as the baseline. The dependent variables for trust and the intention to vaccinate (ITV) are agreements with statements measured on a 5-point Likert scale (1 "I do not agree at all", 2 "I rather disagree", 3 "Neither", 4 "I rather agree", and 5 "I *fully agree*"). The statements were: **ITV**: "*I would get vaccinated with the vaccine*" (column 1); **Trust Overall**: "*All in all, I trust the vaccine*" (column 2); **Trust Effectiveness**: "*I trust that the vaccine is effective*" (column 3); **Trust Safety**: "*I trust that the vaccine is safe*" (column 4). Additionally, we elicited two willingness to pay (**WTP**) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (column 5) and for someone else (i.e., a person of their choice, column 6) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Table A2: Effects of approval procedure on attitudes towards vaccination (without imputation)

	ITV		Trust		WTP	
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.134***	0.132***	0.117***	0.119***	7.819*	7.634*
	(0.031)	(0.029)	(0.028)	(0.026)	(4.362)	(4.137)
AA-150	0.088***	0.091***	0.093***	0.098***	1.247	2.778
	(0.031)	(0.029)	(0.028)	(0.026)	(3.563)	(3.465)
EUA-5	-0.053*	-0.057*	-0.056*	-0.059**	-4.887	-4.691
	(0.031)	(0.029)	(0.029)	(0.026)	(3.405)	(3.242)
Covariates	no	yes	no	yes	no	yes
EUA-20 Mean[1]	0.650		0.677		34.298	
R^2	0.021	0.167	0.024	0.186	0.005	0.089
Obs.	2030	2011	2029	2010	2024	2006
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - ***AA-20***	-0.046	-0.041	-0.025	-0.021	-6.572	-4.856

Notes: ***EUA-20*** serves as the baseline. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** (column 1 & 2) is the binary variable for the intention to vaccinate. **Trust** (column 3 & 4) is the mean of the three binary trust outcomes. **WTP** (column 5 & 6) is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Table A3: Effects of approval procedure on attitudes towards vaccination (attentive respondents)

	ITV		Trust		WTP	
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.119***	0.128***	0.122***	0.131***	5.851	6.332
	(0.037)	(0.034)	(0.033)	(0.031)	(5.129)	(4.935)
AA-150	0.099***	0.106***	0.119***	0.125***	2.919	4.523
	(0.036)	(0.034)	(0.033)	(0.031)	(4.614)	(4.458)
EUA-5	-0.074**	-0.075**	-0.062*	-0.064**	-9.518**	-9.496***
	(0.036)	(0.034)	(0.033)	(0.031)	(3.753)	(3.645)
Covariates	no	yes	no	yes	no	yes
EUA-20 Mean[1]	0.519		0.557		28.082	
R^2	0.025	0.162	0.031	0.177	0.009	0.106
Obs.	1457		1457		1454	
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - ***AA-20***	-0.020	-0.022	-0.003	-0.006	-2.932	-1.809

Notes: ***EUA-20*** serves as the baseline. For this analysis, only respondents that passed the attention-check were considered. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** (column 1 & 2) is the binary variable for the intention to vaccinate. **Trust** (column 3 & 4), is the mean of the three binary trust outcomes. **WTP** (column 5 & 6) is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people). See Table 1 for a description of these variables. Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Table A4: Effects of approval procedure on attitudes towards vaccination (unvaccinated respondents)

	ITV		**Trust**		**WTP**	
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.137***	0.133***	0.121***	0.120***	8.116*	8.489**
	(0.032)	(0.030)	(0.029)	(0.027)	(4.418)	(4.277)
AA-150	0.086***	0.087***	0.095***	0.097***	2.004	3.685
	(0.033)	(0.031)	(0.030)	(0.028)	(3.528)	(3.428)
EUA-5	-0.056*	-0.066**	-0.056*	-0.066**	-6.664**	-6.389**
	(0.033)	(0.031)	(0.030)	(0.028)	(3.144)	(3.043)
Covariates	no	yes			no	yes
EUA-20 Mean[1]	0.496		0.539		24.689	
R^2	0.022	0.159	0.183	0.183	0.008	0.085
Obs.	1865		1864		1859	
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - ***AA-20***	-0.051	-0.046	-0.026	-0.023	-6.112	-4.804

Notes: ***EUA-20*** serves as the baseline. For this analysis, only respondents who have not yet received a COVID-19 vaccine were considered. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** (column 1 & 2) is the binary variable for the intention to vaccinate. **Trust** (column 3 & 4) is the mean of the three binary trust outcomes. **WTP** (column 5 & 6) is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Table A5: Effects of approval procedure on attitudes towards vaccination (w/o COVID-19 infection)

	ITV		**Trust**		**WTP**	
	(1)	(2)	(3)	(4)	(5)	(6)
AA-20	0.141***	0.128***	0.120***	0.113***	7.392*	7.668*
	(0.032)	(0.030)	(0.029)	(0.027)	(4.471)	(4.308)
AA-150	0.092***	0.086***	0.095***	0.093***	1.108	2.473
	(0.032)	(0.030)	(0.029)	(0.027)	(3.748)	(3.613)
EUA-5	-0.045	-0.057*	-0.054*	-0.062**	-5.482	-5.329
	(0.032)	(0.030)	(0.030)	(0.027)	(3.451)	(3.299)
Covariates	no	yes	yes	yes	no	yes
EUA-20 Mean[1]	0.515		0.559		26.934	
R^2	0.022	0.165	0.024	0.188	0.005	0.087
Obs.	1894		1893		1888	
Post-estimation Wald-Tests: Difference of Coefficient						
AA-150 - ***AA-20***	-0.049	-0.043	-0.025	-0.020	-6.284	-5.195

Notes: ***EUA-20*** serves as the baseline. For this analysis, only respondents who have not already had a COVID-19-infection were considered. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: ITV: "*I would get vaccinated with the vaccine.*"; Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Additionally, we elicited two willingness to pay (WTP) outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated three summary indices: **ITV** (column 1 & 2) is the binary variable for the intention to vaccinate. **Trust** (column 3 & 4) is the mean of the three binary trust outcomes. **WTP** (column 5 & 6) is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

[1] Mean of the outcome variable for the baseline group.

Table A6: Effects of approval procedure on attitudes towards vaccination (Probit regressions)

		Trust …		
	ITV	Overall	Effectiveness	Safety
	(1)	(2)	(3)	(4)
AA-20	0.134***	0.122***	0.122***	0.116***
	(-0.028)	(0.029)	(0.027)	(0.028)
AA-150	0.092***	0.104***	0.098***	0.091***
	(-0.029)	(0.029)	(0.028)	(0.029)
EUA-5	-0.056*	-0.067**	-0.048*	-0.065**
	(-0.029)	(0.029)	(0.029)	(0.029)
Covariates	yes	yes	yes	yes
Obs.	2011	2011	2010	2011
Post-estimation Wald-Tests: Difference of Coefficient				
AA-150 - AA-20	-0.042	-0.017	-0.024	-0.025

Notes: ***EUA-20*** serves as the baseline. Reported coefficients represent average marginal effects. The dependent variables for the intention to vaccinate (ITV) and trust are agreements with statements measured on a 5-point Likert scale (1 "I do not agree at all", 2 "I rather disagree", 3 "Neither", 4 "I rather agree", and 5 "I *fully agree*"). The statements were: **ITV**: "*I would get vaccinated with the vaccine*" (column 1); **Trust Overall**: "*All in all, I trust the vaccine*" (column 2); **Trust Effectiveness**: "*I trust that the vaccine is effective*" (column 3); **Trust Safety**: "*I trust that the vaccine is safe*" (column 4). To run a probit regression, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level

Table A7: How do respondents' characteristics relate to attitudes towards vaccination?

	ITV		Trust		WTP	
Sociodemographic characteristics	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.407***	-0.065***	-0.119***	-0.061***	1.759	3.640
	(0.065)	(0.021)	(0.020)	(0.018)	(2.791)	(2.982)
Age in years	0.012***	0.004***	0.004***	0.004***	-0.205**	-0.111
	(0.002)	(0.001)	(0.001)	(0.001)	(0.096)	(0.102)
Born in Germany	0.232	0.048	0.073	0.048	5.331	4.456
	(0.145)	(0.041)	(0.044)	(0.035)	(5.551)	(5.329)
Living in East Germany	-0.313***	-0.057**	-0.083***	-0.041*	-7.072**	-4.405
	(0.085)	(0.024)	(0.026)	(0.022)	(3.324)	(3.341)
Equivalized household size	-0.080	0.004	-0.016	-0.005	4.495	3.940
	(0.066)	(0.021)	(0.020)	(0.018)	(3.037)	(3.058)
Equ. household income	0.183***	-0.001	0.066***	0.003	13.416***	9.047***
(1,000€)	(0.036)	(0.013)	(0.011)	(0.011)	(1.971)	(2.144)
University degree	0.350***	0.007	0.111***	-0.020	27.212***	9.211
	(0.102)	(0.035)	(0.030)	(0.030)	(6.997)	(7.516)
Univ. entrance qualification	0.321***	0.002	0.110***	0.006	22.049***	8.112**
	(0.066)	(0.023)	(0.020)	(0.020)	(3.234)	(3.345)
Work						
Currently works	-0.121*	-0.038*	-0.010	-0.016	7.697***	-2.474
	(0.068)	(0.022)	(0.021)	(0.019)	(2.716)	(3.053)
Works in health sector	-0.009	-0.066	0.003	-0.029	9.759	0.580
	(0.119)	(0.041)	(0.037)	(0.037)	(6.538)	(7.175)
Works in system-relevant	-0.098	-0.044	-0.016	-0.047*	7.438*	-0.951
job	(0.085)	(0.031)	(0.026)	(0.028)	(4.344)	(4.293)
Political party preferences						
Conservative	-0.038		0.014		1.299	
	(0.070)		(0.021)		(2.907)	
AfD supporter	-0.988***	-0.054	-0.276***	-0.077**	-19.436***	-1.292
	(0.110)	(0.034)	(0.034)	(0.031)	(3.112)	(3.506)
COVID-19 exposure						
Already vaccinated	0.823***	0.222***	0.234***	0.175***	24.187***	15.178**
	(0.095)	(0.036)	(0.029)	(0.034)	(7.162)	(7.186)
Already had COVID-19	-0.137	-0.023	-0.026	-0.002	-2.489	-5.451
	(0.139)	(0.041)	(0.039)	(0.036)	(6.159)	(5.668)
Economic preferences						
Risk-taking	0.103***	0.020***	0.033***	0.017***	1.593***	0.185
	(0.013)	(0.004)	(0.004)	(0.004)	(0.614)	(0.652)
Patience	0.146***	0.017***	0.045***	0.017***	3.848***	2.100***
	(0.013)	(0.004)	(0.004)	(0.004)	(0.510)	(0.547)
Altruism	0.073***	0.001	0.021***	-0.003	1.316**	-0.346
	(0.015)	(0.005)	(0.004)	(0.004)	(0.627)	(0.713)
Trust in people	0.434***	-0.006	0.156***	0.016	9.840***	-0.759
	(0.049)	(0.017)	(0.015)	(0.015)	(2.417)	(2.516)
Trust in government	0.729***	0.126***	0.225***	0.109***	16.774***	7.328**
	(0.037)	(0.015)	(0.011)	(0.013)	(2.162)	(2.947)
Trust in science	0.842***	0.151***	0.259***	0.164***	17.541***	7.870***
	(0.036)	(0.015)	(0.010)	(0.013)	(2.100)	(2.924)

Notes: Uni- (uneven columns), and multivariate (even columns) OLS Regressions reporting associations between our main outcomes variables and various background variables. **Equivalized household size** is a measure of household size using a standard (equivalence) scale, the so-called modified OECD scale. This scale gives a weight of 1 to the first adult in the household, 0.5 to each other person in the household aged 14 years or older, and 0.3 to each child under the age of 14 years and adds them up. **Equivalized household income** corresponds to the reported household income divided by the equalized household size. **University degree** takes on the value one if respondents report having graduated from university. **Currently works** takes on the value 1 if respondents report being employed or self-employed. Additionally, respondents answered whether they work in the **health sector** and/or in a **system relevant job** (e.g., health professions including elder care, public health office, police, and fire brigade). **Political party preference** was elicited asking respondents which party they generally sympathize with. Stating political party preference towards either CDU/CSU, AfD, or FDP is considered as conservative. We elicited whether respondents are **already vaccinated** (i.e., if they already received their first dose of some COVID-19-vaccine). Additionally, we asked whether respondents have **already had COVID-19** using a 4-point Likert scale (1 "*Yes, sure*"; 2 "*Probably Yes*"; 3 "*Probably No*"; 4 "*No, sure*") and transformed it into a binary indicator where *one* corresponds to "*Yes*" and *zero* to "*No*". **Risk-taking, patience,** and **altruism** were measured on 11-point Likert scales (1 "no agreement"; 11 "total agreement") following (Falk et al., 2018). **Trust** was measured using a 4-point Likert scale ranging from "*very high trust*" (1) to "*no trust at all*" (4). Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table A8: Heterogeneous treatment effect for different subgroups on intention to vaccinate (**ITV**)

Respondents Characteristics (**omitted subgroup**)	Treatment effect in the **omitted subgroup**			**Treatment-subgroup Interaction**	**Difference in the treatment effect** between the omitted subgroup and the respective indicated subgroup		
	AA-20 *versus* ***EUA-20*** (1)	***EUA-5*** *versus* ***EUA-20*** (2)	***AA-150*** *versus* ***AA-20*** (3)		***AA-20*** *versus* ***EUA-20*** (4)	***EUA-5*** *versus* ***EUA-20*** (5)	***AA-150*** *versus* ***AA-20*** (6)
Sociodemographic characteristics							
Male	0.158***	-0.031	-0.030	x Female	-0.054	-0.054	-0.022
Age 18 – 46	0.106**	-0.073*	-0.065	x Age above 46	0.051	0.036	0.054
Born in Germany	0.117***	-0.063**	-0.039	x not born in Germany	0.272**	-0.011	0.110
Living in the east of Germany	0.145***	-0.079**	-0.042	x Not living in the east of Germany	-0.078	0.104	0.018
Equivalized household size ≤ 1.5	0.162***	-0.041	-0.040	x Equ. household size > 1.5	-0.085	-0.047	-0.006
Equ. household income (≤ 1,580€)	0.162***	0.009	-0.065	x Equ. household income (> 1,580€)	-0.063	-0.135**	0.050
University degree: No	0.129***	-0.065**	-0.035	x University degree	0.023	0.062	-0.055
Univ. entrance qualification: No	0.112***	-0.056	-0.030	x Univ. entrance qualification	0.049	-0.005	-0.028
Work							
Currently works	0.124***	-0.087**	-0.033	x Currently does not work	0.017	0.073	-0.017
Works in health sector	0.124***	-0.061**	-0.028	x Works not in health sector	0.116	0.033	-0.183
Works in system-relevant job	0.129***	-0.041	-0.014	x Works not in system-relevant job	0.022	-0.103	-0.161**
Political party preferences							
Not Conservative	0.146***	-0.047	-0.057	x Conservative	-0.044	-0.034	0.046
No AfD supporter	0.122***	-0.054*	-0.030	x AfD supporter	0.099	-0.006	-0.112
Economic Preferences							
Low altruism§	0.138***	-0.040	-0.036	x High altruism	-0.021	-0.061	-0.013
Low risk-taking§	0.140***	-0.057	-0.046	x High risk-taking	-0.020	-0.002	0.012
Low patience§	0.123***	-0.044	-0.024	x High patience	0.023	-0.029	-0.045
Low trust in other people§	0.130***	-0.065	-0.053	x High trust in other people	-0.084	-0.084	0.043
Low trust government§	0.147***	-0.027	-0.048	x High trust in government	-0.026	-0.028	-0.014
Low trust science§	0.128***	-0.053	-0.035	x High trust in science	-0.020	-0.002	0.012

Notes: ***EUA-20*** serves as the baseline. Each row represents a separate OLS regression that includes dummy variables for the experimental treatments and their interaction terms with the subgroup indicator. The dependent variable is the stated intention to vaccinate (**ITV**). Respondents answered the statement "*I would get vaccinated with the vaccine.*" on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). For the sake of interpretation, we transformed the outcome into a binary variable, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). If subgroups are defined via median-split, the underlying variable(s) used to define subgroups are excluded from the list of covariates for the interacted regressions. Missing values of covariates are imputed. All regressions include imputation dummies. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

§ Subgroups are defined via median split.

Table A9: Heterogeneous treatment effect for different subgroups on **trust**

Respondents Characteristics (**omitted subgroup**)	Treatment effect in the **omitted subgroup**			**Treatment-subgroup Interaction**	**Difference in the treatment effect** between the omitted subgroup and the respective indicated subgroup		
	AA-20 *versus* ***EUA-20*** (1)	***EUA-5*** *versus* ***EUA-20*** (2)	***AA-150*** *versus* ***AA-20*** (3)		***AA-20*** *versus* ***EUA-20*** (4)	***EUA-5*** *versus* ***EUA-20*** (5)	***AA-150*** *versus* ***AA-20*** (6)
Sociodemographic characteristics							
Male	0.128***	-0.024	-0.018	x Female	-0.020	-0.075	-0.008
Age 18 – 46	0.101***	-0.087**	-0.057	x Age above 46	0.034	0.058	0.073
Born in Germany	0.105***	-0.062**	-0.018	x not born in Germany	0.245**	0.039	-0.056
Living in the east of Germany	0.121***	-0.075**	-0.035	x Not living in the east of Germany	-0.018	0.070	0.066
Equivalized household size ≤ 1.5	0.141***	-0.035	-0.008	x Equ. household size > 1.5	-0.064	-0.076	-0.047
Equ. household income (≤ 1,580€)	0.155***	-0.030	-0.064*	x Equ. household income (> 1,580€)	-0.078	-0.061	0.089*
University degree: No	0.115***	-0.076***	-0.017	x University degree	0.024	0.135*	-0.053
Univ. entrance qualification: No	0.092***	-0.064*	-0.006	x Univ. entrance qualification	0.064	0.006	-0.040
Work							
Currently works	0.105***	-0.088**	-0.017	x Currently does not work	0.032	0.067	-0.032
Works in health sector	0.111***	-0.060**	-0.018	x Works not in health sector	0.107	-0.037	-0.086
Works in system-relevant job	0.116***	-0.047	-0.006	x Works not in system-relevant job	0.016	-0.083	-0.095
Political party preferences							
Not Conservative	0.125***	-0.053	-0.037	x Conservative	-0.020	-0.026	0.044
No AfD supporter	0.111***	-0.056**	-0.023	x AfD supporter	0.073	-0.015	0.014
Economic Preferences							
Low altruism§	0.124***	-0.054*	-0.021	x High altruism	-0.020	-0.027	-0.002
Low risk-taking§	0.118***	-0.073**	-0.031	x High risk-taking	-0.003	0.025	0.019
Low patience§	0.094***	-0.076**	-0.016	x High patience	0.062	0.045	-0.016
Low trust in other people§	0.136***	-0.068*	-0.021	x High trust in other people	-0.039	0.014	-0.007
Low trust government§	0.138***	-0.038	-0.025	x High trust in government	-0.098**	-0.053	0.027
Low trust science§	0.105***	-0.070**	-0.009	x High trust in science	0.031	0.055	-0.054

Notes: ***EUA-20*** serves as the baseline. Each row represents a separate OLS regression that includes dummy variables for the experimental treatments and their interaction terms with the subgroup indicator. The dependent variable is our summary index for **trust**. Respondents were asked various statements measured on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). The statements were: Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". For the sake of interpretation, we transformed these variables into binary variables, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. We calculated the summary index for trust as the mean of the three binary trust outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). If subgroups are defined via median-split, the underlying variable(s) used to define subgroups are excluded from the list of covariates for the interacted regressions. Missing values of covariates are imputed. All regressions include imputation dummies. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

§ Subgroups are defined via median split.

Table A10: Heterogeneous treatment effect for different subgroups on willingness to pay (**WTP**)

Respondents Characteristics (**omitted subgroup**)	Treatment effect in the **omitted subgroup**			**Treatment-subgroup Interaction**	**Difference in the treatment effect** between the omitted subgroup and the respective indicated subgroup		
	AA-20 *versus* ***EUA-20*** (1)	***EUA-5*** *versus* ***EUA-20*** (2)	***AA-150*** *versus* ***AA-20*** (3)		***AA-20*** *versus* ***EUA-20*** (4)	***EUA-5*** *versus* ***EUA-20*** (5)	***AA-150*** *versus* ***AA-20*** (6)
Sociodemographic characteristics							
Male	9.310*	-0.126	-8.816*	x Female	-1.425	-9.088	5.852
Age 18 – 46	8.483	-4.097	-9.910	x Age above 46	-0.039	-1.780	7.582
Born in Germany	9.225**	-4.125	-7.119	x not born in Germany	-12.274	-8.393	22.854
Living in the east of Germany	11.401**	-4.156	-7.577	x Not living in the east of Germany	-16.326	-2.982	9.742
Equivalized household size ≤ 1.5	11.320**	-3.224	-7.609	x Equ. household size > 1.5	-8.341	-4.303	4.196
Equ. household income ($\leq$ 1,580€)	3.260	-3.306	-0.686	x Equ. household income (> 1,580€)	8.743	-3.135	-9.546
University degree: No	5.656	-5.131	-3.466	x University degree	29.281	5.823	-24.329
Univ. entrance qualification: No	6.396*	-0.516	-3.155	x Univ. entrance qualification	5.425	-10.319	-6.910
Work							
Currently works	6.333	-4.685	-3.977	x Currently does not work	5.633	0.154	-5.633
Works in health sector	7.029*	-3.386	-3.622	x Works not in health sector	29.984	-16.432	-38.095
Works in system-relevant job	6.184	-3.401	-1.435	x Works not in system-relevant job	16.331	-7.048	-27.679*
Political party preferences							
Not Conservative	15.099***	0.619	-6.729	x Conservative	-18.657**	-15.139**	1.968
No AfD supporter	10.158**	-4.060	-6.355	x AfD supporter	-17.368*	-5.354	4.532
Economic Preferences							
Low altruism§	8.716	-8.951**	-13.284**	x High altruism	-0.756	13.808*	22.730**
Low risk-taking§	7.917	-6.942*	-2.090	x High risk-taking	1.388	4.991	-7.782
Low patience§	3.574	-5.158	-4.510	x High patience	13.280	2.044	-3.671
Low trust in other people§	9.237	-9.195**	-11.499**	x High trust in other people	-1.585	10.313	12.667
Low trust government§	7.499*	-6.656**	-4.692	x High trust in government	2.238	11.157	-3.244
Low trust science§	6.517*	-5.047*	-5.012	x High trust in science	6.645	3.374	-2.551

Notes: ***EUA-20*** serves as the baseline. Each row represents a separate OLS regression that includes dummy variables for the experimental treatments and their interaction terms with the subgroup indicator. The dependent variable is the stated willingness to pay (**WTP**). We elicited two WTP-outcomes: we asked respondents how much they would be willing to pay at most for the vaccination if they received the vaccination themselves (WTP me) and for someone else (i.e., a person of their choice, WTP other) the next day. Prior to the analysis, stated WTPs were winsorized at the 99-percentile to reduce the effect of outliers. We calculated a summary index (**WTP**), which is the mean of the two WTP-outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). If subgroups are defined via median-split, the underlying variable(s) used to define subgroups are excluded from the list of covariates for the interacted regressions. Missing values of covariates are imputed. All regressions include imputation dummies. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

§ Subgroups are defined via median split.

Table A11: Treatment effect on the intention to vaccinate: Accounting for trust as a mediator.

	Intention to Vaccinate (**ITV**)			
	(1)	(2)	(3)	(4)
AA-20	0.134***	0.024	0.131***	0.023
	(0.031)	(0.017)	(0.029)	(0.017)
AA-150	0.088***	0.000	0.090***	0.002
	(0.031)	(0.016)	(0.029)	(0.016)
EUA-5	-0.053*	-0.001	-0.058**	-0.002
	(0.031)	(0.017)	(0.029)	(0.017)
Trust		0.935***		0.916***
		(0.010)		(0.013)
Covariates	no	no	yes	yes
R^2	0.021	0.723	0.169	0.728
Obs.	2,030		2,029	
Post-estimation Wald-Tests: Difference of Coefficient				
AA-150 - AA-20	-0.046	-0.024	0.028	0.016

Notes: ***EUA-20*** serves as the baseline. The dependent variable is the stated intention to vaccinate (**ITV**). Respondents answered the statement "*I would get vaccinated with the vaccine.*" on a 5-point Likert scale (1 "*I do not agree at all*", 2 "*I rather disagree*", 3 "*Neither*", 4 "*I rather agree*", and 5 "*I fully agree*"). For the sake of interpretation, we transformed the outcome into a binary variable, coded as *one* if the respondent agreed with the statement (4 & 5) and *zero* otherwise. The mediator is our summary index for **trust**. Respondents were asked various statements, again measured on a 5-point Likert scale, transformed into binary variables. The statements were: Trust Overall: "*All in all, I trust the vaccine.*"; Trust Effectiveness: "*I trust that the vaccine is effective.*"; Trust Safety: "*I trust that the vaccine is safe.*". We calculated the summary index for trust as the mean of the three binary trust outcomes. Randomized experimental treatment (vignettes): ***AA-20***: *Accelerated Authorization* – 20 days; ***AA-150***: *Accelerated Authorization* – 150 days; ***EUA-5*** *Emergency Use Authorization* – 5 days; ***EUA-20*** *Emergency Use Authorization* – 20 days. ***Covariates*** include gender (female), age, whether respondents are born in Germany, and if they are living in the East of Germany, equivalized household income, whether respondents have a university degree, and if they have a university entrance qualification, whether respondents currently work, whether they work in a "system-relevant" job and/or in the health-sector, their political party preferences (conservative), whether respondents are already vaccinated against COVID-19, or have had COVID-19 already, economic preferences (risk taking, patience, altruism, and trust in other people), and whether they were attentive (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. Robust standard errors in parenthesis. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Appendix B: Survey (translated from German)

To begin with, a few questions about yourself.

[s01] I am ...

- o female
- o male
- o diverse

[s02] When were you born?

Month ____ *MM*

Year ____ *JJJJ*

[s03] What is your highest general education degree?

- o No general school leaving certificate
- o Elementary school certificate
- o Secondary school certificate
- o Advanced technical college certificate
- o High school diploma
- o I am currently a student

[s04] What professional training degree do you have?

Please tick all that apply.

- o I do not have professional training and am not in professional training.
- o I have completed professional-in-company training (apprenticeship) or professional-school training (professional school, commercial school).
- o I have completed training at a technical school, master craftsman school, technical school, professional- or technical academy.
- o I have a polytechnic degree (e.g., diploma, bachelor, master).
- o I have a university degree (e.g., diploma, state examination, bachelor, master).
- o I have another professional degree.
- o I am still in professional training (trainee, apprentice, professional-/ commercial school).
- o I am a student.

[s05] In which state do you live?

[Dropdown with federal states]

[Introduction]

With this survey, we would like to learn more about the attitude of the population in Germany towards COVID-19 vaccination. In addition to questions on the topic of vaccination, we would like to ask you further questions about yourself towards the end of the questionnaire. If you do not wish to answer a question, please simply skip the corresponding questions. Answering the questionnaire will take about **10** minutes. Of course, the survey is anonymous and your answers will be treated with absolute confidentiality. The anonymized data set with the answers of all respondents will be made available to the scientific community after the survey for research purposes only. By clicking "Continue" below, you agree to this provision. No conclusions about your person can be drawn from the data.

We are simply interested in your spontaneous assessments and opinions. Your payoff is independent of your answers. Therefore, please always provide an answer if possible, even if you are a little unsure. The "Next" button will take you to the next question.

Thank you for your participation!

[Survey Start]

[q01] It sometimes happens that survey participants do not read individual questions accurately. To ensure that you read the questions accurately, we ask you to ignore the following question and enter the number twenty-two in the text box.

The federal states are responsible for organizing vaccination against Corona. In how many states do you estimate that primary care physicians are already providing vaccination nationwide?

In _____ of the total of 16 federal states

[Experimental Variation]

***EUA-20*(*5*)**:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a new so-called "**emergency use authorization**" of **20 (5) days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An emergency use authorization is characterized by the fact that the benefit in the

sense of efficacy does not have to be proven. In comparison to a "standard authorization procedure", the presumed benefit must be compared to the known risks.

***AA-20*(*150*)**:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a so-called "**accelerated authorization**" of **20 (150) days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An accelerated authorization is characterized by the fact that assessment processes are already carried out in parallel with the development of the vaccine (i.e., even before the manufacturer submits an application). Compared to a "standard approval procedure", there are no quality differences in the examination of the efficacy and safety of the vaccine.

To what extent do you agree with the following statement in relation **to the situation just described**?

	I fully agree	I rather agree	I rather disagree	I fully disagree	Neither
[q02] "All in all, I trust the vaccine."	○	○	○	○	○
[q03] "I trust that the vaccine is safe."	○	○	○	○	○
[q04] "I trust that the vaccine is effective."	○	○	○	○	○
[q05] "I would get vaccinated with the vaccine."	○	○	○	○	○

[q06] Now it's a question of how much the vaccine described above would be worth to you: What is the most you would be willing to pay to be vaccinated with the vaccine tomorrow?

(State the most you would pay out of your own pocket if the vaccine were available for you to purchase. Please indicate "0" euros if you do not want to be vaccinated with this vaccine. If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated.)

____ Euro

[q07] And what is the most you would be willing to pay to have a person of your choice (not you) vaccinated with the vaccine tomorrow?

(State the maximum amount you would pay out of your own pocket if the vaccine were available for you to purchase. Please indicate "0" euro if you do not want a person of your choice to be vaccinated with this vaccine.)

____ Euro

[q08] How do you rate yourself personally? Are you generally a risk-taker or do you try to avoid taking risks?

Please tick a box on the scale, where the value 0 means "not at all willing to take risks" and the value 10 means "very willing to take risks". You can use the values in between to grade your assessment.

Not at all risky										Very risky
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

[q09] Are you someone who is generally willing to give up something today in order to benefit from it in the future, or are you not willing to do so?

Please tick a box on the scale, where a value of 0 means "not at all willing" and a value of 10 means "very willing". You can use the values in between to grade your assessment.

Not at all										Very
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

[q10] Are you someone who is generally willing to share with others without expecting anything in return, or are you unwilling to do so?

Please tick a box on the scale, where a value of 0 means "not at all willing" and a value of 10 means "very willing". You can use the values in between to grade your assessment.

Not at all										Very
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

How much trust do you have...

	Very high trust	High trust	Little trust	No trust at all
[q11] … in other people?	○	○	○	○
[q12] … in the government?	○	○	○	○
[q13] … in science?	○	○	○	○

[q14] Do you have a profession in the health sector? (e.g., nurse, doctor, pharmacist)

- o Yes
- o No

[q14f] What is your profession?[20]

[q15] Do you practice a profession in a so-called system-relevant profession? (e.g., in a health profession incl. care of the elderly, at the public health department, at the police or fire department)

- o Yes
- o No

[q16] Have you already been vaccinated against COVID-19?

- o Yes, I have received at least one dose
- o No

[q17] Have you already been infected with COVID-19?

- o Yes, for sure
- o Yes, I think so
- o No, I don't think so
- o No, definitely not

[s06] Were you born in Germany?

- o Yes
- o No

[s07] Many people in Germany tend to vote for a particular political party in the long term, even if they occasionally vote for another party. Which party do you generally sympathize with?

- o CDU or CSU
- o SPD
- o AfD
- o FDP
- o Die Linke
- o Bündnis90/Die Gruenen
- o Another party, namely _____
- o None

[20] This question only appeared for people who responded that they have a profession in the health sector.

[s08] What is the best way to describe your acquisition situation?

- o Pupil, trainee, student
- o Full-time employed (incl. short-time work)
- o Part-time employed (incl. short-time work)
- o Self-employed
- o Unemployed
- o Househusband/housewife
- o In retirement, pension or early retirement
- o Other employment situation, namely _____

[s09] How many people currently live with you in a household - including yourself

___ adults (18 years and older)

___ children (under 18)

[s10] What is the total monthly net income of your household?

This means the sum resulting from wages, salary, income from self-employment, pension or retirement pension, in each case after deduction of taxes and social security contributions. Please also include income from public assistance, income from renting, leasing, housing allowance, child benefit, and other income.

- o below 400 Euro
- o 400 until below 500 Euro
- o 500 until below 750 Euro
- o 750 until below 1.000 Euro
- o 1.000 until below 1.250 Euro
- o 1.250 until below 1.500 Euro
- o 1.500 until below 1.750 Euro
- o 1.750 until below 2.000 Euro
- o 2.000 until below 2.250 Euro
- o 2.250 until below 2.500 Euro
- o 2.500 until below 2.750 Euro
- o 2.750 until below 3.000 Euro
- o 3.000 until below 3.250 Euro
- o 3.250 until below 3.500 Euro
- o 3.500 until below 3.750 Euro
- o 3.750 until below 4.000 Euro
- o 4.000 until below 5.000 Euro
- o 5.000 Euro and more

[s11] What is the postal code of your place of residence?

[q18] If you have any comments, criticisms or suggestions for improvement regarding the survey, please use this text field.

[Final Screen]

You have now reached the end of our survey.

THANK YOU FOR YOUR PARTICIPATION!

Finally, we would now like to give you some brief information about the survey in which you have just participated.

The aim of the survey is to find out how high the willingness to vaccinate is in the general population in Germany. In addition, we are investigating whether the duration and type of approval for a vaccine against COVID-19 has an influence on the trust in the vaccine and the willingness to pay for the vaccine.

Although there can, of course, be several important reasons that influence confidence in a vaccine, in this survey, we focused on the duration of approval and the type of approval granted by the European Medicines Agency (EMA).

We, therefore, formed four randomly selected groups in the survey. The first randomly selected group was presented with a hypothetical vaccine with an accelerated approval process of 150 days, the second group was presented with a hypothetical vaccine with an accelerated approval process of 20 days, the third group was presented with a hypothetical vaccine with an emergency approval process of 20 days, and the fourth group was presented with a hypothetical vaccine with an emergency approval process of 5 days.

Here, we compare whether the approval duration and procedure have an impact on confidence and willingness to pay.

Public willingness to vaccinate is a critical factor in the fight against the COVID-19 pandemic. Whether you get vaccinated is your personal decision. This decision may depend on many factors beyond those highlighted in this survey. If you would like even more information about COVID-19 vaccination, here is a list of frequently asked questions and answers from the Robert Koch Institute: *https://www.rki.de/SharedDocs/FAQ/COVID-Impfen/gesamt.html*

Appendix C: Experimental vignettes (translated from German)

Vignette 1: EUA-5:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a new so-called "**emergency use authorization**" of **5 days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An emergency use authorization is characterized by the fact that the benefit in the sense of efficacy does not have to be proven. In comparison to a "standard authorization procedure", the presumed benefit must be compared to the known risks.

Vignette 2: EUA-20:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a new so-called "**emergency use authorization**" of **20 days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An emergency use authorization is characterized by the fact that the benefit in the sense of efficacy does not have to be proven. In comparison to a "standard authorization procedure", the presumed benefit must be compared to the known risks.

Vignette 3: AA-20:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a so-called "**accelerated authorization**" of **20 days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An accelerated authorization is characterized by the fact that assessment processes are already carried out in parallel with the development of the vaccine (i.e., even before the manufacturer submits

an application). Compared to a "standard approval procedure", there are no quality differences in the examination of the efficacy and safety of the vaccine.

Vignette 4: AA-150:

Please imagine the following hypothetical situation:

Assume that a new vaccine against COVID-19 has been developed and tested in Germany. The vaccine is based on a novel mRNA technology and has an efficacy of 90%. One vaccine dose is needed for vaccination protection. The vaccine received authorization from the European Medicines Agency (EMA) and the European Commission after a so-called "**accelerated authorization**" of **150 days** (from the date of the manufacturer's application). The authorization is valid for all countries of the European Union. An accelerated authorization is characterized by the fact that assessment processes are already carried out in parallel with the development of the vaccine (i.e., even before the manufacturer submits an application). Compared to a "standard approval procedure", there are no quality differences in the examination of the efficacy and safety of the vaccine.