콜로키움자료집 19-S39

제24차 NYPI 직원역량강화 콜로키움

정책평가를 위한 이중차분법의 활용: 이중차분법의 이해와 한국아동·청소년패널 데이터 이용 사례

일 시 2019. 12. 02.(월) 15:00~16:30

장 소 한국청소년정책연구원 7층 대회의실

주 최 한국청소년정책연구원

한국청소년정책연구원
National Youth Policy Institute

NYPI

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PROGRAM

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▣ **장 소** : 한국청소년정책연구원 7층 대회의실

▣ **제 목** : 정책평가를 위한 이중차분법의 활용:
이중차분법의 이해와 한국아동·청소년패널 데이터 이용 사례

▣ **발표자** : 고강혁 (고려대학교 경제학과 교수)

시 간	일 정
15:00~15:10	등록 및 오프닝
15:10~16:20	• **정책평가를 위한 이중차분법의 활용: 이중차분법의 이해와 한국아동·청소년패널 데이터 이용 사례** 고강혁 (고려대학교 경제학과 교수)
16:20~16:30	질의응답 및 마무리

주제발표

정책평가를 위한 이중차분법의 활용: 이중차분법의 이해와 한국아동·청소년패널 데이터 이용 사례

고강혁

(고려대학교 경제학과 교수)

Difference-in-Differences for Program Evaluation Application to Korean Children and Youth Panel Survey

Kanghyock Koh
Korea University

December 2, 2019
National Youth Policy Institute

1. Difference-in-Differences Basics

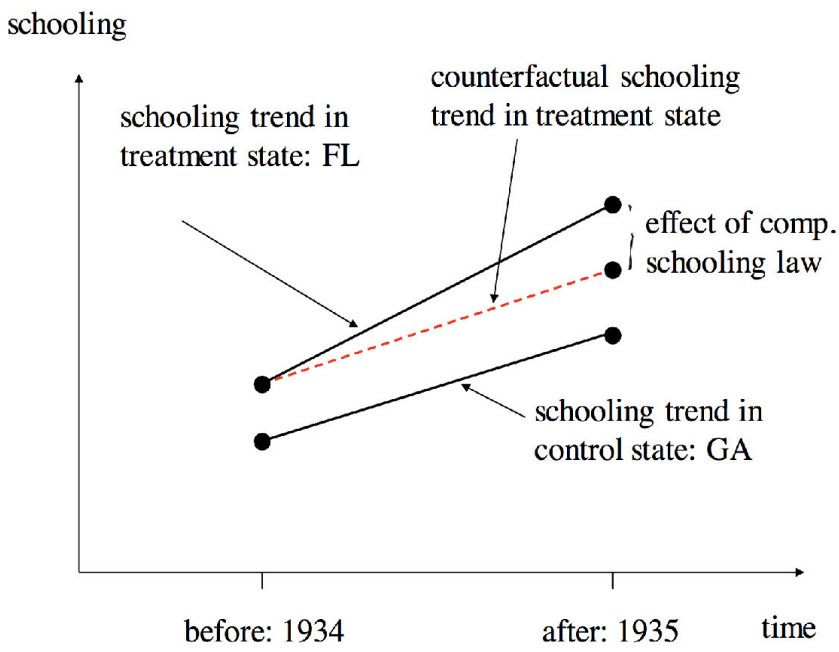
Difference-in-Differences (DID)

- DID model: using variations in treatment status within a "group level" over time
  - e.g. province-level policy in Korea
  - Ggroup fixed effects instead of individual fixed effects
  - FE model: using variations in treatment status within an "individual level" over time
  - Less restriction on data - repeated cross-section sample (from the same group) are sufficient
  - If individual-level panel data is available, even better (individual FE)

Example: Compulsory Schooling Laws in the U.S.

- These laws are set at the state level, and different states change the compulsory schooling laws at different times.
- Florida (FL) raised its compulsory schooling requirement from 5 to 7 grades in 1935.
- Georgia (GA) required 6 grades both before and after 1935.
- We can think of FL as the treatment state and GA as the control state. 1934 is a control period and 1935 is the treatment period.

Research Design



Research Design

- What if we just observe schooling of FL and GA in 1935?
  - FL and GA could be different
  - The difference in schooling could be already there in 1934
  - Cannot disentangle policy effects from state fixed effects
  - Want to see the difference in the schooling between FL and GA in 1934
  - Include group-fixed effects to control for both observable and unobservable differences between FL and GA
- What if we just observe schooling trend of FL?
  - There could be nation-wide changes in schooling
  - The schooling will increase anyway regardless of the policy
  - Cannot disentangle policy effects from year fixed effects
  - Want to see schooling trend of GA as well
  - Include time-fixed effects to capture common changes in schooling for bothe FL and GA

Key Identification Assumption

- Since treatment is at a more aggregated level, it is more likely to be exogenous to individual choices.
- The only thing that is varying differently over time between groups is the treatment.
- In the absence of treatment, the average change in the outcome variable would have been the same for both the treatment and control groups
- **"Parallel (or common) trends"** assumption: the trend in the outcome variable for both treatment and control groups are similar

Key Identification Assumption

- Strictly speaking, it's untestable.
- But, we can inspect trends of dependent variables during the pre-period
  - By definition, this requires more than two periods of data (the more is the better)
- How to inspect?
  - Show Me the Graph - best vs worst

Example - Training Program Evaluation

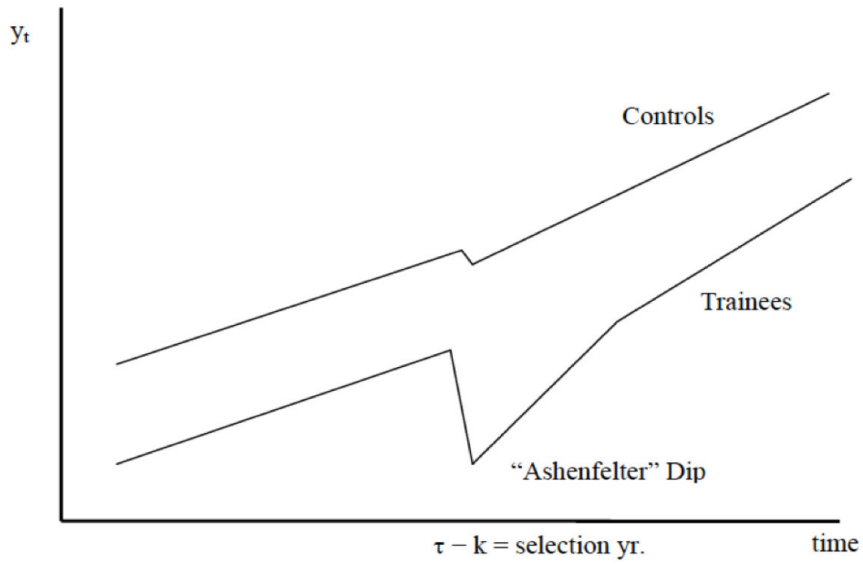
- Ashenfelter and Card (1985, REStat)
- Question: The effects of Comprehensive Employment and Training Act of 1976 (government funded training program) on earnings
- Could non-experimental method provide results as credible as experimental method?
- Issue: selection into training program is nonrandom - Ashenfelter Dip

Ashenfelter Dip

TABLE 1.—DEMOGRAPHIC CHARACTERISTICS AND EARNINGS HISTORIES OF TRAINEE AND CONTROL GROUPS: ADULT MALES

	Trainees[a]	Trainees Finished in 1976[b]	Controls[c]
1. Average Age (years)	30.9	30.9	31.1
2. Education (years)	11.5	11.5	12.5
3. Percentage Married	50.1	50.5	75.0
4. Percentage White (Non-Hispanic)	60.0	58.7	84.3
Earnings in 1967 Dollars[d]			
1970	2102 (2195) (.19/.07)	2099 (2168) (.18/.07)	3178 (2529) (.13/.20)
1971	2180 (2121) (.17/.09)	2153 (2101) (.17/.08)	3401 (2436) (.11/.24)
1972	2621 (2270) (.13/.07)	2590 (2258) (.13/.07)	4078 (2615) (.09/.24)
1973	2970 (2436) (.11/.05)	2958 (2410) (.12/.05)	4683 (2829) (.08/.21)
1974	2785 (2443) (.13/.03)	2746 (2430) (.13/.03)	4979 (3005) (.08/.15)
1975	1898 (2050) (.19/.01)	1832 (1990) (.19/.01)	4869 (2996) (.10/.16)
1976	1959 (1756) (.10/.01)	2032 (1756) (.07/.01)	5238 (3083) (.10/.18)
1977	2785 (2289) (.12/.01)	2794 (2389) (.13/.02)	5392 (3176) (.10/.20)
1978	3052 (2628) (.17/.03)	3014 (2636) (.17/.03)	5238 (3298) (.13/.25)
Sample Size:	3072	2161	5238

Ashenfelter Dip



Ashenfelter Dip

- Fixed diff in y_t before training, but trainees have absolute and relative decline in y_t right before program selection
- Those with negative shocks have most to gain → will participate
  - Don't observe selection rule
- Unstable DD estimates
  - Non-parallel pre trends →: can't control for differential selection with group fixed effects (the selection rule might change over time)
  - Serial correlation between y_t and y_{t-1}: mean reversion → upward bias (if the shock is persistent, then cause downward bias)
  - Different model provides different estimation results
- Without fix for poor research design, we cannot get credible estimates of the effects of training program ⇒ R.A. of training program!

Regression Specification

- In addition to plotting data, we also want to run a regression because
  1. Calculating precise number
  2. Testing for the coefficient of interest.
  3. Extend to $N(>2)$ states and $T(>2)$ years case
  4. Add covariates
- DID specification is just a tool to convey the research design!

Regression Specification

- The simplest regression specification of two states and two periods case is following:

$$Schooling_{i,s,t} = \beta_0 + \beta_1 \cdot Treat_s + \beta_2 \cdot Post_t + \beta_3 Treat_s \cdot Post_t + \epsilon_{i,s,t}$$

where i, s $(= FL\ and\ GA)$, and t $(= 1934,\ 1935)$ are individual, states, and calendar years; $Schooling_{i,s,t}$ is schooling years of i in state s at year t; $Treat_g$ is 1 if s is FL and 0 otherwise; $Post_t$ is 1 if t is 1935 and 0 otherwise.

- Can use state fixed effects and year fixed effects instead of $Treat_s$ and $Post_t$ (if N¿2 and T¿2)
- Testing pre-parallel trends:
  - Estimating differential trends of the outcome varibale during the pre-periods
  - Estimating yearly effects of treatment

Regression Specification

- The interpretations of coefficient values are following:

	Pre-Period (1934)	Post-Period (1935)	Time-Diff.
Control (GA)	β_0	$\beta_0 + \beta_2$	β_2
Treatment (FL)	$\beta_0 + \beta_1$	$\beta_0 + \beta_1 + \beta_2 + \beta_3$	$\beta_1 + \beta_3$
Group-Diff.	β_1	$\beta_1 + \beta_3$	*DID*: β_3

  - β_0: the average of the schooling years in GA in 1934
  - β_1: the difference in the schooling years between FL and GA in 1934
  - β_2: the difference in the schooling years between 1934 and 1935 in GA
  - β_3: the difference in the schooling years between 1934 and 1935 and GA and FL

Regression Specification

- DID is, again, a fixed-effect model
  - group fixed-effect
  - time fixed-effect
  - interaction term of group $\times$ time effect
- If panel data available, then even better. Instead of using group FE, use individual FE. However, main parameter of interest is still the interaction of group $\times$ time effect.

Regression Specification

- We also could run this regression at the state-year level (weighted by the number of obs. in the state-year cell).

$$Schooling_{s,t} = \beta_0 + \beta_1 \cdot Treat_s + \beta_2 \cdot Post_t + \beta_3 Treat_s \cdot Post_t + \epsilon_{s,t}$$

- We can also run DID specification after adding individual and state characteristics.

$$Schooling_{i,s,t} = \beta_0 + \beta_1 \cdot Treat_s + \beta_2 \cdot Post_t + \beta_3 Treat_s \cdot Post_t + X'_{i,s,t}\gamma + \epsilon_{i,s,t}$$

2. Application to Korean Children and Youth Panel Survey

Students' Time Use

The Korean Time Use Survey, 2009 & 2014

Year:		2009			2014	
Provinces:	Gyeonggi	Other	Diff	Gyeonggi	Other	Diff
	(1)	(2)	(3)	(4)	(5)	(6)
Sleep	453	457	-4	499	456	43***
School	360	372	-12	318	382	−64***
Hagwon or self-study	163	163	0	140	143	3
Exercise	9	9	0	6	10	−4***
Hangout	46	43	3	50	47	3
Eating or cleaning	167	165	2	181	169	12***
TV or Internet	52	57	-5	58	49	9*
Commute	83	75	8	69	71	2

Data

- Korean Children and Youth Panel Survey (KCYPS), 2010−2015
  - Survey nationally representative 4th grade students in 2010
  - Trace them over 6 years
- Dependent variables
  - Time use for exercise: "How many hours did you exercise during gym classes in the last week?"
  - Other time use *after* school
  - Health measures: self-reported health status, BMI, and happiness
- Control variables
  - Panel data ⇒ individual FE
  - Time-varying family background: family income, parents' work status, education level, health status, life satisfaction, the presence of sibling

Summary Statistics

	Gyeonggi province (1)	Other provinces (2)
A. Dependent variables		
Hours of exercise during gym class	2.90 (1.14)	3.02 (1.20)
Any exercise during gym class	0.91 (0.29)	0.91 (0.28)
Play with friends, weekdays (minutes)	65 (63)	56 (60)
Play with friends, weekends (minutes)	126 (107)	113 (105)
Attending private institutions (minutes)	125 (90)	119 (84)
Doing homework (minutes)	138 (86)	136 (87)
Gaming (minutes)	65 (61)	58 (56)
Watching TV (minutes)	90 (72)	89 (69)
Physical health status	1.68 (0.59)	1.69 (0.60)
BMI	19 (2.68)	19 (3.23)
Psychological health status	3.30 (0.72)	3.32 (0.74)

+ summary

Difference-in-Differences

Compare changes in dependent variables before and after the 9OAP between Gyeonggi province and other provinces

$$y_{i,p,t} = \beta_0 + \beta_1 Gyeonggi_p \cdot Post_t + \theta_t + \delta_p + \beta_2 X_{i,p,t} + \epsilon_{i,p,t}, \quad (1)$$

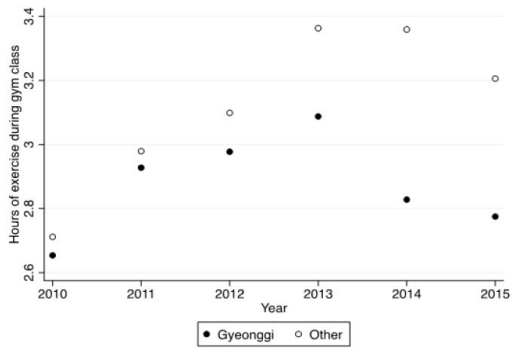
- i, p, t: individual, province, year
- $y_{i,p,t}$: time use for exercise, other time use after school, and health measures
- $Gyeonggi_p = 1$ if i resides in Gyeonggi province, and $=0$ otherwise
- $Post_t = 1$ if year$\geq$2014, and $= 0$ otherwise
- $X_{i,p,t}$: individual FE and other time-varying family background
- β_1: effects of the 9OAP on dependent variables

Synthetic Control Approach

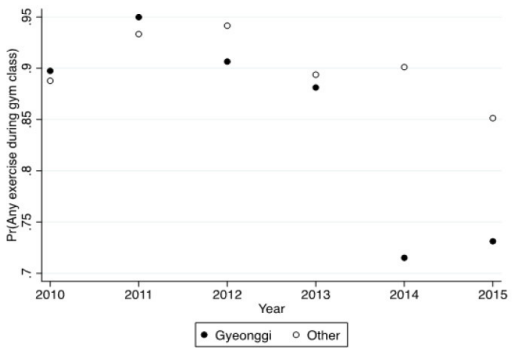
- Arbitrarily choose all other provinces as control group in DID
- Data-driven procedure to construct a synthetic Gyeonggi
  - Weighted average of $y_{i,p,t}$ among other provinces
  - Weights for provinces
    - Make trends of synthetic Gyeonggi and Gyeonggi similar during pre-periods
  - Aggregate individual level data into province-year cell
- Using weights to construct alternative control groups
  - Assumption: provinces with positive weights are much similar to Gyeonggi province than those with zero weight

Trends of Students' Exercise during Gym Class

A. Hours of exercise during gym class



B. Pr(Any exercise during gym class)



noattrition pretrend

Effects of the 9OAP on Students' Exercise

	(1)	(2)	(3)	(4)	(5)
A. Dep Var.: Hours of exercise during gym class					
Gyeonggi×Post	−0.36***	−0.42***	−0.42***	−0.25**	−0.41***
	(0.07)	(0.08)	(0.08)	(0.12)	(0.09)
Observations	13,070	12,278	12,278	12,278	10,547
R-squared	0.04	0.05	0.41	0.41	0.40
B. Dep Var.: Any exercise during gym class					
Gyeonggi×Post	−0.15***	−0.17***	−0.16***	−0.14***	−0.15***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Observations	13,070	12,278	12,278	12,278	10,547
R-squared	0.03	0.03	0.33	0.33	0.31
Controls		Y	Y	Y	Y
Individual FE			Y	Y	Y
Gyeonggi×Year				Y	
Sample surveyed 6 years					Y

hsest1

Province Weights in Synthetic Gyeonggi

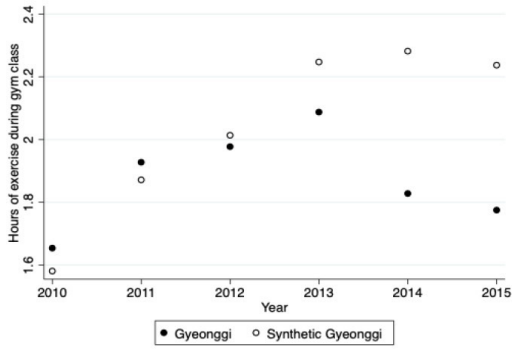
Dep. Var.:	Hours of exercise (1)	Any exercise (2)
Seoul	0	0
Busan	0	0
Daegu	0	0
Incheon	0.72	0.664
Gwangju	0	0
Daejeon	0	0
Ulsan	0.083	0
Gangwon	0.057	0
North Chungcheong	0	0.295
South Chungcheong	0	0
North Jeolla	0.14	0.041
South Jeolla	0	0
North Gyeongsang	0	0
South Gyeongsang	0	0
Jeju	0	0

aggregate map

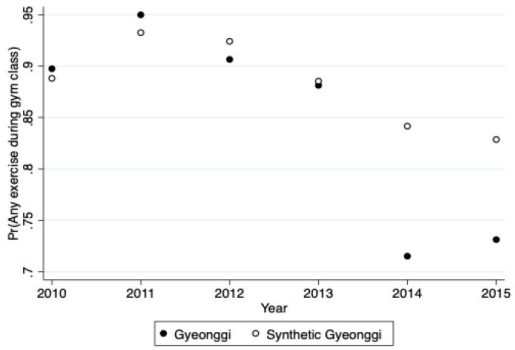
Trends of Students' Exercise during Gym Class

Gyeonggi vs. Synthetic Gyeonggi

A. Hours of exercise during gym class



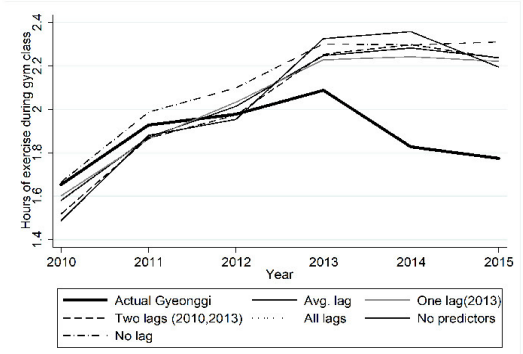
B. Pr(Any exercise during gym class)



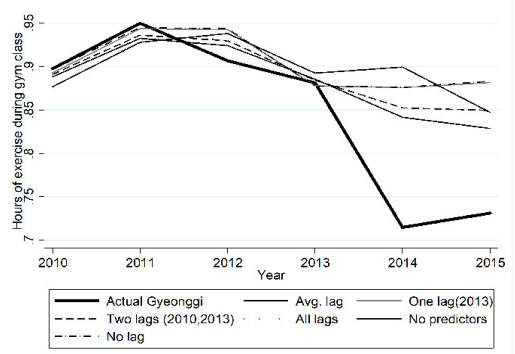
Trends of Students' Exercise during Gym Class

Gyeonggi vs. Synthetic Gyeonggi

A. Hours of exercise during gym class



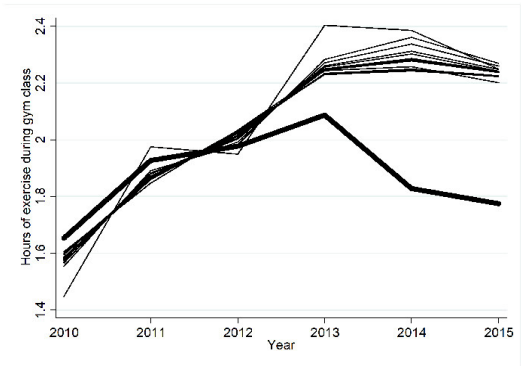
B. Pr(Any exercise during gym class)



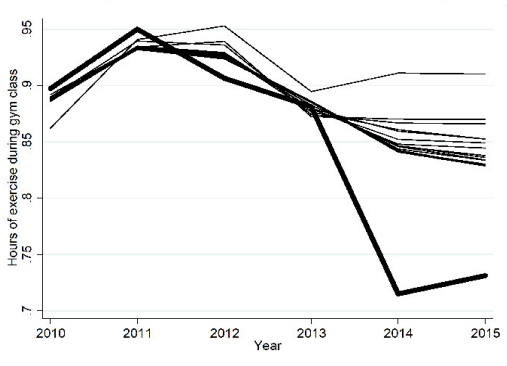
Trends of Students' Exercise during Gym Class

Gyeonggi vs. Synthetic Gyeonggi

A. Hours of exercise during gym class



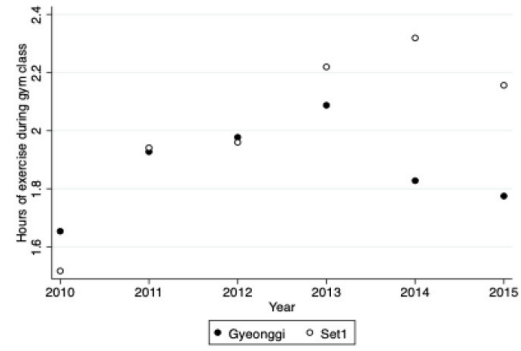
B. Pr(Any exercise during gym class)



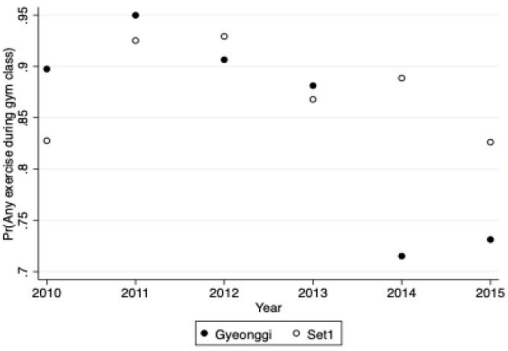
Trends of Students' Exercise during Gym Class

Alernative control group1: Incheon, Ulsan, Gangwon, and North Jeolla (set 1)

A. Hours of exercise during gym class



B. Pr(Any exercise during gym class)

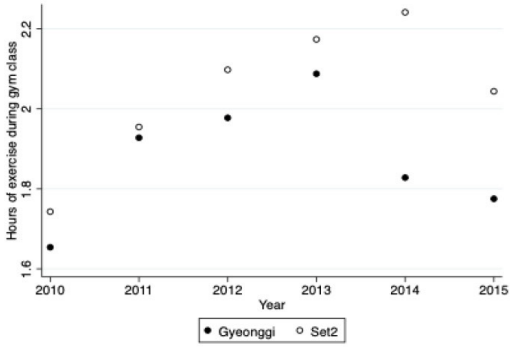


map

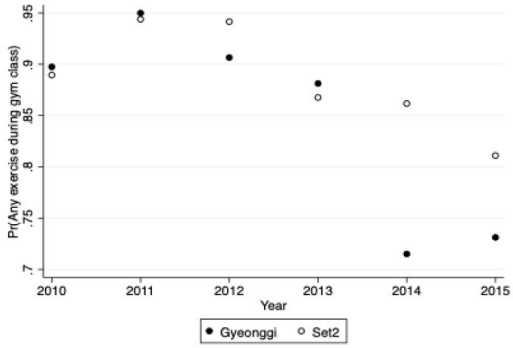
Trends of Students' Exercise during Gym Class

Alernative control group2: Incheon, North Chungcheong, and North Jeolla (set 2)

A. Hours of exercise during gym class



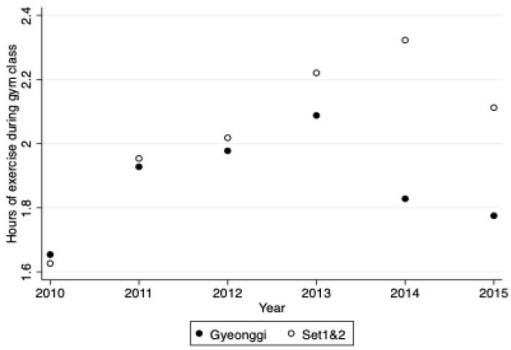
B. Pr(Any exercise during gym class)



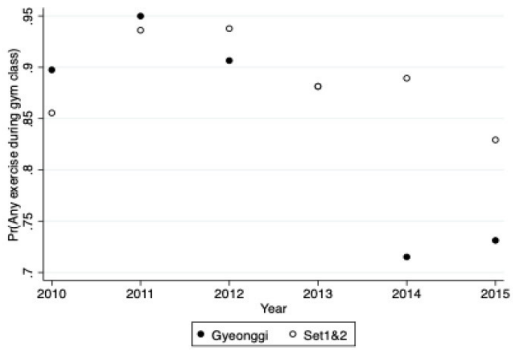
Trends of Students' Exercise during Gym Class

Alernative control group3: *set*1, 2

A. Hours of exercise during gym class



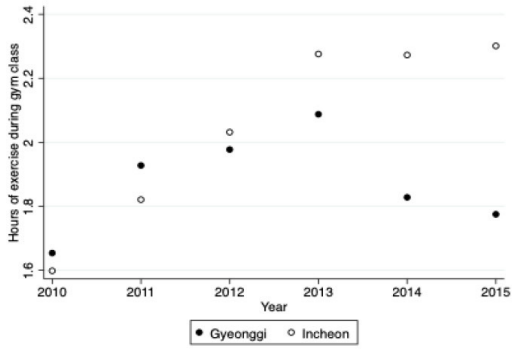
B. Pr(Any exercise during gym class)



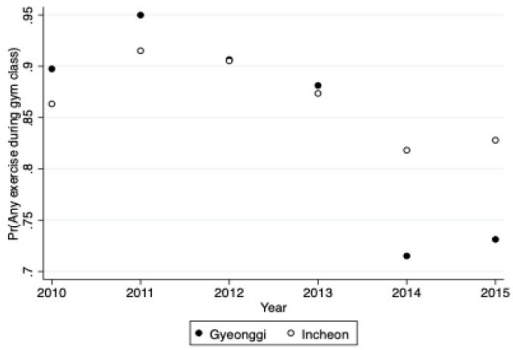
Trends of Students' Exercise during Gym Class

Alernative control group4: Incheon

A. Hours of exercise during gym class



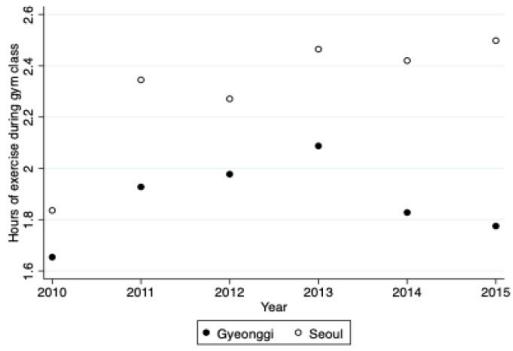
B. Pr(Any exercise during gym class)



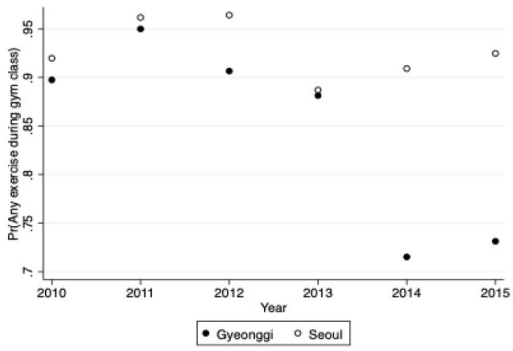
Trends of Students' Exercise during Gym Class

Alernative control group5: Seoul

A. Hours of exercise during gym class



B. Pr(Any exercise during gym class)



map

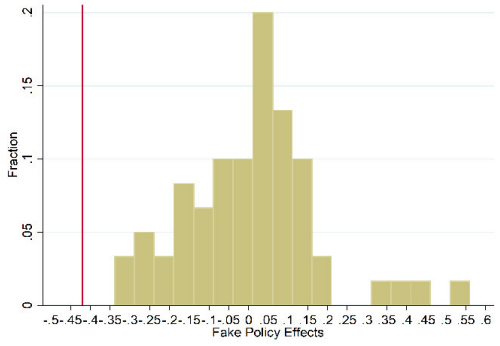
Effects of the 9OAP on Students' Exercise

Using Alternative Control Groups

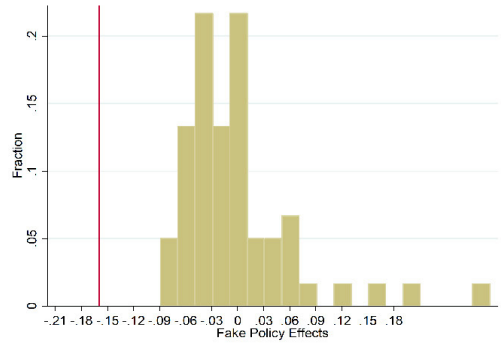
	(1)	(2)	(3)	(4)	(5)
A. Dep Var.: Hours of exercise during gym class					
Gyeonggi×Post	−0.50***	−0.31***	−0.43***	−0.54***	−0.45***
	(0.10)	(0.11)	(0.10)	(0.17)	(0.11)
Observations	4,221	3,862	4,985	2,365	3,210
R-squared	0.41	0.42	0.41	0.41	0.42
B. Dep Var.: Any exercise during gym class					
Gyeonggi×Post	−0.17***	−0.12***	−0.15***	−0.12***	−0.19***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Observations	4,221	3,862	4,985	2,365	3,210
R-squared	0.35	0.37	0.35	0.37	0.38
Control Groups:	Set 1	Set 2	Set 1, 2	Incheon	Seoul
Controls	Y	Y	Y	Y	Y
Individual FE	Y	Y	Y	Y	Y

Distribution of Effects of Fake 9OAP

A. Hours of exercise during gym class



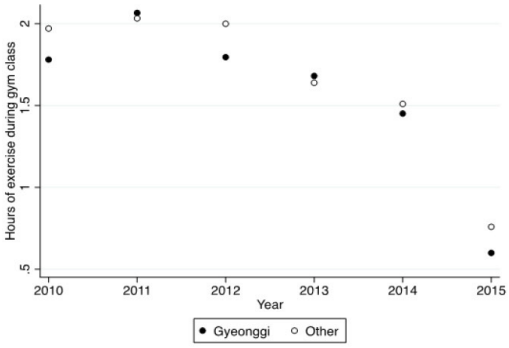
B. Pr(Any exercise during gym class)



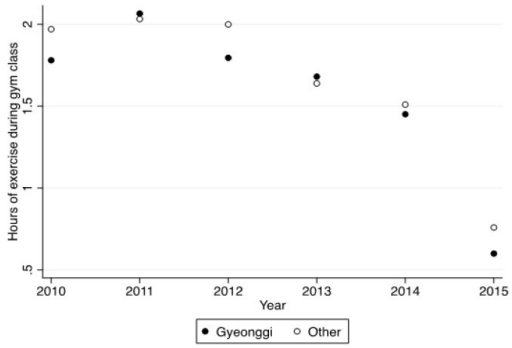
Trends of Students' Exercise during Gym Class

High school sample

A. Hours of exercise during gym class



B. Pr(Any exercise during gym class)



Effects of the 9OAP on High School Students' Exercise

Using the Baseline Control Group

	(1)	(2)	(3)	(4)	(5)
A. Dep Var.: Hours of exercise during gym class					
Gyeonggi×Post	-0.02	0.03	0.001	-0.12	0.07
	(0.04)	(0.04)	(0.05)	(0.08)	(0.05)
Observations	13,018	12,084	12,084	12,084	9,544
R-squared	0.13	0.12	0.48	0.48	0.47
B. Dep Var.: Any exercise during gym class					
Gyeonggi×Post	−0.03**	−0.02*	−0.04**	−0.07**	-0.00
	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)
Observations	13,018	12,084	12,084	12,084	9,544
R-squared	0.17	0.16	0.43	0.43	0.43
Controls		Y	Y	Y	Y
Individual FE			Y	Y	Y
Gyeonggi×Year				Y	
Sample surveyed 6 years					Y

hsest2

Effects of the 9OAP on Students' Play Time

Using the Baseline Control Group

	(1)	(2)	(3)	(4)	(5)
A. Dep Var.: Time play with friends, weekday (minutes)					
Gyeonggi×Post	1.66	0.50	0.62	0.40	-0.20
	(3.48)	(3.68)	(4.08)	(6.25)	(5.58)
Observations	12,989	12,207	12,207	12,207	9,578
R-squared	0.02	0.04	0.37	0.37	0.36
B. Dep Var.: Time play with friends, weekend (minutes)					
Gyeonggi×Post	0.91	0.15	1.38	-3.82	-0.23
	(6.58)	(7.16)	(8.09)	(11.94)	(11.11)
Observations	13,005	12,219	12,219	12,219	9,588
R-squared	0.03	0.04	0.40	0.40	0.40
Controls		Y	Y	Y	Y
Individual FE			Y	Y	Y
Gyeonggi×Year				Y	
Sample surveyed 6 years					Y

othertime1 othertime2 othertime3 friendrobust afterschool1 afterschool1robust afterschool2 afterschool2robust

Effects of the 9OAP on Students' Health

Using the Baseline Control Group

	(1)	(2)	(3)	(4)	(5)
A. Dep Var.: Self-reported Physical Health Status					
Gyeonggi×Post	0.02	0.04	0.08**	-0.02	0.18***
	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)
Observations	13,062	12,271	12,271	12,271	9,629
R-squared	0.01	0.01	0.47	0.47	0.45
B. Dep Var.: Self-reported Mental Health Status					
Gyeonggi×Post	0.01	0.02	0.04	0.18***	0.03
	(0.03)	(0.04)	(0.04)	(0.07)	(0.06)
Observations	13,070	12,278	12,278	12,278	9,633
R-squared	0.01	0.02	0.44	0.44	0.42
Controls		Y	Y	Y	Y
Individual FE			Y	Y	Y
Gyeonggi×Year				Y	
Sample surveyed 6 years					Y

health healthrobust bmi bmiest1 bmiest2

Concluding Remarks

- DSSTs could decrease the quantity of time use
  - 9OAP decreased students' time use for exercise
  - Under-explored behavioral response to the policy
- Provide new insights into the effects of DSSTs on students' well-being
  - DSSTs' health impacts might not be significant as much as expected by biology
- Limitation
  - Korean context: little bias due to students' self-selection
  - Would observe similar response in other countries that students can self-select classes, peers, and instructors?

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