

**Impacts of an Early Education Intervention on
Students' Learning Achievements in the Philippines
Application of Propensity Score Matching with
Panel Data**

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Objectives

- *Introduce impact evaluation concepts and method - counterfactual*
- *Example: Third Elem Educ Project (TEEP) from the Philippines*

The Archetypal Evaluation Problem (1)

- **Impact evaluation assesses outcomes for a specific program *relative to* the situation in the absence of the program**
- Let **P** denote program participation status of unit (household, student, school, etc) i . With **$P_i = 1$** if unit i receives program (treated) and **$P_i = 0$** if not.
- Let **S** be observable outcome , e.g, school performance. Two potential outcomes of each program participant i are
 - S_{1i} = outcome with the program
 - S_{0i} = outcome without the program

The Archetypal Evaluation Problem (2)

- The impact of the program for unit i is
$$\text{IMPACT} = E(S_{1i} | P_i=1) - E(S_{0i} | P_i=1)$$
- The first term is the **actual outcome** for participant
- The second term is what would have happened to participant without the program (a **counterfactual outcome**)
- The impact is the difference between the actual outcome and the counterfactual outcome

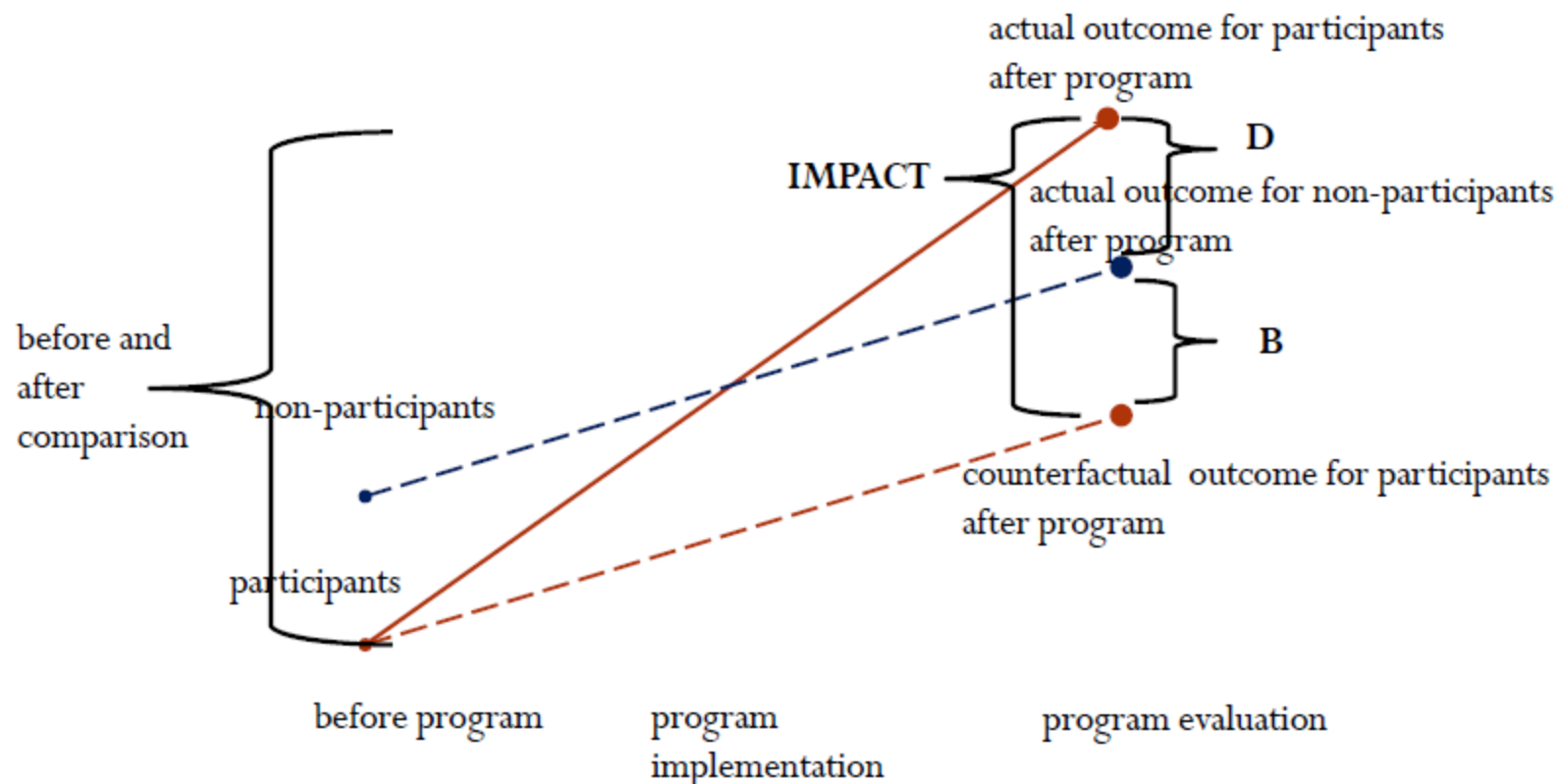
The Fundamental Issue and a Naïve Solution

- The fundamental issue in impact evaluation is that **the counterfactual outcome $E(S_{0i} | P_i=1)$ is not observable**
- One naïve solution is to use outcome of the non-participants: $E(S_{1i} | P_i=1) - \textit{\textbf{E}(S_{0i} | P_i=0)}$

Does the Naïve Solution Work?

- Whether the naïve solution works or not depends on whether $E(S1i | P_i=1) - E(S0i | P_i=0)$ can approximate IMPACT
- In other words, **Is the counterfactual outcome the same as the outcome of non-participants?**
- The difference between the counterfactual outcome and the outcome of non-participants is called ***Selection bias***: $Bias = E(S0i | P_i=1) - E(S0i | P_i=0)$

A Graphic Representation of the Counterfactual and the Impact



Is It Hard to Find the Counterfactual?

- Theoretically, yes. Because no one can be in two different conditions at the same time.
- But if the participants are randomly selected then it is NOT hard to find the counterfactual.
- ***Randomization***: the assignment of the program is independent of the characteristics of the recipients
- Such a design is called a ***social experiment***. ***The naïve solution works!***

When Randomization is Not Implemented

- Why not?
 - **Targeting**: Donors want to target the most needed, eg. TEEP targeted areas with poor school infrastructure.
 - **Agents decision**: Eligible units make their own participation decision.
 -
- ***We have to understand how the participants are selected into the project.***

Selection Problem

- ***Selection problem:*** Participants are different from nonparticipants in many ways

We cannot simply assume that the outcome of non-participants provides a good estimate for the counterfactual

- Two sources of selection:
 - (i) Selection on observables (to researcher)
 - (ii) Selection on unobservables (to researcher)
- We have to use econometric methods to take care of the counterfactual.

Econometric Methods to Deal with Selection on Observables

Idea: Develop a **comparison group** (a group of non-participants) that is similar to the treatment group in **observable characteristics**

Propensity Score Matching

- Propensity score: the probability of participating in the project conditional on observed characteristics: $\text{Prob}(P_i=1 | X_i)$
- Compare participants and non-participants that share the same $\text{Prob}(P_i=1 | X_i)$
 - Rosenbaum and Rubin (1983) show that, matching on propensity score is as good as matching on X_i .
 - Reducing a multiple dimension problem into a single dimension problem

How about Selection on Unobservables?

- More challenging task is to deal with selection on unobservables (participants and non-participants are different in unobservable characteristics)
- Two types of unobservables
 - Unobservables that are fixed over time
 - Unobservables that are changing over time
- Econometric methods
 - Double-difference (DD) method
 - Discontinuity design
 - Pipeline comparison
 - Instrumental variable (IV) method

Double-Difference (DD) Method

- DD requires **panel data**, which include
 - **baseline data** collected before the program started
 - **a follow-up survey** that collect data after the program was implemented
- **Before intervention**: $S_{i0} = a_0 + cX_{i0} + v_i + u_{i0}$
- **After intervention**: $S_{i1} = a_1 + bG_i + cX_{i1} + v_i + u_{i1}$
- **DD**: $dS_i = (a_1 - a_0) + bG_i + c dX_i + (u_{i1} - u_{i0})$
- Impact estimate: b
- Time-invariant or fixed unobservable term v_i disappears!

Combination of Two or More Methods: Eg. DD+PSM

- DD method assumes selection bias doesn't change over time.
- However, participants and non-participants have different trends.
- Solution: match the initial condition between the participants and non-participants before doing the DD
- More on DD+PSM later → We take this approach in TEEP IE study

Example: School Interventions

TEEP in the Philippines (1)

- *Historically large intervention to poor divisions in 2001-2006*
- *Integrated package of reforms and inputs to schools*
- *Both hard and soft components*
- *Not randomized: Targeted to poor divisions (the most depressed)*
- *Initially 3 batch plan, but implemented sequentially if division is ready (esp. batches 1 & 2 were mixed)*

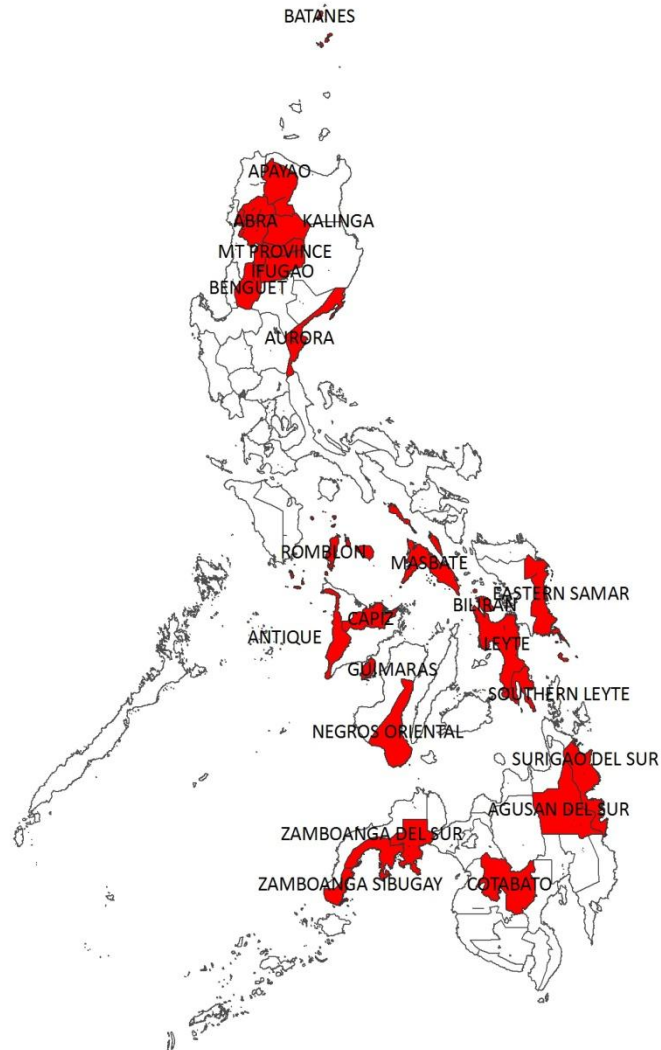
Example: School Interventions

TEEP in the Philippines (2)

Components:

- *School building construction & renovations*
- *Teacher training: instructional & subject-based*
- *Textbooks*
- *School-based management (parents, barangay, school: localized school governance)*
- *Equipment*

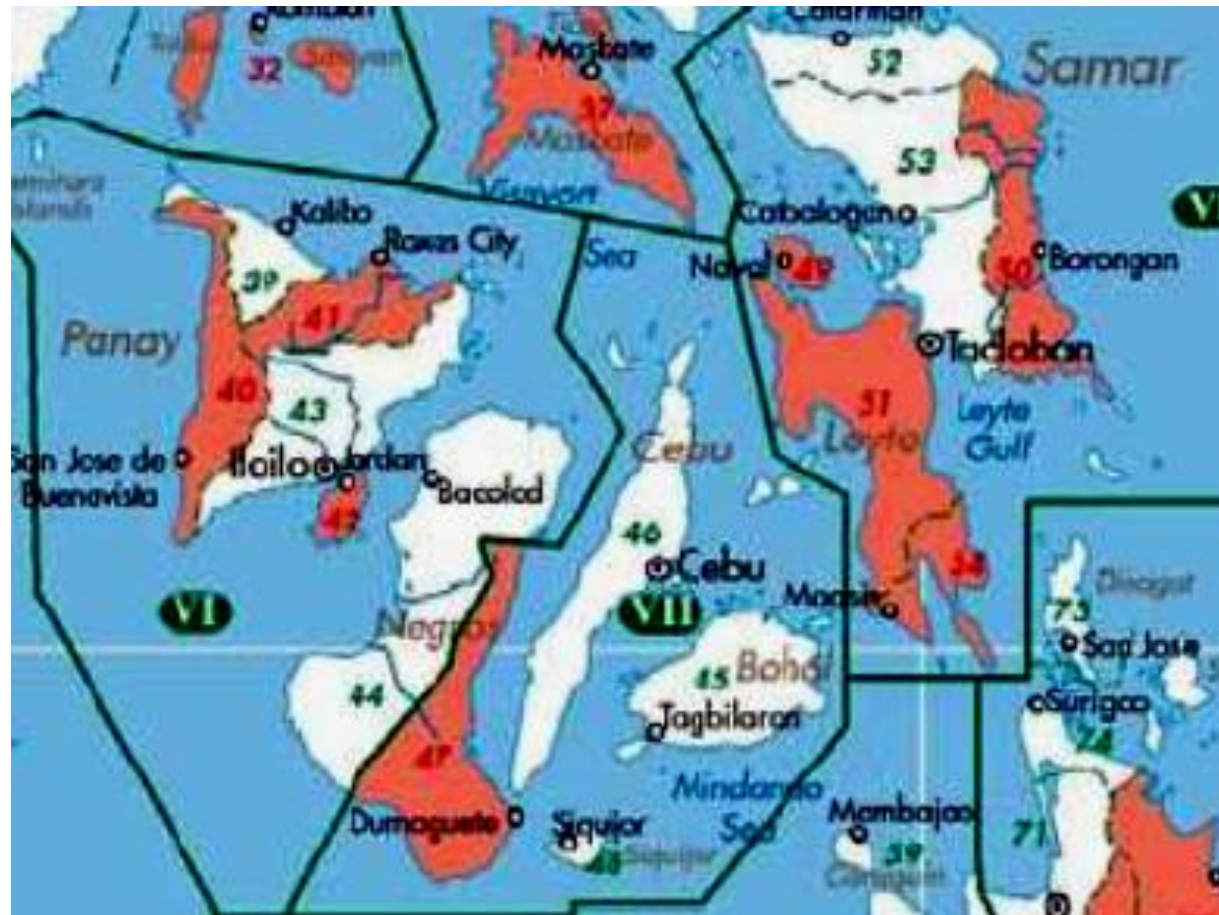
TEEP Geographic Distribution



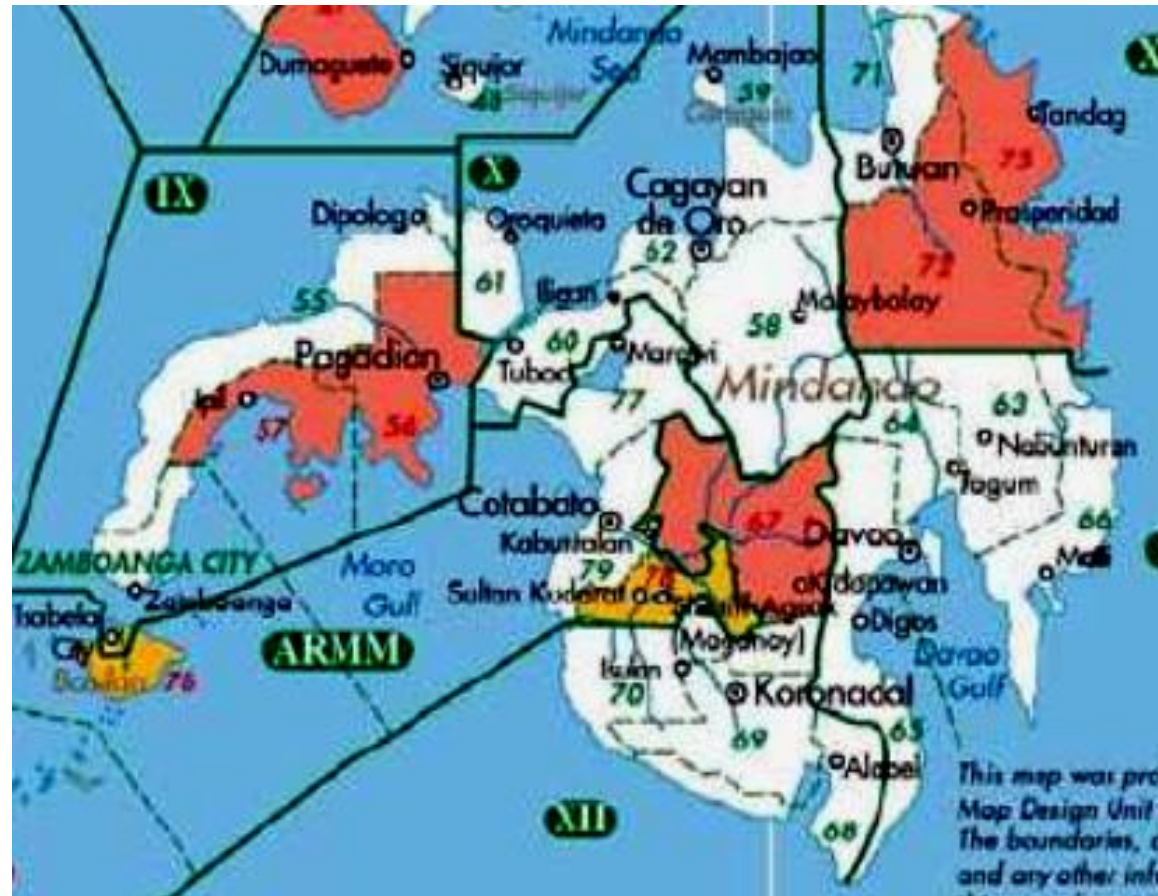
- Luzon Sample



- Visayas Sample



- Mindanao Sample

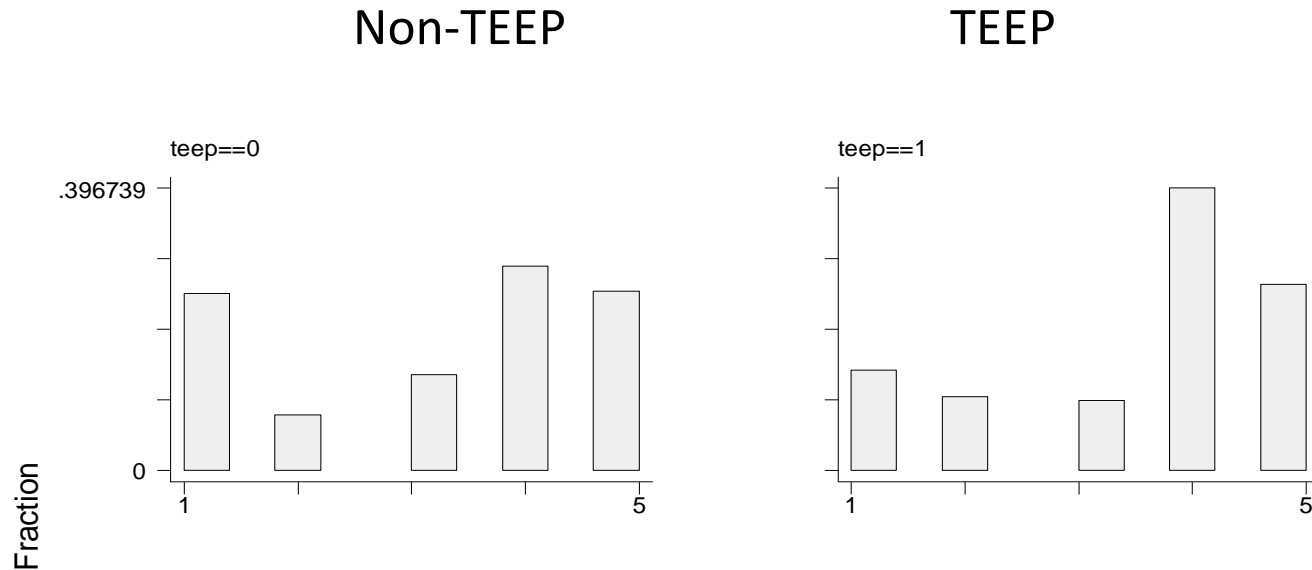


Our Strategy

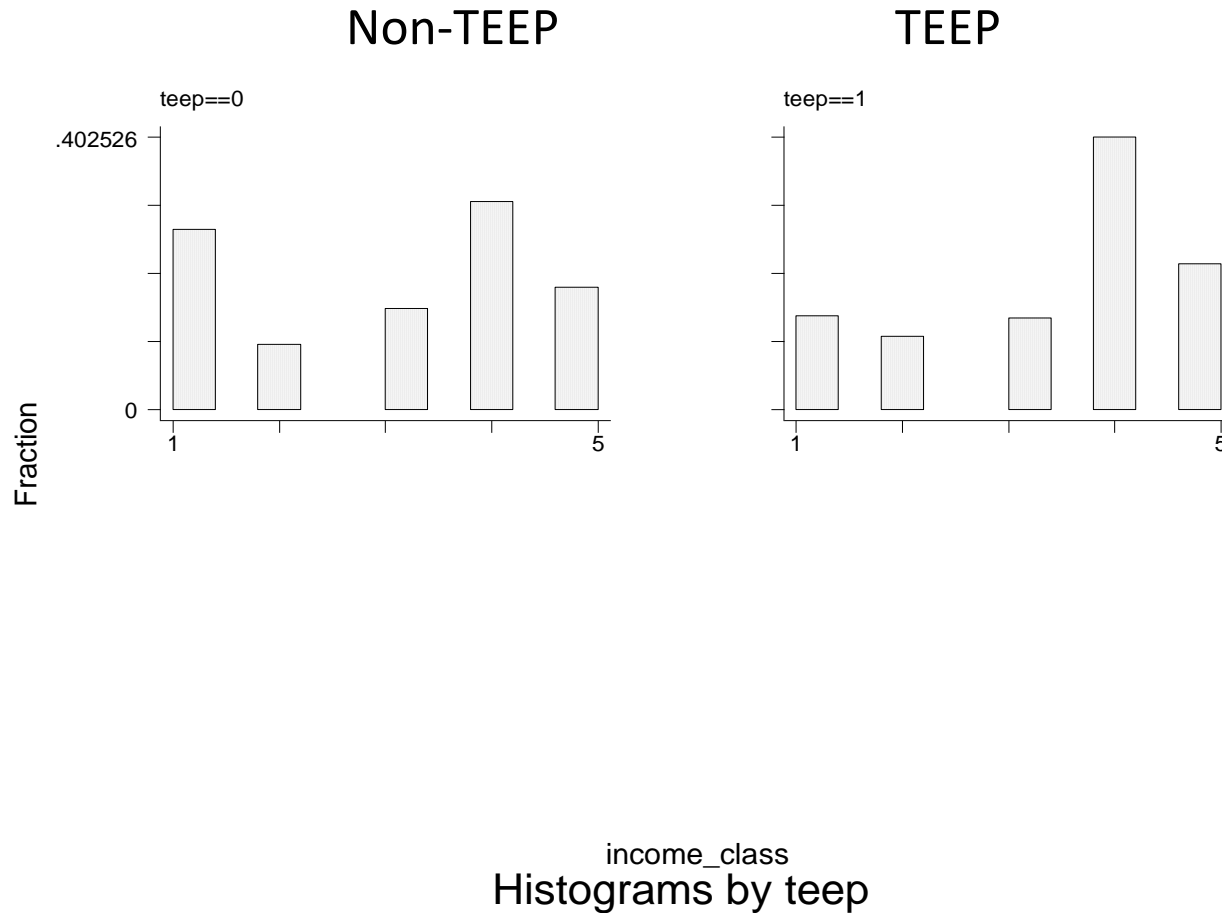
- Outcome variables: Change in test score
 - *Difference between NAT Grade 4 (2002/03) and Grade 6 (2004/05)*
 - *Overall score, mathematics score*
- Conditioning variable for TEEP in PSM
 - Municipality (school district) income class
- *Intuition*: Compare TEEP and Non-TEEP schools in under the similar initial condition (municipality income level) within each region

Income Class Dist in Visayas

School Districts by TEEP



Income Class Dist in Visayas Schools by TEEP



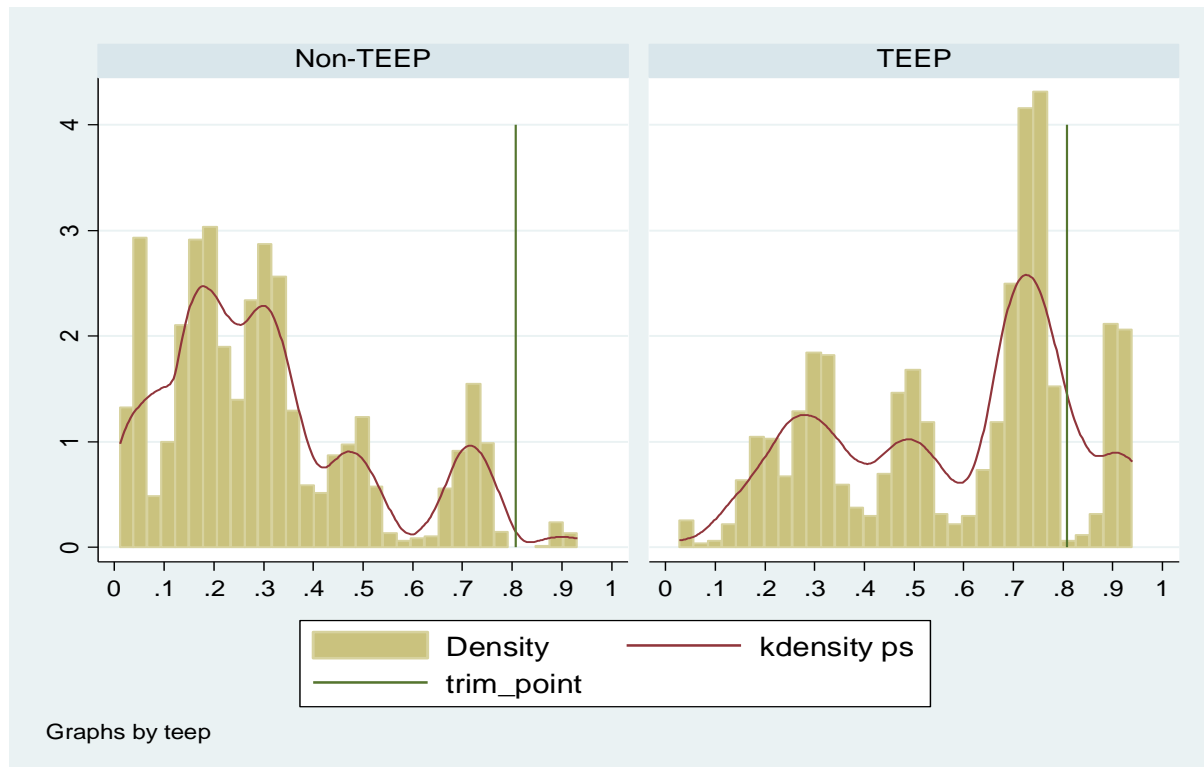
Logit Results: P(Z)

Teep	Coef.	Std. Err.	Sig.
Region 6	-2.161	0.211	***
Region 8	-2.518	0.226	***
Income 2	1.341	0.308	***
Income 3	1.702	0.370	***
Income 4	0.306	0.190	
Income 5	0.141	0.186	
Region 6 * Income 2	-1.337	0.419	***
Region 6 * Income 3	-1.097	0.425	***
Region 6 * Income 4	0.330	0.259	
Region 6 * Income 5	-1.980	0.388	***
Region 8 * Income 2	-0.784	0.397	**
Region 8 * Income 3	-0.911	0.426	**
Region 8 * Income 4	1.325	0.264	***
Region 8 * Income 5	0.954	0.312	***
Pupil teacher ratio (both local and national)	-0.008	0.004	*
Grade 4 total enrollment (in ages 6 to 11)	-0.008	0.001	***
Number of multi-grade classes	-0.042	0.040	
Proportion of local funded teachers	0.203	0.596	
Constant	1.304	0.212	***
Number of obs.	4208		
LR chi2(18)	1258		
Prob > chi2	0		
Log likelihood	-2236		
Pseudo R2	0.22		

Balancing Property

	diff1	se1	sig1	diff2	se2	sig2	diff3	se3
Region 6	-0.287	0.047	***	-0.004	0.046		-0.010	0.046
Region 8	-0.144	0.050	***	0.000	0.055		-0.003	0.057
Income 2	0.012	0.032		0.002	0.017		-0.004	0.022
Income 3	-0.012	0.040		0.000	0.035		-0.004	0.034
Income 4	0.108	0.050	**	0.004	0.062		0.022	0.060
Income 5	0.021	0.039		-0.001	0.054		0.000	0.041
Region 6 * Income 2	-0.024	0.015		0.000	0.010		-0.002	0.011
Region 6 * Income 3	-0.026	0.026		-0.001	0.025		-0.002	0.028
Region 6 * Income 4	-0.048	0.033		-0.002	0.032		0.001	0.038
Region 6 * Income 5	-0.101	0.020	***	0.000	0.005		-0.002	0.005
Region 8 * Income 2	-0.032	0.019	*	0.000	0.014		-0.004	0.014
Region 8 * Income 3	-0.041	0.027		0.000	0.025		-0.003	0.027
Region 8 * Income 4	0.026	0.038		0.001	0.047		0.003	0.044
Region 8 * Income 5	-0.008	0.014		-0.001	0.014		0.004	0.014
Pupil teacher ratio	-2.254	0.758	***	-1.101	0.847		-1.306	0.930
Grade 4 total enrollment	-7.475	1.325	***	0.687	1.198		0.511	1.257
Number of multi-grade classes	0.134	0.050	***	-0.037	0.077		-0.038	0.090
Proportion of local funded teachers	-0.005	0.003		-0.001	0.004		0.000	0.004
Number of observations	4208			3949			3949	

Propensity and Trimming: Teep and Non-TEEP



PSM Results

	Untrimmed sample, simple DD				
	Treated diff	Control diff	DD	se	sig.
Overall score	16.737	15.348	1.389	0.874	
Math score	17.645	16.385	1.260	1.090	
Number of obs.	1774	2434			
	Trimmed sample, DD+PS weighted regression				
	Treated diff	Control diff	DD	se	sig.
Overall score	16.074	12.139	3.934	1.129	***
Math score	16.961	11.719	5.242	1.473	***
Number of obs.	1541	2408			
	Trimmed sample, DD+PS weighted kernel				
	Treated diff	Control diff	DD	se	sig.
Overall score	16.074	12.260	3.813	1.172	***
Math score	16.961	11.961	5.000	1.442	***
Number of obs.	1541	2408			

- Downward bias in DD: TEEP was allocated to schools with a lower trend in NAT change over time
- Confirming that TEEP was targeted to areas/schools that have constraints on growth

Component Effects

	TEEP & Non-TEEP			TEEP only		
	Coef.	Std. Err.		Coef.	Std. Err.	
Grade 4 textbooks (per pupil)	0.014	0.004	***	0.013	0.004	***
Grade 5 textbooks (per pupil)	-0.003	0.004		-0.005	0.004	
Grade 6 textbooks (per pupil)	-0.004	0.003		-0.002	0.003	
Instructional training (man-hours per pupil)	0.339	0.192	*	0.274	0.151	*
Subject training (man-hours per pupil)	-0.582	0.260	**	-0.331	0.236	
New constructions (SY2003/04)	2.287	1.199	*	3.364	1.099	**
New renovations (SY 2003/04)	0.235	0.292		0.547	0.319	*
Region 6	0.388	2.672		-5.387	3.186	*
Region 8	-2.808	2.716		-7.928	3.612	**
Income 2	5.629	2.906	*	2.924	3.025	
Income 3	-0.036	2.864		-1.827	2.854	
Income 4	-0.424	2.711		-0.940	2.855	
Income 5	1.666	2.526		0.992	2.667	
Region 6 * Income 2	-2.378	3.584		-4.206	3.840	
Region 6 * Income 3	-1.943	3.791		-1.516	3.557	
Region 6 * Income 4	-0.373	3.314		-5.089	4.279	
Region 6 * Income 5	0.467	3.156		-1.329	4.257	
Region 8 * Income 2	-1.671	3.738		-2.342	4.446	
Region 8 * Income 3	-0.382	3.349		3.524	4.528	
Region 8 * Income 4	0.066	3.187		0.943	4.178	
Region 8 * Income 5	2.788	3.473		2.117	4.180	
Pupil teacher ratio (both local and national)	-0.101	0.037	***	-0.095	0.051	*
Grade 4 total enrollment (in ages 6 to 11)	0.050	0.008	***	0.063	0.015	***
Number of multi-grade classes	-0.533	0.284	*	0.094	0.441	
Proportion of local funded teachers	-10.257	5.170	**	-11.512	9.816	
Constant	17.540	2.624	***	19.570	2.936	***
Number of obs	4186.000			1766.000		
F(25, 446)	5.870			8.230		
R-squared	0.046			0.108		

Conclusions

- TEEP Average Effect
 - *Significantly positive impact*
 - *12 to 15 NAT score point increase over 6 years of elementary school (compared to non-TEEP)*
 - *Larger impact on mathematics*
- Component Effects
 - Textbook: Early stage investment has dynamic positive effect on performance (cumulative effect)
 - Training: Methodology/theory training has a positive effect, while subject-wise training showed a negative effect
 - School Building: New constructions have a large positive effect (One new building/classroom = 3 to 4 NAT score increase in 2 years)
 - SBM: “Funding” does not show positive effect (however, SBM is thought to increase the above component effects)

Long-term impact study (On-going)

3500 hhs/students from 8 divisions [TEEP divisions]:

Ifugao, Neuva Viscaya*

Antique, Iloilo*

Negros Oriental, Cebu*

Leyte and Western Samar*

Gr-6 SY 1999/00 [Pre-TEEP cohort]

Gr-6 SY 2004/05, 2005/06 [In-TEEP cohort]

Gr-6 NEAT/NAT score data

*Siblings data of the 3500 students ($3500 * 6 = 21000$)*

Tracking 3500 students to capture schooling and work history