Adding Nudge-based Reminders to Monetary Incentives for Promoting Rubella Antibody Testing and Vaccination*

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Abstract

We study effects of combining financial incentives with nudges to promote rubella antibody testing and vaccination. In FY2019, the Japanese government began providing vouchers for free testing and vaccination to men aged 40–57 years. Vouchers were mailed to 40–46-year-old men in FY2019. While those aged 47–57 received vouchers in FY2020, they could obtain vouchers and receive testing and vaccination in FY2019 through applying. Focusing on this policy distinction, we conduct a late-FY2019 online field experiment with Japanese 40–57-year-old men. We randomly send nudge-based reminder messages recommending antibody testing and vaccination, and track self-reported behavior until the end of FY2019. One nudge-based reminder with an altruistic message on fetal harm through infection from men to pregnant women significantly promotes antibody testing and vaccination among those who have already received vouchers as a financial incentive. For those who must apply for vouchers, nudge-based reminders have no promoting effect.

JEL classification: D90, I12, I18
Keywords: Rubella; Vaccination; Antibody Test; Text Messages; Reminders; Free Vouchers.

1 Introduction

2 Background of Rubella Vaccination in Japan

3 Nationwide Online Survey Experiment

4 Results

4.1 Study Population

Our target population consists of men who did not have antibody testing or vaccinations. We exclude respondents who stated in wave 1 that they had already received either antibody testing or vaccination. In wave 2, we asked respondents whether they had already received either testing or vaccination until wave 1.

1

Thus, when estimating the effect on behavior, we exclude respondents who stated in either wave that they had received either antibody testing or vaccination prior to wave 1.

Our aim is to estimate the effect of text messages in situations where men received monetary incentives as vouchers by default and where they had to incur transaction costs to obtain them. To accomplish this, we create a subsample of men aged 40–46 years and another of men aged 47–56 years. Men in the former subsample automatically received the free vouchers (*default incentive* group). Meanwhile, men in the latter subsample received no incentives or required a costly procedure to get it (*opt-in incentive* group). We believe that most men in the opt-in group did not receive free vouchers in FY2019 because 77.5% of respondents in wave 1 did not know that rubella routine immunization began in FY2019. Thus, in the default incentive group, monetary incentives and text message reminders are more closely combined than in the opt-in incentive group.

4.2 Effect of Text Messages on Intentions

This subsection estimates the effect of text messages on intentions. We find that individuals' observable characteristics are balanced across experimental arms in both default incentive and opt-in incentive group (See Table 7 and 8 in Appendix). Thus, we first report the difference-in-mean test (t-test) for each group.

4.2.1 Difference-in-mean Test

Figure 1: Effect of Text Messages on Intention for Antibody Testing Notes: Numbers in the figure indicate the proportion of each experimental arm. Error bars indicate the standard error of the mean. Asterisks are p-values of t-tests for the difference-in-mean: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

We show the proportion of intention for antibody testing in each experimental arm for the default incentive group (Panel A) and the opt-in incentive group (Panel B) in Figure 1. The results show that, in the default incentive group only, the Altruistic message increases the intention for antibody testing by a statistically significant 14.3 pp compared to the MHLW (control) message group (35.1% in the Altrustic message group versus 20.8% in the MHLW (control) message group). Because the Altruistic message changes both the age expression and the message content, the effect relative to MHLW (control) can be interpreted as the

combined effect of the two changes. However, MHLW (Age), which only changes the age expression, does not increase intention. Thus, the effect of the Altruistic message is attributed to the message content. Compared to MHLW (Age), Altruistic message content increase the intention for antibody testing by 12.2 pp (35.1% in the Altruistic message group versus 22.9% in the MHLW (Age) message group), which is statistically significant (see Table 9 in the Appendix).

On the other hand, in the opt-in incentive group, altruistic messages increased intention by 5.3 pp, which is statistically insignificant (32.9% in the Altrustic message group versus 27.6% in the MHLW (control) message group).[1] The regression analysis presented later suggests that the Altruistic message effects may differ between the two incentive groups.
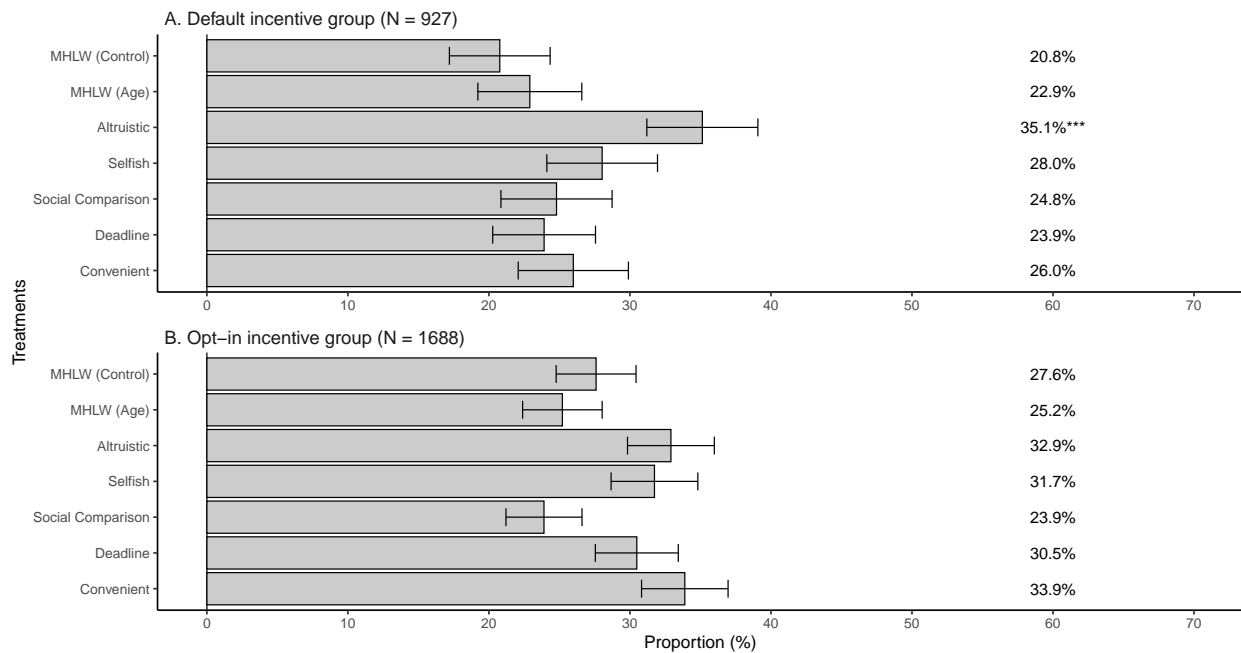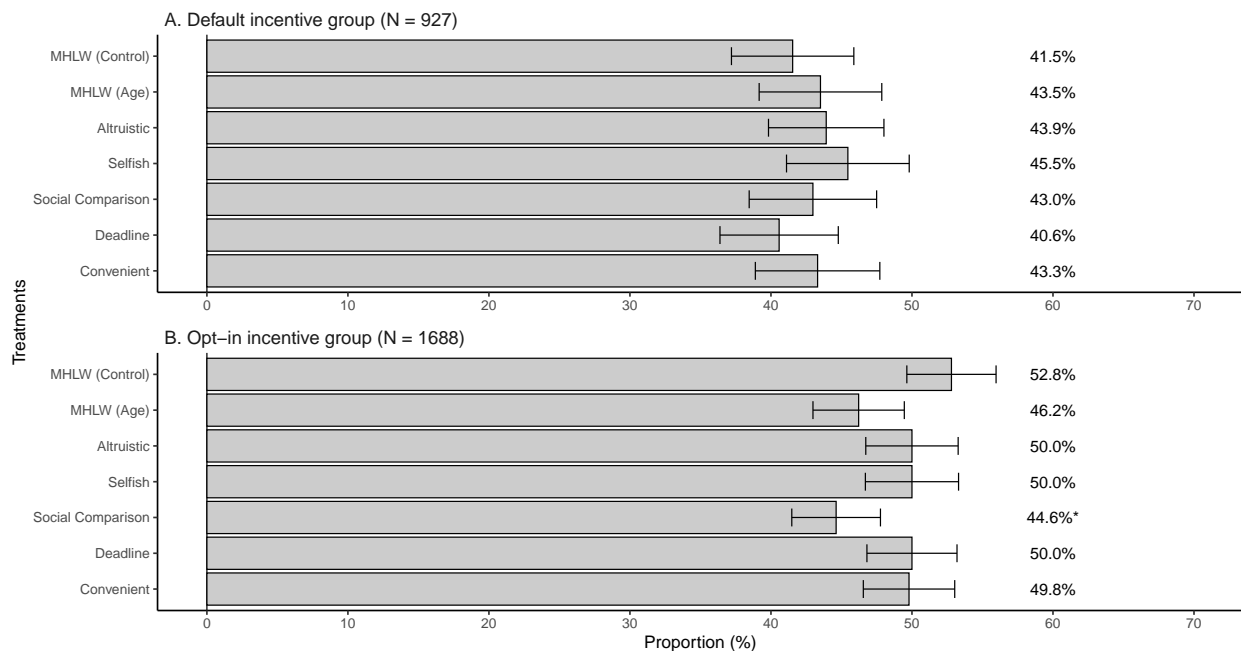

Figure 2: Effect of Text Messages on Intention for Vaccination Notes: Numbers in the figure indicate the proportion of each experimental arm. Error bars indicate the standard error of the mean. Asterisks are p-values of t-tests for the difference-in-mean: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2 depicts the proportions of intention for vaccination for the default incentive group (Panel A) and the opt-in incentive group (Panel B). Results show that in the two incentive groups, most text messages, including the Altruistic messages, do not statistically significantly increase vaccination intentions compared to NHLW (control).

In the opt-in incentive group, the Social Comparison message may lower vaccination intention than the MHLW (control) message (44.6% in the Social Comparison message group versus 52.8% in the MHLW (control) message group). This result is due to the age expression rather than the message content, as social comparison messages hardly lower intention compared to MHLW (age).[2]

Note that the intention ratio of vaccination in all experimental arms is higher than that of antibody testing in

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[1]However, even in the opt-in incentive group, the Altruistic message content may increase testing intention. Compared to the MHLW(age) message group, the Altruistic messages increased the intention to take the antibody test by 7.7 pp (32.9% in the Altruistic message group versus 25.2% in the MHLW (age) message group), which is statistically significant at the 10% level (see Table 10 in the Appendix).

[2]Free-riding may explain why the Social Comparison message content does not increase intention. The Social Comparison message emphasizes that "one in five people do not have antibodies.'' Conversely, four out of five individuals have antibodies. The readers of such a message may have believed that even if they lacked rubella antibodies, the likelihood of infection would be low because 80% of the population possesses them. When eligible men were required to undergo costly procedures to receive free vouchers, this belief may have made vaccination less beneficial.

both incentive groups. This result may be explained by the stimulus of the question eliciting the vaccination intention. We asked respondents to report their willingness to vaccinate if they did not have antibodies. This condition may strongly stimulate the need for vaccination. Thus, when assessed by actual behavior, the results may differ.

4.2.2 Regression Analysis

Since age determines whether eligible men received the free vouchers automatically in FY2019, the different effect of text messages for two groups is influenced by the presence or absence of monetary incentives, and by the differences of other dimentions (especially, age) between the two groups. This motivates us to estimate a following linear probability model:

$$Y_{ij} = \alpha + \sum_j \beta_j \text{Message}_j + \sum_j \gamma_j (\text{Message}_j \times \text{Opt-in}_i) + \delta \text{Opt-in}_i \\ + \lambda X'_{ij} + \epsilon_{ij}, \tag{1}$$

where Message_j is a treatment dummy (the reference group is MHLW (control) message), Opt-in_i is a binary variable indicating the opt-in incentive group (47–56 years old), and X is a set of covariates including age. Our parameter of interest is β_j and γ_j. The parameter β_j represents a text message effect for the default incentive group. The linear combination of parameters, $\beta_j + \gamma_j$, is a text message effect for the opt-in incentive group. The parameter γ_j shows a difference in the message effect between the two groups.

The regression analysis also shows that the Altruistic messages increase the intention to take the antibody test only in the default incentive group (Table 1). Controlling for covariates, altruism messages increase the intention to take the antibody test by 16.6 pp in the default incentive group (column (2)). Furthermore, although marginally statistically significant, the effect of this message weakens by 12.1 pp as the cost of obtaining a free vaccination ticket becomes more expensive. As a result, the effect of the Altruistic message in the opt-in incentive group is 4.5 pp, which is not statistically significant (column (2) in Table 2). Also statistically insignificant or marginal, the effect of other nudge messages changes in a negative direction as the cost of obtaining free vaccination tickets increases.

Table 9 in the Appendix estimates the effect of modifying the message content, excluding age expression. In the estimation, we exclude from the sample those assigned to MHLW (control). The reference group is MHLW (Age). Controlling for covariates, the Altruistic message content in the default incentive group statistically significantly increased the intention to take the antibody test by 12.8 pp, which is the main driver of the positive effect of the Altruistic message in the default incentive group. However, the difference in the effect of message content in the two incentive groups is not statistically significant. Therefore, the F-test results suggest that the Altruistic messages may increase the intention to take the antibody test in the opt-in incentive group (Table 10 in the Appendix).[3]

4.3 Effect of Text Messages on Behavior

This subsection estimates the effect of text messages on behavior. We tested a balance of individual characteristics again because a few respondents dropped out between waves 1 and 2. The results show that the observable characteristics are balanced across experimental arms in both default incentive and opt-in incentive group (see Table 11 and 12 in the Appendix). Therefore, we first present the difference-in-mean test (t-test).

Table 1: Regressions of Intention

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
MHLW (Age)	0.021	0.039	0.020	0.047
	(0.051)	(0.049)	(0.061)	(0.059)
Altruistic	0.144***	0.166***	0.024	0.050
	(0.053)	(0.049)	(0.060)	(0.056)
Selfish	0.073	0.115**	0.039	0.087
	(0.053)	(0.050)	(0.061)	(0.058)
Social Comparison	0.040	0.067	0.014	0.039
	(0.053)	(0.050)	(0.063)	(0.059)
Deadline	0.031	0.039	−0.010	0.003
	(0.051)	(0.048)	(0.060)	(0.058)
Convenient	0.052	0.060	0.018	0.032
	(0.053)	(0.050)	(0.062)	(0.058)
Opt-in	0.068	0.081	0.113**	0.077
	(0.046)	(0.050)	(0.054)	(0.059)
MHLW (Age) × Opt-in	−0.045	−0.072	−0.086	−0.122*
	(0.065)	(0.061)	(0.076)	(0.072)
Altruistic × Opt-in	−0.091	−0.121*	−0.052	−0.088
	(0.068)	(0.064)	(0.075)	(0.071)
Selfish × Opt-in	−0.031	−0.097	−0.067	−0.141*
	(0.068)	(0.064)	(0.077)	(0.073)
Social Comparison × Opt-in	−0.077	−0.111*	−0.096	−0.126*
	(0.066)	(0.062)	(0.077)	(0.072)
Deadline × Opt-in	−0.003	−0.006	−0.018	−0.024
	(0.065)	(0.062)	(0.075)	(0.071)
Convenient × Opt-in	0.011	−0.001	−0.048	−0.063
	(0.067)	(0.064)	(0.077)	(0.072)
Covariates		X		X
Num.Obs.	2615	2615	2615	2615
R2	0.009	0.112	0.005	0.118

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. Covariates are age, education year, annual income, usual health behavior (exercise, medical checkup and ful shot habit) and preference for compliance with social norm.

Table 2: Text Message Effects for Opt-in Incentive Group Estimated by Regressions

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
MHLW (Age)	−0.024	−0.033	−0.066	−0.074*
	(0.040)	(0.037)	(0.045)	(0.042)
Altruistic	0.053	0.045	−0.028	−0.038
	(0.042)	(0.040)	(0.046)	(0.043)
Selfish	0.041	0.017	−0.028	−0.054
	(0.042)	(0.039)	(0.046)	(0.043)
Social Comparison	−0.037	−0.044	−0.082*	−0.087**
	(0.039)	(0.037)	(0.045)	(0.041)
Deadline	0.029	0.033	−0.028	−0.021
	(0.041)	(0.039)	(0.045)	(0.042)
Convenient	0.063	0.059	−0.030	−0.031
	(0.042)	(0.040)	(0.045)	(0.043)
Covariates		X		X

Notes: * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$. Robust standard errors are in parentheses. Message effects are estimated by a sum of main term of treatment dummy and cross term between treatment dummy and opt-in dummy.
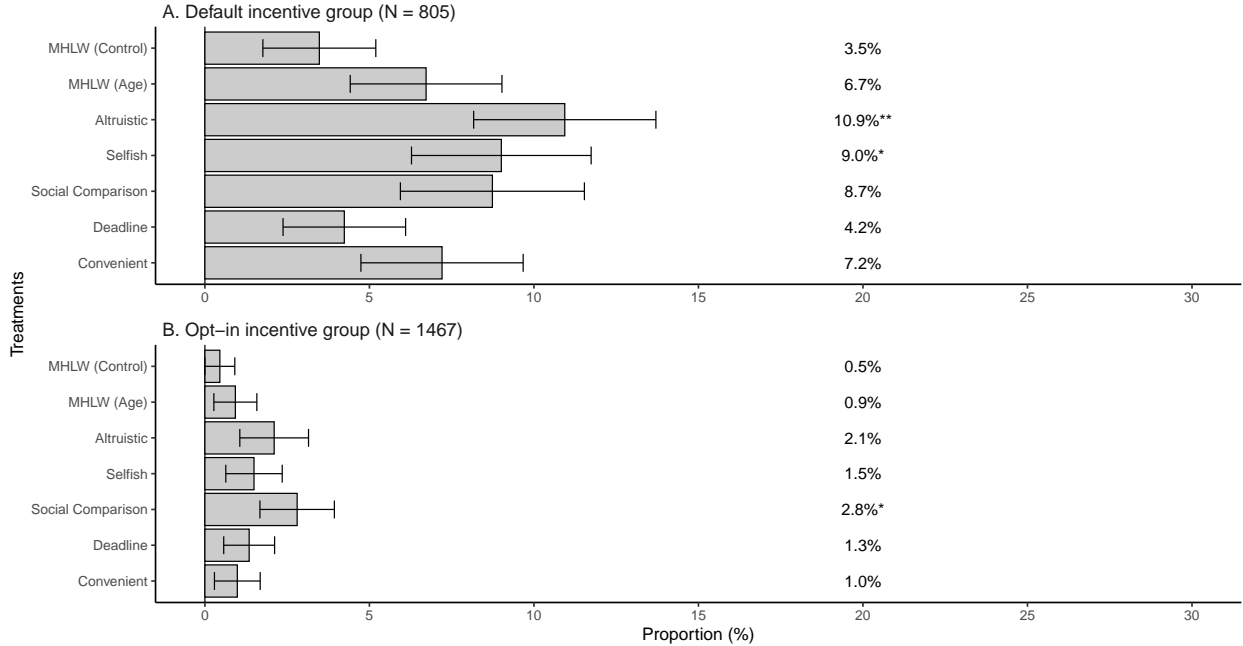

Figure 3: Effect of Text Messages on Behavior for Antibody Testing Notes: Numbers in the figure indicate the proportion of each experimental arm. Error bars indicate the standard error of the mean. Asterisks are p-values of t-tests for the difference-in-mean: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3.1 Difference-in-mean Test

We show the uptake rate of antibody testing in each experimental arm for the default incentive group (Panel A) and the opt-in incentive group (Panel B) in Figure 3. We find that, as in the intention case, the Altruistic message statistically significantly increases the antibody test uptake rate compared to the MHLW (control) message by 7.4 pp in the default incentive group only (10.9% in the Altruistic message group versus 3.5% in the MHLW (control) message group).

Unlike the intention case, the effect of the Altruistic messages on behavior is not solely due to the content of the message. Compared to MHLW (Age), which only changed the expression of age, the Altruistic message group increases the antibody test uptake rate by 4.2 pp (10.9% in the Altruistic message group versus 6.7% in the MHLW (Age) message group). However, regression analysis indicates that this increase is not statistically significant (see Table 13 in the Appendix). Also, although the regression analysis is not statistically significant, modifying the age expression increases the antibody test uptake rate by 3.2 pp (6.7% in the MHLW (Age) message group versus 3.5% in the MHLW (Control) message group). Thus, the effect of the Altruistic message on behavior is a combination of the addition of a simple age expression and the revision of the message content.

Selfish messages may boost antibody testing uptake in the default incentive group by 5.5 pp (9% in the Selfish message group versus 3.5% in the MHLW (control) message group). Moreover, Social Comparison message may also increase antibody testing uptake in the opt-in incentive group (4.9% in the Social Comparison message group versus 3.5% in the MHLW (control) message group). These effects are statistically significant at the 10% level.
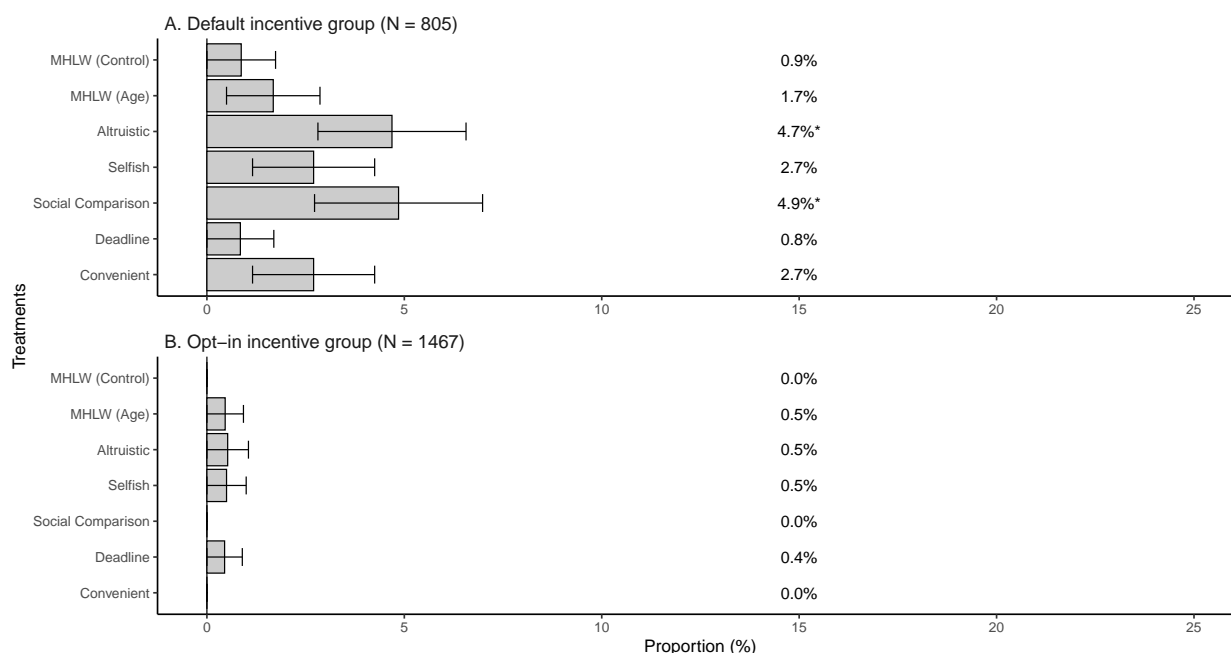
Figure 4: Effect of Text Messages on Behavior for Vaccination. Notes: Numbers in the figure indicate the proportion of each experimental arm. Error bars indicate the standard error of the mean. Asterisks are p-values of t-tests for the difference-in-mean: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 4 shows the vaccination rates in each experimental arm for the default incentive group (Panel A) and

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[3]An interesting finding is that only in the opt-in incentive group did the content of the Convinient message statistically significantly increase the intention to take the antibody test by about 9 pp. This group may not have a full understanding of the routine immunization campaign. In fact, the Wave 1 survey shows that only about 20% of the opt-in incentive group are aware of routine vaccination.

Table 3: Regressions of Behavior

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
MHLW (Age)	0.032	0.029	0.008	0.005
	(0.029)	(0.028)	(0.015)	(0.015)
Altruistic	0.075**	0.073**	0.038*	0.037*
	(0.033)	(0.032)	(0.021)	(0.021)
Selfish	0.055*	0.061*	0.018	0.018
	(0.032)	(0.032)	(0.018)	(0.018)
Social Comparison	0.053	0.056*	0.040*	0.040*
	(0.033)	(0.033)	(0.023)	(0.023)
Deadline	0.008	0.005	0.000	−0.002
	(0.025)	(0.025)	(0.012)	(0.012)
Convenient	0.037	0.038	0.018	0.018
	(0.030)	(0.030)	(0.018)	(0.018)
Opt-in	−0.030*	−0.018	−0.009	−0.003
	(0.018)	(0.020)	(0.009)	(0.012)
MHLW (Age) × Opt-in	−0.028	−0.026	−0.003	−0.002
	(0.030)	(0.030)	(0.015)	(0.016)
Altruistic × Opt-in	−0.058*	−0.057*	−0.033	−0.032
	(0.034)	(0.034)	(0.021)	(0.021)
Selfish × Opt-in	−0.045	−0.054	−0.013	−0.013
	(0.034)	(0.033)	(0.018)	(0.018)
Social Comparison × Opt-in	−0.029	−0.034	−0.040*	−0.039*
	(0.035)	(0.035)	(0.023)	(0.023)
Deadline × Opt-in	0.001	0.003	0.005	0.006
	(0.027)	(0.026)	(0.013)	(0.013)
Convenient × Opt-in	−0.032	−0.031	−0.018	−0.018
	(0.031)	(0.031)	(0.018)	(0.018)
Covariates		X		X
Num.Obs.	2272	2272	2272	2272
R2	0.030	0.047	0.019	0.029

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. Covariates are age, education year, annual income, usual health behavior (exercise, medical checkup and ful shot habit) and preference for compliance with social norm.

the opt-in incentive group (Panel B).[4] In the default incentive group, the Altruistic message may increase the vaccination rate by 3.8 pp (4.7% in the Altruistic message group versus 0.9% in the MHLW (control) message group). In the same group, the Social Comparison message may also increase vaccination rate by 4 pp (4.9% in the Social Comparison message group versus 0.9% in the MHLW (control) message group). These effects are statistically siginificant at 10% level.

4.3.2 Regression Analysis

As in the case of intention, the different effects of text messages for two incentive group is influenced by dimentions including age difference other than the presence or absence free vouchers. Thus, we estimate a linear probability model ((1)) and shows results in Table 3.

Regression analysis also shows that the Altruistic messages increase antibody test uptake only in the default

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[4]Vaccination is a dummy variable that takes the value of 1 if respondents have been tested and vaccinated. Thus, the vaccination rate can be regarded as the proportion of newly acquired antibodies through vaccination. This outcome variable matches MHLW's policy goal.

Table 4: Text Message Effects on Behavior for Opt-in Incentive Group Estimated by Regressions

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
MHLW (Age)	0.005	0.003	0.005	0.004
	(0.008)	(0.008)	(0.005)	(0.005)
Altruistic	0.017	0.016	0.005	0.005
	(0.011)	(0.011)	(0.005)	(0.005)
Selfish	0.010	0.007	0.005	0.005
	(0.010)	(0.010)	(0.005)	(0.005)
Social Comparison	0.023*	0.022*	0.000	0.000
	(0.012)	(0.013)		(0.001)
Deadline	0.009	0.009	0.004	0.005
	(0.009)	(0.009)	(0.004)	(0.005)
Convenient	0.005	0.007	0.000	0.000
	(0.008)	(0.009)	(0.000)	(0.001)
Covariates		X		X

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. Message effects are estimated by a sum of main term of treatment dummy and cross term between treatment dummy and opt-in dummy.

incentive group. Controlling for covariates, the Altruistic messages increase antibody test uptake by a statistically significant 7.3 pp in the default incentive group (column (2)). Furthermore, although the statistical significance is weak, the effect of this message weakens by 5.7 pp as the cost of obtaining a free vaccination ticket becomes more expensive. As a result, the effect of the Altruistic message in the opt-in incentive group is 1.6 pp, which is not statistically significant (column (2) in Table 4). A similar trend is observed for the effect on vaccination, but it is weakly statistically significant.

We summarize the results for the other messages. Controlling for covariates, the Selfish message may have increased the antibody test-taking rate in the default incentive group, although the statistical significance is weak (column (2) in Table 3). We also find that the Social Comparison message may have increased antibody testing rates in the two incentive groups (See column (2) in Table 3 and 4). However, the effect size is larger in the default incentive group than in the opt-in incentive group (not a statistically significant difference).

As confirmed by the difference-in-means test, the Social Comparison message may increase vaccination rates in the default incentive group (column (4) in Table 3). Although weakly statistically significant, the effect of this message weakens by 5.7 pp as the cost of obtaining vaccination tickets increases. As a result, the Social Comparison message does not increase vaccination rates in the opt-in incentive group (column (4) in Table 4). Again, the effect of the Altruistic message follows a similar trend.

4.4 Monetary Value of Text Messages

Altruistic (and possibly Social Comparison) messages encourage men who received free vouchers by default to obtain antibody testing and be vaccinated. In this subsection, we attempt to evaluate the effect of these messages in the default incentive group in terms of monetary value. That is, we seek to determine the extent to which the nudge messages increase the monetary value of the rubella vaccination. In other words, we are looking for an amount of additional subsidy equivalent to the message effects in terms of government subsidies.

We use willingness to pay (WTP) for the rubella vaccine.[5] Let WTP_i be an individual's willingness to pay and follow a distribution F. Then, for a given cost C, men will be vaccinated if $WTP_i \geq C$. The vaccination

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[5]Several studies calculate the monetary value of text messages. For example, Bursztyn et al. (2019) calculated it using the two

rate is $F_0 = 1 - F(C)$. Suppose that our treated message changes WTP by β. An individual who receives a treated message will be vaccinated if $WTP_i \geq C - \beta$. The vaccination rate of the treated message group is $F_1 = 1 - F(C - \beta)$. Thus, the treated message effect is $\tau = F_1 - F_0 = F(C) - F(C - \beta)$. From the perspective of government subsidies, the amount of subsidy equal to the effect of the nudge message τ is β. We want to estimate β.

Once F, C, and τ are determined, we obtain \$ \$. To begin, let us discuss the estimation of F (demand function). We elicit the WTP for vaccination in the first wave before participants read messages. If the vaccination costs 5,000 JPY, we ask respondents if they will get it if the local government pays s_j. The subsidy amounts are $s_j \in \{0, 1000, 2000, \dots, 10000\}$. Let $s_i^{\min}$ be the lowest subsidy at which respondents indicate that they would vaccinate. Let $s_i^{\max}$ be the highest subsidy that respondents indicate they would not vaccinate. We can identify the willingness to pay for vaccination within the range $[5000 - s_i^{\max}, 5000 - s_i^{\min})$. Thus, without additional assumptions, the demand curve is step-wise, and we estimate the monetary value of the message effect with bounds.[6] To obtain a point estimate, we assume that the true WTP is uniformly distributed within the range $[5000 - s_i^{\max}, 5000 - s_i^{\min})$. Then, The vaccination demand curve can then be linearly interpolated (see Figure 5 in Appendix).

In the default incentive group, eligible males receive free vaccination at no cost. Therefore, the natural setting is $C = 0$. In addition, the message effect τ is used for the effect on antibody test uptake. The person taking the antibody test wants to get the antibody, i.e. the vaccination, against rubella. However, the effect of the message on vaccination is different from the effect on (true) vaccination intention, because people with a positive antibody test result cannot be vaccinated. Therefore, τ is not the effect on vaccination, but the effect on antibody testing.

In our framework, $F_0 = 1 - F(0)$, but one potential concern remains. The message effect τ is estimated by the difference from the MHLW (control) group, and $F(0)$ does not take into account the 3.5% antibody test uptake rate of the MHLW (control) (see Figure 3). Assuming that everyone who did not participate in our survey did not take the antibody test after the survey, the uptake rate of MHLW (control) can be considered as an effect of providing the message in the survey. To account for this explicitly, we use $F_0 = (1 - F(0)) + (F(0) - F(-\alpha))$. The second term is the antibody testing rate of the control group (3.5%) under no vaccination cost. The demand function is estimated to be $F_0 = 0.7$ and $\alpha = 394$.

We find β holding that $\tau = F(-\alpha) - F(-\beta)$. Table 5 shows the estimated message value. The second and third columns show τ and $F_1 = \tau + F_0$, respectively. The fourth column shows β in terms of the value of the Japanese yen (in U.S. dollar value, shown in the sixth column). The Altruistic and Social Comparison message, which promotes antibody testing, value about 2,000 JPY (about 18 USD; 40% of assumed vaccination price) and 600 JPY (about 5.5 USD; 12% of assumed vaccination price), respectively. The total monetary value is the product of the per capita value and the number of people who have not yet used the free vouchers issued in FY2019 (5.29 million as of January 2020). In the fifth column, the Altruistic and Social Comparison messages are worth 10 billion JPY (about 98 million USD) and 3 billion JPY (about 28 million USD), respectively.

5   Discussion and Conclusions

This study uses RCTs to investigate effective messages for promoting rubella antibody testing and vaccination in two situations regarding financial incentives. Our experiment reveals that the Altruistic message, which emphasizes the negative externality of infection, increases the intention for antibody testing uptake by 14.3 pp among men who already received free vaccination tickets in FY2019. However, this message is less effective for men who incur transaction costs to obtain the vaccination tickets. There may be a statistically significant difference in the effect of this message between the two groups.

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relative effects of financial incentives and text message treatment groups. Moriwaki et al. (2020) also surveyed WTP amounts and calculated monetary value. The latter study is similar to our approach.

[6]If respondents indicated that they would not vaccinate at all subsidy amounts, then $s_i^{\max} = 10000$. However, we cannot define $s_i^{\min}$ in the data. Therefore, we assume $s_i^{\min} = 11000$. This assumption does not affect the monetary value of the messages.

Table 5: Estimated Monetary Value of Text Messages

Text messages	Effect	Baseline + effect	Monetary value (JPY)		Monetary value (USD)	
			pp	total	pp	total
MHLW (Age)	0.032	0.732	367.854	1.946	3.679	17.690
Altruistic	0.075	0.774	2037.553	10.779	20.376	97.988
Selfish	0.055	0.755	744.045	3.936	7.440	35.782
Social Comparison	0.053	0.752	596.335	3.155	5.963	28.678
Deadline	0.008	0.707	86.059	0.455	0.861	4.139
Convenient	0.037	0.737	422.789	2.237	4.228	20.332

We use the effect size of each text messages on antibody testing. Baseline is the sum of the rate of antibody test in the control and the free vaccination rates. The monetary value is the amount per person multiplied by the number of people who received the coupon in 2019 but did not use it until January 2020 (5.29 million). We valued it in Japanese Yen and US Dollars (1 USD = 110 JPY). The unit of monetary value per person is 1 JPY and 1 USD, respectively. The unit of total monetary value is 1 billion JPY and 1 million USD, respectively.

Similar results are found for the antibody test uptake. Among men who had already received vaccination vouchers in FY 2019, the Altruistic message increases the antibody test uptake by 7.5 pp, which is equivalent to a subsidy of 40% of the vaccination price. However, this message is less effective for men who incurred the cost of obtaining the vaccination tickets. The effect between the two groups may be statistically significant.

This finding suggests that text message reminders are effective when financial incentives and reminders are closely combined. In addition to the Altruistic message, the Selfish and the Social Comparison message may also raise the intention and the acutual uptake rate for the antibody testing among men who already received the vaccination tickets by default. However, these effect sizes are not large enough to maintain statistical power, requiring a re-examination with a large sample size.

One potential concern is that all behavior-related outcomes were self-reported. These outcomes may contain recall bias. We believe that these biases are less problematic because Wave 2 measures behavior within the last month (the time of Wave 1). The self-reported behavioral outcomes may also be subject to the experimenter demand effect and social desirability bias. To address these biases, our regression analysis directly controls for respondents' psychological factors related to these biases (e.g., following social norm). Even if these biases cannot be eliminated perfectly, they are not fatal to the identification of message effects since this study is a RCT and if these biased exist to the same extent in each group.

Finally, we discuss three points about mechanisms. The first is the mechanism of the Altruistic messages. The effect of Altruistic message (especially on the intention to test for antibodies) is due to a change in the content of the message rather than to the addition of a simple expression of age. The Altruistic message emphasizes the possibility of disability in infants and appeals to the negative externalities of not vaccinating. We analyze the heterogeneity of the message content effect to test which individuals respond more strongly to this message content.

First, in Wave 1, we examine the knowledge that infants born to infected pregnant women may have disabilities and test the heterogeneity of the effect of the altruistic message content on antibody testing intentions depending on whether respondents possessed this knowledge (see column (1) of Table 15 in the Appendix). The results show that the effect of the altruistic message content may be more effective for those who do not possess the knowledge than for those who do. Although there are no statistically significant difference between the effects with and without knowledge, the effects of message content for those with knowledge are not statistically significant. Thus, altruistic message content may modify knowledge about the negative externalities of infection.

It is also important whether a man is altruistic, caring about others' benefit (externality). We investigate

whether he feels pleasure in actions for others on a 5 scale in Wave 1 and test the heterogeneous effect of the Altruistic message content by the extent to which he does (see column (2) of Table 15 in the Appendix). The results show that the more altruistic one is, the stronger the effect of the Altruistic message content (this trend is statistically significant). Thus, the Altruistic messages may not be effective for those who do not care about others, even if they perceive negative externalities from reading messages.

The second argument is the effect on vaccination rates. Our experiments reveal that the Altruism and the Social Comparison messages may increase vaccination rates among men who received free vaccination tickets by default. The message effect on vaccination is created through two channels. First, the messages increase the number of negative individuals who need to be vaccinated. Second, the messages encourage unvaccinated negative individuals to vaccinate. Our data suggest that the first channel is more important than the second.

Table 16 in the Appendix shows the number of men who had antibody testing, who had a negative antibody test, and who were vaccinated in each experimental arm in the default incentive group. This table shows that most of those with negative antibody test results were vaccinated in all experimental arms. Furthermore, the number of negative antibody tests varied between experimental arms. Especially, the 25% (= 1/4) antibody tests are negative in the MHLW (Control) message group. In contrast, the negative ratios of antibody tests for the Altruistic and Social Comparison messages, which may have a positive effect on vaccination, are 50% (= 7/14) and 56% (= 5/9), respectively.[7] Thus, the experimental arms with higher vaccination rates have a greater negative ratio, resulting in a positive effect on vaccination. However, the difference in the ratio of negative antibody tests is not statistically significant.

A final discussion is why text messages are ineffective in groups that must incur transaction costs to obtain the free vaccination tickets. Our messages may not increase the value of antibody testing and vaccination sufficiently to outweigh their cost. In addition, another possibility is low awareness of rubella immunization campaign beginning in FY2019. Before presenting the messages, we inquire about the MHLW's policy in Wave 1. As a result, approximately 77.5% are unaware of the vaccination campaign Thus, even if they read the messages and realized the importance of rubella antibody testing and vaccination, they would believe they had to pay for these preventive actions.[8]

The last two arguments are important issues outside our context. The second argument concerns the targeting of interventions (e.g., Finkelstein & Notowidigdo 2019). That is, the question is whether marginal individuals whose behavior is changed by a policy intervention receive significant benefits from that policy. In our context, we suggest that the Altruistic message increases the number of negative individuals who receive a large benefit (vaccination) from the FY2019 vaccination campaign. The third argument relates to testing the effectiveness of vouchers (e.g., Kacker et al. 2022). The experimental data in this study alone do not allow us to fully explore these arguments, and they are a topic for future research.

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[7]The negative ratio of antibody testing for the Selfish message, which is only effective for antibody test uptake, is 30% (= 3/10). This value is similar to the MHLW (control) message.

[8]The fact that many people are unaware of the additional routine rubella vaccinations precludes the possibility that they stopped getting antibody testing and were vaccinated in the first year (FY2019) because they expected to automatically receive the voucher the following year.

A Tables and Figures

Table 6: List of Covariates

	Description	Mean	Std.Dev.
age	(Wave1) Age as of April 2019 based on year of birth and month of birth.	48.66	5.69
married	(Wave1) Dummy variable taking one if a respondent is married.	0.58	0.49
education	(Wave1) Years of education.	14.75	2.31
income	(Wave1) Household income. For those who did not respond with household income, the overall average was substituted.	684.90	375.74
noinfo_income	(Wave1) Dummy variable taking one if a respondent did not answer household income.	0.15	0.36
exercise_w1	(Wave1) Dummy variable taking one if a respondent exercises or plays sports more than once a week.	0.22	0.42
health_check	(Wave1) Dummy variable taking one if a respondent has had a medical examination at his/her city or place of employment in the past year from the time of the wave 1.	0.68	0.46
flushot	(Wave1) Dummy variable taking one if a respondent is vaccinated against influenza every year.	0.27	0.45
norm	(Wave2) Five-point Likert scale for the question "I wash my hands and gargle frequently during the period from the end of the previous questionnaire response to today."	11.24	2.32
handwash	(Wave2) Five-point Likert scale for the question "I take my temperature frequently during the period from the end of the previous questionnaire response to today."	3.91	1.04
temp_check	(Wave2) Five-point Likert scale for the question "I am refraining from going out during the end of the previous questionnaire response to today."	2.26	1.22
avoid_out	(Wave2) Five-point Likert scale for the question "I avoid crowded places when I go out from the end of the previous questionnaire response to today."	2.96	1.20
avoid_crowd	(Wave2) Five-point Likert scale for the question "I always wear a medical mask when I go out or meet people during the period from the end of the previous questionnaire response to today."	3.38	1.10
wear_mask		3.14	1.38

References

Bursztyn, L., Fiorin, S., Gottlieb, D. & Kanz, M. (2019), 'Moral Incentives in Credit Card Debt Repayment: Evidence from a Field Experiment', *Journal of Political Economy* **127**(4), 1641–1683.

Finkelstein, A. & Notowidigdo, M. J. (2019), 'Take-Up and Targeting: Experimental Evidence from SNAP', *The Quarterly Journal of Economics* **134**(3), 1505–1556.

Kacker, S., Macis, M., Gajwani, P. & Friedman, D. S. (2022), 'Providing vouchers and value information for already free eye exams increases uptake among a low-income minority population: A randomized trial', *Health Economics* **31**(3), 541–551.

Moriwaki, D., Harada, S., Schneider, J. & Hoshino, T. (2020), Nudging Preventive Behaviors in COVID-19 Crisis: A Large Scale RCT using Smartphone Advertising, Technical Report DP2020-021, Institute for Economic Studies, Keio University, Tokyo, Japan.

Table 7: Balance Tests for Default Incentive Groups (Sample for Estimating Effect on Intention)

	MHLW (Control)	MHLW (Age)	Altruistic	Selfish	Social Comparison	Deadline	Convenient	F-test, p-value
age	42.862	43.046	43.135	43.045	42.909	42.906	42.866	0.874
married	0.408	0.458	0.412	0.417	0.455	0.478	0.480	0.785
education	14.654	14.473	14.595	14.205	14.099	14.348	14.575	0.446
income	557.562	645.556	613.156	623.542	569.530	590.422	633.487	0.149
noinfo_income	0.162	0.168	0.203	0.197	0.157	0.130	0.181	0.706
exercise_w1	0.246	0.176	0.277	0.189	0.165	0.217	0.213	0.285
health_check	0.654	0.626	0.696	0.538	0.603	0.674	0.614	0.150
flushot	0.238	0.260	0.203	0.144	0.140	0.239	0.236	0.055
norm	11.100	10.679	10.649	10.864	11.165	10.855	10.945	0.492

Notes: Table 6 describes variables. Columns 2–8 show sample averages for each experimental arm. Column 9 shows p-value of the joint null hypothesis (F-test).

Table 8: Balance Tests for Opt-In Incentive Group (Sample for Estimating Effect on Intention)

	MHLW (Control)	MHLW (Age)	Altruistic	Selfish	Social Comparison	Deadline	Convenient	F-test, p-value
age	51.632	51.408	51.226	51.657	51.582	51.545	51.502	0.712
married	0.600	0.588	0.628	0.657	0.602	0.549	0.619	0.334
education	14.572	14.655	14.530	14.830	14.566	14.634	14.393	0.578
income	712.622	707.190	687.764	677.141	656.419	707.708	710.713	0.540
noinfo_income	0.184	0.164	0.145	0.117	0.155	0.163	0.205	0.211
exercise_w1	0.156	0.193	0.239	0.230	0.183	0.203	0.218	0.252
health_check	0.632	0.664	0.701	0.683	0.653	0.659	0.644	0.742
flushot	0.228	0.244	0.197	0.270	0.275	0.228	0.251	0.433
norm	11.336	11.340	11.346	11.304	11.187	11.122	11.293	0.922

Notes: Table 6 describes variables. Columns 2–8 show sample averages for each experimental arm. Column 9 shows p-value of the joint null hypothesis (F-test).

Table 9: Massage Content Effects on Intentions Compared to MHLW (Age)

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
Altruistic	0.122**	0.128**	0.004	0.004
	(0.054)	(0.051)	(0.060)	(0.057)
Selfish	0.051	0.075	0.019	0.040
	(0.054)	(0.052)	(0.061)	(0.059)
Social Comparison	0.019	0.028	−0.005	−0.007
	(0.054)	(0.052)	(0.063)	(0.059)
Deadline	0.010	0.000	−0.029	−0.045
	(0.052)	(0.050)	(0.060)	(0.058)
Convenient	0.031	0.021	−0.002	−0.016
	(0.054)	(0.051)	(0.062)	(0.058)
Opt-in	0.023	0.023	0.027	−0.031
	(0.046)	(0.052)	(0.054)	(0.060)
Altruistic × Opt-in	−0.045	−0.050	0.034	0.032
	(0.068)	(0.065)	(0.075)	(0.071)
Selfish × Opt-in	0.014	−0.026	0.018	−0.020
	(0.068)	(0.065)	(0.077)	(0.073)
Social Comparison × Opt-in	−0.032	−0.039	−0.011	−0.006
	(0.067)	(0.063)	(0.077)	(0.073)
Deadline × Opt-in	0.043	0.065	0.067	0.097
	(0.066)	(0.063)	(0.076)	(0.072)
Convenient × Opt-in	0.056	0.071	0.038	0.059
	(0.068)	(0.065)	(0.077)	(0.073)
Covariates		X		X
Num.Obs.	2235	2235	2235	2235
R2	0.008	0.108	0.004	0.113

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. We exclude from the sample those assigned to MHLW (control). The reference group is MHLW (Age). Covariates are age, education year, annual income, usual health behavior (exercise, medical checkup and ful shot habit) and preference for compliance with social norm.

Table 10: Message Content Effects for Opt-in Incentive Group Estimated by Regressions

| | Testing | | Vaccination | |
	(1)	(2)	(3)	(4)
Altruistic	0.077*	0.077*	0.038	0.036
	(0.042)	(0.040)	(0.046)	(0.043)
Selfish	0.065	0.049	0.038	0.020
	(0.042)	(0.039)	(0.046)	(0.044)
Social Comparison	−0.013	−0.011	−0.016	−0.013
	(0.039)	(0.036)	(0.045)	(0.042)
Deadline	0.053	0.065*	0.038	0.053
	(0.041)	(0.039)	(0.046)	(0.043)
Convenient	0.087**	0.092**	0.036	0.043
	(0.042)	(0.039)	(0.046)	(0.043)
Covariates		X		X

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. We exclude from the sample those assigned to MHLW (control). The reference group is MHLW (Age). Message effects are estimated by a sum of main term of treatment dummy and cross term between treatment dummy and opt-in dummy.

Table 11: Balance Tests for Default Incentive Group (Sample for Estimating Effect on Behavior)

	MHLW (Control)	MHLW (Age)	Altru- istic	Selfish	Social Com- pari- son	Dead- line	Con- ve- nient	F-test, p-value
age	42.861	43.059	43.102	43.036	42.893	42.898	42.964	0.953
married	0.391	0.454	0.391	0.360	0.437	0.466	0.477	0.467
education	14.496	14.471	14.547	14.126	14.010	14.407	14.595	0.474
income	548.244	649.778	614.512	599.124	555.083	591.597	637.056	0.102
noinfo_income	0.174	0.126	0.203	0.207	0.146	0.136	0.171	0.522
exercise_w1	0.252	0.185	0.266	0.171	0.165	0.195	0.225	0.375
health_check	0.643	0.639	0.680	0.532	0.631	0.661	0.640	0.391
flushot	0.235	0.261	0.227	0.135	0.146	0.246	0.207	0.082
norm	11.174	10.706	10.758	11.063	11.204	10.831	10.982	0.523
handwash	3.861	3.916	3.797	3.757	3.767	3.915	3.829	0.835
temp_check	2.139	2.235	2.414	2.126	2.204	2.203	2.117	0.535
avoid_out	3.096	3.034	3.047	2.793	2.932	3.025	2.928	0.544
avoid_crowd	3.296	3.336	3.273	3.234	3.350	3.305	3.324	0.990
wear_mask	2.930	3.076	3.109	3.009	3.010	3.144	3.207	0.794

Notes: Table 6 describles variables. Columns 2–8 show sample averages for each experimental arm. Column 9 shows p-value of the joint null hypothesis (F-test).

Table 12: Balance Tests for Opt-in Incentive Group (Sample for Estimating Effect on Behavior)

	MHLW (Control)	MHLW (Age)	Altru-istic	Selfish	Social Comparison	Dead-line	Con-ve-nient	F-test, p-value
age	51.695	51.394	51.179	51.662	51.421	51.605	51.512	0.564
married	0.591	0.560	0.611	0.652	0.598	0.547	0.596	0.407
education	14.505	14.620	14.553	14.876	14.593	14.610	14.345	0.472
income	712.165	707.809	686.355	671.407	644.798	699.289	718.575	0.370
noinfo_income	0.173	0.157	0.137	0.114	0.159	0.166	0.222	0.142
exercise_w1	0.159	0.194	0.232	0.229	0.173	0.211	0.202	0.432
health_check	0.632	0.667	0.684	0.677	0.645	0.673	0.631	0.849
flushot	0.223	0.245	0.189	0.264	0.280	0.215	0.241	0.376
norm	11.355	11.329	11.384	11.189	11.220	11.224	11.222	0.964
handwash	3.823	3.889	3.926	3.751	3.836	3.861	3.867	0.769
temp_check	2.095	2.204	2.221	2.100	2.136	2.085	2.182	0.841
avoid_out	2.886	2.889	2.932	2.866	2.855	2.964	2.941	0.960
avoid_crowd	3.295	3.361	3.447	3.239	3.313	3.309	3.433	0.437
wear_mask	3.082	3.176	3.116	3.144	2.977	2.942	3.010	0.533

Notes: Table 6 describes variables. Columns 2–8 show sample averages for each experimental arm. Column 9 shows p-value of the joint null hypothesis (F-test).
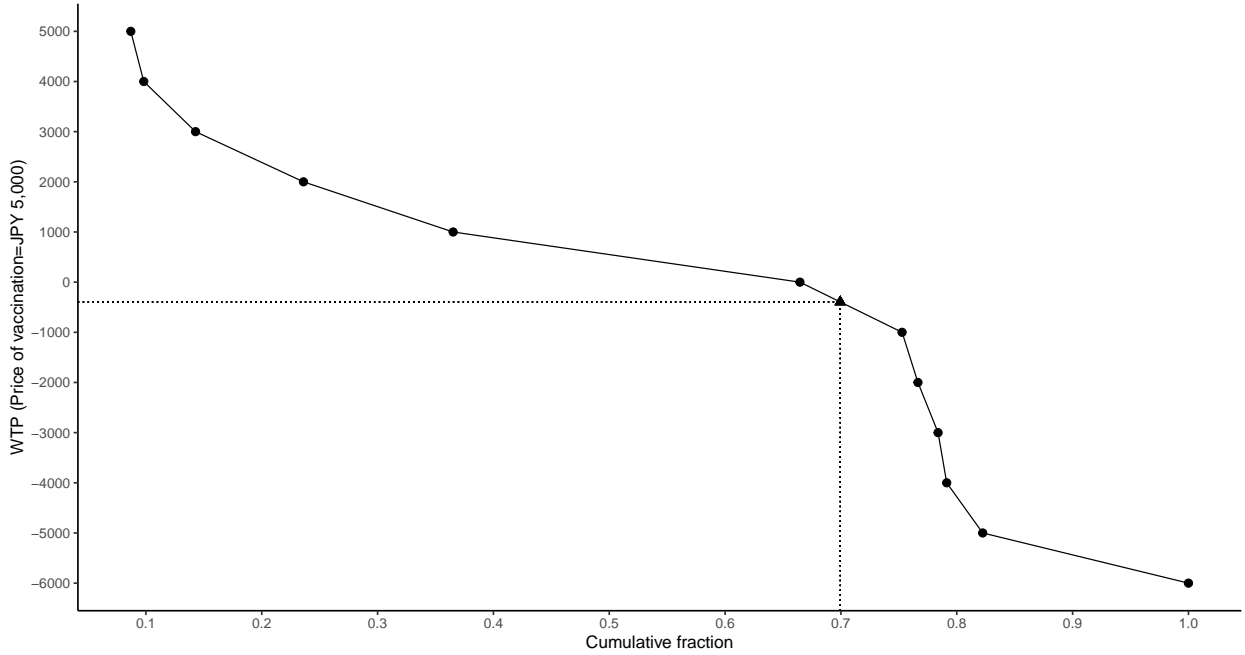

Figure 5: Demand Curve of Rubella Vaccination for Default Incentive Group. Notes: Black triangles indicate the baseline vaccination rate F_0 and the corresponding WTP.

Table 13: Message Content Effects on Behaivor Compared to MHLW (Age)

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
Altruistic	0.042	0.045	0.030	0.032
	(0.036)	(0.036)	(0.022)	(0.022)
Selfish	0.023	0.032	0.010	0.013
	(0.036)	(0.035)	(0.019)	(0.020)
Social Comparison	0.020	0.027	0.032	0.034
	(0.036)	(0.036)	(0.024)	(0.025)
Deadline	−0.025	−0.024	−0.008	−0.007
	(0.030)	(0.029)	(0.015)	(0.014)
Convenient	0.005	0.009	0.010	0.013
	(0.034)	(0.034)	(0.019)	(0.019)
Opt-in	−0.058**	−0.046*	−0.012	−0.002
	(0.024)	(0.026)	(0.013)	(0.015)
Altruistic × Opt-in	−0.030	−0.031	−0.029	−0.031
	(0.038)	(0.038)	(0.023)	(0.024)
Selfish × Opt-in	−0.017	−0.027	−0.010	−0.012
	(0.037)	(0.037)	(0.021)	(0.021)
Social Comparison × Opt-in	−0.001	−0.008	−0.036	−0.038
	(0.038)	(0.039)	(0.025)	(0.025)
Deadline × Opt-in	0.029	0.030	0.008	0.008
	(0.031)	(0.031)	(0.016)	(0.016)
Convenient × Opt-in	−0.004	−0.004	−0.015	−0.017
	(0.035)	(0.035)	(0.020)	(0.020)
Covariates		X		X
Num.Obs.	1937	1937	1937	1937
R2	0.029	0.047	0.019	0.030

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. We exclude from the sample those assigned to MHLW (control). The reference group is MHLW (Age). Covariates are age, education year, annual income, usual health behavior (exercise, medical checkup and ful shot habit) and preference for compliance with social norm.

Table 14: Message Content Effects for Opt-in Incentive Group Estimated by Regressions

	Testing		Vaccination	
	(1)	(2)	(3)	(4)
Altruistic	0.012	0.014	0.001	0.001
	(0.012)	(0.013)	(0.007)	(0.007)
Selfish	0.006	0.004	0.000	0.002
	(0.011)	(0.011)	(0.007)	(0.007)
Social Comparison	0.019	0.019	−0.005	−0.004
	(0.013)	(0.013)	(0.005)	(0.005)
Deadline	0.004	0.006	0.000	0.001
	(0.010)	(0.010)	(0.006)	(0.007)
Convenient	0.001	0.005	−0.005	−0.004
	(0.010)	(0.010)	(0.005)	(0.005)
Covariates		X		X

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. We exclude from the sample those assigned to MHLW (control). The reference group is MHLW (Age). Message effects are estimated by a sum of main term of treatment dummy and cross term between treatment dummy and opt-in dummy.

Table 15: Heterogeneous Effects of Altruistic Message Contents

	Intention for testing	
	(1)	(2)
Altruistic	0.199***	−0.115
	(0.068)	(0.112)
Altruistic × Handicap	−0.120	
	(0.081)	
Altruistic × Generosity		0.079**
		(0.035)
Other nudges	0.034	0.031
	(0.039)	(0.040)
Linear combination test		
Altruistic + Altruistic × Handicap	0.079	
	(0.063)	
Altruistic + Altruistic × Most generous		0.280***
		(0.088)
Covariates	X	X
Num.Obs.	797	797
R2	0.136	0.150

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. We exclude from the sample those assigned to MHLW (control), The reference group is MHLW (Age). Covariate "Other nudges" is a dummy that indicating respondents are assigned to the Selfish, Social Comparison, Deadline, and Covenient message group. Covariate "Handicap" is a dummy that respondent knows that infants born to infected pregnant women may have disabilities. Covariates "Generosity" indicates on a 5-point scale the degree to which respondent feels pleasure in actions for others. Respondents who give a score of 5 to this are the most generous. Covariates are age, education year, annual income, usual health behavior (exercise, medical checkup and ful shot habit) and preference for compliance with social norm.

Table 16: Number of Anitbody Testing, Negatives, and Vaccinations in Default Incentive Group

Text message	Sample size	Anitbody test		Negatives			Vaccination		
		N	% of sample	N	% of test	% of sample	N	% of negatives	% of sample
MHLW (Control)	115	4	3.5	1	25.0	0.9	1	100.0	0.9
MHLW (Age)	119	8	6.7	2	25.0	1.7	2	100.0	1.7
Altruistic	128	14	10.9	7	50.0	5.5	6	85.7	4.7
Selfish	111	10	9.0	3	30.0	2.7	3	100.0	2.7
Social Comparison	103	9	8.7	5	55.6	4.9	5	100.0	4.9
Deadline	118	5	4.2	1	20.0	0.8	1	100.0	0.8
Convenient	111	8	7.2	5	62.5	4.5	3	60.0	2.7