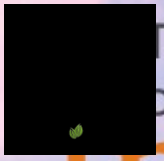

The Impact of Research on EU Agriculture

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Sustainability of farm biogas diffusion in Italy

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Presentation outline

- Background
- Theoretical model
- Methodology
- Results
- Discussion
- Next steps

1. Background

Impacts of farm biogas: open debate

(Kirkels, 2012)

- Pros
  - Reduced environmental burden compared to fossil fuels

    (Ausilion et al., 2009; Yiridoe et al., 2009; OECD, 2010)
  - Labour opportunities and income increase in rural areas

    (Domac et al., 2005; Bartolini et al., forthcoming)
  - Distributed generation and energy security at the farm level

    (OECD, 2010)
- Cons
  - Competion for land uses

    (Capodaglio et al., 2016)
  - Vulnerability to food price increase

    (Walla and Schneeberger, 2008)
  - Irriversibility and High costs

    (Massé et al., 2011)
  - Dependence on public support

    (Wilkinson, 2011; European Commission, 2013; Cannemi et al., 2014)

1. Background

Adopting biogas may lead to spatial spillover or agglomeration effects

- Land demand, land use
- Patterns of farming, livestock units
- Rural labour

Biomass: livestock waste, crops (roughly 400ha per 1 MWh)

Policy constraints: 51% self supply and the rest within 70 km

Purpose of the study

Estimating the spatial impact of biogas diffusion at the national level, considering direct and spillover effects on host-areas and host-neighbours

Theoretical model

- Two areas: treated and nontreated
- Two situations: before and after treatment
- y generic outcome variable for *i*-th area

Before $$y_{i,t}^{b} = y_{i,nt}^{b} = \mu(x) + u_i$$

After $$y_{i,t}^{a} = y_{i,t}^{b} + \alpha d_t$$

$$y_{i,nt}^{a} = y_{i,nt}^{b} + \mathbf{W} d_t \beta$$

α = direct effect on the treated (t)

β = indirect effect on the nontreated (nt)

d = treatment

$\mathbf{W}$ = spatial weight matrix

Methodology

Spatial propensity score analysis to estimate treatment effect

Academic interest in integration of ps into spatial analyses

(*Mitze, 2014*)

Examples:

- *Towe & Tra (2012)*: nearest neighbour matching based on distance

- *Chagas et al. (2016)*: spatial diff in diff model accounting for direct and indirect treatment effect on both the treated and the control in describying impact of sugar cane burning on the HDI index

Methodology

Steps

1. Allocate observations to treatment-nontreatment via logistic regression on observed variables

2. Identify nontreated neighbours

3. Correct outcomes for spatial unstationarity (spatial lag model)

4. Estimate potential outcomes using difference in differences

Treatment effects

average treatment effect

ATE= $E(Y(1) - Y(0))$

average treatment effect on the nontreated

ATENT = $E(Y(1)|t = 0) - E(Y(0)|t = 0)$

Methodology

Spatial units = Italian municipalities

Treatment = hosting at least 1 plant

Outcome variables

- Hired labour
- Household labour
- Utilised agricultural area
- Number of farms
- Livestock intensity

Data

ISTAT (Italian statistical office)

- Census of Agriculture **2000** and **2010**
- Population Census **2001** and **2011**

CRPA (leading research centre on farm biogas in Italy)

- Biomass-to-energy census **2010**
  - Number
  - Biomass
  - Rated power

Descriptive statistics

	treated				
Variable	Obs	Mean	Std. Dev.	Min	Max
wd_lab_ex1	538	186.61	4969.07	-65476	25890
wd_lab_hh1	538	-4982.98	17296.07	-184823	51829
wd_uaa1	538	14.26	446.85	-2138	4913
wd_farm1	538	-21.01	134.81	-2212	177
wd_livch1	538	-0.32	2.05	-18	14
wp_lab_ex1	538	0.98	10.33	-1	218
wp_lab_hh1	538	-0.08	0.18	-1	1
wp_uaa1	538	-0.01	0.22	-3	2
wp_farm1	538	-0.05	0.17	-1	1
wp_livch1	538	25.99	288.00	-12	5420
	nontreated				
Variable	Obs	Mean	Std. Dev.	Min	Max
wd_lab_ex1	7556	169.68	10346.32	-266934	190308
wd_lab_hh1	7556	-8878.81	20014.19	-315313	108050
wd_uaa1	7556	-42.24	756.88	-6595	21201
wd_farm1	7556	-70.68	200.22	-3858	815
wd_livch1	7556	-2.21	30.97	-2009	24
wp_lab_ex1	7556	4.18	46.18	-1	2424
wp_lab_hh1	7556	-0.17	0.65	-1	20
wp_uaa1	7556	0.11	2.51	-5	148
wp_farm1	7556	-0.17	0.48	-2	8
wp_livch1	7556	2.19	53.11	-13	2997

Results

indicator	estimate	outcome variable	Coef.	sign	Std. Err.	[95% Conf.	Interval]
	ate	wp_lab_ex1	-0.02901		1.987804	-3.92503	3.867019
hired labour	atent	wNTp_lab_ex1	-2.13723	***	0.771622	-3.64958	-0.62488
household	ate	wp_lab_hh1	-0.07937	***	0.029044	-0.13629	-0.02244
labour	atent	wNTp_lab_hh1	0.015637		0.026078	-0.03548	0.06675
	ate	wp_uaa1	2.14573	***	0.948433	0.24065	4.0508
uaa	atent	wNTp_uaa1	0.003617		0.044943	-0.08447	0.091704
farm #	ate	wp_farm1	-1.1352	***	0.028522	-3.1911	-0.0793
	atent	wNTp_farm1	0.029872		0.03061	-0.03012	0.089866
LSU/ha	ate	wp_livch1	45.82037	***	14.23917	17.91211	73.72862
	atent	wNTp_livch1	12.13051	***	4.86288	2.599443	21.66158

Robustness check: Rosenbom sensitivity anakysis

Discussion

- Relevance of spatial spillover
- Biogas plant distribution is spatially **uneven**
- Legal constraints affect **sourcing area** of biomass and **transport costs**
- Biogas diffusion has impacted on **land demand and livestock intensity**
- **Preliminar analysis … relevance of the method**

Next steps

- Test spatial weight matrix (inverse distance matrix) with constraint 70 km
- Check different outcomes and explanaroty variables (rental prices)
- Improve model interptretation
- Testing other treatments: number and size of biogas plants (dose-response model)

Thank you!

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Discussion\2

Further research

What is it missing	How could it be fixed
Non-rural drivers of rural area Viability: sector mobility, off-farm income, availability of infrastructures	Supplementing the dataset
Block modelling of the treatment	Using different methodologies for testing results and try deliver robust ATE estimates

Sustainability indicators – outcome variables (Y=ATT)

1. Hired labour
2. Household labour
3. Utilised agricultural area
4. Number of farms
5. Livestock intensity

plant	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
altitude	.9984804	.0004708	-3.23	0.001	.9975581	.9994036
lit	.5756035	.2183307	-1.46	0.145	.2736883	1.210572
mont	.488158	.1151777	-3.04	0.002	.3074149	.7751681
pop_00	.999999	1.20e-06	-0.84	0.401	.9999966	1.000001
density_00	.9997072	.000196	-1.49	0.135	.9993232	1.000091
wine_ha	.9994208	.0003824	-1.51	0.130	.9986715	1.000171
olive_ha	.9995233	.0004216	-1.13	0.258	.9986973	1.00035
lab_mainhh	.9973923	.0020526	-1.27	0.205	.9933775	1.001423
cond_dir	.9153155	.0357053	-2.27	0.023	.8479426	.9880414
cond_sal	.9158206	.0356865	-2.26	0.024	.8484805	.9885051
farmnum	1.096241	.0427893	2.35	0.019	1.015503	1.183398
taal	1.00343	.0037771	0.91	0.363	.9960546	1.010861
no_taa	.997282	.0391728	-0.07	0.945	.9233857	1.077092
land_rent_nu	1.004498	.0030042	1.50	0.133	.9986274	1.010404
land_prop_nu	.9990746	.0003416	-2.71	0.007	.9984053	.9997444
uaal	.9934039	.0038507	-1.71	0.088	.9858852	1.00098
live_head	1.000033	.0000461	0.72	0.474	.9999427	1.000123
liv_num	1.001507	.0031009	0.49	0.627	.9954476	1.007603
live_cow	1.000102	.0001366	0.75	0.454	.9998346	1.00037
farmer_day	.9999999	9.00e-06	-0.02	0.988	.9999822	1.000018
fam_day	1.000038	.0000299	1.26	0.208	.9999791	1.000096
hh_day	1.000068	.0000281	2.43	0.015	1.000013	1.000123
tot_hh	.9999774	.0000227	-1.00	0.319	.9999329	1.000022
tractown_num	.9981	.000792	-2.40	0.017	.996549	.9996534
equip_num	1.003824	.0027329	1.40	0.161	.9984821	1.009195
equip_sum	.9978189	.0019619	-1.11	0.267	.9939811	1.001672
cereal_farm	.9992889	.0008686	-0.82	0.413	.9975879	1.000993
vegetable_nu	1.00021	.001487	0.14	0.888	.9972998	1.003129
vegetable_ha	1.00028	.0004313	0.65	0.516	.9994349	1.001125
fodder_ha	1.000451	.0001837	2.45	0.014	1.000091	1.000811
foddre_nu	.9974343	.0016178	-1.58	0.113	.9942685	1.00061
_cons	.0540365	.0083123	-18.97	0.000	.0399714	.0730508

Logistic regression on covariates

Balance of covariates: placebo OLS regression on covariates
R^2=0.8949

Results (Diff.inDiff. 2010-2000)
Average annual effects on biogas-host municipalities

Variable	Sample	Treated	Controls	Difference	Std. Err.	[95% Conf.	Interval]	
HLdiff	Unmatched	441.86	104.973264	336.886736	693.0544	-2040.63	744.8603	(N)
	ATT	441.86	350.280792	91.5792076		-2072.704	252.1491	(P)
						-2072.704	524.0533	(BC)
hhLdiff	Unmatched	312.731959	198.798704	113.933255	709.338	-1992.905	858.0314	(N)
	ATT	312.731959	880.168599	-567.43664		-1920.687	469.4555	(P)
						-1804.47	587.9859	(BC)
UAAdiff	Unmatched	33.089964	-46.7965106	79.8864746	54.599	-49.22894	170.2127	(N)
	ATT	33.089964	-27.4019056	60.4918696		-33.76959	180.5949	(P)
						.8450283	186.7943	(BC)
Fdiff	Unmatched	-89.5309278	-96.1274964	6.59656853	16.93983	-42.82306	25.26065	(N)
	ATT	-89.5309278	-80.7497217	-8.78120614		-51.82318	12.46815	(P)
						-38.99933	26.99867	(BC)
LSUdiff	Unmatched	1.99955991	2.73834621	-.738786296	.8929052	-2.325588	1.263132	(N)
	ATT	1.99955991	2.53078767	-.53122776		-2.350833	1.574421	(P)
						-2.350833	1.574421	(BC)

Sensitivity analysis

Discussion\1

- Biogas plant distribution is spatially **uneven**
- Legal constraints affect feedstock **sourcing area** and **transport costs**
- Biogas diffusion has impacted on **land demand**
  - Scale
  - Supply contracts

Discussion\2

Further research

What is it missing	How could it be fixed
Non-rural drivers of rural area Viability: sector mobility, off-farm income, availability of infrastructures	Supplementing the dataset
Block modelling of the treatment	Using different methodologies for testing results and try deliver robust ATE estimates

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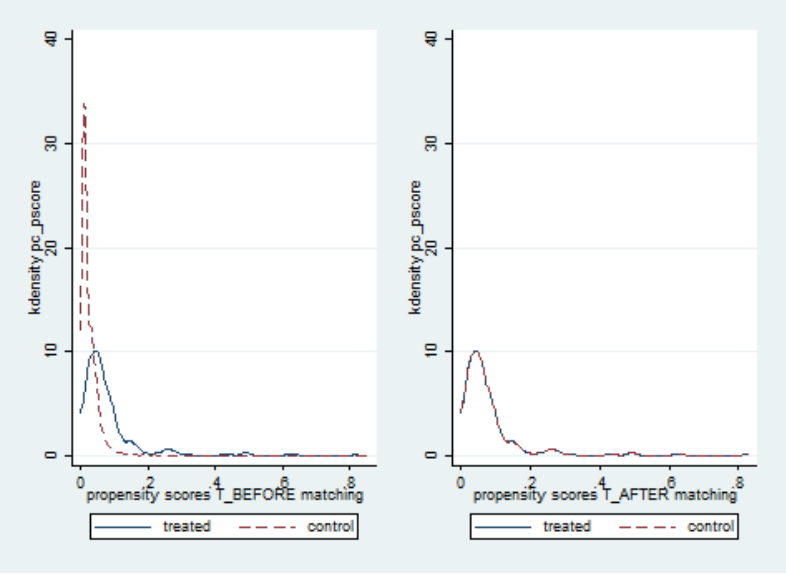
	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
altitude	0.9988	0.0004	-2.85	0.004	0.998	1.000
lit	0.5450	0.2111	-1.57	0.117	0.255	1.164
mont	0.4555	0.1032	-3.47	0.001	0.292	0.710
pop_00	1.0000	0.0000	-1.04	0.298	1.000	1.000
density_00	0.9997	0.0002	-1.72	0.086	0.999	1.000
wine_ha	0.9993	0.0004	-1.75	0.080	0.999	1.000
olive_ha	0.9994	0.0004	-1.39	0.164	0.999	1.000
lab_mainhh	0.9963	0.0022	-1.7	0.090	0.992	1.001
cond_dir	0.9119	0.0349	-2.41	0.016	0.846	0.983
cond_sal	0.9125	0.0349	-2.39	0.017	0.847	0.984
farmnum	1.1012	0.0422	2.52	0.012	1.022	1.187
taa1	1.0057	0.0038	1.51	0.132	0.998	1.013
no_taa	1.0138	0.0180	0.77	0.440	0.979	1.050
land_rent_nu	1.0045	0.0030	1.47	0.140	0.999	1.010
land_pror_nu	0.9988	0.0003	-3.33	0.001	0.998	1.000
uaa1	0.9905	0.0038	-2.48	0.013	0.983	0.998
live_head	1.0000	0.0000	0.3	0.767	1.000	1.000
liv_num	1.0055	0.0026	2.13	0.033	1.000	1.011
live_cow	1.0001	0.0001	0.95	0.344	1.000	1.000
farmer_day	1.0000	0.0000	-0.61	0.545	1.000	1.000
fam_day	1.0000	0.0000	0.93	0.350	1.000	1.000
hh_day	1.0001	0.0000	2.51	0.012	1.000	1.000
tot_hh	1.0000	0.0000	-0.48	0.632	1.000	1.000
tractown_num	0.9977	0.0008	-2.91	0.004	0.996	0.999
equip_num	1.0039	0.0026	1.47	0.143	0.999	1.009
equip_sum	0.9980	0.0018	-1.11	0.269	0.994	1.002
cereal_farm	0.9989	0.0008	-1.3	0.195	0.997	1.001
vegetable_nu	1.0008	0.0014	0.54	0.588	0.998	1.004
vegetable_ha	1.0002	0.0004	0.46	0.642	0.999	1.001

Goodness of matching



Common Support

Extent to which distributions of propensity scores in treatment and comparison groups **overlap**