

Energy access and development: An empirical analysis of household' access to electricity effects on scholar instruction in Burkina Faso.

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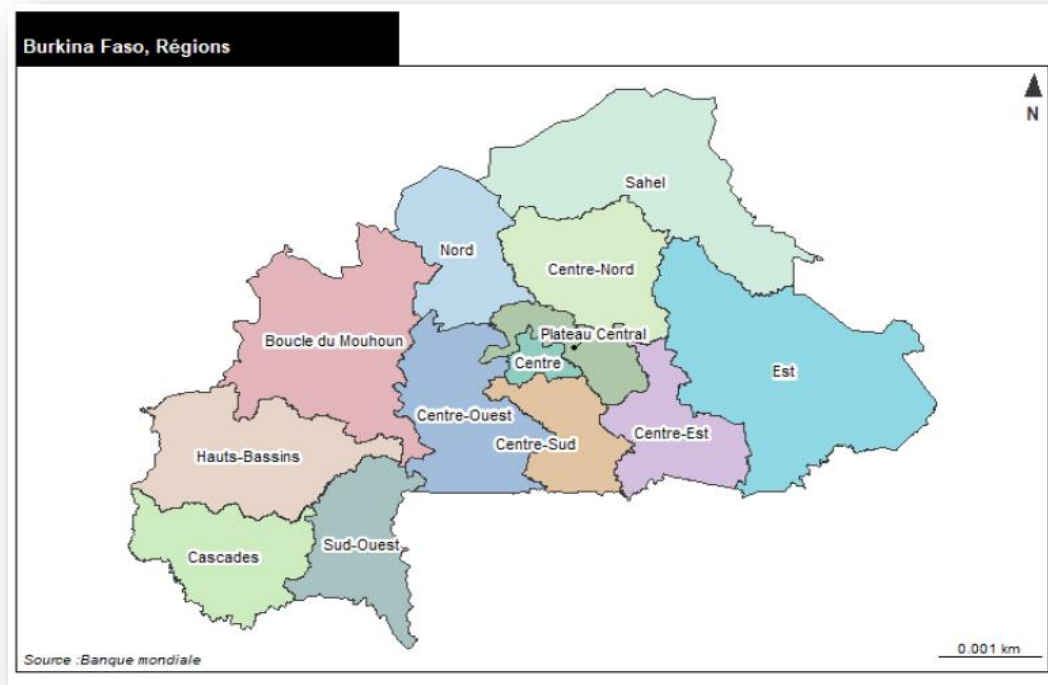


Plan

- **Context**
- **Data base**
- **General methodology**
- **Procedure**
- **Results**
- **Conclusion**

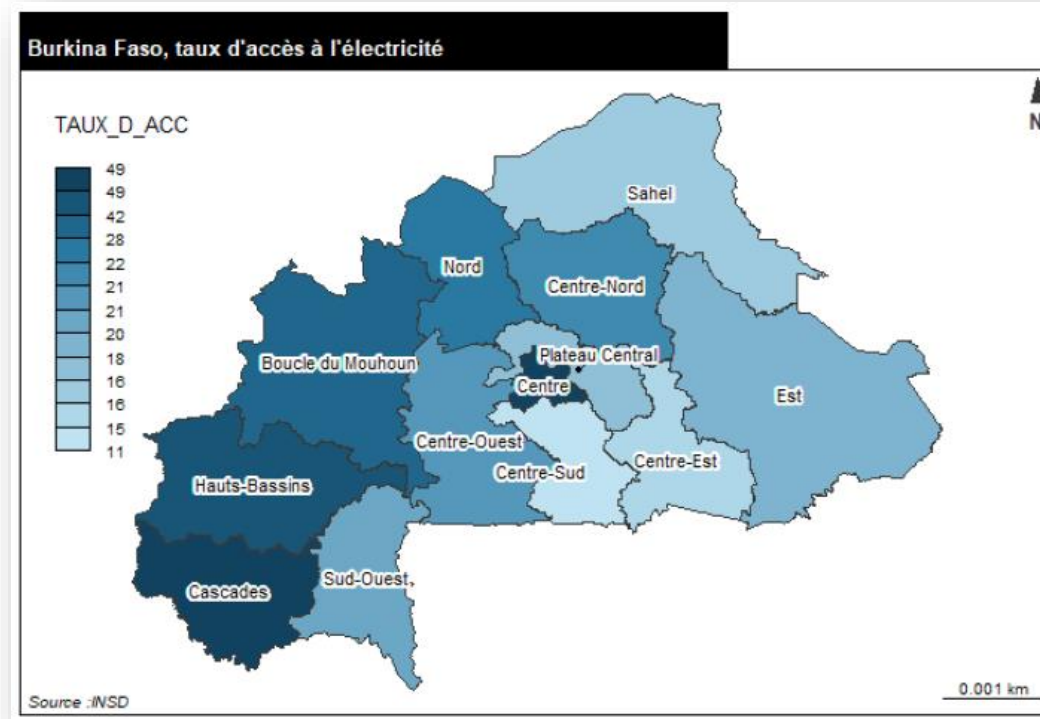
Context

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- A low Human Development Index (around 0.420 in 2014)
- A low literacy rate for people over 15 years (around 35% in 2014)
- A low rate of national access to electricity (around 14% in 2018, World Bank)

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- SDGs (horizon 2030):
Objective 7 - Guarantee universal access to modern and sustainable energy
Objective 13 - Fight against climate change

- The SE4ALL program (2030): Providing access to modern energy while taking into account the climate
- IRED (2030): Increase access to electricity, reduce its price, increase the share of renewable energies in the energy mix in the West African Economic and Monetary Union (WAEMU)
- Several projects to extend the network and the capacities of the centralized electricity sector in Burkina-Faso

Access to electricity and education

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- Jacobson, 2007: Solar electrification contributes modestly to education; households with low capacity facilities <25 W (Kenya)
- Khandker, 2012: Grid electrification has a positive impact on the academic performance of students by increasing the number of years of study (Bangladesh, rural)
- Khandker et al., 2013: There is an increase in the enrollment rate and the duration of studies when the household has access to grid electricity (Vietnam, rural)
- Aguirre, 2017: Electrification increases study time (Peru, rural)
- BOAD (West African development bank), 2018: There is market pollution by poor quality photovoltaic installations (WAEMU area)

Research question

- Which mode of electrification (Centralized, decentralized) optimizes education in Burkina Faso?

Goals

- Measure the effect of access to electricity on the access, quality and duration of schooling in Burkina Faso.
- Measure the relative efficiency of centralized electrification versus decentralized photovoltaic electrification on access, quality and duration of schooling in Burkina Faso.

Database

- Database: Multifactor survey on household' living conditions in Burkina Faso 2013-2014 conducted on 10,800 households:
 - Two-stage stratified survey
- Study sample: Selection of people between 5 and 26 years; approximately 46,000 individuals.
- Constitution of sub-samples taking into account the living area, gender and age, in order to take into account potential heterogeneity, and check the robustness of our results.

Descriptives statistics

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Descriptive statistics (Schooling rate) ; mean by variable by sub-sample

	SPL total		SPL 5-18		SPL 5-12		SPL 13-18		SPL 19-26	
	N_elec	elec	N_elec	elec	N_elec	elec	N_elec	elec	N_elec	elec
urban	0,22	0,72	0,21	0,70	0,20	0,66	0,24	0,75	0,26	0,78
total_expenses	167400	402938	164518	398419	159806	375641	173901	431287	176794	413097
level_intr_hh1	0,28	1,40	0,26	1,35	0,23	1,24	0,31	1,50	0,37	1,51
level_intr_hh2	0,25	1,14	0,23	1,07	0,20	0,95	0,29	1,23	0,31	1,30
dist_tranp_com	48,10	30,20	48,38	30,71	49,11	31,68	46,92	29,30	47,19	29,07
dist_service_civ	58,37	39,25	58,60	39,90	59,36	41,45	57,09	37,67	57,61	37,79
Age	13,32	14,73	10,60	11,34	8,27	8,48	15,25	15,46	22,20	22,35
gender_male	0,50	0,47	0,52	0,49	0,52	0,50	0,51	0,46	0,44	0,45
Alpha	0,41	0,68	0,43	0,68	0,35	0,60	0,58	0,79	0,34	0,69

Descriptive statistics (Instruction level expressede in number or years) ; mean by variable by sub-sample

	SPL total		SPL 5-18		SPL 5-12		SPL 13-18		SPL 19-26	
	N_elec	elec	N_elec	elec	N_elec	elec	N_elec	elec	N_elec	elec
urbain	0,32	0,81	0,30	0,79	0,28	0,76	0,34	0,83	0,56	0,94
total_expenses	179761	423801	175982	414356	168523	398218	191170	440225	229570	469304
level_intr_hh1	0,41	1,67	0,37	1,56	0,32	1,47	0,47	1,69	0,97	2,21
level_intr_hh2	0,41	1,36	0,36	1,23	0,31	1,14	0,46	1,38	1,04	1,96
dist_tranp_com	42,71	26,92	43,27	27,45	44,45	28,09	40,87	26,44	35,22	24,33
dist_service_civ	53,03	35,43	53,76	36,14	55,06	37,36	51,12	34,19	43,43	32,02
Age	11,69	13,10	10,99	11,34	9,09	8,90	14,87	15,24	20,84	21,60
gender_male	0,54	0,50	0,53	0,50	0,54	0,50	0,53	0,50	0,61	0,52
Number of schooling years	5,66	7,19	5,24	6,05	3,95	4,25	7,88	8,92	11,18	12,71

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Descriptive statistics (Schooling rate) ; mean by variable by sub-sample

	SPL total		SPL 5-18		SPL 5-12		SPL 13-18		SPL 19-26	
	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid
urban	0,15	0,91	0,14	0,90	0,13	0,90	0,17	0,92	0,19	0,93
total_expenses	284618	442173	280494	440494	281328	417309	294900	470341	280726	445593
level_intr_hh1	0,63	1,65	0,63	1,62	0,59	1,53	0,70	1,73	0,62	1,72
level_intr_hh2	0,37	1,39	0,35	1,33	0,33	1,23	0,40	1,47	0,42	1,51
dist_tranp_com	46,30	24,87	46,85	24,67	47,74	24,59	45,09	24,78	44,57	25,26
dist_service_civ	58,43	32,89	59,00	32,76	60,12	33,20	56,76	32,20	56,68	33,15
Age	13,483	15,14	10,61	11,61	8,24	8,587	15,33	15,50	22,39	22,34
gender_male	0,50	0,47	0,52	0,47	0,53	0,49	0,50	0,45	0,43	0,46
Alpha	0,48	0,75	0,50	0,74	0,43	0,67	0,65	0,83	0,41	0,76

Descriptive statistics (Instruction level expressede in number or years) ; mean by variable by sub-sample

	SPL total		SPL 5-18		SPL 5-12		SPL 13-18		SPL 19-26	
	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid	elec_sol	elec_grid
urbain	0,23	0,93	0,21	0,92	0,19	0,91	0,27	0,93	0,44	0,97
total_expenses	301499	448111	300405	440791	301680	424120	297542	465611	318762	478482
level_intr_hh1	0,93	1,81	0,89	1,71	0,82	1,64	1,06	1,81	1,52	2,25
level_intr_hh2	0,58	1,51	0,54	1,39	0,52	1,31	0,58	1,52	1,17	2,01
dist_tranp_com	41,13	24,09	41,52	24,19	43,08	24,06	38,02	24,38	34,92	23,69
dist_service_civ	53,29	31,89	54,31	31,93	56,62	32,20	49,10	31,54	37,27	31,70
Age	11,39	13,44	10,80	11,46	9,00	8,88	14,84	15,31	20,69	21,66
gender_male	0,54	0,50	0,54	0,49	0,54	0,49	0,54	0,49	0,60	0,52
Number of schooling years	5,62	7,50	5,24	6,23	4,00	4,32	8,03	9,10	11,5	12,78

General methodology

Evaluation of public policies

Calculation of mean effects after matching by propensity score.

Rubin, 1974, 1977, 2001 ; Rubin and Thomas, 1996 ; Givord, 2014.

$\Delta^{ATT} = E (Y_i^1 - Y_i^0 \mid T_i=1)$ (Average effect of access to electricity or grid access on treated peoples)

Variables of interest

Individual literacy : Binary variable indicating whether a person is literate (1) or not (0).

Number of years of study: Class reached by the individual during the 2013/2014 school year, ranging from preschool to the last year of the license (between 1 and 17). Approximation of the level of education.

Procedure

- Estimation of a Logit model for each sub-sample

$$P(y_i = 1) = \frac{e^{\alpha + \beta X}}{1 + e^{\alpha + \beta X}}$$

Dependent variables

- ***elec*** : Binary variable indicating the individual's access to electricity. This variable takes the value 1 if the individual belongs to a household using grid electricity or solar photovoltaic electricity and 0 otherwise.
- ***elec_grid*** : Binary indicator variable allowing the distinction between network electricity and solar electricity. It takes the value 1 if the individual belongs to a household using grid electricity and 0 if the household uses solar photovoltaic electricity.

Independent variables

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- **urban** : indicator variable of the area of residence of the individual. (1 = urban; 0 = rural)
- **total_expenses**: total household expenditure for the last three months (approximation of the individual's household income level)
- **level_intr_hh1** : educational level of the head of household (generally the father of the family); between 0 and 5 (0 = none; 5 = university level).
- **level_intr_hh2**: educational level of the sSPLond head of household (generally the mother of the family).
- **dist_tranp_com** : average distance between the individual's home and the nearest means of public transport (in minutes).
- **dist_service_civ** : distance between the individual's accommodation and the nearest civil status service (in minutes).
- **gender_male** : binary variable indicating the gender of an individual. This variable takes the value 1 if the individual is male and 0 otherwise.
- **Age** : Age of the individual

- Calculation of propensity scores

Forecasts from Logit models for each sub-sample.

- Pairing
 - Use of calculated propensity scores (Matching parameter 0.25 standard deviations)
 - Use of additional variables: exact matching on age, living area and gender.

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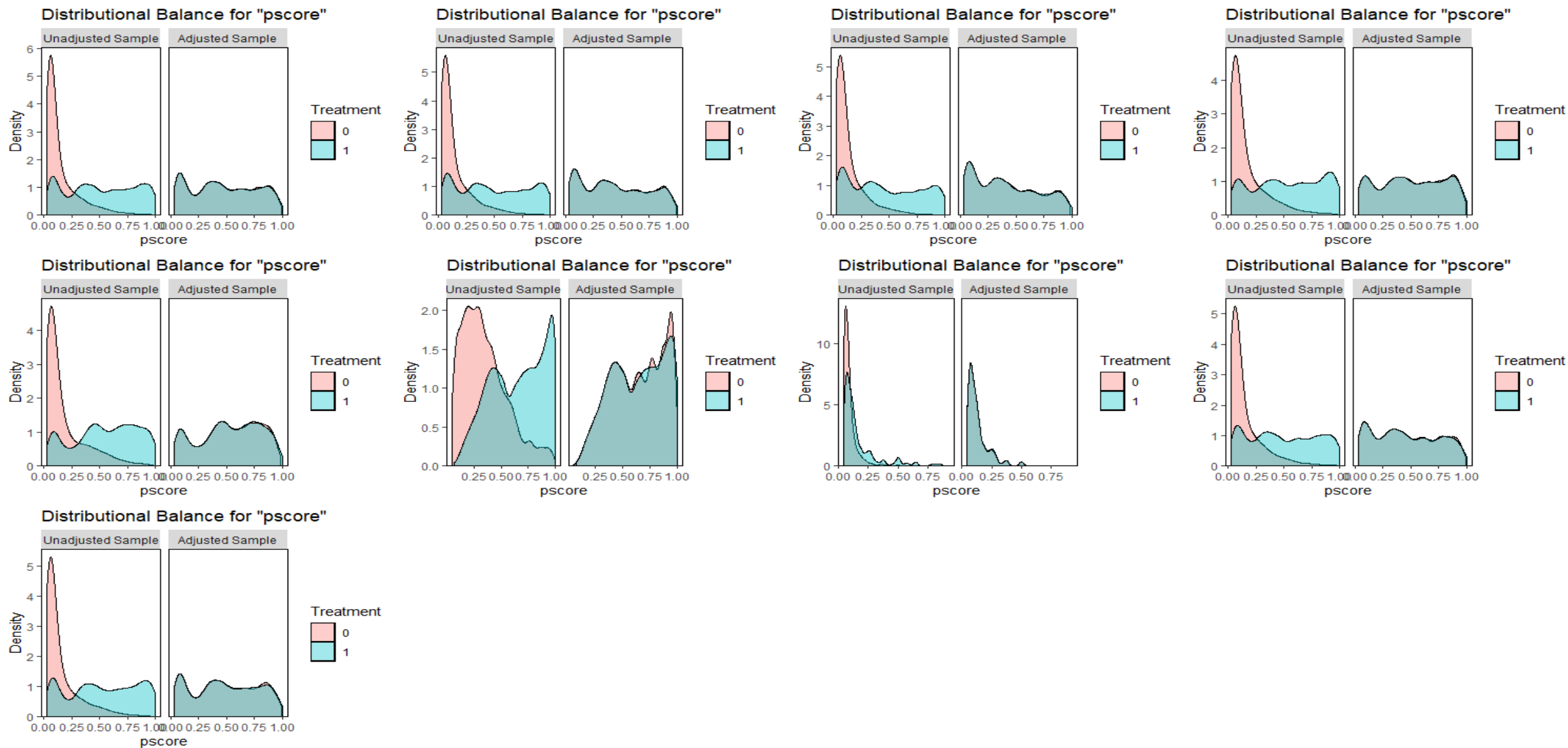
- Verification of the common support and the effectiveness of the pairing.
- The existence of a common support between the two groups shows that there are both comparable beneficiaries and non-beneficiaries (with the same probability of being treated)
- Using the standardized differences of means between the control group to check the balancing property of our match and ensure it is efficient.

$$\frac{\bar{x}_t - \bar{x}_c}{\sqrt{\frac{s_t^2 + s_c^2}{2}}}$$

With \bar{x}_t et \bar{x}_c representing the respective means of the treated group and the control group for the control variable x and s_t^2 s_c^2 the variances of the two groups.

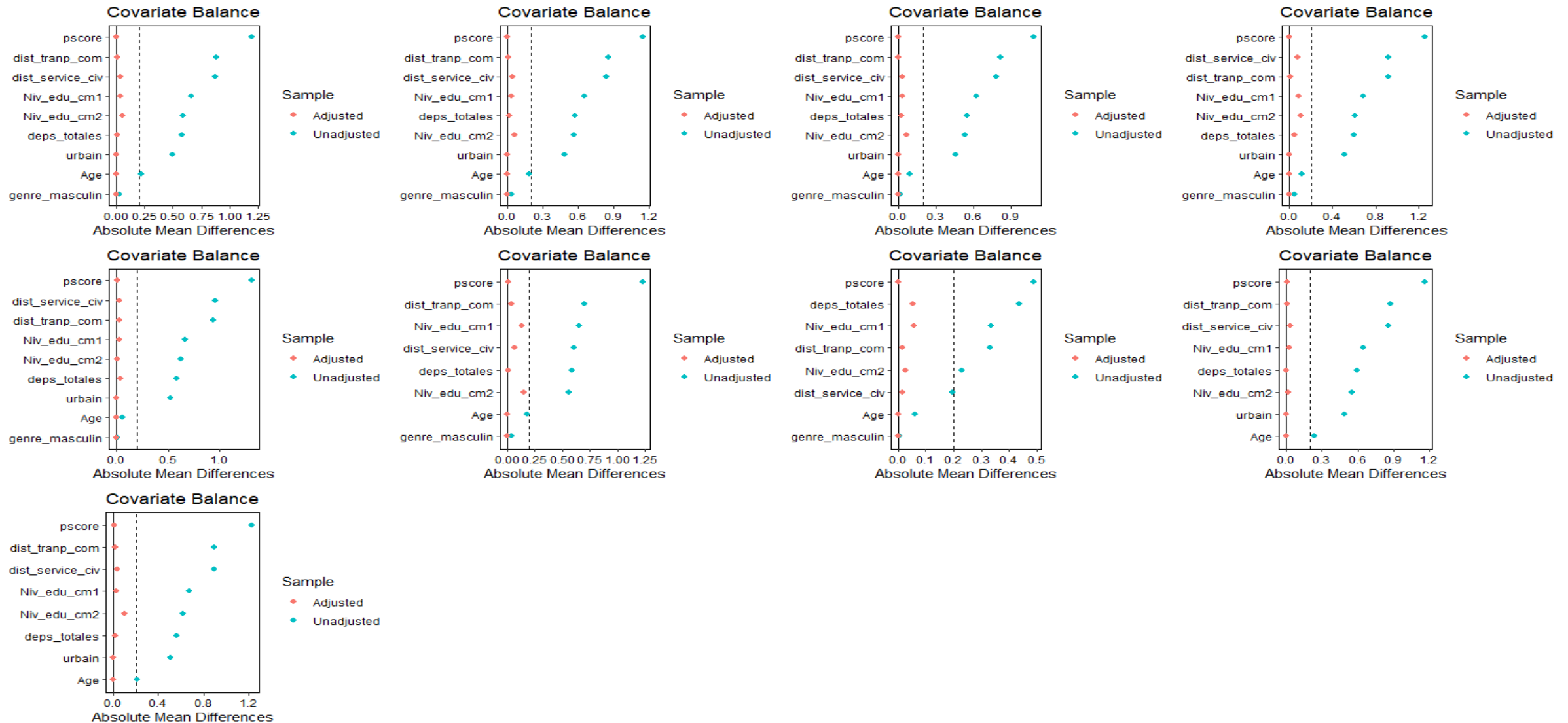
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Common supports by sub-samples (Literacy, elec vs Nelec)



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Differences standardized by sub-samples (literacy rate)



- Estimation of average effects

$$\Delta^{ATT} = \frac{1}{N_T} \sum_{i=1}^{N_T} \left(Y_i - \frac{1}{M} \sum_{j \in j_m(i)} Y_j \right)$$

$j_m(i)$ represents the set of untreated individuals matched to a treated individual i . Thus, each of the N_T individuals treated has as counterfactual income, the average of the income Y_j of the units j which are paired with it, M being their number.

Results

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Average effect of access to electricity on literacy rate

	SPL total	SPL 5-18	SPL 5-12	SPL 13-18	SPL 19-26	SPL URBAN	SPL RURAL	SPL MALE	SPL FEMALE
Estimate...	0,046***	0,034***	0,057***	0,012	0,057***	0,050***	0,059***	0,045***	0,041659***
AI-SE...	0,008	0,009	0,011	0,015	0,015	0,011	0,010	0,010	0,011
T-stat...	5,68	3,67	4,93	0,79	3,67	4,41	5,55	4,20	3,47
p.val...	1,33E-08	0,0002	8,16E-07	0,429	0,0002	9,99E-06	2,85E-08	2,60E-05	0,0005
Original number of observations...	38888	29084	18883	10201	9804	13272	25616	19225	19663
Original number of treated obs...	9212	6376	3766	2610	2836	6652	2560	4368	4844
Matched number of observations...	8451	5777	3377	2398	2639	6296	2327	4022	4392
Number of obs dropped by 'exact' or 'caliper'	761	599	389	212	197	356	233	346	452

Signif. Codes : . p<0,1 ; * p<0,05 ; ** p<0,01 ; *** p<0,001

Effect of access to electricity on the average level of studies achieved (Average number of years)

	SPL total	SPL 5-18	SPL 5-12	SPL 13-18	SPL 19-26	SPL URBAN	SPL RURAL	SPL MALE	SPL FEMALE
Estimate...	0,291***	0,264***	0,212***	0,336***	0,800***	0,376***	0,195***	0,317***	0,315***
AI-SE ...	0,041	0,040	0,039	0,080	0,138	0,048	0,051	0,058	0,057
T-stat...	7,07	6,52	5,39	4,18	5,79	7,82	3,77	5,44	5,51
p.val...	1,46E-12	6,79E-11	6,69E-08	2,87E-05	6,85E-09	5,11E-15	0,0001	5,15E-08	3,49E-08
Original number of observations...	16055	14389	9411	4978	1666	7707	8348	8476	7579
Original number of treated obs...	5265	4360	2685	1675	905	4273	992	2655	2610
Matched number of observations...	4611	3906	2385	1528	700	3660	845	2392	2229
Number of obs dropped by 'exact' or 'caliper'	654	454	300	147	205	613	147	263	381

Signif. Codes : . p<0,1 ; * p<0,05 ; ** p<0,01 ; *** p<0,001

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	Average effect of grid electricity on literacy rate								
	SPL total	SPL 5-18	SPL 5-12	SPL 13-18	SPL 19-26	SPL URBAN	SPL RURAL	SPL MALE	SPL FEMALE
Estimate...	0,013	0,001	0,030	-0,048	0,049	0,021.	-0,030	-0,028	0,036
AI-SE...	0,023	0,027	0,036	0,041	0,043	0,012	0,022	0,029	0,035
T-stat...	0,57	0,04	0,82	-1,16	1,11	1,75	-1,35	-0,96	1,03
p.val...	0,5676	0,9634	0,4072	0,2438	0,2632	0,0784	0,1753	0,3321	0,3005
Original number of observations...	9212	6376	3766	2610	2836	6652	2560	4368	4844
Original number of treated obs...	6918	4641	2612	2029	2277	6300	618	3230	3688
Matched number of observations...	6538	4446	2515	1939	2102	2589	453	2998	3529
Number of obs dropped by 'exact' or 'caliper'	380	195	97	90	175	3711	165	232	159

Signif. Codes : . p<0,1 ; * p<0,05 ; ** p<0,01 ; *** p<0,001

	Average effect of grid electricity on the average level of studies reached (Average number of years)								
	SPL total	SPL 5-18	SPL 5-12	SPL 13-18	SPL 19-26	SPL URBAN	SPL RURAL	SPL MALE	SPL FEMALE
Estimate...	0,361***	0,210*	0,236*	0,250	1,396***	0,266***	0,221**	0,669***	0,184
AI-SE....	0,095	0,099	0,106	0,188	0,236	0,041	0,070	0,137	0,133
T-stat...	3,76	2,12	2,21	1,33	5,89	6,36	3,15	4,86	1,38
p.val...	0,0001	0,0338	0,0265	0,1831	3,66E-09	2,01E-10	0,0016	1,12E-06	0,1658
Original number of observations...	5265	4360	2685	1675	905	4273	992	2655	2610
Original number of treated obs...	4392	3539	2117	1422	853	4074	318	2183	2209
Matched number of observations...	3553	3139	1999	1111	349	1195	183	1863	1663
Number of obs dropped by 'exact' or 'caliper'	839	400	118	311	504	2879	135	320	546

Signif. Codes : . p<0,1 ; * p<0,05 ; ** p<0,01 ; *** p<0,001

Conclusion

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- Positive effect of electricity on literacy and school level;
- Higher efficiency of grid electricity compared to decentralized solar electricity on the instruction level;
- No effect of grid electricity compared to decentralized solar electricity on literacy;
- Need to strengthen photovoltaic support systems;
- Need diversify the energy mix by integrating more renewables energy into the grid

Limitations

- Need of an other matching method (Kernel matching for instance) for the robustness.
- Need for a sensitivity analysis to check that the CIA (conditionnal independance assumption) is respected.

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Thank you for your attention