Effects of Power Plants on Local Residents' Wealth: A Case Study of Nigeria

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BACKGROUND

- Power plants generate the electricity needed for households in many low-income countries to improve their livelihoods.
- An assessment of their impacts in the largest economy in Africa is worthwhile, where there is no quantitative evidence of their effects on local livelihoods.
- Nigeria still suffers from electricity shortages, although electricity generation and supply date back to 1886.
- The government has an ongoing plan to bridge the gap between electricity demand and supply by providing energy access to 90% of the population by 2030.

OBJECTIVES

- We quantitatively examine the local wealth impacts of power plants in Nigeria and their underlying mechanisms.
- We explore heterogeneous impacts and mechanisms for policy implications.

DATA

- Comprehensive data on power plant opening years, locations, capacity, and the type of energy source, etc., purchased from African Energy.
- Social Demographic and biophysical data: four rounds of the Nigeria Demographic and Health Survey (NDHS), two rounds of Nigeria Malaria Indicator Surveys (NMIS), and World Food Program Geographical Data repository.

EMPIRICAL STRATEGY

- Exploit variations in power plant opening years.
- Treatment assignment: Household is treated if within 20km of operational power plant and control if within 20km of non-operational power plant only.
- *Identification assumption*: treatment and control groups would have followed parallel paths in the absence of the treatment, and once a household or individual becomes treated, it is treated in subsequent periods.

MODELS: Event-study difference-in-differences (DID) with staggered adoption

$$Y_{it} = \alpha + \gamma_v + \delta_t + \lambda X_{it} + \sum_{y=-5}^{-2} \theta_y D_i(t - T^* = y) + \sum_{y=0}^{5} \rho_y D_i(t - T^* = y) + \varepsilon_{it}$$

Y_{it}: an outcome indicator (wealth score)

X_{it}: household-level and biophysical

D_i: dummy variable equal to 1 if a household is located within 20km of an operational power plant (Treatment) and 0 otherwise (Control)

T^*: opening period of a power plant

$t - T^* = y$: leads and lags' periods

$y = -1$: universal base time and refers to a period before power plants open

- Event studies with variation in treatment timing (Outcome Regression estimand by Callaway & Sant'Anna (2020):

  Estimates an interpretable causal parameters and allows for arbitrary treatment effect heterogeneity and dynamic effects.

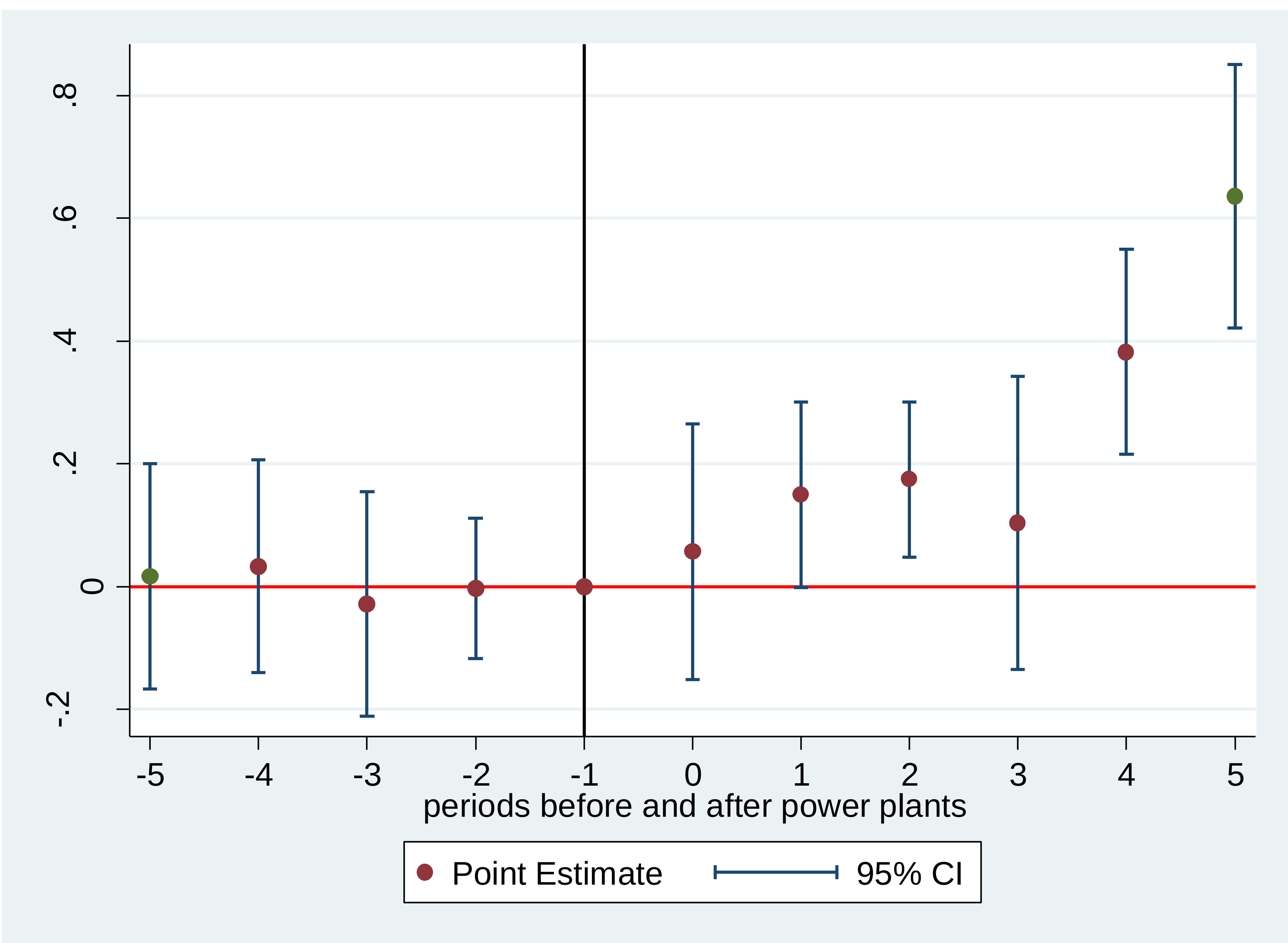
DESCRIPTIVE STATISTICS

Variables	Minimum	Maximum	Control	SD	Treatment	SD
wealthscore	-2.3723	3.03444	0.185	(0.929)	0.621	(0.979)
household head number	1	40	4.587	(3.079)	4.396	(3.067)
household head education(years)	0	23	7.161	(5.769)	8.772	(5.586)
household head age (years)	10	97	46.184	(16.193)	43.738	(14.704)
household head sex (1=male, 0=female)	0	1	0.784	(0.412)	0.787	(0.409)
number of children under five	0	10	0.873	(1.119)	0.809	(1.042)
1 if urban, 0 if rural	0	1	0.476	(0.499)	0.590	(0.492)
capacity(mw)	0	1200	108.343	(212.612)	61.652	(136.913)
mean temperature (degrees celcius)	20.8917	29.675	27.124	(1.009)	27.363	(0.445)
vegetation index (0=least vegetation, 10000=Most vegetation	1007	4936	3,192.405	(772.109)	2,905.091	(835.089)
trave minutes	0	1141.867	77.156	(114.369)	50.466	(78.875)
proximity to protected areas (km)	0	274.0682	73.448	(56.116)	62.754	(58.837)
proximity to water (km)	0	478.5949	124.488	(101.503)	127.426	(154.079)
distance to nearest road (km)	0.00014	14.56369	0.506	(0.845)	0.415	(0.777)
slope	0	4.343184	0.581	(0.612)	0.408	(0.448)
Observations			32,763		10,342	

Notes: SD is defined as the Standard Deviation.

EVENT STUDY DIFF-IN-DIFF (DID) RESULTS

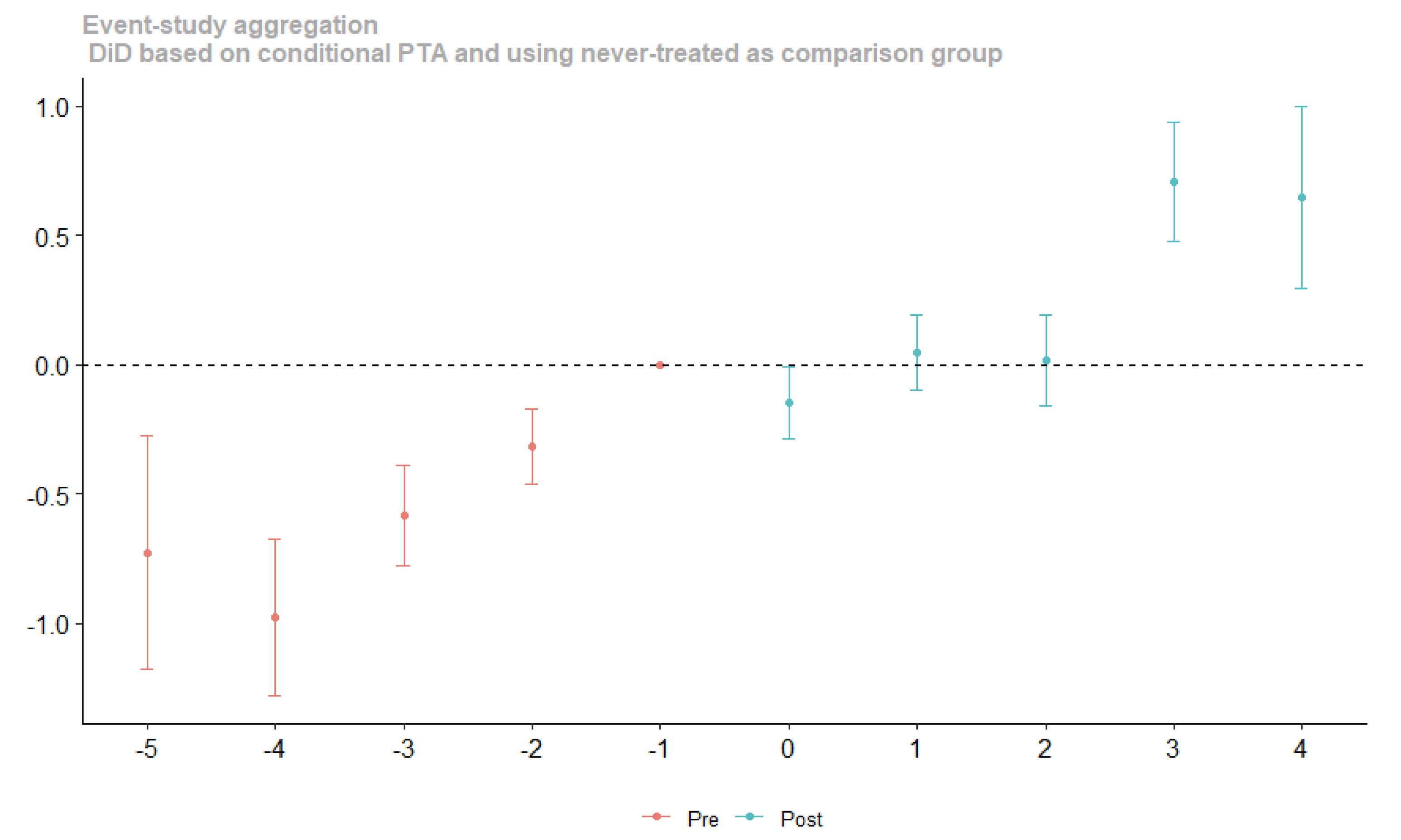
Evidence that **power plants lead to increase in asset-based wealth scores** 2-5 periods after they became operational. The impacts seem to increase with the length of power plants' exposure.



OUTCOME REGRESSION DID RESULTS
(Callaway & Sant'Anna 2020)

- Average treatment on the treated (ATT) is positive and significant (0.2541).
- However, we are skeptical about the plausibility of the conditional parallel trends because pre-trends appear significant.
- Therefore, we conduct sensitivity analysis to gauge sensitivity to the parallel trends' assumption violations.

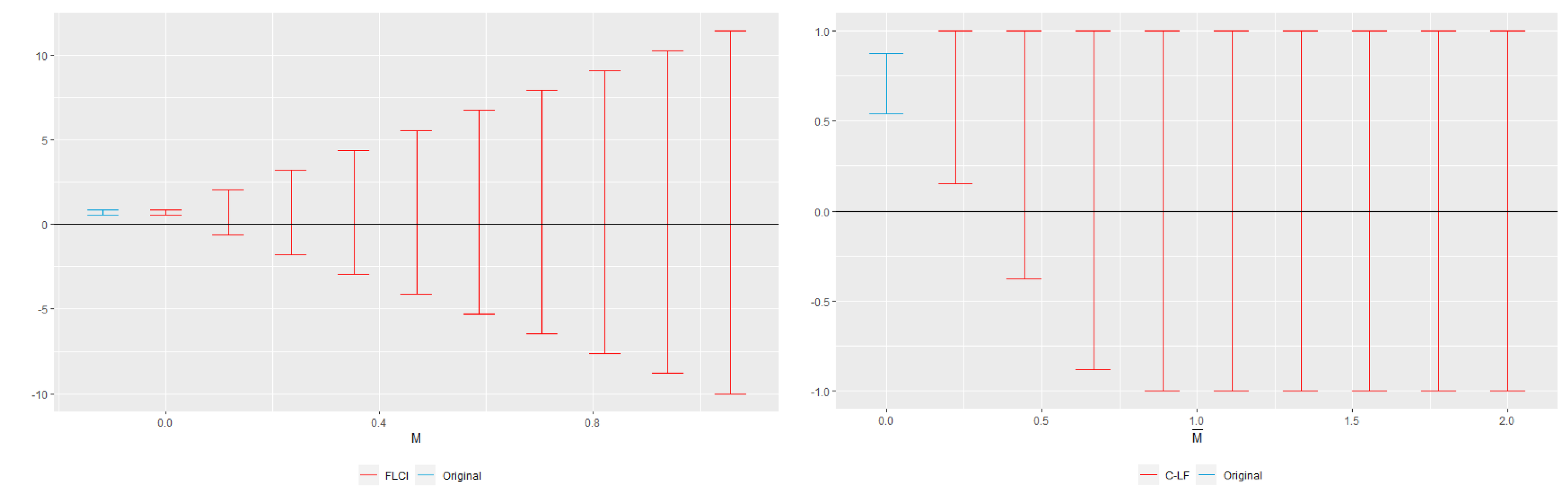
OUTCOME REGRESSION RESULTS (cont'd)



SENSITIVITY TEST (HonestDiD)
(Rambachan and Roth, 2020)

Shows how the outcome would have changed if parallel trends assumption is violated:

- For the 3rd lag from the above graph gives breakdown values for a significant effect at M= 0.12 (smoothness restrictions) or $\bar{M}$= 0.44 (relative magnitude).
- We can reject a null effect in the 3rd period if we can assume that the slope of the differential trend to change by less than 0.12 point of wealth score.
- Positive and significant effect (3rd period) is robust to allowing a non-linearity in the differential trend equal to 0.44 times the maximum observed before the treatment



HETEROGENOUS IMPACTS

- Power plants with a capacity of less than 100MW seem to drive the results.
- About 80% households live near power plants with less than 100MW capacity, while households near power plants with a larger capacity have no substantial increase in their wealth.

ADDITIONAL WORK

- Assess underlying mechanisms for the heterogenous impacts between power plants with a larger capacity and others that have capacity less than 100MW.
- Explore further heterogeneous impacts by education level and occupations by using data at the individual level.

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