

Biannual health screening: selection and effect

Siho Park

University of Illinois Urbana-Champaign

September 2022

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

- First stage

- Selection

- Effect of screening

Conclusion

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

- First stage

- Selection

- Effect of screening

Conclusion

Motivation

- Health screening leads to healthy living and low health care costs
 - Early diagnosis \Rightarrow treatment success \uparrow , premature death \downarrow , health care costs \downarrow
 - Most important and cost-effective contribution in war on cancer ([Cutler \(2008\)](#))
 - Annual physical \approx 10% of visits to primary care
Cost $>$ \$10 bil/year ([Mehrotra and Prochazka \(2015\)](#))
 - Incentives for screening (recommendations, health insurance, public screening program)
- Mixed empirical evidence
 - Clinical RCTs show limited impact on mortality and morbidity ([Krogsbøll et al. \(2012\)](#))
 - Selection: Compliers to mammogram age cutoff are healthier than always-takers ([Einav et al. \(2020\)](#))
- Waste of medical resources on healthy people
 - Crowding out primary care to emergency care ([Uscher-Pines et al. \(2013\)](#))

Research question

1. How does biannual screening subsidy affect take-up?
 - National Health Screening Program in Korea offers subsidies for various screenings
 - Effect of biannual subsidy on take-up
2. Who responds to screening subsidy?
 - Health conditions
 - Socioeconomic status
3. What is the effect of screening on
 - Health care utilization
 - Health behaviors

Preview of results

1. Screening take-up increases in response to biannual subsidy and there is positive inter-screening spillover
2. Subsidizing screening induces compliers with worse health conditions and from lower socioeconomic background.
3. Subsidizing screening increases hospital visits for a new illness.

Lit. Review

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

- First stage

- Selection

- Effect of screening

Conclusion

Korean health screening policy

- 3 types of screening provided 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
 - Colorectal cancer screening
 - Liver cancer screening
 - Breast cancer screening
 - Cervical cancer screening

Screening subsidy criteria

- Biannual health screening
 - Those born in even years can get subsidized screening in even years
 - Those born in odd years can get subsidized screening in odd years
- Calculated age = Current year - Year of birth
 - Screening subsidy when calculated age is even
 - No subsidy when calculated age is odd
 - Age as of December 31
- Age cutoff
 - $\text{Age} \geq 40$: biannual screening
 - $\text{Age} < 40$: no subsidy

Variation in screening subsidy eligibility

	Biannual				Annual		No-subsidy	
	General	Stomach	Breast	Cervical	Liver	Colorectal	Lung	Prostate
Frequency	2 years	2 years	2 years	2 years	0.5 year	1 year		
Age cutoff	40	40	40	30	40	50		
NHIS subsidy	100%	90%	90%	100%	90%	90%	0%	0%
Copay (\$)	0	7	3.5	0	10	16		

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

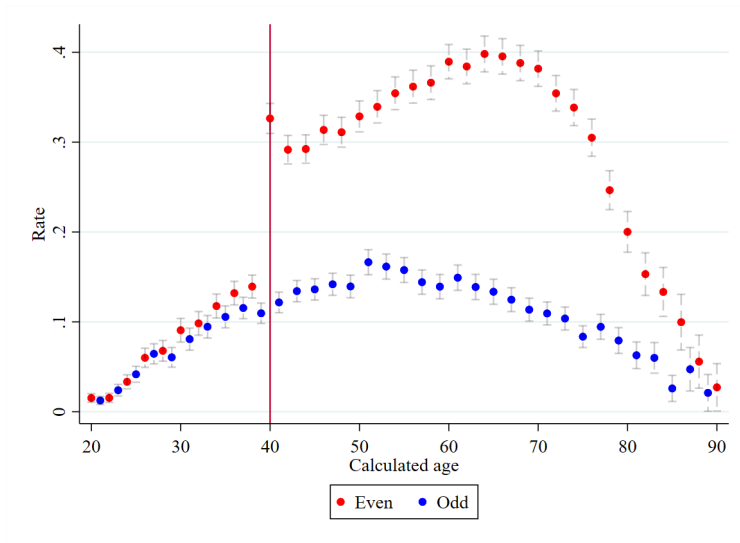
- First stage

- Selection

- Effect of screening

Conclusion

Screening rate by calculated age



Identification strategy

- Two types of variation
 - Discontinuity at age 40
 - **Even (eligible) vs Odd (ineligible) after age 40**
- Plausibly random variation
 - Variation comes from year of birth
 - Even birth year vs Odd birth year
- Not balanced on age
 - Mechanical effect due to starting age 40
 - Imbalance on other covariates correlated with age
- Random conditional on $f(\text{age})$

Econometric specification

- Analytical sample
 - Age $\in [40,89]$
- Identifying assumption
 - Subsidy eligibility based on even age is random conditional on $f(\text{age})$
 - E.g. $f(\text{age})$: piecewise linear function with 5 years interval
- Econometric specification

$$y_{it} = \alpha + \beta \cdot \text{age_even}_{it} + f(\text{age}_{it}) + \varepsilon_{it} \quad (1)$$

Balance table

	(1)	(2)	(3)	(4)
	Eligible	Ineligible	Unconditional difference	Conditional difference
Age	58.697 (12.532)	59.240 (12.353)	-0.543*** (0.026)	- -
Female	0.530 (0.499)	0.532 (0.499)	-0.002** (0.001)	-0.002 (0.001)
Currently married	0.799 (0.401)	0.798 (0.402)	0.001 (0.001)	-0.001 (0.001)
Years of education	10.320 (4.510)	10.227 (4.538)	0.093*** (0.009)	-0.005 (0.008)
Working	0.610 (0.488)	0.608 (0.488)	0.001 (0.002)	-0.003* (0.002)
Individual income	1446.3 (2081.6)	1425.7 (2068.1)	20.6*** (5.5)	5.9 (5.5)
Household income	4104.4 (3708.6)	4086.7 (3737.9)	17.7 (14.6)	4.1 (14.0)
Own a house	0.734 (0.442)	0.737 (0.441)	-0.002* (0.001)	0.000 (0.001)
Number of household members	3.067 (1.317)	3.051 (1.317)	0.016*** (0.003)	-0.005 (0.003)
N	54274	52909		
Share	(0.51)	(0.49)		

- Korean health panel study dataset
 - Panel data from 2008 to 2018
 - Annual individual level survey data from 2008 to 2018
 - Household random sampling / Individual level data
 - Survey data collected through face-to-face interview (self-reported)
 - Information on
 - Demographic and SES
 - Health care usage
 - Health behavior
- Health care utilization (op, ip, er)
 - Unit of observations: **every visit to a hospital**
 - Information
 - Date
 - Hospital bills, drug expenditures
 - Type of hospitals visited
 - First visit vs Recurring visit
 - Health screening records: cancer screening, tests performed, screening results, disease found

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

- First stage

- Selection

- Effect of screening

Conclusion

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

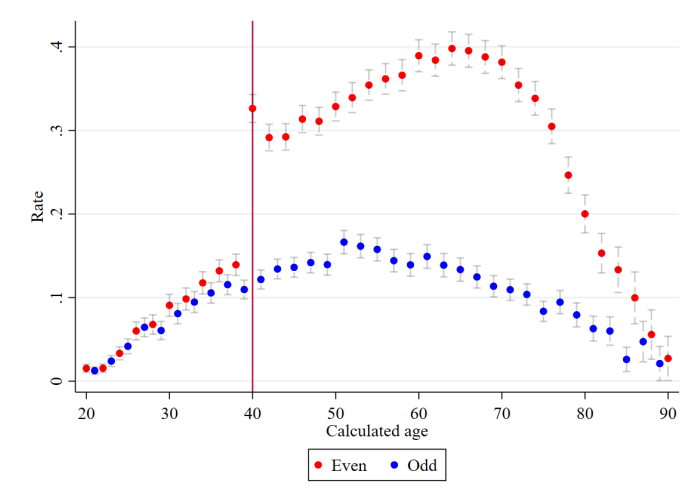
- First stage

- Selection

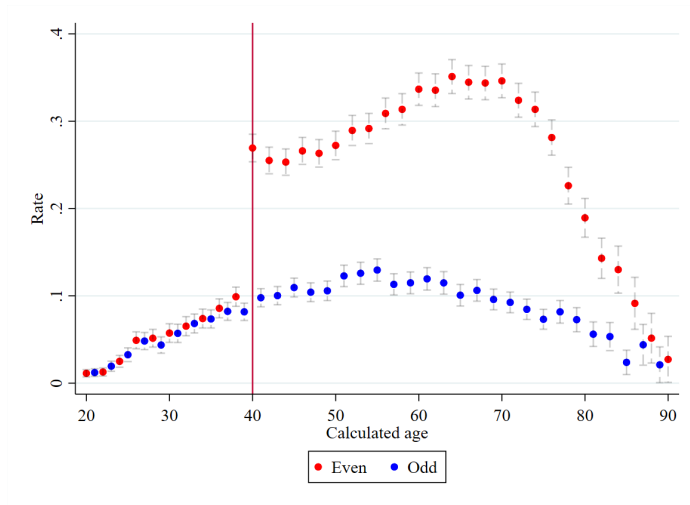
- Effect of screening

Conclusion

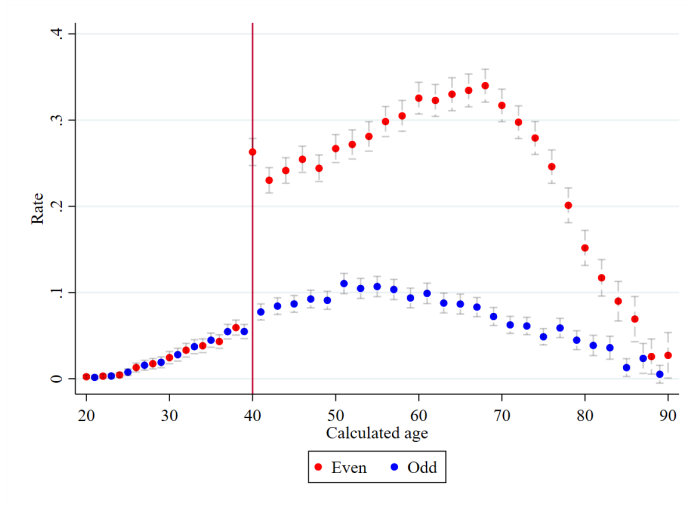
Screening rate by age



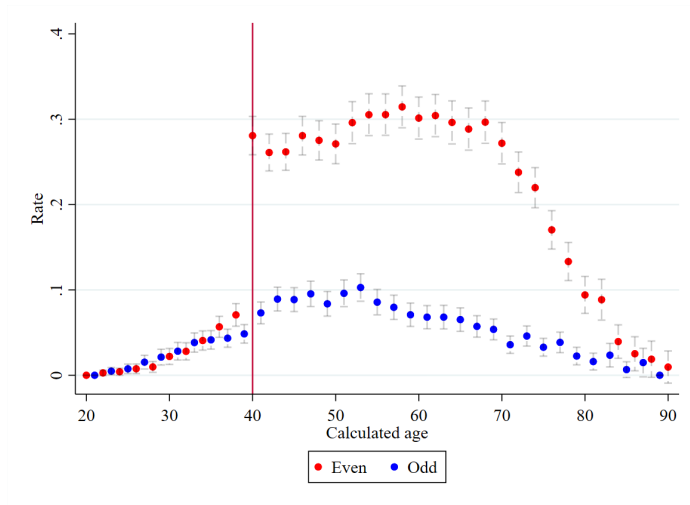
General screening - biannual



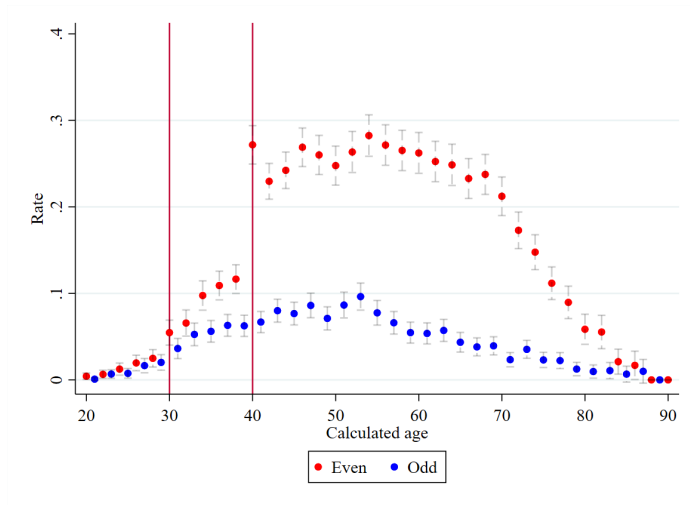
Stomach screening - biannual



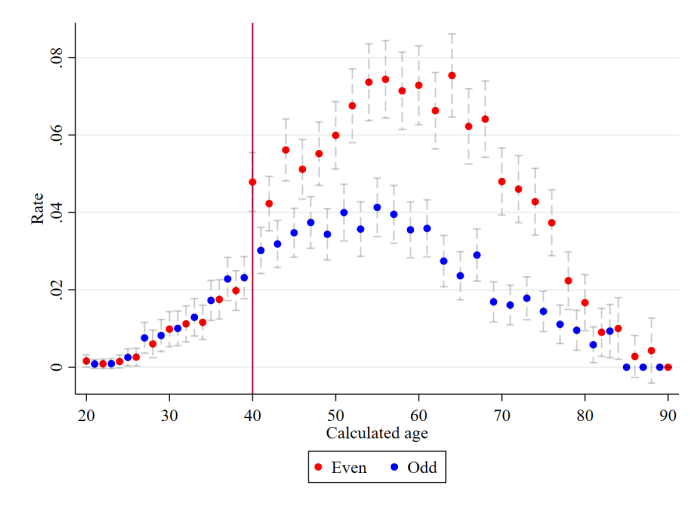
Breast screening - biannual



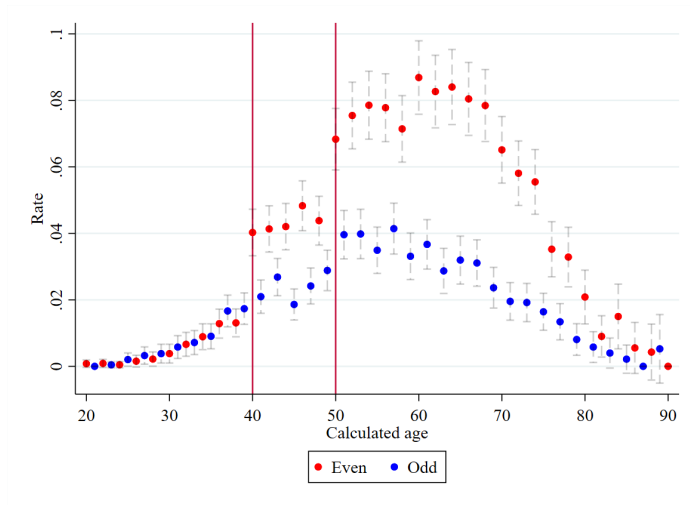
Cervical screening - biannual



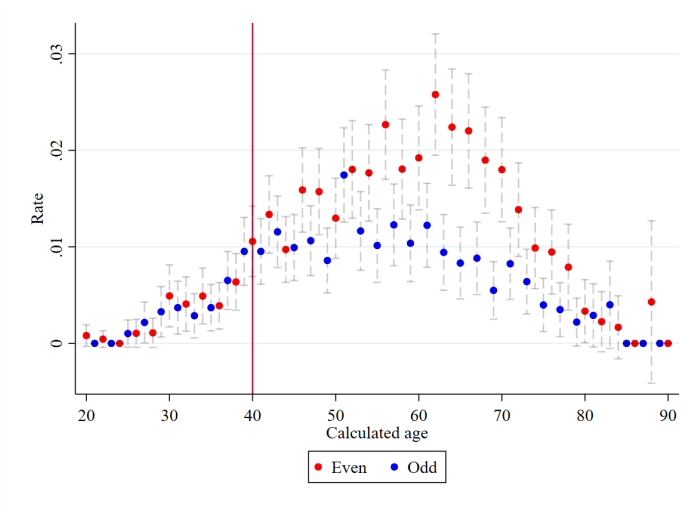
Liver screening - annual



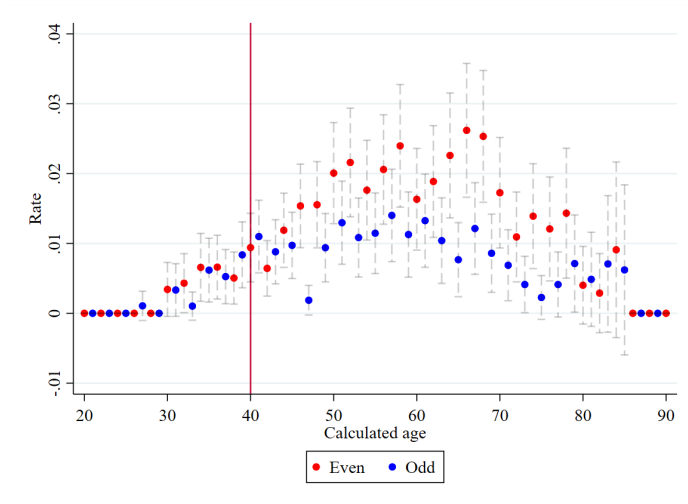
Colorectal screening - annual



Lung screening - no-subsidy



Prostate screening - no-subsidy



Spillover

Spillover by day diff

Table of Contents

Research question

Institutional background

Identification and data

Results

Inter-screening spillover

First stage

Selection

Effect of screening

Conclusion

First stage regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Biannual screenings				Annual screenings		No-subsidy screenings	
	Total	General	Stomach	Breast	Cervical	Liver	Colorectal	Lung	Prostate
Eligible	0.203*** (0.003)	0.186*** (0.003)	0.189*** (0.003)	0.191*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.032*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
N	107183	107183	107183	56923	56923	107183	107183	107183	50260
Adj R^2	0.068	0.062	0.069	0.080	0.074	0.008	0.012	0.002	0.002
Odd group mean	0.128	0.102	0.082	0.067	0.055	0.028	0.026	0.009	0.009

Robustness

Table of Contents

Research question

Institutional background

Identification and data

Results

Inter-screening spillover

First stage

Selection

Effect of screening

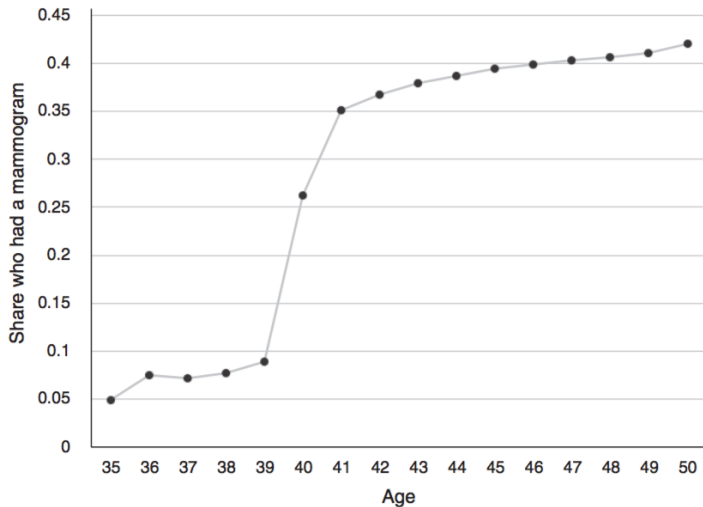
Conclusion

Selection into screening

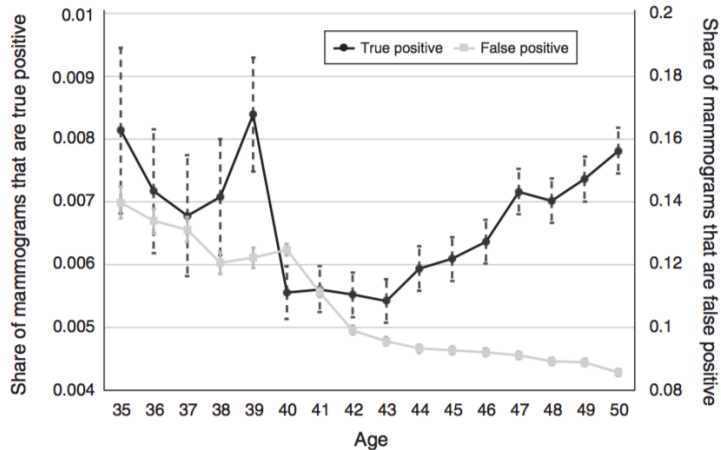
- Who selects into screening?

	No incentive (odd age)	With incentive (even age)
Always-takers	Yes	Yes
Compliers	No	Yes
Never-takers	No	No

- Complier characteristics
 - Health conditions
 - Socioeconomic status
- How do we measure it?
 - Share of positive diagnoses out of screening participants
 - Average income (education level) among screening participants



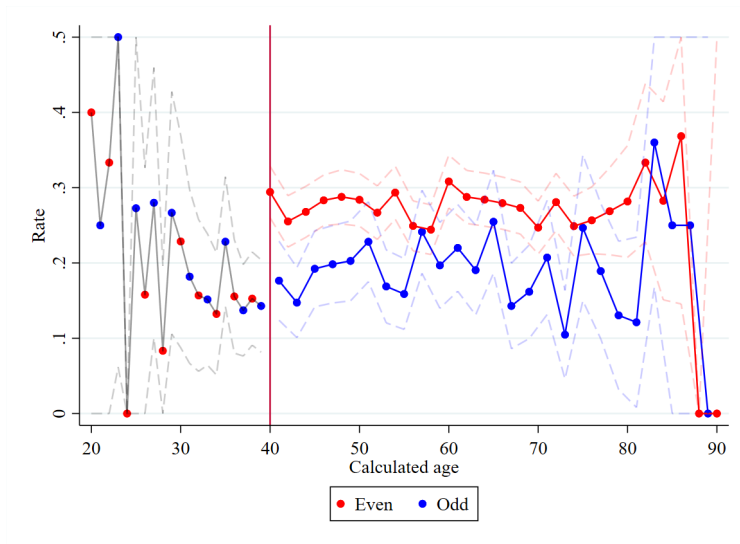
Panel A. Share of mammograms that are true positive and false positive



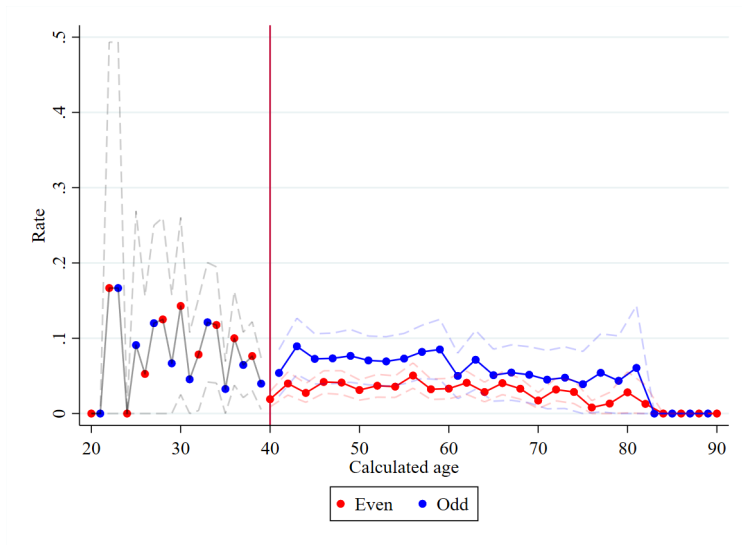
Measuring screening results

- Sample adjustment
 - Stomach screening & endoscopy recipient
- Find any disease? → Which disease?
 - Using disease classification codes based on ICD-10
- Grouping by organ and screening tests
 - Screening results

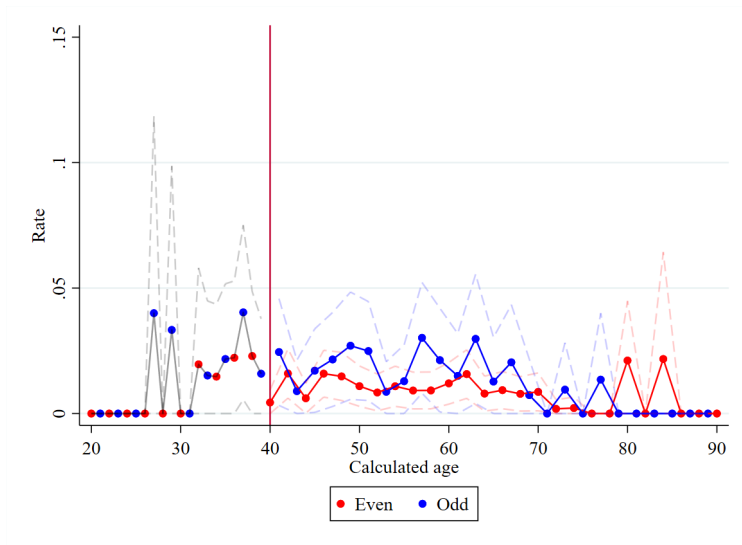
Share of stomach related disease



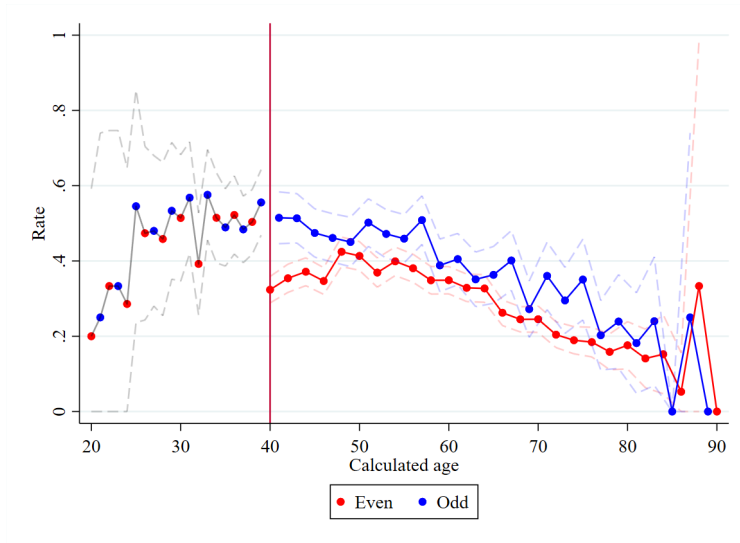
Share of receiving medical test: CT



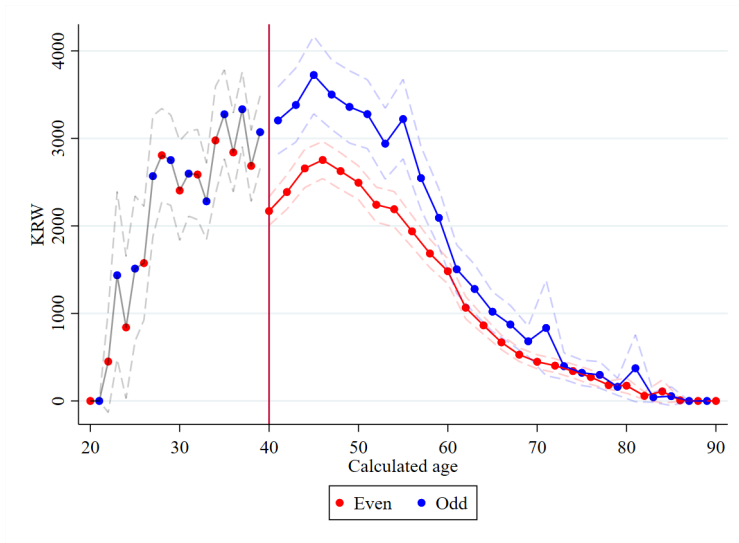
Share of receiving medical test: MRI



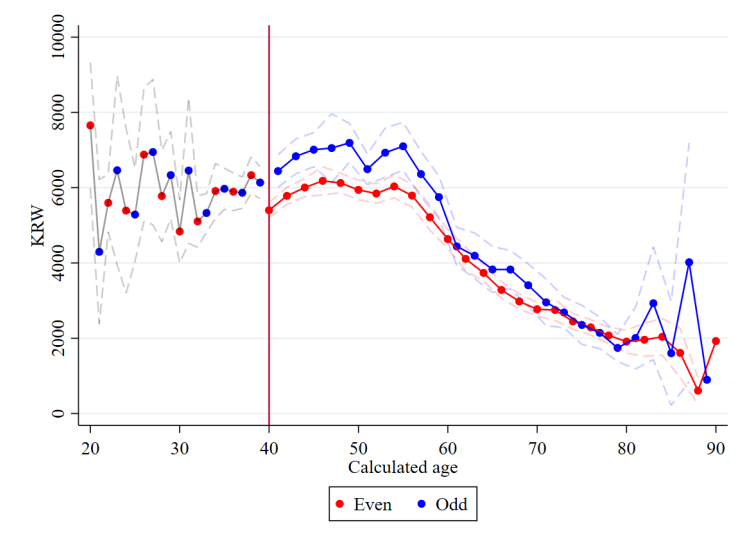
Share of receiving medical test: sonogram



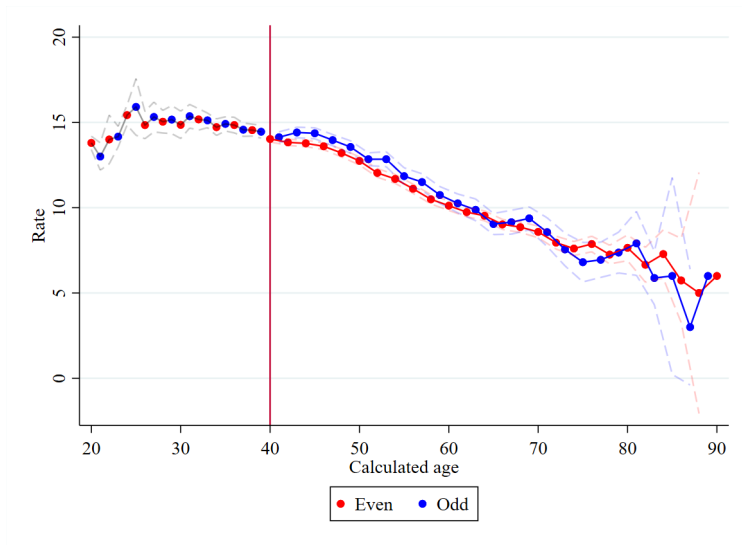
Socioeconomic status: individual income



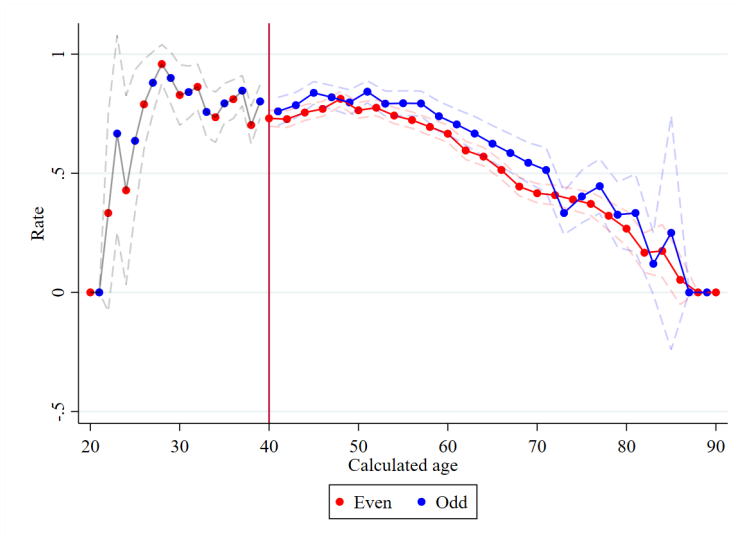
Socioeconomic status: household income



Socioeconomic status: years of schooling



Socioeconomic status: working status



Complier characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stomach disease	CT	MRI	Sonogram	Individual income	Household income	Years of education	Working status
Eligible	0.083*** (0.008)	-0.031*** (0.005)	-0.007*** (0.002)	-0.094*** (0.010)	-592*** (53)	-640*** (78)	-0.361*** (0.073)	-0.056*** (0.009)
N	15650	15650	15650	15650	15649	15634	15650	15650
Adj R^2	0.006	0.006	0.001	0.032	0.177	0.162	0.293	0.111
Odd group mean	0.192	0.066	0.017	0.424	2308	5527	11.492	0.704

Robustness

Complier characteristics

- Health conditions and medical tests
 - More likely to have stomach disease diagnoses
 - Less likely to get various tests
- Socioeconomic status
 - Lower income
 - Lower educational attainment
 - Less likely to work
- Different treatment from Einav et al. (2020)
 - Screening fee subsidy vs Age recommendation based on scientific evidence
 - Evidence that subsidizing screening induces compliers who need screening more

Table of Contents

Research question

Institutional background

Identification and data

Results

Inter-screening spillover

First stage

Selection

Effect of screening

Conclusion

Effect of screening

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Health care usage				Health behaviors			
	Outpatient visit	First outpatient visit	Inpatient visit	ER visit	Smoker	Smoke everyday	Drinker	Drink everyday
Panel A. Reduced form								
Eligible	0.111 (0.080)	0.065*** (0.016)	0.005 (0.004)	-0.002 (0.003)	0.002 (0.001)	0.002** (0.001)	0.003* (0.002)	-0.001 (0.001)
N	107183	107183	107183	107183	95192	95192	95287	95287
Adj R^2	0.132	0.061	0.022	0.009	0.026	0.025	0.107	0.002
Panel B. Second stage								
Screening	0.545 (0.395) [0.548]	0.321*** (0.078) [0.000]	0.026 (0.020) [0.548]	-0.010 (0.013) [0.548]	0.008 (0.005) [0.548]	0.011** (0.005) [0.208]	0.014* (0.008) [0.412]	-0.006 (0.005) [0.548]
N	107183	107183	107183	107183	95192	95192	95287	95287
Odd group mean	20.071	3.916	0.233	0.125	0.192	0.183	0.624	0.070

Reduced form plot

Robustness

Table of Contents

Research question

Institutional background

Identification and data

Results

- Inter-screening spillover

- First stage

- Selection

- Effect of screening

Conclusion

Conclusion

1. There is spillover in take-up across different types of screening.
2. Biannual screening policy raises screening rate by 20%P from 13%
3. Subsidizing screening induces compliers with worse health conditions and from lower socioeconomic background
4. Subsidizing screening increases first hospital visits for a new illness by 8.2%.

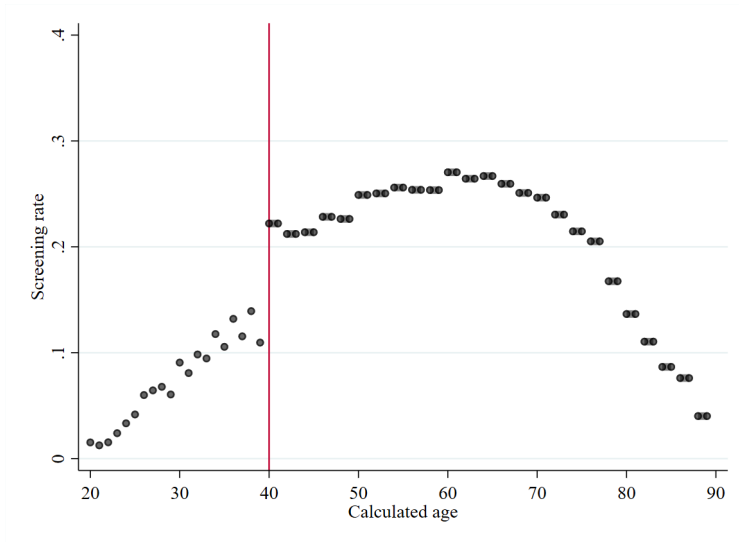
References

- Bitler, M. P. and Carpenter, C. S. (2016). Health insurance mandates, mammography, and breast cancer diagnoses. *American Economic Journal: Economic Policy*, 8(3):39–68.
- Cutler, D. M. (2008). Are we finally winning the war on cancer? *Journal of Economic Perspectives*, 22(4):3–26.
- Einav, L., Finkelstein, A., Oostrom, T., Ostriker, A., and Williams, H. (2020). Screening and selection: The case of mammograms. *American Economic Review*, 110(12):3836–70.
- Iizuka, T., Nishiyama, K., Chen, B., and Eggleston, K. (2021). False alarm? estimating the marginal value of health signals. *Journal of Public Economics*, 195:104368.
- Kadiyala, S. and Strumpf, E. (2016). How effective is population-based cancer screening? regression discontinuity estimates from the us guideline screening initiation ages. In *Forum for Health Economics and Policy*, volume 19, pages 87–139. De Gruyter.
- Kim, H. B., Lee, S. A., and Lim, W. (2019). Knowing is not half the battle: Impacts of information from the national health screening program in korea. *Journal of health economics*, 65:1–14.
- Kim, H. B. and Lee, S.-m. (2017). When public health intervention is not successful: Cost sharing, crowd-out, and selection in korea's national cancer screening program. *Journal of health economics*, 53:100–116.
- Krogsbøll, L. T., Jørgensen, K. J., Larsen, C. G., and Gøtzsche, P. C. (2012). General health checks in adults for reducing morbidity and mortality from disease: Cochrane systematic review and meta-analysis. *Bmj*, 345.
- Mehrotra, A. and Prochazka, A. (2015). Improving value in health care—against the annual physical. *N Engl J Med*, 373(16):1485–7.
- Uscher-Pines, L., Pines, J., Kellermann, A., Gillen, E., and Mehrotra, A. (2013). Emergency department visits for nonurgent conditions: systematic literature review. *The American journal of managed care*, 19(1):47–59.

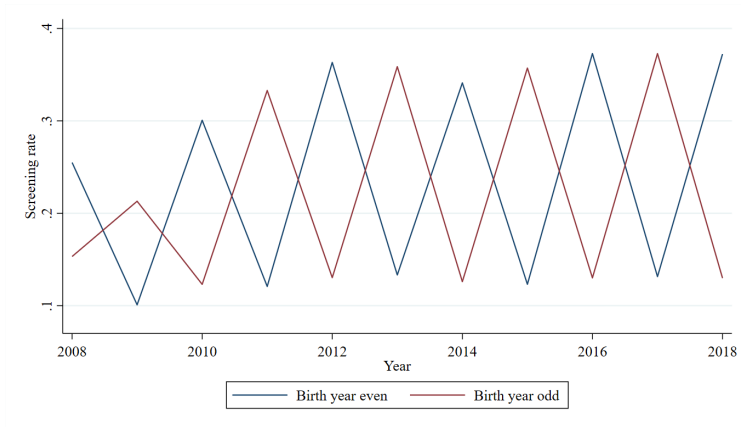
Current evidence

- Screening decision
 - Screening recommendation age (Einav et al. (2020) Kadiyala and Strumpf (2016))
 - Health insurance mandate (Bitler and Carpenter (2016))
 - Screening subsidy (Kim and Lee (2017))
- Selection
 - Healthy people are more likely to respond and participate in screening (CDC recommendation for starting age: Einav et al. (2020), stomach & breast screening subsidy: Kim and Lee (2017))
- Cutoff in health indicators
 - Effect of being classified as obese/diabetic on health behaviors and future health outcomes (Kim et al. (2019), Iizuka et al. (2021))

Screening rate by binned age



First stage by birth year



Comparison with administrative dataset

	Health panel survey	Administrative panel
N / year	18,000	1,000,000
Used by		Kim and Lee (2017) Kim et al. (2019)
Unit of sampling	Household	Individual
Health behavior	Every year	Conditional on screening
First visit for an illness	Yes	No
Demographic & SES	Detailed	Limited

back

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

① 건강가계부 작성방법 ①

● 병의원에 다녀왔을 때

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

(작성 예시) 아들 홍길동이 이비인후과에 비염 때문에 다녀온 후

의 료 이 동 형 태	<input checked="" type="checkbox"/> 외래	<input type="checkbox"/> 입원	<input type="checkbox"/> 응급	<input type="checkbox"/> 건강검진
진 료 일	2019년 4월 10일 (목) 월 일(일자)			
가 구 원 이 름	홍길동			
병 의 원 이 름	존슨한 이비인후과			
방 문 이 유	알레르기 비염			
병 원 수 납 금 액	4,000 원			
교 통 수 단	내선	걸어서	귀가	걸어서
보 관 여 부	<input checked="" type="checkbox"/> 진료비 납입 영수증	<input type="checkbox"/> 처방전	<input checked="" type="checkbox"/> 약국영수	

● 약약품 및 보건의료용품을 샀을 때

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

(예시) 엄마와 함께 먹으려고 멀티비타민 구입. 감기 기운이 있어 엄마가 종합감기약을 약국에서 구매

2019년 1월			
구입품목	구입 장소	비율	
1. 일반약/의료품/약품	<input type="checkbox"/> 병의원 <input checked="" type="checkbox"/> 약국 <input type="checkbox"/> 마트/편의점	{ } 원 { 6,000 } 원 { } 원	
2. 한약 및 한약재 (처방 한약 제외)	<input type="checkbox"/> 약국 <input type="checkbox"/> 한약방	{ } 원 { } 원	
3. 건강보조식품 (홍삼, 비타민 등)	<input type="checkbox"/> 병의원 및 약국 <input checked="" type="checkbox"/> 인터넷 및 홈쇼핑 <input type="checkbox"/> 백화점, 마트, 시장 등	{ } 원 { 47,500 } 원 { } 원	
4. 의료기기 및 의료용품 ※ 예시 - 보건의료소모품(밴드, 마스크, 시중산, 한약, 모기(파)매 등) - 안전 및 방역제(밴드, 구입 및 수리) - 방충기 구입 및 수리 - 신체보호용 의료기기 등 기타 의료용품 구매, 대여 및 수리 (안경, 안경 렌즈, 책상, 척추 교정기, 열상기, 열상치료기 등)		{ } 원	

<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 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.) - Bandage, mask, insect repellent - Glasses, contact lenses - Hearing aid		{ } KRW

back

Inter-screening spillover

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Biannual screenings				Annual screenings		No-subsidy screenings	
	All	General	Stomach	Breast	Cervical	Liver	Colorectal	Lung	Prostate
Age even	0.203*** (0.003)	0.186*** (0.003)	0.189*** (0.003)	0.190*** (0.004)	0.037*** (0.005)	0.026*** (0.001)	0.019*** (0.002)	0.006*** (0.001)	0.007*** (0.001)
Age ≥ 40					-0.00 (0.003)				
Age even \times Age ≥ 40					0.127*** (0.006)				
Age ≥ 50							0.004** (0.002)		
Age even \times Age ≥ 50							0.019*** (0.003)		
Odd group mean	0.128	0.102	0.082	0.067	0.055	0.028	0.026	0.009	0.009
N	107330	107330	107330	57027	69340	107330	107330	107330	50303
Adj R^2	0.058	0.055	0.061	0.066	0.056	0.004	0.008	0.001	0.001
Age range	[40,90]	[40,90]	[40,90]	[40,90]	[30,90]	[40,90]	[40,90]	[40,90]	[40,90]

[back](#)

Same day vs Separate screenings

	(1)	(2)	(3)	(4)	(5)	(6)
	Liver screening			Colorectal screening		
	Same day	Separate day	diff > 30	Same day	Separate day	diff > 30
Age even	0.023*** (0.001)	0.001*** (0.000)	0.000 (0.000)	0.016*** (0.002)	0.008*** (0.001)	0.001* (0.000)
Age ≥ 50				0.001 (0.001)	0.004*** (0.001)	0.001*** (0.000)
Age even \times Age ≥ 50				0.012*** (0.002)	0.002* (0.001)	0.000 (0.001)
Odd group mean	0.022	0.002	0.001	0.017	0.007	0.002
N	107330	107330	107330	107330	107330	107330
Adj R^2	0.004	0.000	-0.000	0.006	0.002	0.000

[back](#)

Robustness: balance table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Female	Currently married	Years of edu	Working	Individual income	Household income	Own a house	HH members
Panel A. Polynomial controls								
Degree 1	-0.001 (0.001)	-0.003*** (0.001)	-0.022*** (0.008)	-0.007*** (0.001)	-18*** (5)	-35** (14)	-0.001 (0.001)	-0.012*** (0.003)
Degree 2	-0.001 (0.001)	-0.001 (0.001)	-0.022*** (0.008)	-0.005*** (0.001)	-18*** (5)	-28* (15)	0.001 (0.001)	-0.019*** (0.003)
Degree 3	-0.001 (0.001)	-0.001 (0.001)	-0.010 (0.008)	-0.003* (0.001)	-0 (5)	8 (15)	0.000 (0.001)	-0.008*** (0.003)
Degree 4	-0.002* (0.001)	-0.001 (0.001)	-0.002 (0.008)	-0.003* (0.001)	6 (5)	7 (15)	-0.000 (0.001)	-0.003 (0.003)
Degree 5	-0.002** (0.001)	-0.001 (0.001)	-0.000 (0.008)	-0.003** (0.001)	3 (5)	-5 (14)	-0.000 (0.001)	-0.000 (0.003)
Panel B. Piecewise linear controls								
Interval 3 years	-0.001 (0.001)	0.000 (0.001)	0.045*** (0.011)	0.000 (0.002)	-3 (8)	-18 (15)	0.000 (0.002)	0.000 (0.004)
Interval 5 years	-0.002 (0.001)	-0.001 (0.001)	-0.005 (0.008)	-0.003* (0.002)	6 (6)	4 (14)	0.000 (0.001)	-0.005 (0.003)
Interval 7 years	-0.003** (0.001)	-0.002 (0.001)	-0.010 (0.009)	-0.003* (0.002)	-3 (6)	-18 (15)	0.001 (0.001)	-0.004 (0.003)
Panel C. Piecewise quadratic controls								
Interval 5 years	-0.002* (0.001)	-0.002* (0.001)	-0.009 (0.009)	-0.004** (0.002)	-1 (6)	-3 (14)	-0.001 (0.001)	-0.003 (0.003)
Interval 7 years	-0.003** (0.001)	-0.002** (0.001)	-0.013 (0.010)	-0.003* (0.002)	-6 (6)	-23 (15)	-0.000 (0.001)	-0.002 (0.003)
Odd group mean	0.532	0.798	10.227	0.608	1426	4087	0.737	3.051

Robustness: first stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	General	Stomach	Breast	Cervical	Liver	Colorectal	Lung	Prostate
Panel A. Polynomial controls									
Degree 1	0.203*** (0.003)	0.186*** (0.003)	0.189*** (0.003)	0.190*** (0.004)	0.163*** (0.003)	0.026*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Degree 2	0.205*** (0.003)	0.187*** (0.003)	0.190*** (0.003)	0.191*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Degree 3	0.204*** (0.003)	0.187*** (0.003)	0.189*** (0.003)	0.191*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Degree 4	0.204*** (0.003)	0.186*** (0.003)	0.189*** (0.003)	0.190*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Degree 5	0.204*** (0.003)	0.187*** (0.003)	0.189*** (0.003)	0.190*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Panel B. Piecewise linear controls									
Interval 3 years	0.205*** (0.003)	0.188*** (0.003)	0.192*** (0.003)	0.195*** (0.004)	0.168*** (0.004)	0.027*** (0.002)	0.033*** (0.002)	0.006*** (0.001)	0.008*** (0.001)
Interval 5 years	0.203*** (0.003)	0.186*** (0.003)	0.189*** (0.003)	0.191*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.032*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Interval 7 years	0.204*** (0.003)	0.187*** (0.003)	0.189*** (0.003)	0.190*** (0.004)	0.164*** (0.003)	0.027*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Panel C. Piecewise quadratic controls									
Interval 5 years	0.200*** (0.003)	0.185*** (0.003)	0.186*** (0.003)	0.190*** (0.004)	0.162*** (0.004)	0.025*** (0.001)	0.032*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Interval 7 years	0.205*** (0.003)	0.187*** (0.003)	0.189*** (0.003)	0.189*** (0.004)	0.162*** (0.004)	0.026*** (0.001)	0.034*** (0.001)	0.007*** (0.001)	0.007*** (0.001)
Odd group mean	0.128	0.102	0.082	0.067	0.055	0.028	0.026	0.009	0.009

Robustness: selection

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stomach disease	CT	MRI	Sonogram	Individual income	Household income	Years of education	Working status
Panel A. Polynomial controls								
Degree 1	0.083*** (0.008)	-0.033*** (0.005)	-0.007*** (0.002)	-0.098*** (0.010)	-662*** (53)	-773*** (79)	-0.399*** (0.073)	-0.066*** (0.009)
Degree 2	0.084*** (0.008)	-0.033*** (0.005)	-0.007*** (0.002)	-0.095*** (0.010)	-655*** (53)	-745*** (78)	-0.408*** (0.073)	-0.062*** (0.009)
Degree 3	0.084*** (0.008)	-0.032*** (0.005)	-0.007*** (0.002)	-0.092*** (0.010)	-604*** (53)	-664*** (78)	-0.371*** (0.073)	-0.057*** (0.009)
Degree 4	0.084*** (0.008)	-0.032*** (0.005)	-0.007*** (0.002)	-0.092*** (0.010)	-597*** (52)	-661*** (78)	-0.362*** (0.073)	-0.057*** (0.009)
Degree 5	0.084*** (0.008)	-0.032*** (0.005)	-0.007*** (0.002)	-0.092*** (0.010)	-598*** (52)	-665*** (78)	-0.361*** (0.073)	-0.057*** (0.009)
Panel B. Piecewise linear controls								
Interval 3 years	0.085*** (0.009)	-0.032*** (0.005)	-0.006** (0.003)	-0.094*** (0.011)	-589*** (60)	-708*** (93)	-0.268*** (0.082)	-0.050*** (0.010)
Interval 5 years	0.083*** (0.008)	-0.031*** (0.005)	-0.007*** (0.002)	-0.094*** (0.010)	-592*** (53)	-640*** (78)	-0.361*** (0.073)	-0.056*** (0.009)
Interval 7 years	0.086*** (0.008)	-0.033*** (0.005)	-0.007*** (0.002)	-0.095*** (0.010)	-659*** (55)	-775*** (80)	-0.469*** (0.077)	-0.062*** (0.009)
Panel C. Piecewise quadratic controls								
Interval 5 years	0.081*** (0.009)	-0.030*** (0.005)	-0.008*** (0.003)	-0.105*** (0.011)	-596*** (56)	-636*** (92)	-0.399*** (0.081)	-0.058*** (0.010)
Interval 7 years	0.087*** (0.009)	-0.033*** (0.005)	-0.007** (0.003)	-0.092*** (0.010)	-678*** (59)	-830*** (84)	-0.526*** (0.084)	-0.064*** (0.010)
Odd group mean	0.192	0.066	0.017	0.424	2308	5527	11.492	0.704

Robustness: causal effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Outpatient visit	First visit	Inpatient visit	ER visit	Smoker	Smoke everyday	Drinker	Drink everyday
Panel A. Polynomial controls								
Degree 1	0.195*** (0.075)	0.069*** (0.015)	0.007* (0.004)	-0.001 (0.003)	0.001 (0.001)	0.002 (0.001)	0.001 (0.002)	-0.002** (0.001)
Degree 2	0.221*** (0.074)	0.081*** (0.015)	0.006 (0.004)	-0.002 (0.003)	0.001 (0.001)	0.002* (0.001)	0.002 (0.002)	-0.002* (0.001)
Degree 3	0.042 (0.075)	0.058*** (0.015)	0.006 (0.004)	-0.002 (0.003)	0.001 (0.001)	0.002** (0.001)	0.003 (0.002)	-0.002* (0.001)
Degree 4	0.106 (0.075)	0.060*** (0.015)	0.006 (0.004)	-0.002 (0.003)	0.002 (0.001)	0.003** (0.001)	0.003* (0.002)	-0.002* (0.001)
Degree 5	0.098 (0.075)	0.060*** (0.015)	0.005 (0.004)	-0.003 (0.003)	0.002** (0.001)	0.003*** (0.001)	0.003* (0.002)	-0.002* (0.001)
Panel B. Piecewise linear controls								
Interval 3 years	-0.082 (0.105)	0.050** (0.020)	0.004 (0.005)	-0.007** (0.003)	0.003** (0.002)	0.004** (0.002)	0.003 (0.002)	-0.003** (0.001)
Interval 5 years	0.111 (0.080)	0.065*** (0.016)	0.005 (0.004)	-0.002 (0.003)	0.002 (0.001)	0.002** (0.001)	0.003* (0.002)	-0.001 (0.001)
Interval 7 years	0.125 (0.082)	0.062*** (0.016)	0.006 (0.004)	-0.004 (0.003)	0.002** (0.001)	0.003*** (0.001)	0.003* (0.002)	-0.001 (0.001)
Panel C. Piecewise quadratic controls								
Interval 5 years	0.145 (0.091)	0.070*** (0.018)	0.005 (0.005)	-0.001 (0.003)	0.002 (0.001)	0.002* (0.001)	0.003 (0.002)	-0.001 (0.001)
Interval 7 years	0.155* (0.091)	0.072*** (0.018)	0.007* (0.004)	-0.003 (0.003)	0.003** (0.001)	0.004*** (0.001)	0.003 (0.002)	-0.001 (0.001)
Odd group mean	20.071	3.916	0.233	0.125	0.192	0.183	0.624	0.070

Screening results

Disease	Share	Disease classification
Find disease	0.292	
Stomach	0.151	ICD
Colon and rectum	0.032	ICD
Breast	0.013	ICD
Female reproductive system	0.034	ICD
Hypertension	0.008	
Hyperlipidemia	0.015	
Diabetes	0.004	

[back](#)

Disease classifications for stomach

- Gastritis and duodenitis
- Other noninfective gastroenteritis and colitis
- Gastro-oesophageal reflux disease
- Gastric ulcer
- Helicobacter pylori
- Other diseases of stomach and duodenum
- Oesophagitis
- Malignant neoplasm of stomach
- Duodenal ulcer

[back](#)

Disease classifications for colon and rectum

- Other diseases of intestine
- Benign neoplasm of colon, rectum, anus and anal canal
- Benign neoplasm of other and ill-defined parts of digestive system
- Other symptoms and signs involving the digestive system and abdomen
- Malignant neoplasm of colon

[back](#)

Disease classifications for breast

- Unspecified lump in breast
- Other disorders of breast
- Benign neoplasm of breast
- Benign mammary dysplasia
- Malignant neoplasm of breast

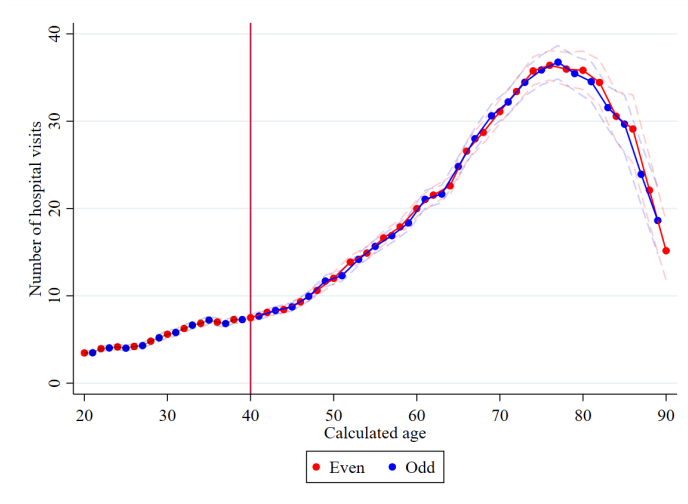
[back](#)

Disease classifications for female reproductive system

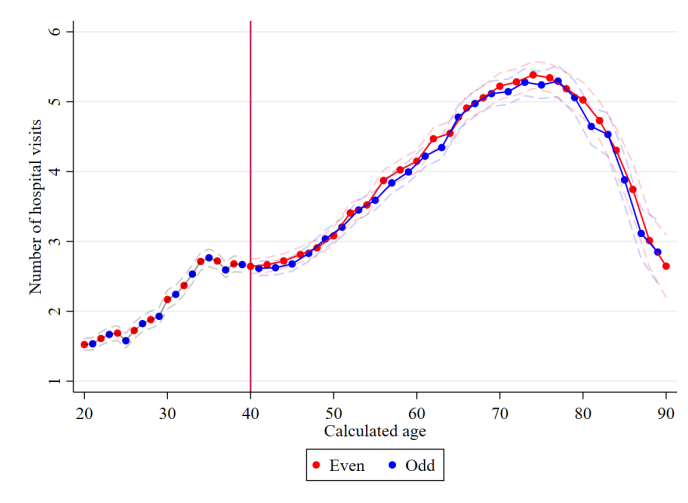
- Other inflammation of vagina and vulva
- Inflammatory disease of uterus, except cervix
- Other noninflammatory disorders of uterus, except cervix
- Noninflammatory disorders of ovary, fallopian tube and broad ligament

[back](#)

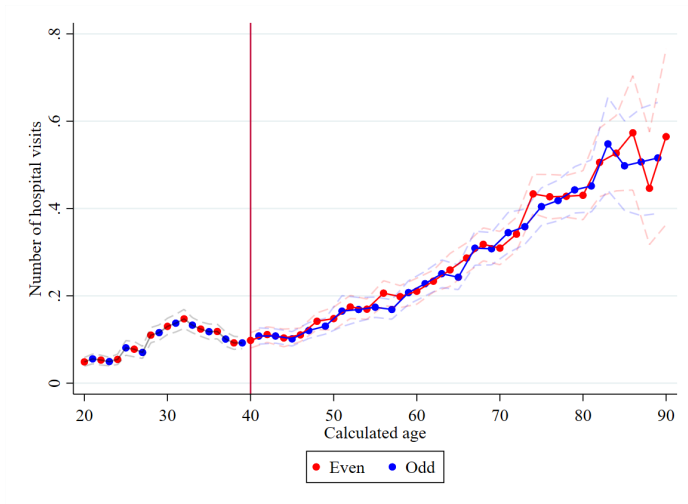
Reduced form plot - outpatient visit



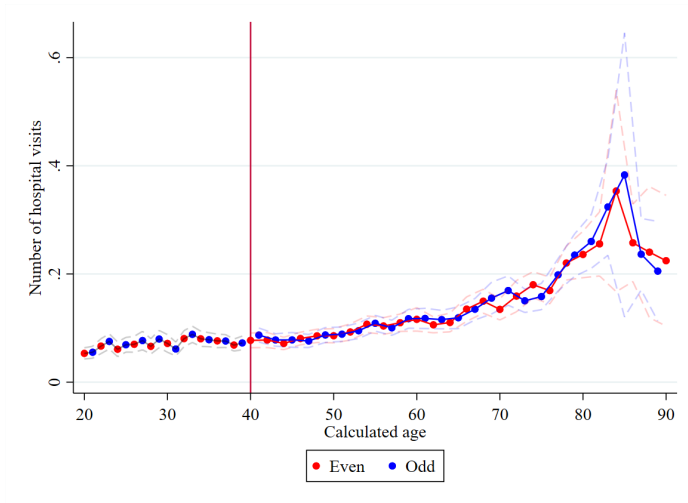
Reduced form plot - first outpatient visit



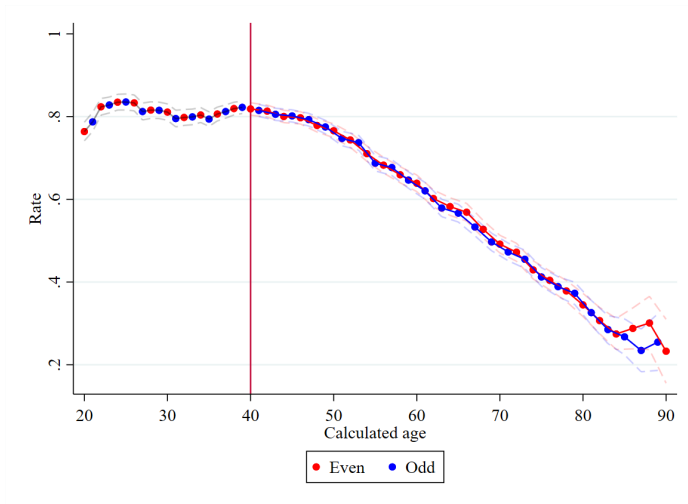
Reduced form plot - inpatient visit



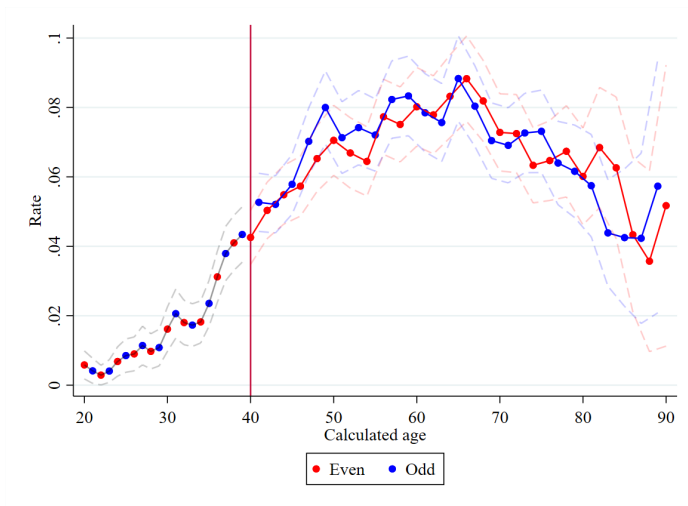
Reduced form plot - emergency visit



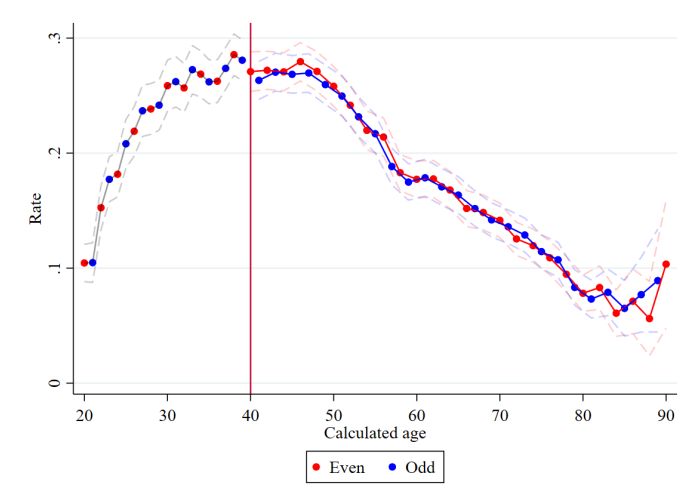
Reduced form plot - drinker



Reduced form plot - drink everyday



Reduced form plot - smoker



Reduced form plot - smoke everyday

