Effect of health screening on health care utilization and health behavior: Evidence from Korean screening policy

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Motivation

- Health screening leads to healthy living and low health care costs
  - Early diagnosis of a disease $\Rightarrow$ treatment success $\uparrow$, premature death $\downarrow$, health care costs $\downarrow$
  - Important for examinees and health insurance providers
- Incentives to get screening
  - Health care providers cover basic screening tests
  - Workplace wellness programs
  - Public screening policy
- Programs are growing
  - US Workplace wellness industry revenue tripled in size to \$8 billion since 2010 (Mattke et al. (2013))
  - Korea budget for general health screening: \$2.2 million (2011) $\Rightarrow$ \$640 million (2021) (Division (2021))

Current evidence on health screening

- Clinical studies
  - Randomization guarantees causal estimates
  - Small sample, controlled setting, no selection
- Observational studies
  - Selection bias
- Artificial thresholds in health indicators
  - e.g. BMI cutoff for obesity, blood sugar level cutoff for diabetes
  - Conditional on screening
  - Exogenous variation in screening is scarce

Research question

1. What are the (SR) causal effects of screening on health care utilization and health behaviors?
    - Nationally implemented health screening program in Korea
    - Random variation in free screening
2. How does economic incentives and peer affect the screening decision?
    - Subsidy for screening common for encouraging participation
    - Complier characteristics in response to economic incentives
    - Peer effect in screening

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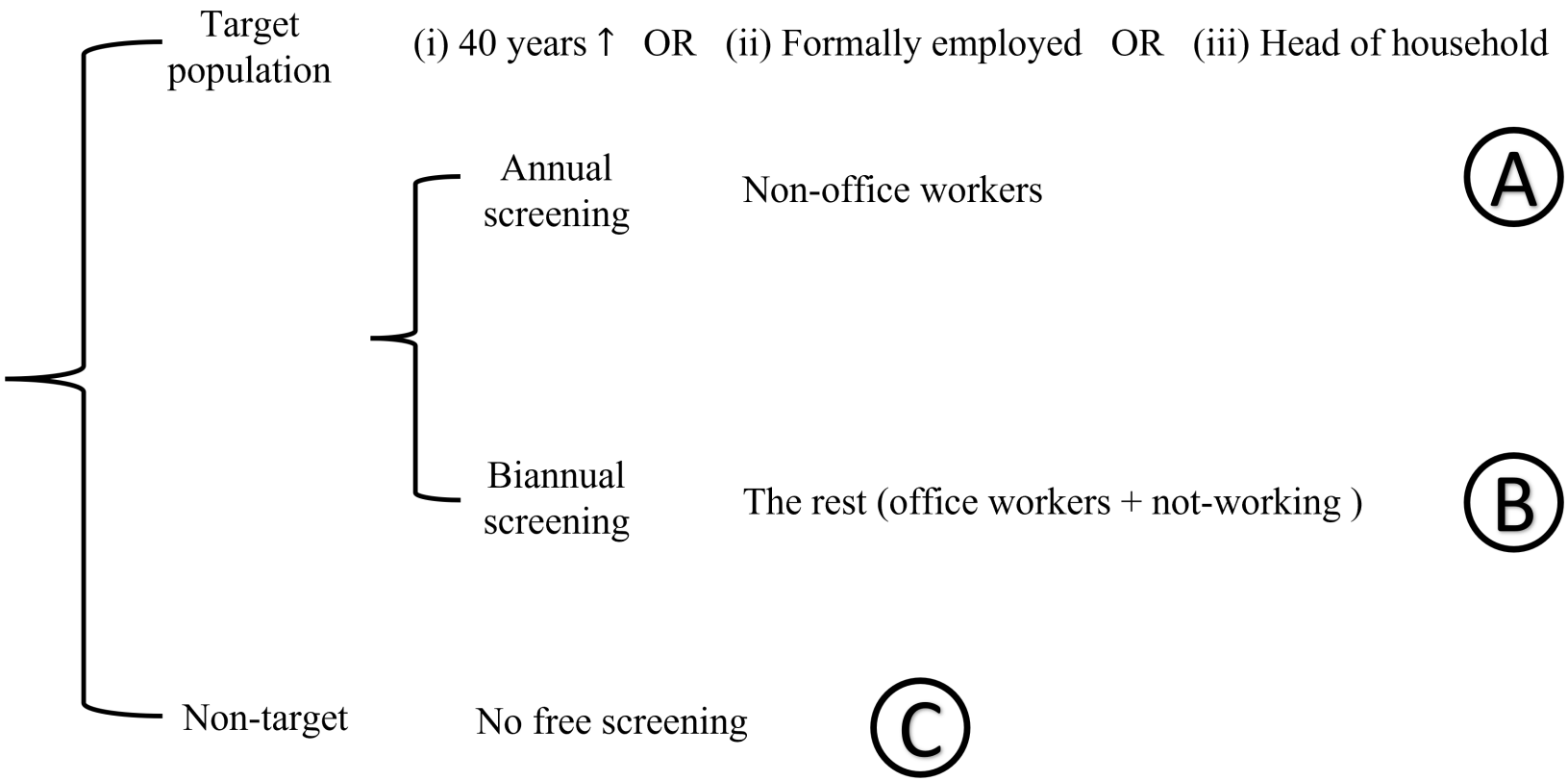
Korean health screening policy

- 3 types of screening provided by NHIS
  - 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
- IV - Eligibility for free screening
  - Provided biannually (every other year)
  - Even-odd design based on year of birth
  - Off year screening should be fully paid by the examinee ($40)

Screening result form | Cancer screening

Analytical sample

Composition of total population



- Analytical sample is group (B)
- Demographic and job characteristic (52 group) variables are used
- Robustness check: sample adjustment using (A) + (B)

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Exogenous variation in screening

- Who pays for screening?

Population \ year	
Born in odd year	
Born in even year	

Exogenous variation in screening

- Who pays for screening?

Population \ year	2009	
Born in odd year	Free	
Born in even year	Pay	

Exogenous variation in screening

- Who pays for screening?

Population \ year	2009	2010	
Born in odd year	Free	Pay	
Born in even year	Pay	Free	

Exogenous variation in screening

- Who pays for screening?

Population \ year	2009	2010	2011
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Population \ year	2009	2010	2011
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- Treatment group and control group

Exogenous variation in screening

- Who pays for screening?

Population \ year	2009	2010	2011
Born in odd year	Free	Pay	Free
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- Treatment group and control group
  - Difference in take-up: $x^T - x^C$
  - Difference in outcome: $y^T - y^C$

Exogenous variation in screening

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  - Difference in outcome: $y^T - y^C$
- *ITT* : $y^T - y^C$ *LATE* : $\frac{y^T - y^C}{x^T - x^C}$

Exogenous variation in screening

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- Treatment group and control group
  - Difference in take-up: $x^T - x^C$
  - Difference in outcome: $y^T - y^C$
- *ITT* : $y^T - y^C$ *LATE* : $\frac{y^T - y^C}{x^T - x^C}$
- Short-run effect
  - Treatment effect that shows up in 1 year
  - Population is already regularly getting screened
  - Recurring nature

Econometric specification - IV analysis

- Two-stage least square regression
  - First stage

$$Screening_{it} = \alpha_0 + \alpha_1 Eligible_{it} + X_{it} + \eta_{it} \quad (1)$$

  - Second stage

$$Outcome_{it} = \beta_0 + \beta_1 Screening_{it} + X_{it} + \varepsilon_{it} \quad (2)$$

  - Control variables
    - Baseline: no control
    - Demographic and SES, year FE
    - individual FE, year FE
- Standard error
  - Clustered at individual level
  - Westfall-Young stepdown adjusted p-values (replication = 1,000)
- Standardized treatment effect following Kling et al. (2007)
  - Equal weight on each outcome variable in a domain
  - Drinker dummy excluded in drinking domain

Data

- Korean health panel study dataset
  - Annual individual level survey data from 2009 to 2017
  - Household random sampling
  - Face-to-face interview with CAPI (self-reported)
  - Information on
    - Demographic and SES
    - Health care usage
    - Health behavior

- 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. (2010)
Random sampling	Household	Individual
Health behavior	Every year	Conditional on screening
First visit for an illness	Yes	No

Variables - health care usage

- Type
  - Outpatient care
  - First outpatient care for a new illness
  - Inpatient care
  - Emergency care
- Measures
  - Number of hospital visits
  - Hospital bills
  - Drug expenditures
- Size of hospitals
  - General hospital: bed 100 +
  - Local hospital: bed 30 - 100
  - Local clinic: bed 0 - 30
- Flow
  - Total number of visits and medical expenditures incurred during a calendar year

Data collection

Variables - health behaviors

- Health behavior outcome variables

	Smoking	Drinking	Exercise (Vig, Mod, Walk)
Extensive	smoker	drinker	doing exercise
Frequency	Days/year once/week↑ Everyday	once/month↑ once/week↑ Everyday + binge drinking	Days/year
Amount	Cigarettes/day 3 cig/day↑ 10 cig/day↑	5 cup/day↑ 10 cup/day↑	30 min/day↑
Standardized treatment effect	Smoking index	Drinking index	Exercise index

Data collection

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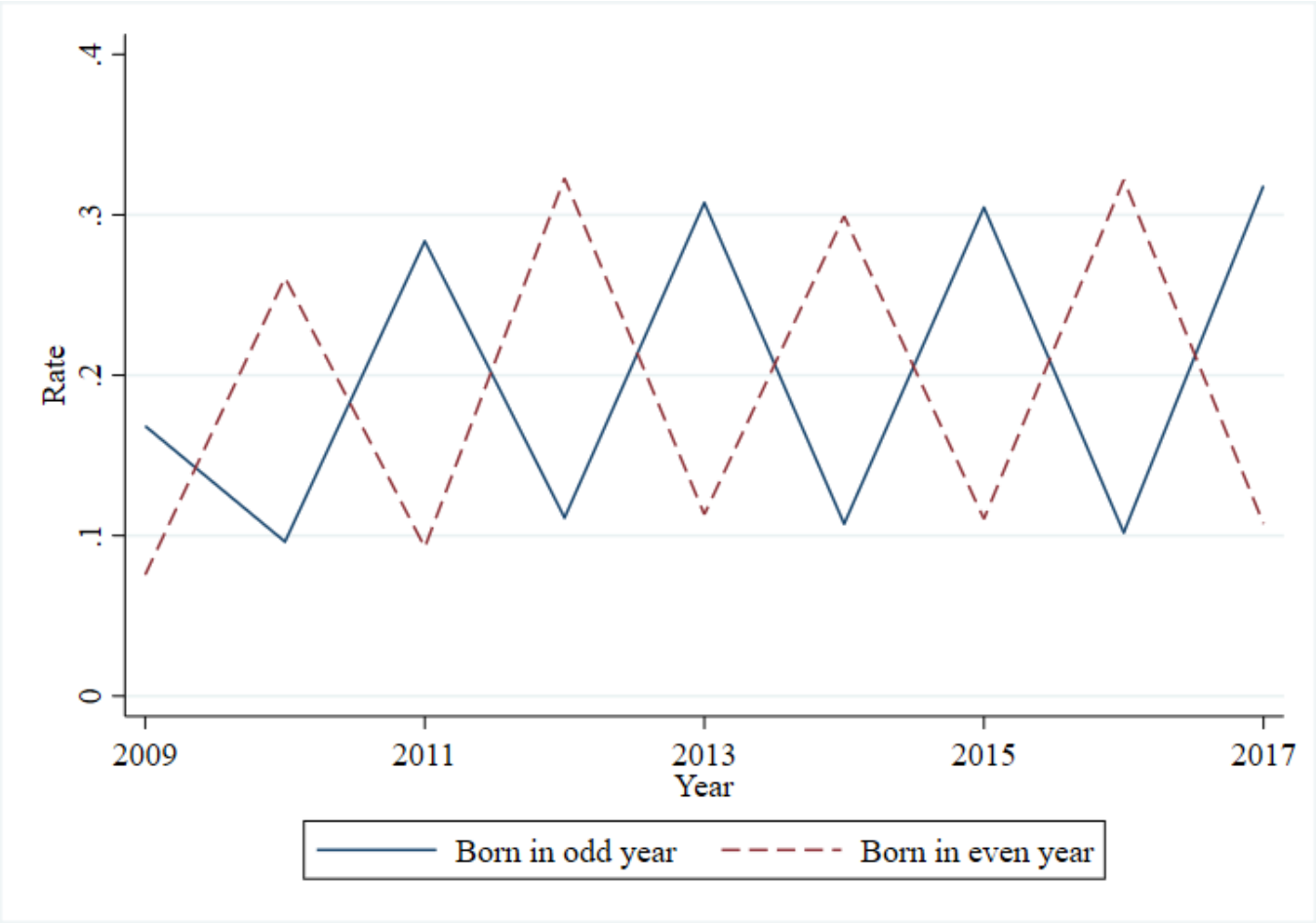
IV - 1st stage

Figure: Screening rate for biannual screening target population



IV - 1st stage

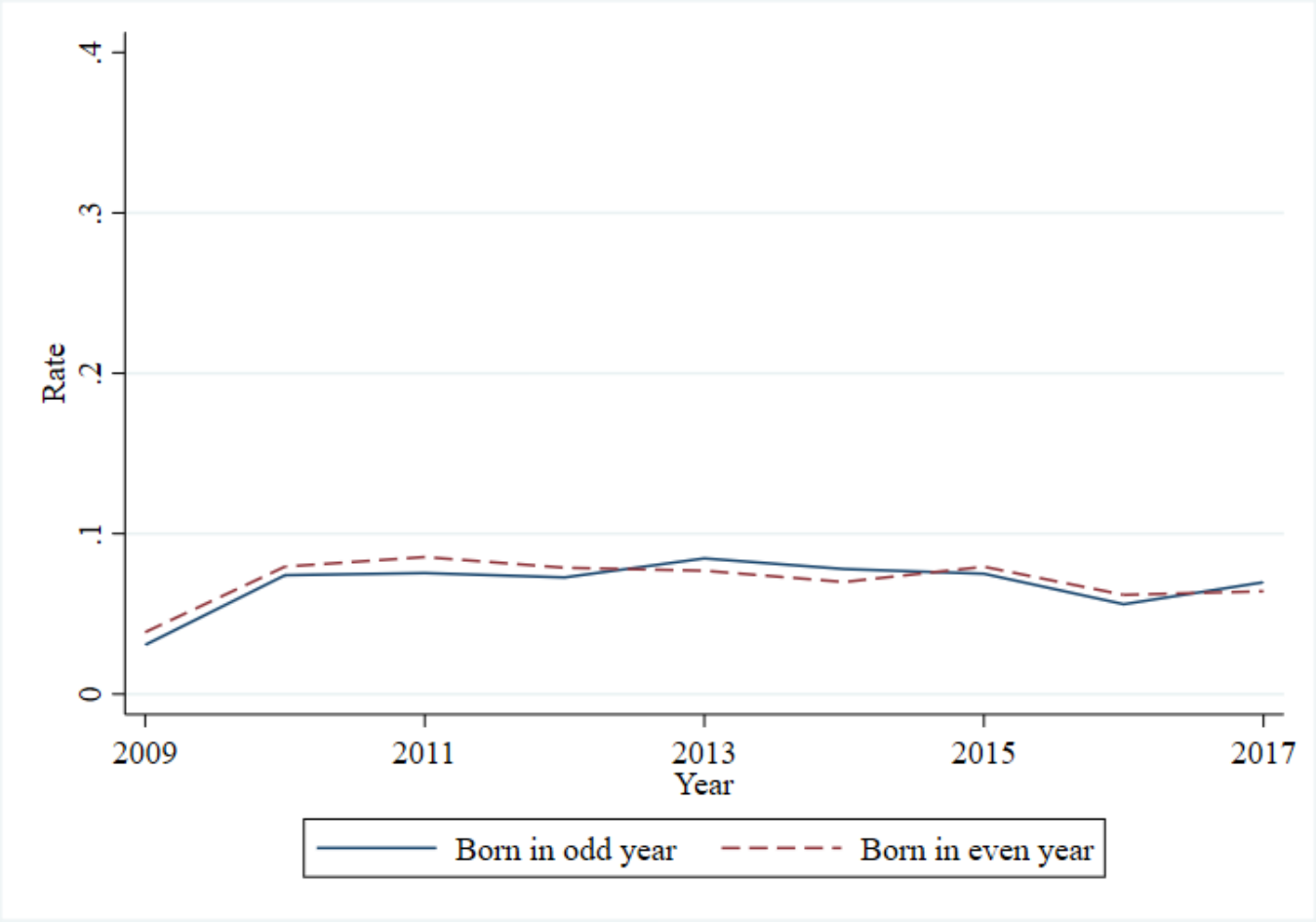
Table: Effect of free health screening provision on takeup

	(1)	(2)	(3)
		Dep Var: Health screening takeup	
Eligible	0.185***	0.185***	0.190***
	(0.003)	(0.003)	(0.003)
N	68,317	68,317	65,626
Adj R^2	0.055	0.055	0.161
Controls		Y	
Year FE		Y	Y
Individual FE			Y

Notes: Outcome variable is the takeup of health screening. Independent variable is eligibility for National Health Insurance Service-provided biannual health screening. Standard errors are clustered at individual level and reported in parentheses. A */**/*** indicates significance at the 10/5/1% levels.

IV - Falsification test

Figure: Screening rate for non-target population



Analytical sample

Balance table

	Treatment group	Control group	Difference
Individual characteristics			
Age	55.80	56.02	–0.23*
	(15.71)	(15.69)	(0.12)
Female	0.56	0.55	0.00
	(0.50)	(0.50)	(0.00)
Married	0.74	0.74	–0.00
	(0.44)	(0.44)	(0.00)
Years of schooling	11.03	11.01	0.03
	(4.78)	(4.79)	(0.04)
Working status	0.53	0.53	–0.00
	(0.50)	(0.50)	(0.00)
Handicapped	0.09	0.09	–0.00
	(0.28)	(0.29)	(0.00)
Employment-based insurance	0.56	0.56	–0.00
	(0.50)	(0.50)	(0.00)
Individual income	1461.42	1470.06	–8.65
	(2148.42)	(2153.68)	(15.87)
Household characteristics			
Income decile	5.78	5.75	0.03
	(2.94)	(2.94)	(0.02)
Household income	4331.70	4315.12	16.58
	(4044.67)	(3986.58)	(29.62)
House ownership	0.70	0.70	0.00
	(0.46)	(0.46)	(0.00)
Number of Household members	3.12	3.11	0.01
	(1.32)	(1.32)	(0.01)
Observations	37024	36511	
Share	(54.19)	(53.44)	
F-stat (12, 73370)			1.16
p-value			(0.30)

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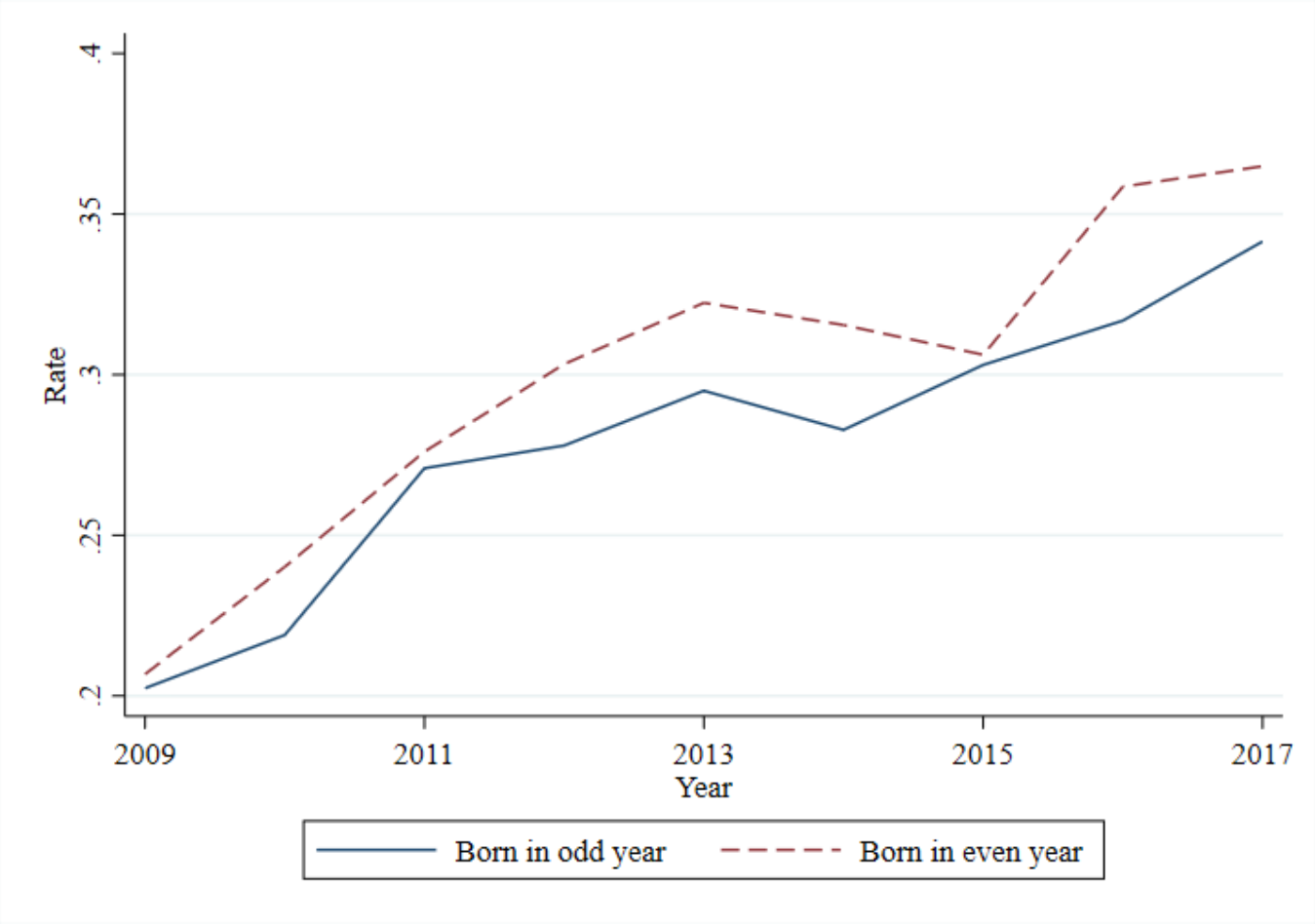
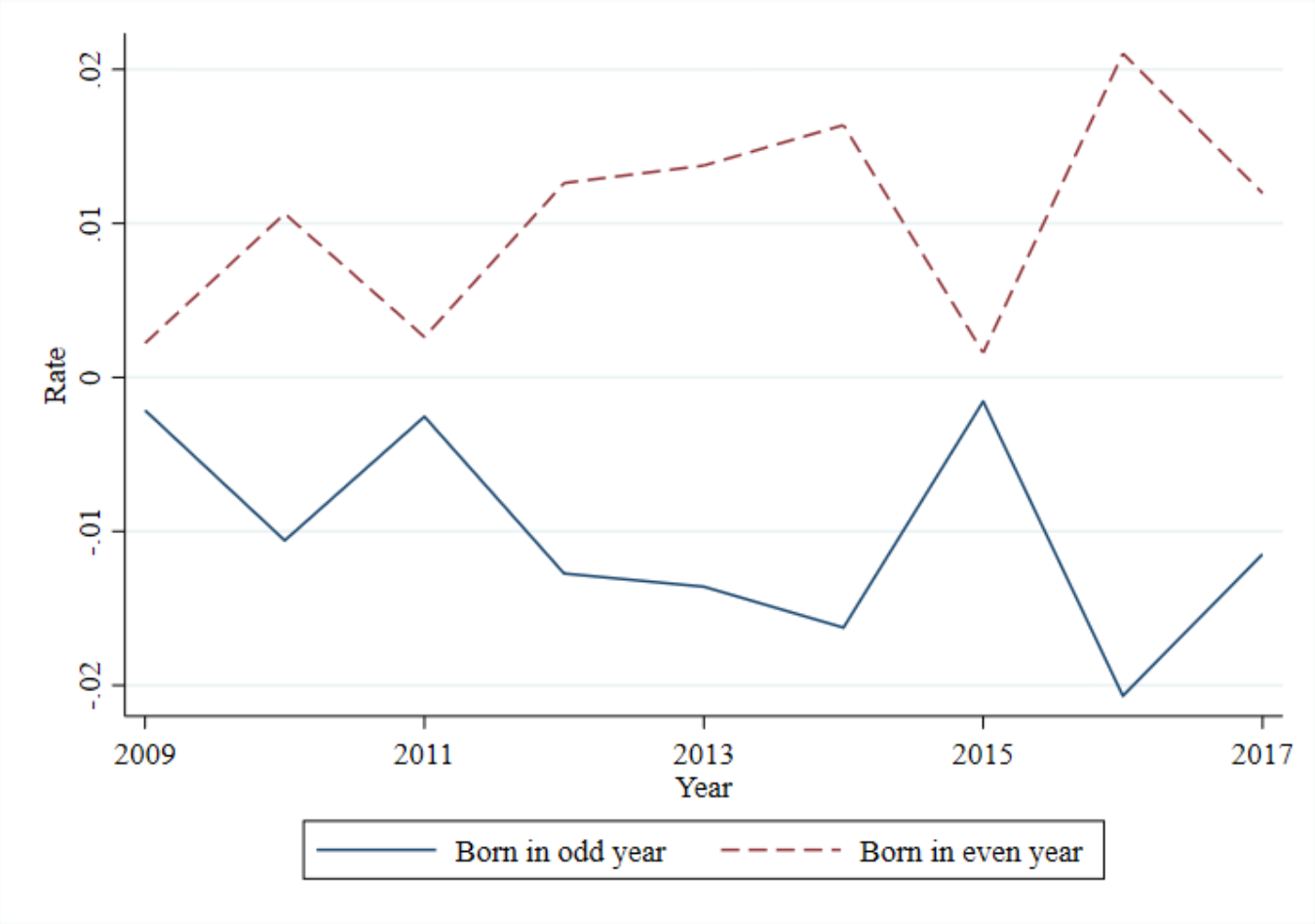
Reduced form

Figure: First visit to hospital for a new illness



Reduced form

Figure: Detrended first visit to hospital for a new illness



Outpatient care

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	19.021	18.869	-0.153	-0.847	-4	0.573	0.400	73535
General hospital	2.473	2.516	0.043	0.238	10	0.154	0.400	73535
Local hospital	1.448	1.461	0.013	0.072	5	0.144	1.000	73535
Local clinic	15.100	14.891	-0.209	-1.157	-8	0.524	0.200	73535
Hospital bill								
Total	340847	336962	-3885	-21553	-6	25571	1.000	73535
General hospital	83558	85175	1617	8971	11	9242	0.800	73535
Local hospital	40985	40606	-378	-2098	-5	9061	1.000	73535
Local clinic	215702	210526	-5176	-28715	-13	22093	0.600	73535
Drug expenditures								
Total	113003	112472	-531	-2945	-3	3819	1.000	73535
General hospital	41091	41341	249	1383	3	2879	1.000	73535
Local hospital	8168	8093	-75.018	-416	-5	966	1.000	73535
Local clinic	61677	60975	-702	-3896	-6	2345	0.400	73535

Significant at 10%
Significant at 5%
Significant at 1%

Control FE

Outpatient care

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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Outpatient care - first visit

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Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
First hospital visit for a new illness								
Total	3.696	3.758	0.063	0.348	9	0.108	0.000	73535
General hospital	0.353	0.371	0.018	0.100	28	0.032	0.000	73535
Local hospital	0.286	0.293	0.007	0.038	13	0.026	0.400	73535
Local clinic	2.847	2.884	0.037	0.203	7	0.093	0.200	73535
First hospital bill for a new illness								
Total	89527	93896	4369	24238	27	10707	0.200	73535
General hospital	20347	21728	1380	7658	38	3689	0.200	73535
Local hospital	13010	13988	978	5426	42	4079	0.600	73535
Local clinic	55986	57996	2010	11153	20	9190	0.600	73535
First drug expenditures for a new illness								
Total	10982	11351	369	2048	19	662	0.000	73535
General hospital	1924	2011	87.830	487	25	407	0.600	73535
Local hospital	1000	1035	35.198	195	20	188	0.800	73535
Local clinic	7947	8193	246	1363	17	466	0.000	73535

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Inpatient care

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Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.236	0.237	0.001	0.004	2	0.027	1.000	73535
General hospital	0.125	0.123	-0.002	-0.012	-9	0.021	1.000	73535
Local hospital	0.076	0.080	0.004	0.020	27	0.013	0.800	73535
Local clinic	0.036	0.035	-0.001	-0.005	-14	0.009	1.000	73535
Hospital bill								
Total	209413	208121	-1292	-7170	-3	40095	1.000	73535
General hospital	128569	126258	-2312	-12824	-10	32903	1.000	73535
Local hospital	66662	68826	2164	12007	18	21596	1.000	73535
Local clinic	14113	13021	-1092	-6061	-43	6255	1.000	73535
Drug expenditures								
Total	85.934	90.767	4.833	26.811	31	90.724	1.000	73535
General hospital	43.834	58.667	14.833	82.287	188	80.775	1.000	73535
Local hospital	17.758	14.806	-2.952	-16.374	-92	31.448	1.000	73535
Local clinic	24.343	17.294	-7.048	-39.101	-161	26.565	0.800	73535

Significant at 10%
Significant at 5%
Significant at 1%

Control FE

Emergency care

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.127	0.121	-0.006	-0.032	-25	0.018	0.400	73535
General hospital	0.094	0.088	-0.006	-0.035	-37	0.015	0.200	73535
Local hospital	0.032	0.032	0.000	0.002	5	0.009	1.000	73535
Local clinic	0.001	0.001	0.000	0.001	125	0.002	1.000	73535
Hospital bill								
Total	7444	7372	-71.574	-397	-5	2352	1.000	73535
General hospital	6589	6559	-29.872	-166	-3	2295	1.000	73535
Local hospital	814	791	-23.072	-128	-16	472	1.000	73535
Local clinic	40.059	21.429	-18.630	-103	-258	105	1.000	73535
Drug expenditures								
Total	50.376	54.718	4.343	24.091	48	49.191	1.000	73535
General hospital	26.558	31.530	4.972	27.581	104	44.912	1.000	73535
Local hospital	23.776	22.940	-0.836	-4.640	-20	20.002	1.000	73535
Local clinic	0.041	0.248	0.207	1.151	2801	1.233	1.000	73535

Significant at 10%
Significant at 5%
Significant at 1%

Control FE

Emergency care

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.127	0.121	-0.006	-0.032	-25	0.018	0.400	73535
General hospital	0.094	0.088	-0.006	-0.035	-37	0.015	0.200	73535
Local hospital	0.032	0.032	0.000	0.002	5	0.009	1.000	73535
Local clinic	0.001	0.001	0.000	0.001	125	0.002	1.000	73535
Hospital bill								
Total	7444	7372	-71.574	-397	-5	2352	1.000	73535
General hospital	6589	6559	-29.872	-166	-3	2295	1.000	73535
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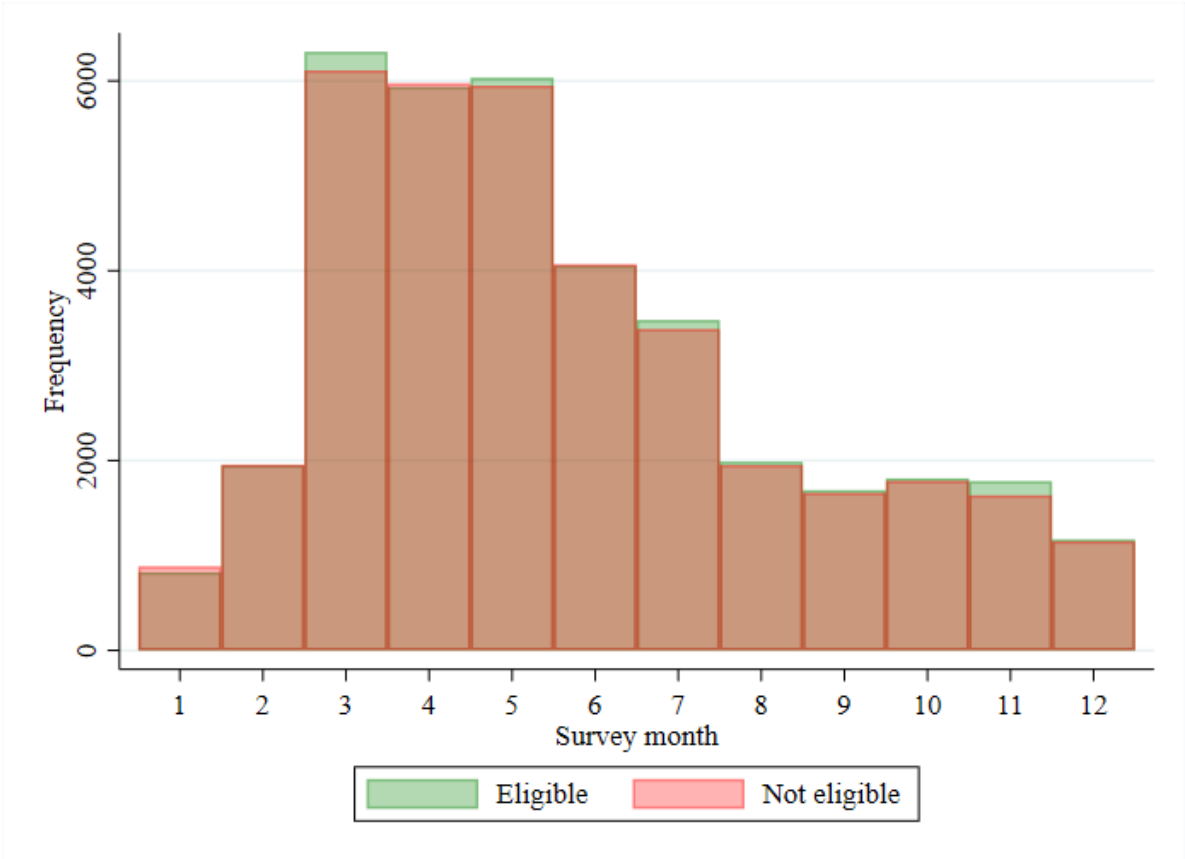
Control FE

Table of Contents

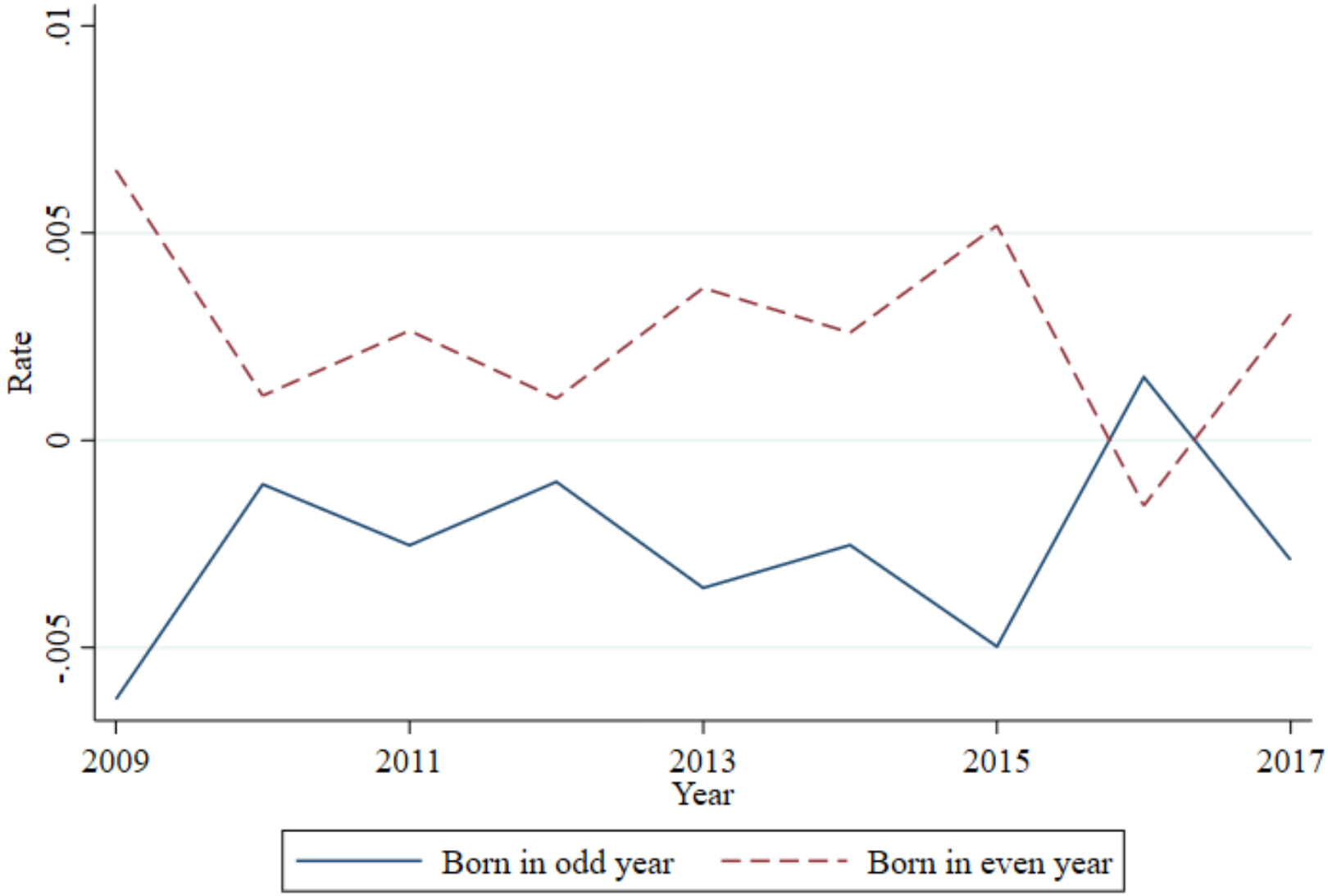
Survey date balance

- Timing of health behaviors
  - Behavior at one point in time (stock)
  - Recent past of survey date
- Distribution of survey date
  - More surveys are affected by screening in the treatment group



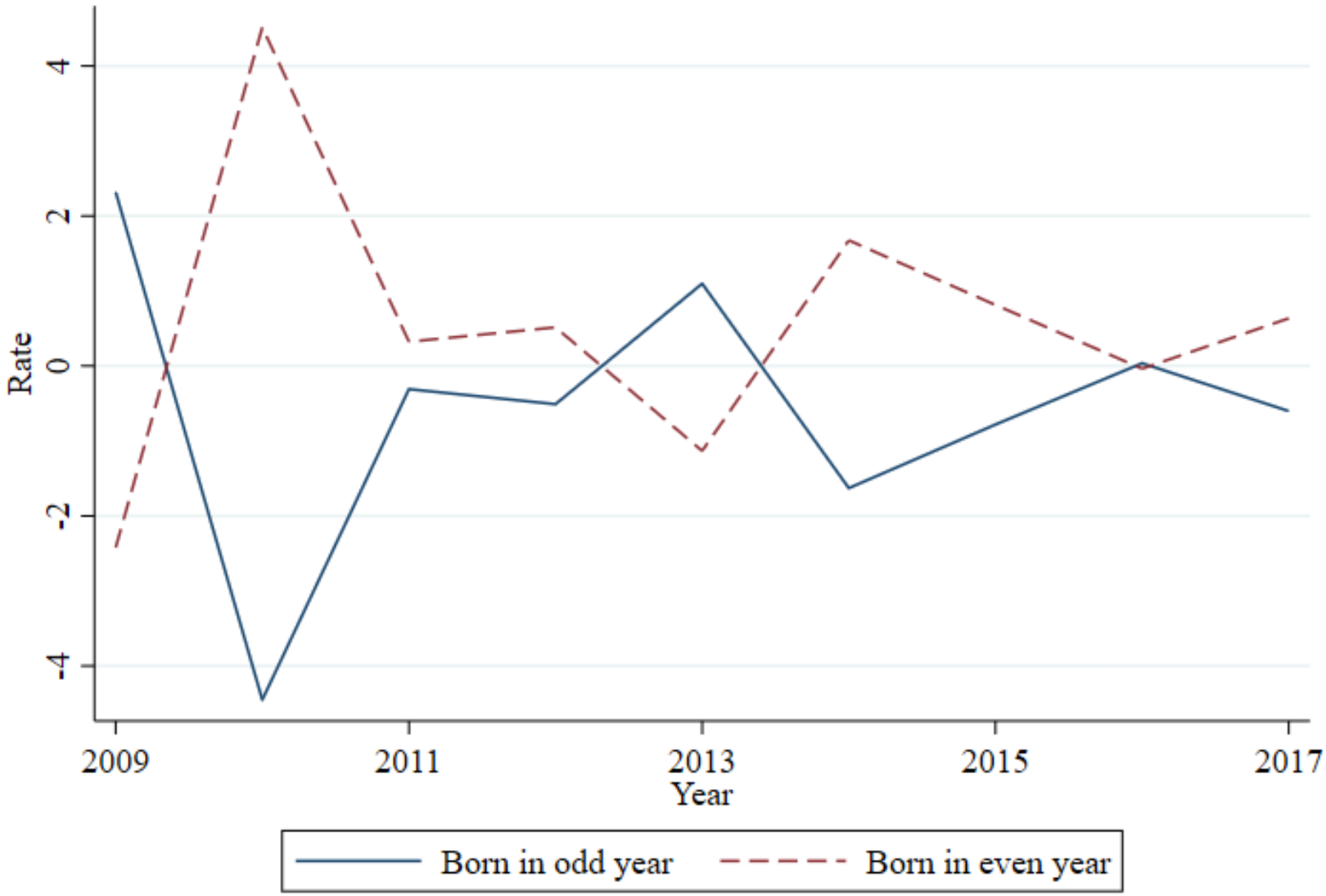
date interval

Reduced form - everyday drinker



Raw data

Reduced form - days of walking



Raw data

Smoking

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Extensive margin								
Smoker	0.193	0.190	-0.003	-0.014	-7	0.009	0.400	71691
Frequency								
Smoking days per year	68.018	67.159	-0.860	-4.664	-7	3.053	0.400	71691
Smoking once a week or more	0.190	0.188	-0.002	-0.013	-7	0.009	0.400	71691
Smoking everyday	0.184	0.182	-0.002	-0.013	-7	0.008	0.400	71691
Amount								
Cigarettes per day	2.838	2.816	-0.023	-0.122	-4	0.155	0.600	71691
Smoking 3 cigarettes or more	0.184	0.182	-0.003	-0.014	-8	0.009	0.400	71691
Smoking 10 cigarettes or more	0.154	0.151	-0.003	-0.016	-10	0.008	0.400	71691
Standardized treatment effect								
Smoking index				-0.033		0.021		

Significant at 10%
Significant at 5%
Significant at 1%

Smoking

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Extensive margin								
Drinker	0.633	0.638	0.005	0.025	4	0.012	0.400	71814
Frequency								
Drinking once a month or more	0.497	0.494	-0.003	-0.017	-3	0.013	0.600	71814
Drinking once a week or more	0.287	0.283	-0.004	-0.021	-7	0.012	0.600	71814
Drinking everyday	0.057	0.054	-0.003	-0.018	-31	0.007	0.000	71814
Binge drinking once a month or more	0.217	0.215	-0.002	-0.010	-4	0.012	0.600	71796
Binge drinking once a week or more	0.130	0.126	-0.003	-0.017	-13	0.010	0.600	71796
Binge drinking everyday	0.022	0.020	-0.002	-0.009	-39	0.005	0.600	71796
Amount								
Drinking 5 cups or more	0.255	0.253	-0.002	-0.009	-4	0.012	0.600	71793
Drinking 10 cups or more	0.070	0.072	0.001	0.008	11	0.008	0.600	71793
Standardized treatment effect								
Drinking index				-0.037		0.015		

Significant at 10%
Significant at 5%
Significant at 1%

Drinking

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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Significant at 5%
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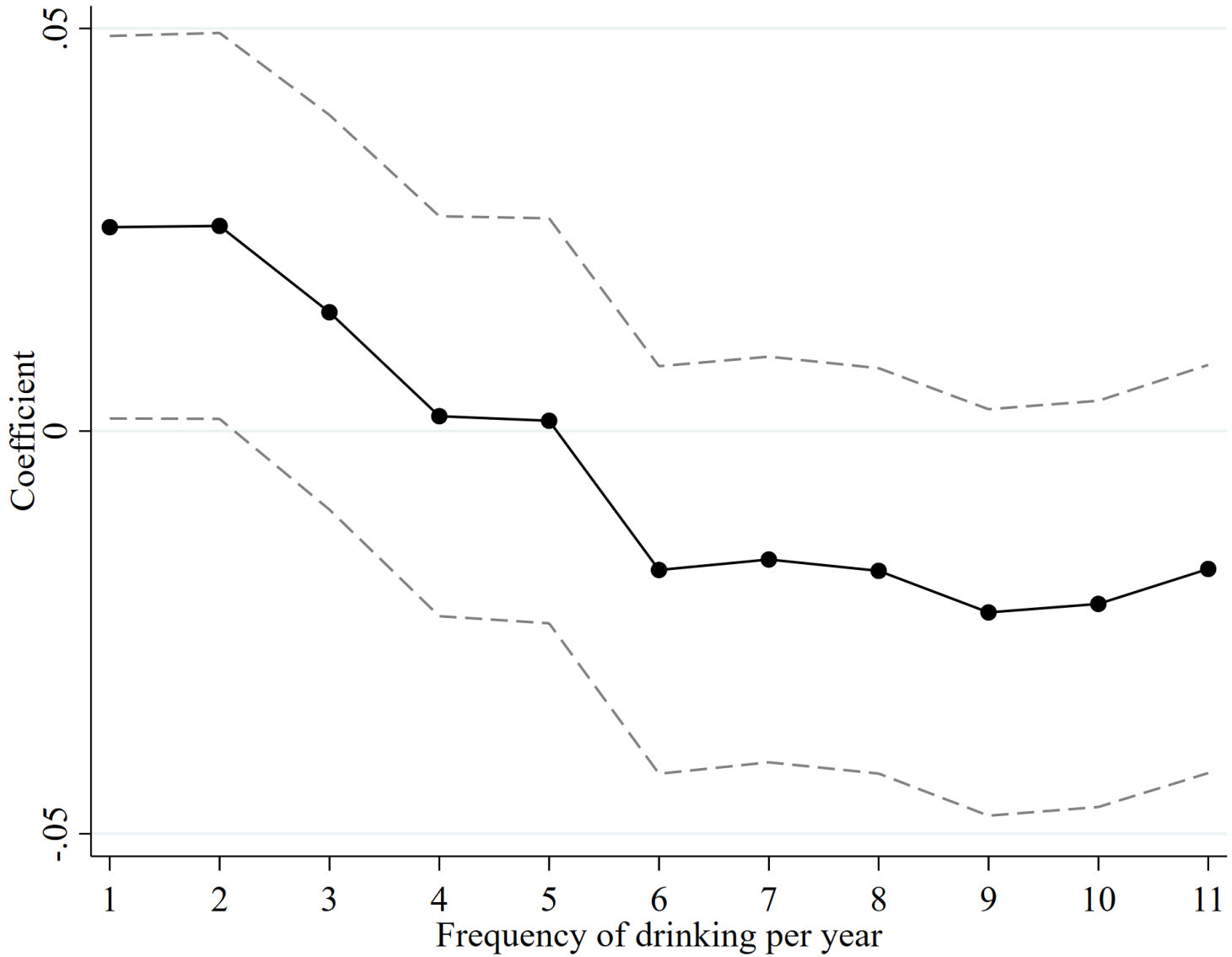
Drinking - new drinkers

- Screening induced drinking
  - Drinking less than once a month (12 times a year)
  - How many times did you drink last year?
  - Outcome: $1\left[\text{Drinking frequency per year} \geq j\right]$ for $1 \leq j \leq 11$
  - Prediction: positive $\Rightarrow$ negative

Drinking - new drinkers



Exercise

Table: Health screening and behavior

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Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Extensive margin								
Doing vigorous exercise	0.215	0.214	-0.001	-0.005	-2	0.014	1.000	71813
Doing moderate exercise	0.351	0.350	-0.001	-0.005	-2	0.017	1.000	71812
Doing walking exercise	0.772	0.777	0.005	0.025	3	0.015	0.200	71812
Frequency								
Days of vigorous exercise	36.886	36.859	-0.027	-0.146	-0	2.955	1.000	71813
Days of moderate exercise	71.154	71.085	-0.069	-0.375	-1	3.995	1.000	71812
Days of walking	206	208	1.951	10.602	5	5.031	0.200	71812
Amount								
30 min vigorous exercise	0.166	0.167	0.001	0.006	4	0.013	1.000	71813
30 min moderate exercise	0.256	0.259	0.003	0.019	7	0.015	0.600	71811
30 min walking	0.416	0.412	-0.004	-0.021	-5	0.018	0.600	71812
Standardized treatment effect								
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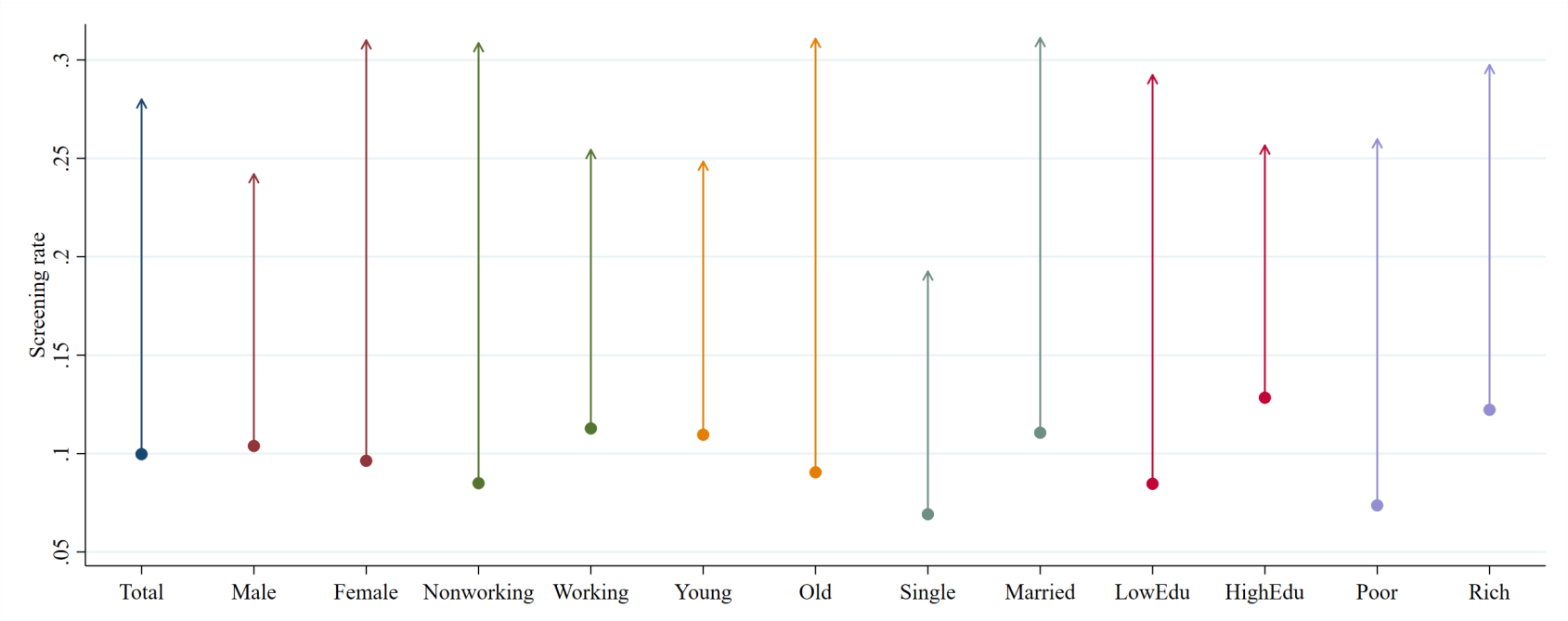
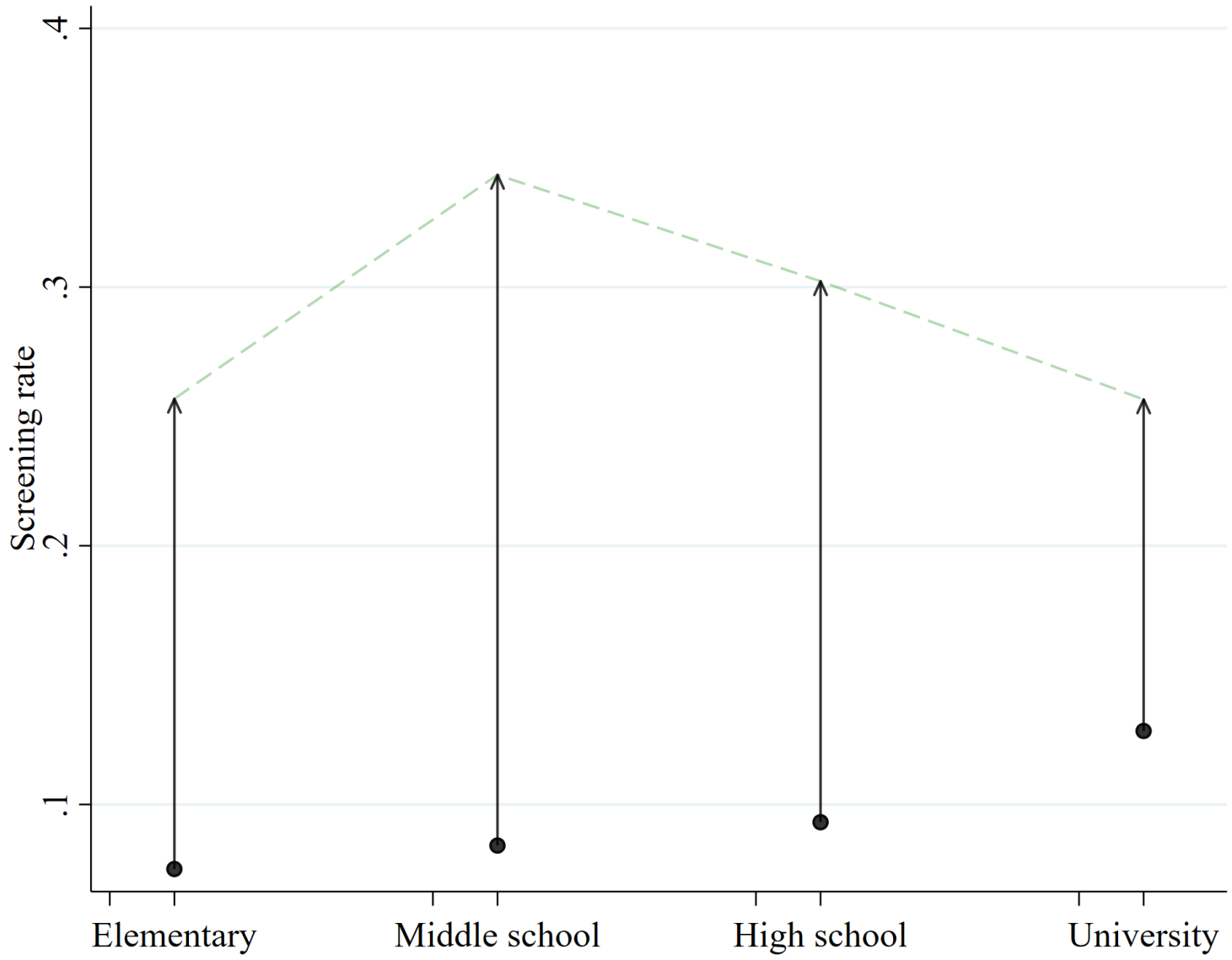
Complier analysis

- Compliers
  - How does economic incentives affect screening participation?
  - Who takes part in screening thanks to free screening but otherwise would not
  - LATE estimates stem from compliers
- Complier characteristics
  - Split the sample by demographic groups
  - First stage coefficients by subsamples give relative likelihood of being a complier (Angrist and Pischke (2008))

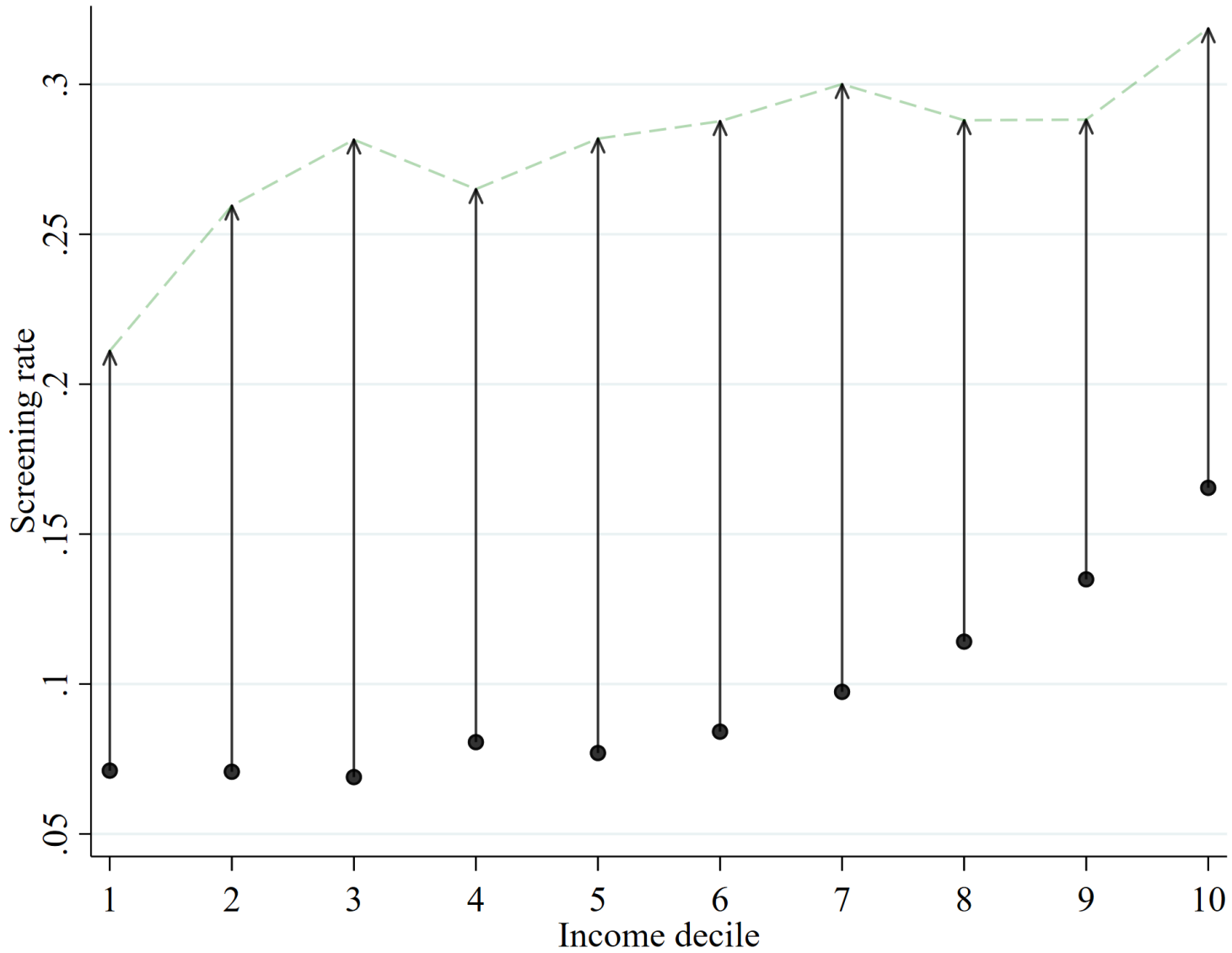
Complier analysis



Complier analysis - Education



Complier analysis - Income



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Spillover effect

- Composition of free screening eligibilities

Odd year		Spouse: Odd	Spouse: Even
Self	Odd	(Free, Free) $\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3$	(Free, Pay) $\gamma_0 + \gamma_1$
	Even	(Pay, Free) $\gamma_0 + \gamma_2$	(Pay, Pay) γ_0

- Econometric specification

$$Screening_{ict}^{A} = \gamma_0 + \gamma_1 Eligible_{ict}^{A} + \gamma_2 Eligible_{ict}^{B} + \gamma_3 Eligible_{ict}^{A} \times Eligible_{ict}^{B} + \psi_{ict}$$

- Sample adjustment
  - Married couples both of whom subject to biannual health screening

Spillover effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Outcome: Spouse screening		Outcome: Own screening			
Eligible			0.210***	0.210***	0.208***	0.209***
			(0.008)	(0.007)	(0.005)	(0.005)
Spouse eligible	0.210***	0.211***	0.018***	0.017***		
	(0.005)	(0.005)	(0.006)	(0.006)		
Eligible × Spouse eligible			–0.001	0.001		
			(0.012)	(0.011)		
Spouse screening					0.082***	0.082***
					(0.023)	(0.023)
N	40,258	40,170	40,258	40,170	40,258	40,170
Controls		Y		Y		Y
Year FE		Y		Y		Y
Specification	OLS	OLS	OLS	OLS	IV	IV

Spillover effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Outcome: Spouse screening		Outcome: Own screening			
Eligible			0.210***	0.210***	0.208***	0.209***
			(0.008)	(0.007)	(0.005)	(0.005)
Spouse eligible	0.210***	0.211***	0.018***	0.017***		
	(0.005)	(0.005)	(0.006)	(0.006)		
Eligible × Spouse eligible			–0.001	0.001		
			(0.012)	(0.011)		
Spouse screening					0.082***	0.082***
					(0.023)	(0.023)
N	40,258	40,170	40,258	40,170	40,258	40,170
Controls		Y		Y		Y
Year FE		Y		Y		Y
Specification	OLS	OLS	OLS	OLS	IV	IV

Spillover effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Outcome: Spouse screening		Outcome: Own screening			
Eligible			0.210***	0.210***	0.208***	0.209***
			(0.008)	(0.007)	(0.005)	(0.005)
Spouse eligible	0.210***	0.211***	0.018***	0.017***		
	(0.005)	(0.005)	(0.006)	(0.006)		
Eligible × Spouse eligible			–0.001	0.001		
			(0.012)	(0.011)		
Spouse screening					0.082***	0.082***
					(0.023)	(0.023)
N	40,258	40,170	40,258	40,170	40,258	40,170
Controls		Y		Y		Y
Year FE		Y		Y		Y
Specification	OLS	OLS	OLS	OLS	IV	IV

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Conclusion

- Free screening eligibility based on odd-even year of birth as IV
- Effect on health care usage
  - Outpatient care
  - Inpatient care
  - Emergency care
- Effect on health behaviors
  - Smoking
  - Drinking
  - Exercise
- Complier analysis
  - Education
  - Income
- Spillover effect

References

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly harmless econometrics*. Princeton university press.

Division, H. P. (2021). *National Health Screening Policy 2021*. Ministry of Health and Welfare.

Kling, J. R., Liebman, J. B., and Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica*, 75(1):83–119.

Mattke, S., Schnyer, C., and Van Busum, K. R. (2013). A review of the us workplace wellness market. *Rand health quarterly*, 2(4).

Literature review

1. Demand for screening and peer effect in screening takeup
   - Thornton (2005), Oster et al. (2013), Kim et al. (2018)
2. Behavioral response to screening
   - Clinical studies and RCT

     Deutekom et al. (2011), Wood et al. (1994), Group (1995), Larsen et al. (2007), Strychar et al. (1998), Jones et al. (2019)
   - Behavioral response to diagnosis of certain diseases

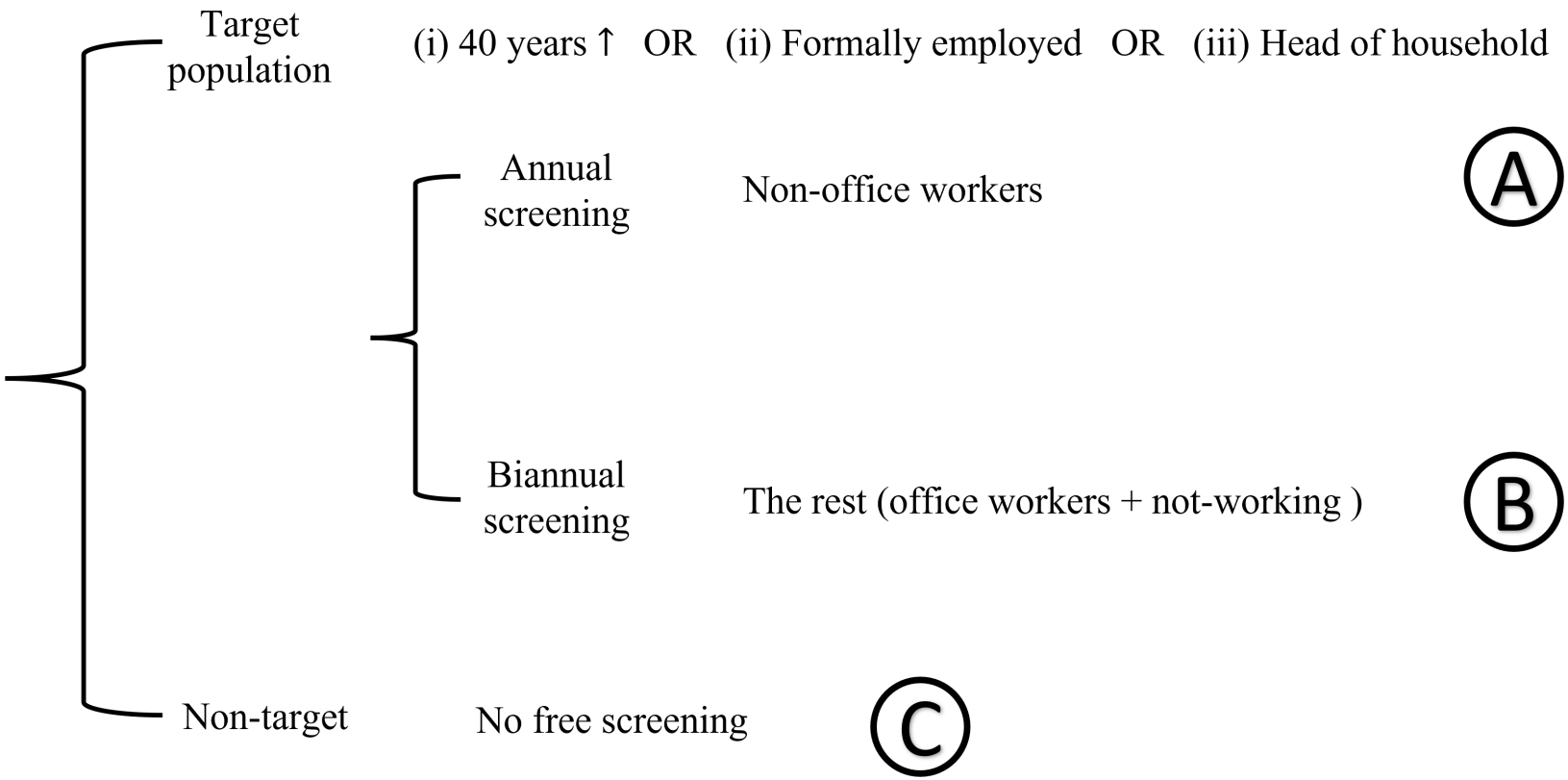
     Thornton (2005), Oster (2015), Oster (2012), Slade (2012)
   - Cutoff in health indicators

     Kim et al. (2019), Iizuka et al. (2021)
3. Risky health behaviors
   - Grossman (1972), Kenkel (1991), Cutler and Lleras-Muney (2010), Ruhm (2000), Cutler and Glaeser (2005)

back

Analytical sample

Composition of total population

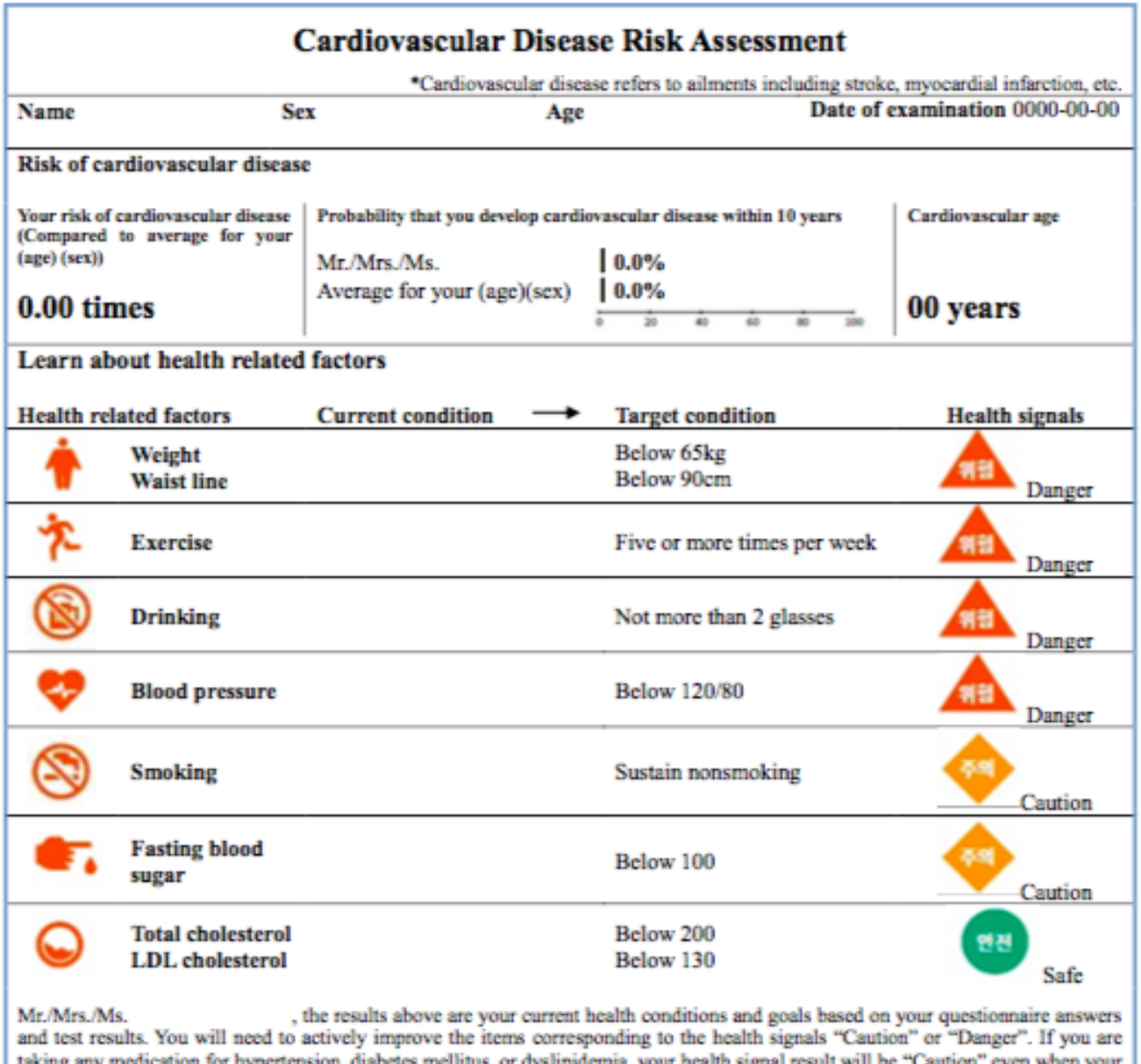


- Analytical sample is group (B)
- Demographic and job characteristic (52 group) variables are used
- Robustness check: sample adjustment using (A) + (B)

back

Screening result form

back



Cardiovascular Disease Risk Assessment

*Cardiovascular disease refers to ailments including stroke, myocardial infarction, etc.

Name **Sex** **Age** **Date of examination** 0000-00-00

Risk of cardiovascular disease

Your risk of cardiovascular disease (Compared to average for your (age) (sex))	Probability that you develop cardiovascular disease within 10 years	Cardiovascular age
0.00 times	Mr./Mrs./Ms. **0.0%** Average for your (age)(sex) **0.0%** 0 20 40 60 80 100	**00 years**

Learn about health related factors

Health related factors	Current condition →	Target condition	Health signals
Weight **Waist line**		Below 65kg Below 90cm	위험 Danger
Exercise		Five or more times per week	위험 Danger
Drinking		Not more than 2 glasses	위험 Danger
Blood pressure		Below 120/80	위험 Danger
Smoking		Sustain nonsmoking	주의 Caution
Fasting blood sugar		Below 100	주의 Caution
Total cholesterol **LDL cholesterol**		Below 200 Below 130	안전 Safe

Mr./Mrs./Ms. , the results above are your current health conditions and goals based on your questionnaire answers and test results. You will need to actively improve the items corresponding to the health signals "Caution" or "Danger". If you are taking any medication for hypertension, diabetes mellitus, or dyslipidemia, your health signal result will be "Caution" even when your

Cancer screening

Table: Cancer screening

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	General	Stomach cancer	Liver cancer	Lung cancer	Colorectal cancer	Prostate cancer	Breast cancer	Cervical cancer
NHIS subsidy	100%	90%	90%	0%	90%	0%	90%	90%
Frequency	2 years	2 years	1 year		1 year		2 years	2 years
Eligible population	Target population	40 or older	40 or older AND high-risk group		50 or older		Women 40 or older	Women 30 or older

back

Data collection - health care usage

- Unit of observations: **every visit to a hospital**
- Information
  - Date
  - Hospital bills, drug expenditures
  - Type of hospitals visited
  - First visit
  - Health screening records
- Recording health care usage
  - Survey participants keep health diary and store receipts from every visit to hospitals and pharmacies Health diary
- No gap
  - During the interview, enumerator goes through health diary from the last time of interview

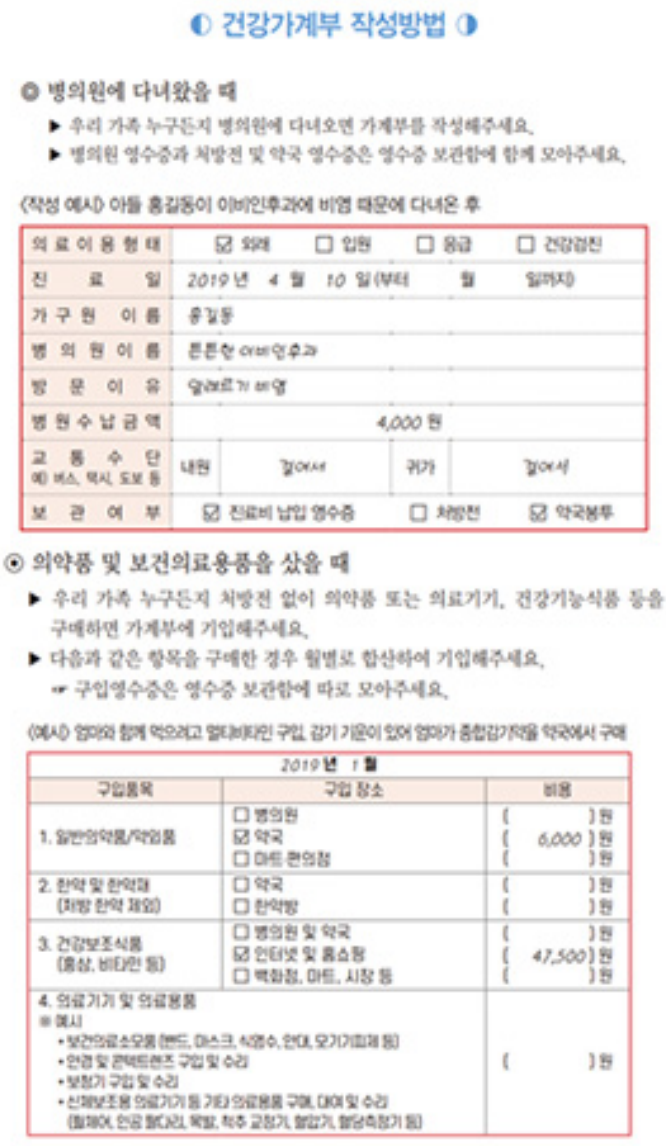
back

Data collection - health behaviors

- Unit of observation: yearly (stock)
  - Smoking and drinking (exercising) behaviors in the past 1 month (week) of survey date
- Current engagement $\Rightarrow$ Frequency $\Rightarrow$ Amount
  - Threshold crossing model based on frequency
  - Frequency: Once a month/Once a week/Everyday
  - Amount: How much do you smoke/drink/exercise on the day you smoke/drink/exercise?

back

Health diary



◐ 건강가계부 작성방법 ◑

◎ 병의원에 다녀왔을 때

▶ 우리 가족 누구든지 병의원에 다녀오면 가계부를 작성해주세요.

▶ 병의원 영수증과 처방전 및 약국 영수증은 영수증 보관함에 함께 모아주세요.

〈작성 예시〉 아들 홍길동이 아비인후과에 비염 때문에 다녀온 후

의료이용형태	☑ 외래	☐ 입원	☐ 응급	☐ 건강검진
진료일	2019년 4월 10일(부터	월	일까지)	
가구원 이름	홍길동			
병의원 이름	튼튼한 아비인후과			
방문이유	알레르기 비염			
병원수납금액	4,000원			
교통수단 예) 버스, 택시, 도보 등	내원	걸어서	귀가	걸어서
보관여부	☑ 진료비 납입 영수증	☐ 처방전	☑ 약국봉투	

◎ 의약품 및 보건의료용품을 샀을 때

▶ 우리 가족 누구든지 처방전 없이 의약품 또는 의료기기, 건강기능식품 등을 구매하면 가계부에 기입해주세요.

▶ 다음과 같은 항목을 구매한 경우 월별로 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	비용
1. 일반의약품/약외품	☐ 병의원 ☑ 약국 ☐ 마트 편의점	( )원 (6,000)원 ( )원
2. 한약 및 한약재 (처방 한약 제외)	☐ 약국 ☐ 한약방	( )원 ( )원
3. 건강보조식품 (홍삼, 비타민 등)	☐ 병의원 및 약국 ☑ 인터넷 및 홈쇼핑 ☐ 백화점, 마트, 시장 등	( )원 (47,500)원 ( )원
4. 의료기기 및 의료용품 ※ 예시 • 보건의료소모품 (밴드, 마스크, 식염수, 안대, 모기기피제 등) • 안경 및 콘택트렌즈 구입 및 수리 • 보청기 구입 및 수리 • 신체보조용 의료기기 등 기타 의료용품 구매, 대여 및 수리 (휠체어, 안경 렌즈리, 목발, 척추 교정기, 혈압기, 혈당측정기 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	□Outpatient □Inpatient □ Emergency □ 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	□ Hospital □ Prescription □ 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	□ Hospital □ Pharmacy □ CVS	{ } KRW { } KRW { } KRW
Oriental medicine	□ Pharmacy □ Acupuncture clinic	{ } KRW { } KRW
Dietary supplement (ginseng, vitamin, etc)	□ Hospital or pharmacy □ Internet shopping □ Department store	{ } KRW { } KRW { } KRW
Any other medical products (e.g.) - Bandage, mask, insect repellent - Glasses, contact lenses - Hearing aid		{ } KRW

back

Outpatient care with controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	19.021	18.869	0.027	0.151	1	0.517	1.000	73372
General hospital	2.473	2.516	0.055	0.304	12	0.148	0.400	73372
Local hospital	1.448	1.461	0.021	0.117	8	0.145	1.000	73372
Local clinic	15.100	14.891	-0.049	-0.269	-2	0.469	1.000	73372
Hospital bill								
Total	340847	336962	-3335	-18372	-5	25276	1.000	73372
General hospital	83558	85175	1732	9540	11	9004	1.000	73372
Local hospital	40985	40606	-685	-3775	-9	9135	1.000	73372
Local clinic	215702	210526	-4428	-24393	-11	21881	1.000	73372
Drug expenditures								
Total	113003	112472	526	2895	3	3451	1.000	73372
General hospital	41091	41341	807	4445	11	2679	0.600	73372
Local hospital	8168	8093	-38.984	-215	-3	918	1.000	73372
Local clinic	61677	60975	-263	-1448	-2	2189	1.000	73372

Significant at 10%
Significant at 5%
Significant at 1%

back

Outpatient care with FE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	19.021	18.869	0.104	0.563	3	0.479	0.600	70913
General hospital	2.473	2.516	0.055	0.295	12	0.149	0.400	70913
Local hospital	1.448	1.461	0.056	0.302	21	0.141	0.400	70913
Local clinic	15.100	14.891	-0.006	-0.034	-0	0.434	1.000	70913
Hospital bill								
Total	340847	336962	-1278	-6906	-2	25193	1.000	70913
General hospital	83558	85175	1457	7874	9	8992	1.000	70913
Local hospital	40985	40606	333	1801	4	8838	1.000	70913
Local clinic	215702	210526	-3092	-16711	-8	22014	1.000	70913
Drug expenditures								
Total	113003	112472	808	4367	4	2851	0.600	70913
General hospital	41091	41341	795	4295	10	2335	0.400	70913
Local hospital	8168	8093	118	637	8	837	1.000	70913
Local clinic	61677	60975	-104	-559	-1	1681	1.000	70913

Significant at 10%
Significant at 5%
Significant at 1%

back

Outpatient care for first visit with controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
First hospital visit for a new illness								
Total	3.696	3.758	0.074	0.408	11	0.103	0.000	73372
General hospital	0.353	0.371	0.019	0.105	30	0.031	0.000	73372
Local hospital	0.286	0.293	0.009	0.047	16	0.026	0.600	73372
Local clinic	2.847	2.884	0.042	0.234	8	0.089	0.200	73372
First hospital bill for a new illness								
Total	89527	93896	4273	23544	26	10717	0.400	73372
General hospital	20347	21728	1309	7214	35	3678	0.600	73372
Local hospital	13010	13988	969	5339	41	4130	0.600	73372
Local clinic	55986	57996	1989	10958	20	9204	1.000	73372
First drug expenditures for a new illness								
Total	10982	11351	398	2192	20	651	0.000	73372
General hospital	1924	2011	100	552	29	407	0.600	73372
Local hospital	1000	1035	43.102	237	24	186	0.600	73372
Local clinic	7947	8193	253	1393	18	453	0.000	73372

Significant at 10%
Significant at 5%
Significant at 1%

back

Outpatient care for first visit with FE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
First hospital visit for a new illness								
Total	3.696	3.758	0.068	0.365	10	0.099	0.000	70913
General hospital	0.353	0.371	0.022	0.117	33	0.031	0.000	70913
Local hospital	0.286	0.293	0.010	0.055	19	0.025	0.400	70913
Local clinic	2.847	2.884	0.036	0.194	7	0.086	0.400	70913
First hospital bill for a new illness								
Total	89527	93896	4405	23806	27	10544	0.400	70913
General hospital	20347	21728	1312	7092	35	3735	0.400	70913
Local hospital	13010	13988	995	5375	41	3857	0.600	70913
Local clinic	55986	57996	2086	11274	20	9144	0.600	70913
First drug expenditures for a new illness								
Total	10982	11351	376	2034	19	631	0.200	70913
General hospital	1924	2011	106	572	30	388	0.600	70913
Local hospital	1000	1035	42.803	231	23	186	0.600	70913
Local clinic	7947	8193	225	1217	15	444	0.200	70913

Significant at 10%
Significant at 5%
Significant at 1%

back

Inpatient care with controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.236	0.237	0.003	0.016	7	0.027	1.000	73372
General hospital	0.125	0.123	-0.001	-0.007	-5	0.020	1.000	73372
Local hospital	0.076	0.080	0.005	0.026	34	0.013	0.400	73372
Local clinic	0.036	0.035	-0.001	-0.003	-8	0.009	1.000	73372
Hospital bill								
Total	209413	208121	1486	8184	4	40563	1.000	73372
General hospital	128569	126258	198	1092	1	33319	1.000	73372
Local hospital	66662	68826	2418	13323	20	21827	1.000	73372
Local clinic	14113	13021	-1067	-5876	-42	6148	1.000	73372
Drug expenditures								
Total	85.934	90.767	3.868	21.310	25	92.246	1.000	73372
General hospital	43.834	58.667	15.631	86.114	196	81.963	1.000	73372
Local hospital	17.758	14.806	-3.704	-20.406	-115	33.142	1.000	73372
Local clinic	24.343	17.294	-8.059	-44.398	-182	26.186	0.600	73372

Significant at 10%
Significant at 5%
Significant at 1%

back

Inpatient care with FE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value[a]	Obs
Number of hospital visits								
Total	0.236	0.237	0.007	0.040	17	0.027	0.800	70913
General hospital	0.125	0.123	0.001	0.005	4	0.020	1.000	70913
Local hospital	0.076	0.080	0.007	0.036	47	0.013	0.000	70913
Local clinic	0.036	0.035	-0.000	-0.001	-3	0.009	1.000	70913
Hospital bill								
Total	209413	208121	3744	20235	10	39703	1.000	70913
General hospital	128569	126258	1029	5561	4	32339	1.000	70913
Local hospital	66662	68826	3585	19372	29	21915	1.000	70913
Local clinic	14113	13021	-796	-4302	-30	6159	1.000	70913
Drug expenditures								
Total	85.934	90.767	10.171	54.963	64	92.973	1.000	70913
General hospital	43.834	58.667	17.191	92.903	212	83.552	1.000	70913
Local hospital	17.758	14.806	-2.155	-11.646	-66	32.209	1.000	70913
Local clinic	24.343	17.294	-4.866	-26.294	-108	24.829	1.000	70913

Significant at 10%
Significant at 5%
Significant at 1%

back

Emergency care with controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.127	0.121	-0.006	-0.031	-24	0.018	0.400	73372
General hospital	0.094	0.088	-0.006	-0.034	-36	0.015	0.200	73372
Local hospital	0.032	0.032	0.000	0.001	4	0.011	1.000	73372
Local clinic	0.001	0.001	0.000	0.001	134	0.002	1.000	73372
Hospital bill								
Total	7444	7372	0.238	1.311	0	2406	1.000	73372
General hospital	6589	6559	38.548	212	3	2349	1.000	73372
Local hospital	814	791	-22.228	-122	-15	478	1.000	73372
Local clinic	40.059	21.429	-16.081	-88.598	-221	108	1.000	73372
Drug expenditures								
Total	50.376	54.718	6.752	37.201	74	54.211	1.000	73372
General hospital	26.558	31.530	6.852	37.752	142	49.829	1.000	73372
Local hospital	23.776	22.940	-0.342	-1.886	-8	21.244	1.000	73372
Local clinic	0.041	0.248	0.242	1.335	3250	1.374	1.000	73372

Significant at 10%
Significant at 5%
Significant at 1%

back

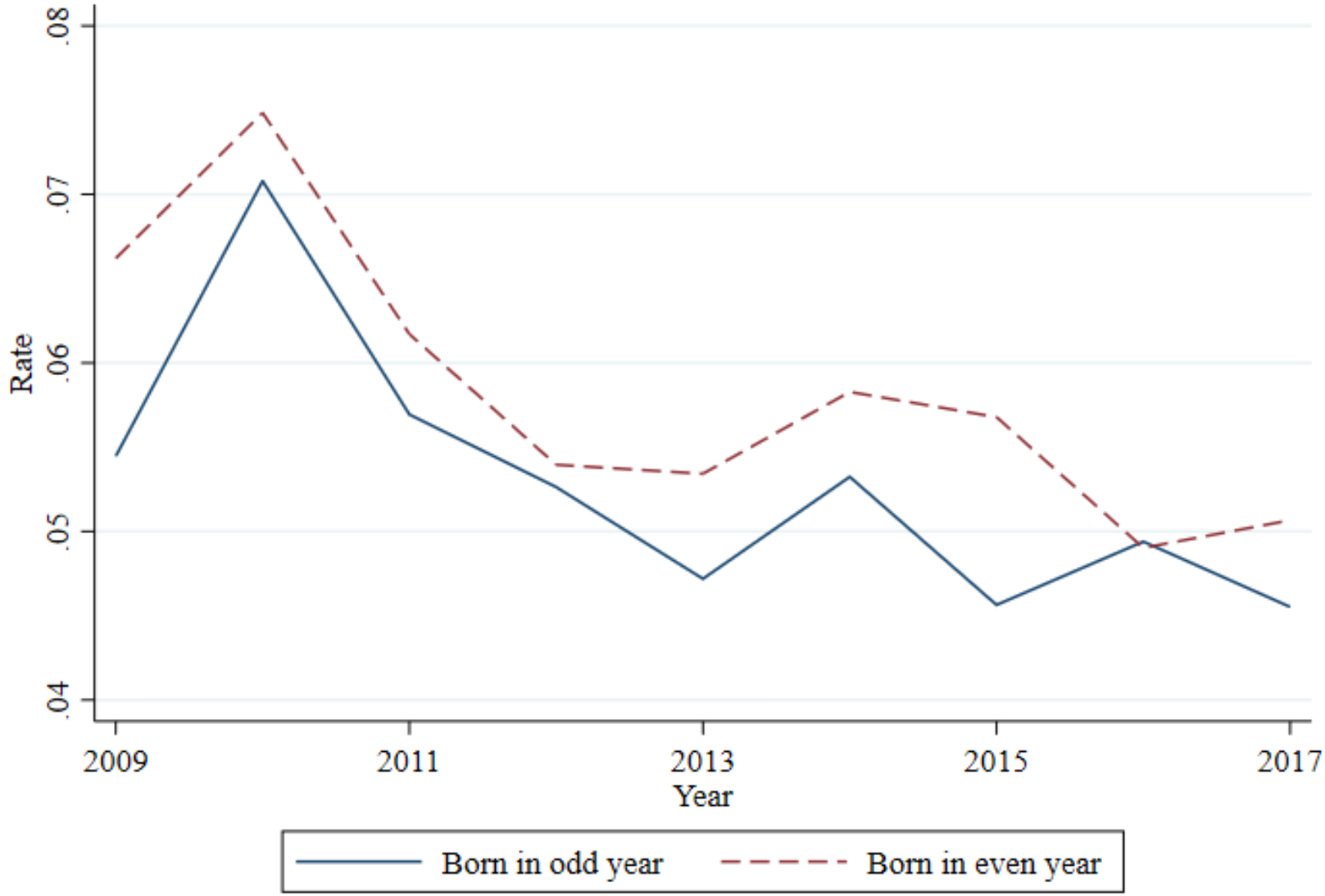
Emergency care with FE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Control group	Treatment group	ITT	LATE	Percentage change	Standard error	Adjusted p-value	Obs
Number of hospital visits								
Total	0.127	0.121	-0.005	-0.026	-20	0.018	0.600	70913
General hospital	0.094	0.088	-0.006	-0.034	-37	0.015	0.200	70913
Local hospital	0.032	0.032	0.001	0.007	21	0.010	1.000	70913
Local clinic	0.001	0.001	0.000	0.002	156	0.002	1.000	70913
Hospital bill								
Total	7444	7372	-31.493	-170	-2	2442	1.000	70913
General hospital	6589	6559	-33.152	-179	-3	2393	1.000	70913
Local hospital	814	791	10.764	58.167	7	442	1.000	70913
Local clinic	40.059	21.429	-9.104	-49.200	-123	105	1.000	70913
Drug expenditures								
Total	50.376	54.718	10.194	55.088	109	63.375	1.000	70913
General hospital	26.558	31.530	9.457	51.104	192	59.669	1.000	70913
Local hospital	23.776	22.940	0.478	2.584	11	21.244	1.000	70913
Local clinic	0.041	0.248	0.259	1.401	3409	1.451	1.000	70913

Significant at 10%
Significant at 5%
Significant at 1%

back

Reduced form - everyday drinker



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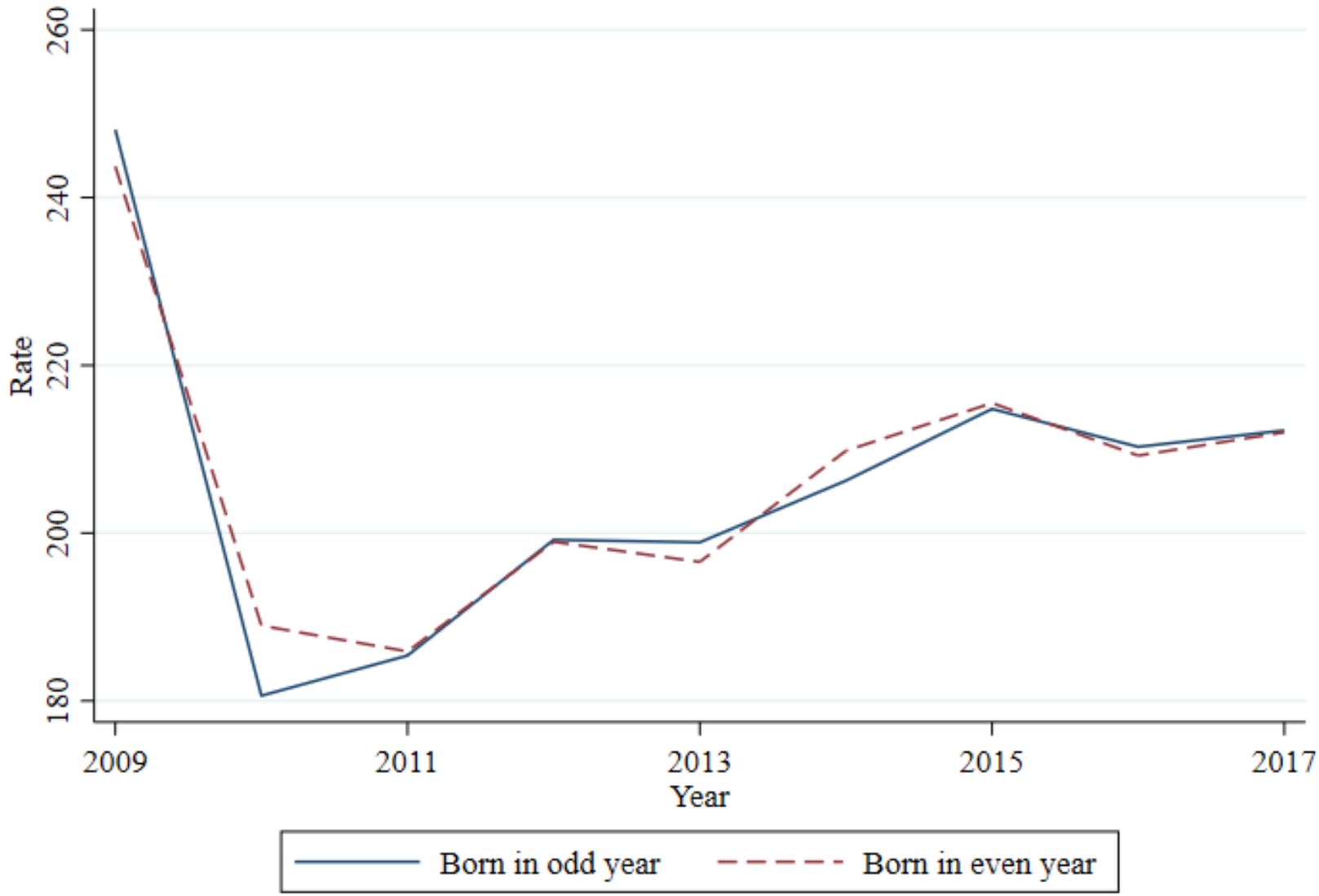
Reduced form - days of walking



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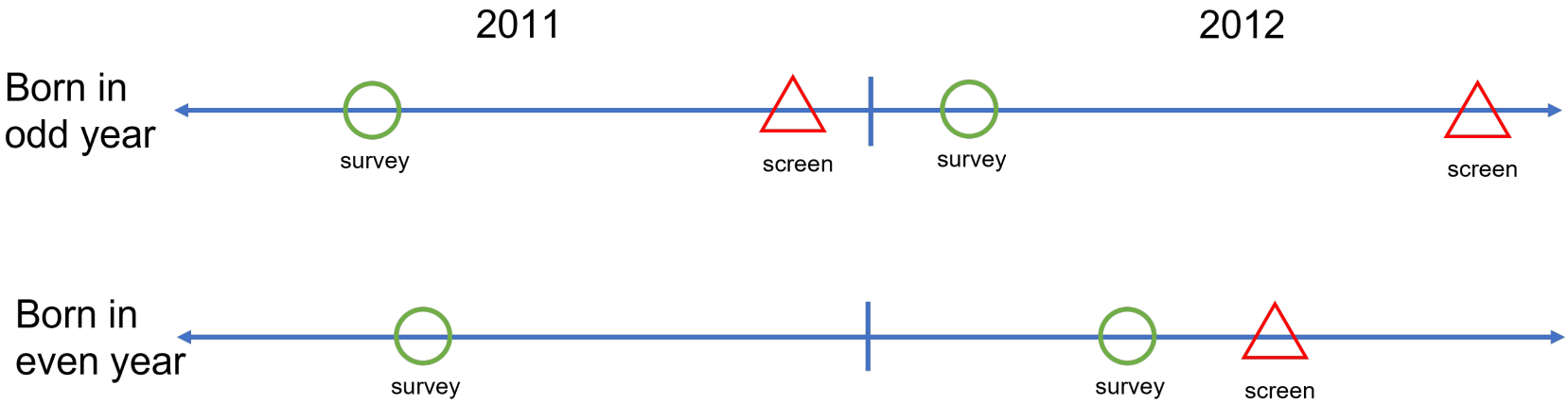
Causal interpretation

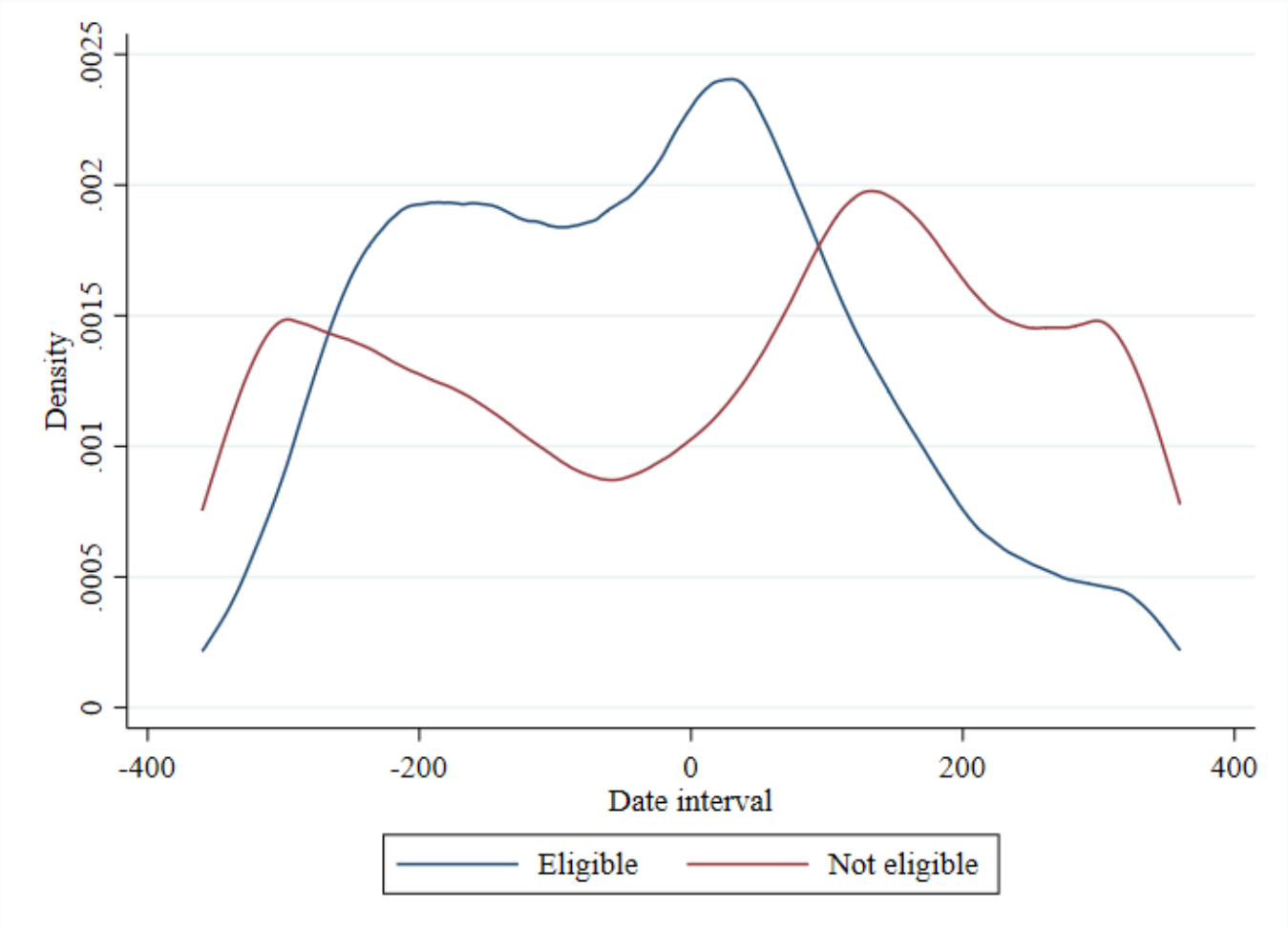
- Health behavior in one point in time



- Assumptions
  1. There are both anticipatory and ex-post effect of screening
  2. The closer the survey and screening dates, the stronger the effect
  3. The effect persists at most up to one year

- Date interval = survey date - screening date
  - Date interval < 0: anticipatory effect
  - Date interval > 0: ex-post effect

Date interval



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