

# Health screening and selection: Evidence from biennial subsidies in South Korea

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# Motivation

- The goal of health screening is to detect diseases early in people who do not have any symptoms of diseases
- Early detection and treatment reduce premature deaths and suffering from diseases

Table: 5 year survival rates for cancers by summary stage in Korea

	Localized	Regional	Distant
Total	91.8%	74.5%	26.0%
Stomach	97.4%	61.4%	6.6%
Colorectal	93.8%	82.2%	20.3%
Breast	98.9%	92.7%	45.2%
Cervical	96.9%	81.0%	35.2%
Liver	62.4%	25.0%	3.1%

# Motivation

- Should people with symptoms get tested?
  - Symptoms only become noticeable when a disease has significantly advanced
  - Symptomatic people are motivated to seek screening without intervention  
(Same for high risk group due to a genetic predisposition)
- Mismatch of ideal and actual participants among asymptomatic people
  - Ideal participants
    - Those at increased risk and likely to have a disease
  - Actual participants
    - Participants are from higher socioeconomic background ([Bender et al., 2014](#))
    - Participants are more likely to show positive health behaviors ([Oster, 2020](#))
    - Participants show lower mortality ([Strandberg et al., 1995](#))
- What policy can better target unhealthy people?
  - Providing subsidies for health screenings
  - Low income people may be more sensitive to subsidies
  - Lower income people are often less healthy

# Research question

1. How do subsidies affect screening participation?
  - National Health Screening Program in Korea
  - Subsidies for various screenings (general and cancer screenings)
  - Multiple policies (age-based recommendation, subsidies, reminders)
  - Variation in age cutoff and subsidy schedules (biennial, annual)
2. Who responds to screening subsidies?
  - Characterize compliers with subsidies
  - Compare compliers with always-takers and never-takers
  - Health conditions / socioeconomic status / health behaviors
3. What is the effect of screening on diagnoses and health care utilizations?
  - Use exogenous variation in subsidies

## Preview of results

1. Subsidies increase screening participation from 10% to 30%
2. There are spillover effects in take-up within an individual across different types of screenings and within each screening between spouses
3. Screening subsidies increase participation among those with lower socioeconomic backgrounds and worse health conditions
4. Screening leads to increases in new diagnoses and hospital visits for a new illness one was not initially aware of

# Contributions to literature

## 1. Selection in health screening and preventive services

- Mismatch between those most likely to benefit and those who use screening, vaccination and contraceptive and so forth  
(Bender et al., 2014, 2015; Strandberg et al., 1995; Jones et al., 2019; Thomas et al., 2021; Hungerford et al., 2016; Gafar et al., 2020)
- Health screening policies and selection of marginal participants  
(Kim and Lee, 2017; Einav et al., 2020; Kowalski, 2023; Bitler and Carpenter, 2016)

## 2. Health screening and health behaviors

- Spillover in take-up of different health screenings  
(Bitler and Carpenter, 2016)
- Peer effect in health behaviors and health conditions  
(Leibenstein, 1950; Manski, 1993, 2000; Kling et al., 2007; Christakis and Fowler, 2007; Cohen-Cole and Fletcher, 2008; Argys and Rees, 2008; Lundborg, 2006; Carrell et al., 2011)

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# Korean health screening program

- 3 types of screening covered by the National Health Insurance in Korea
  - General health screening
  - Cancer screenings (5 types)
  - Infant/children health screening
- General health screening
  - Most basic tests for health conditions
  - Measurement of height, weight, blood pressure, chest X-ray, dental test, blood test, uroscopy and health risk evaluation
- Cancer screening
  - Stomach cancer screening
  - Breast cancer screening
  - Cervical cancer screening
  - Liver cancer screening
  - Colorectal cancer screening

# Screening subsidy criteria

- Biennial subsidy rule
  - Those born in even years can get subsidized screening in even years
  - Those born in odd years can get subsidized screening in odd years
- Eligible for subsidies during a calendar year when the age is even
  - Age = current year - birth year
  - No subsidy when age is odd
  - Subsidy eligibility switch on and off every year
  - Eligible once every two years
- Subsidy starting age
  - $\text{Age} \geq 40$ : biennial subsidy
  - $\text{Age} < 40$ : no subsidy

# Variation in subsidy eligibility across screenings

	Biennial subsidy				Annual subsidy		No subsidy	
	General	Stomach	Breast	Cervical	Liver	Colorectal**	Lung	Prostate
Frequency	2 years	2 years	2 years	2 years	0.5 year*	1 year		
Subsidy starting age	40	40	40	30***	40	50		
Subsidy amount	100%	90%	90%	100%	90%	90%	0%	0%
Copay (\$)	0	7	3.5	0	10	5	110	20
Target		Female	Female	High risk group			Male	
Subsidized medical tests	Gastroscopy, biopsy	Mammogram	Pap smear	Ultrasound, MSAFP	Fecal occult blood test*****, colonoscopy, biopsy			

\* Liver screening is subsidized up to twice a year.

\*\* Colorectal screening was biennially subsidized until 2012 after which it became annually subsidized.

\*\*\* The subsidy starting age for cervical screening was lowered to 20 in 2016.

\*\*\*\* Colonoscopy is subsidized only for those with positive result from FOBT.

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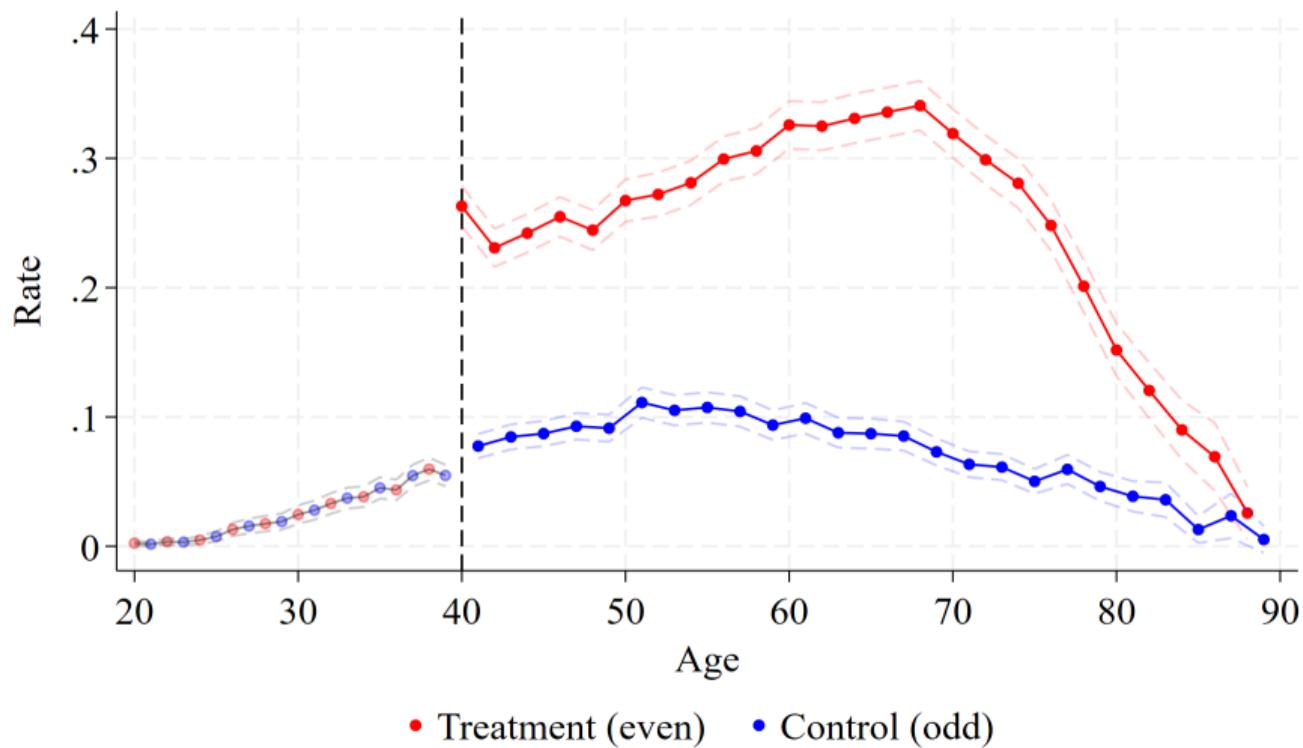
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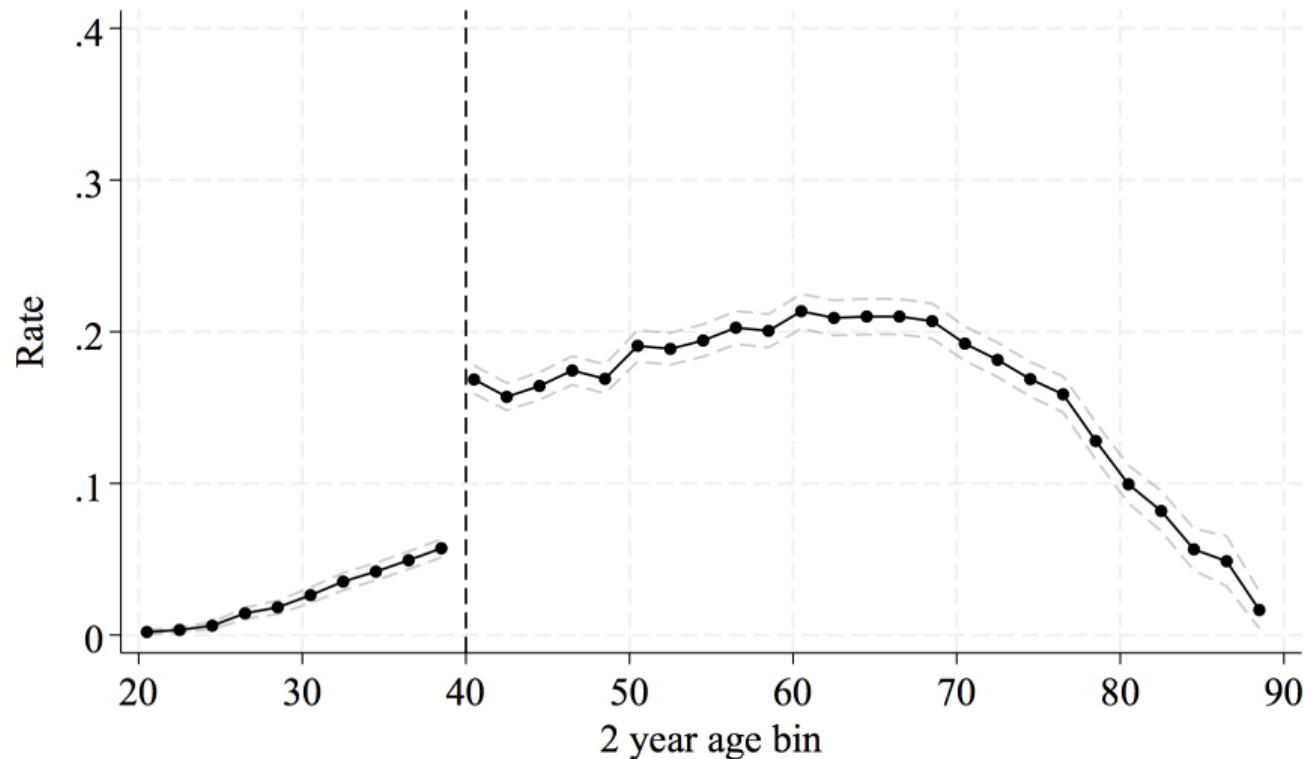
# Stomach cancer screening take-up by age



# Measuring the effect of subsidies on take-up

- 3 effects from biennial subsidy design
  - Recommendation effect: even ↑, odd ↑
  - Subsidy effect: even ↑
  - Substitution effect: even ↑, odd ↓
- Regression discontinuity design at age 40 using 2 year average take-up
  - Binning ages by 2 years: [38, 39], [40, 41]
  - 2-year average take-up ⇒ substitution effect cancels out
  - Measuring recommendation effect + subsidy effect
- Comparing even vs odd age group from age 40
  - Age  $\geq 40$  ⇒ recommendation effect cancels out
  - Measuring subsidy effect + substitution effect

## Stomach screening - 2 year age bins



# Regression discontinuity at age 40 using 2 year bins

- Binning

- Bin ages by 2 years and use bins as a unit of age  
 $\Rightarrow [34, 35], [36, 37], [38, 39], [40, 41], [42, 43], [44, 45]$
- Denote each bin with the midpoint  
 $\Rightarrow \text{agebin}_{it} = 34.5, 36.5, 38.5, 40.5, 42.5, 44.5$

- Econometric specification

$$\text{screen}_{it} = \alpha_0 + \alpha_1 \cdot a_{it} + \alpha_2 \cdot \mathbb{1}\{a_{it} > 0\} + \alpha_3 \cdot a_{it} \times \mathbb{1}\{a_{it} > 0\} + \varepsilon_{it} \quad (1)$$

- $a_{it} = (\text{agebin}_{it} - 39.5)$
- Individual  $i$  in year  $t$
- Analytical sample: age  $\in [34, 45]$
- Standard error clustered at the individual level

## Comparing even vs odd age groups from age 40

- Comparison between even age vs odd age from age 40
  - Variation comes from year of birth being even or odd
- Balance between even (treatment) and odd (control) group
  - Even age (treatment) group is younger than the odd age (control) group by design
  - Subsidy eligibility is random conditional on  $f(\text{age})$
- Econometric specification

$$y_{it} = \beta_0 + \beta_1 \cdot \text{age\_even}_{it} + f(\text{age}_{it}) + \epsilon_{it} \quad (2)$$

- Individual  $i$  in year  $t$
- Analytical sample:  $\text{age} \in [40, 89]$
- $f(\text{age})$ : linear splines with 5 years interval
- Standard error clustered at the individual level

## Balance table: balanced conditional on f(age)

	(1)	(2)	(3)
	Treatment group	Control group	Conditional difference
Age	58.697 (12.532)	59.240 (12.353)	- -
Female	0.530 (0.499)	0.532 (0.499)	-0.002* (0.001)
Currently married	0.799 (0.401)	0.798 (0.402)	-0.001 (0.001)
Years of education	10.320 (4.510)	10.227 (4.538)	-0.003 (0.008)
Working status	0.610 (0.488)	0.608 (0.488)	-0.003* (0.001)
Individual income	1446.3 (2081.6)	1425.7 (2068.1)	2.8 (5.2)
Household income	4104.4 (3708.6)	4086.7 (3737.9)	3.2 (14.3)
Own a house	0.734 (0.442)	0.737 (0.441)	-0.000 (0.001)
Number of household members	3.067 (1.317)	3.051 (1.317)	-0.004 (0.003)
N	54274	52909	
Share	(0.51)	(0.49)	
F(8, 15939)			1.65 (0.10)

# Data

- Korean health panel study dataset
  - Annual panel data from 2008 to 2018
  - Household level sampling (7000) / Individual level data (21,300)
  - Survey data collected through face-to-face interview (self-reported)
  - Information on
    - Demographic and SES
    - Health care usage
    - Health behaviors
- Health care usage (outpatient, inpatient, emergency)
  - Unit of observations: **every visit to a hospital**
  - Information
    - Date
    - Hospital bills, drug expenditures
    - Type of hospitals visited
    - Diagnosis (ICD-10)
    - First visit vs Recurring visit
    - Health screening records: screening type, tests performed, screening results, disease found

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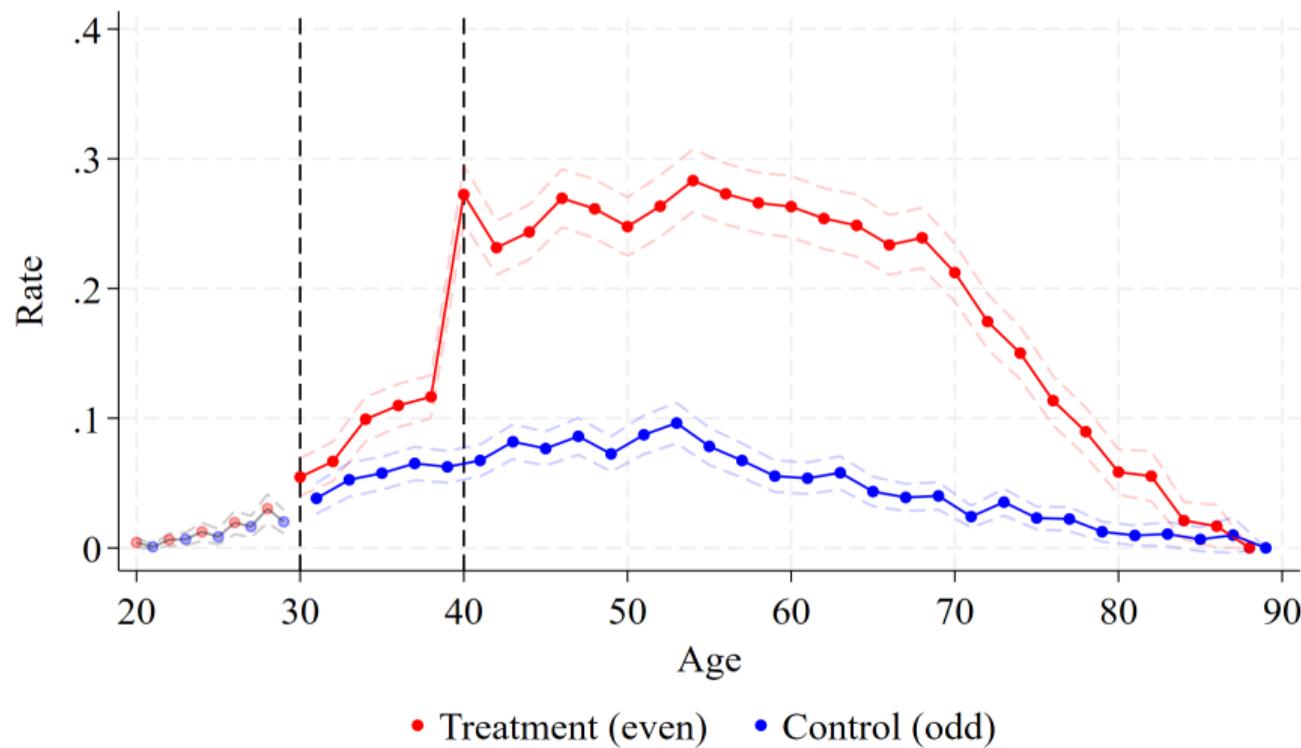
Spousal spillover

Selection

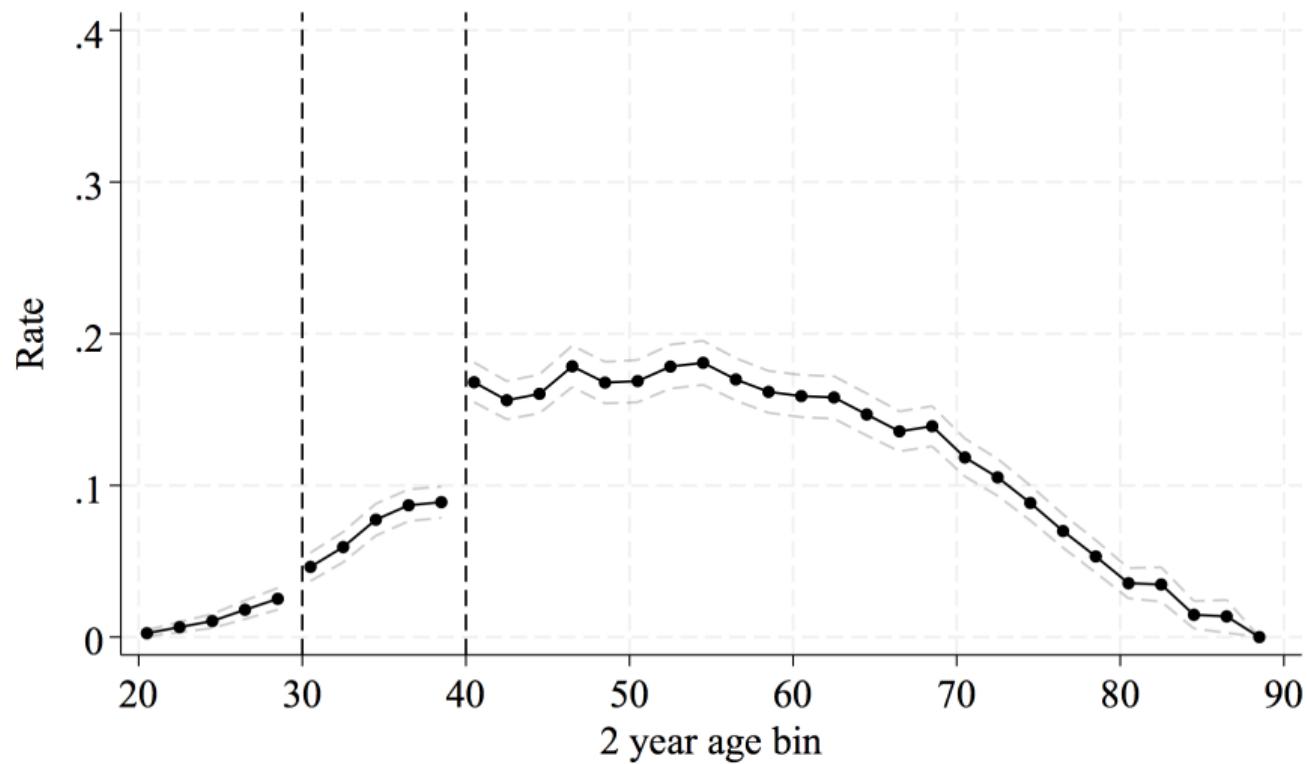
Effect of screening

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## Cervical screening - even vs odd age



## Cervical screening - 2 year age bins



# Regression discontinuity using 2-year age bins

	(1)	(2)	(3)	(4)	(5)
	Any	General	Stomach	Breast	Cervical
Age $\geq$ 40	0.097*** (0.008)	0.086*** (0.007)	0.105*** (0.006)	0.112*** (0.009)	0.074*** (0.010)
Constant	0.121*** (0.005)	0.095*** (0.005)	0.061*** (0.004)	0.064*** (0.005)	0.093*** (0.006)
N	34713	34713	34713	17725	17725
Adj $R^2$	0.017	0.020	0.032	0.037	0.013
Sample age range	[34, 45]	[34, 45]	[34, 45]	[34, 45]	[34, 45]
Subsidy starting age	40	40	40	40	30

# Comparing even vs odd ages

	(1)	(2)	(3)	(4)	(5)
	Any	General	Stomach	Breast	Cervical
Age even	0.204*** (0.003)	0.187*** (0.003)	0.190*** (0.003)	0.191*** (0.004)	0.164*** (0.003)
N	107183	107183	107183	56923	56923
Adj $R^2$	0.068	0.061	0.069	0.080	0.074
F-statistic	5012	4804	4830	2904	2520
Sample age range	[40, 89]	[40, 89]	[40, 89]	[40, 89]	[40, 89]
Subsidy starting age	40	40	40	40	30
Age controls	Y	Y	Y	Y	Y
Control group mean	0.122	0.102	0.083	0.067	0.056

# Intertemporal substitution

- Increase in participation or change in screening timing?
  - Intertemporal substitution widen the gap without any net increase in take-up
  - Hard to disentangle the subsidy effect from substitution effect
  - Counterfactual: recommendation for biennial screening from age 40 but without subsidies
- Evidence for (or against) intertemporal substitution
  1. Change in cervical screening subsidy starting age from 30 to 20 Cervical age change
  2. Ages before and after the subsidies Around age 40
  3. Monthly distribution of screening take-up Screening months

⇒ No strong sign of substitution

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**Cross spillover**

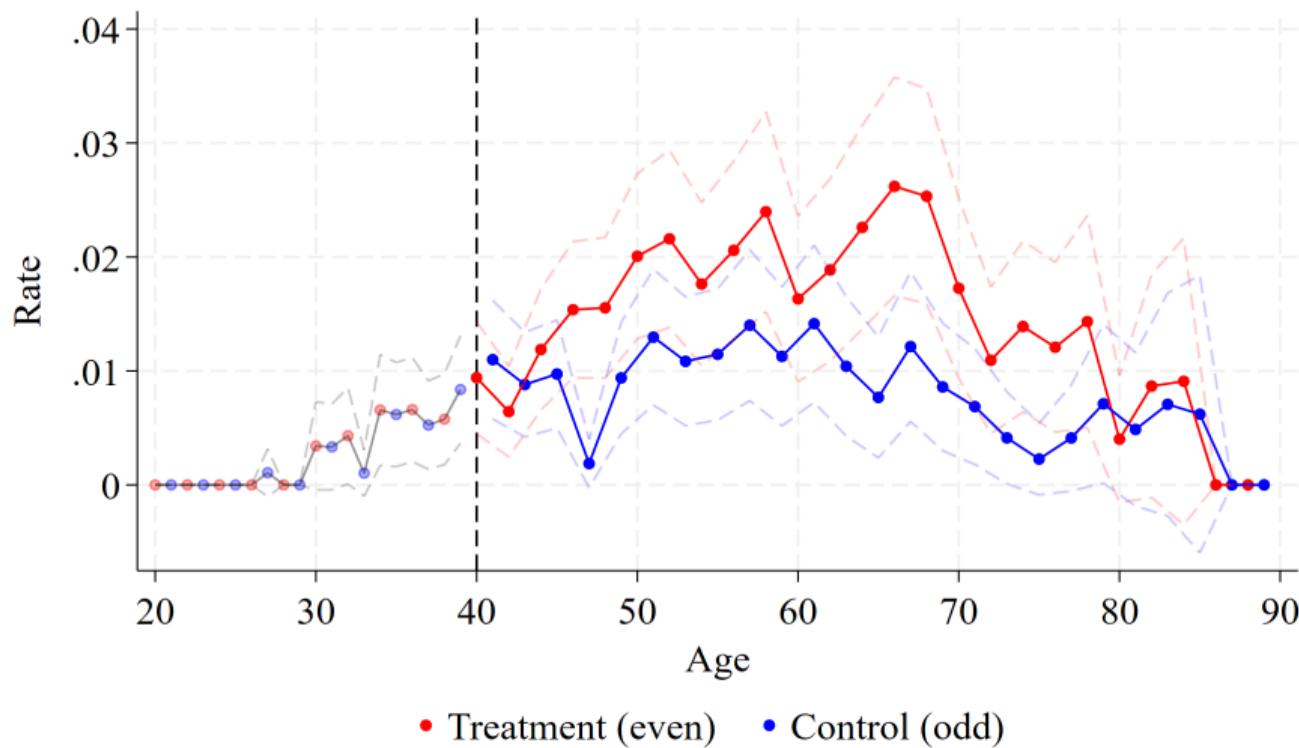
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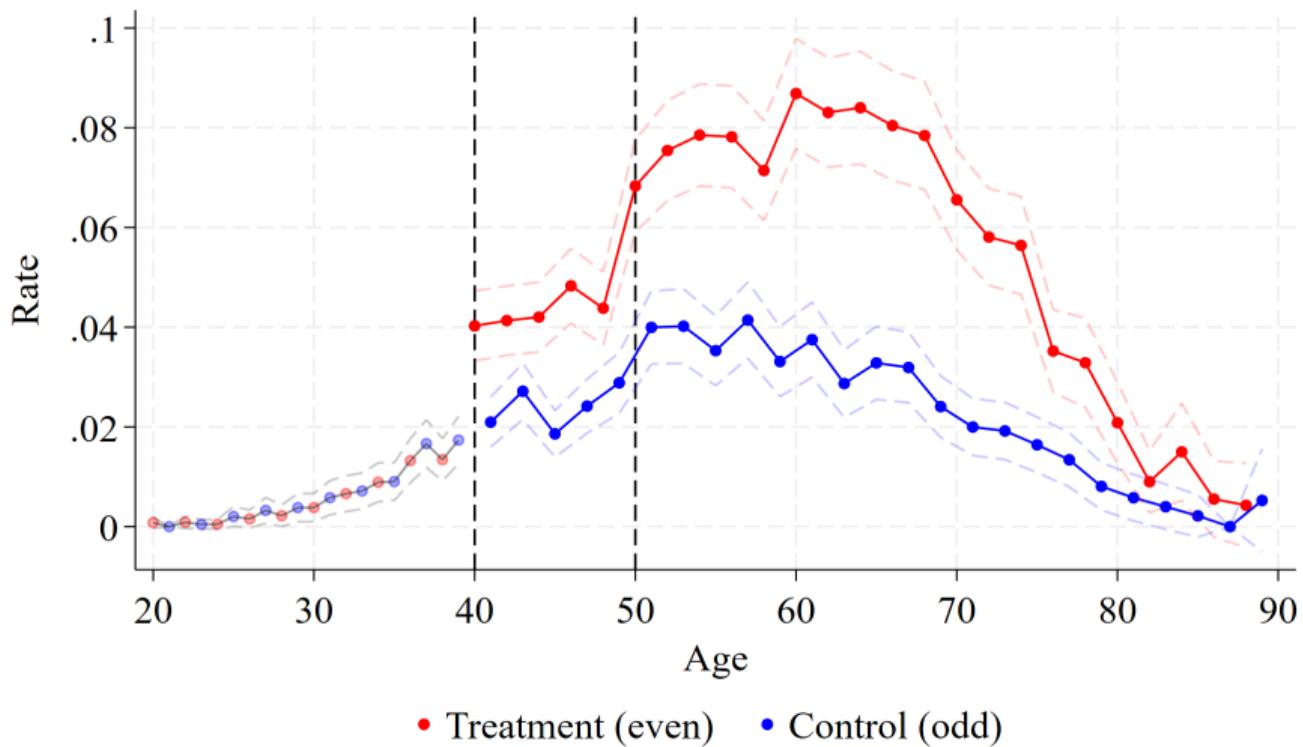
Effect of screening

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## Prostate screening - no subsidy



# Colorectal screening - annual subsidy



# Cross spillover across different types of screenings

	(1)	(2)	(3)	(4)	(5)
	Annual subsidy		No subsidy		Biennial subsidy
	Liver	Colorectal	Prostate	Lung	Cervical
Age even	0.027*** (0.001)	0.017*** (0.002)	0.007*** (0.001)	0.006*** (0.001)	0.037*** (0.004)
Age even $\times$ age $\geq 50$		0.023*** (0.002)			
Age even $\times$ age $\geq 40$					0.128*** (0.005)
N	107183	107183	50260	107183	69236
Sample age range	[40, 89]	[40, 89]	[40, 89]	[40, 89]	[30, 49]
Subsidy starting age	40	50	40	40	30
Age controls	Y	Y	Y	Y	Y
Control group mean	0.028	0.027	0.009	0.009	0.056

Cervical screening

## Interpretation: positive or negative spillover?

- Common take-up pattern: biennial take-up from age 40
  - Most common subsidy rule
  - Major screening (general and stomach) subsidy rule
- Positive spillover: less frequent subsidies than biennial schedule from 40
  - Prostate / lung screening
  - Liver screening of non-high risk group
  - Colorectal screening at age [40, 49]
  - Colorectal screening using colonoscopy
- Negative spillover: more frequent subsidies than biennial schedule from 40
  - Cervical screening at age [30, 39]
  - Liver screening of high-risk group
  - Colorectal screening at age [50, 59]
  - Colorectal screening using fecal occult blood test

# Mechanisms

- Annual and no-subsidy screening participants are a subset of biennial screening participants

Subset

- People receive multiple screenings on the same day
  - Fixed cost in visiting hospital
  - Many clinics and hospital provide screenings as a bundle
  - Among hospitals that offer general screening, 70% conduct stomach and colorectal screening and 37% conduct all major cancer screenings

- If received on different dates, people receive them after general screening
  - Doctor's recommendation to receive other screenings at the general screening

Share (same day)

Reg (same day)

- Breast and cervical screenings are not the ones generating spillover
  - General and stomach screening have the highest take-up

Heterogeneity (gender)

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# Spillover in take-up between spouses

- Analytical sample

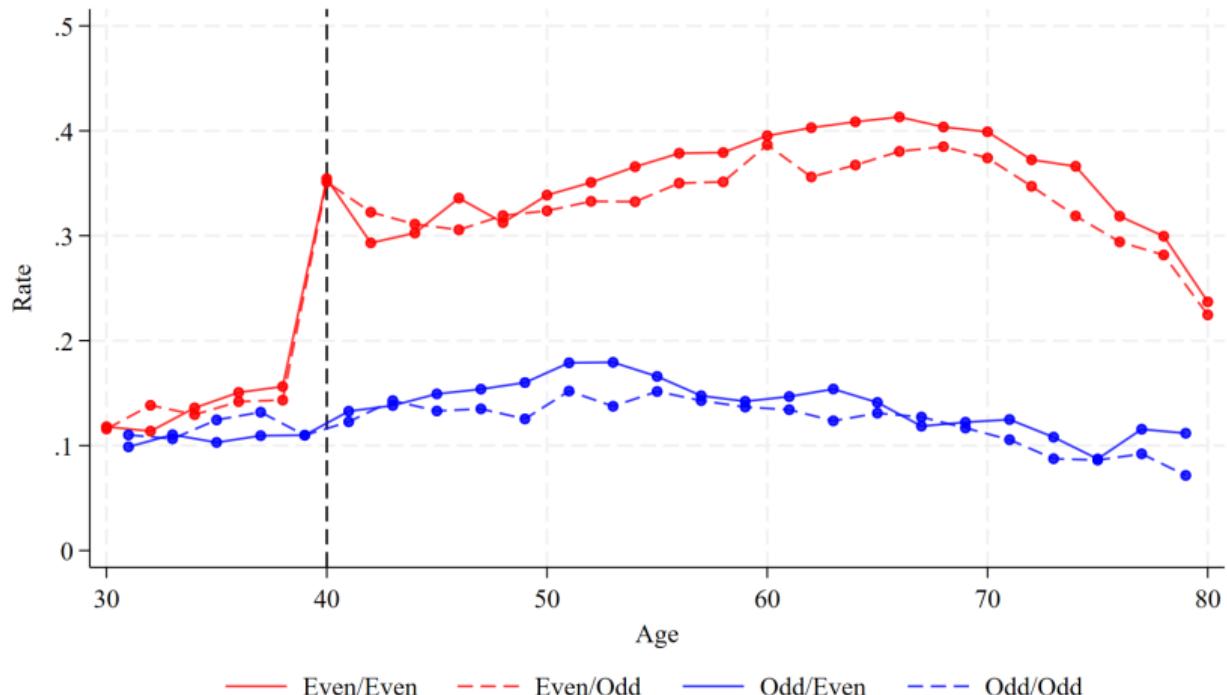
- Dataset contains all the household members
- Currently married people (50,863 couple pairs)
- Own age  $\geq 40$  & spouse age  $\geq 40$

- Econometric specification

$$y_{it} = \gamma_0 + \gamma_1 \cdot \text{age\_even}_{it} + \gamma_2 \cdot \text{spouse\_age\_even}_{it} + \gamma_3 \cdot \text{age\_even}_{it} \times \text{spouse\_age\_even}_{it} + \phi_{it} \quad (3)$$

- $y_{it}$ : own screening take-up of individual  $i$  in year  $t$
- Standard error clustered at couple level
- Variation comes from 4 types of couples with different subsidy compositions

## Comparing between 4 types of couples



# Spousal spillover in take-up

	(1)	(2)	(3)	(4)
Outcome var: Own screening take-up				
Age even	0.214*** (0.006)	0.213*** (0.006)	0.213*** (0.004)	0.213*** (0.004)
Spouse age even	0.016*** (0.005)	0.015*** (0.004)		
Age even × Spouse age even	0.001 (0.009)	0.003 (0.009)		
Spouse screening			0.078*** (0.017)	0.079*** (0.017)
N	79962	79782	79962	79782
Odd/Odd group mean	0.128	0.128	0.128	0.128
Demographic controls		Y		Y
Estimator	OLS	OLS	2SLS	2SLS

# Mechanisms

- Husbands are more likely to participate if wives are eligible for subsidies, but not vice versa

Direction

- Spouses can get screening together on the same day.

Share (same day)

Reg (same day)

- No spousal spillover for screenings that are for women or men only

In each screening

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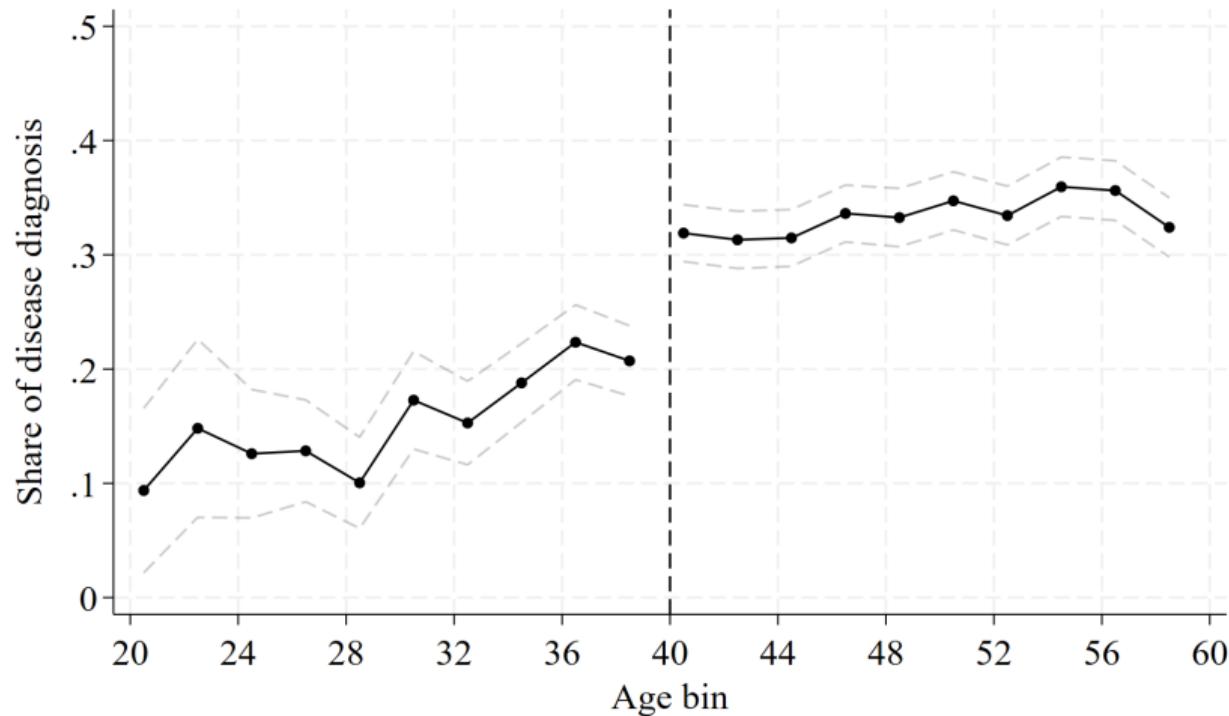
## Selection into screening

- We care not only the increase in screening participation rate, but the characteristics of the new participants (compliers)
- Compliance groups following [Angrist et al. \(1996\)](#)

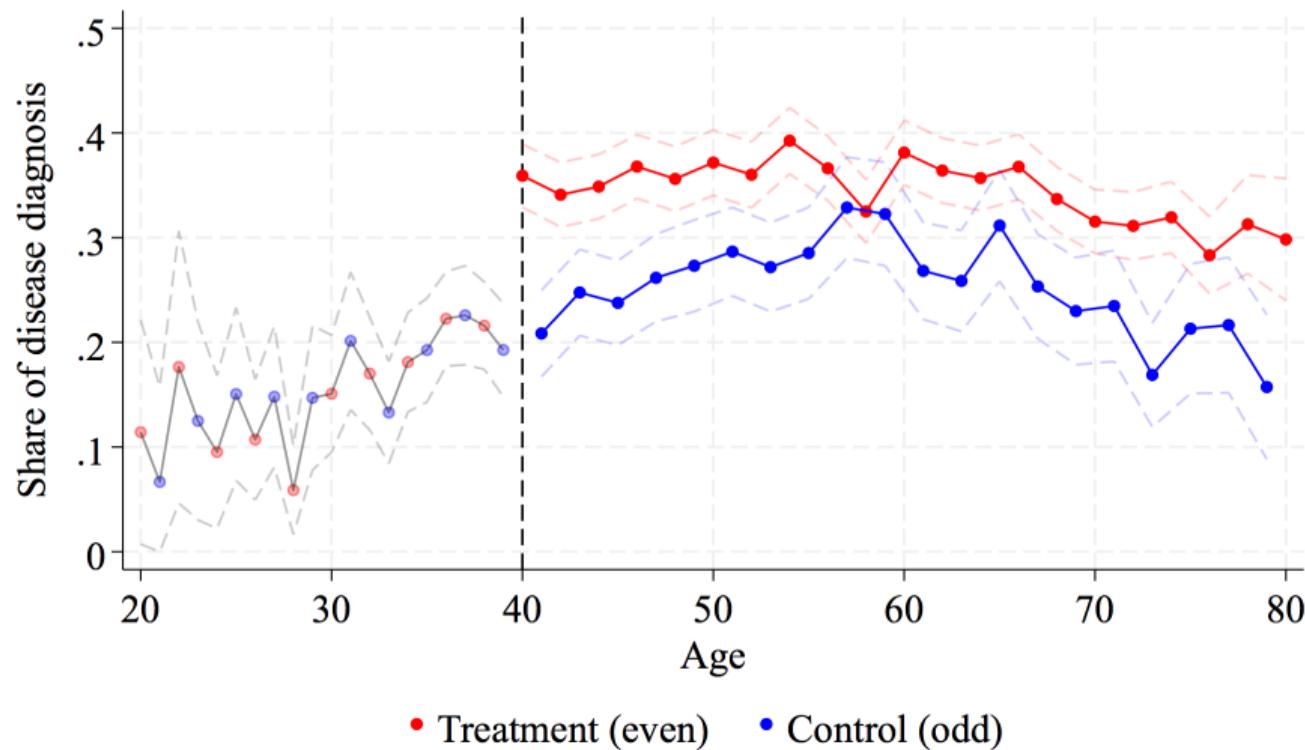
	Even age (treatment)	Odd age (control)
Always-takers	Yes	Yes
Compliers	Yes	No
Defiers	No	Yes
Never-takers	No	No

- We want the policy to target compliers who are more likely to have a disease
- 2 reference groups in comparing compliers
  - Compliers vs Always-takers  $\Rightarrow$  composition of screening participants
  - Compliers vs Never-takers  $\Rightarrow$  who complies with the policy?

# Compliers are more likely to be diagnosed with a disease than always-takers



# Compliers are more likely to be diagnosed with a disease than always-takers



# How can we more rigorously characterize compliers?

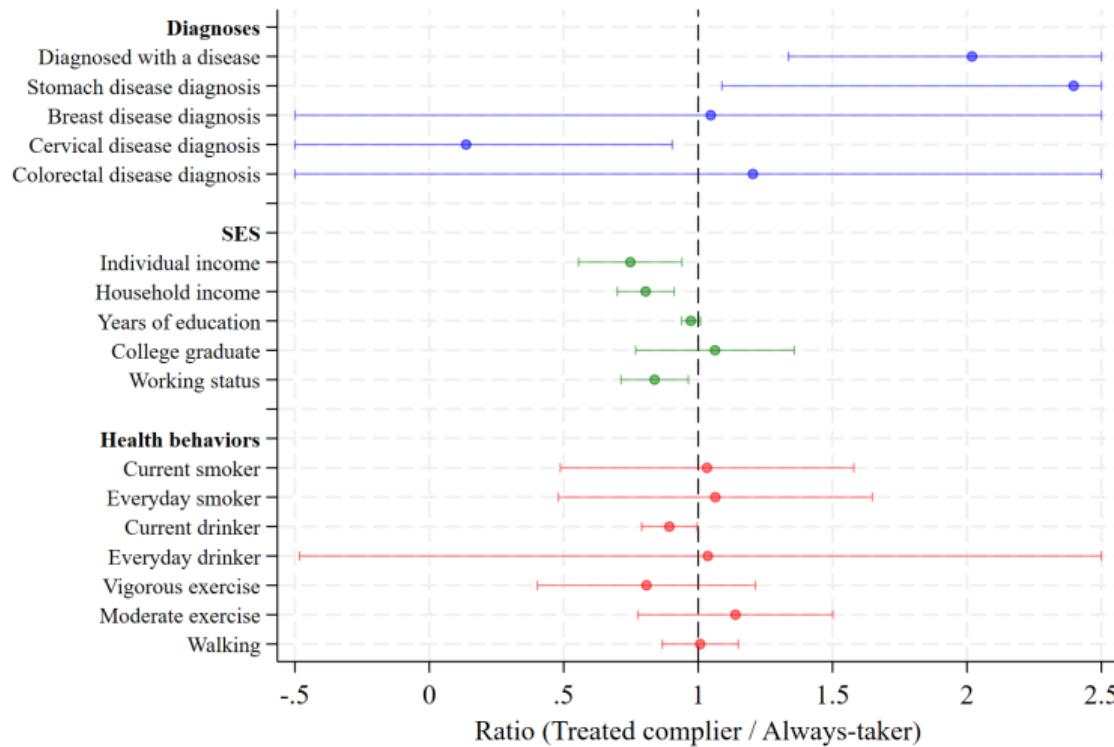
- We need to adjust for group shares when estimating characteristics
- 3 steps
  1. Estimate always- and never-takers characteristics
  2. Back out complier characteristics
  3. Compare compliers to always- and never-takers

	Even age (treatment)	Odd age (control)
Always-takers	Yes	Yes
Compliers	Yes	No
Never-takers	No	No

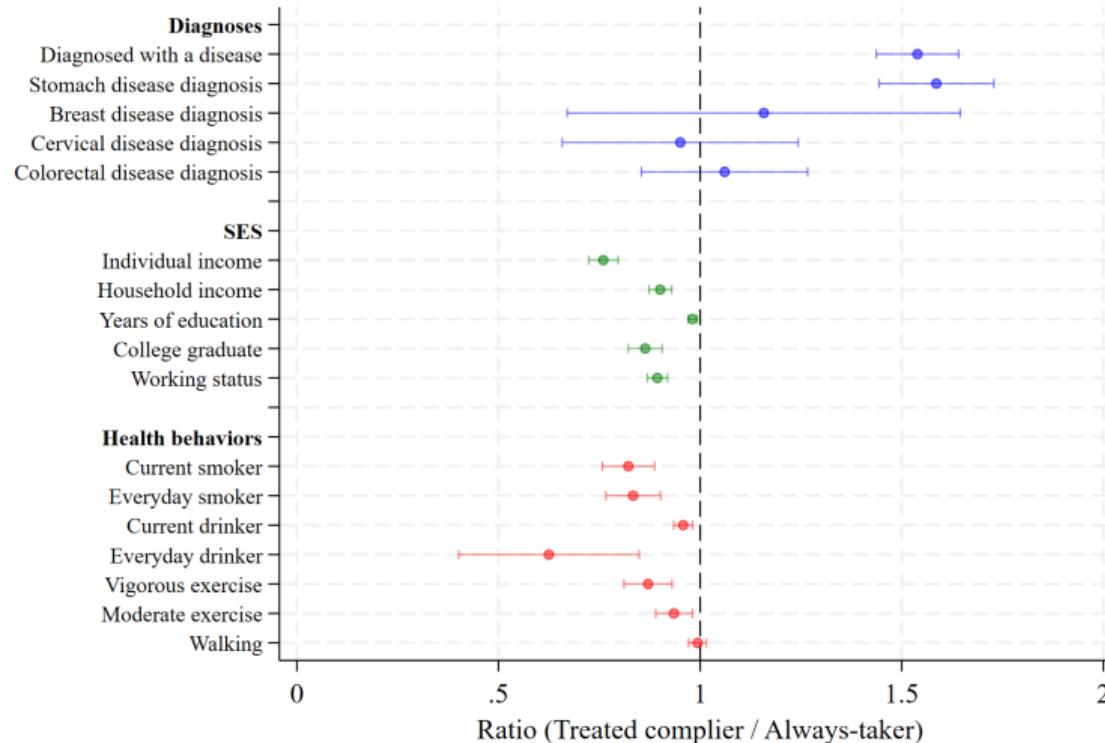
- Ratios
  - Treated compliers / Always-takers
  - Untreated compliers / Never-takers

Detail

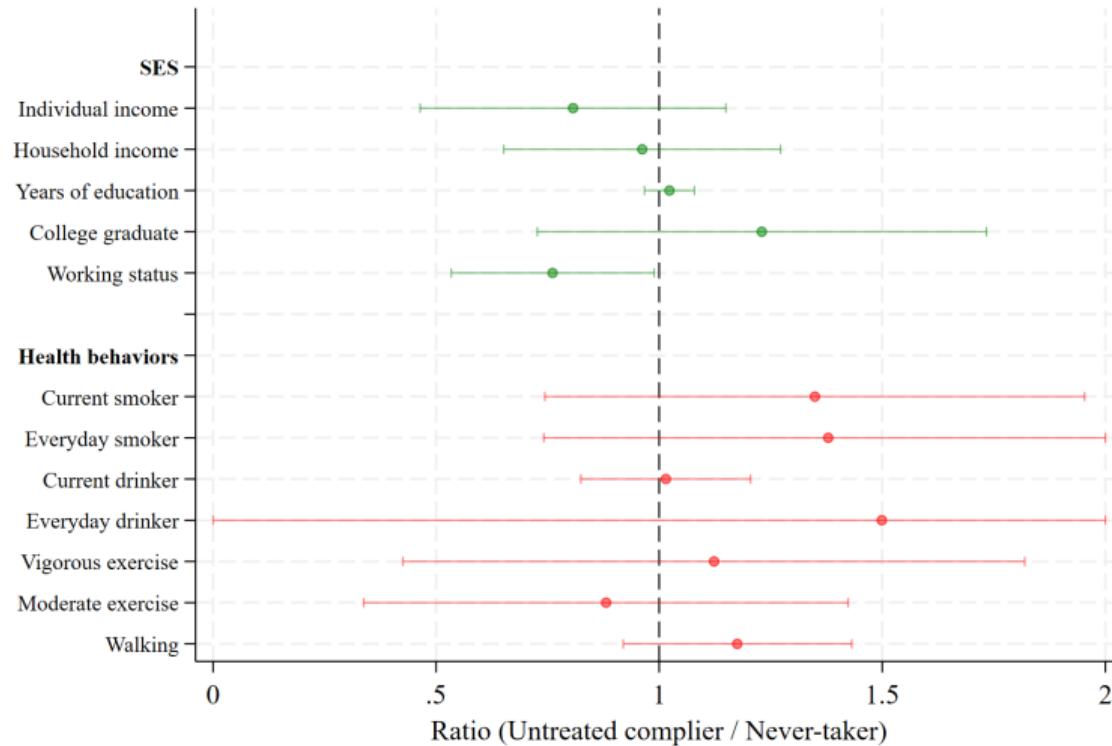
# Compliers vs Always-takers using age 40 discontinuity



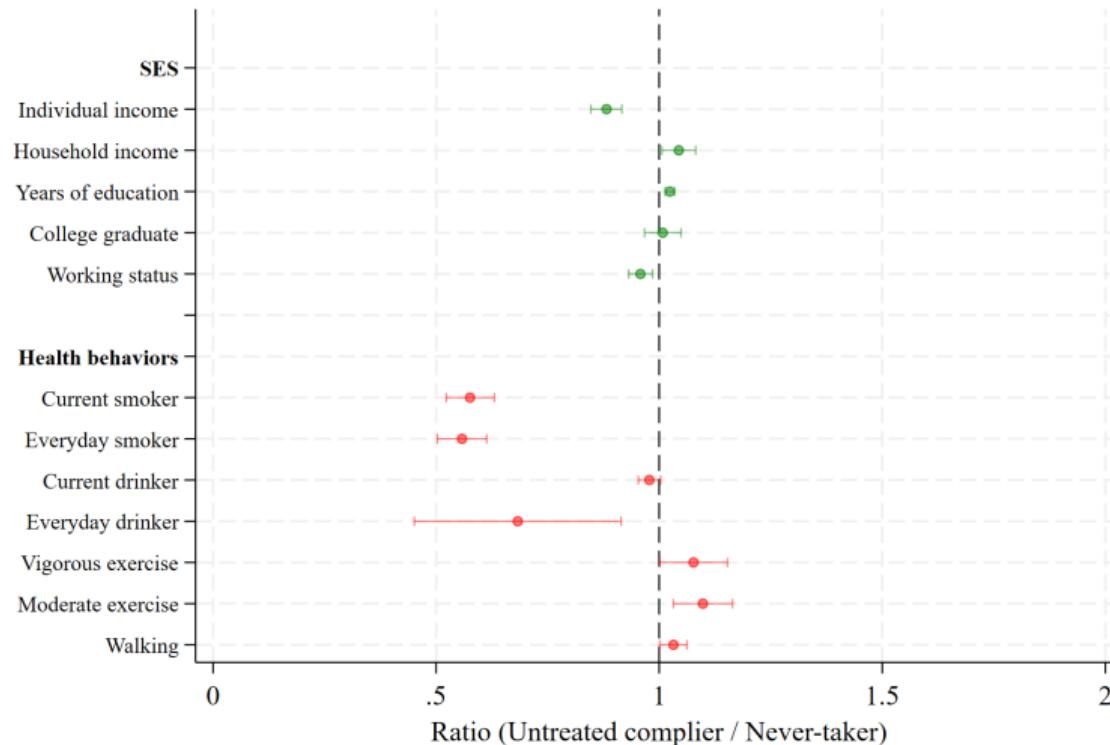
# Compliers vs Always-takers by comparing even and odd ages



# Compliers vs Never-takers using age 40 discontinuity



# Compliers vs Never-takers by comparing even and odd ages



## Who are compliers in cross spillover effects?

- Annual and no-subsidy screening participants are a subset of biennial screening participants
- Compliers are the ones who participate in annual and no-subsidy screenings among biennial screening participants (one-sided noncompliance)
- Econometric specification

$$y_{it} = \delta_0 + \delta_1 \cdot screen_{it} + \varepsilon_{it} \quad (4)$$

- Sample: biennial screening participants
- Outcome: diagnosis, socioeconomic status and health behaviors
- Explanatory variable: take-up of annual or no-subsidy screenings
- Standard errors are clustered at the individual level

# Spillover compliers are healthier and have higher socioeconomic status

	(1)	(2)	(3)
	Annual	No-subsidy	Sample mean
<b>Panel A. Diagnoses</b>			
Stomach disease diagnosis	-0.026*** (0.006)	-0.086*** (0.010)	0.228
Breast disease diagnosis	-0.006* (0.003)	-0.019*** (0.004)	0.022
Cervical disease diagnosis	-0.018*** (0.006)	-0.022 (0.016)	0.062
<b>Panel B. SES</b>			
Individual income	874*** (49)	1499*** (110)	1592
Household income	1012*** (66)	1393*** (145)	4564
Years of education	0.975*** (0.073)	1.342*** (0.129)	10.769
College graduate	0.074*** (0.007)	0.131*** (0.014)	0.196
Working status	0.063*** (0.008)	0.141*** (0.012)	0.635

# Spillover compliers show health behaviors consistent with higher income

	(1)	(2)	(3)
	Annual	No-subsidy	Sample mean
<b>Panel C. Health behaviors</b>			
Current smoker	0.044*** (0.006)	0.116*** (0.013)	0.146
Everyday smoker	0.041*** (0.006)	0.100*** (0.013)	0.138
Current drinker	0.066*** (0.008)	0.149*** (0.012)	0.655
Everyday drinker	0.018*** (0.004)	0.035*** (0.009)	0.060
Vigorous exercise	0.050*** (0.007)	0.104*** (0.014)	0.235
Moderate exercise	0.050*** (0.008)	0.107*** (0.014)	0.409
Walking	0.012** (0.006)	0.031*** (0.010)	0.812

# Summary of selection analysis

- Compliers with subsidies
  - Compared to always-takers, compliers have lower socioeconomic status and worse health conditions ([Kim and Lee, 2017](#))
  - Compared to never-takers, compliers show better health behaviors ([Oster, 2020; Einav et al., 2020; Kowalski, 2023](#))

Panel

- Compliers in cross spillover
  - Compliers have higher socioeconomic status and better health conditions
- Opposite selection pattern compared to [Einav et al. \(2020\)](#)
  - [Einav et al. \(2020\)](#): Mammogram starting age recommendation based on medical studies
  - This study: Subsidies (90-100%) for various screening
    - ⇒ Subsidies better target those who are more likely to benefit from screenings

[Einav et al. \(2020\)](#)

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# Effect of screening on diagnoses and health care utilizations

- Outcome variables
  - Health care utilizations
    - Number of hospital visits (aggregate + diagnosis category)
    - Outpatient, inpatient and emergency care
  - Proxy for new diagnosis
    - NOT disease diagnosis from health screening
    - First outpatient hospital visit
- Two-stage least square estimation

$$y_{it} = \eta_0 + \eta_1 \cdot screen_{it} + \mathbf{f}(\mathbf{age}_{it}) + \varepsilon_{it} \quad (5)$$

- $screen_{it}$  is instrumented by  $age\_even_{it}$
- Standard error clustered at individual level
- Westfall-Young adjusted p-values for multiple hypotheses testing ([Jones et al., 2019](#))
- Only capture short-run effect

# Effect of health screening on outpatient visits

	(1)	(2)	(3)	(4)	(5)
	Control group mean	ITT	LATE	Adjusted p-values	N
<b>Panel A. Outpatient visits</b>					
Outpatient visit	20.8088	0.0977 (0.0757)	0.4784 (0.3709)	0.866	107183
High blood pressure	2.7100	0.0001 (0.0115)	0.0007 (0.0618)	0.993	107183
Hyperlipidemia	0.9847	0.0073 (0.0073)	0.0390 (0.0391)	0.888	107183
Diabetes	1.1378	0.0115 (0.0097)	0.0616 (0.0521)	0.866	107183
Stomach	0.9716	0.0685*** (0.0117)	0.3613*** (0.0616)	0.000	107183
Breast	0.1141	0.0013 (0.0116)	0.0066 (0.0608)	0.993	56923
Female genital	0.3440	0.0053 (0.0094)	0.0321 (0.0571)	0.932	56923
Liver	0.1114	0.0030 (0.0043)	0.1118 (0.1604)	0.932	107183
Colorectal	0.3069	0.0086 (0.0064)	0.2603 (0.1955)	0.866	107183
Male genital	1.2352	-0.0343 (0.0259)	-4.6905 (3.6077)	0.866	50260
Lung	0.1435	0.0066 (0.0064)	1.0699 (1.0402)	0.888	107183

# Health screening increases first hospital visits for a new illness

	(1)	(2)	(3)	(4)	(5)
	Control group mean	ITT	LATE	Adjusted p-values	N
<b>Panel B. First outpatient visits</b>					
First outpatient visit	3.9335	0.0742*** (0.0153)	0.3632*** (0.0749)	0.000	107183
High blood pressure	0.0509	0.0015 (0.0015)	0.0082 (0.0080)	0.767	107183
Hyperlipidemia	0.0239	0.0034*** (0.0010)	0.0184*** (0.0054)	0.005	107183
Diabetes	0.0255	0.0009 (0.0011)	0.0048 (0.0057)	0.771	107183
Stomach	0.1863	0.0246*** (0.0031)	0.1300*** (0.0161)	0.000	107183
Breast	0.0085	0.0023** (0.0011)	0.0121** (0.0055)	0.164	56923
Female genital	0.0891	0.0062** (0.0027)	0.0380** (0.0166)	0.150	56923
Liver	0.0097	0.0009 (0.0007)	0.0320 (0.0272)	0.737	107183
Colorectal	0.0786	0.0035* (0.0019)	0.1054* (0.0590)	0.351	107183
Male genital	0.0681	-0.0024 (0.0027)	-0.3222 (0.3749)	0.771	50260
Lung	0.0197	0.0003 (0.0010)	0.0551 (0.1689)	0.771	107183

# Effect of health screening on inpatient visits

	(1)	(2)	(3)	(4)	(5)
	Control group mean	ITT	LATE	Adjusted p-values	N
<b>Panel A. Inpatient visits</b>					
Inpatient visit	0.23291	0.00555 (0.00391)	0.02719 (0.01915)	0.804	107183
High blood pressure	0.00571	0.00021 (0.00056)	0.00115 (0.00299)	0.997	107183
Hyperlipidemia	0.00043	0.00018 (0.00018)	0.00095 (0.00097)	0.939	107183
Diabetes	0.00692	-0.00025 (0.00067)	-0.00133 (0.00357)	0.997	107183
Stomach	0.01181	0.00133 (0.00101)	0.00703 (0.00534)	0.843	107183
Breast	0.00721	0.00041 (0.00146)	0.00216 (0.00762)	0.997	56923
Female genital	0.00412	-0.00016 (0.00083)	-0.00094 (0.00507)	0.997	56923
Liver	0.00524	0.00082 (0.00069)	0.03084 (0.02593)	0.882	107183
Colorectal	0.01633	-0.00026 (0.00135)	-0.00799 (0.04094)	0.997	107183
Male genital	0.01249	0.00059 (0.00127)	0.08096 (0.17323)	0.997	50260
Lung	0.01183	0.00207* (0.00116)	0.33331* (0.19063)	0.588	107183

# Effect of health screening on emergency visits

	(1)	(2)	(3)	(4)	(5)
	Control group mean	ITT	LATE	Adjusted p-values	N
<b>Panel B. Emergency visits</b>					
ER visit	0.12520	-0.00238 (0.00259)	-0.01165 (0.01268)	0.956	107183
High blood pressure	0.00113	-0.00004 (0.00025)	-0.00021 (0.00136)	0.993	107183
Hyperlipidemia	0.00008	-0.00001 (0.00007)	-0.00004 (0.00035)	-	107183
Diabetes	0.00261	-0.00032 (0.00045)	-0.00174 (0.00239)	0.956	107183
Stomach	0.00758	-0.00015 (0.00061)	-0.00077 (0.00324)	0.993	107183
Breast	0.00043	-0.00020 (0.00024)	-0.00106 (0.00126)	0.956	56923
Female genital	0.00060	-0.00031 (0.00023)	-0.00190 (0.00139)	0.858	56923
Liver	0.00157	0.00054 (0.00046)	0.02024 (0.01742)	0.928	107183
Colorectal	0.00720	0.00072 (0.00062)	0.02189 (0.01886)	0.928	107183
Male genital	0.00586	-0.00055 (0.00072)	-0.07544 (0.09920)	0.956	50260
Lung	0.00414	0.00009 (0.00049)	0.01407 (0.07856)	0.993	107183

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## Conclusion

1. Screening subsidies are effective in increasing participation and targeting less healthy group
2. Receiving screenings together (multiple screenings AND with a spouse) increases participation
3. Screening leads to new diagnoses and subsequently induce individuals to seek medical care.

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# Implementation of the health screening program

- Nationwide program
  - Target: all the citizens covered by National Health Insurance Service (NHIS)
  - History: (1980) Beginning of the program → (2004) Current system
- How can I receive subsidized screenings
  - Providers: public health clinics / private clinics and hospitals designated by the NHIS  
⇒ (Dec 2023) 6,600 screening centers for general screening → 4600 people per center
  - Appointment: normally required but varies by hospitals and type of screenings
- Do people know about the screening program and the subsidies?
  - Even-odd subsidy rule has been used throughout the study period
  - Reminder mails (and mobile notifications)
    - Sent to those eligible for subsidies
    - Mail contains the type of screenings to receive and screening providers in the neighborhood

Back

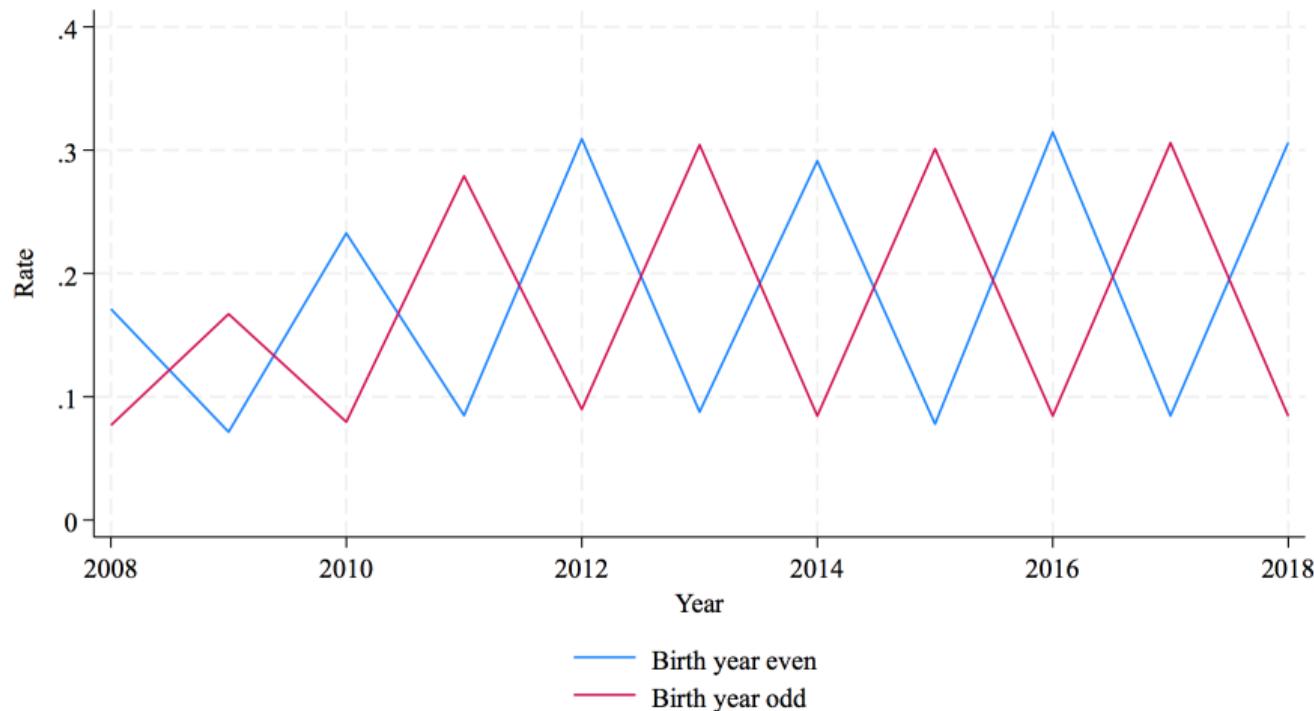
# High risk group for liver screening

1. Individuals with the following diseases
  - Cirrhosis
  - Chronic liver disease
2. Individuals who were diagnosed with positive results in the previous year general health screening
  - Hepatitis B surface antigen test
  - Hepatitis C virus HCV antibody test

⇒ can be found through blood test
3. Individuals who used medical services for the following diseases in the past two years are excluded
  - Liver cell carcinoma, hepatocellular carcinoma and liver cancer (C22.0)
  - Intrahepatic bile duct carcinoma and Cholangiocarcinoma (C22.1)

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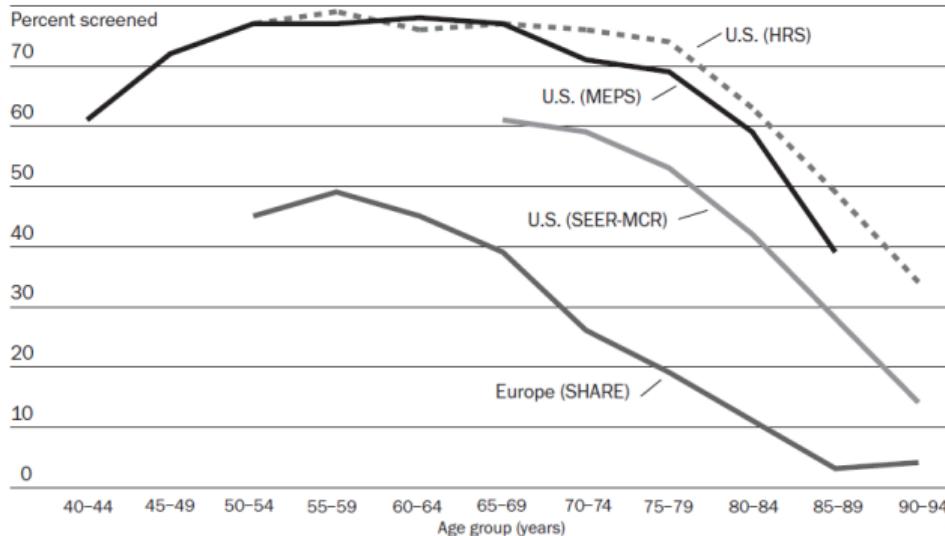
## First stage by birth year



# Breast screening in the US and Europe (Howard et al., 2009)

## EXHIBIT 3

### Receipt Of Mammography In The Past Two Years Among Women Ages 44–94 In Europe And The United States, By Age Group, 2004

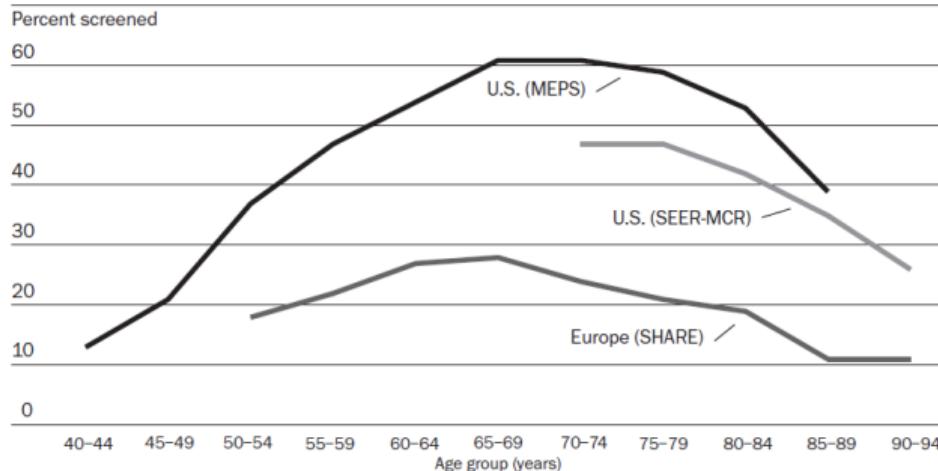


**SOURCES:** U.S. screening rates are from the Medical Expenditure Panel Survey (MEPS), the Health and Retirement Study (HRS), and Surveillance, Epidemiology, and End Results (SEER)-Medicare data (SEER-MCR). European rates are from the Survey of Health, Ageing, and Retirement in Europe (SHARE).

# Colorectal screening in the US and Europe (Howard et al., 2009)

## EXHIBIT 4

Receipt Of Colonoscopy, Sigmoidoscopy, And Fecal Occult Blood Tests Among Women And Men Ages 44-94 In The Past Ten Years In Europe And In The Past Five Years In The United States, By Age Group, 2004



**SOURCES:** U.S. screening rates are from the Medical Expenditure Panel Survey (MEPS); and Surveillance, Epidemiology, and End Results (SEER)-Medicare data (SEER-MCR). European rates are from the Survey of Health, Ageing, and Retirement in Europe (SHARE).

## Health care usage data collection

- Recording health care usage
  - Survey participants are asked to keep health diary and store receipts from every visit to hospitals and pharmacies
- No gap
  - During annual interviews, enumerator goes through health diary from the last time of interview

# Health diary

## ❶ 건강기록부 작성방법 ❷

### ❶ 병의원에 다녀왔을 때

- ▶ 우리 가족 누구든지 병의원에 다녀오면 가계부를 작성해주세요.
- ▶ 병의원 영수증과 처방전 및 약국 영수증은 영수증 보관함에 함께 모아주세요.

<작성 예시> 이를 흥길동이 이비인후과에 비염 때문에 다녀온 후

의료 이용 형태	<input checked="" type="checkbox"/> 외래	<input type="checkbox"/> 입원	<input type="checkbox"/> 응급	<input type="checkbox"/> 건강진진
진료 일	2019년 4월 10일(화)			
가구 원 이동	동일동			
병의원 이름	흔흔한 이비인후과			
방문 이유	알레르기 비염			
병원 수납금액	4,000 원			
교통수단 (버스, 택시, 도보 등)	내원	걸어서	공사	걸어서
보관 여부	<input checked="" type="checkbox"/> 진료비 납입 영수증	<input type="checkbox"/> 처방전	<input checked="" type="checkbox"/> 약국불통	

### ❶ 의약품 및 보건의료용품을 삼을 때

- ▶ 우리 가족 누구든지 처방전 없이 의약품 또는 의료기기, 건강기능식품 등을 구매하면 가계부에 기입해주세요.
- ▶ 다음과 같은 항목을 구매한 경우 활별로 합산하여 기입해주세요.  
→ 구입영수증은 영수증 보관함에 따로 모아주세요.

<예시> 정파와 함께 먹으려고 멀티비타민 구입. 갑자기 기운이 있어 엄마가 종합건강제를 먹으려서 구매

2019년 5월		
구입목록	구입 장소	비용
1. 일반음식물/약품	<input type="checkbox"/> 병원 <input type="checkbox"/> 약국 <input type="checkbox"/> 마트/편의점	( ) 원
2. 한약 및 한약재 (처방 한약 제외)	<input type="checkbox"/> 약국 <input type="checkbox"/> 한약방	( ) 원
3. 건강보조식품 (홍삼, 비타민 등)	<input type="checkbox"/> 병원과 약국 <input checked="" type="checkbox"/> 인터넷 및 품소통 <input type="checkbox"/> 백화점, 마트, 시장 등	( ) 원 ( ) 원
4. 의약기기 및 의료용품		( ) 원
※ 예시		
<ul style="list-style-type: none"> <li>- 보건의료소모품(绷带, 마스크, 액정수, 연대, 모기기, 고체제)</li> <li>- 안경 및 관제안경은 구입 및 수리</li> <li>- 보청기 구입 및 수리</li> <li>- 신약보조제(당뇨기 등) 개요 영수증을 구매, 대여 및 수리 (체크아웃, 신약 분양권, 약방, 치과 고장기, 불교기, 향상화장기 등)</li> </ul>		

## <How to write health diary>

### • Visit to hospital

- Record it for all the household members
- Store hospital receipts, prescriptions and pharmacy receipts in a box

<Example> After a visit to ENT for allergy

Type	<input checked="" type="checkbox"/> Outpatient	<input type="checkbox"/> Inpatient	<input type="checkbox"/> Emergency	<input type="checkbox"/> Screening
Date	From: April 10, 2019 To:			
Name	John Doe			
Name of the hospital	Dr. Jane M. Doe, MD			
Purpose	Allergy			
Hospital bills	\$40			
Transportation	To	Walking	From	Walking
Receipts	<input type="checkbox"/> Hospital	<input type="checkbox"/> Prescription	<input type="checkbox"/> Pharmacy	

### • Purchase of OTC drugs, oriental medicine, dietary supplements

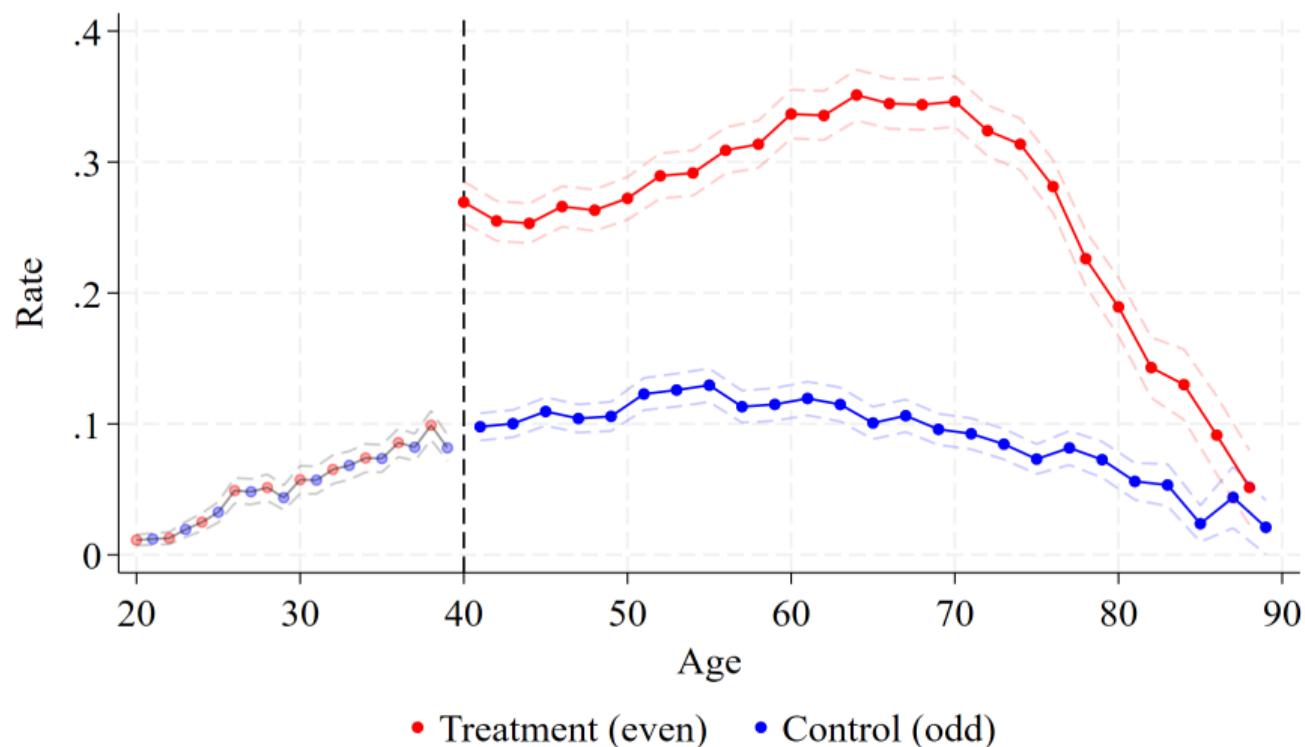
- Record it for all the household members
- Store hospital receipts, prescriptions and pharmacy receipts in a box

<Example> Purchase of multivitamin and Tylenol

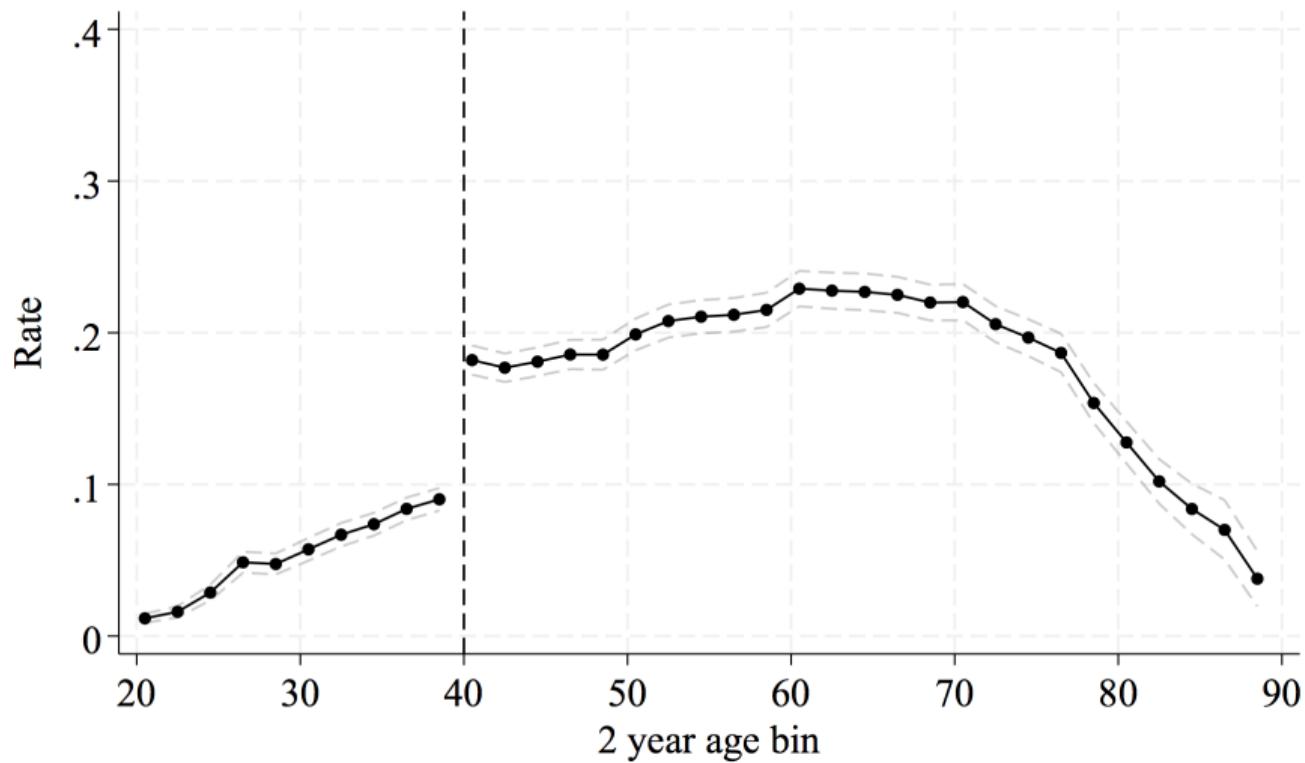
January 2019		
Item	Place	Cost
OTC drugs	<input type="checkbox"/> Hospital <input type="checkbox"/> Pharmacy <input type="checkbox"/> CVS	( ) KRW ( ) KRW ( ) KRW
Oriental medicine	<input type="checkbox"/> Pharmacy <input type="checkbox"/> Acupuncture clinic	( ) KRW ( ) KRW
Dietary supplement (ginseng, vitamin, etc)	<input type="checkbox"/> Hospital or pharmacy <input type="checkbox"/> Internet shopping <input type="checkbox"/> Department store	( ) KRW ( ) KRW ( ) KRW
Any other medical products (e.g.)		( ) KRW
- Bandage, mask, insect repellent		
- Glasses, contact lenses		
- Hearing aid		

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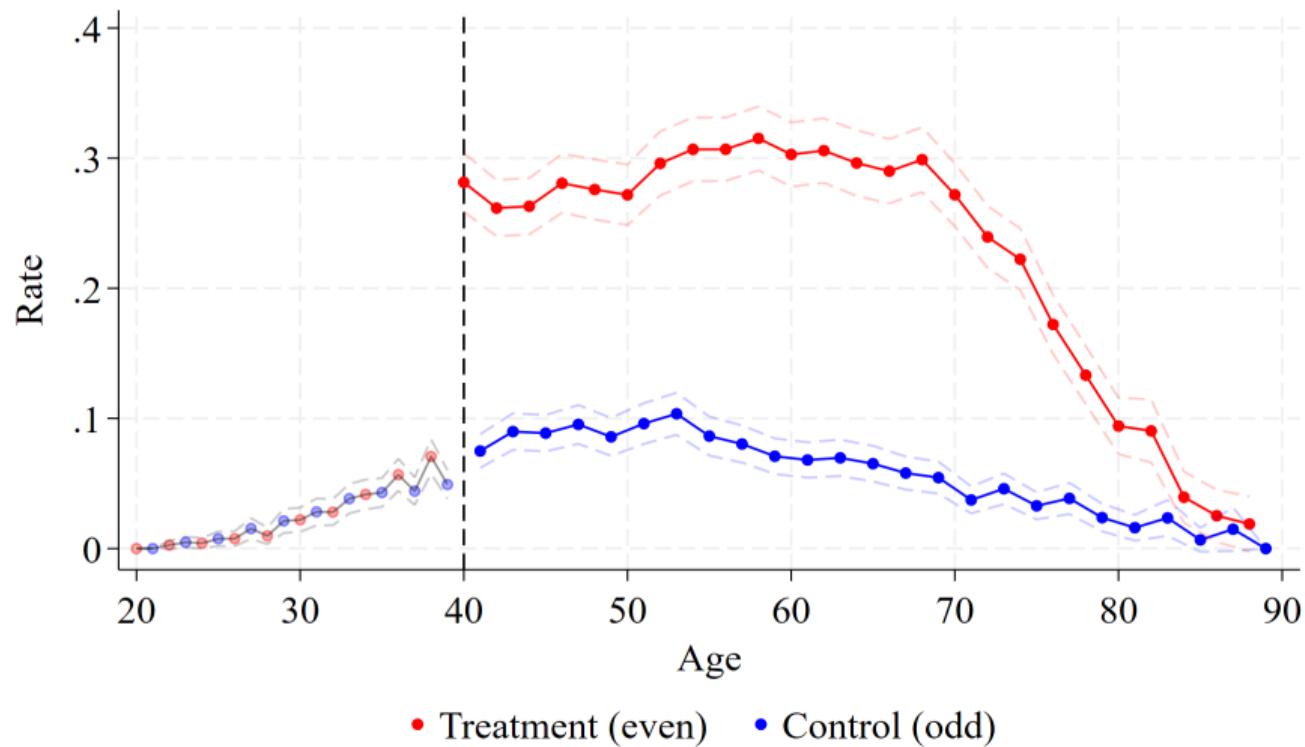
## General screening - even vs odd age



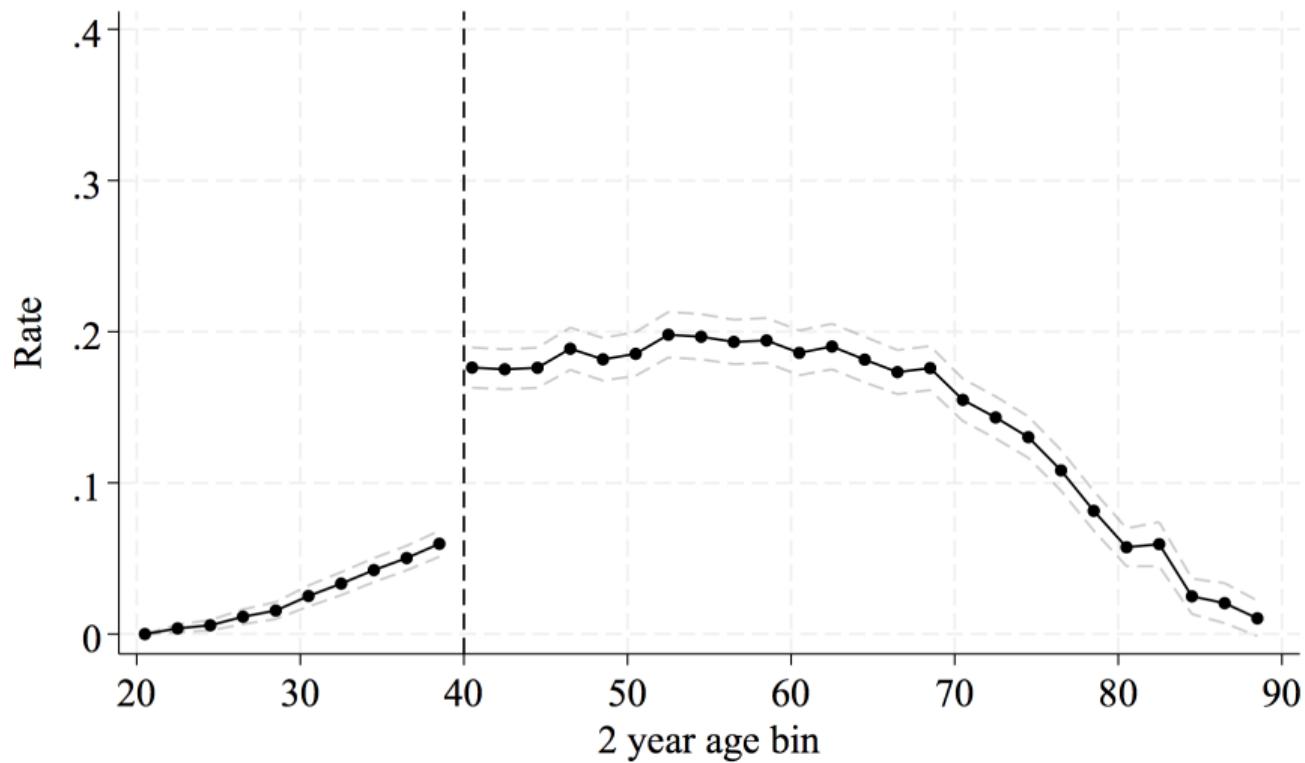
## General screening - 2 year age bins



## Breast screening - even vs odd age



## Breast screening - 2 year age bins



# No substitution due to biennial subsidies (cervical screening)

- Subsidy starting age: 30  $\Rightarrow$  20 (in 2016)
- Subsidy schedule: No subsidy  $\Rightarrow$  biennial subsidy (age 20 to 29)
- If substitution exists, take-up at even  $\uparrow$  odd  $\downarrow$

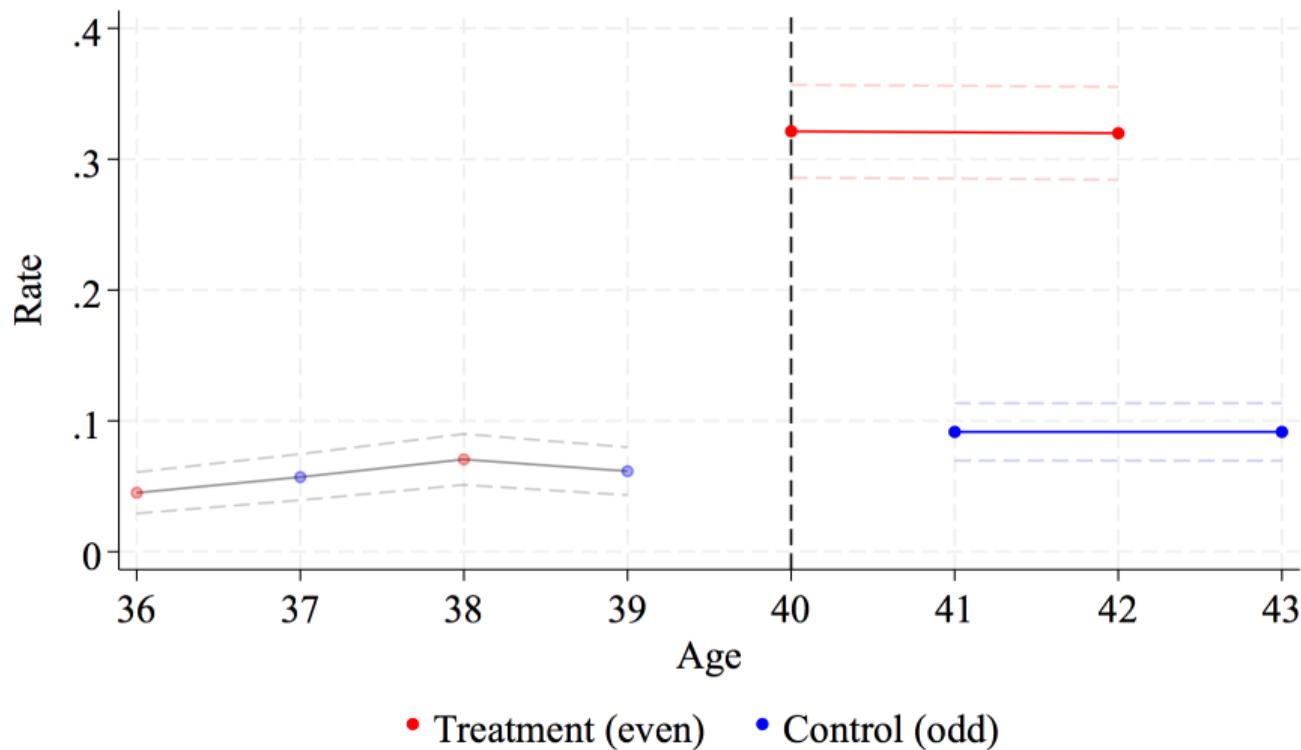
	(1)	(2)
Outcome var: cervical screening		
Age even	0.002 (0.003)	0.002 (0.003)
After 2016	0.006* (0.004)	-0.003 (0.006)
Age even $\times$ After 2016	0.008 (0.006)	0.008 (0.006)
Year		0.003* (0.002)
Age even + Age even $\times$ After 2016	0.010** (0.005)	0.010** (0.005)
N	5221	5221
Adj $R^2$	0.003	0.003
Sample age range	[20, 29]	[20, 29]
Year	[2013, 2018]	[2013, 2018]

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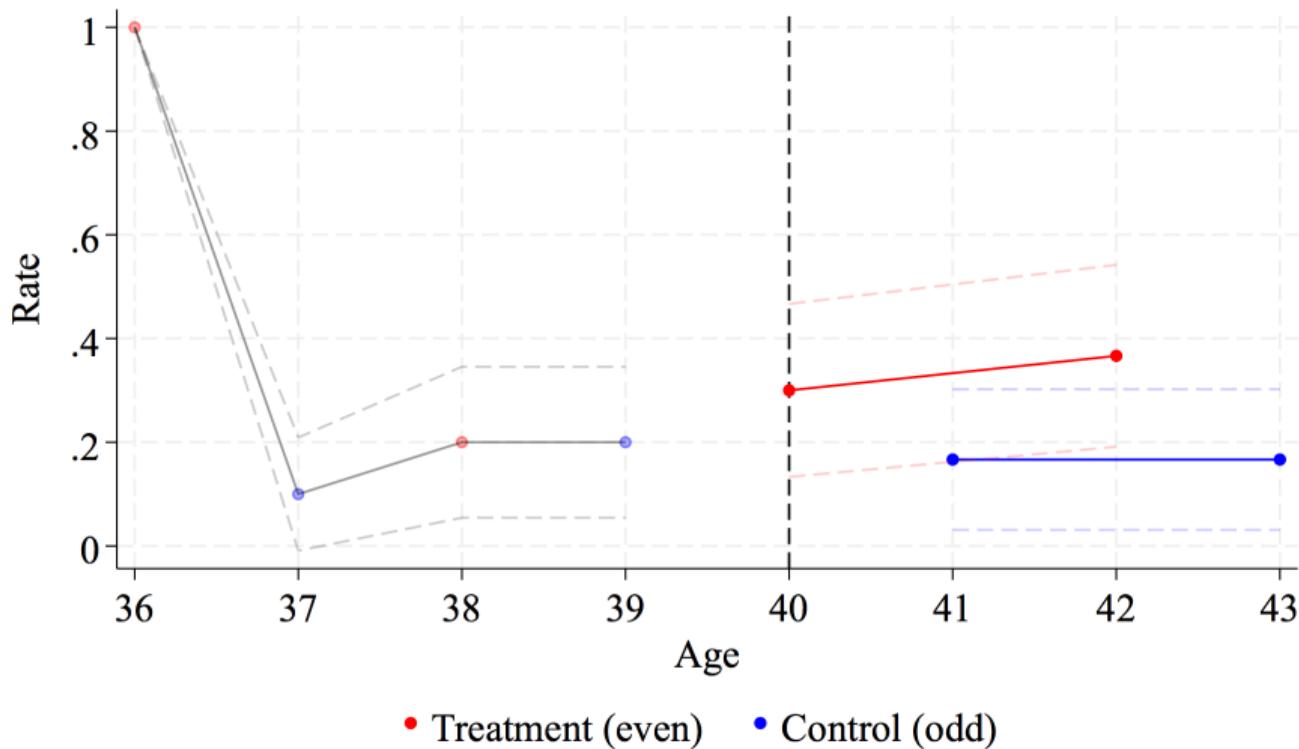
## Tracking cohorts around age 40

- Drop in screening rate in odd age group after 40 is a clear sign of intertemporal substitution
- Opposing recommendation effect can increase participation in odd age group canceling out substitution effect
- Shut down recommendation effect by examining people who were already participating in screening before 40
  - Track 4 age cohorts around age 40
  - Common age range 36 - 43
  - Examine those who took up screening at age 36, 37, 38 and 39

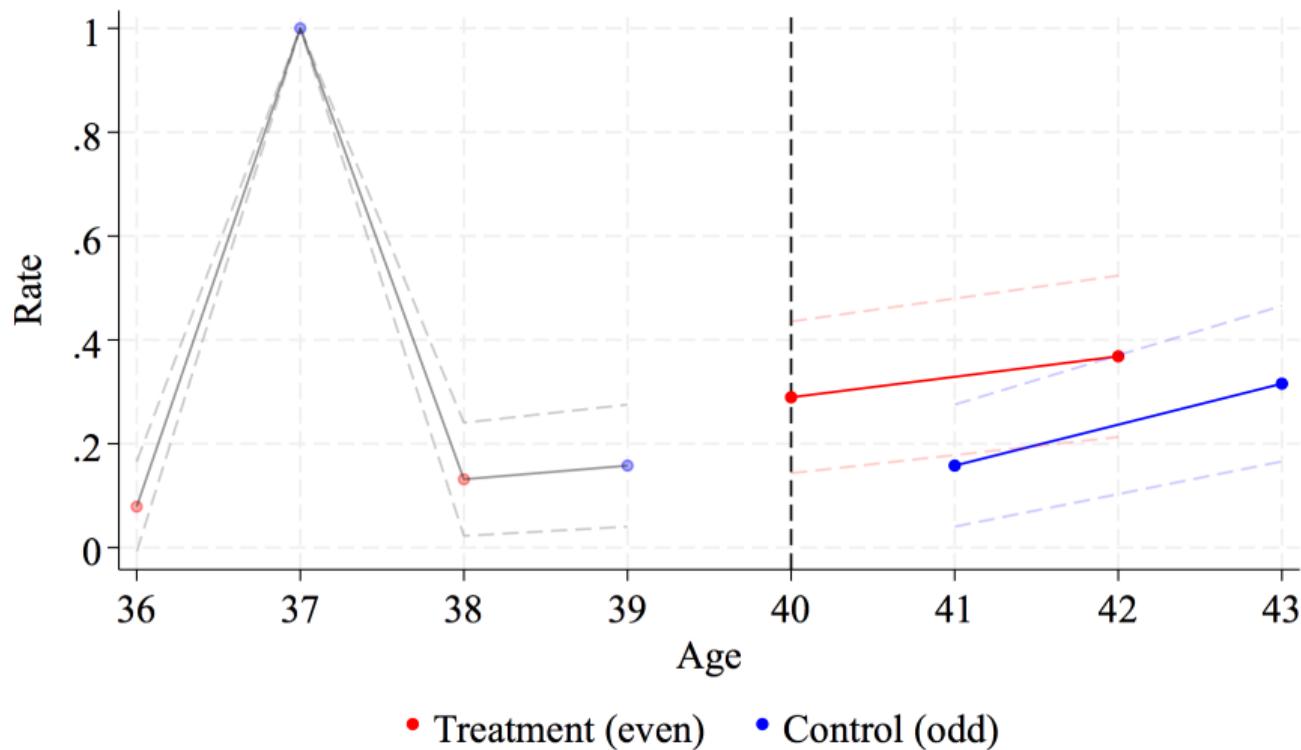
## Stomach screening take-up for the 4 cohorts



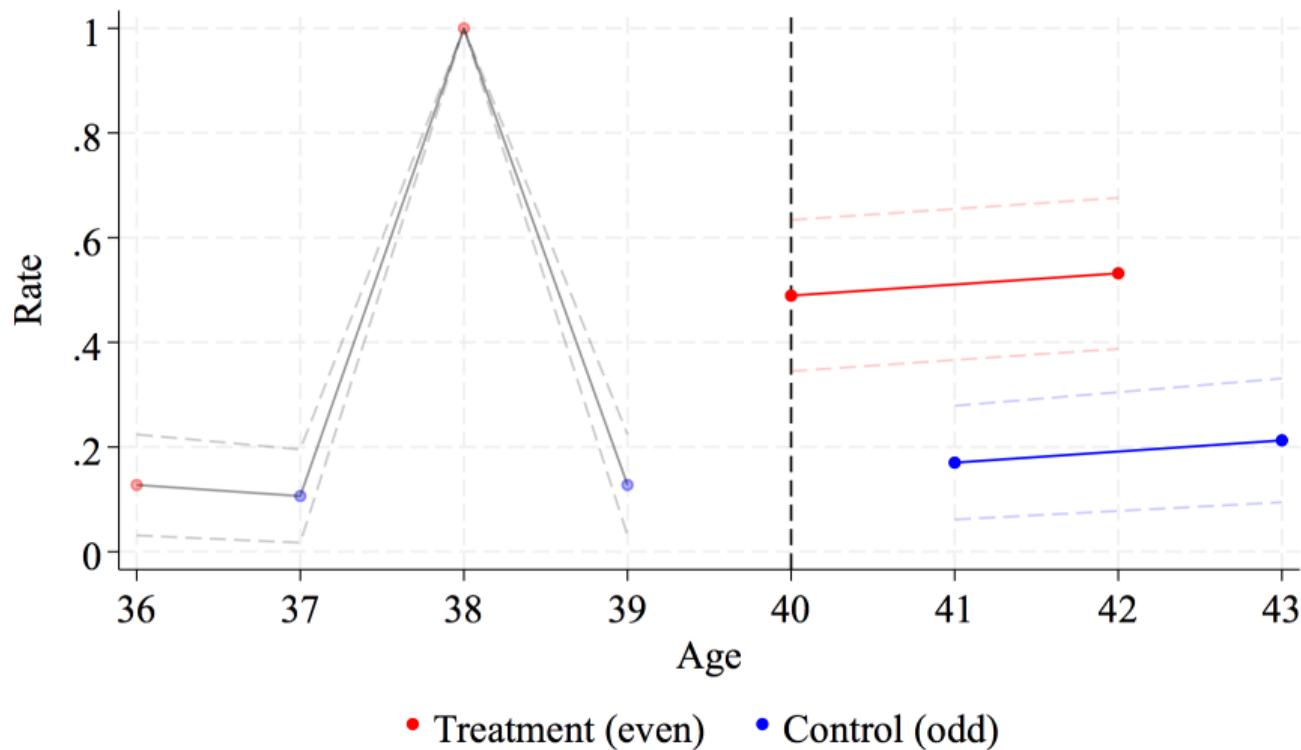
## Stomach screening take-up for participants at age 36



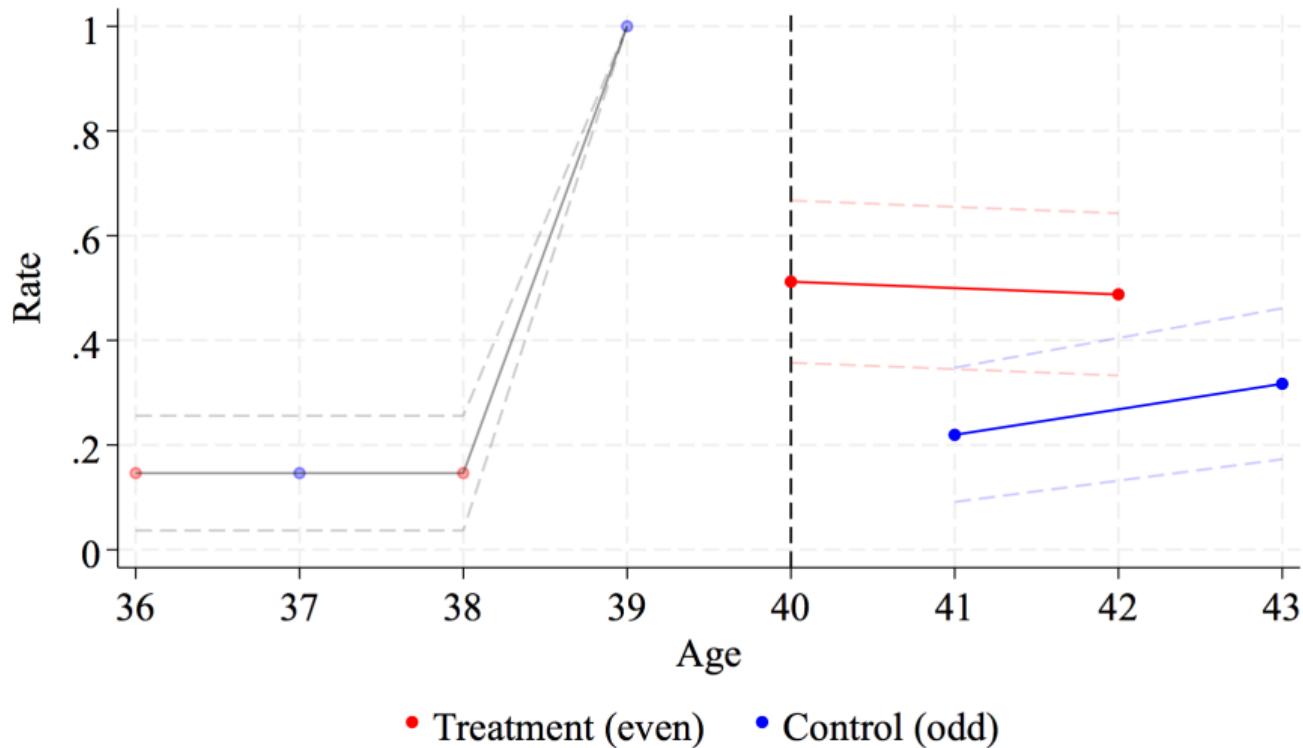
## Stomach screening take-up for participants at age 37



## Stomach screening take-up for participants at age 38

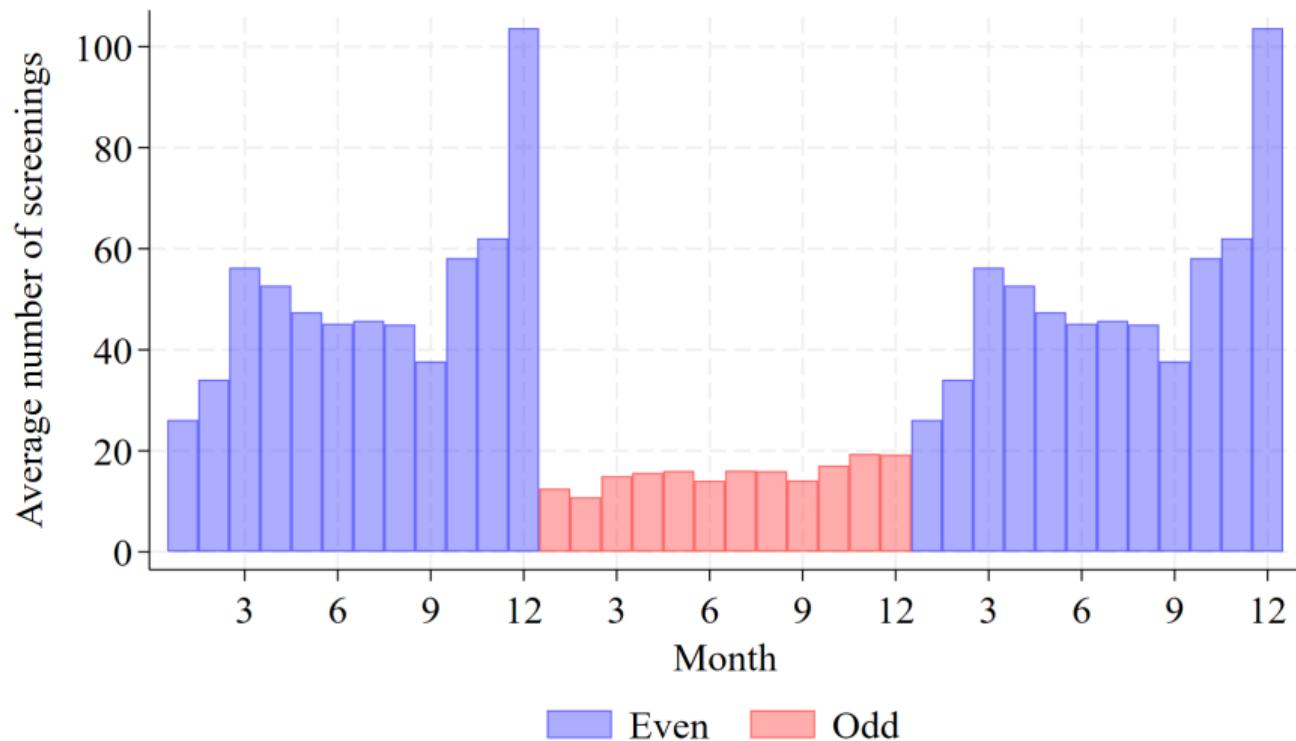


## Stomach screening take-up for participants at age 39



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# Months of stomach screening for age [40, 89]



# Comparing screening months before and after 40

- Stacked regression

$$screen_{imt} = \gamma_0 + \gamma_1 \cdot after40_{imt} + \gamma_2 \cdot age\_even_{imt} + \sum_{m=2}^{12} month_m \quad (6)$$

$$+ \gamma_3 \cdot after40_{imt} \cdot age\_even_{imt} + \sum_{m=2}^{12} month_m \cdot after40_{imt} + \sum_{m=2}^{12} month_m \cdot age\_even_{imt} \quad (7)$$

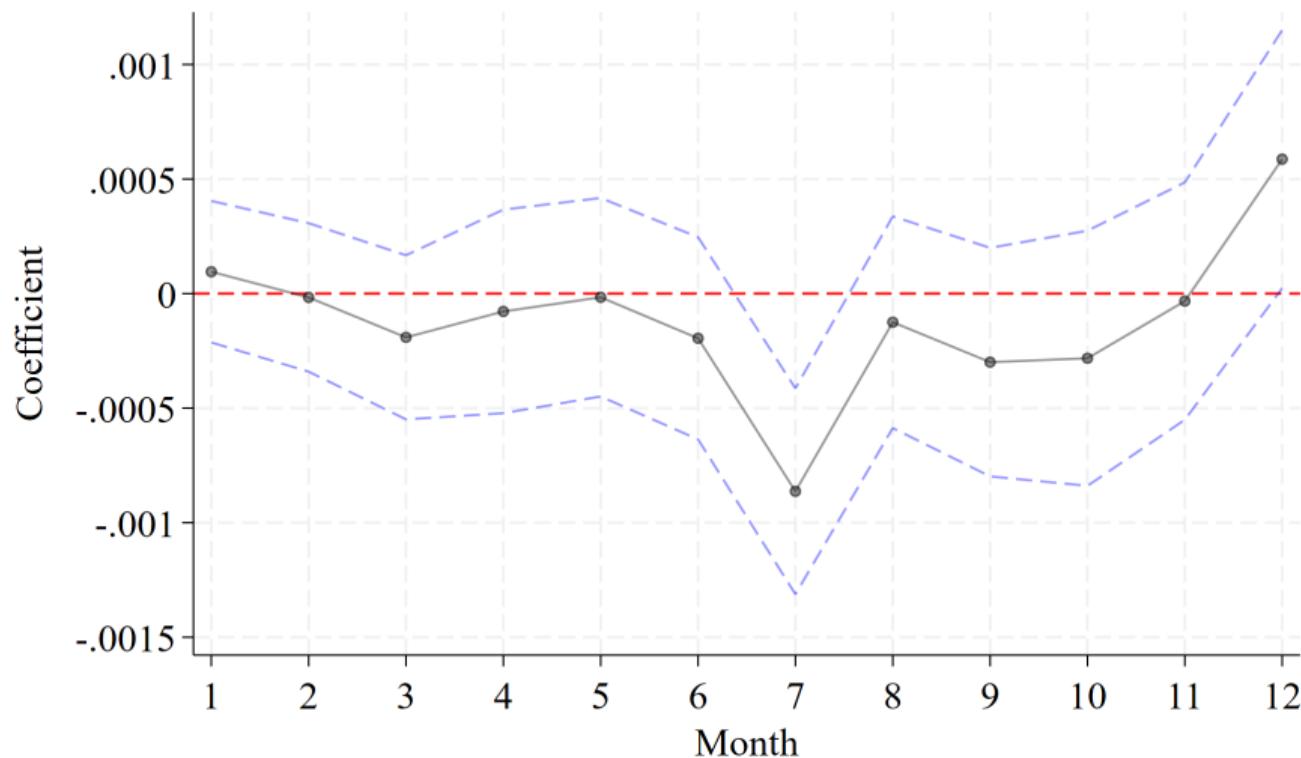
$$+ \sum_{m=2}^{12} month_m \cdot after40_{imt} \cdot age\_even_{imt} \quad (8)$$

- Stacked by months  $\Rightarrow$  Unit of observations: individual-month-year
- Sample: age  $\in [20, 89]$
- Saturated model of 3 variables:  $after40_{imt}$ ,  $age\_even_{imt}$  and  $\sum_{m=2}^{12} month_m$
- Standard error clustered at the individual level

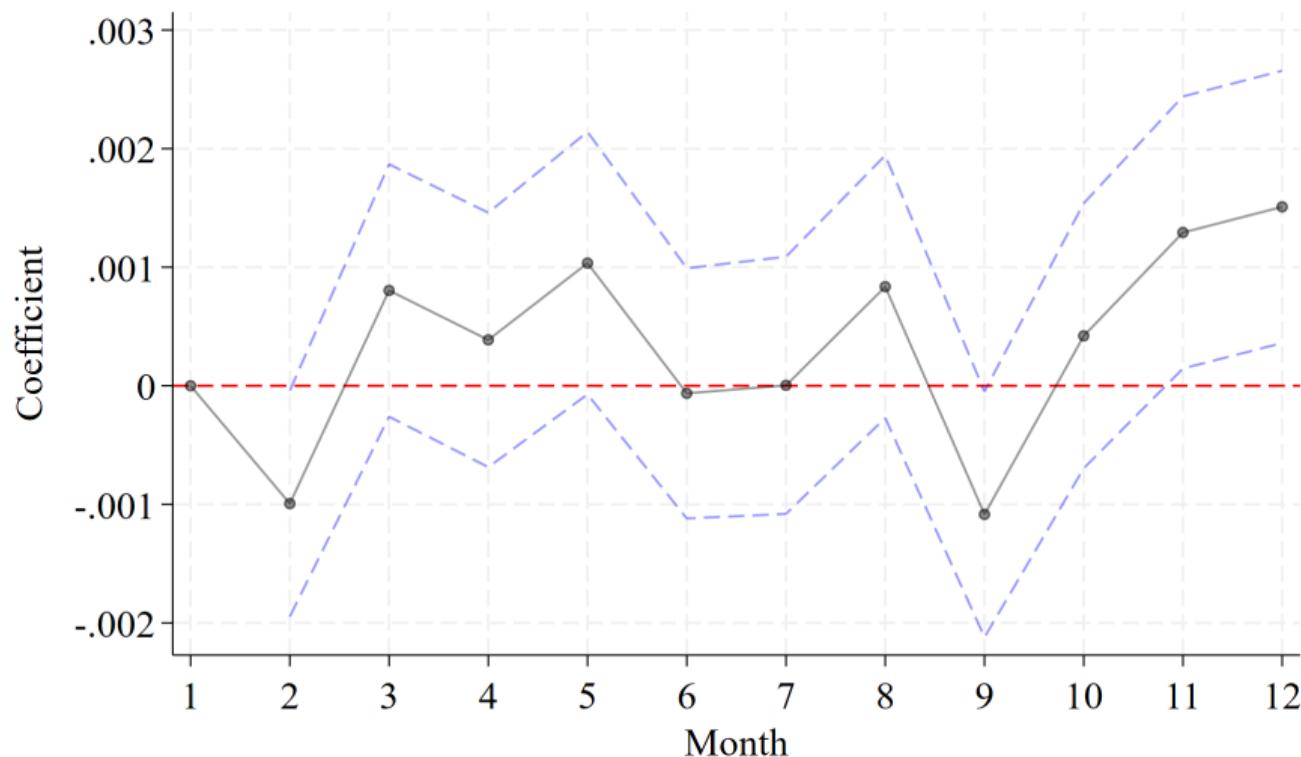
## Interpretation of coefficients

- $age\_even_{imt} + \sum_{m=2}^{12} month_m \cdot age\_even_{imt}$ 
  - ⇒ comparison between even and odd before 40
  - ⇒ There should be no difference
- $\sum_{m=2}^{12} month_m \cdot above40_{imt}$ 
  - ⇒ comparison between odd ages before and after 40
  - ⇒ Jan/Feb/Nov/Dec should show smallest increase (inverted U-shape)

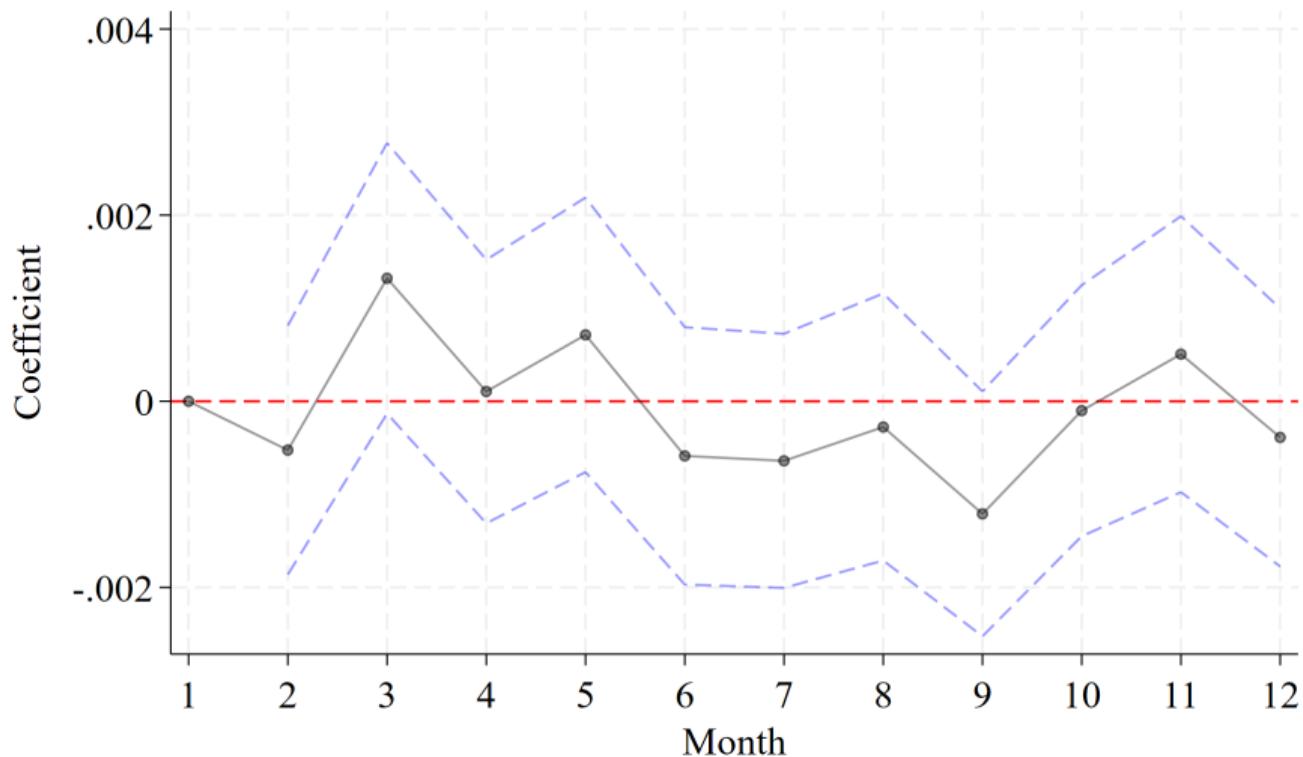
## No difference in monthly take-up between even and odd before 40



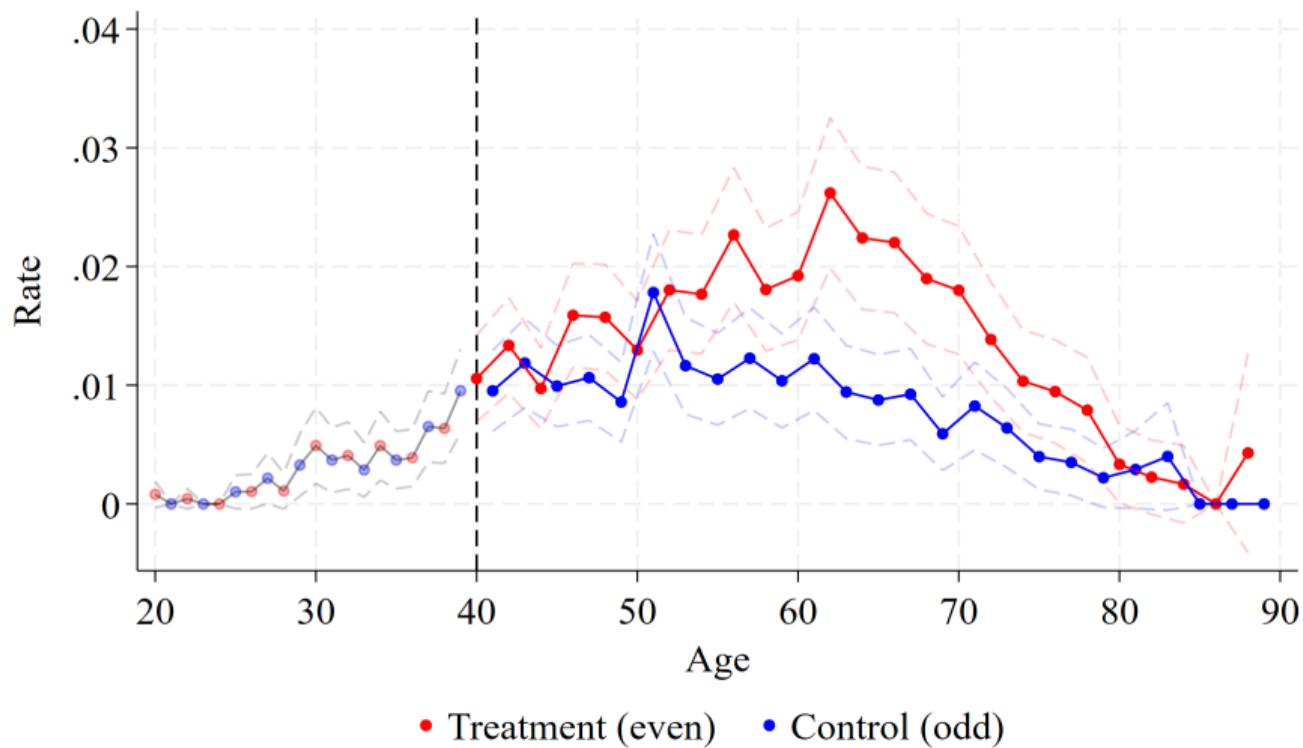
## No inverted U-shape for increase in take-up for odd before and after 40



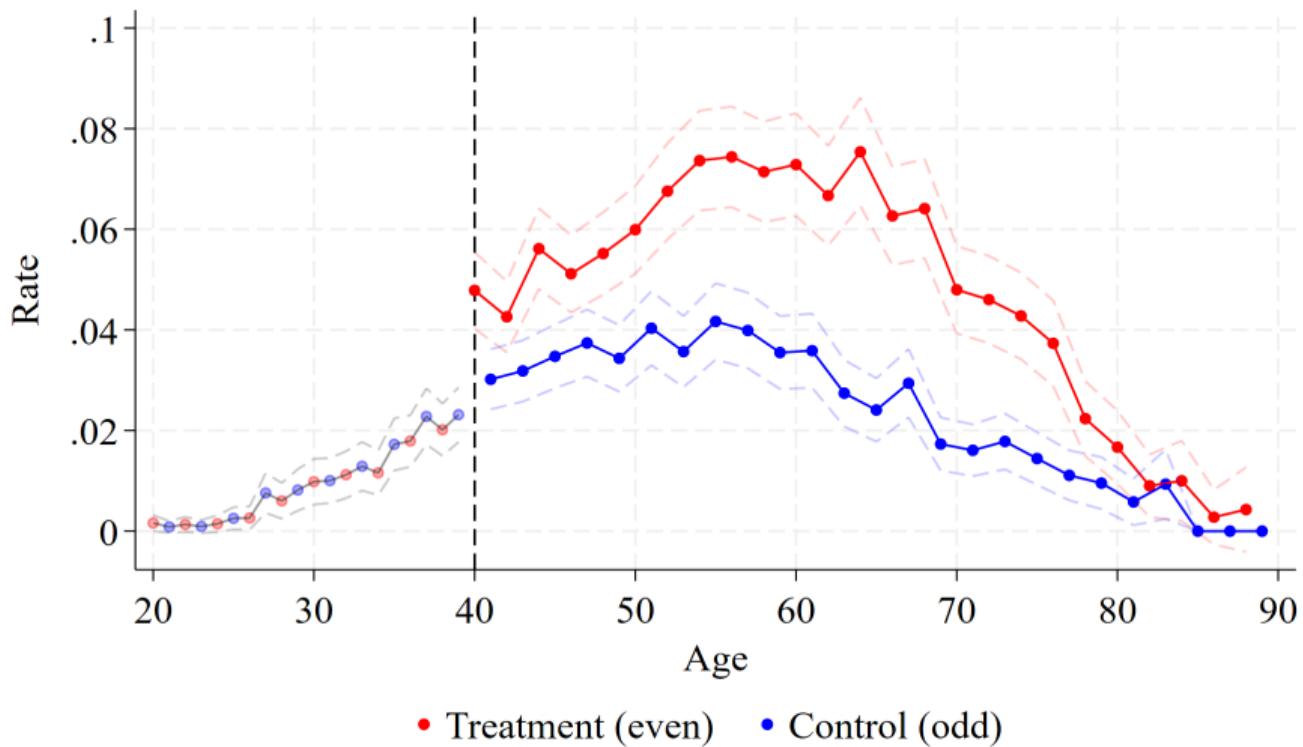
## No inverted U-shape for low income households either



## Lung screening - no subsidy



## Liver screening - annual subsidy



## Annual and no-subsidy screening participants receive biennial screenings

Annual- and no-subsidy screening participants are a subset of biennial subsidy screening participants

- $\Pr(\text{Any biennial screening} = 1 \mid \text{liver screening} = 1) = 0.98$
- $\Pr(\text{Any biennial screening} = 1 \mid \text{colorectal screening} = 1) = 0.96$
- $\Pr(\text{Any biennial screening} = 1 \mid \text{lung screening} = 1) = 0.98$
- $\Pr(\text{Any biennial screening} = 1 \mid \text{prostate screening} = 1) = 0.99$

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## Cross spillover: people receive multiple screenings on the same day

	(1)	(2)	(3)	(4)
	Liver	Colorectal	Prostate	Lung
$\Pr(\text{general} = 1 \mid \text{screen} = 1)$	0.844	0.799	0.786	0.699
$\Pr(\text{same day} \mid \text{screen} = 1, \text{general} = 1)$	0.948	0.856	0.960	0.937
$\Pr(\text{general first} \mid \text{screen} = 1, \text{general} = 1)$	0.036	0.120	0.024	0.047
$\Pr(\text{general later} \mid \text{screen} = 1, \text{general} = 1)$	0.008	0.178	0.004	0.002

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# Cross spillover: people receive multiple screenings on the same day

	(1)	(2)	(3)	(4)
	Annual subsidy		No subsidy	
	Liver	Colorectal	Prostate	Lung
<b>Panel A. Outcome: conducted on the same day with general screening</b>				
Age even	0.023*** (0.001)	0.024*** (0.001)	0.005*** (0.001)	0.004*** (0.001)
N	107183	107183	50260	107183
Control group mean	0.022	0.017	0.007	0.006
<b>Panel B. Outcome: conducted after general screening</b>				
Age even	0.0012*** (0.0002)	0.0040*** (0.0004)	0.0001 (0.0001)	0.0005*** (0.0001)
N	107183	107183	50260	107183
Control group mean	0.0007	0.0022	0.0002	0.0002
<b>Panel C. Outcome: conducted before general screening</b>				
Age even	0.0003*** (0.0001)	0.0064*** (0.0005)	0.0001 (0.0001)	0.0000 (0.0000)
N	107183	107183	50260	107183
Control group mean	0.0001	0.0029	0.0000	0.0000
Sample age range	[40, 89]	[40, 89]	[40, 89]	[40, 89]
Subsidy starting age	40	50		
Age controls	Y	Y	Y	Y

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## Cross spillover: women do not show stronger spillover

	(1)	(2)	(3)
	Liver	Colorectal	Lung
Age even	0.025*** (0.002)	0.036*** (0.002)	0.007*** (0.001)
Age even × Female	0.003 (0.003)	-0.005* (0.003)	-0.002 (0.001)
Female	-0.017*** (0.002)	-0.012*** (0.002)	-0.008*** (0.001)
N	107183	107183	107183
Control group mean	0.028	0.027	0.009

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## Spousal spillover direction

	(1)	(2)	(3)	(4)
	Among wives (husband $\Rightarrow$ wife)		Among husbands (wife $\Rightarrow$ husband)	
Age even	0.220*** (0.004)	0.219*** (0.004)	0.142*** (0.004)	0.141*** (0.004)
Spouse age even	0.006 (0.004)		0.017*** (0.004)	
Spouse screening		0.046 (0.030)		0.079*** (0.017)
N	50863	50863	50863	50863
Estimator	OLS	2SLS	OLS	2SLS

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## Spousal spillover: take-up on the same day

	(1)	(2)	(3)	(4)	(5)
	Total	Even/Even	Even/Odd	Odd/Even	Odd/Odd
Pr(same day   both participate)	0.423	0.494	0.303	0.362	0.462
Pr(Spouse first   both participate)	0.114	0.132	0.095	0.105	0.096
Pr(Spouse later   both participate)	0.114	0.134	0.088	0.113	0.091

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# Spousal spillover by screening day

	(1)	(2)	(3)	(4)	(5)	(6)
	Outcome var: On the same day		Outcome var: In 30 days before spouse		Outcome var: In 30 days after spouse	
Age even	0.002 (0.002)	0.002 (0.002)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
Spouse age even	0.002 (0.002)	0.002 (0.002)	0.004*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Age even × Spouse age even	0.069*** (0.005)	0.070*** (0.005)	0.014*** (0.002)	0.015*** (0.002)	0.014*** (0.002)	0.015*** (0.002)
N	101726	101493	101726	101493	101726	101493
Odd/Odd group mean	0.029	0.029	0.006	0.006	0.006	0.006
Demographic controls		Y		Y		Y
Estimator	OLS	OLS	OLS	OLS	OLS	OLS

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# Spousal spillover in each screening

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	General	Stomach	Liver	Colorectal	Lung	Breast	Cervical	Prostate
Age even	0.163*** (0.003)	0.165*** (0.003)	0.023*** (0.001)	0.030*** (0.001)	0.005*** (0.001)	0.168*** (0.004)	0.156*** (0.003)	0.007*** (0.001)
Spouse age even	0.010*** (0.003)	0.012*** (0.003)	0.002 (0.001)	0.004*** (0.001)	0.001 (0.001)	0.001 (0.004)	0.000 (0.003)	-0.001 (0.001)
N	101726	101726	101726	101726	101726	50863	50863	50863

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# Screening results

- Screening results

- Find any disease? ⇒ Which disease? (ICD-10)
- Multiple answers allowed
- Not available for never-takers

Screening	Take-up	Disease diagnosis
Aggregate		32.6%
Stomach	17.8%	22.8%
Breast	16.3%	2.2%
Cervical	13.9%	6.2%
Colorectal	4.3%	19.8%

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## Disease classifications for stomach

- (K29) Gastritis and duodenitis
- (K52) Other noninfective gastroenteritis and colitis
- (K21) Gastro-oesophageal reflux disease
- (K25) Gastric ulcer
- (B98) Helicobacter pylori
- (K31) Other diseases of stomach and duodenum
- (K20) Esophagitis
- (C16) Malignant neoplasm of stomach
- (K26) Duodenal ulcer

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## Disease classifications for breast

- (N63) Unspecified lump in breast
- (N64) Other disorders of breast
- (D24) Benign neoplasm of breast
- (N60) Benign mammary dysplasia
- (C50) Malignant neoplasm of breast

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## Disease classifications for female genital

- (N76) Other inflammation of vagina and vulva
- (N71) Inflammatory disease of uterus, except cervix
- (N85) Other noninflammatory disorders of uterus, except cervix
- (N83) Noninflammatory disorders of ovary, fallopian tube and broad ligament

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## Disease classifications for colon and rectum

- (K63) Other diseases of intestine
- (D12) Benign neoplasm of colon, rectum, anus and anal canal
- (D13) Benign neoplasm of other and ill-defined parts of digestive system
- (R19) Other symptoms and signs involving the digestive system and abdomen
- (C18) Malignant neoplasm of colon

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# 1. Estimate Always- and Never-takers characteristics

- Individually identifiable always- and never-takers

	Even age (treatment)	Odd age (control)
Always-takers	Yes	Yes
Compliers	Yes	No
Never-takers	No	No

- Estimating equation

$$y_{it} = \beta_0 + \beta_1 treat_{it} + \beta_2 screen_{it} + \beta_3 treat_{it} \times screen_{it} + \nu_{it} \quad (9)$$

- Average characteristics

- Always-takers:  $g_{AT}(y) = \hat{\beta}_0 + \hat{\beta}_2$
- Never-takers:  $g_{NT}(y) = \hat{\beta}_0 + \hat{\beta}_1$

## 2. Back out complier characteristics

- Treated compliers in the treatment group, untreated compliers in the control group

	Even age (treatment)	Odd age (control)
Always-takers	Yes	Yes
Compliers	Yes	No
Never-takers	No	No

- Estimating equation

$$y_{it} = \beta_0 + \beta_1 treat_{it} + \beta_2 screen_{it} + \beta_3 treat_{it} \times screen_{it} + \nu_{it} \quad (10)$$

- Those getting screened in the treatment group

$$\begin{aligned} g_T(y) &= \frac{\pi_{AT}}{\pi_{AT} + \pi_C} g_{AT}(y) + \frac{\pi_C}{\pi_{AT} + \pi_C} g_C^1(y) \\ &= \hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 \end{aligned}$$

- Those not getting screened in the control group

$$\begin{aligned} g_U(y) &= \frac{\pi_{NT}}{\pi_{NT} + \pi_C} g_{NT}(y) + \frac{\pi_C}{\pi_{NT} + \pi_C} g_C^0(y) \\ &= \hat{\beta}_0 \end{aligned}$$

### 3. Compare compliers to always- and never-takers

- Taking ratios
  - Treated compliers to always-takers:  $g_C^1(y)/g_{AT}(y)$
  - Untreated compliers to never-takers:  $g_C^0(y)/g_{NT}(y)$
- Why differentiate between treated and untreated compliers?
  - Characteristics in the same year
  - Unclear pre-determined characteristics
  - Difference between treated and untreated complier characteristics = LATE
- Minor details in estimation
  - Age = 40
  - Standard error calculated with bootstrap with clustering at individual level (500 replications)

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# Selection analysis using panel variation in even vs odd age take-up

- Using 11 years of panel information to define compliance groups

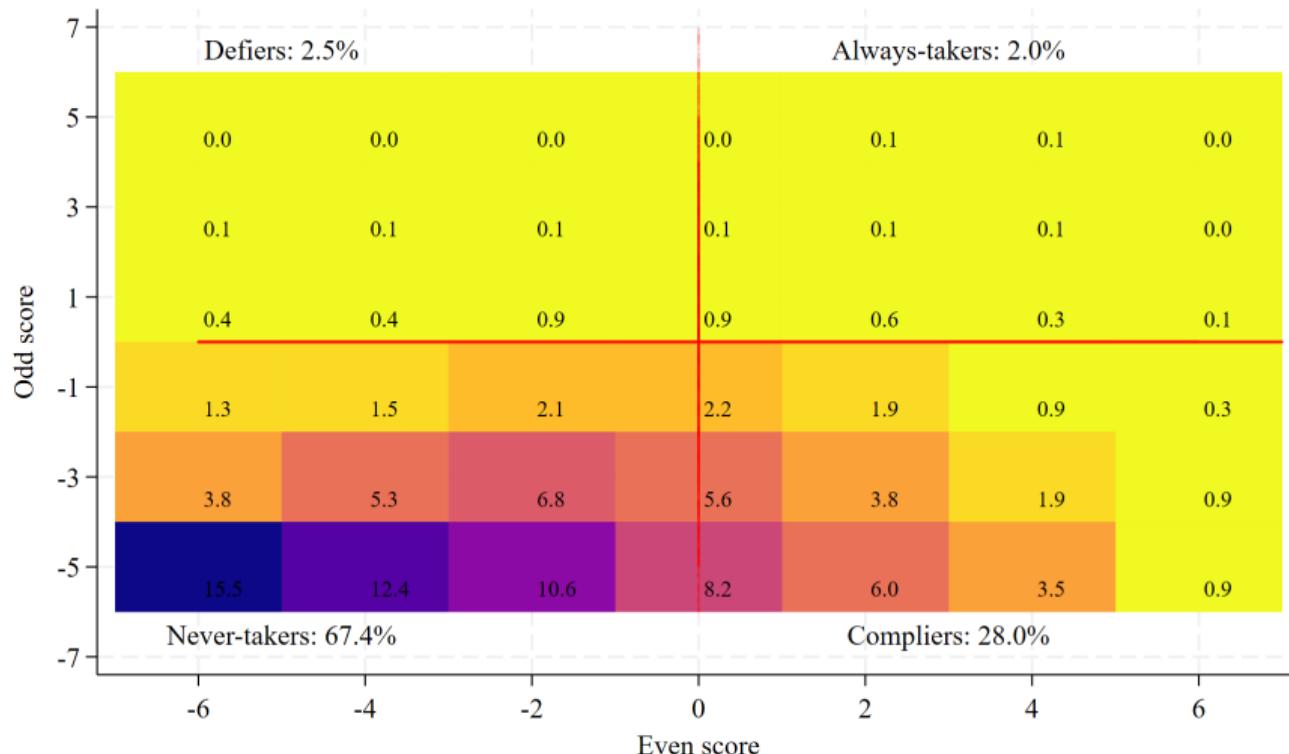
	Even age (treatment)	Odd age (control)
Always-takers	Yes	Yes
Compliers	Yes	No
Defiers	No	Yes
Never-takers	No	No

- Analytical sample
  - Balanced sample without attrition during 11 years
  - First year age  $\geq 40$
  - 5,514 unique individuals
- Even and odd scores for classification

$$\text{even\_score}_i = \sum_t [\mathbb{1}\{\text{screen}_{ia} = 1\} - \mathbb{1}\{\text{screen}_{ia} = 0\}], \quad a \text{ even}$$

$$\text{odd\_score}_i = \sum_t [\mathbb{1}\{\text{screen}_{ia} = 1\} - \mathbb{1}\{\text{screen}_{ia} = 0\}], \quad a \text{ odd}$$

# Bivariate distribution of even and odd scores for first year even age



# Compliers have worse health conditions and lower socioeconomic status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Always	Complier	Defier	Never	Complier / Always	Complier / Defiers	Complier / Never
<b>Panel A. Diagnoses</b>							
Diagnosed with a disease	0.277 (0.018)	0.350 (0.006)	0.306 (0.019)	0.321 (0.007)	1.264*** (0.084)	1.146*** (0.076)	1.093*** (0.031)
Stomach disease diagnosis	0.141 (0.014)	0.203 (0.006)	0.154 (0.016)	0.182 (0.006)	1.435*** (0.145)	1.314*** (0.139)	1.114*** (0.047)
Breast disease diagnosis	0.011 (0.004)	0.011 (0.002)	0.012 (0.006)	0.009 (0.002)	1.005** (0.422)	0.933** (0.471)	1.241*** (0.297)
Cervical disease diagnosis	0.030 (0.007)	0.031 (0.003)	0.026 (0.010)	0.031 (0.004)	1.032*** (0.264)	1.168*** (0.445)	0.999*** (0.146)
Colorectal disease diagnosis	0.042 (0.008)	0.042 (0.003)	0.048 (0.009)	0.042 (0.003)	1.001*** (0.207)	0.886*** (0.180)	0.993*** (0.095)
<b>Panel B. SES</b>							
Individual income	2456 (244)	990 (37)	2391 (209)	1225 (27)	0.403*** (0.043)	0.414*** (0.039)	0.808*** (0.035)
Household income	5817 (313)	3862 (67)	5443 (271)	3634 (44)	0.664*** (0.038)	0.710*** (0.037)	1.063*** (0.023)
Years of education	11.949 (0.359)	9.789 (0.099)	11.476 (0.343)	9.445 (0.075)	0.819*** (0.026)	0.853*** (0.027)	1.036*** (0.013)
College graduate	0.279 (0.040)	0.115 (0.008)	0.271 (0.037)	0.137 (0.006)	0.411*** (0.066)	0.424*** (0.065)	0.840*** (0.068)
Working status	0.742 (0.031)	0.555 (0.010)	0.729 (0.031)	0.598 (0.007)	0.748*** (0.034)	0.761*** (0.036)	0.928*** (0.020)

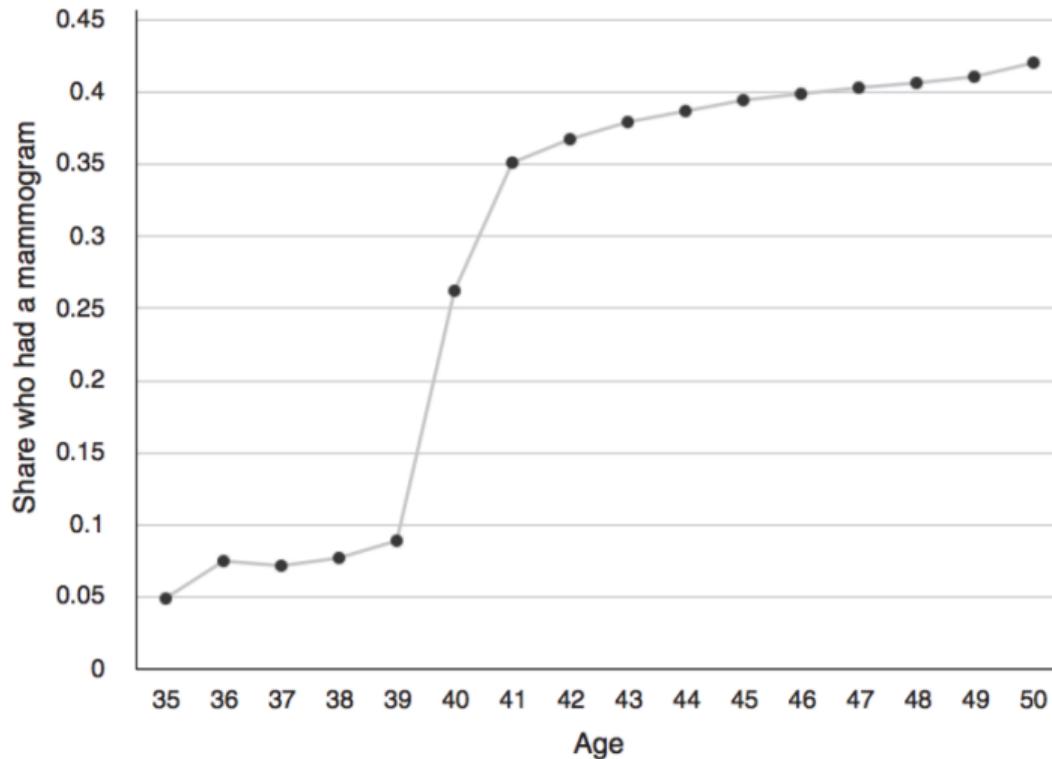
# Compliers are less likely to smoke, drink and exercise

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Always	Complier	Defier	Never	Complier / Always	Complier / Defiers	Complier / Never
<b>Panel C. Health behaviors</b>							
Current smoker	0.128 (0.024)	0.099 (0.007)	0.222 (0.031)	0.207 (0.006)	0.779*** (0.158)	0.447*** (0.068)	0.479*** (0.035)
Everyday smoker	0.118 (0.023)	0.096 (0.007)	0.208 (0.030)	0.200 (0.006)	0.811*** (0.171)	0.460*** (0.073)	0.478*** (0.036)
Current drinker	0.701 (0.034)	0.601 (0.010)	0.705 (0.032)	0.593 (0.007)	0.858*** (0.044)	0.853*** (0.041)	1.013*** (0.020)
Everyday drinker	0.038 (0.011)	0.057 (0.004)	0.096 (0.018)	0.080 (0.003)	1.479*** (0.443)	0.589*** (0.120)	0.702*** (0.062)
Vigorous exercise	0.298 (0.022)	0.200 (0.005)	0.272 (0.019)	0.191 (0.004)	0.671*** (0.053)	0.735*** (0.056)	1.050*** (0.035)
Moderate exercise	0.498 (0.020)	0.385 (0.006)	0.462 (0.023)	0.338 (0.004)	0.773*** (0.034)	0.833*** (0.043)	1.141*** (0.023)
Walking	0.843 (0.016)	0.816 (0.005)	0.817 (0.013)	0.771 (0.003)	0.969*** (0.019)	0.999*** (0.017)	1.059*** (0.008)
<b>Panel D. Married subsample</b>							
Pr(even/odd or odd/even)	0.505	0.477	0.616	0.500			
Share	0.022	0.283	0.026	0.669			

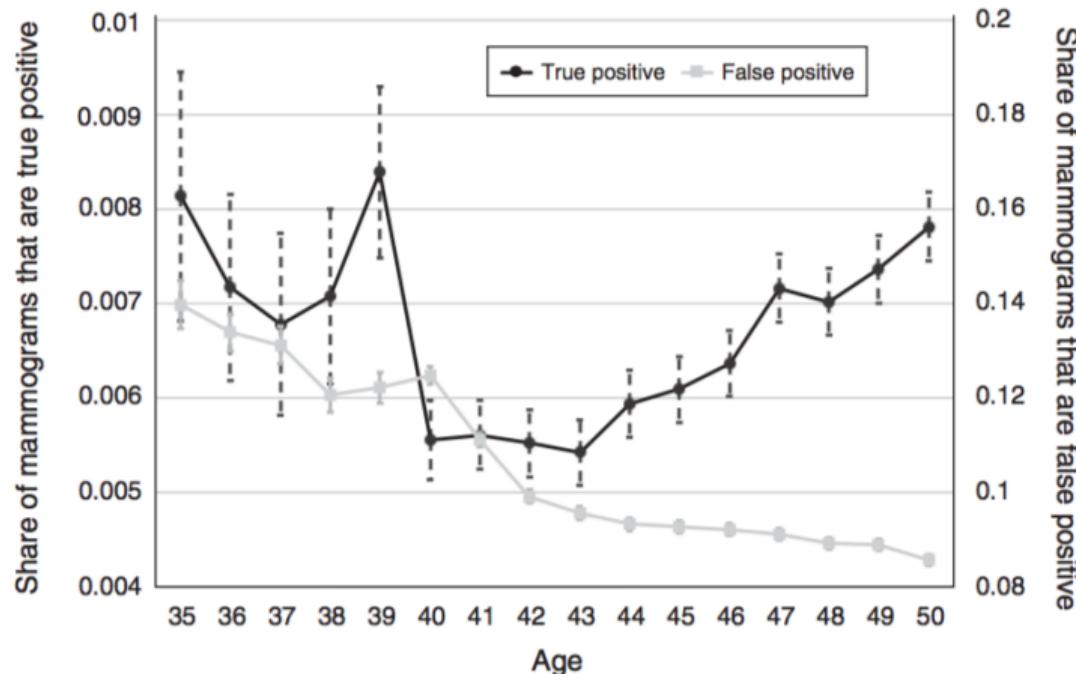
# Summary of selection analysis using panel variation

- Compliers compared to always-takers
  - More likely to find a disease through screening
  - Have less income and education
  - Less likely to smoke, drink and exercise
- Compliers compared to never-takers
  - Less likely to smoke and drink and more likely to exercise
- Who are defiers?
  - More likely to have a spouse with different even or odd age

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Panel A. Share of mammograms that are true positive and false positive



# Effect of spouse's subsidy eligibility on first hospital visits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	First outpatient visit	High blood pressure	Hyperlipidemia	Diabetes	Stomach	Breast	Female genital	Liver	Colorectal	Male genital	Lung
<b>Panel A. Reduced form regressions</b>											
Age even	0.0689*** (0.0179)	0.0014 (0.0017)	0.0032*** (0.0012)	-0.0005 (0.0012)	0.0245*** (0.0035)	0.0014 (0.0014)	0.0075** (0.0035)	0.0001 (0.0008)	0.0047** (0.0022)	-0.0020 (0.0031)	0.0008 (0.0012)
Spouse age even	0.0198 (0.0179)	0.0017 (0.0017)	0.0010 (0.0012)	0.0015 (0.0012)	0.0046 (0.0035)	0.0008 (0.0014)	0.0003 (0.0035)	0.0001 (0.0008)	0.0000 (0.0022)	0.0009 (0.0031)	0.0008 (0.0012)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
<b>Panel B. Second stage regressions</b>											
Screening	0.3165*** (0.0827)	0.0062 (0.0079)	0.0146*** (0.0054)	-0.0029 (0.0055)	0.1135*** (0.0164)	0.0049 (0.0054)	0.0290** (0.0138)	0.0005 (0.0040)	0.0220** (0.0103)	-0.0122 (0.0186)	0.0037 (0.0057)
Spouse screening	0.0676 (0.0828)	0.0076 (0.0079)	0.0037 (0.0054)	0.0073 (0.0055)	0.0126 (0.0164)	0.0043 (0.0081)	0.0004 (0.0209)	0.0002 (0.0040)	-0.0017 (0.0103)	0.0045 (0.0120)	0.0035 (0.0057)
Estimator	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
N	79782	79782	79782	79782	79782	39890	39890	79782	79782	39892	79782
Odd/Odd	4.0076	0.0466	0.0244	0.0252	0.1947	0.0104	0.1063	0.0089	0.0819	0.0738	0.0193
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

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