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Abstract

Public trust in government is a critical determinant of compliance with policies during crises such as economic downturns and pandemics. The reverse causal relationship—that implementing effective policies can enhance trust in government—has also attracted interest, but remains under-explored and empirically untested. The current paper addresses this gap by examining the causal link from policy implementation to trust, using the COVID-19 vaccination roll-out as a case study. Leveraging a regression discontinuity design (RDD) based on Japan's vaccination prioritization for individuals aged 65 and older, along with a novel panel survey conducted before the policy's implementation, we identify the causal effect of vaccination on public trust. Our estimations suggest that while the vaccination did not alter trust in the central government responsible for policy design, it significantly increased trust in local governments tasked with policy execution. Notably, this effect was more pronounced among women, a demographic whose mental health was disproportionately affected during the pandemic. Further analysis indicates that this increase in trust was driven by the tangible benefits of having received a vaccine rather than anticipations stemming from policy design and initiation. Our findings highlight the potential for governments to build public trust through effective, well-executed policies, thereby providing an incentive for ensuring policy completion.

Keywords: Policy implementation, Political trust, Central and local government, COVID-19 vaccination, Natural experiment
JEL: I12, H40, C21, C90

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1. Introduction

In times of crisis, such as the Great Depression and the COVID-19 pandemic, citizens face significant economic and health threats, leading to heightened uncertainty and increased anxiety. Prolonged crises can erode public trust in government, especially when its response is perceived as inadequate (Ervasti et al., 2019; Lee, 2009; Miller and Listhaug, 1999). Trust in government, however, plays a crucial role in ensuring compliance with policies and regulations, creating a positive feedback loop between trust and policy adherence (Algan and Cahuc, 2013; Knack and Keefer, 1997). Conversely, distrust in government responses can trigger a vicious cycle of distrust and non-compliance (Blair et al., 2017), highlighting the importance of managing public trust during crises.

The COVID-19 pandemic has made public trust in government a pivotal factor in overcoming the crisis. Several studies have shown that countries with higher levels of pre-existing trust experienced lower mortality rates (Elgar et al., 2020; Oksanen et al., 2020) and greater compliance with infection control measures such as lockdowns, social distancing, and vaccination efforts (Barrios et al., 2021; Brodeur et al., 2021; Devine et al., 2024; Jelnov and Jelnov, 2022). Additionally, trust appears to enhance the effectiveness of such policies, as demonstrated by the increased impact of lockdown measures in countries with higher trust levels (Bargain and Aminjonov, 2020). However, there remains a critical gap in the literature: while much attention has been paid to how trust influences policy compliance, there is limited empirical evidence on the reverse causal relationship—whether implementing effective policies can build trust in government.

A few studies have focused on the 2020 lockdowns as exceptional cases to explore the causal effect of policies on public trust (Bol et al., 2021; Oude Groeniger et al., 2021). However, there are two key concerns with using lockdown policies to verify the causality from policy implementation to trust. The first concern is that lockdowns may have long-term negative impacts on both the economy and mental health, as they restrict services in both public and private sectors and limit individual behavior. In other words, the restrictive nature of lockdown policies might not necessarily enhance trust. Indeed, lockdowns have led to issues such as social isolation, shortages of goods, declines in employment rates, and worsened mental health, particularly among populations with lower socioeconomic status (Altindag et al., 2022; Adams-Prassl et al., 2022; Banks et al., 2021; Blundell et al., 2022; Brodeur et al., 2021). Even non-mandatory measures, such as Japan's stay-home advisory, had adverse effects on mental health (Yamamoto et al., 2020).

The second concern is the challenge of distinguishing the actual effects of policy from the "rally-round-the-flag" phenomenon. This phenomenon refers to a temporary surge in public support for the government during crises, regardless of the effectiveness of its policies (Mueller, 1970; Kritzinger et al., 2021; van der Meer et al., 2023). In fact, evidence suggests that the increase in trust due to lockdowns was merely a short-lived effect, which gradually diminished over time (Davies et al., 2021; Weinberg, 2022). Furthermore, Schraff (2021) empirically demonstrates that the results reported by Bol et al. (2021) may suffer from violations of the exclusion restriction due to pre-lockdown trends, concluding that the observed increase in trust was driven by the rally effect rather than the lockdown policy itself. Similarly, in most countries, including Japan, trust in the government declined by 2021 (OECD, 2022, 2023), despite the initial high levels observed in 2020 when the rally-round-the-flag effect was stronger.

In contrast to the limitations of lockdown policies, this study focuses on the COVID-19 vaccination policies as a means of examining the impact on public trust. Vaccination was prioritized as a key exit strategy from the pandemic, helping to mitigate behavioral restrictions and stabilize society. Unlike lockdowns, vaccination policies are more likely to reduce economics and health threats, making them more likely to restore public trust. Additionally, the rollout of vaccination began in late 2020, nearly a year after the initial outbreak, providing a distinct advantage for causal identification as it occurred beyond the peak of the rally-round-the-flag effect. In this study, we reveal the causal link from the vaccination policy to public trust in the government, extracting treatment effects of the policy and thereby receiving the vaccine. We use a regression discontinuity design (RDD) with a policy-based threshold and unique panel survey data collected before the start of the vaccination in Japan.

Our analysis offers two distinctive aspects that significantly enhance both the academic and policy implications of this study. First, we differentiate between trust in the central government and trust in the local government (hereafter referred to as central government trust and local government trust, respectively). Typically, the public sector operates within a vertical structure, where different levels of government fulfill distinct roles: the central government serves as the policymaker, while local governments are responsible for policy administration. This vertical structure was adopted by most countries for their COVID-19 vaccination strategies. Such a division of responsibilities may confer specific advantages, as highlighted in the literature on fiscal federalism. Oates (1999) argues that the practice of "learning-by-doing" at the local government level can yield public benefits. Learning-by-doing refers to local governments improving their effectiveness through hands-on experience, allowing for better adaptation to local backgrounds. Another advantage of this vertical structure is its potential for more efficient resource allocation, facilitated by improved preference matching between governments and citizens. Consequently, focusing solely on central government trust may introduce a downward bias in evaluating the overall effectiveness of public policies. These features provide a strong rationale for analyzing trust outcomes separately for central and local governments. While previous empirical research has examined the relationship between the vertical structure of governance and public trust in non-crisis contexts, our study extends this literature by empirically demonstrating this causal relationship through a natural experiment during a public health crisis.

Second, we investigate the underlying mechanisms that increase government trust by focusing on the tangible benefits provided by the vaccination policy. We begin by analyzing its impact on mental health. During the prolonged pandemic, deteriorating mental health became a significant concern, particularly among women (Banks et al., 2021; Choi et al., 2020; O'Connor et al., 2021; Sibley et al., 2020). Improved mental health has been shown to correlate with increased government trust and greater compliance with infection control measures (Bernardi and Gotlib, 2023; Taylor, 2022). Thus, receiving the vaccine could enhance mental health in addition to its medical and epidemiological benefits. To further clarify this mechanism, we conduct a mediation analysis that explores the pathway between the priority vaccination policy, the action of receiving a vaccine, and the resulting trust. This approach enables us to disentangle whether the observed increase in trust is primarily driven by the tangible benefits of vaccination itself, or by the anticipation and commitments associated with policy design and initiation. By distinguishing these effects, we provide deeper insights into how vaccination policies can build public trust beyond their immediate health impacts.

To the best of our knowledge, no prior study has empirically examined the causal impact of vaccination policies on government trust. The primary challenge lies in designing a study that can accurately identify causal effects. In most countries, vaccinations were not mandatory or were only partially mandated for specific groups, such as healthcare professionals (Cameron-Blake et al., 2023). This led to self-selection bias, where vaccination uptake was driven by individuals' willingness to receive the vaccine. The ideal solution to address this bias would be to conduct a randomized controlled trial (RCT) with enforced compliance. However, due to ethical concerns, it is not feasible to randomly assign individuals to vaccination or restrict access to those who wish to be vaccinated, nor to force vaccination upon those who are unwilling.

There exist several studies in the medical context that have utilized natural experiment methods to identify the causal effects of vaccination on reducing COVID-19 infections (Bermingham et al., 2021; Greene et al., 2022; Kennedy-Shaffer, 2024; Mukherjee et al., 2022). None have explored the impact of vaccination policies on public trust in government, although a few studies have analyzed trust-related variables. Takahashi et al. (2022) examines Japan's priority vaccination policy for the elderly using an age-based regression discontinuity design (RDD), similar to our approach. They find that receiving a vaccine improved public evaluations of local government performance in areas like vaccination rollout and infection prevention efforts (e.g., "Vaccinations are progressing well in your municipality" and "Your municipality has adequate COVID-19 prevention measures"). Agrawal et al. (2021) focuses on the varying eligibility age for priority vaccination across U.S. regions and use an instrumental variables approach, showing that vaccination reduced anxiety and depressive symptoms (measured using the PHQ scale) by about 30%.[1] Unlike these previous studies, we combine measurements of trust in both the central and local governments, as assessed according to the World Values Survey's question format, with mental health measured using the K6 scale, into a single, integrated dataset. We incorporate several improvements to the empirical strategies used in previous studies, explore the mechanisms in detail, and thus add more direct and in-depth insights to this emerging field of research.

The main findings of this study are as follows. The priority vaccination policy led to an increase in trust in local governments, which were responsible for administering the vac-

[1] There are other studies that have examined the mental health benefits of vaccination. For instance, Koltai et al. (2022) employs a difference-in-differences method to demonstrate that vaccination improved mental health by approximately 25% with a particularly significant effect among Indigenous populations. Chaudhuri and Howley (2022) uses a matching method and find that the mental health benefits of COVID-19 vaccination were more pronounced among the elderly and those with high-risk conditions. Additionally, Yamamura et al. (2023) reports a positive correlation between vaccination and improved mental health among Japanese women.

cination, while it had no significant effect on trust in the central government. Given the substantial impact of the pandemic on women's mental health, we conducted gender-specific analyses, revealing that both local government trust and mental health improved among women. Mediation analysis further indicates that the observed increase in trust was driven by the tangible benefits of having received a vaccine rather than anticipations stemming from policy design and initiation. We discuss that these results highlight the potential for governments to build public trust through effective, well-executed policies, thereby providing an incentive for ensuring policy completion.

The structure of this paper is as follows: Section 2 provides an overview of Japan's vaccination policy and the research design. In Section 3, we apply a fuzzy regression discontinuity design to examine the impact of the vaccination policy on trust, with a focus on its relationship to gender and mental health. Section 4 explores the pathways through which trust increases, specifically analyzing the effects of policy anticipation. Section 5 discusses the results, and Section 6 concludes with a discussion of the policy implications.

2. Research Design

This study employs a Fuzzy Regression Discontinuity Design, leveraging the characteristics of Japan's COVID-19 vaccination policy, which prioritizes individuals aged 65 years and older. This section begins with an overview of Japan's vaccination policy, highlighting its similarities and differences with those of other countries. We then describe the identification strategy based on Japan's unique institutional features, followed by details on the survey methodology, data summary, and estimation methods.

2.1. Japan's Vaccination Policy

Japan's priority vaccination policy for COVID-19 shared several features with other countries: (1) the central government was responsible for policy design and formulation, while local governments handled implementation; (2) essential workers and the elderly were prioritized; and (3) vaccinations were provided free of charge (see international comparison of vaccination policy (van Kessel et al. (2023); Mathieu et al. (2021)). However, Japan's approach included unique institutional characteristics, making it particularly suitable for a natural experiment using a Fuzzy RDD. These features include a consistent, well-scheduled vaccination rollout, clear eligibility criteria, and non-incentive, non-mandatory vaccination policy. The following sections elaborate on the specific features of Japan's vaccination policy that support the research design.

Different Roles of Central and Local Governments:

In Japan, the central and local governments played distinct roles in the execution of the vaccination policy. The central government was responsible for procuring vaccines from international suppliers, formulating distribution plans, and overseeing nationwide distribution. In contrast, local governments handled on-the-ground implementation, including dispatching vaccination vouchers, securing healthcare workers, and organizing vaccination sites. A noteworthy aspect of Japan's policy was that while local governments could facilitate the execution of the central government's plan, they were not permitted to make significant alterations. This centralized approach ensured uniformity in vaccination coverage, unlike in countries such as the United States, where state-level variations in vaccine policies led to considerable differences in vaccination rates (Bollyky et al., 2023).[2] In Japan, the strong alignment between central and local governments reduced discrepancies, thereby enabling a more consistent implementation of the priority vaccination policy.

Vaccination Voucher System:

A unique feature of Japan's vaccination policy was its use of a vaccination voucher system, which enabled the implementation of a centralized and uniform vaccination process. Unlike in other countries where vaccination eligibility was confirmed primarily through ID checks, Japan required vaccination vouchers issued by local governments in addition to IDs. These vouchers were distributed according to a schedule set by the central government, ensuring a controlled and phased rollout based on priority eligibility. Notably, no vaccine appointments could be made without a voucher. This system ensured a clear discontinuity in vaccination coverage between eligible and non-eligible groups for the priority vaccination, which is essential for implementing a Fuzzy RDD.

While other countries, such as the United States, also implemented priority vaccination policies, these were less consistent due to state-level variations. For example, states differed in their age criteria for vaccine eligibility and other qualifying conditions. As a result, one month after the start of the vaccination campaign, nearly 70% of vaccinated individuals in the U.S. were under the age of 65. In contrast, Japan maintained stricter age-based criteria; by the end of June 2021—over two months after the campaign began—only 13% of vaccinated individuals were under 65 (excluding healthcare workers). This consistency in Japan's policy created a clearer threshold for evaluating the causal impact of vaccination on public trust using a Fuzzy RDD.

Eligibility for Priority Vaccination:

The Japanese government defined its priority vaccination coverage as follows: first, healthcare workers; second, individuals aged 65 years and older; and third, non-elderly individuals with underlying medical conditions and workers in elderly care facilities. This prioritization was strictly enforced using the previously mentioned vaccination voucher system.

Notably, Japan took a unique approach by defining eligibility based on the Japanese fiscal year rather than the birth date, which is more commonly used in other countries. Specifically, those who would turn 65 years of age or older within fiscal year 2021 (i.e., by April 1, 2022) were eligible for priority vaccination. Throughout this paper, the term '65 years and older' refers to eligibility based on the fiscal year. We utilize this unique eligibility as a threshold in our identification strategy in Section 2.2.

[2] In the United States, these variations may have been driven by citizen political preferences. This situation poses a potential issue: even with lower vaccination rates, trust in state governments among those opposing vaccination might remain relatively high.

Vaccination Policy Stringency:

In 2021, some US states and European countries not only made vaccination free but also incentivized with financial rewards (Kuznetsova et al., 2022; National Governors Association, 2021). In such cases, it cannot be said that only the priority vaccination policy influenced the government trust. This is because financial rewards may increase the government trust due to reciprocity, while mandatory vaccination against one's will could lead to resistance against the government. In contrast, the Japanese government adopted a policy of recommending vaccination without making it mandatory, leaving the decision to vaccinate up to the individual. This approach allows us to observe the impact of vaccination on the government trust in a more unbiased manner.

Implementation Schedule:

Finally, we explain the details of the vaccination plan and schedule. The central government prioritized vaccinations for the elderly, excluding healthcare workers, due to their higher risk of COVID-19 severity and death. Specifically, the policy allowed those aged 65 and older as of April 1, 2022, to receive vaccinations earlier than those who were not. This priority vaccination began on April 12, 2021. To implement this prioritization, the central government instructed local governments to mail vaccination vouchers to those aged 65 and older around mid-March 2021, and to those under 65 after April 2021 (Ministry of Health, Labour and Welfare, 2024). While there were slight variations in the mailing dates among local governments, the prioritization was largely consistent across the country. For example, Toyonaka City in Osaka Prefecture sent out vaccination vouchers on March 29, 2021, to those aged 65 and older, while vouchers for those under 65 were dispatched after June 21, 2021 (Toyonaka City, 2021).

This unique and structured approach led to a clear discontinuity in vaccination rates between those aged 65 and older and those under 65. By the end of June 2021, according to official statistics (Digital Agency Vaccine Record System (VRS), accessed October 30, 2022), the first-dose vaccination rate for those aged 65 and older reached 68% (approximately 24.39 million doses administered), whereas it remained below 5% (approximately 3.5 million doses administered) for individuals under 65. This distinct difference in vaccination rates creates a natural threshold, which we utilize in Section 2.2 to introduce a Fuzzy Regression Discontinuity Design (RDD) as our identification method.

2.2. Fuzzy RDD Identification strategy

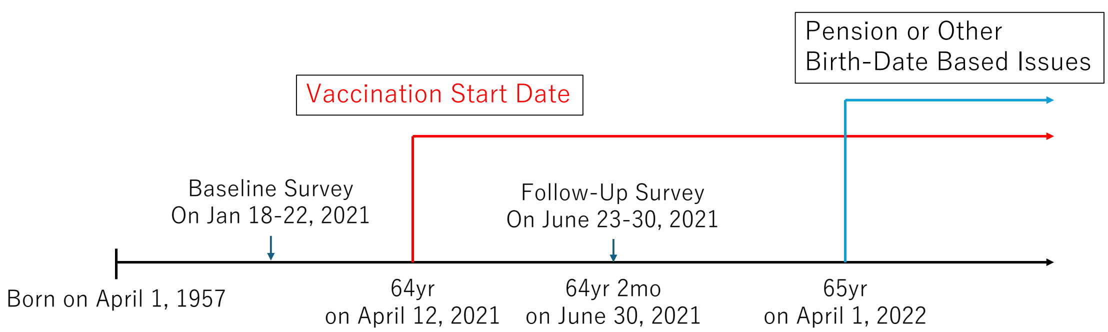
In this study, we leverage the discontinuity in vaccination rates around the eligibility cutoff to estimate the causal effect of vaccination on the government trust. Given that the decision to receive the vaccine was left to individuals, non-compliance was observed: some eligible individuals chose not to be vaccinated.[3] To consider this condition, we apply a fuzzy

[3]There was also some degree of non-compliance among individuals under 65 years of age. As mentioned in Section 2.1, individuals with chronic conditions were permitted to receive the vaccination relatively early. Additionally, in municipalities where vaccinations for the prioritized groups had been completed, others outside these groups were allowed to apply for vaccination with vouchers. However, this issue is minor,

regression discontinuity design (RDD) with age-in-days as a running variable and estimate the intervention effect among compliers. This approach is analogous to instrumental variable methods (Cattaneo and Titiunik, 2022) and is particularly suited for dealing with partial compliance in observational data.

A fuzzy RDD must satisfy two key conditions: exclusion restriction and non-manipulation. The exclusion restriction implies that the age threshold of the priority policy affects the government trust only through receiving a vaccination, with no other pathways. The non-manipulation condition means that individuals cannot precisely manipulate their age-by-date based on the threshold, ensuring that assignment around the threshold is sufficiently random.

First, we verify the exclusion restriction. As shown in Figure 1, Japan's vaccination policy did not overlap with other policies around the priority eligibility threshold. For example, policies related to pension eligibility or retirement allowances are based on age as determined by birth date, whereas the priority vaccination eligibility was based on Japan's fiscal year age starting from April 1. This distinction ensures that the threshold in age affects government trust only through vaccination.[4]



Note: The figure shows when people who were born on the cutoff date (i.e., on or before April 1, 1957) become eligible for the vaccination priority policy and other issues. Although they became eligible for vaccination priority in June 2021, they were not eligible for pensions or other benefits based on birth date (As shown in the figure, they are 64 years and 2 months old, which is less than 65. We use this notation in our figures to indicate that individuals around the threshold are independent of policies based on birth date). Therefore, these individuals are only eligible for the priority policy during the period between April 12, 2021, and April 1, 2022. This ensures the exclusion restriction. As we focus on trust in June, the priority policy affects on only people born after July 1956.

Figure 1: Eligibility Timeline for Priority Vaccination

Second, we examine the non-manipulation condition, which clearly holds in this context since individuals cannot alter their age. To confirm this assumption, we conduct a McCrary

as such individuals constitute less than 3% of our analysis sample. To ensure robustness, we conducted a sensitivity analysis by excluding these individuals, and the results remained consistent.

[4]There is a possibility that even if individuals have not yet received the vaccination, the mere commitment to a priority vaccination policy might increase government trust due to the anticipation that they will soon be able to receive the vaccine. If such an anticipation effect is present, it would imply that the exclusion restriction is not satisfied. In Section 4.1, we empirically check whether there is an increase in trust purely due to this anticipation effect.

density test, as shown in Figure A.7. The test results confirm that there is no evidence of manipulation around the eligibility cutoff, supporting the validity of our fuzzy RDD approach.

2.3. Survey Data

We conducted online panel surveys across five periods, commissioned through MyVoice Communications, Inc., to construct the analysis dataset for the fuzzy RDD. During the COVID-19 pandemic, researchers widely employed online surveys,[5] primarily due to social distancing measures encouraged by the government to prevent the spread of infection. Large-scale face-to-face or mail surveys became challenging under these conditions. Online surveys, by contrast, offered the advantage of rapid deployment, enabling timely data collection in response to the rapidly changing context of vaccination policy details and schedules. As such, online surveys were both feasible and efficient in this setting. While online surveys are often criticized for concerns about representativeness and response accuracy, in this study, we took maximum measures to address these issues, such as careful respondent allocation and conducting multiple follow-up surveys.

The initial baseline survey was conducted from January 18 to 22, 2021, targeting 6,266 residents aged 60 to 74 in Japan. Notably, the Japanese government officially finalized the priority vaccination policy for individuals aged 65 and older on January 25, 2021, following our initial survey. The priority vaccinations began on April 12, 2021. To ensure representativeness, respondents were allocated based on gender, five-year age groups, and ten regional divisions (Hokkaido, Tohoku, Northern Kanto, Southern Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, and Kyushu/Okinawa) in line with the Basic Resident Register, a Japan's official population census.

Subsequently, a total of four follow-up surveys were conducted (May 21–27, June 23–30, July 21–28, and August 27–September 5, 2021) to ascertain the timing of participants' vaccinations, along with other relevant details. We recorded the vaccination dates separately for the first and second doses. In this study, we specifically focus on the vaccination status in June, as this is when the difference in first-dose vaccination rates is most pronounced around the 65-year age threshold. By concentrating on whether the first dose was administered, we aim to extract a clearer intervention effect. In contrast to other studies on COVID-19 vaccination, which primarily focus on whether participants received the second dose, our approach addresses a common limitation in existing data. The emphasis on the second dose in prior research is likely due to the short interval (approximately three weeks) between doses, which often results in individuals who had already received the first dose being included in the untreated group. By employing multiple follow-up surveys over a short period, our study design allows for a more precise comparison between individuals who received the first dose and those who did not. Hereafter, when we refer to "vaccination," we specifically denote the first dose as identified in the June survey.

[5] A back-of-the-envelope search on ScienceDirect.com revealed that from 2016 to 2019, there were 102,635 publications containing the keyword "online survey." From 2020 to 2023, this number increased to 151,028, representing an increase of approximately 50,000 publications. Notably, 36,984 of these publications included the keyword "COVID-19," accounting for around 76% of the increase (as of April 26, 2024).

A total of 4,019 respondents completed all surveys and the completion rate was 64.1%. To maintain representativeness, we ensured that the proportions of gender, age, and regional distribution in our sample matched the administrative data for each follow-up survey (See Table A.8). Thus, any attrition from the baseline survey did not compromise the representativeness of our sample.

Conducting multiple follow-up surveys also reduced the risk of measurement errors regarding vaccination dates. By surveying respondents at regular intervals, we could measure trust and mental health metrics relatively close to the timing of vaccination. For instance, a single follow-up survey conducted in September 2021 would have been prone to recall bias for respondents vaccinated in June. Additionally, using trust variables measured in September would have obscured the impact of vaccinations administered in June due to the time lag. By employing multiple follow-ups, we proactively mitigated these concerns.

As a result of these efforts, our survey data closely reflect real-world trends. Figure A.8 compares vaccination rates from official statistics for individuals aged 65 and older with those in our survey data for the priority vaccination groups. Although the official statistics include individuals aged 75 and older, the trends in vaccination rates for those aged 65 and above are largely consistent between the two data sources. To further verify the accuracy of self-reported vaccination dates, we cross-referenced these with official vaccination records for respondents who consented to participate. The self-reported dates matched the official records for 89.7% of respondents (see Appendix B). Even among mismatched responses, the average discrepancy was only 2.25 days (standard deviation of 7.28 days), indicating a high level of accuracy. Based on these findings, we conclude that the vaccination date data obtained from our follow-up surveys are sufficiently accurate for analysis.

2.4. Estimation Model and Variables

We describe the variables and the estimation model used in our analysis. Drawing from related research, we incorporate several enhancements to our estimation model and variable definitions. First, we measured the government trust according to the World Values Survey question format and use this as the main outcome variable. Additionally, we measure trust separately for the central and local governments. This distinction is aligned with Japan's political system, where the central government primarily handled the planning of the vaccination policy, while the local governments were responsible for its implementation. It is generally acknowledged that trust in central and local governments can differ, and during the COVID-19 pandemic, trust in local governments tended to increase relative to trust in the central government (OECD, 2023). Second, to assess mental health, we use the Kessler Psychological Distress Scale (K6) as a secondary outcome variable. Third, leveraging our panel survey data, we conduct first-difference regression discontinuity (FD-RD) estimation (Lemieux and Milligan, 2008) to analyze changes in outcome variables before and after vaccination, while controlling for individual characteristics.

For the main analysis, we employ a fuzzy RDD estimation using two-stage regressions. Most of our analysis relies on data collected at two points: the baseline survey conducted in January 2021 and the follow-up survey in June 2021. The first-stage regression is specified with vaccination as the dependent variable and age-in-days as the running variable.

Table 1: Description of Key Variables

Treatment Variable: $Vaccine_i$	
Receiving a Vaccination	Whether the respondent received the first dose of the COVID-19 vaccine (binary variable)
Running Variable: d_i	
Age-in-days	The number of days from the threshold date of April 1, 1957 (set to 0).
Covariate Variables: X_i	
Cumulative Vaccine Supply	Cumulative vaccine supply per capita in the respondent's prefecture of residence
State of emergency	whether a state of emergency or semi-emergency measures were in effect in the respondent's prefecture of residence
Ease of making a reservation	In the last follow-up survey (August-September 2021), we asked respondents who had been vaccinated, "How easy was it to make a reservation for vaccination in your municipality?" They rated it on a scale was from 1 ("Very difficult") to 5 ("Very easy"). To objectively measure it, we are using the municipal average.
Outcome Variables: Y_i	
Change in the government trust (Main Outcome)	We asked respondents, "To what extent do you trust the following organizations and institutions?" They rated the central and local government trust on a scale from 1 ("Not at all") to 5 ("Very much"). We take the difference between the responses from January 2021 (before vaccination started) and June 2021.
Change in anxiety or depression (Secondary Outcome)	A binary variable indicating whether the respondent had anxiety or depressive symptoms (K6 score of 5 or higher) (Sakurai et al., 2011). We take the difference between the responses from January 2021 and June 2021.

$$\text{First stage:} \quad Vaccine_i = \alpha_1 + \beta_1 \mathbb{I}\{d_i \geq 0\} + f_{1L}(d_i < 0) + f_{1R}(d_i > 0) + X_i + \epsilon_i \tag{1}$$

where i denotes the individual respondent. $Vaccine_i$ is a binary variable indicating whether the respondent received the first dose of vaccination. d_i is the running variable, defined as the number of days from the cutoff date of April 1, 1957. TIf the running variable is 0 or above, it means individuals are 65 years old or older as of April 1, 2022. Additionally, since using discrete running variable,such as age-in-years or age-in-months, is problematic in RD estimation (Lee and Card, 2008), we use age-in-days as much more continuous running variable. $\mathbb{I}\{d_i \geq 0\}$ is an indicator function that takes the value 1 if the respondent is eligible for priority policy. $f_{1L}(d_i < 0)$ and $f_{1R}(d_i > 0)$ are functions representing the relationship between d_i and vaccination on the left and right sides of the cutoff, respectively. X_i represents covariates that capture the local vaccination environment and infection status in the respondent's area, which cannot be fully captured by a single difference. Specifically, it includes the cumulative vaccine supply per capita in the respondent's prefecture, whether a state of emergency or quasi-emergency measures were in effect, and the ease of making vaccination reservations. The details of these variables are listed in Table 1.

The second-stage regression is specified as a reduced form regression to estimate the impact of vaccination on the outcome variable:

$$\text{Second stage:} \quad Y_i = \alpha_2 + \beta_2 \widehat{Vaccine}_i + f_{2L}(d_i < 0) + f_{2R}(d_i > 0) + X_i + \epsilon_i \tag{2}$$

where the primary outcome variable Y_i includes the central government trust and the local government trust, measured in a manner consistent with the format of the World Values Survey. We asked the respondents to rate their trust in these institutions on a five-point scale from 1 ("None at all") to 5 ("A great deal"). The secondary outcome variable is mental health, measured using the K6 scale, which assesses anxiety and depressive symptoms with six items scored from 0 to 4, totaling 24 points. A binary variable indicating anxiety and depressive symptoms (K6 $\geq$ 5) is used based on the threshold suggested by Sakurai et al. (2011).

In our analysis, the main outcome variable Y_i is the first difference of the trust variable, measured before and after the priority policy. Taking the difference allows us to control for individual heterogeneity, allowing us to capture the effect of receiving vaccination on changes in the government trust. This is a strength of using panel data, which is absent in related research. For instance, Agrawal et al. (2021) points out that their cross-sectional analysis is limited because it does not account for changes in mental health within individuals over time or control for individual fixed effects.

We use non-parametric local polynomial regressions as proposed by Calonico et al. (2014, 2017). In general, low-order polynomials are recommended Gelman and Imbens (2019),[6]

[6] Gelman and Imbens (2019) argues that high-order polynomials in RD have three major problems: noisy estimates, sensitivity to the degree of the polynomial, and poor coverage of confidence intervals.

and we follow this guideline by using linear regressions. We also use robust bias-corrected confidence intervals suggested by Calonico et al. (2014, 2017). Standard errors are clustered at the prefecture level to account for serial correlation in the error terms within prefectures. We apply a triangular kernel function to give more weight to data near the cutoff. The bandwidth is set to three years on either side of the cutoff.

When selecting the bandwidth, there is a trade-off between bias and variance (Iizuka and Shigeoka, 2022; Lee and Lemieux, 2010): a wider bandwidth includes more observations, leading to more precise estimates, but it may also introduce bias by incorporating observations farther from the threshold. To address this, we confirm the estimates using three data-driven bandwidths, as shown in Table A.10. Since the results remained robust across these bandwidths, we set the bandwidth at three years from the threshold. This bandwidth is close to the mean value of the three bandwidth. Using a uniform bandwidth to allow comparisons across the same sample for different outcomes and sub-samples, we ensure consistent interpretation even with a small sample size.

2.5. Validity of the Regression Discontinuity Design

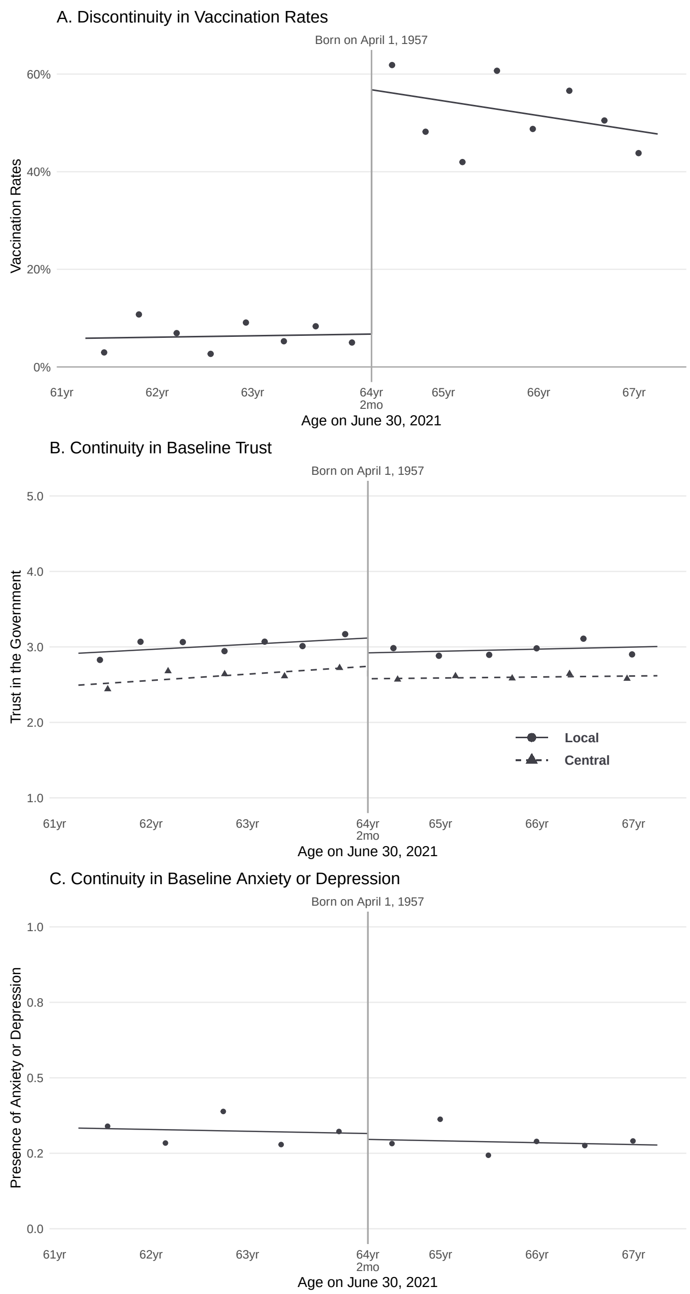
This section confirms the validity of employing a fuzzy RDD with our survey data. First, we examine the discontinuity in vaccination rates at the eligibility threshold. Second, we conduct balance tests to confirm the continuity of outcome variables and covariates in the baseline survey near the threshold.[7]

First, the follow-up survey conducted in June 2021 reveals a vaccination rate of over 52% among those eligible for the priority vaccination policy, compared to only 6% among those who were not eligible, indicating a significant discontinuity. Panel A of Figure 2 visualizes the first-stage regression results, confirming a substantial discontinuity at the threshold.

Second, we verify the continuity of outcome variables and covariates at baseline. Since the priority vaccination program began in April 2021, there should be no discontinuity in the baseline survey conducted in January 2021.[8] As a preliminary step for the balance test and to verify continuity around the threshold, we present descriptive statistics (Table 2). In addition to overall descriptive statistics, we include a summary for the analytical sample restricted to respondents born within three years before and after the priority vaccination policy threshold (i.e., from April 1, 1954, to April 1, 1960). This subset includes 1,567 respondents, with 834 eligible for priority vaccination and 733 not eligible. The outcome variables, taken from the baseline survey conducted before the start of the priority vaccination program, show minimal differences between the eligible and non-eligible groups. This lack of variation is visually confirmed in Panels B and C of Figure 2, which indicate minimal age-related differences in trust and mental health prior to the rollout of priority vaccinations.

[7]One of the key identification conditions for a regression discontinuity design is the "continuity of conditional regression functions." This implies that the potential outcome variables should be continuous near the threshold, suggesting that in the absence of policy intervention, there should be no differences in outcomes at the threshold.

[8]The Japanese central government began discussing the vaccination policy in December 2020. However, as we have confirmed, the specific eligibility threshold for the priority vaccination policy was finalized and



Note: In this figure, we confirm whether our RDD satisfies conditions. Panel A represents discontinuity of treatment, i.e. the vaccination policy. Around the threshold, we can find that there is a discontinuity of first dose vaccination rates in June survey. Panel C and D show continuity of our outcomes measured before the start of the vaccination policy. We measure the government trust on a 5-point scale. We measure symptoms of anxiety or depression using the K6 scale, which we convert into a dummy variable. This dummy variable takes the value of 1 if the K6 score exceeds 5 points, indicating the presence of anxiety or depression. The curves present linear regression. We calculate the bandwidth using the mean squared error (MSE).

Figure 2: RDD Condition Checks

Table 2: Descriptive Statistics

	All		Non-eligible		Eligible	
Variables	Mean	SD	Mean	SD	Mean	SD
Vaccination rates:						
June	0.46	0.50	0.06	0.24	0.52	0.50
August (the Last Survey)	0.86	0.35	0.75	0.43	0.87	0.34
Socio-economic characteristics:						
Female	0.53	0.50	0.52	0.50	0.52	0.50
College Graduate	0.45	0.50	0.50	0.50	0.50	0.50
Employed	0.36	0.48	0.56	0.50	0.42	0.49
Income (million yen)	5.07	3.33	5.50	3.72	5.20	3.39
Assets (million yen)	22.86	23.14	21.87	23.54	23.91	24.32
Outcome variables:						
Local Government Trust	3.00	0.87	3.01	0.89	2.97	0.86
Central Government Trust	2.61	1.02	2.61	1.01	2.60	1.00
Symptoms of Anxiety or Depression	0.27	0.44	0.33	0.47	0.29	0.45
Observations	4,019		733		834	

Note: "Non-eligibele" includes respondents who were born within three years after the priority vaccination policy threshold (from April 2, 1957, to April 1, 1960). "Eligible" includes respondents who were born within three years before the priority vaccination policy threshold (from April 1, 1954, to April 1, 1957). The vaccination rates were calculated from surveys conducted in June and August. Other variables are from the baseline survey in January. Annual income represents the total household income in the year before the survey, and assets represent the balance of financial assets at the time of the survey. For responses of "don't know" or "don't want to answer," the median value was substituted.

We perform balance tests on pre-intervention covariates (Cattaneo and Titiunik, 2022) by substituting the dependent variable Y in the regression model specified in Section 2.4 with each of the covariates. As shown in Table A.9, row (a), there are no statistically significant differences in socioeconomic attributes between those eligible and not eligible for the priority policy, except for household income.[9] To assess whether this difference is due to chance, we conduct a sensitivity analysis using the donut hole RD approach(Barreca et al., 2011). The results, presented in Table A.9, row (b), indicate no significant differences in income within the donut hole RD analysis, confirming that the observed discontinuity in income is not robust.

announced on 25 January, 2021, after our baseline survey(Ministry of Health, Labour and Welfare, 2024).

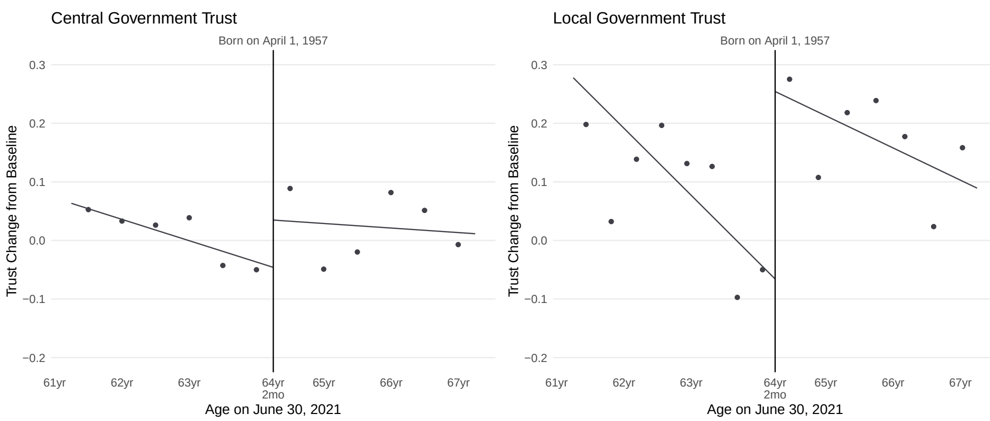
[9] A potential reason for the observed income difference could be that individuals near the threshold received severance payments or pensions earlier, which may have contributed to an increase in income. Including income as a covariate in our model does not significantly alter the results for trust and mental health.

3. Main Analysis

In this section, we present the estimation results of the impact of COVID-19 vaccination on the government trust. Section 3.1 shows the estimation results of the impact on the central and local government trust. Section 3.2 discusses the heterogeneity of the impact by gender. In this section 3.3, we conduct robustness checks via donut hole RD and placebo test.

3.1. Impact of Vaccination Policy on the Government Trust

Figure 3 illustrates the relationship between priority eligibility for vaccination policy and changes in the central and local government trust from January to June 2021. Graphs for RDD are useful for visually understanding the discontinuity around the threshold (Cattaneo and Titiunik, 2022). The left graph shows no significant difference in the central government trust around the threshold. In contrast, the right graph shows that there is a discontinuity at the eligibility threshold, with the local government trust increasing among those who are eligible for priority vaccination.



Note: The vertical axis represents the change in central and local government trust, measured on a 5-point scale, between January 2021 and June 2021, before and after the start of the vaccination campaign. The estimate reported inside the figure is a sharp-RD estimate. We calculate the bandwidth using the mean squared error (MSE). The curve represents a local linear regression with a triangular kernel function. There is not a discontinuity around the threshold for central government trust, which is responsible for policy making. On the other hand, we can find a discontinuity in local government trust, which implemented the policy, with an increase in trust among those prioritized for vaccination.

Figure 3: Discontinuity of the Government Trust by Priority Eligibility

Table 3 presents the RD estimation results. Panel A shows the effects of the priority policy on vaccination, indicating a raise of 55.5 percentage points in the vaccination rate for the eligible group. Panel B shows the ITT effects of the priority policy on the government trust. There is no significant effect on the central government trust in column (1); however, we observe a 0.399 point increase in the local government in column (2). Panel B results correspond to the size of the jumps near the threshold shown in Figure 3.[10] Panel C, using a

[10]The values of Panel B in Table 3 and Figure 3 are slight different because robust bias-corrected estimator is reported in Table 3.

fuzzy RDD, shows the LATE effects of vaccination under the priority policy on the government trust. There is also no significant effect on the central government trust. In contrast, column (2) indicates a 0.727 point increase in the local government trust at the 5% significance level. This represents a 24.3% increase based on the baseline average trust score of 2.99. The results suggest that the prompt receipt of the vaccine, due to being coincidentally selected for priority vaccination, increased the local government trust, which was responsible for the administration and implementation of the vaccination policy. However, there was no change in trust towards the central government, which was responsible for policy making. These results remain robust, even when we include second-dose vaccination or underlying health conditions as covariates.

Table 3: Impacts of Priority Vaccination Policy on the Government Trust

	(1)	(2)
	A. First Stage Regression From Priority Policy to Vaccination	
RD Estimate	0.555***	0.555***
	(0.084)	(0.084)
Observations	1567	1567
	B. Sharp Regression Discontinuity From Priority Policy to:	
	Central Government Trust	Local Government Trust
RD Estimate	0.110	0.399***
	(0.171)	(0.129)
Observations	1567	1567
	C. Fuzzy Regression Discontinuity From Vaccination under Priority Policy to:	
	Central Government Trust	Local Government Trust
RD Estimate (LATE)	0.202	0.727***
	(0.338)	(0.266)
Observations	1567	1567

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Panel A shows effects of priority policy on the vaccination in the eligible group. Panel B shows ITT effects of priority policy on the government trust. Panel B results correspond to the size of the jumps near the threshold in Figure 3. Panel C shows the LATE effects of vaccination under the priority policy on the government trust by a fuzzy RDD. Panel C's estimates are almost equals to the ratio of Panel B and Panel A. This approach is similar to IV methods. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.

3.2. Gender Heterogeneity

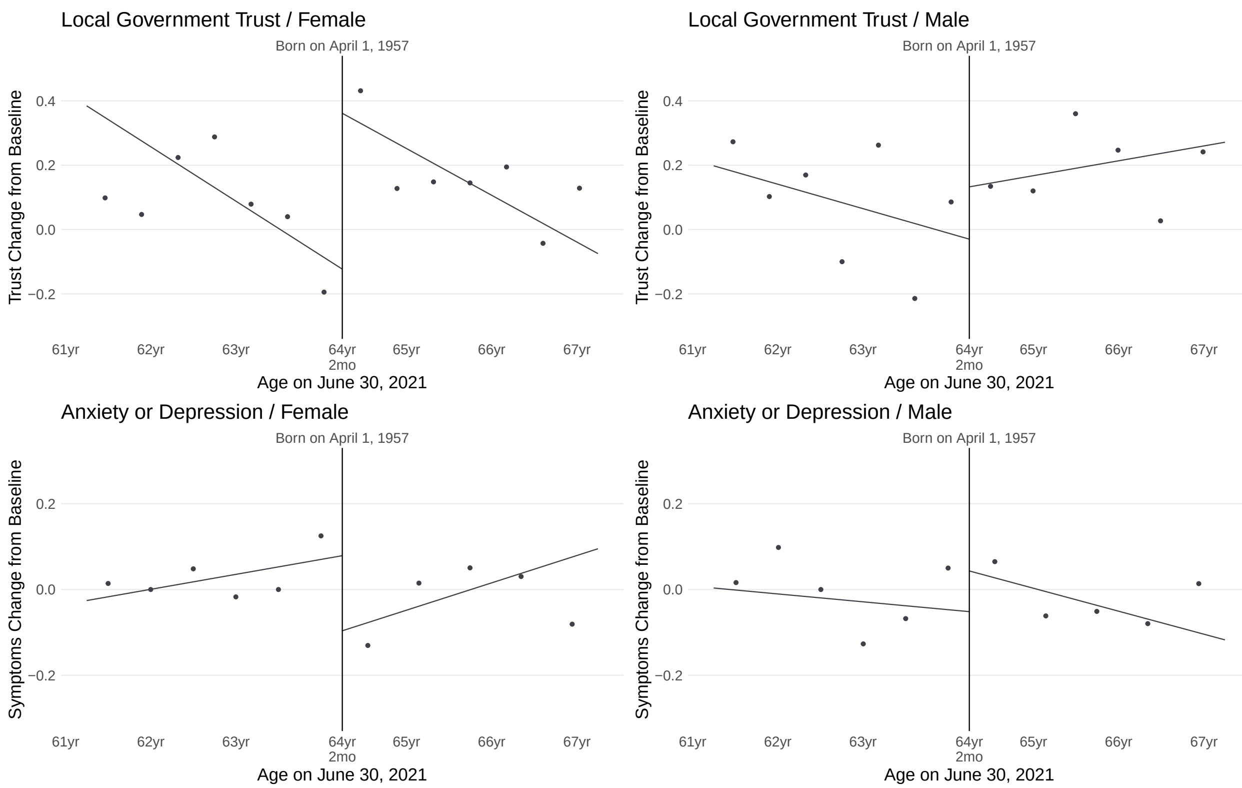
In this section, to better understand the mechanism how vaccination influences the local government trust, we conduct an analysis of gender heterogeneity. It is well known that the pandemic especially worsened women's mental health. The increase in the local government trust due to the prompt receipt of vaccination may be more pronounced among those who were more negatively affected by the pandemic. Receiving the vaccination, as part of the pandemic exit strategy, likely contributes to improving mental health through the anticipation of well-being and the pandemic's end. Additionally, the implementation of such positively impactful vaccinations could lead to higher evaluations of the relevant institutions. Therefore, we examine whether the increase in the local government trust is particularly strong among women and whether vaccination has improved women's mental health as one of the policy benefits.

Figure 4 illustrates the relationship between priority eligibility for vaccination and changes in the local government trust and mental health from January to June 2021. The discontinuity around the threshold is more pronounced for women than for men.

Table 4 presents the RD estimation results difference between female and male. Panel A shows the effects of the priority policy on vaccination, indicating a raise of vaccination rate 49.8% points for female and 61.4% points for male respectively. As same as Table 3, panel B shows ITT effects of vaccination policy and panel C shows LATE of vaccination under priority policy. Columns (1) and (2) show the impact on the local government trust . Column (1) in panel C indicates that vaccination under priority policy increased the local government trust among women by 1.609 points ($p < 0.10.01$), which is more than twice the overall average effect 0.727 points found in Section 3.1. In contrast, column (2) shows no significant impact among men. This suggests that the increase in the local government trust due to vaccination occurred predominantly among women.

Columns (3) and (4) present the estimation results for mental health. These also suggest that the impact of vaccination among women. We use the difference between the baseline survey and the follow-up survey for a binary variable that takes the value 1 if anxiety or depressive symptoms are present. Thus, the outcome variable takes the value -1 if "anxiety or depressive symptoms improved" over the two points in time, 0 if "no change" occurred, and +1 if "symptoms worsened." From column (3), it can be seen that receiving the vaccination decreased women's anxiety and depressive symptoms by 0.683 points ($p < 0.10.01$), indicating an improvement in mental health. In contrast, similar to the local government trust, the effect size for men is 0.100, which is small and not statistically significant. Our analysis shows that the improvement in mental health occurs exclusively among women. This finding also holds when we adjust the cutoff of K6 from 5 to other values (Table A.11).

These results suggest that women, whose mental health has worsened during the COVID-19 pandemic, experienced an increase in the local government trust and a decrease in anxiety and depressive symptoms due to receiving the vaccination promptly as a result of being prioritized for vaccination.



Note: The vertical axis of the top figure represents the difference in the local government trust, measured on a 5-point scale, between January 2021 and June 2021, before and after the start of the vaccination campaign. We can find a larger discontinuity around the threshold for women on the left side of the figure, indicating an increase in trust among those prioritized for vaccination. The vertical axis of the bottom figure represents the difference in the K6 score between January 2021 and June 2021, with scores of 5 or above classified as indicating anxiety and depressive symptoms (Sakurai et al., 2011). On the left side, we find the discontinuity around the threshold for women. This indicates a decrease in anxiety and depressive symptoms among those prioritized for vaccination. We calculate the bandwidth using the mean squared error (MSE). The curve represents a local linear regression with a triangular kernel function.

Figure 4: Gender Heterogeneity of the Policy Impacts

Table 4: Gender Heterogeneity in Priority Vaccination Policy Impacts

	(1) Female	(2) Male	(3) Female	(4) Male
	A. First Stage Regression From Priority Policy to Vaccination			
RD Estimate	0.498***	0.614***	0.498***	0.614***
	(0.091)	(0.096)	(0.091)	(0.096)
Observations	815	752	815	752
	B. Sharp Regression Discontinuity From Priority Policy to:			
	Local Government Trust		Symptoms of Anxiety or Depression	
RD Estimate	0.790***	0.050	-0.334***	0.067
	(0.202)	(0.182)	(0.093)	(0.104)
Observations	815	752	815	752
	C. Fuzzy Regression Discontinuity From Vaccination under Priority Policy to:			
	Local Government Trust		Symptoms of Anxiety or Depression	
RD Estimate	1.609***	0.049	-0.683***	0.100
(LATE)	(0.448)	(0.343)	(0.209)	(0.191)
Observations	815	752	815	752

Note: *p < 0.1, **p < 0.05, ***p < 0.01. Panel A shows effects of priority policy on the vaccination in the eligible group. Panel B shows ITT effects of priority policy on the government trust. Panel B results correspond to the size of the jumps near the threshold in Figure 4. Panel C shows the LATE effects of vaccination under the priority policy on the government trust by a fuzzy RDD. Panel C's estimates are almost equals to the ratio of Panel B and Panel A. This approach is similar to IV methods. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.

3.3. Donut Hole RD and Placebo Tests

Here, we show robustness checks of the estimation results obtained above. First, We perform donut hole RD to confirm that outliers do not influence the results.

If the RDD estimation results are sensitive to observations near the threshold, they cannot be robust (Barreca et al., 2011). Therefore, we conduct donut hole RD (Barreca et al., 2011), excluding samples within 30 days before and after the threshold, to verify the robustness of the results concerning the local government trust and mental health. Additionally, this procedure has the advantage of excluding the relative age effect (Bedard and Dhuey, 2006; Yamaguchi et al., 2023), as we use April 1 as the threshold raises concerns about this effect.

Table 5: Robustness checks with donut hole RD

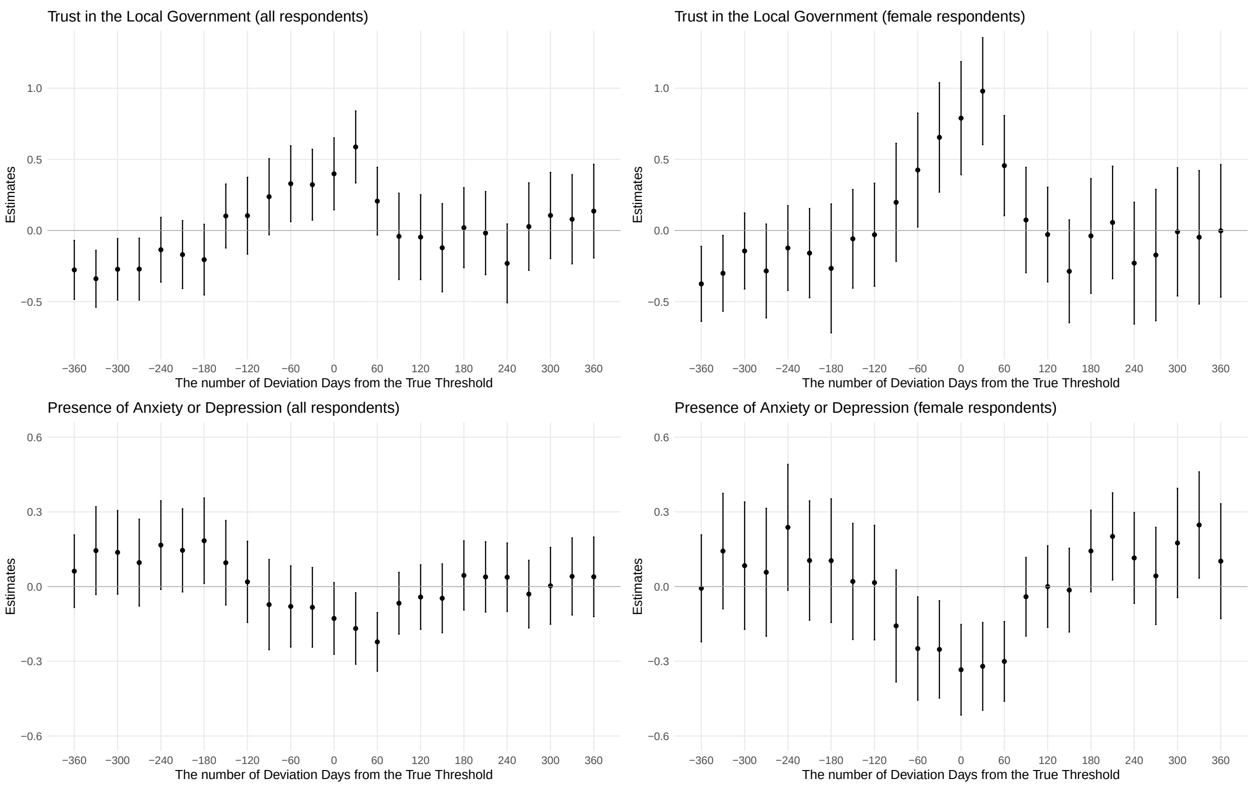
	(1) All	(2) Female	(3) Male	(4) All	(5) Female	(6) Male
	A. First Stage Regression From Priority Policy to Vaccination					
RD Estimate	0.499***	0.412***	0.592***	0.499***	0.412***	0.592***
	(0.095)	(0.108)	(0.105)	(0.095)	(0.108)	(0.105)
Observations	1546	805	741	1546	805	741
	B. From Vaccination under Priority Policy to:					
	Local Government Trust			Symptoms of Anxiety or Depression		
RD Estimate	1.095***	2.297***	0.223	-0.311*	-0.823***	0.078
(LATE)	(0.306)	(0.508)	(0.367)	(0.188)	(0.272)	(0.234)
Observations	1546	805	741	1546	805	741

Note: *p < 0.1, **p < 0.05, ***p < 0.01. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.The results are estimated using donut hole RD (Barreca et al., 2011) which excludes samples within 30 days before and after the threshold.

Columns (1) to (3) in Table 5 present the results of the donut hole RD, showing that vaccination increases the local government trust. This effect is particularly strong among women, with an effect size of 2.297 points, statistically significant at the 1% level. Columns (4) to (6) show similar results for mental health, with vaccination significantly improving women's mental health by reducing anxiety and depressive symptoms by 0.823 points, also statistically significant at the 1% level.

Then, we show a placebo test to verify that there are no effects when the cutoff deviates from the true threshold. We conduct placebo cutoffs (Barreca et al., 2016; Cattaneo and Titiunik, 2022), which involve shifting the threshold from the true value of April 1, 1957, to dates 30 to 360 days before and after. This revalidates whether the results concerning the local government trust and mental health arise from the discontinuity at the true threshold.

Figure 5 shows the results of the placebo tests. The upper panel shows the results for the local government trust, and the lower panel shows the results for anxiety and depressive symptoms. We can find that most of the jumps take place around the threshold. These results support that the increase in the local government trust and the improvement in mental health due to vaccination are caused around the true threshold.



Note: This figure shows placebo tests results using robust confidence intervals and non-parametric local polynomial regressions as proposed by Calonico et al. (2014, 2017). In these tests, deviation from the true threshold increases the number of non-compliers, making the first stage estimation unstable. Therefore, unlike previous analyses, we use a sharp regression discontinuity (RD) design instead of a fuzzy RD. The confidence intervals represent the 95% confidence interval.

Figure 5: Placebo Tests

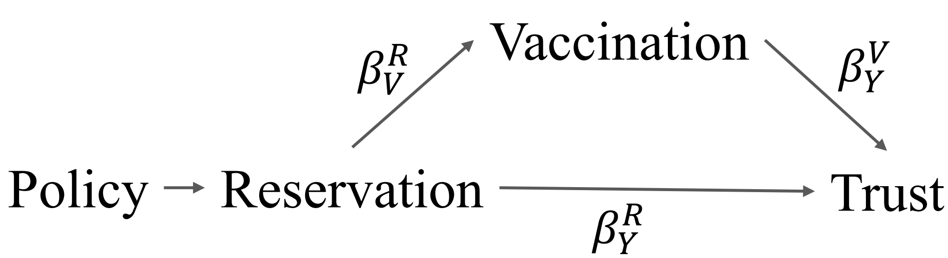
4. Further Analysis

In Section 4.1, we use a causal mediation analysis(Dippel et al., 2020) to determine whether the increase in the local government trust results from receiving the vaccination or, even without receiving it, simply from being prioritized for the policy. In Section 4.2, we examine the impact on trust in medical institutions (as same as government, we call medical institution trust) that vaccinate people directly, to make sure whether the increase in the local government trust results from the policy or vaccine itself.

4.1. Identifying the Effect of Anticipation through Policy Initiation

So far, our analysis has assumed that the priority vaccination policy influences government trust solely through the act of vaccination itself, as discussed in Section 2.2. However, it is possible that simply being prioritized for vaccination, even without actually receiving the vaccine, could increase trust by evoking anticipation among citizens that they will soon be vaccinated. This mechanism could violate the exclusion restriction, as the increase in trust might not be solely due to the actual vaccination. Moreover, from a policy perspective, this issue is critical because the government may have an incentive to leverage this anticipation effect rather than fully implementing the policy if it is sufficient to boost trust. However, not fully implementing the policy would provide no tangible benefits to the public.

To clarify the anticipation path, we focus on the vaccine reservation process as the initiation phase when individuals are merely prioritized. The reservation process itself, administered by local governments, may generate anticipation, which can impact local government trust. Thus, we aim to determine whether trust is more effectively enhanced by the anticipation created through reservation or by the tangible benefits of actual vaccination. Figure 6 illustrates the causal relationships among the priority vaccination policy, the act of making a reservation, receiving a vaccine, and local government trust. Whether people can make a reservation is also determined by the priority policy. In Section 3, we have operated under the assumption that there is no direct effect of the reservation process on trust. However, if the direct effect of reservation β_Y^R is found to be positive and significant, it would indicate that policy initiation could enhance government trust even before full implementation.



Note: This figure shows causal relationships among the vaccination policy, making reservation, receiving vacctination, and the local government trust. Both reservation and vaccination is depend on the priority policy. If the direct effect of reservation β_Y^R is positive and significant, it implies that policy initiation could enhance the government trust even before full implementation.

Figure 6: Mediation Path Diagram

To verify the causality in Figure 6, we conduct a causal mediation analysis using the methodology of Dippel et al. (2020), employing reservation and vaccination variables. Causal mediation analysis integrates instrumental variables into the mediation analysis (Baron and Kenny, 1986) to address the endogeneity of both the running and mediator variables, thus relaxing the identification conditions. Here, we estimate the direct effect of making a vaccination reservation (treatment variable: R) and the indirect effect of actually receiving the vaccination (mediator variable: V) on the local government trust (outcome variable: Y), using priority vaccination status (instrumental variable: Z) as the instrument.[11] As before, the local government trust Y is the first difference from the baseline survey conducted in January. To make the setting close to RDD, we only analyze respondents born within one year before and after, as this mediation method can not focus on the effect near threshold.

Table 6 shows the results of the causal mediation analysis for the local government trust. Column (1) indicates that the direct effect of making an reservation is not statistically significant and even shows a negative direction. The indirect effect through vaccination is positive and statistically significant at the 10% level, with an effect size of 0.651, similar to the overall effect 0.727 found in Section 3.1. In column (2) and (3), there is an gender gap, which is consistent with previous results.

These results suggest that making an reservation for vaccination does not directly increase the local government trust. Instead, it indirectly increases trust through the actual receipt of the vaccination. In other words, there is no direct effect of the priority vaccination policy; people increase their the local government trust only after experiencing the benefits of the policy.

[11] The estimation is conducted by combining two-stage least squares (2SLS) as follows:

$$\begin{aligned}\text{First stage: } & R = \gamma_R^Z Z + X + \epsilon_R \\ \text{Second stage: } & V = \beta_V^R \hat{R} + X + \epsilon_V \\ \text{First stage: } & V = \gamma_V^Z Z + \gamma_V^R \hat{R} + X + \epsilon_V \\ \text{Second stage: } & Y = \beta_Y^V \hat{V} + \beta_Y^R \hat{R} + X + \epsilon_Y\end{aligned} \tag{3}$$

The identification condition is that $\epsilon_R \perp \epsilon_Y | \epsilon_V, X$, meaning there are no unobserved confounding factors that independently influence both the reservation variable and trust, and are independent of the vaccination variable or covariates. As far as the author can determine, there are no variables that are independent of vaccination but influence the reservation variable (for example, it is unlikely that a variable indicating willingness to vaccinate would not correlate with receiving the vaccination). However, in the context of this study, some respondents might have been able to make an reservation but were unable to receive the vaccination due to the variation of local vaccination infrastructure. These respondents are correlated with the reservation variable but independent of vaccination. To address this, variables related to the local vaccination environment were included in the covariates X.

Table 6: Identification Using Causal Mediation Analysis

	(1) All	(2) Female	(3) Male
		From Reservation to: Local Government Trust	
Total Effects	0.400***	0.635***	0.212
	(0.134)	(0.226)	(0.167)
Direct Effects	-0.251	-0.642	0.156
	(0.247)	(0.436)	(0.315)
Indirect Effects	0.651*	1.277*	0.056
	(0.352)	(0.669)	(0.427)
Observations	423	207	216

Note: *p < 0.1, **p < 0.05, ***p < 0.01. Standard errors are reported in parentheses. This table shows results of mediation analysis by Dippel et al. (2020). For column (1), $\beta_Y^R = -0.251$, $\beta_V^R = 0.786$ and $\beta_Y^V = 0.830$. Indirect effect 0.651 is comuputed by $\beta_V^R \times \beta_Y^R$.

4.2. Impact on Medical Institution Trust

The increase in the local government trust, rather than the central government which planned the vaccination policy, suggests that people tend to focus on the final outcomes when accessing the government. If this is the case, the medical institution that actually administered the vaccinations would have gained public trust most, and the increase in the local government trust might be just a spillover.

Table 7: Impacts of Vaccination Policy on Medical Institution Trust

	(1) All	(2) Female	(3) Male
		A. First Stage Regression From Priority Policy to Vaccination	
RD Estimate	0.555***	0.498***	0.614***
	(0.084)	(0.091)	(0.096)
Observations	1567	815	752
		B. From Vaccination under Priority Policy to: Medical Institution Trust	
RD Estimate	-0.036	-0.201	0.085
(LATE)	(0.358)	(0.436)	(0.472)
Observations	1567	815	752

Note: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.

In this section, to clarify what people evaluated, we shift our focus from the local government to medical institutions. We conduct the measurement of medical institution trust in the same manner as the local government trust.

Table 7 presents the fuzzy RDD estimation results of the impact of vaccination on medical institution trust. In column (1), the estimated value is -0.036, which is small, even negative, and not statistically significant. The results in columns (2) and (3) also show no causal effect of vaccination on medical institution trust, even among women.

These results indicate that the vaccination policy does not change the central government trust or medical institutions but only increases the local government trust. This implies people evaluate not policy planning or vaccination itself, but the smooth implementation.

5. Interpretations and Discussion

This section interprets the findings and discussion. Our fuzzy RDD analysis reveals that the vaccination policy increased trust exclusively in local governments, which were responsible for administering the policy. In contrast, trust in the central government and medical institutions remained unchanged, despite these entities being in charge of planning and executing the vaccinations, respectively.

A potential mechanism behind this result relates to the vertical structure between central and local governments, as discussed in the literature on fiscal federalism (Ligthart and van Oudheusden, 2015; Oates, 1999). Local governments implement policies designed by the central government, which may lead people to evaluate the effectiveness of local implementation more favorably. This mechanism likely played a role in the observed trust dynamics. Another explanation may be psychological. For example, as noted by Van de Walle and Bouckaert (2003), local governments interact with citizens more frequently than central governments, potentially leveraging the mere-exposure effect, where familiarity breeds trust. However, the lack of change in trust toward medical institutions suggests that the mere-exposure effect was not a significant factor. Thus, our findings are likely driven by the effective implementation of policies by local governments.

To extract the pure impact of policy implementation, we conducted a mediation analysis focusing on the anticipation effect generated during the reservation process. Here, we treat the reservation process as the initiation phase of the vaccination campaign. The results show that merely offering a reservation did not enhance the local government trust; rather, trust increased only after people received the vaccine. This indicates that citizens evaluate government policies based on actual benefits rather than mere promises. This finding aligns with existing literature on political commitment and implementation, which suggests that voters are more likely to support a politician when informed that the politician has actually implemented their policy commitments (Cruz et al., 2024). Although they focus on various policies, including healthcare, their findings are consistent with our findings, emphasizing the importance of policy implementation for building political trust. Our study contributes to this literature by demonstrating that fully implementing the policy increased trust in governmental entities beyond individual politicians.

Our analysis also highlights the significance of implementation from the perspectives of mental health and gender disparities. The increase in the local government trust was particularly pronounced among women, who experienced significant mental health challenges during the pandemic. The findings indicate that not only did trust improve, but women's mental health also showed marked improvement following vaccination. Additionally, Table A.12 shows a decrease in the subjective probability of severe COVID-19 outcomes among women after vaccination, suggesting that the tangible benefits of policy implementation are crucial for building trust.

To gauge the significance of our findings, we compare them with existing studies on the effects of vaccination policies on public perceptions. For instance, Takahashi et al. (2022) reported that responses to questions such as "Vaccinations are progressing well across the country" and "The government's response to the pandemic has been successful" did not change significantly with priority vaccination. However, positive responses increased for statements like "Vaccinations are progressing well in your municipality" and "Your municipality has adequate measures to prevent COVID-19 infection." While these patterns align with our findings, the uniqueness of our study lies in revealing this difference using a general indicator of trust. Our findings highlight a difference in trust dynamics between central and local governments, indicating that citizens perceived the priority vaccination policy as appropriate and thereby increased their local government trust. Although it seems intuitive that policy implementation influences public evaluations, empirical evidence on this causal relationship remains limited. Our study contributes to the growing literature on the causal link from policy implementation to trust.

In terms of effect size, our analysis shows that the standardized impact of vaccination on trust in local governments is 0.40. By contrast, previous studies reported smaller effect sizes, typically ranging between 0.21 and 0.23. As detailed in Appendix C, their analysis focused on individuals who had completed the second vaccination, which may have led to an underestimation of the impact. Since there is a significant number of people who have only received the first dose among those who have not completed the second dose, it is challenging to isolate the effect of vaccination by analyzing those who completed the second dose. Additionally, data collection in these studies coincided with a surge in infections in August 2021, potentially introducing negative biases in evaluating government policies. In Appendix C, we confirm that the impact of the second dose on trust is smaller than that of the first dose, especially among women.

In summary, this study elucidates the causal processes between policy implementation and public trust in government by focusing on the roles of different agencies involved in the vaccination policy. Additionally, our findings indicate that the increase in trust was driven by the tangible benefits of receiving a vaccine rather than mere anticipations from policy design and initiation.

6. Conclusion and Policy Implications

This paper concludes by summarizing the policy implications and limitations of our study. Our analysis confirms that the effective implementation of policies during a crisis can significantly increase public trust in the government. This finding provides strong incentives for governments to implement effective policies to garner public support. Even prior to the COVID-19 pandemic, the importance of government trust during crises had been widely discussed, with suggestions that demonstrating high policy performance is key to enhancing public trust (Beshi and Kaur, 2020; Ervasti et al., 2019). During the pandemic, reports by OECD (2022); United Nations Department of Economic and Social Affairs and Perry (2021) narratively emphasized the critical role of governments in building trust with the public to navigate through crises. However, empirical evidence on whether the implementation of effective policies causally increases public trust in government has been limited. In this regard, our study holds significant policy contributions by providing evidence that connects appropriate policy implementation to increased public trust. Accumulating such evidence may create a virtuous cycle where governments implement better policies to gain public support.

In this study, vaccination increased trust only in local governments. However, Ligthart and van Oudheusden (2015) suggests that improved performance by local governments can positively spill over to the central government trust. Thus, if we were to conduct a longer-term survey, we might observe such spillover effects on the central government trust as well. This remains an area for future research.

Our study also demonstrates that, beyond the medical and epidemiological benefits, vaccination has the effects of enhancing public trust in government and improving mental health. This highlights the importance of vaccination not only as a public health measure but also as a socioeconomic policy. There is evidence of a positive correlation between government trust and economic growth during normal times (Knack and Keefer, 1997). Additionally, increased government trust can potentially facilitate economic recovery in times of crisis (Demirgüç-Kunt et al., 2021), implying that the increase in trust from vaccination may contribute to broader economic recovery.

Of course, our study's findings are subject to certain limitations, particularly in terms of generalizability. The estimates presented reflect the Local Average Treatment Effect (LATE) based on a regression discontinuity design, which captures the effect on elderly individuals near the threshold who complied with the priority vaccination policy. Consequently, it remains uncertain whether these results can be generalized to other age groups. Nonetheless, since there is evidence of potential mental health benefits from vaccination among younger cohorts (Agrawal et al., 2021), it is plausible that increased trust could also extend to other generations. Moreover, given that the initial policy target was elderly individuals at high risk of severe COVID-19 outcomes, the observed effects on the elderly population alone carry substantial policy implications. An increase in trust among this demographic could lead to higher compliance with government requests, including subsequent vaccination campaigns, thereby reducing the risk of severe illness and mortality. Additionally, since older adults generally face higher risks of severe outcomes from various infectious diseases, the insights from our study could be applicable to future pandemics beyond COVID-19.

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Appendix A. Appendix Tables and Figures

Table A.8: A Comparison in Regional Distribution between Survey Respondents and Administrative Data

	60-64 yr		65-69 yr		70-74 yr	
Region	Survey (N=1,254)	Admin (N=7,490,400)	Survey (N=1,416)	Admin (N=9,096,371)	Survey (N=1,349)	Admin (N=8,201,584)
Hokkaido	4.1%	4.7%	4.6%	4.9%	5.0%	4.5%
Tohoku	7.3%	8.5%	7.4%	8.1%	6.0%	7.0%
Northern Kanto	8.0%	8.3%	7.7%	8.3%	7.4%	8.0%
Southern Kanto	27.8%	25.4%	27.9%	25.2%	29.5%	26.7%
Hokuriku	4.2%	4.5%	3.6%	4.5%	4.7%	4.4%
Chubu	12.5%	11.3%	11.7%	11.4%	12.3%	11.9%
Kansai	15.1%	15.1%	16.5%	15.7%	16.4%	16.8%
Chugoku	6.3%	6.0%	5.9%	6.2%	5.4%	6.3%
Shikoku	3.0%	3.4%	3.0%	3.4%	3.0%	3.4%
Kyushu/Okinawa	11.8%	12.8%	11.7%	12.3%	10.3%	10.9%
Chi-squared test	$p = 0.40$		$p = 0.30$		$p = 0.31$	

Note: This table summarizes the distribution between our survey respondents (N=4,019) and the administrative data. Data is classified by five-year age groups, consistent with the classification of the administrative data. The chi-squared test evaluates the goodness-of-fit between the survey respondents and the administrative data, indicating no significant differences.

Table A.9: Balance tests of pre-intervention covariates

Outcomes:	(i) Female	(ii) College Grad	(iii) Employed	(iv) Income	(v) Assets
(a) Fuzzy RDD					
RD Estimate	-0.142	0.018	0.115	3.022**	3.720
(LATE)	(0.169)	(0.178)	(0.188)	(1.241)	(8.578)
Observations	1567	1567	1567	1567	1567
(b) Donut Hole RD					
RD Estimate	-0.012	-0.022	0.143	2.434	-7.011
(LATE)	(0.207)	(0.199)	(0.205)	(1.467)	(9.288)
Observations	1546	1546	1546	1546	1546

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. In this table, balance tests of pre-intervention covariates are conducted to confirm that local randomization is functioning properly. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses. The covariates are measured in the baseline survey in January. Only column (iv), income, shows discontinuity. However, as shown in row (b), when we apply a donut hole RD excluding samples within 30 days before and after the threshold, the discontinuity is not statistically significant. Furthermore, when we use income as a covariate variable in our main analysis, the results show little difference.

Table A.10: Impacts of Vaccination Policy on Local Government Trust with Various Bandwidth

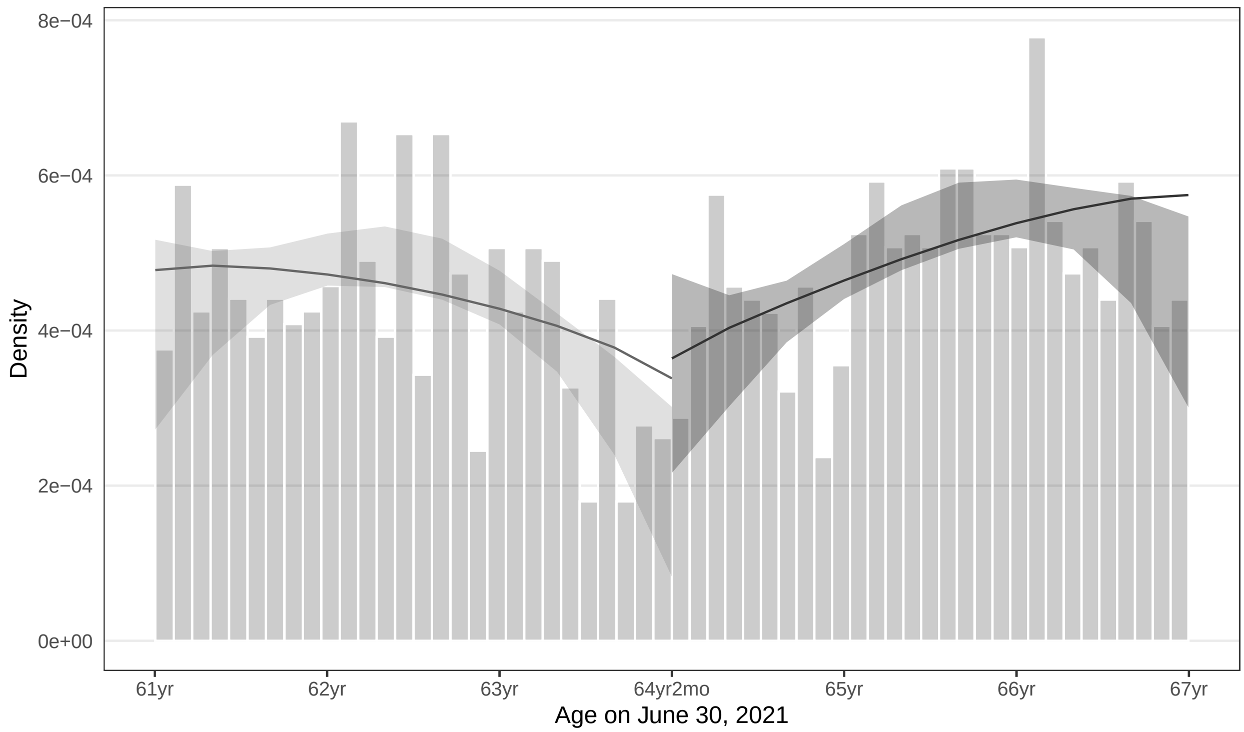
	CCT Bandwidth			IK Bandwidth			Cross Validation Bandwidth		
	(1) All	(2) Female	(3) Male	(4) All	(5) Female	(6) Male	(7) All	(8) Female	(9) Male
	A. First Stage Regression From Priority Policy to Vaccination								
RD Estimate	0.599***	0.570***	0.708***	0.565***	0.600***	0.595***	0.534***	0.576***	0.585***
	(0.092)	(0.104)	(0.108)	(0.087)	(0.106)	(0.088)	(0.073)	(0.102)	(0.084)
Observations	903	394	264	1266	714	1119	2010	611	945
Bandwidth	667.820	598.164	436.635	892.043	967.766	1916.611	1388.000	852.800	1388.000
	B. From Vaccination under Priority Policy to: Local Government Trust								
RD Estimate	0.632**	1.430**	0.027	0.700**	1.410**	0.138	0.785***	1.443**	0.158
(LATE)	(0.298)	(0.567)	(0.355)	(0.284)	(0.631)	(0.348)	(0.236)	(0.610)	(0.325)
Observations	903	394	264	1266	714	1119	2010	611	945
Bandwidth	667.820	598.164	436.635	892.043	967.766	1916.611	1388.000	852.800	1388.000

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The table show vaccination policy impacts on local government trust with three different bandwidths. Robust bias-corrected standard errors, clustered at the prefecture level, are reported in parentheses. The bandwidths in columns (1)-(3), (4)-(6), and (7)-(9) are selected using methods proposed by Calonico et al. (2015), Imbens and Kalyanaraman (2012), and Ludwig and Miller (2007), respectively. All bandwidths are computed using the Rdrobust package (See Calonico et al. (2023)). Our IK and cross-validation bandwidths are not entirely precise due to the selector function being available only for sharp RD designs. However, this is a minor issue since we use these bandwidths as robustness checks for different bandwidths. We find that the results across various bandwidths are consistent with our main results.

Table A.11: Results of Other Cutoffs of K6

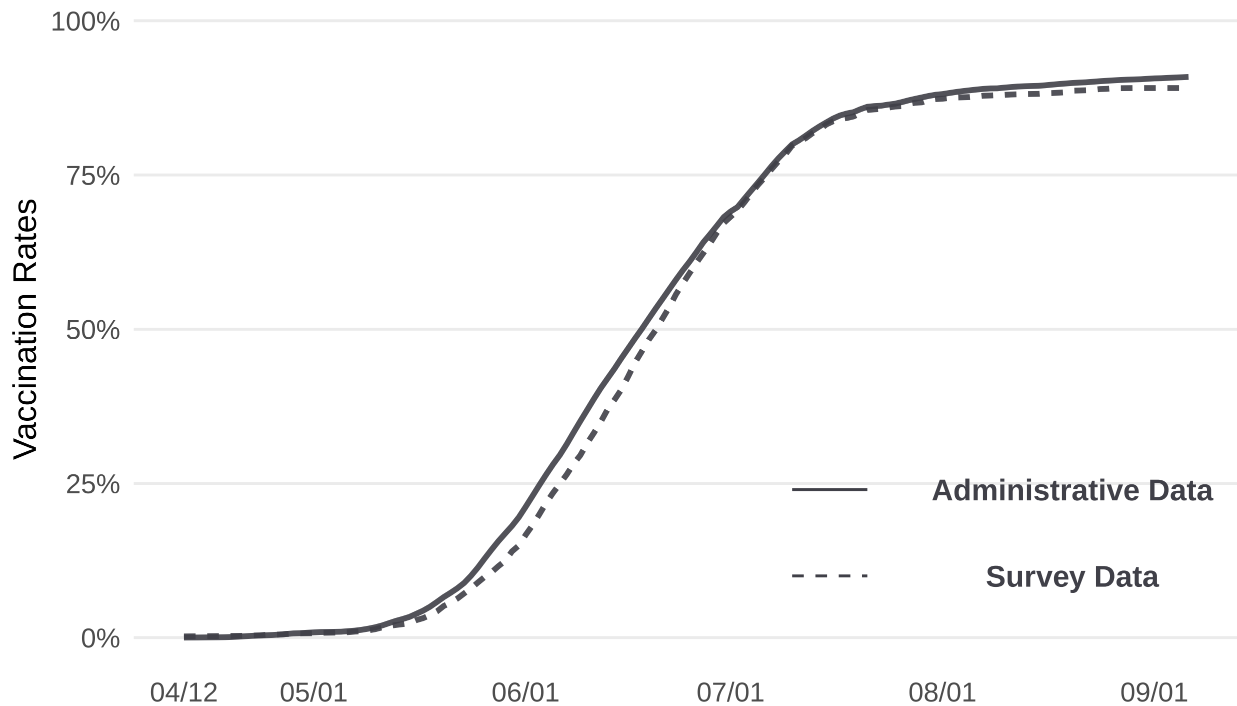
	(1) ALL	(2) Female	(3) Male
4/5 cutoff (Sakurai et al.2011)			
RD Estimate	-0.245*	-0.683***	0.100
(LATE)	(0.148)	(0.209)	(0.191)
9/10 cutoff (Comprehensive Survey of Living Conditions in Japan)			
RD Estimate	-0.092	-0.433**	0.155
(LATE)	(0.117)	(0.174)	(0.175)
12/13 cutoff (Kessler et al. 2003)			
RD Estimate	-0.275**	-0.354**	-0.212
(LATE)	(0.118)	(0.170)	(0.153)
K6 at 24-point scale (Kessler et al. 2002)			
RD Estimate	-2.422*	-6.264***	0.403
(LATE)	(1.413)	(1.926)	(1.838)
Observations	1546	805	741

Note: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. This table shows the results when we change the K6 cutoff which represents Symptoms of Anxiety or Depression. The first row shows same cutoff results in Table 4. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses. Each results shows vaccination policy impacts on Symptoms of Anxiety or Depression among women.



The figure shows McCrary density test of running variable, i.e. age-in-days. The 95% confidence intervals show continuity of the density around the threshold of the priority policy (born on or before April 1, 1957). Therefore, there is non-manipulation.

Figure A.7: McCrary Density Test of Running Variable



Note: We obtained the administrative data from the Vaccination Record System (VRS). Both of the graphs only show the vaccination rates of those who have the vaccination priority. Administrative data includes all people aged 65 and older, though our survey data covers the age range of 65-74.

Figure A.8: Comparison of Vaccination Trends between Administrative and Survey Data

Table A.12: Impacts on the Subjective Probability of COVID-19 Severity

	(1) All	(2) Female	(3) Male
	A. First Stage Regression From Priority Policy to Vaccination		
RD Estimate	0.555***	0.498***	0.614***
	(0.084)	(0.091)	(0.096)
Observations	1567	815	752
	B. From Vaccination under Priority Policy to: the Subjective Probability of COVID-19 Severity		
RD Estimate	-0.798	-1.633**	0.081
(LATE)	(0.640)	(0.784)	(0.947)
Observations	1567	815	752

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.The outcome variable is the logarithmic transformation of the subjective probability of COVID-19 severity, derived from the question, "If you were to contract COVID-19 in the future, what do you think is the likelihood that you would develop severe symptoms and have lasting severe aftereffects?" The difference in this transformed value is calculated between January 2021 and June 2021, before and after the start of the vaccination campaign.

Appendix B. Verification of Vaccination Dates Accuracy

To directly verify the accuracy of vaccination history data, we requested 117 elderly individuals who consented to cooperate to submit photographic data of their vaccination records, and compared the records in the photographs with their self-reported responses.[12] Among the elderly, the records in the photographs completely matched the self-reported responses for 102 out of 117 individuals. For the unmatched responses, the average discrepancy with the photographic data was 2.25 days (standard deviation 7.28 days). To account for selection bias due to vaccination intention, we asked the survey company to ensure that the respondents submitting photographic data had varying levels of vaccination intention as of the January survey. We confirmed that there is no statistically significant relationship between the rate of matching responses and prior vaccination intention.

[12] For review and approval to conduct the photo survey, we submitted a separate application to the Ethics Committee of the Graduate School of Economics, Osaka University. For the photographic survey, we requested participants to take and upload photos showing only the parts of the vaccination record that included the "date of vaccination," "type of vaccine," "lot number," and "vaccination site." We confirmed in advance that this information does not qualify as personal information. For example, we inquired with Takeda Pharmaceutical's "COVID-19 Vaccine Moderna Dedicated Line" regarding the lot number and received a response that "the lot number is related to the manufacturing batch and does not identify individuals." When requesting participants to take and upload the photos, we provided clear instructions on how to avoid capturing personal information. In the event that personal information was inadvertently included in the photos, the contracted survey company appropriately handled it to ensure that such information was not provided to the researchers.

Appendix C. Impact of the Second Dose Vaccination on Trust in the government

Similar to ours, Takahashi et al. (2021) used a regression discontinuity design to evaluate the impact of priority vaccination on the assessment of COVID-19 measures. They analyzed the effects on individuals who had completed their second vaccination. However, significant number of those who have not received the second dose would have already completed the first dose. Thus, it is challenging to extract a clear effect of vaccination. In this section, nevertheless, we will use our data on the second dose to verify whether our results are consistent with their findings.

Table C.13 shows the estimated impact of the second vaccination on trust. Column (4) indicates that the local government trust increased by 0.635 points (p<0.1), while column (1) shows no significant difference in the central government trust. Additionally, column (5) reveals that the local government trust is higher among women. These results are consistent with those in Section 3.1 and, despite using different outcome variables, align with the main message of Takahashi et al. (2021).

Table C.13: Impacts of the Second Dose vaccination

	(1) All	(2) Female	(3) Male	(4) All	(5) Female	(6) Male
	A. First Stage Regression From Priority Policy to Vaccination					
RD Estimate	0.669***	0.635***	0.723***	0.669***	0.635***	0.723***
	(0.076)	(0.069)	(0.102)	(0.076)	(0.069)	(0.102)
Observations	1213	631	582	1213	631	582
	B. From Vaccination under Priority Policy to:					
	Central Government Trust			Local Government Trust		
RD Estimate	0.229	-0.073	0.465	0.635*	0.936**	0.381
(LATE)	(0.286)	(0.326)	(0.472)	(0.372)	(0.429)	(0.587)
Observations	1213	631	582	1213	631	582

Note: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. Robust bias-corrected standard errors, clustered at prefecture level, are reported in parentheses.The number of observations is smaller than in the previous results because it excludes respondents who received only the first dose vaccination.