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Does Free Cancer Screening Make a Difference? Evidence from the effects of a free-coupon program in Japan

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Does Free cancer Screening Make a Difference? Evidence from the effects of a free-coupon program in Japan*

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Abstract

Since the 1980s, cancer has been the leading cause of death in Japan. The substantial and long-term adverse effects on labor productivity and health expenditures make cancer control an important public health issue. To identify and treat cancer in its early stages, mass cancer screening for target populations is increasingly becoming a common practice. However, cancer screening rates remain low in many areas including Japan. In 2009, a free-coupon program was launched to provide free breast and uterine cancer screening to the target populations. The program further provided free coupons for colorectal cancer screening in 2011. Using rich data from the Comprehensive Survey of Living Conditions (CSLC) in Japan from 2004 to 2019, this study exploits the exogeneous variation in the incentive to receive cancer screening driven by the eligibility for the free-coupon program to analyze: (a) the effects of the program on screening rates and (b) the effects of cancer screening on the physical and mental health of individuals. Our results suggest that providing free coupons significantly increased the probability of attending breast and cervical cancer screenings by approximately 9-10% and that of colorectal cancer screening by approximately 5% for females and 2% for males. Moreover, although young women with low incomes seem to be more likely to use the free coupon for cervical cancer screening, the disadvantaged, such as those with more children and/or old family members in need of care, benefit less from the program. Lastly, we find that receiving cancer screenings could significantly improve individuals' self-reported health status and reduce the probability of feeling mentally stressed.

Keywords: Cancer Screening, Free coupon, Japan, Health Status, Stress

JEL codes: I18, I14, I11

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1. Introduction

Mass cancer screening for target population is increasingly becoming a common practice in many countries as a strategy to combat cancer, the leading cause of death worldwide. These efforts are motivated by a large body of literature that have proven the effectiveness of screening such as early detection before major symptoms occur, more successful cancer treatment and, hence, lower mortality and morbidity rates (e.g., Cutler, 2008; Levin et al., 2008; Nelson et al., 2009; Whitlock et al., 2008 and 2011; Schiffman et al., 2015, Ma and Richardson, 2022). Moreover, economic evaluation has shown that screening for breast, cervical and colorectal cancers are often cost-effective, which explains why many developed countries actively promote mass screening for these cancers (e.g., Esselen and Feldman, 2013; Feig, 2010; Lansdorp-Vogelaar et al., 2011; Ratushnyak et al., 2019).

However, despite the potential benefits, utilization of cancer screening is still suboptimal and unequal. For example, in 2020, the prevalence of biennial breast cancer screening among women aged 50-75 was 78% in the U.S. and 40.9% in Japan. The rates are even lower for annual colorectal cancer screening, 69.4% in the U.S. and 46.35% in Japan. Among women aged 21-65, more than 20% did not receive cervical cancer screening in the past 3 years in the U.S. and the rate was as high as 47.5% in Japan (Ma and Richardson, 2022; CSLC 2019 data)[2]. Moreover, socioeconomically disadvantaged groups are also found to be much less likely to receive cancer screening.

[2] The rates for female cancers in Japan are for biennial screening reported in 2019. A survey on the perceptions of cancer screening conducted by Japan's Cabinet Office in 2017 pointed out that the most common reason given for not receiving cancer screening in Japan is the lack of time for screening (30.6%), which seems plausible given that working hours in Japan is usually much higher than other developed countries. The second reason is that individuals believe that they are not at risk of cancer (29.2%). Concern about out-of-pocket costs was given as the fourth major reason (15.9%). (JCO, 2017)

Previous studies have shown that monetary costs (Tabuchi et al., 2013; Collazo et al., 2015), nonmonetary costs such as travel time and distance (St-Jacques et al., 2013; Sano et al., 2016), risk perception (Atkinson et al., 2015), health literacy (Davis, 2002) and social influence (Paskett et al., 2013) may prevent individuals from receiving cancer screening. In order to remove such barriers to cancer screening, free or subsidized public cancer screenings are sometimes provided. However, previous studies have shown that there is still a selection problem exists for these public interventions, so that the disadvantaged groups may not be reached as expected (Kim and Lee, 2017; Einav et al., 2020). Furthermore, besides the proven benefits, cancer screening may have a negative effect coming from the mental stress due to false-positive results, or overdiagnosis of lesions that may not become evidence during the lifetime of patient (Brett and Austoker, 2001; Bond et al., 2013; Wadsworth et al., 2022).

To develop a better understanding of the effects of free population-based cancer screening, this study analyzes the effects of a quasi-experimental national program in Japan that provided free breast, cervical and colorectal cancer screenings to targeted population in 2009-2013. In 2009, the Japanese government introduced a free-coupon program which provided a voucher for a free breast cancer screening to women whose ages reached the first year of a 5-year age group in their 40s and 50s, a free cervical cancer screening to those turned the first year of a 5-year age group in their 20s and 30s. Later in 2011, a voucher for a free colorectal cancer screening was also provided.

Several previous studies have examined the impact of the free-coupon program in Japan (Tabuchi et al., 2013; Ueda et al., 2015; Tabuchi et al., 2017). These studies mainly focus on the effect of intervention on cancer screening rates. We contribute to this literature in three ways. First, we compare various specifications to carefully identify the effect of free coupon on the probability of taking cancer screening. Second, we specifically examine the heterogeneous effects for subgroups with different childcare and nursing care burden which have gained little attention so far. Third, we further explore the exogenous variation in cancer screening uptake driven by the program to estimate the effect receiving cancer screening on self-reported health status.

Using rich repeated cross-sectional data from the Comprehensive Survey of Living Conditions (CSLC) in Japan from 2004 to 2016, this study exploits the exogeneous variation in the incentive to take a cancer screening driven by the program to analyze: (a) the effects of the program on cancer screening uptake and (b) the effects of taking cancer screening on individuals' physical and mental health. Our results suggest that the program significantly increased the probability of attending breast and cervical cancer screenings by approximately 9-10% and that of colorectal cancer screening by approximately 5% for female and 2% for male. Moreover, although young women with low incomes seem to be more likely to use the voucher for cervical cancer screening, the disadvantaged, such as those with heavier childcare burden and/or nursing care burden, do not really benefit more from the program. Lastly, we find that receiving cancer screening could significantly improve individuals' self-reported health status and reduce the probability of feeling mentally stressed within a year after the screening.

The remaining part of the paper is organized as follows. Section 2 provides a brief introduction of the institution background in Japan. We discuss our identification strategies in Section 3, followed by the description of the data and sample in Section 4. Section 5 discusses the results in detail and Section 6 concludes.

2. Institutional background

2.1 Cancer screening in Japan

Cancer control has gained increasing attention from Japanese government since the start of the 1980s when cancer became the leading cause of death in Japan. Two important policies on cancer control, the Comprehensive 10-year Strategy for Cancer Control and the New 10-year Strategy to Overcome Cancer, were launched in 1984 and 1994, respectively. These policies mainly focus on the development of cancer research and the improvement of cancer treatment. In 2004, the 3rd Term Comprehensive 10-year Strategy for Cancer Control further included the prevention of cancer as an important focus, named as one of the three pillars of cancer control strategies.[3]

The promotion of cancer screening is by far the most important component of the prevention of cancer. In 1983, the Health Care for the Aged Law started to introduce mass screening of stomach and cervical cancer in Japan. Four years later, the screening of lung breast cancer was added, followed by the inclusion of colorectal cancer in 1992. The population-based screening of these five cancers is largely subsidized by the government, implemented by the local governments and contracted healthcare service providers. The target population eligible for theses cancer screenings are listed in Table 1, and the implementation often varies slightly across local governments.

The universal health insurance system in Japan requires everyone enroll in a health insurance plan in Japan. Basically, there are two major types of health insurance: (a) employment-based insurance and (b) government-based insurance, called National Health Insurance, for people without employment, e.g., the self-employed, retirees and

[3] The other two pillars are the development of cancer research and the improvement of cancer treatment and social environment.

the unemployed. In 2008, a specific health insurance scheme was launched for the elderly aged 75 or above. Besides the municipal cancer screening, some employment-based insurance also provide their members cancer screenings which are usually more expensive, but may be more comprehensive and time saving because they could be taken as a part of an annual general health checkup if offered as an option.

2.2 Free-coupon program

To promote cancer screening, especially for female cancer, a national free-coupon program was launched by the Ministry of Health, Labour and Welfare (MHLW) in September of 2009. Basically, all women who turned the first year of a five-year age group on 31 March, 2009, received a voucher by mail from their local administrative offices, together with an information booklet. That is, women aged 41, 46, 51, 56 and 61 years could receive a free breast cancer screening by the end of March of 2010. Similarly, women aged 21, 26, 31, 36 and 41 could receive a free cervical cancer screening within the same period. Furthermore, following the similar scheme, free colorectal cancer screening voucher was also provided to both sexes aged 41, 46, 51, 56 and 61 years.

The major tests implemented in the female cancer screenings include a common mammogram for breast cancer screening and a Pap smear for cervical cancer screening. For the colorectal cancer screening, a standard fecal occult blood test (FOBT) is implemented. Individuals could choose to receive the tests either at a screening venue on a given day or at a contracted health clinic upon the appointment made by themselves. According to the prices set by the MHLW, a mammogram usually costs 5,500JPY (approximately $39), a Pap smear 3,400JPY (approximately $24), and a FOBT 710JPY (approximately $5). But the out-of-pocket costs are usually lower and vary across different regions because of the subsidies from local governments.

The national free-coupon program was implemented until the end of 2013, and then it was maintained by local governments at their discretion. Some municipalities abandoned the program, while some kept the original scheme or revised the eligibility criteria. For example, the program was continued until 2016 in the city of Chiba. Since 2017, only females at 41(21) could receive free breast(cervical) cancer screening and the voucher for colorectal cancer screening was terminated completely.

2.3 Stylized facts

Before we move on to discuss the methodology, we first examine the trends and in cancer screening rates by age in Japan to visualize any possible changes due to the program. The Comprehensive Survey of Living Conditions (CSLC) provides the most accurate and representative information on cancer screening behaviors in Japan every three years since 2001. More details on the CSLC data will be given in Section 4. Using data from four waves in 2007, 2010, 2013 and 2016 that are most relevant to the free-coupon program, in Figures 1-5, the shares of people who have received annual cancer screening are plot against ages.

We look at five types of cancers that are highly recommended and subsidized by the government, namely breast, cervical, colorectal, stomach and lung cancers. In general, screening rates increase at age, especially after age 30 and peak around the 50s. For each age level, screening rates increased more or less over time. For example, breast cancer screening rates were around 45% for the 40s and 50s in 2016, in comparison to nearly 30% in 2007. An increase in cervical cancer screening rates was quite obvious among young women over time, probably due to the free-coupon program targeted at younger ages. For the other three cancer screenings, a significant increase was observed after 2013, especially for the middle age groups.

Taking a closer look at the ages eligible for free screenings, it is quite clear that the screening rates are significantly higher compared to the other age groups. For example, the breast cancer screening rates jumped by around 10~15% at ages 41, 46, 51, 56 and 61 in 2010, while they were not significantly different in 2007. The gaps became smaller in 2013 and almost disappeared in 2016. A similar pattern is visible for cervical and colorectal cancer screening. In comparison, no such specific age pattern is observed for stomach and lung cancers for which free coupon was not provided. The figures are very suggestive of the effects of free-coupon program. We then discuss the method to formally estimate the program effects in the following section.

3. Empirical Model

We use several identification frameworks to estimate the effects of free-coupon program. The most straightforward approach would be to compare those who are eligible for the program and those who are not, because the eligibility is exogenously determined by the policy. We could define the group eligible for free coupon, called treatment group hereafter, based on whether one's age is the first year of a 5-year age group, being the eligibility age as listed in Table 1. One the other hand, there are two plausible ways to define the comparison group: (a) using only those with ages 1 year different from the eligibility age; (b) including all of those in a 5-year age group except for the eligibility age. The former provides a clearest comparison between the treatment and comparison groups, while the latter may increase the power with a larger sample.

3.1. The effect of offering free coupon on screening rate

Empirically, we could estimate the treatment effect by a standard probit model. Assuming that a person i decides whether to receive her cancer screening, denoted as $Y_i = 1$, based on the underlying tendency y^*. Mathematically,

$$y_i^* = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \varepsilon_i \ , \quad \begin{cases} Y_i = 1 \ if \ y_i^* > 0 \\ Y_i = 0 \ if \ y_i^* \leq 0 \end{cases}. \qquad (1)$$

where T_i is a dummy variable indicating whether in the treatment group, and $\boldsymbol{X}_i$ includes basic characteristics such as county dummies, continuous age, as well as a dummy variable that equals 1 if age is 40 or above to control for regional differences and other age effects. The treatment effect, or technically the effect of being offered with the free coupon, could be identified by estimating the coefficient β. But because we do not observe y_i^*, we estimate a standard probit model instead. Since the error term ε is independent of T and X, following a standard normal distribution, the density of Y_i (Y_i=1 , 0) can be written as

$$f(Y_i|T_i, \boldsymbol{X}_i) = [\boldsymbol{\Phi}(z)]^{y_i}[1 - \boldsymbol{\Phi}(z)]^{1-y_i}, \qquad (2)$$

$$z = \alpha + \beta T_i + \gamma \boldsymbol{X}_i$$

where $\boldsymbol{\Phi}(.)$ is the c.d.f. of a standard normal distribution. The model is estimated by maximizing the sum of log-likelihood function for the whole sample. In the probit model, the treatment effect will the marginal effect of T on the predicted probability, that is

$$\boldsymbol{\Phi}(\alpha + \beta + \gamma \boldsymbol{X}_i) \text{-} \ \boldsymbol{\Phi}(\alpha + \gamma \boldsymbol{X}_i). \qquad (3)$$

Note that we could estimate the treatment effect based on the two different ways to define the comparison group, as discussed at the beginning of this section.

Equation (2) could only be estimated for the years when the program was implemented. Yet including the data from the years before the program started might increase the precision of the estimation. We therefore compare the difference in the probability of receiving cancer screening between the treatment and comparison groups before and after the program started, analogous to a difference-in-difference model. That is, equation (2) could be now written as

$$f(Y_i|T_i, \boldsymbol{X}_i) = [\boldsymbol{\Phi}(z)]^{y_i}[1 - \boldsymbol{\Phi}(z)]^{1-y_i}, \quad (4)$$

$$z = \alpha + \theta T_{it} + \tau A_{it} + \beta T_{it} * A_{it} + \gamma \boldsymbol{X}_{it}$$

where A_{it} is time dummy indicating whether the program has started. Note that since our data are not panel, we are not able to compare the outcomes for the same individuals over time. In a standard DID model, the treatment effect will be the coefficient of the interaction term β. But in our specification, we need to calculate the marginal effect of the interaction term by taking the difference between the predicted probability with and without the interaction term, in a manner similar to equation (3). Note that coefficient θ could be used as a check of the randomization before the program started. If there is no systematic difference between the treatment and comparison groups at baseline, the estimate of θ should be statistically insignificant.

Furthermore, it is also useful to estimate the heterogenous treatment effect to examine whether individuals with certain characteristics benefit more or less from the program. Empirically, we could include a triple interaction term between *T*, *A* and the characteristics of interest X_h as the follows

$$f(Y_i|T_i, \boldsymbol{X}_i) = [\boldsymbol{\Phi}(z)]^{y_i}[1 - \boldsymbol{\Phi}(z)]^{1-y_i}, \quad (5)$$

$$z = \alpha + \theta T_{it} + \tau A_{it} + \beta T_{it} * A_{it} + \gamma \boldsymbol{X}_{it} + \delta T_{it} * A_{it} * X_h + \mu X_h.$$

Note that the other interaction terms between *A* and X_h and those between *T* and X_h are absorbed in $\boldsymbol{X}$. The coefficient for this term could be interpreted as the heterogenous treatment effect. In this study, we are specifically interested in six measures of socioeconomic status: (a) income measured by the log of per capita household monthly expenditure; (b) burden of child care measured by the number of children under age 6 in a household; (c) care burden measured by the number of family members in need of nursing care; (d) marriage status measured by whether one has a spouse; (e) working status measured by whether one is currently working; and (f) type of health insurance measured by whether one is a member of the National Health Insurance.

3.2. The effect of receiving cancer screening on health

The method discussed so far basically estimate the effect of being eligible and receiving a free coupon. Instead, we could also estimate the effect of receiving cancer screening on physical and mental health status. Because cancer screening is often a behavioral choice, the estimate will be biased if we directly include it as an explanatory variable in a health regression. To address the endogenous issue, we exploit the exogenous variation in cancer screening behavior driven by the offer of free coupon. Since the eligibility of program is randomly determined by the policy makers, eligibility age could be used as an instrument variable (IV) which is not likely to be correlated with other unobservable characteristics that affect individuals' health.

Health outcome of interest in this study includes whether one is currently receiving cancer treatment, whether one evaluates her health status as good, and whether she feels daily stress. The first outcome is the optimal goal of cancer screening, i.e., early detection and treatment of cancer. While cancer screening is generally beneficially, there are also concerns about the side effects such as the stress from uncomfortable tests and the anxiety arise from test results. This is especially a problem for those who have to take a secondary test, only to find their tests are actually normal, so called "false positive".

Consider the case that we have two endogenous binary variables, health *H* and cancer screening *Y*, where *H* is a function of *Y*. We rely on a bivariate probit model to estimate the effect of receiving cancer screening on health. Mathematically,

$$H_{it} = \mathbf{1}[a_1 + b_1 Y_{it} + c_1 \boldsymbol{X}_{it} + u_{it} > 0] \tag{6}$$

$$Y_{it} = \mathbf{1}[a_2 + b_2 \boldsymbol{Z}_{it} + c_2 \boldsymbol{X}_{it} + v_{it} > 0] \tag{7}$$

where $\mathbf{1}[.]$ is an indicator function which equals unity if the statement in the bracket is true, and zero otherwise. The error terms u and v are independent of the instrumental variable $\boldsymbol{Z}$, and follow a bivariate normal distribution with mean zero, unit variance and correlation $\rho = \mathrm{Corr}(u, v)$. Therefore,

$$P(H_i = 1 | Y_i = 1, \boldsymbol{Z})$$

$$= \frac{1}{\boldsymbol{\Phi}(a_2 + b_2 \boldsymbol{Z}_i)} \int_{-\infty}^{-(a_2 + b_2 \boldsymbol{Z}_i)} \boldsymbol{\Phi}[\frac{a_1 + b_1 Y_i + c_1 \boldsymbol{X}_{i+} \rho\, v_i}{(1-\rho^2)^{1/2}}] \emptyset(v_i) dv_i \tag{8}$$

where $\emptyset$ is the standard normal density function. Similarly,

$$P(H_i = 1 | Y_i = 0, \boldsymbol{Z})$$

$$= \frac{1}{1 - \boldsymbol{\Phi}(a_2 + b_2 \boldsymbol{Z}_i)} \int_{-(a_2 + b_2 \boldsymbol{Z}_i)}^{\infty} \boldsymbol{\Phi}[\frac{a_1 + b_1 Y_i + c_1 \boldsymbol{X}_{i+} \rho\, v_i}{(1-\rho^2)^{1/2}}] \emptyset(v_i) dv_i. \tag{9}$$

Consequently,

$$P(H_i = 0 | Y_i = 1, \boldsymbol{Z}) = 1 - P(H_i = 1 | Y_i = 1, \boldsymbol{Z}) \tag{10}$$

$$P(H_i = 0 | Y_i = 0, \boldsymbol{Z}) = 1 - P(H_i = 1 | Y_i = 0, \boldsymbol{Z}). \tag{11}$$

Based on equations (7)-(10), we could derive the log-likelihood function for the four possible outcomes of (H_i, Y_i) and estimate the model by maximizing the sum of log-likelihood function for all $i = 1, \ldots, N$.

4. Data and descriptive statistics

We make use of national representative household survey data collected from the

Comprehensive Survey of Living Conditions (CSLC), conducted by Japan's Ministry of Health, Labour and Welfare (MHLW) from 2004 to 2019. The CSLC data are cross-sectional data repeated every three years. The stratified random sample was basically drawn from the national census sampling units, adjusted for factors such as population and industrial structure. The survey collected comprehensive data on individuals' health, and other personal and household characteristics by the trained enumerators who often left and picked up the questionaries in June.

In sum, the CSLC collected information from approximately 220,000 - 230,000 households in every wave, involving 530,000 - 620,000 individuals aged 0~109. As shown in Figure 6, among all the interviewed people, 1,603 (0.5%) women and 1,190 (0.4%) men were currently visiting a doctor for the treatment of cancers. The numbers continuously increased to 2,815 (1.01%) and 2,286 (0.89%) in 2019, respectively. The national cancer incidence rate was 0.65% for female and 0.908% for male in 2018 (FPCR, 2022). The possible reason why a higher rate of cancer treatment is observed in our sample is attributable to the difference in the use of healthcare services, i.e., women are more likely to see a doctor and receive the treatment for their diseases.

We mainly use the CSLC data from 2004, 2007, 2010, 2013 and 2016 which cover the periods before (years of 2004 and 2007) and after (years of 2010, 2013, 2016) the start of the free-coupon program. For a clear comparison between those who are eligible for free coupon and those who are not, we focus on women aged 36-64 for the analysis of breast cancer screening and women aged 16-45 for cervical cancer screening. Note that females with ages 41, 46, 51, 56 and 61 were offered of both breast and colorectal cancer screening coupons from 2011 to 2013, we therefore focus on male sample aged 36-64 for the analysis of colorectal cancer.

Table 2 provides a brief description of the characteristics of the three samples of interest in 2007 and 2010, the available data that were collected in the years nearest to the start of the program. As shown in the table, compared to 2007, an obvious increase is observed in the share of those who received breast and cervical cancer screening in 2010. On the other hand, since the program did not cover colorectal cancer until 2011, we see little change in colorectal cancer screening rate between these two years. There is a small increase in the share of those who were currently receiving cancer treatment, probably due to population aging or increased female cancer screening rates.

Approximately 15-18% of the samples are eligible for the free coupon, which is solely determined by eligibility ages. A small increase among those in their 40s, 50s and 60s in 2010 may be simply due to a random changing age structure. For other characteristics, such as household expenditures and number of children, working and marital status, there is little difference between 2007 and 2010 for all the samples. The possible reason why we observe a decrease in the averages of number of family members who need nursing care is because the CSLC set a stricter criterion to determine who need to answer the long-term care questionnaire since 2010.

The last variable reported in Table 2 is the share of national health insurance (NHI) membership. As explained in Subsection 2.1, Japanese under 75 usually belong to either residence-based NHI, for those who are self-employed or unemployed, or employment-based health insurances (EHI).[4] In fact, there is an inequality between these two insurance societies, with the former suffer from higher health expenditures and lower

[4] According to the CSLC data, approximately 1-2% of Japanese do not have any of the three major health insurance: NHI, employment-based insurance and elderly health insurance for those age 75 or over.

incomes, while the latter usually is in a better financial and health conditions. This gap is also reflected in cancer screening rates as shown in Table 3. Generally, cancer screening rates are higher among EHI members, and the gaps appear greater after the program started.

5. Results

5.1 Effects of free coupon on cancer screening behavior

Following the methodology discussed in Subsection 3.1, we estimate the effect of being offered of free coupon on the probability of receiving cancer screening based on the CSLC data. Basically, we have tried several different specifications. First, we estimate equation (2) which compares cancer screening behavior between the treatment (or eligible) group and that of the comparison group for each year. We could define the comparison group in two ways, i.e., people with ages 1 year different from the eligibility ages for coupon program, called type (a), and people with ages other than eligibility ages, called type (b). We report the results based on the former in Table 4 and those based on the latter in Table 5. Another approach is a difference-in-difference (DID) specification, comparing the difference between the treatment and comparison groups before and after the program started. This model is also estimated based on different samples, and the selected results are reported in Table 6.

Taking a closer look at Table 4, the probit estimates are reported for five waves, respectively. The first two years, 2004 and 2007, were before the coupon program started and 2016 was after the nationally program was localized. We examined three samples, females and males aged 36-64 and females age 16-44 for three types of cancer screening in panels (a)-(d). the effect of free coupon is obtained by estimating the coefficient for T, a dummy variable that indicates whether one's age is eligible for the free screening. The marginal effect of T is calculated as described in equation (3), based on the estimates and the means of other explanatory variables.

As shown in the table, the estimates for T are generally not statistically significant in 2004 and 2007, suggesting that there is little different between the treatment and comparison groups. Note that some estimates in 2007 are marginally significant, but have a negative sign indicating that the treatment group might had a slightly lower cancer screening rate at the baseline. In 2010 and 2013, the estimates turn positive, statistically significant at the 1% level, for both breast and cervical cancer screenings. The estimated marginal effect is an increase of 9.2% in the probability of receiving breast cancer screening in 2010, and the effect decreased to 6.7% in 2013. The probability of receiving cervical cancer screening also increases by 8.5% in 2010, and dropped to 7.5% three years later. However, the estimates become statistically insignificant again in 2016, after the national program was terminated.

Meanwhile, as shown in panels (c) and (d), for both sexes, the estimates for colorectal cancer screening are positively significant only in 2013, the year that was supposed to be directly affected by the program after the coupon for free colorectal cancer screening was also distributed. Note that the marginal effect seems much smaller than those for breast and cervical cancer screenings, probably because the cost of a FOBT (the major test implemented in a colorectal cancer screening) is much lower, so that economic incentive provided by free coupon is smaller. In addition, females seem to be more responsive to the free coupon (marginal effect = 5.1%) than their male counterparts are (marginal effect = 2.2%).

If we estimate the effect of free coupon based on the comparison between treatment and comparison group defined as all individuals with ages other than eligibility ages, the sample sizes double and the precision of estimation is improved slightly. In general, compared to the results discussed above, the patterns and the estimated marginal effects of free coupon are similar in Table 5. However, the estimate for cervical cancer screening in 2004 turned positively significant. This might be due to some random difference between age groups, which actually disappeared in 2007 before the program started. Moreover, though very small in magnitude, the effect of free coupon appears to last until 2016 when we include more people into the comparison group.

Next, we examine the results based on a DID specification in Table 6. Concerning the heterogenous effect over time suggested in Tables 4 and 5, we interact the treatment variable T with the year dummy for 2010 and 2013 separately, so that we have two interaction terms. We have tried various samples and report the results for four of them for comparison. The first two columns show the results based on data from three waves closest to the start of the program: 2007, 2010 and 2013. The difference between these two columns is the definition of comparison group: column (1) using type (a) comparison group, while column (2) type (b) comparison group. For column (3), data from wave 2004 are included, so that the sample before and after the start of the program becomes more balanced, with two waves on each side. Lastly, the sample is further expanded by including data from 2016.

As shown in Table 6, the estimates for the interaction terms are quite robust and consistent across various samples. In general, the estimated marginal effect of free coupon on receiving breast cancer screening is approximately 10% for 2010 and 7-8% for 2013, slightly higher than those in Tables 4 and 5. Regarding cervical cancer screening, the marginal effect is estimated to be around 9.0-9.9% (7.3-8.1%) in 2010(2013), which are quite similar to the yearly estimates. Lastly, we also estimate the DID specification for colorectal cancer screening for both sexes, as reported in panels (c) and (d). Again, the results are quite consistent across columns (1)-(4) and similar to those in Tables 4 and 5.

Note that, theoretically, the estimate for T should be statistically insignificant if the treatment and comparison groups are similar before the program started. But some estimates for T are actually significantly negative, especially when the sample size is increased. It is implausible that those eligible for the program intentionally withhold their cancer screening before the program was announced and started, expecting to make use of the free coupon years later. Therefore, it is probably due to some random difference between various age groups.

5.2 Heterogeneous effects of free coupon on cancer screening behavior

To better understand the impact of the program, heterogeneous effects of free coupon are investigated by estimating the coefficient of a triple interaction term, as described in equation (5), based on the sample of 2004-2013, using type (b) comparison group. As described in Subsection 3.1, we focus on six characteristics: income, childcare burden, nursing care burden, marital and working status, and type of health insurance. Table 7 summarize the results.

For income measured by household expenditures, in general, we find a strong positive effect on the probability of receiving cancer screening. Interestingly, however, income has a mixed interacting effect with that of free coupon: the rich tend to respond to a free breast cancer screening more, while the poor appear to benefit more from a free cervical cancer screening. On the other hand, there seems not much difference in the effect of free coupon for colorectal cancer screening. The difference probably comes from two effects interacting with each other: the rich generally have a higher demand for cancer screening, while the poor have a larger economic incentive to use the free coupon.

When it comes to childcare burden measured by the number of children under 6 years, we also find a mixed interacting effect for different samples. Females with more childcare burden seem to be less likely to use free coupon, which suggests that economic cost may not be the major barrier for them to receive cancer screening. In addition, having more children seems to increase the probability of receiving colorectal cancer screening for males. Similarly, having a heavier nursing burden, measured by the number of household members in need of nursing care, seems to reduce the probability of receiving cancer screening either through the direct effect (i.e., for cervical cancer) or through the interacting effect (i.e., for breast cancer), or through both (i.e., for males' colorectal cancer).

Next, we examine the heterogenous effects for marital and working status. Focusing on the partner effect in a marriage, we specifically examine whether one has a spouse rather than whether one is married. Working status is measured by a dummy variable indicating positive working hours in a week in the previous month. In general, having a spouse increases the probability of receiving cancer screening, which becomes greater after being interacted with that of free coupon for both those aged 36-64 but gets smaller for younger females aged 16-34. Similarly, working individuals generally are more likely to receiving cancer screening, yet working females are less likely to make use of the free coupon for breast and cervical cancer screening. This may be because the tests implemented in the female cancer screenings are more time consuming. On the other hand, working individuals are more likely to use free coupon for colorectal cancer screening which is usually less time consuming.

Lastly, the effect of free coupon also differs by the type of health insurance society one belongs to. As shown in the last column of Table 7, compared to those with employment-based health insurance (EHI), members of National Health Insurance (NHI) tend to be less likely to receive these three cancer screenings, statistically significant at the 1% level. Moreover, except for breast cancer, NHI members benefit less from free coupon compared to those with employment-based health insurance. EHI members may be more likely to receive cancer screening, often combined with their general annual health screening, which may be less time consuming. With higher education level and health information, they may also have a higher demand for cancer screening.

Overall, the results in Table 7 suggest a large variation in the effects of free coupon across the population, based on their income, household structure, working status and insurance type. Ideally, free-coupon program is expected to help the disadvantaged who are lack of monetary and time resources more. But the actually effects are opposite in some cases.

5.3 Effects of receiving cancer screening on health status

This subsection discusses the estimation of the effects of receiving cancer screening on physical and mental health. Cancer screening is recommended for the benefit of early detection and treatment of cancer, but it may also have other impacts on health such as unnecessary stress coming from the tests or further investigation. In mass cancer screening in Japan, around 6% of the examines are usually recommended for further investigation, marked as “positive”, among whom more than 95% are eventually confirmed to be normal, called “false positive” (MHLW, 2019). On one hand, those who do not get clear results in the first-round check usually suffer from severe stress. On the other hand, a clear result in the first-round check may be a reassurance and improves one’s mental health.

We specifically examine three outcome variables: (a) whether one is receiving cancer treatment currently; (2) whether one reported health status to be good or very good; and (3) whether one feels stressed recently. Ideally, we want to examine the diagnosis and treatment of cancer right after receiving cancer screening. Yet, due to the lack of data, we could only analysis the effect of screening on health status in May, 1-12 months after the last screening. The explanatory variable of interest is whether received a cancer screening in the past 12 months. Since the outcomes are all binary variables, we first estimate a probit model, assuming cancer screening behavior as exogenous. We then treat whether received a cancer screening as an endogenous variable, and estimate a bivariate probit model for the two endogenous binary variables, using free coupon availability T and the interaction of T and A as instrumental variables. For each outcome, results for three types of cancer screening, based on 2004-2013 CSLC data, are reported in Table 8. Note that since females aged 35-64 was affected by free coupon for both breast and colorectal cancer screening, we only examine male sample for colorectal cancer screening for a stronger power.

The probit estimates show that receiving any of these cancer screenings increases the probability of receiving current cancer treatment, which is aligned with our expectation. However, the estimates are likely to be biased as people may choose to take cancer screening due to the concerns about some health conditions or minor symptoms unobserved in the error term. In fact, the bivariate probit estimates all turn insignificant once the endogeneity issue is addressed. The results suggest two possibilities. The first one is that receiving cancer screening does not necessarily increase cancer detection and treatment. The second possibility is that detected cancers have already been treated right after the screening, so that we could not detected it in health status 1-12 months later.

Regarding the self-rated health status, interestingly, we find a much larger positive effect on the probability of reporting good health after we taking care of the endogeneity issue of cancer screening behavior, all statistically significant at the 1% level. The probit estimates underestimate the effect probably because those who are more health concerned are more likely to take cancer screening. The positive effect on health status could come from two sources: (a) an improvement in health after receiving doctors' general advice on life habits or early treatment of diseases detected; (b) a higher evaluation of own health status because of the reassurance obtained from a clear result of the screening.

Lastly, opposite to our expectation, cancer screening does not seem to increase the probability of feeling stressed. Previous literature show that individuals may feel stressed due to the test procedures, overdiagnosis or "false positive". The probit estimates do suggest that cancer screening increases stress. However, once we control for the endogeneity issue, the bivariate probit estimates turn negative, and we actually find the probability of feeling stressed is reduced after receiving cervical and colorectal cancer screenings.

To test the validity of the IVs used for the bivariate probit model, assuming a linear relationship, we have conducted an overidentification test which is a necessary condition to check if the IVs are valid. As reported in Table 8, we generally find the p-values much greater than 0.1, suggesting that the IVs have passed the test. For the estimation of health status and stress, we have also excluded individuals who were currently receiving cancer treatment. Therefore, the estimated effects will be for those who are free of cancer treatment. The results do not change much whether excluding cancer treatment receivers.

6. Conclusions

Cancer screening is promoted for many well-known benefits such as early detection and treatment of cancer. Yet, cancer screening rates are still lower than expected in many areas. This study examines a quasi-experimental free-coupon program in Japan to develop a better understanding of the effect of public program that removes the costs of cancer screening. Furthermore, the study also investigates the heterogeneous effects of the program and the effects of receiving cancer screening on individuals' physical and mental health status.

Using the rich data from Comprehensive Survey of Living Conditions, our results suggest that providing free coupon increase the probability of taking screening by approximately 10% for breast cancer and 9% for cervical cancer. The effects both dropped to 7-8% three years later. Free coupon for colorectal cancer screening has a smaller impact on screening rate, only about 4-5% for females and 2-3% for males. These estimates are quite robust to different model specifications and sample choices.

Although the significantly higher screening rate among the group who used to be eligible for free coupon appear to disappear after 2013 when the national program was terminated and localized, we observed a generally much higher screening rate among those target age groups in the recent years, suggesting that the effect of free coupon may be long lasting. Unfortunately, this study could not provide the direct evidence on that due to the lack of panel data.

The findings on the heterogeneous effects of the program are also important for public policy makers, pointing to the concern of a serious inequality in cancer screening rate and the benefit of free coupon. The disadvantaged remain lack of access to a public program that supposed to help them, resulting in an even wider gap across different socioeconomic status. If reducing the inequality in the access to cancer screening is also the objective of public intervention, policy makers need to take into consideration not only monetary costs, but also nonmonetary costs such as time costs. Providing a paid leave for cancer screening or combining cancer screening to annual general health screening, as workplace cancer screenings usually are, may be an effective approach to promote cancer screening in the future.

Lastly, our results show that cancer screening by itself actually has a positive effect on physical and mental health. Despite the possible negative effects of overdiagnosis and "false positive", health benefits of early detection and treatment, together with the reassurance obtained from a clear result, seem to outweigh the negative ones. These findings provide important evidence for public policy makers to further promote cancer screening. Note that the caveat of this study is that we do not have panel data to keep track of individuals screening behavior and health status over time. Further research is needed to that end.

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Figures and Tables

Figure 1: Share of people received annual breast cancer screening by age.

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

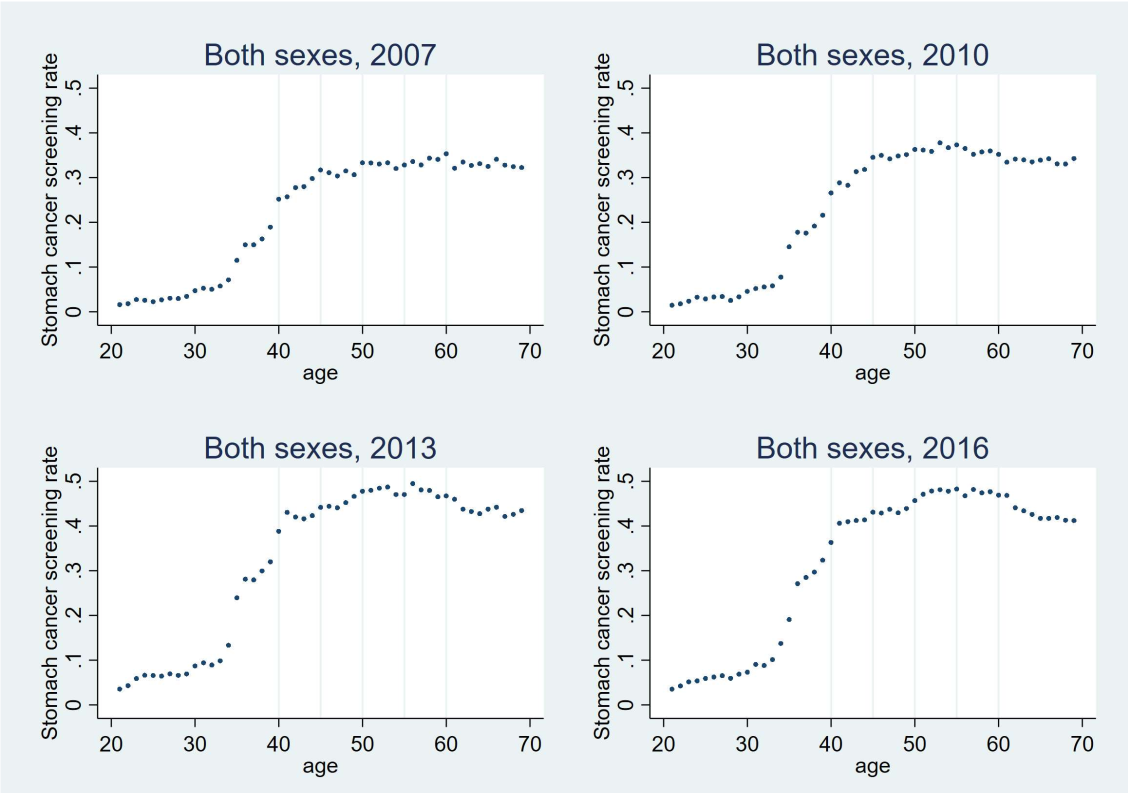
Figure 2: Share of people received annual cervical cancer screening by age.

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Figure 3: Share of people received annual colorectal cancer screening by age.

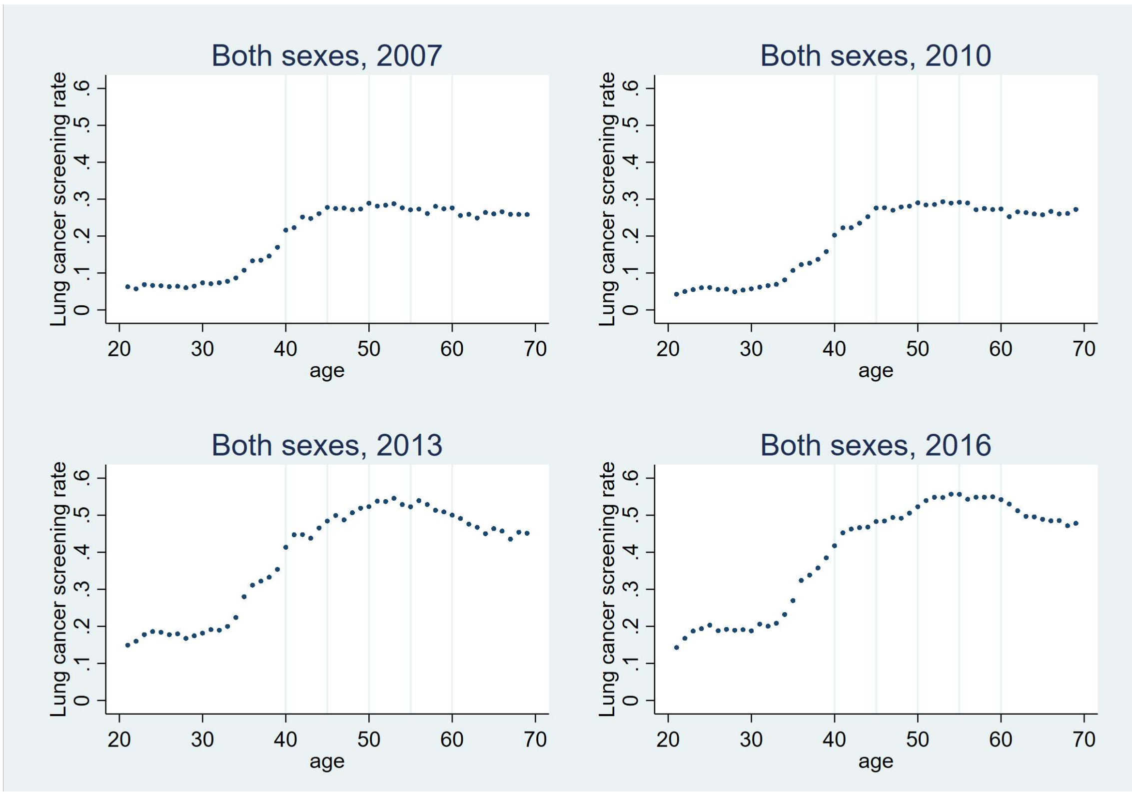
Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Figure 4: Share of people received annual stomach cancer screening by age.



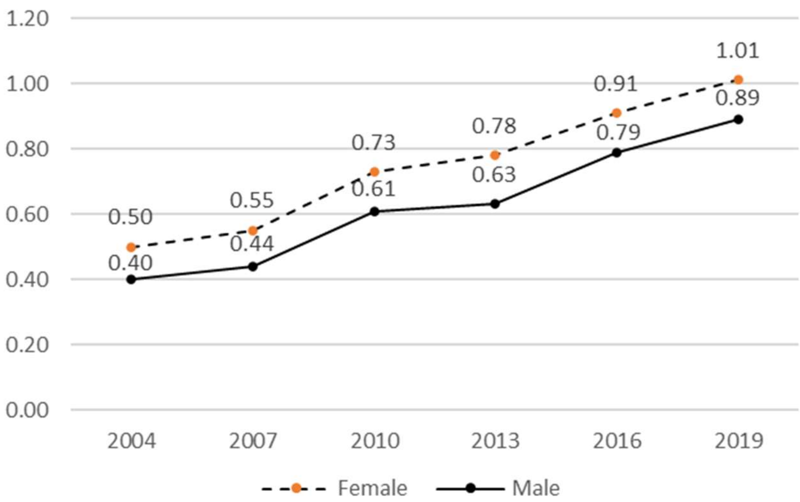
Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Figure 5: Share of people received annual lung cancer screening by age.



Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Figure 6: Share of individuals currently receiving cancer treatment (%)



Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Table 1: Municipal cancer screening and free-coupon program eligibility

Type	Recommended Starting age	Recommended frequency	Free-coupon program starting year	Free-coupon program eligibility
Breast cancer	40~	Once every two years	2009	Women aged 40, 45, 50, 55, 60
Cervical cancer	20~	Once every two years	2009	Women aged 20, 25, 30, 35, 41
Colorectal cancer	40~	Once a year	2011	Individuals aged 40, 45, 50, 55, 60
Stomach cancer	40~	Once a year		
Lung cancer	40~	Once a year		

Notes:

1. Before 2003, the recommended age for breast cancer screening was 50 or above and the frequency was once a year.
2. Before 2003, the recommended age for cervical cancer screening was 31 or above and the frequency was once a year.
3. The recommended starting age for stomach cancer was raised to 50 in 2016, while those aged between 40-49 may still be eligible for abdominal X-ray check.

Table 2: Descriptive statistics

	2007			2010		
	Obs	Mean	Std. dev.	Obs	Mean	Std. dev.
			Females aged 36-64			
Received breast cancer screening (1=yes)	123,682	0.258	0.438	122,386	0.315	0.465
Currently receiving cancer treatment (1=yes)	127,073	0.008	0.089	126,579	0.011	0.104
Eligible for free coupon (1=yes)	127,073	0.158	0.365	126,579	0.178	0.383
Log of monthly household expenditures	116,769	2.032	0.642	119,683	1.994	0.609
No. of children under 6	127,073	0.690	1.034	126,579	0.694	1.040
No. of family members in need of nursing care	127,073	0.039	0.276	126,579	0.022	0.153
Currently working (1=yes)	126,298	0.652	0.476	125,590	0.656	0.475
Married (1=yes)	127,073	0.804	0.397	126,579	0.792	0.406
National Health Insurance member (1=yes)	127,073	0.340	0.474	126,579	0.309	0.462
			Females aged 16-44			
Received cervical cancer screening (1=yes)	90,129	0.227	0.419	84,126	0.299	0.458
Currently receiving cancer treatment (1=yes)	104,989	0.002	0.044	98,231	0.003	0.053
Eligible for free coupon (1=yes)	104,989	0.172	0.377	98,231	0.175	0.380
Log of monthly household expenditures	96,344	1.894	0.614	92,970	1.859	0.578
No. of children under 6	104,989	0.914	1.152	98,231	0.903	1.153
No. of family members in need of nursing care	104,989	0.024	0.216	98,231	0.014	0.120
Currently working (1=yes)	104,387	0.639	0.480	97,635	0.643	0.479
Married (1=yes)	104,989	0.503	0.500	98,231	0.496	0.500
National Health Insurance member (1=yes)	104,989	0.223	0.417	98,231	0.199	0.399
			Males aged 36-64			
Received colorectal cancer screening (1=yes)	117,826	0.263	0.440	116,470	0.264	0.441
Currently receiving cancer treatment (1=yes)	121,346	0.004	0.061	120,915	0.005	0.068
Eligible for free coupon (1=yes)	121,346	0.159	0.366	120,915	0.177	0.381
Log of monthly household expenditures	111,291	2.041	0.674	114,126	1.994	0.627
No. of children under 6	121,346	0.720	1.054	120,915	0.718	1.056
No. of family members in need of nursing care	121,346	0.039	0.276	120,915	0.022	0.155
Currently working (1=yes)	119,258	0.902	0.297	118,261	0.888	0.316
Married (1=yes)	121,346	0.799	0.400	120,915	0.778	0.415
National Health Insurance member (1=yes)	121,346	0.307	0.461	120,915	0.297	0.457

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Notes:

1. For consistent comparison over time, annual breast and cervical cancer screening rates, rather than biennial ones are reported.
2. Household expenditures do not include medical expenditures and housing loan payments.
3. Family members in need of nursing care are counted based those who filled in the long-term care questionnaires claimed to be in need of nursing care for daily life.
4. Currently working are defined as those who have positive weekly working hours.

Table 3: Annual cancer screening rates by health insurance type (%)

	2004	2007	2010	2013	2016	2019
Breast cancer, females aged 21-69						
NHI	18.59	17.85	21.43	27.1	27.61	-
EHI	21.25	21.79	27.6	33.41	34.24	-
Diff.	2.66	3.94	6.17	6.31	6.63	-
Cervical cancer, females aged 21-69						
NHI	22.17	21.05	23.18	28.79	27.61	-
EHI	28.16	28.78	33.69	41.1	39.77	-
Diff.	5.99	7.73	10.51	12.31	12.16	-
Colorectal cancer, both sexes aged 21-69						
NHI	15.99	17.93	19.06	28.57	30.89	34.59
EHI	15.18	20.1	20.62	35.27	37.03	41.82
Diff.	-0.81	2.17	1.56	6.7	6.14	7.23

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Table 4: Effect of free coupon on cancer screening behavior by year, treatment group vs. type (a) comparison group[1]

	2004			2007			2010			2013			2016		
	Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|	
(a) Breast cancer, females aged 36-64															
T (treatment)	-0.014	0.207		-0.020	0.082	*	0.249	0.000	***	0.174	0.000	***	-0.015	0.193	
	(0.011)			(0.012)			(0.011)			(0.011)			(0.011)		
est. mar.effct							0.092			0.067					
No. of obs.	65,534			62,240			65,302			57,232			55,820		
(b) Cervical cancer, females aged 16-44															
T (treatment)	0.023	0.095	*	-0.016	0.229		0.252	0.000	***	0.206	0.000	***	-0.022	0.111	
	(0.014)			(0.013)			(0.013)			(0.013)			(0.014)		
est. mar.effct							0.085			0.075					
No. of obs.	54,071			52,913			50,226			44,948			38,871		
(c) Colorectal cancer, females aged 36-64															
T (treatment)	0.008	0.528		-0.001	0.903		-0.004	0.723		0.134	0.000	***	-0.016	0.164	
	(0.012)			(0.012)			(0.012)			(0.011)			(0.011)		
est. mar.effct										0.051					
No. of obs.	65,534			62,240			65,302			57,039			55,802		
(d) Colorectal cancer, males aged 36-64															
T (treatment)	0.005	0.676		-0.021	0.080	*	-0.013	0.244		0.056	0.000	***	0.014	0.219	
	(0.012)			(0.012)			(0.011)			(0.011)			(0.012)		
est. mar.effct										0.022					
No. of obs.	62,958			59,308			62,075			54,433			52,812		

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Notes:

1. Type (a) comparison group is defined as those with ages 1 year different from the eligibility ages for free coupon.
2. Estimated marginal effect is calculated based on the means of other explanatory variables and the estimated coefficients.
3. All regressions have controlled for age, age squared, dummy variable indicating age over 40, and county fixed effects. Standard errors are reported in parentheses.
4. * Statistical significance at the 10% level; ** Statistical significance at the 5% level; *** Statistical significance at the 1% level.

Table 5: Effect of free coupon on cancer screening behavior by year, treatment group vs. type (b) comparison group[1]

	2004			2007			2010			2013			2016		
	Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|		Coef.	P>|z|	
(a) Breast cancer, females aged 36-64															
T (treatment)	-0.005	0.597		-0.016	0.132		0.263	0.000	***	0.192	0.000	***	-0.005	0.640	
	(0.010)			(0.011)			(0.010)			(0.010)			(0.010)		
est. mar.effct							0.095			0.073					
No. of obs.	122,062			123,682			122,386			112,511			107,634		
(b) Cervical cancer, females aged 16-44															
T (treatment)	0.033	0.008	***	-0.017	0.178		0.262	0.000	***	0.205	0.000	***	-0.027	0.038	
	(0.013)			(0.012)			(0.012)			(0.012)			(0.013)		
est. mar.effct							0.090			0.076					
No. of obs.	90,611			90,129			84,126			77,158			68,475		
(c) Colorectal cancer, females aged 36-64															
T (treatment)	0.014	0.189		0.003	0.802		-0.003	0.769		0.155	0.000	***	0.005	0.602	*
	(0.011)			(0.011)			(0.011)			(0.010)			(0.010)		
est. mar.effct										0.057			0.002		
No. of obs.	122,062			123,682			122,386			112,166			107,595		
(d) Colorectal cancer, males aged 36-64															
T (treatment)	0.002	0.840		-0.017	0.087	*	-0.017	0.108		0.065	0.000	***	0.021	0.047	**
	(0.012)			(0.011)			(0.011)			(0.010)			(0.011)		
est. mar.effct										0.025			0.008		
No. of obs.	116,383			117,826			116,470			106,285			101,142		

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Notes:

1. Type (b) comparison group is defined as those with ages year other than the eligibility ages for free coupon.
2. Estimated marginal effect is calculated based on the means of other explanatory variables and the estimated coefficients.
3. All regressions have controlled for age, age squared, dummy variable indicating age over 40, and county fixed effects. Standard errors are reported in parentheses.
4. * Statistical significance at the 10% level; ** Statistical significance at the 5% level; *** Statistical significance at the 1% level.

Table 6: Effects of the free coupon on cancer screening behavior

	(1) DIDa: 2007-2013[1]			(2) DIDb: 2007-2013[2]			(3) DIDb: 2004-2013			(4) DIDb: 2004-2016		
	Coef.	P>|z|	M.E.[3]	Coef.	P>|z|	M.E.	Coef.	P>|z|	M.E.	Coef.	P>|z|	M.E.
(a) Breast cancer, females aged 36-64												
T	-0.020	0.084 *		-0.021	0.045		-0.019	0.010 **		-0.022	0.003 ***	
	(0.012)			(0.011)			(0.007)			(0.007)		
T # yr2010	0.269	0.000 ***	0.100	0.282	0.000 ***	0.102	0.284	0.000 ***	0.102	0.284	0.000 ***	0.103
	(0.016)			(0.014)			(0.012)			(0.012)		
T # yr2013	0.194	0.000 ***	0.072	0.218	0.000 ***	0.079	0.221	0.000 ***	0.079	0.221	0.000 ***	0.080
	(0.016)			(0.015)			(0.012)			(0.012)		
T # yr2016										0.028	0.024 **	0.001
										(0.013)		
No. of obs.	184,774			358,579			480,641			588,275		
(b) Cervical cancer, females aged 16-44												
T	-0.017	0.192		-0.024	0.045 **		-0.024	0.045 **		-0.004	0.635	
	(0.013)			(0.012)			(0.012)			(0.009)		
T # yr2010	0.270	0.000 ***	0.090	0.289	0.000 ***	0.099	0.289	0.000 ***	0.091	0.276	0.000 ***	0.093
	(0.018)			(0.017)			(0.017)			(0.014)		
T # yr2013	0.224	0.000 ***	0.075	0.236	0.000 ***	0.081	0.236	0.000 ***	0.073	0.223	0.000 ***	0.074
	(0.019)			(0.017)			(0.017)			(0.015)		
T # yr2016										-0.017	0.271	-0.006
										(0.015)		
No. of obs.	148,087			251,413			251,413			410,499		
(c) Colorectal cancer, females aged 36-64												
T	-0.003	0.778		-0.002	0.858		0.006	0.405		0.005	0.531	
	(0.012)			(0.011)			(0.008)			(0.008)		
T # yr2010	0.007	0.655		-0.002	0.901		-0.010	0.419		-0.009	0.472	
	(0.017)			(0.015)			(0.013)			(0.013)		
T # yr2013	0.138	0.000 ***	0.047	0.161	0.000 ***	0.052	0.154	0.000 ***	0.048	0.154	0.000 ***	0.050
	(0.016)			(0.015)			(0.013)			(0.013)		
T # yr2016										0.006	0.658	
										(0.013)		
No. of obs.	184,581			358,234			480,296			587,891		
(d) Colorectal cancer, males aged 36-64												
T	-0.022	0.061 *		-0.018	0.088 *		-0.006	0.429		-0.005	0.475	
	(0.012)			(0.011)			(0.008)			(0.008)		
T # yr2010	0.010	0.563		0.002	0.966		-0.012	0.966		-0.011	0.373	
	(0.016)			(0.015)			(0.013)			(0.013)		
T # yr2013	0.079	0.000 ***	0.028	0.082	0.000 ***	0.028	0.069	0.000 ***	0.023	0.069	0.000 ***	0.024
	(0.016)			(0.015)			(0.013)			(0.013)		
T # yr2016										0.024	0.064 *	0.008
										(0.013)		
No. of obs.	175,816			340,581			456,964			558,106		

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Notes:

1. DIDa stands for the difference-in-difference specification using type (a) comparison group.
2. DIDb stands for the difference-in-difference specification using type (b) comparison group.
3. M.E. reports the estimated marginal effect for the treatment effect, based on the means of other explanatory variables and the estimated coefficients.
4. All regressions have controlled for age, age squared, dummy variable indicating age over 40, and year and county fixed effects.
5. * Statistical significance at the 10% level; ** Statistical significance at the 5% level; *** Statistical significance at the 1% level.

Table 7: Heterogeneous effects of free coupon based, 2004-2013

X=	ln(hhexp)		# Children<6		# Elderly need care		Having spouse=1		Working=1		NHI=1	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
(a) Breast cancer, females aged 36-64												
X	0.128	0.000 ***	-0.002	0.307	0.012	0.163	0.203	0.000 ***	0.032	0.000 ***	-0.301	0.000 ***
	(0.003)		(0.002)		(0.009)		(0.005)		(0.001)		(0.005)	
T # yr>=2010 # X	0.025	0.027 **	-0.001	0.041 **	-0.072	0.068 *	0.050	0.002 ***	-0.015	0.044 **	-0.016	0.291
	(0.011)		(0.001)		(0.040)		(0.017)		(0.007)		(0.015)	
No. of obs.	432,151		358,579		480,641		480,641		457,815		480,641	
(b) Cervical cancer, females aged 16-44												
X	0.075	0.000 ***	0.037	0.000 ***	-0.078	0.000 ***	0.377	0.000 ***	0.011	0.000 ***	-0.259	0.000 ***
	(0.004)		(0.002)		(0.014)		(0.006)		(0.001)		(0.006)	
T #yr>=2010 # X	-0.079	0.000 ***	-0.057	0.000 ***	-0.166	0.265	-0.189	0.000 ***	-0.067	0.000 ***	-0.050	0.014 **
	(0.009)		(0.011)		(0.149)		(0.019)		(0.011)		(0.021)	
No. of obs.	305,224		342,024		342,024		342,024		321,696		342,024	
(c) Colorectal cancer, females aged 36-64												
X	0.114	0.000 ***	-0.002	0.398	0.003	0.700	0.128	0.000 ***	0.035	0.000 ***	-0.265	0.000 ***
	(0.004)		(0.002)		(0.009)		(0.005)		(0.000)		(0.005)	
T # yr>=2013 # X	0.006	0.732	0.009	0.345	-0.025	0.662	0.036	0.116	0.035	0.001 ***	-0.087	0.000 ***
	(0.016)		(0.009)		(0.058)		(0.023)		(0.011)		(0.022)	
No. of obs.	431,816		480,296		480,296		480,296		457,482		480,296	
(d) Colorectal cancer, males aged 36-64												
X	0.113	0.000 ***	0.013	0.000 ***	-0.026	0.003 ***	0.460	0.000 ***	0.050	0.000 ***	-0.515	0.000 ***
	(0.003)		(0.002)		(0.009)		(0.006)		(0.000)		(0.005)	
T # yr>=2013 # X	-0.002	0.905	0.004	0.678	-0.161	0.015 **	0.054	0.022 **	0.093	0.000 ***	-0.188	0.000 ***
	(0.016)		(0.009)		(0.066)		(0.023)		(0.017)		(0.023)	
No. of obs.	410,081		456,964		456,964		456,964		426,923		456,964	

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW

Notes:

1. Yr>=2010 is a dummy variable that indicates the years of 2010 or later, and T#YR>=2010#X stands for the triple interaction between this variable, treatment T and characteristics X.
2. In(hhexp) stands for the log of per capita monthly household expenditures.
3. All regressions have controlled other interaction terms between T and X, age, age squared, dummy variable indicating age over 40, and year and county fixed effects.
4. Standard errors are reported in parentheses.
5. * Statistical significance at the 10% level; ** Statistical significance at the 5% level; *** Statistical significance at the 1% level.

Table 8: Effects of receiving cancer screening on health status

	Cancer treatment				Good health				Stress			
	Probit		Bivariate Probi		Probit		Bivariate Probit		Probit		Bivariate Probit	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
(a) Breast cancer, females aged 35-65												
Receive CS	0.484	0.000 ***	-0.095	0.548	0.079	0.000 ***	0.200	0.005 ***	0.027	0.000 ***	-0.099	0.156
	(0.012)		(0.158)		(0.004)		(0.071)		(0.004)		(0.069)	
No. of obs.	480,641		480,641		444,534		444,534		451,989		451,989	
rho=0: P>Chi[1]			0.001				0.085				0.071	
Overid: P>Chi[2]			0.764				0.357				0.901	
(b) Cervical cancer, females aged 15-45												
Receive CS	0.393	0.000 ***	0.251	0.206	0.025	0.000 ***	0.349	0.000 ***	0.114	0.000 ***	-0.247	0.000 ***
	(0.023)		0.1984		(0.005)		(0.056)		(0.005)		(0.055)	
No. of obs.	342,024		342,024		327,440		327,440		331,474		332,345	
rho=0: P>Chi			0.473				0.000				0.000	
Overid: P>Chi			0.894				0.785				0.723	
(c) Colorectal cancer, males aged 35-65												
Receive CS	0.226	0.000 ***	-0.115	0.576	0.078	0.000 ***	0.400	0.000 ***	0.019	0.000 ***	-0.386	0.000 ***
	(0.017)		0.2051		(0.004)		(0.088)		(0.004)		(0.084)	
No. of obs.	456,964		456,964		425,998		425,998		431,968		431,968	
rho=0: P>Chi			0.107				0.008				0.000	
Overid: P>Chi			0.756				0.459				0.459	

Source: Comprehensive Survey of Living Conditions (CSLC), MHLW
Notes:

1. Probability that the chi-square for the Wald test of $\rho = 0$ greater than the critical value.
2. Probability that the Sargan chi-square score for the overidentification test greater than the critical value.
3. All regressions have controlled for age, age squared, dummy variable indicating age over 40, and year and county fixed effects.
4. Standard errors are reported in parentheses.
5. * Statistical significance at the 10% level; ** Statistical significance at the 5% level; *** Statistical significance at the 1% level.