Do renewables create local jobs?

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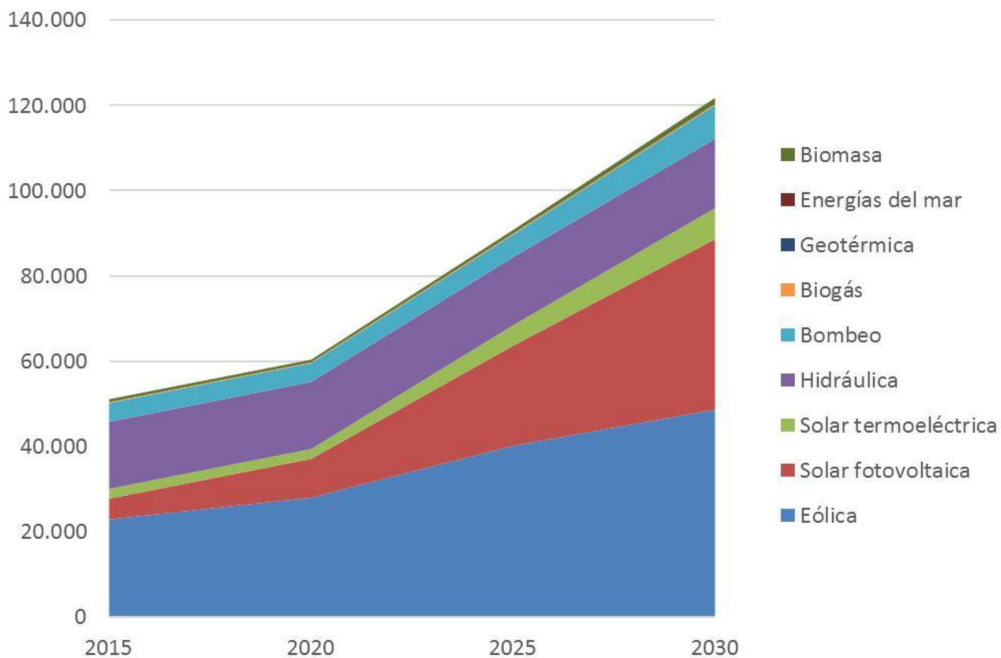
Workshop CEMFI-BdE

Motivation

- Renewable energy is bound to increase significantly:
  - The EU climate and energy framework sets a **renewable energy target** of at least 32% of consumption in 2030 (19.7% in 2019).
  - Spain's PNIEC 2021-2030 aims at reaching 42% in 2030 (18.3% in 2019).

Figura 2.7. Capacidad instalada de tecnologías renovables (MW)



Fuente: Ministerio para la Transición Ecológica y el Reto Demográfico, 2019

Motivation

- Increasing concerns on the local effects of renewable plants on environmental and economic grounds.

Medio Ambiente

En pie de guerra por las energías renovables

El alud de 'macroplantas' eólicas y solares hace elevar la protesta de ecologistas, agricultores y vecinos

Manifestación contra el macroparque solar de Coín, Málaga. / EL PERIÓDICO

Motivation

- In Spain, the location of renewable energy plants speaks to the debate on the spatial distribution of population.

EL PAÍS Sociedad SUSCRÍBETE INICIAR SESIÓN

NOTICIA PATROCINADA

Viento y sol para llenar la España vacía

Endesa ha impulsado la construcción de parques eólicos y fotovoltaicos en 37 municipios. Una manera de acelerar la transición ecológica y revitalizar comarcas que sufren despoblación

This Paper

- We study the **local labor market** effects of renewable plant investments in Spain (2003-2018).
  - Before and after the plant opening date, to capture the effects of the construction and maintenance phases.
  - We focus on solar, wind and biomass energies.

- **We find:**
  - Results are strongly heterogeneous by technology.
  - An employment increase of plants/firms based in the municipality where a solar or biomass plant is opened.
    - ⇒ for a 0.5 MW solar plant, the employment multipliers imply 1.4 and 0.9 more jobs one year before and after the start-up, respectively.
    - ⇒ job creation by solar plants in our sample period (5.9k MW invested) would reach 16k and 11k jobs, respectively.
    - ⇒ biomass is more labor intensive yet it is less prevalent (328 MW) ⇒ job creation would attain 1.5k - 0.8k jobs.
  - A small decrease in the number of unemployed workers living in the municipality.

The Data

Administrative registry of renewable energy plants

- Originated from the obligation to register plants producing electricity from renewable sources.
- Variables: energy type, installed capacity, municipality, registry and start-up dates.

Number of renewable plants and installed capacity

	N	Median (MW)	Mean (MW)
	(1)	(2)	(3)
Solar	61,196	0.1	0.2
Wind	1,104	17.9	20.0
Biomass/bioliquid	206	1.1	3.3
Total	62,506	0.1	0.6

Notes: The sample is restricted to plants opened after 2003.

Administrative registry of renewable energy plants

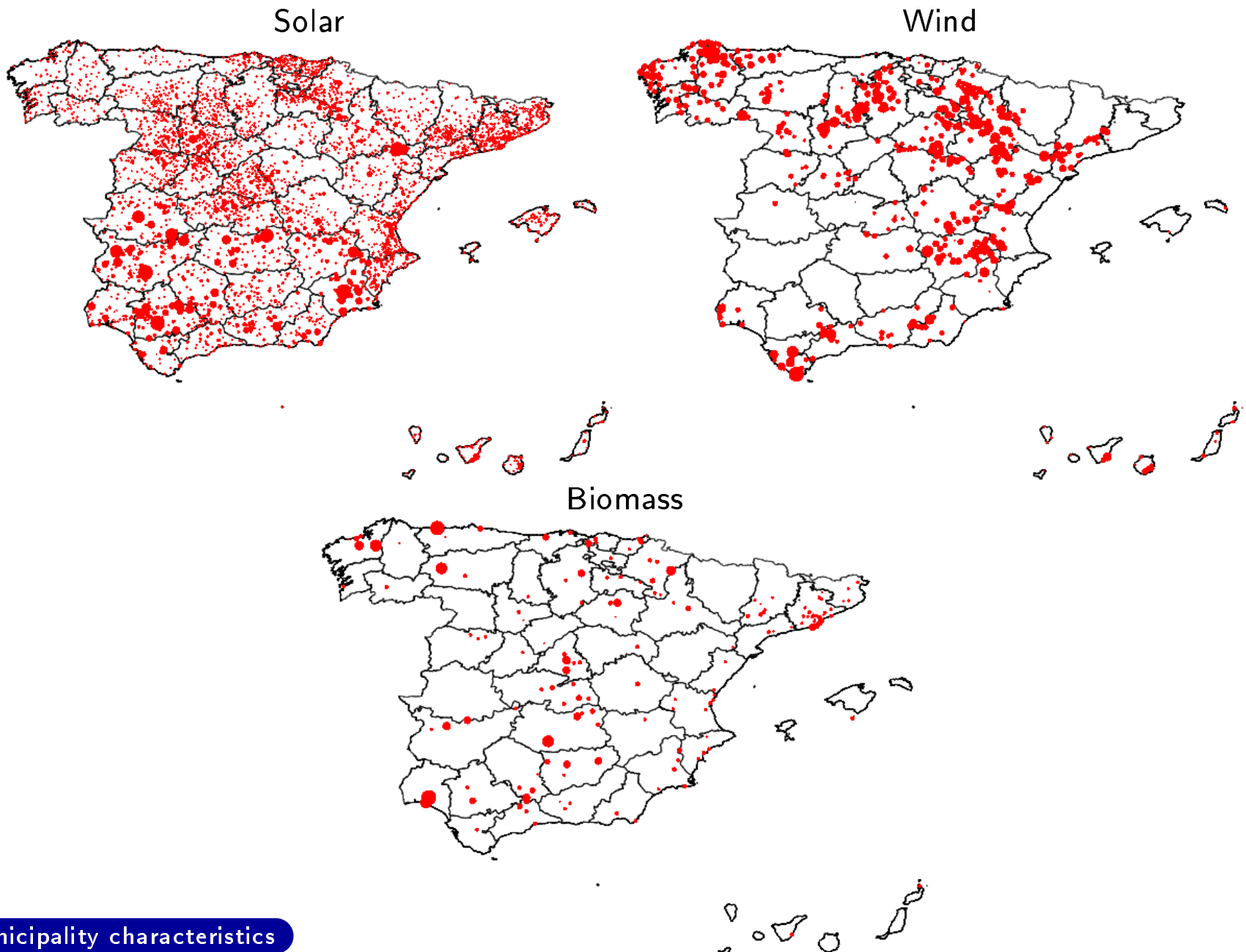
- There are two relevant dates: final registration and start-up date.
- We use the **start-up date** as the $t = 0$ event:
  - This is the date of a test to confirm the plant's power $\Rightarrow$ it indicates that the construction process is completed.
  - It precedes the final registration date.
  - Between the two dates, administrative procedures (the median is about 1-2 months).
- Our **event window** spans three years before and two years after the plant start-up date.

  $\Rightarrow$ **Construction periods** are about 6-12 months for photovoltaic plants, 14-24 months for wind parks and 15 months for biomass plants.

Renewable plants' construction and maintenance processes

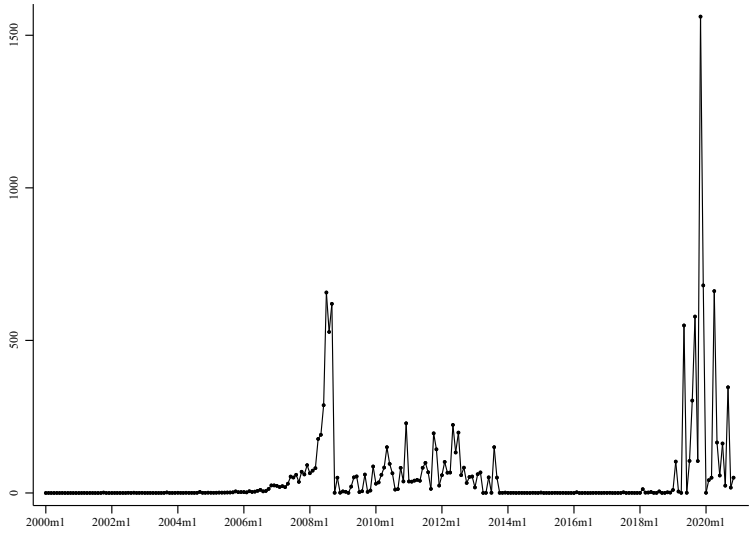
- Widely **heterogeneous by technology** and size of the plant.
- Phases (according to IRENA reports): project planning, manufacturing, transportation, installation, and operation and maintenance.
  - Transportation, construction and maintenance are more likely to be done at the local level in solar and biomass plants (wind blades require especial equipment and skills).
  - The installation phase (construction) requires both construction workers and technical personnel.
  - Operation and maintenance of solar and wind parks do not require a large staff.
  - Biomass plants are more labor-intensive, since they require the collection, transportation, storage, and process of biomass.

Spatial distribution of all renewable energy plants

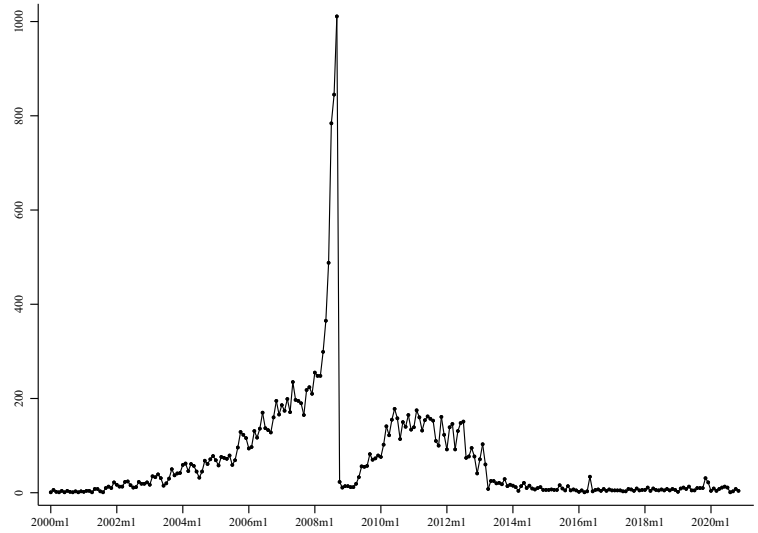


Over time distribution of plant openings - solar

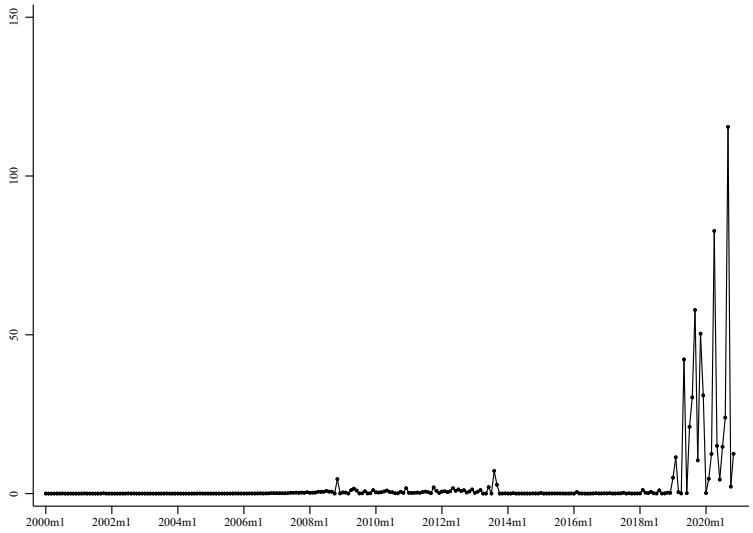
Installed capacity (MW)



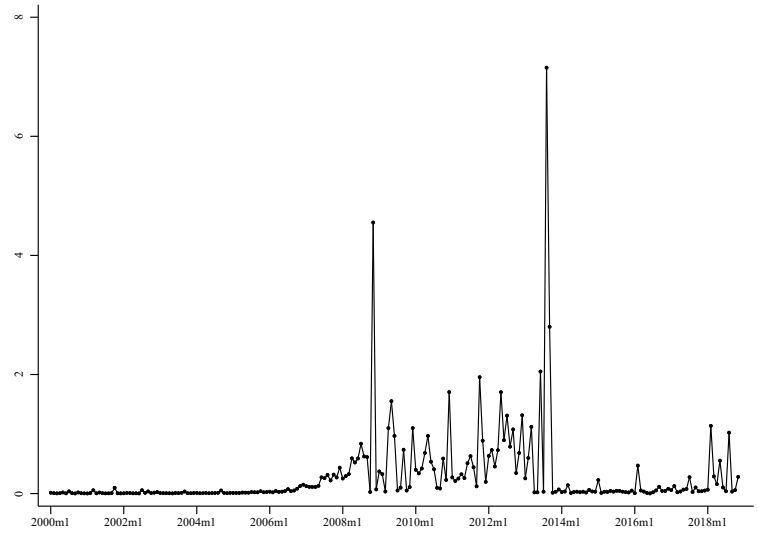
N. of municipalities opening at least one plant



Avrg. size of plants: 2003 - 2020

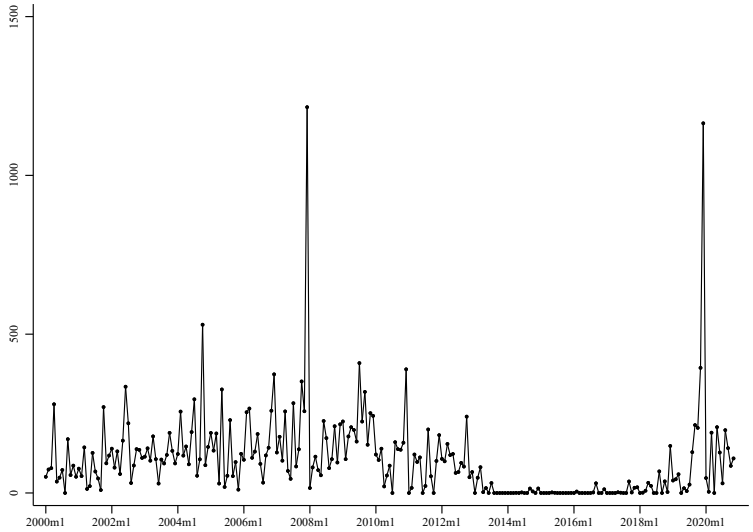


Avrg. size of plants: 2003 - 2018

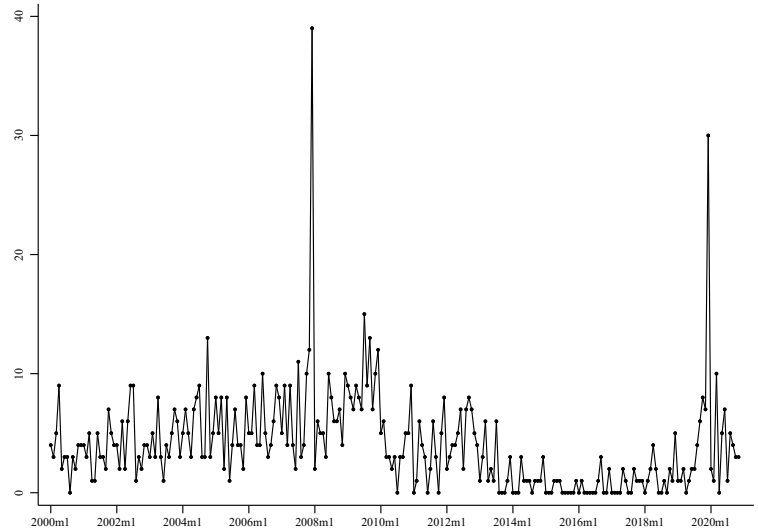


Over time distribution plant openings- wind

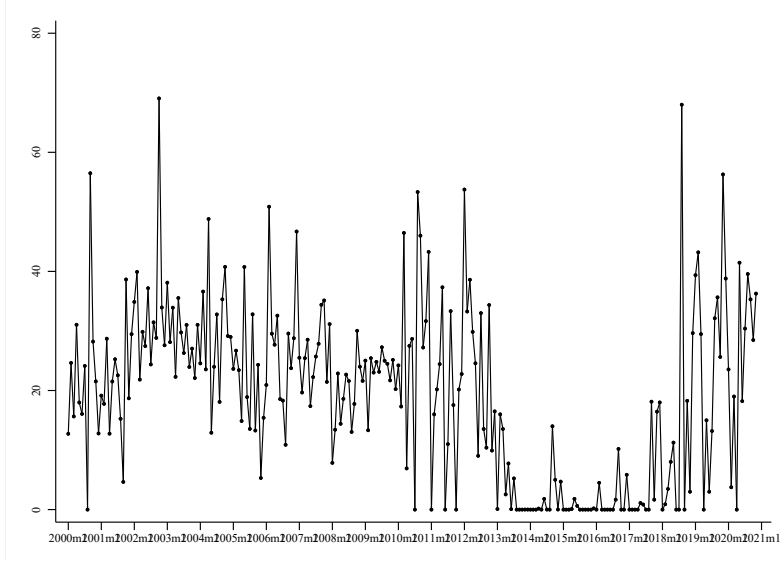
Installed capacity (MW)



N. of municipalities opening at least one plant

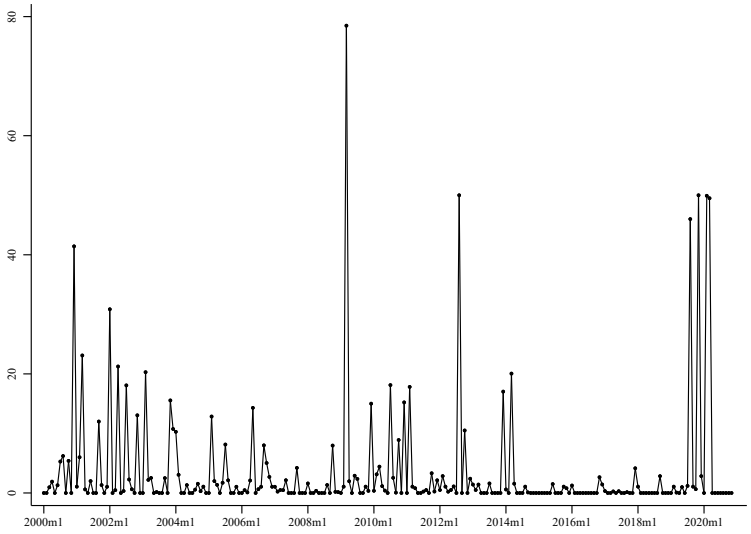


Avrg. size of plants opened

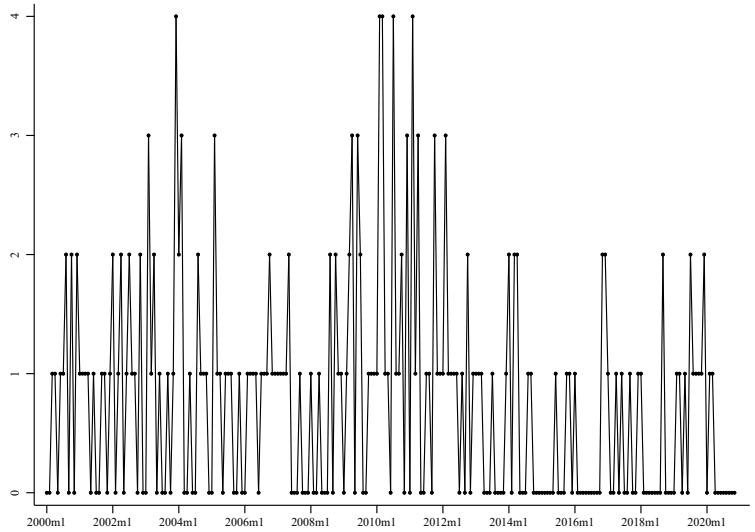


Over time distribution plant openings - biomass

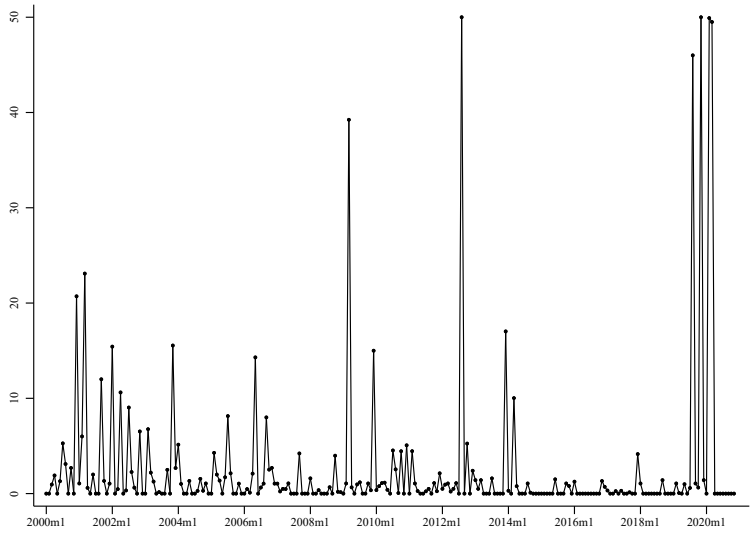
Installed capacity (MW)



N. of municipalities opening at least one plant



Avrg. size of plants opened



Municipality labor market data

1. Social Security affiliates (since January 2003)
   - \+ Unaffected by participation rates.
   - – Figures correspond to firms'/plants' addresses.
   - – One person can have more than one affiliation.
   - – The data is censored if the number of affiliates is below 5 (since Feb. 2019, if this happens in *any* SS regime).
2. Registered unemployment (since May 2005)
   - \+ Figures correspond to workers' place of residence.
   - \+ Allows a disaggregation by sector and gender.
   - – Covers workers only if registered in an employment office.
   - – Affected by participation rates
   - – Shorter series.

Interpretation of labor market data & rural/urban locations

- The employment effects are a proxy of the *local* economic benefits reaped through the labor market.
- Unemployment effects might understate them if newly hired workers are not registered unemployed or participation rates or migration change.
- Rural / urban dichotomy:
  - Urban employment effects are expected to be larger, since they are more likely to host the plants carrying out the investment.
  - Disparities between employment and unemployment are expected to be larger in rural areas.
  - Spatial effects should be larger in urban areas.

Empirical approach

Empirical approach

- **Local projections** approach of Alloza and Sanz (2021)):

$$y_{i,t+h} = \alpha_{h,i} + \lambda_{h,t} + \beta_h R_{i,t} + \gamma_h X_{i,t} + \epsilon_{i,t+h},$$

where:

  - $h = -36, ..., 0, ...24.$
  - $y_{i,t+h}$: employment or unemployment in municipality i in month $t+h$.
  - $R_{i,t}$: installed capacity of the plant being opened in t.
  - $X_{i,t}$: set of lags of the dependent variable, from $t-42$ to $t-37$ and 12 lags of $R_{i,t}$.
  - $y_{i,t+h}$, $R_{i,t}$ and the variables included in $X_{i,t}$ are normalized by population in $t-25 \Rightarrow \beta_h$ is the **job multiplier** in $t+h$ of a 1 MW opened in t.

- We focus on municipalities with more than 1,000 inhabitants and with at least one plant opening.

Empirical approach

- The **cumulative effects** are estimated through the following regression:

$$\frac{1}{12}\sum_{h=-12}^{11} y_{i,t+h} = \tilde{\alpha}_i + \tilde{\lambda}_t + \tilde{\beta} R_{i,t} + \tilde{\gamma} X_{i,t} + \tilde{\epsilon}_{i,t},$$

  where:

  - $\tilde{\beta}$ measures the overall effect (in jobs-years) of a plant's opening, during the period one year before and one year after.
  - We also break the cumulative multiplier into the yearly pre- and post-start-up dates (construction and maintenance periods, respectively).

Sample descriptive statistics

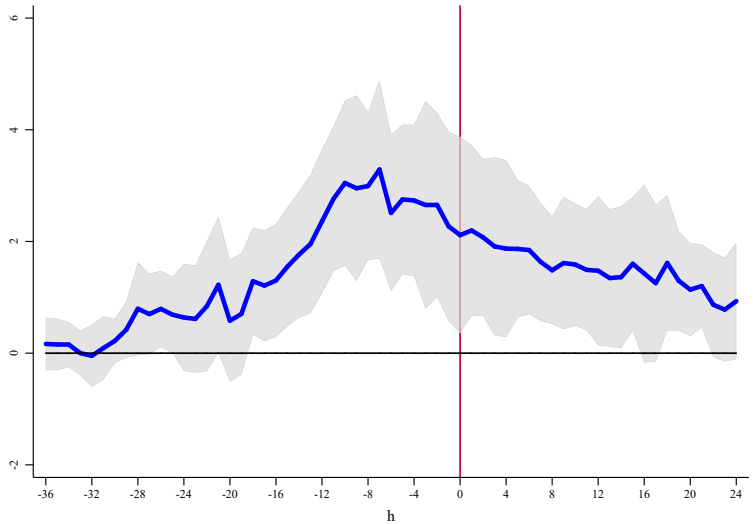
	(1) Solar	(2) Wind	(3) Biomass
Municipalities opening at least one plant			
All	2210	168	79
Rural	1482	117	26
Urban	728	51	53
Population			
Mean	18,793	22,320	137,430
Percentile 25	2,384	2,430	7,327
Percentile 50	5,187	4,274	20,658
Percentile 75	13,363	13,429	91,714
Population growth			
Mean	0.005	-0.002	0.005
Percentile 25	-0.008	-0.014	-0.005
Percentile 50	0.001	-0.004	0.003
Percentile 75	0.014	0.006	0.012
Size of shocks (MW)			
mean	0.528	18.723	3.350
Percentile 25	0.016	4.000	0.499
Percentile 50	0.050	14.400	1.063
Percentile 75	0.110	28.000	1.600

Results

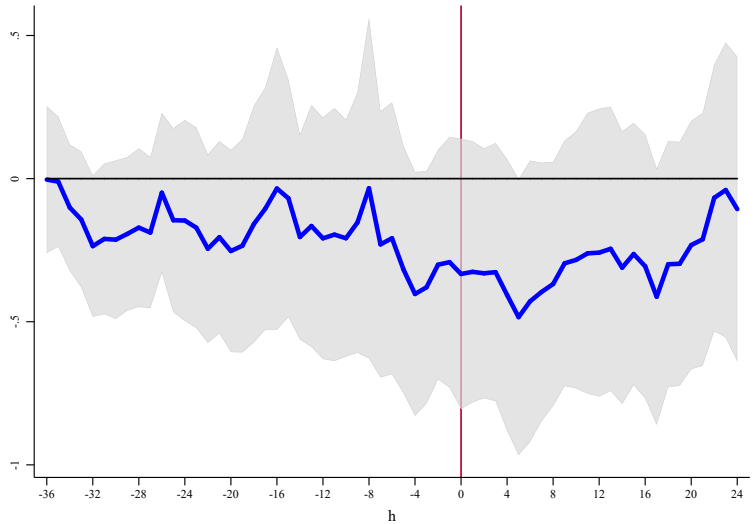
employment of local plants

Employment effects - baseline

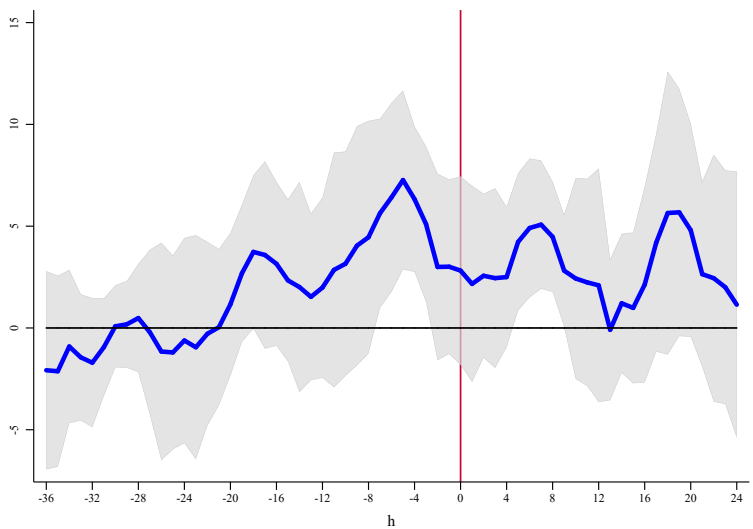
Solar



Wind



Biomass



Employment effects - cumulative

CUMULATIVE EMPLOYMENT EFFECTS PER MEGAWATT INVESTED

	(1) Solar	(2) Wind	(3) Biomass
Overall (2 years)	4.552***	-0.597	7.659*
	(1.342)	(0.409)	(3.954)
Pre-opening	2.749***	-0.244	4.437**
	(0.709)	(0.205)	(2.255)
Post-opening	1.803***	-0.353	3.223*
	(0.638)	(0.220)	(1.755)
Observations	359,172	359,172	359,172
Municipalities	2,398	2,398	2,398

Effects by Sector

Employment effects - rural vs. urban municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	2.355***	2.512***	2.114**	1.842***	1.465**	2.749***	1.803***
	(0.656)	(0.714)	(0.897)	(0.584)	(0.679)	(0.709)	(0.638)
Rural	2.320***	2.458***	2.063**	1.795***	1.395**	2.711***	1.758***
	(0.659)	(0.715)	(0.898)	(0.589)	(0.682)	(0.713)	(0.641)
Urban	4.190**	5.878***	2.628	2.679**	2.100*	4.655***	2.409*
	(1.899)	(1.874)	(1.675)	(1.256)	(1.247)	(1.679)	(1.255)
Wind							
Baseline	-0.209	-0.208	-0.333	-0.428*	-0.259	-0.244	-0.353
	(0.215)	(0.242)	(0.241)	(0.251)	(0.257)	(0.205)	(0.220)
Rural	-0.205	-0.202	-0.346	-0.454*	-0.295	-0.246	-0.380*
	(0.210)	(0.235)	(0.234)	(0.247)	(0.251)	(0.200)	(0.216)
Urban	-3.048	-3.244	-4.155*	-3.331	-4.142	-3.002	-3.472
	(2.322)	(3.299)	(2.130)	(3.524)	(2.858)	(2.686)	(3.048)
Biomass							
Baseline	1.985	6.416***	2.819	4.910***	2.095	4.437**	3.223*
	(2.258)	(2.369)	(2.356)	(1.740)	(2.927)	(2.255)	(1.755)
Rural	1.961	6.032***	2.672	4.393***	1.997	4.336*	3.029*
	(2.273)	(2.331)	(2.334)	(1.628)	(2.932)	(2.261)	(1.741)
Urban	-3.402	13.432	-1.667	15.092	-12.107	-2.879	-4.500
	(19.185)	(28.510)	(23.908)	(30.245)	(23.962)	(23.055)	(24.754)

Employment effects - robustness/sensitivity

- Alternative dynamic structures. Details
- Controlling for serial correlation in R_t. Details
- Region-time fixed effects. Details
- Province-time fixed effects. Details
- Population deciles-time fixed effects. Details
- Population growth deciles-time fixed effects. Details

Table - solar Table - wind Table - biomass

Employment effects - summary

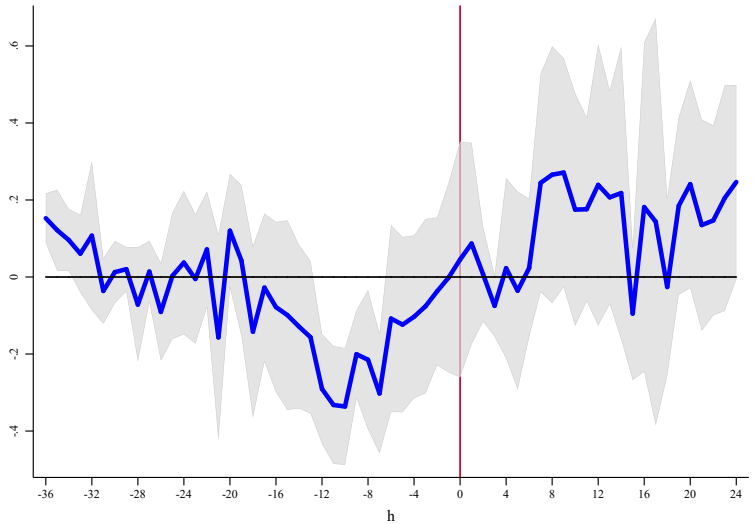
- One MW of **solar energy** is associated with 2.7 and 1.8 more jobs in local firms in the year before and after the plant start-up date, respectively.
  - This entails a job creation of 0.42 and 0.27 per €100,000, respectively.
  - Job creation in urban areas would be larger: 4.6 and 2.4 more jobs, respectively.
  - For solar plants opened after 2019, we find lower and less persistent employment effects. Details
- We find no employment increases in the months surrounding the opening of **wind parks**.
- **Biomass plants** would create the largest amount of jobs, 4.4 and 3.2 in the year before and after the start-up, respectively.
  - The multiplier per €100,000 would be 0.1 and 0.07, respectively.

Results

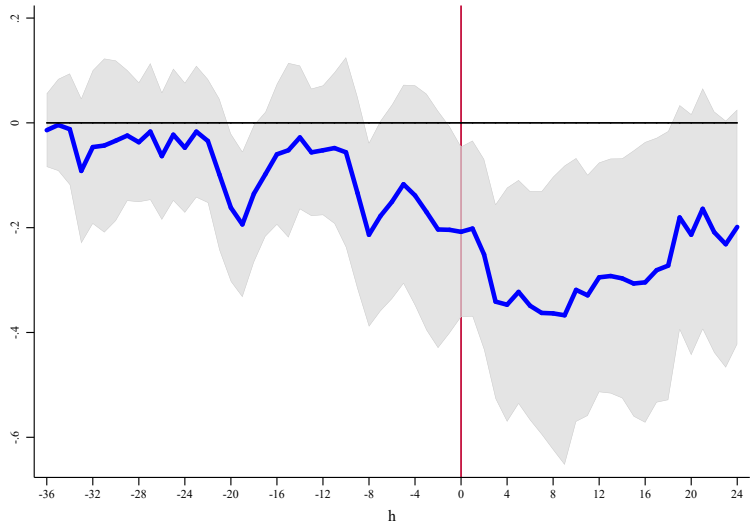
local unemployment

Unemployment effects - baseline

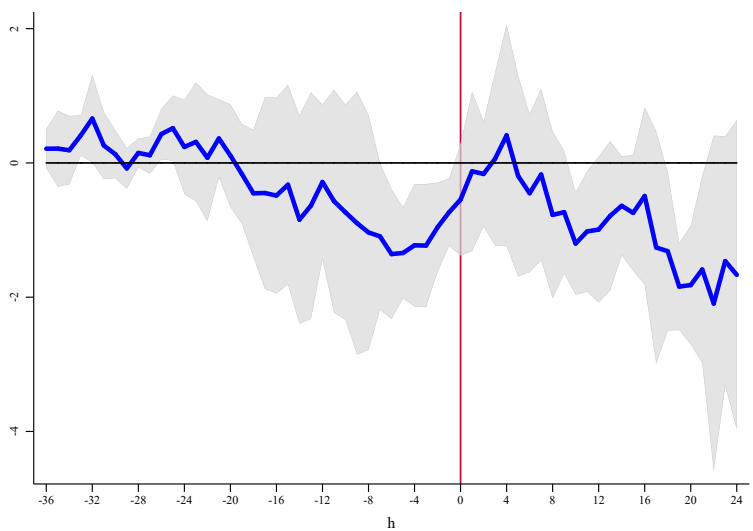
Solar



Wind



Biomass



Unemployment effects - cumulative

CUMULATIVE LOCAL LABOR MARKET EFFECTS PER MEGAWATT INVESTED

	(1)	(2)	(3)	(4)	(5)	(6)
	Employment			Unemployment		
	Solar	Wind	Biomass	Solar	Wind	Biomass
Overall (2 years)	4.552***	-0.597	7.659*	-0.077	-0.452***	-1.365**
	(1.342)	(0.409)	(3.954)	(0.154)	(0.169)	(0.644)
Pre-opening	2.749***	-0.244	4.437**	-0.177***	-0.139*	-0.955**
	(0.709)	(0.205)	(2.255)	(0.060)	(0.084)	(0.451)
Post-opening	1.803***	-0.353	3.223*	0.101	-0.313***	-0.409
	(0.638)	(0.220)	(1.755)	(0.109)	(0.098)	(0.325)
Observations	359,172	359,172	359,172	291,138	291,138	291,138
Municipalities	2,398	2,398	2,398	2,389	2,389	2,389

Unemployment effects - rural vs. urban municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	-0.291***	-0.108	0.045	0.023	0.239	-0.177***	0.101
	(0.073)	(0.124)	(0.156)	(0.092)	(0.186)	(0.060)	(0.109)
Rural	-0.258***	-0.071	0.073	0.053	0.260	-0.141***	0.128
	(0.069)	(0.115)	(0.156)	(0.090)	(0.188)	(0.052)	(0.106)
Urban	-1.439***	-1.528**	-1.125**	-1.191	-0.489	-1.531***	-0.928
	(0.402)	(0.678)	(0.474)	(0.857)	(0.615)	(0.412)	(0.567)
Wind							
Baseline	-0.052	-0.151	-0.208**	-0.349***	-0.295***	-0.139*	-0.313***
	(0.063)	(0.095)	(0.083)	(0.111)	(0.112)	(0.084)	(0.098)
Rural	-0.032	-0.120	-0.172**	-0.307***	-0.263**	-0.113	-0.276***
	(0.062)	(0.095)	(0.080)	(0.108)	(0.109)	(0.084)	(0.095)
Urban	-0.676	1.112	-0.847	0.232	0.018	0.579	-0.024
	(1.249)	(0.945)	(1.044)	(1.452)	(1.336)	(0.747)	(1.212)
Biomass							
Baseline	-0.284	-1.357***	-0.546	-0.451	-0.993*	-0.955**	-0.409
	(0.589)	(0.493)	(0.425)	(0.600)	(0.554)	(0.451)	(0.325)
Rural	-0.154	-1.129***	-0.384	-0.209	-0.783	-0.785**	-0.234
	(0.528)	(0.407)	(0.398)	(0.579)	(0.584)	(0.383)	(0.304)
Urban	-8.543***	-13.513***	-8.697***	-10.936***	-10.753***	-10.076***	-7.019***
	(3.064)	(3.416)	(3.143)	(2.392)	(3.109)	(2.689)	(2.684)

Unemployment effects by sector - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	-0.291***	-0.108	0.045	0.023	0.239	-0.177***	0.101
	(0.073)	(0.124)	(0.156)	(0.092)	(0.186)	(0.060)	(0.109)
Services	-0.060	-0.005	-0.026	-0.038	0.075	-0.029	0.000
	(0.098)	(0.075)	(0.100)	(0.058)	(0.083)	(0.080)	(0.062)
Industry	-0.025*	-0.054***	-0.037**	-0.035**	0.005	-0.043***	-0.016
	(0.014)	(0.010)	(0.016)	(0.017)	(0.014)	(0.008)	(0.012)
Construction	-0.108***	0.092	0.248*	0.093	0.072**	0.053	0.136**
	(0.030)	(0.072)	(0.128)	(0.057)	(0.029)	(0.039)	(0.056)
Agriculture	-0.067***	-0.079***	-0.091***	-0.002	0.085	-0.105***	-0.010
	(0.021)	(0.027)	(0.020)	(0.057)	(0.136)	(0.023)	(0.061)
No previous sector	0.010	-0.014	-0.005	0.043*	0.035**	-0.009	0.028
	(0.021)	(0.015)	(0.010)	(0.025)	(0.016)	(0.013)	(0.018)

Unemployment effects by sector - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Baseline	-0.052	-0.151	-0.208**	-0.349***	-0.295***	-0.139*	-0.313***
	(0.063)	(0.095)	(0.083)	(0.111)	(0.112)	(0.084)	(0.098)
Services	-0.105*	-0.163***	-0.138***	-0.259***	-0.189***	-0.137**	-0.204***
	(0.056)	(0.054)	(0.050)	(0.066)	(0.064)	(0.054)	(0.056)
Industry	0.019	-0.001	-0.029	-0.054*	-0.034	-0.006	-0.053**
	(0.026)	(0.030)	(0.028)	(0.031)	(0.034)	(0.024)	(0.026)
Construction	-0.009	-0.007	-0.044*	-0.008	-0.026	-0.016	-0.024
	(0.049)	(0.033)	(0.027)	(0.030)	(0.028)	(0.033)	(0.025)
Agriculture	0.008	-0.023	-0.026	-0.056**	-0.065**	-0.021	-0.052**
	(0.020)	(0.022)	(0.025)	(0.025)	(0.031)	(0.020)	(0.025)
No previous sector	0.051	0.043	0.043	0.023	0.032	0.044	0.020
	(0.037)	(0.045)	(0.026)	(0.030)	(0.032)	(0.042)	(0.026)

Unemployment effects by sector - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Biomass							
Baseline	-0.284	-1.357***	-0.546	-0.451	-0.993*	-0.955**	-0.409
	(0.589)	(0.493)	(0.425)	(0.600)	(0.554)	(0.451)	(0.325)
Services	0.208	-0.571**	-0.182	-0.040	-0.340	-0.307**	-0.096
	(0.190)	(0.225)	(0.270)	(0.477)	(0.268)	(0.151)	(0.306)
Industry	-0.142	-0.353**	0.014	-0.219*	0.249	-0.227***	0.011
	(0.097)	(0.150)	(0.173)	(0.118)	(0.183)	(0.078)	(0.112)
Construction	0.017	0.026	-0.106	-0.001	-0.577***	0.017	-0.056
	(0.359)	(0.231)	(0.195)	(0.359)	(0.131)	(0.171)	(0.320)
Agriculture	-0.260	-0.330	-0.155	-0.136	-0.099	-0.310	-0.143
	(0.269)	(0.246)	(0.248)	(0.157)	(0.276)	(0.259)	(0.191)
No previous sector	-0.111	-0.154	-0.103	-0.055	-0.202***	-0.117	-0.096
	(0.106)	(0.143)	(0.100)	(0.084)	(0.074)	(0.143)	(0.078)

Unemployment effects by gender and age group - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	-0.291***	-0.108	0.045	0.023	0.239	-0.177***	0.101
	(0.073)	(0.124)	(0.156)	(0.092)	(0.186)	(0.060)	(0.109)
Males	-0.305***	-0.128*	0.056	0.002	0.175	-0.161***	0.061
	(0.050)	(0.070)	(0.119)	(0.055)	(0.122)	(0.037)	(0.065)
Males < 25	-0.055***	0.018	0.051	0.034***	0.068	0.002	0.046***
	(0.009)	(0.017)	(0.037)	(0.013)	(0.044)	(0.010)	(0.014)
Males $25 - 45$	-0.190***	-0.117***	-0.002	-0.052**	0.062	-0.119***	0.003
	(0.041)	(0.035)	(0.077)	(0.024)	(0.067)	(0.024)	(0.037)
Males > 45	-0.054**	-0.033	0.014	0.017	0.052*	-0.040**	0.019
	(0.023)	(0.026)	(0.026)	(0.026)	(0.031)	(0.019)	(0.024)
Females	0.028	0.035	0.012	0.042	0.091	0.001	0.063
	(0.050)	(0.076)	(0.058)	(0.053)	(0.089)	(0.053)	(0.058)
Females < 25	0.018	0.036	0.032	0.005	0.022	0.008	0.033
	(0.031)	(0.035)	(0.026)	(0.019)	(0.041)	(0.026)	(0.029)
Females $25 - 45$	-0.046***	-0.041*	-0.046*	-0.002	0.027	-0.040**	0.004
	(0.017)	(0.023)	(0.025)	(0.022)	(0.051)	(0.019)	(0.025)
Females > 45	0.048**	0.018	0.020	0.018	0.038**	0.022	0.016
	(0.021)	(0.023)	(0.022)	(0.016)	(0.016)	(0.019)	(0.014)

Unemployment effects by gender and age group - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Baseline	-0.052	-0.151	-0.208**	-0.349***	-0.295***	-0.139*	-0.313***
	(0.063)	(0.095)	(0.083)	(0.111)	(0.112)	(0.084)	(0.098)
Males	-0.058	-0.102*	-0.143***	-0.212***	-0.178**	-0.097*	-0.198***
	(0.045)	(0.061)	(0.048)	(0.070)	(0.080)	(0.052)	(0.061)
Males < 25	-0.011	-0.014	-0.024	-0.041*	-0.012	-0.019	-0.035*
	(0.015)	(0.022)	(0.016)	(0.024)	(0.017)	(0.015)	(0.019)
Males $25 - 45$	-0.050*	-0.055*	-0.079***	-0.126***	-0.100**	-0.053**	-0.109***
	(0.030)	(0.032)	(0.024)	(0.040)	(0.047)	(0.027)	(0.032)
Males > 45	-0.003	-0.034	-0.047**	-0.047**	-0.074**	-0.030	-0.059***
	(0.025)	(0.021)	(0.024)	(0.023)	(0.031)	(0.023)	(0.021)
Females	0.011	-0.039	-0.060	-0.128**	-0.113**	-0.036	-0.110**
	(0.036)	(0.049)	(0.048)	(0.057)	(0.051)	(0.043)	(0.051)
Females < 25	-0.016	-0.031**	-0.037**	-0.045***	-0.051***	-0.027**	-0.049***
	(0.015)	(0.016)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)
Females $25 - 45$	-0.000	-0.025	-0.016	-0.082***	-0.056*	-0.023	-0.062**
	(0.031)	(0.038)	(0.030)	(0.031)	(0.033)	(0.030)	(0.027)
Females > 45	0.018	0.009	-0.019	-0.011	-0.018	0.003	-0.011
	(0.019)	(0.025)	(0.024)	(0.031)	(0.026)	(0.022)	(0.027)

Unemployment effects by gender and age group - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Biomass							
Baseline	-0.284	-1.357***	-0.546	-0.451	-0.993*	-0.955**	-0.409
	(0.589)	(0.493)	(0.425)	(0.600)	(0.554)	(0.451)	(0.325)
Males	-0.113	-0.299	-0.197	0.096	-0.633*	-0.321	-0.018
	(0.383)	(0.229)	(0.200)	(0.423)	(0.345)	(0.212)	(0.235)
Males < 25	-0.127	-0.136**	-0.128	-0.008	-0.144*	-0.129	-0.074
	(0.126)	(0.065)	(0.146)	(0.106)	(0.078)	(0.091)	(0.061)
Males $25 - 45$	-0.212	-0.447***	-0.213	0.068	-0.488	-0.358***	-0.027
	(0.300)	(0.166)	(0.197)	(0.295)	(0.330)	(0.136)	(0.224)
Males > 45	0.243***	0.275***	0.149	0.019	-0.000	0.176***	0.085
	(0.052)	(0.086)	(0.097)	(0.088)	(0.056)	(0.067)	(0.101)
Females	-0.127	-1.023***	-0.304	-0.518**	-0.322	-0.591**	-0.351
	(0.236)	(0.326)	(0.282)	(0.258)	(0.301)	(0.261)	(0.260)
Females < 25	-0.176	-0.274**	-0.197	-0.117	-0.037	-0.187	-0.099
	(0.155)	(0.135)	(0.178)	(0.116)	(0.085)	(0.140)	(0.121)
Females $25 - 45$	0.001	-0.576***	-0.190	-0.454***	-0.444**	-0.335**	-0.344**
	(0.151)	(0.179)	(0.157)	(0.170)	(0.204)	(0.143)	(0.163)
Females > 45	0.001	-0.202**	0.026	0.021	0.097	-0.103	0.051
	(0.101)	(0.096)	(0.092)	(0.130)	(0.112)	(0.078)	(0.081)

Unemployment effects - robustness/sensitivity

- Alternative dynamic structures. Details
- Controlling for serial correlation in R_t. Details
- Region-time fixed effects. Details
- Province-time fixed effects. Details
- Population deciles-time fixed effects. Details
- Population growth deciles-time fixed effects. Details

Table - solar Table - wind Table - biomass

Unemployment effects - summary

- We find **small local unemployment decreases** in the months surrounding renewable plant openings.
  - The construction phase of solar and biomass plants would reduce unemployment by 0.17 and 0.96 workers, respectively.
  - Unemployment would be 0.31 lower after the opening of a wind park.
- Lower unemployment (relative to employment) multipliers might suggest smaller job opportunities for local workers, especially in rural areas.
- Solar (mega) plants opened after 2019 deliver smaller unemployment reductions. Details

Results

spatial effects

Spatial effects

- We study the existence of **spillover effects** from nearby (30km) investments by enlarging the baseline specification:

$$y_{i,t+h} = \alpha^*_{h,i} + \lambda^*_{h,t} + \beta^*_h R_{i,t} + \delta_h Z^d_{i,t} + \gamma^*_h X_{i,t} + \epsilon^*_{i,t+h}$$

where:

  - $Z^d_{i,t} = \frac{\sum_{j \neq i \in d} \text{cap}_{j,t}}{\sum_{j \neq i \in d} \text{pop}_{j,t-24}}$: normalized installed capacity in municipalities within d km.
  - To make β_h and δ_h comparable, the latter is scaled by $\frac{\overline{\text{pop}^d_{t-24}}}{\overline{\text{pop}_{t-24}}}$.

Employment - spatial effects (30 km)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Local Effect	2.313***	2.453***	2.037**	1.709***	1.299**	2.694***	1.679***
	(0.661)	(0.721)	(0.905)	(0.576)	(0.655)	(0.715)	(0.632)
Spatial Effect	0.016	0.052*	0.028	0.112**	0.111***	0.038	0.080**
	(0.031)	(0.030)	(0.042)	(0.045)	(0.034)	(0.028)	(0.034)
Wind							
Local Effect	-0.189	-0.185	-0.327	-0.426*	-0.275	-0.228	-0.354*
	(0.211)	(0.237)	(0.235)	(0.241)	(0.249)	(0.200)	(0.212)
Spatial Effect	-0.014	0.001	0.001	0.004	0.004	-0.004	0.002
	(0.021)	(0.023)	(0.025)	(0.022)	(0.022)	(0.022)	(0.022)
Biomass							
Local Effect	1.846	6.283***	2.539	4.612***	1.728	4.279*	2.914*
	(2.229)	(2.296)	(2.370)	(1.688)	(2.929)	(2.210)	(1.751)
Spatial Effect	-0.168	0.190	0.192	0.415***	0.061	0.098	0.247**
	(0.184)	(0.144)	(0.143)	(0.127)	(0.122)	(0.146)	(0.108)

Alt. distances Rural-urban - solar Rural-urban - wind Rural-urban - biomass

Unemployment - spatial effects (30 km)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Local Effect	-0.258***	-0.077	0.063	0.038	0.257	-0.143**	0.122
	(0.068)	(0.123)	(0.156)	(0.093)	(0.183)	(0.060)	(0.109)
Spatial Effect	-0.037***	-0.031*	-0.025*	-0.013	0.033**	-0.033**	-0.001
	(0.011)	(0.016)	(0.015)	(0.017)	(0.014)	(0.013)	(0.014)
Wind							
Local Effect	-0.024	-0.101	-0.152**	-0.279***	-0.247**	-0.093	-0.250***
	(0.062)	(0.090)	(0.076)	(0.105)	(0.110)	(0.079)	(0.092)
Spatial Effect	-0.008	-0.016**	-0.021***	-0.026***	-0.012	-0.015**	-0.022***
	(0.006)	(0.008)	(0.007)	(0.009)	(0.008)	(0.007)	(0.008)
Biomass							
Local Effect	-0.232	-1.315***	-0.489	-0.388	-0.936*	-0.909**	-0.346
	(0.562)	(0.471)	(0.414)	(0.599)	(0.558)	(0.426)	(0.315)
Spatial Effect	0.065	-0.045	-0.134***	-0.189***	-0.274***	-0.046	-0.181***
	(0.043)	(0.031)	(0.040)	(0.031)	(0.046)	(0.032)	(0.033)

Alt. distances Rural-urban - solar Rural-urban - wind Rural-urban - biomass

Conclusions I

- We find employment increases in local plants in the months surrounding a renewable plant opening.
  - The effects are technology specific, ranging from no effects in wind parks to the highest increase in biomass plants.
  - They are concentrated on the construction period rather than on the operation and maintenance phase.
  - For the average solar plant in 2003-2018, they imply 0.9 and 1.4 more jobs, respectively.
  - The evidence suggests that the job creation of firms in urban areas is higher.
- The effects of renewable plants on local unemployment are much smaller, though they are present in the three technologies.
- Spatial effects are limited, and seem to be larger in urban areas.

Conclusions II

- These effects suggests that municipalities gains (in terms of increased employment or reduced unemployment) from renewable investments are modest, particularly so in rural areas.
- It thus suggests that the investment gains should be more evenly shared with the municipalities for them not to oppose the investments

Thank you

Appendix

Municipality characteristics

	non-renewable	renewable	solar	wind	biomass
	(1)	(2)	(3)	(4)	(5)
Potencia Instalada (KW)	0	9461,9	7465,5	54204,2	27587,3
Solar (% of renewable capacity)	0	91,4	100	57,9	88,6
Wind (% of renewable capacity)	0	12	7,6	100	12,8
Biomass (% of renewable capacity)	0	3,4	3,3	3,6	100
Distance to capital (km)	47,3	41,4	41	45,6	30,4
Height above sea level (m)	789,9	580,2	557	695,1	422,5
Ruggedness (height STD)	88,0	83,8	79,9	103,7	81,5
Temperature (°C)	12,2	13,6	13,7	12,6	14,6
Rainfall (hundreds of ml)	5,9	6	5,9	6,5	5,9
Population in 2018	768,2	10089,8	10911	9004,8	92789,3
Population growth 2011-2018	-10,5	-5,2	-4,7	-7,6	-0,1
Rural (%)	99,1	82,8	81,4	86,1	42,3
House prices (euros/m2)	1028,3	1188,0	1200,4	1027,5	1495,5
# municipios	3740	4376	4000	525	149

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Employment effects, by sector

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	2.355***	2.512***	2.114**	1.842***	1.465**	2.749***	1.803***
	(0.656)	(0.714)	(0.897)	(0.584)	(0.679)	(0.709)	(0.638)
General Regime	2.151***	2.447***	2.026**	1.792***	1.538**	2.643***	1.749***
	(0.633)	(0.683)	(0.851)	(0.511)	(0.621)	(0.677)	(0.586)
Self-employed	0.007	0.016	0.122***	0.048	0.009	0.037	0.064
	(0.045)	(0.052)	(0.037)	(0.041)	(0.042)	(0.028)	(0.040)
Agriculture	0.145	-0.009	0.077	-0.028	-0.068	0.064	0.025
	(0.117)	(0.060)	(0.079)	(0.069)	(0.088)	(0.061)	(0.059)
Wind							
Baseline	-0.209	-0.208	-0.333	-0.428*	-0.259	-0.244	-0.353
	(0.215)	(0.242)	(0.241)	(0.251)	(0.257)	(0.205)	(0.220)
General Regime	-0.181	-0.213	-0.268	-0.425*	-0.226	-0.222	-0.338
	(0.204)	(0.240)	(0.250)	(0.249)	(0.255)	(0.206)	(0.226)
Self-employed	-0.079	-0.167	-0.282**	-0.013	-0.099	-0.182	-0.100
	(0.125)	(0.129)	(0.129)	(0.089)	(0.081)	(0.128)	(0.086)
Agriculture	-0.016	0.004	0.216	-0.203	0.103	0.053	-0.016
	(0.161)	(0.190)	(0.149)	(0.159)	(0.095)	(0.160)	(0.104)
Biomass							
Baseline	1.985	6.416***	2.819	4.910***	2.095	4.437**	3.223*
	(2.258)	(2.369)	(2.356)	(1.740)	(2.927)	(2.255)	(1.755)
General Regime	0.838	4.384**	1.848	4.015**	1.737	2.733*	2.580*
	(1.733)	(1.722)	(1.857)	(1.669)	(2.038)	(1.529)	(1.452)
Self-employed	0.949**	1.888**	0.483*	0.410**	0.071	0.948***	0.386*
	(0.444)	(0.904)	(0.277)	(0.191)	(0.283)	(0.286)	(0.202)
Agriculture	0.381	1.076	0.627	0.417	0.258	0.952	0.232
	(1.017)	(1.327)	(1.093)	(0.722)	(1.235)	(1.231)	(0.769)

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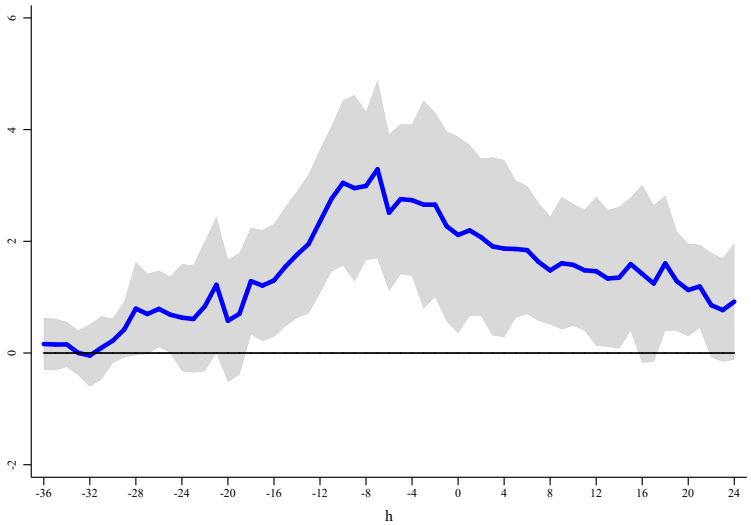
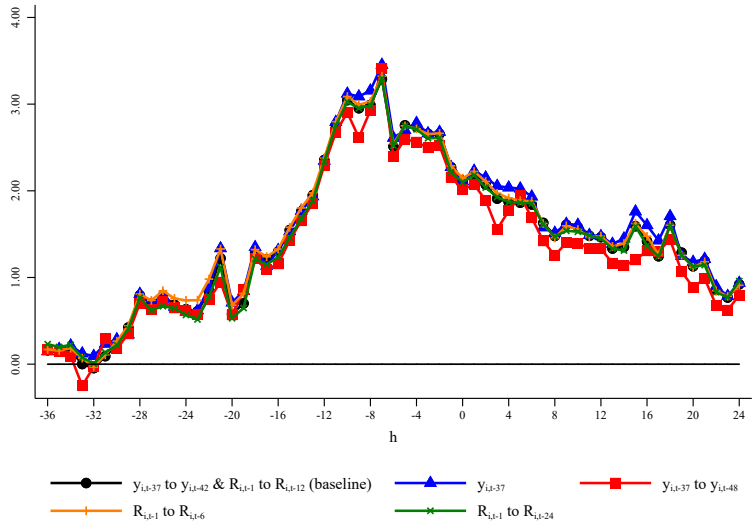
Employment - alternative dynamic structures

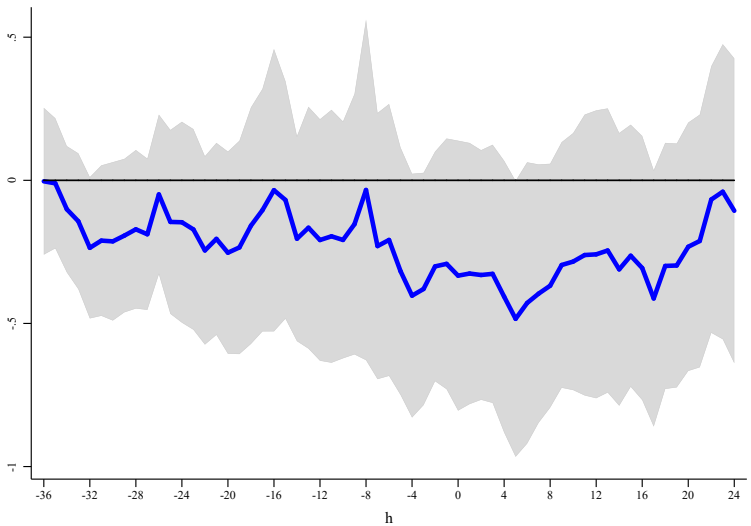
Baseline - solar



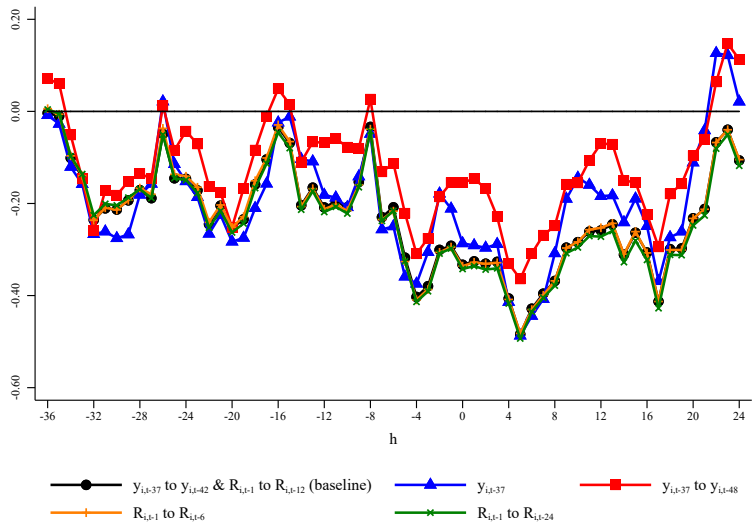
Alternative dynamic structures - solar



Baseline - wind



Alternative dynamic structures - wind



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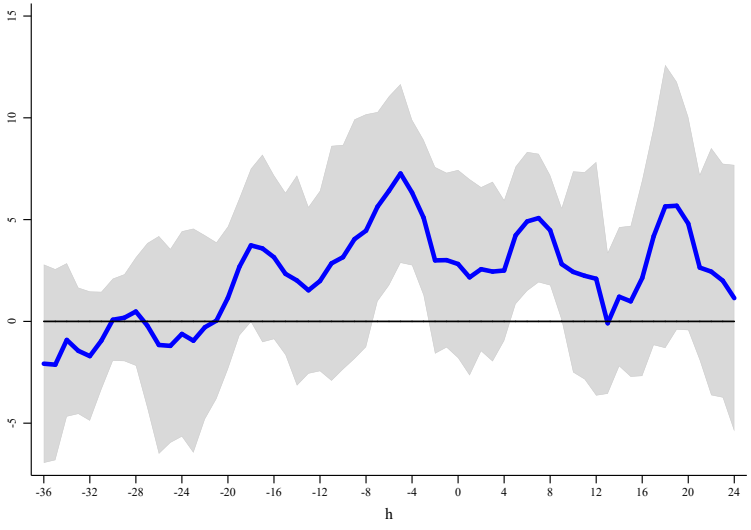
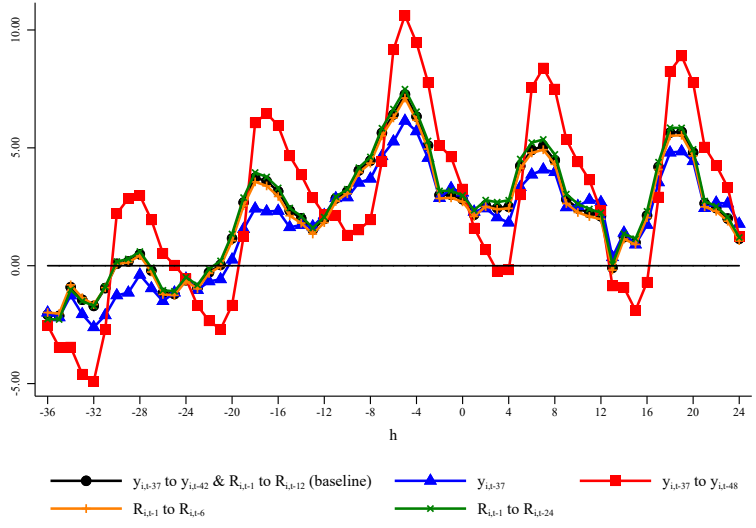
Employment - alternative dynamic structures

Baseline - biomass



Alternative dynamic structures - biomass



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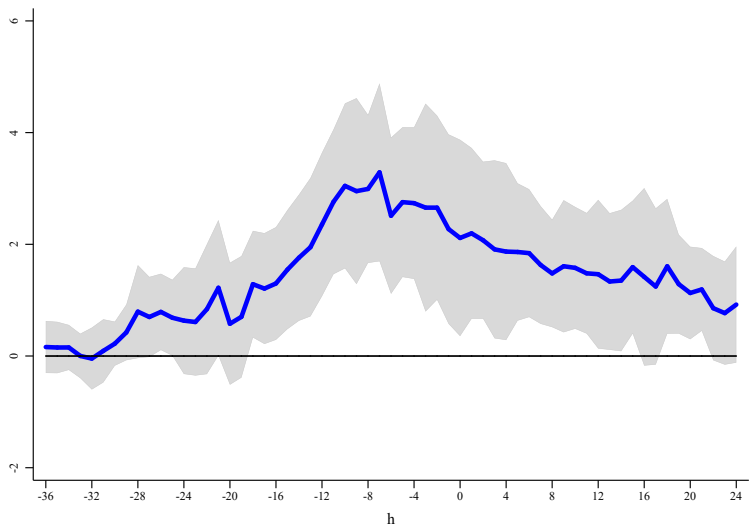
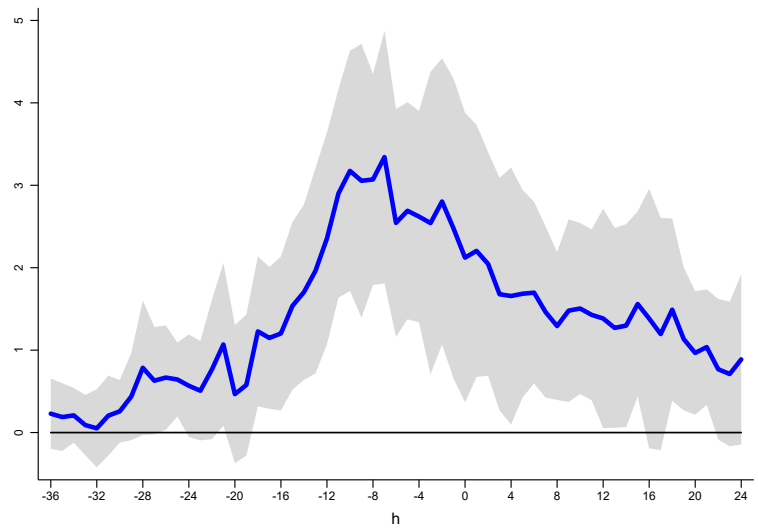
Employment - controlling for serial correlation in R_t

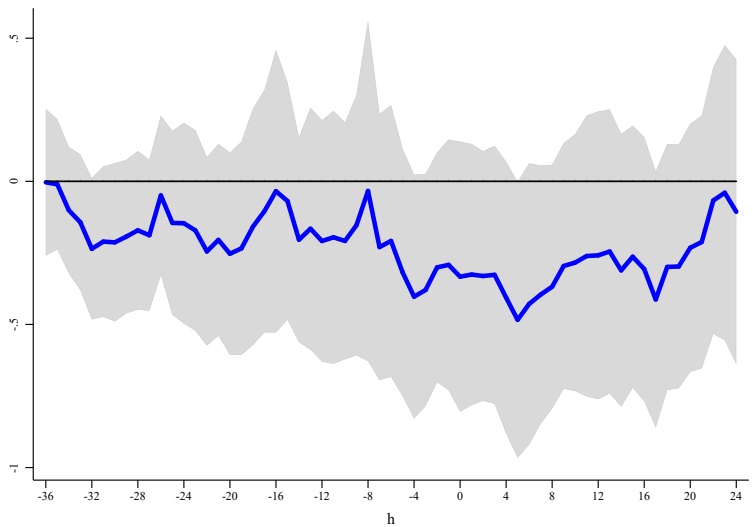
Baseline - solar



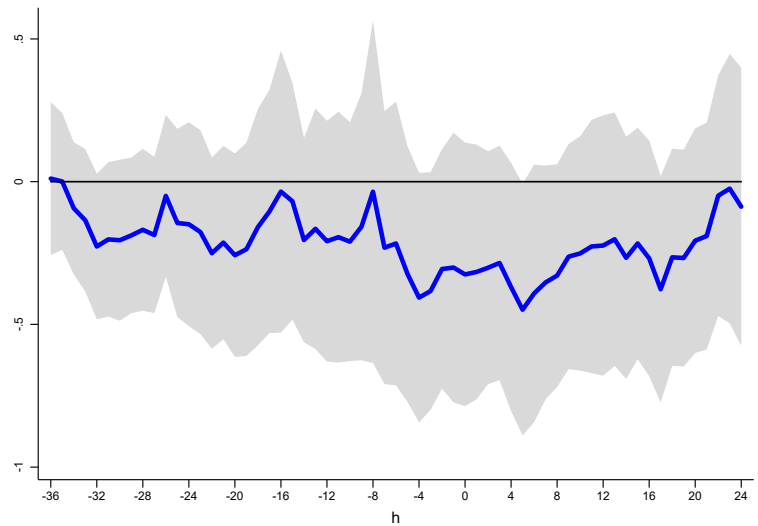
controlling for serial correlation - solar



Baseline - wind



controlling for serial correlation - wind



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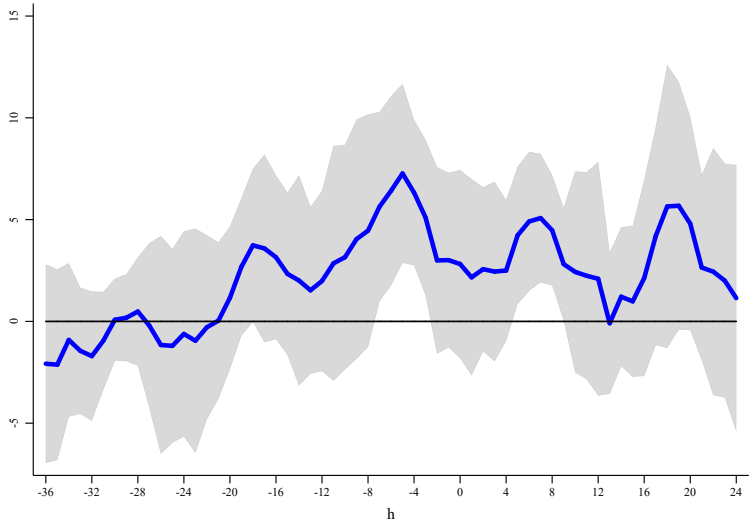
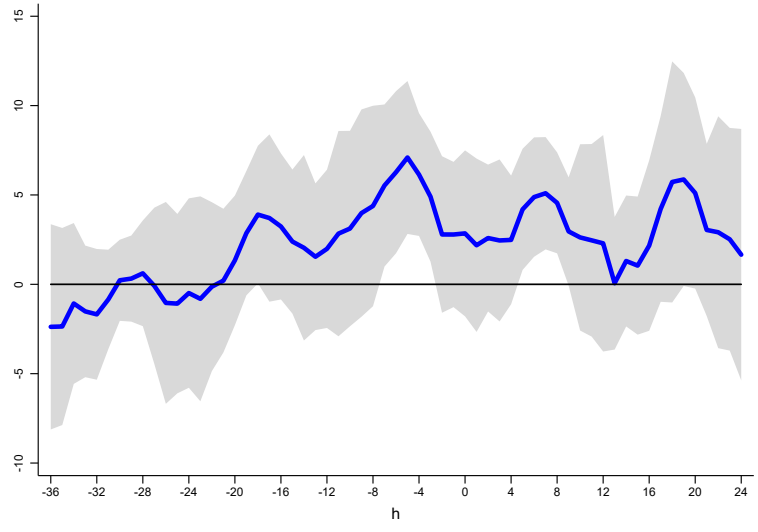
Employment - controlling for serial correlation in R_t

Baseline - biomass



controlling for serial correlation in R_t - biomass



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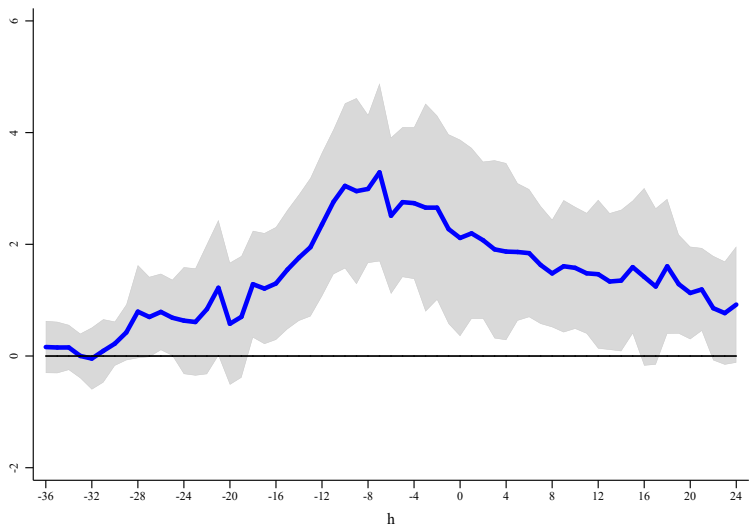
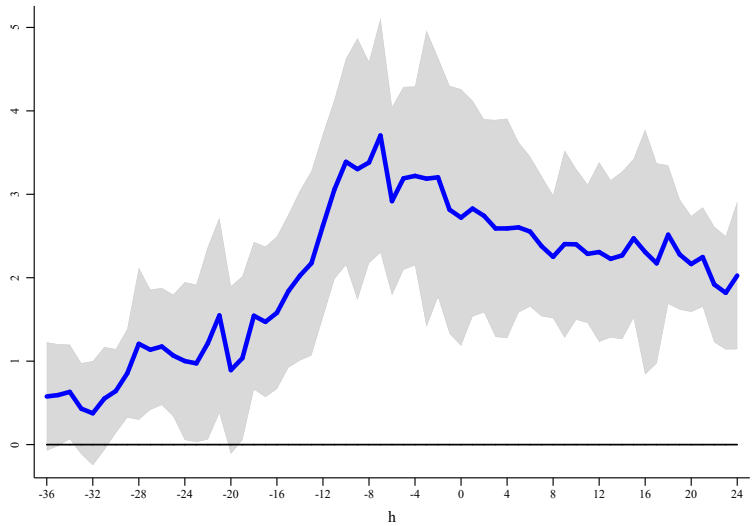
Employment - region-time fixed effects

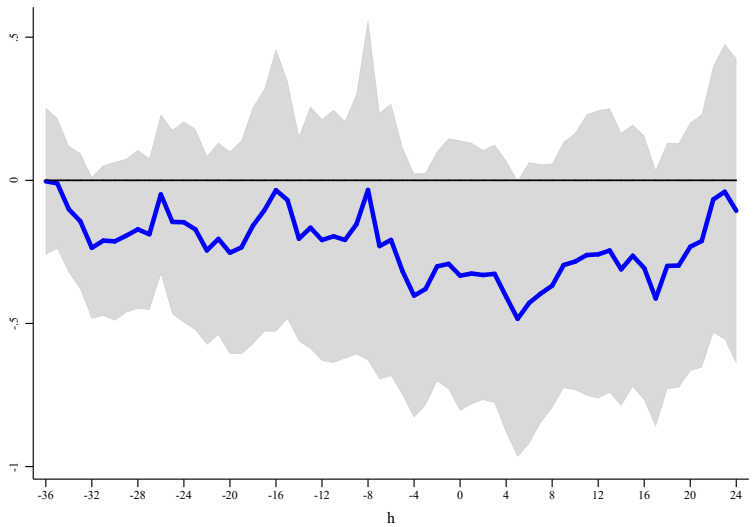
Baseline - solar



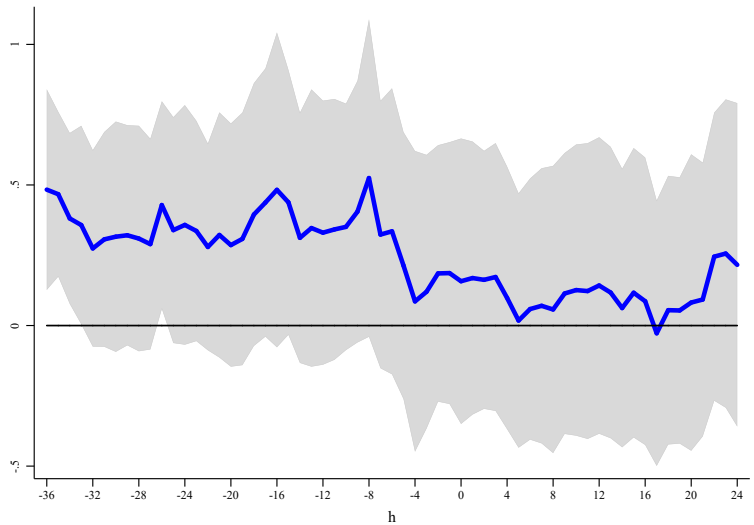
Region-time fixed effects - solar



Baseline - wind



Region-time fixed effects - wind



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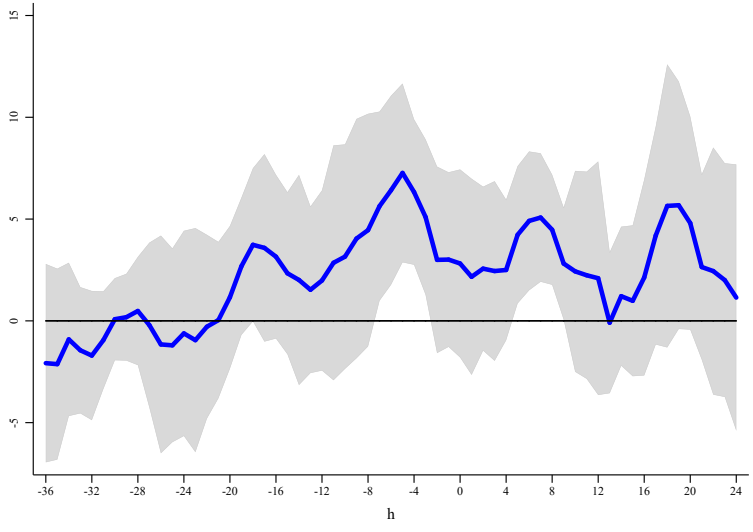
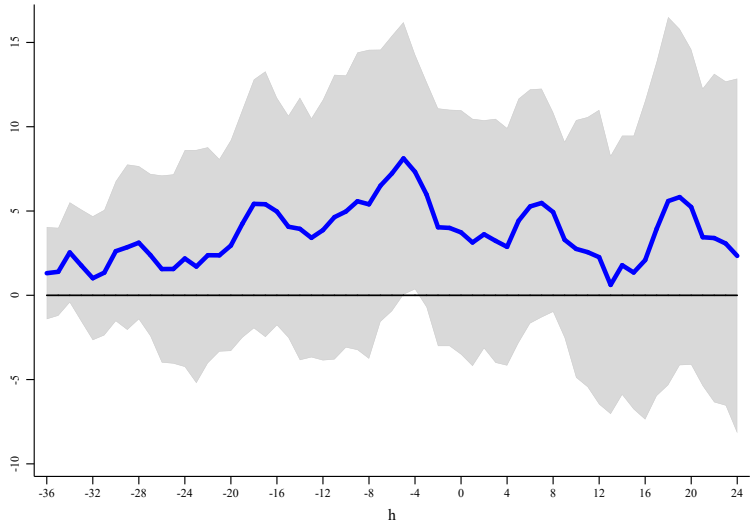
Employment - region-time fixed effects

Baseline - biomass



Region time fixed-effects - biomass



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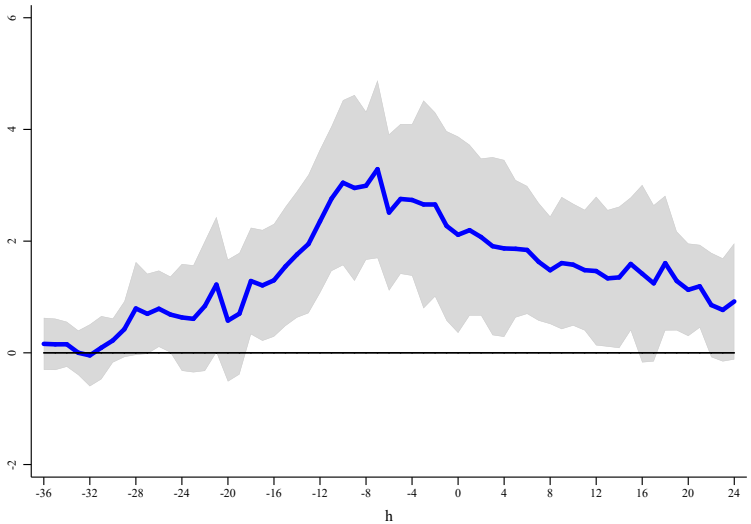
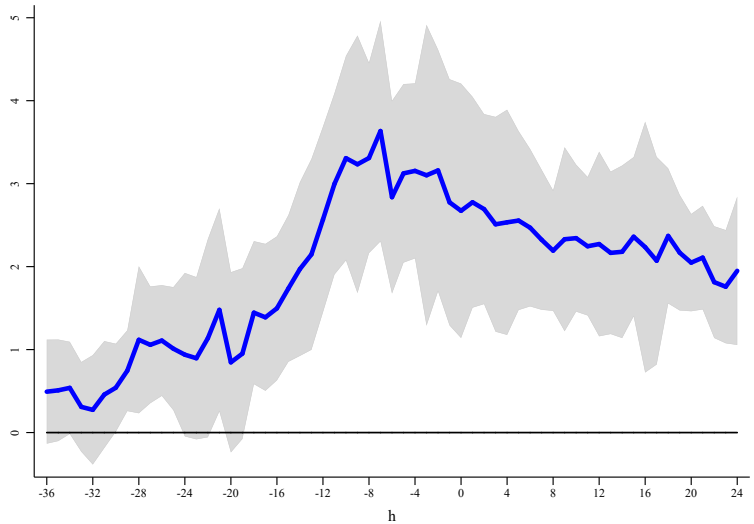
Employment - province-time fixed effects

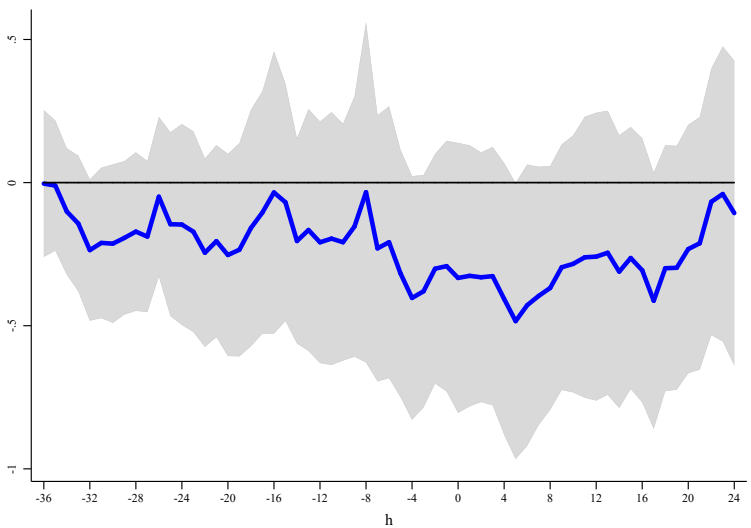
Baseline - solar



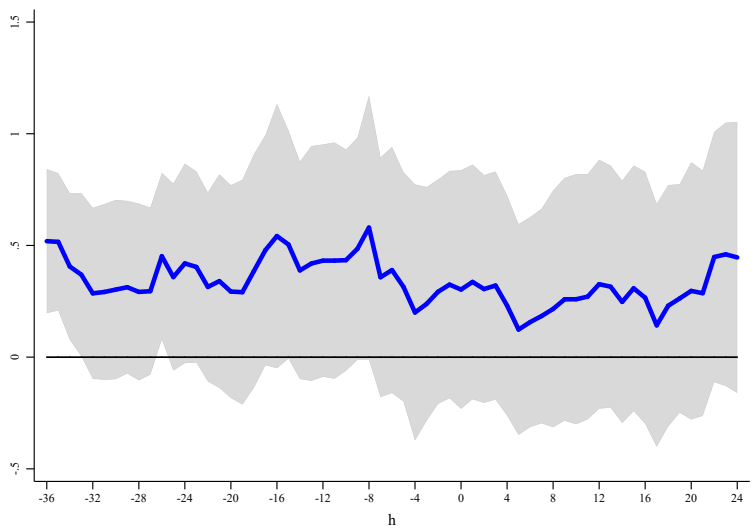
Province-time fixed effects - solar



Baseline - wind



Province-time fixed effects - wind



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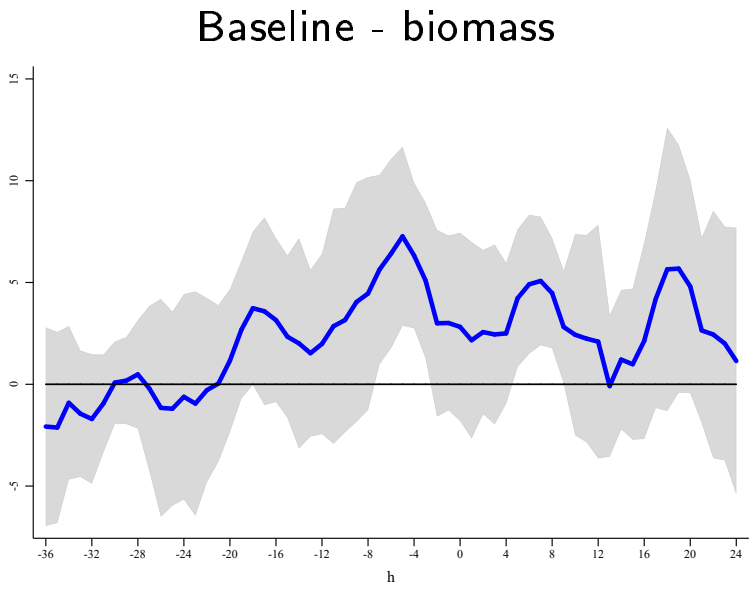
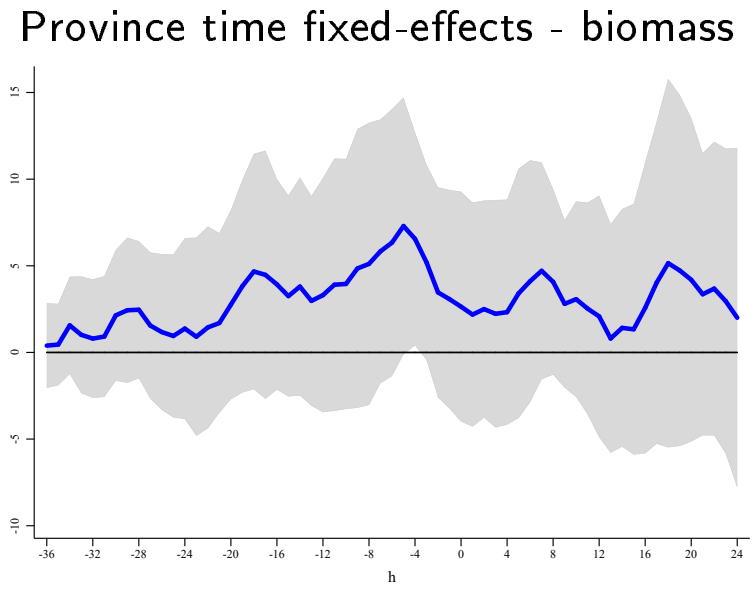
Employment - province-time fixed effects





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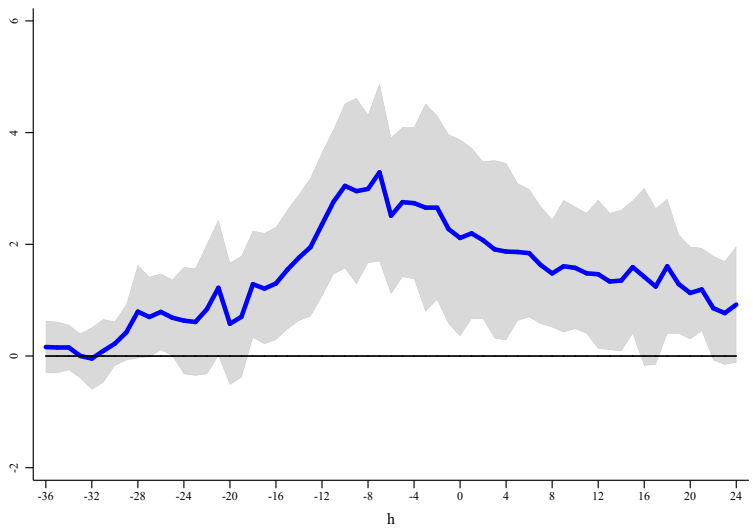
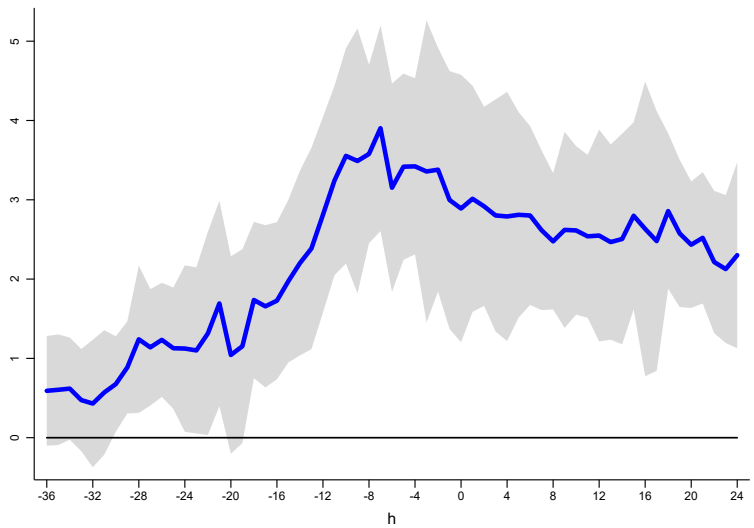
Employment - population deciles -time fixed effects

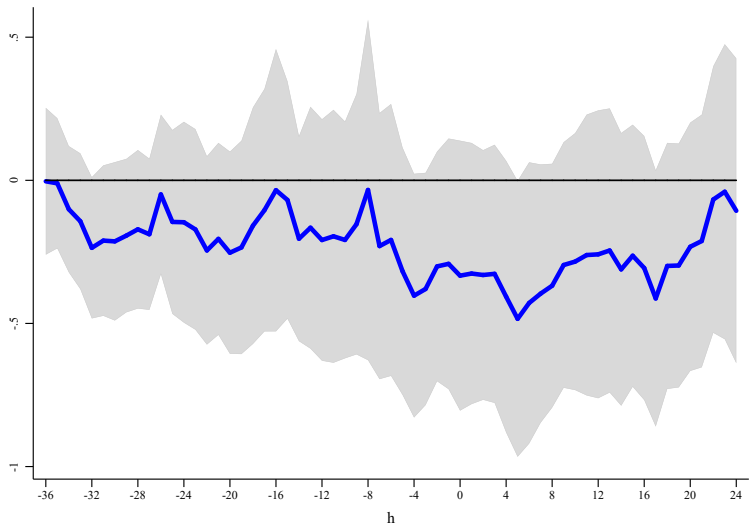
Baseline - solar



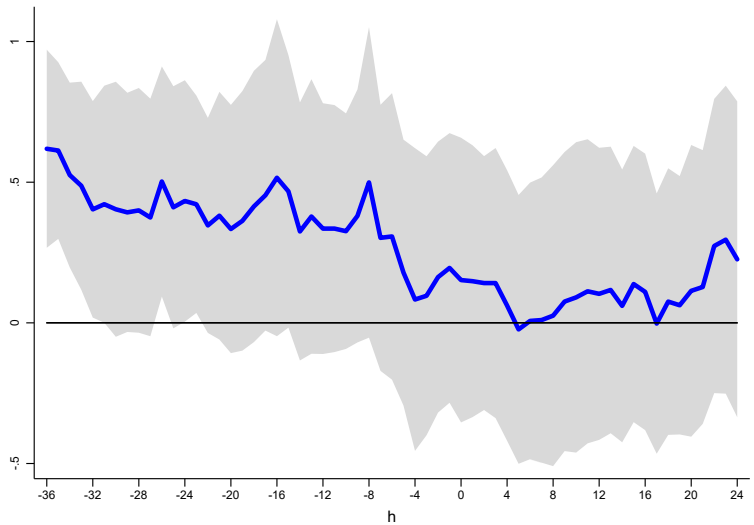
Population deciles-time FE - solar



Baseline - wind



Population deciles-time FE - wind



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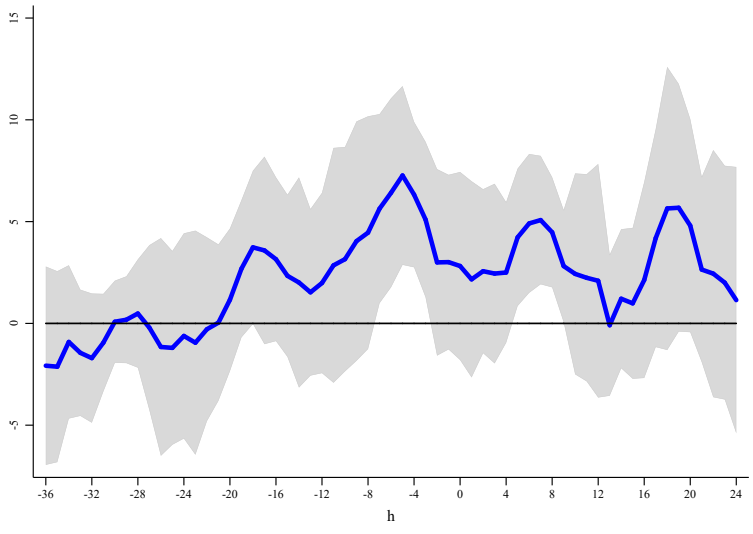
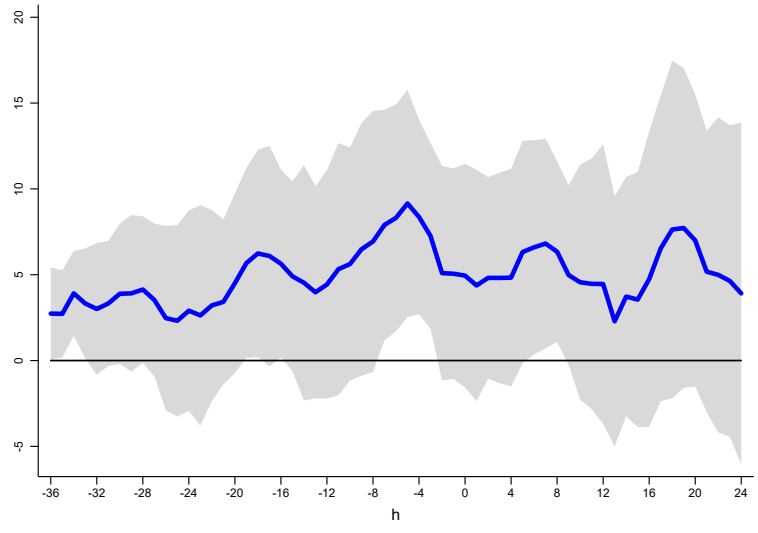
Employment - population deciles-time fixed effects

Baseline - biomass



Population deciles-time fixed effects - biomass



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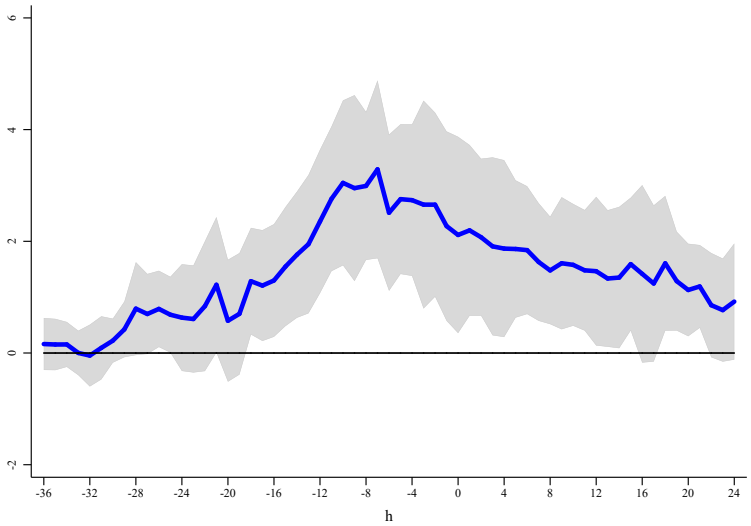
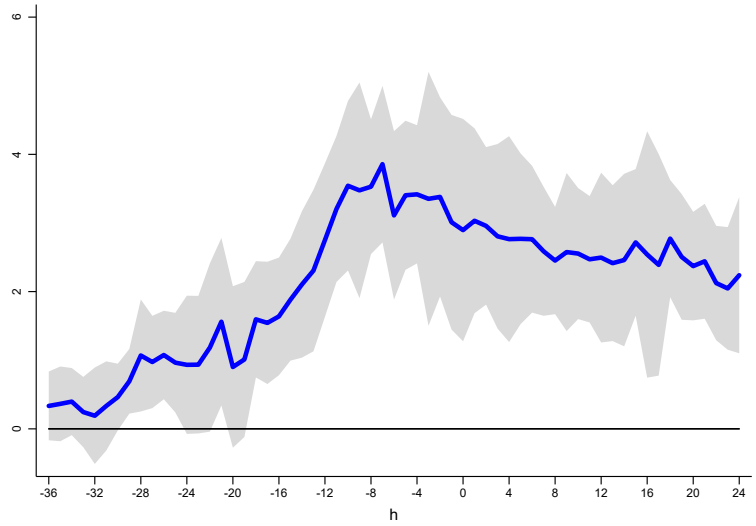
Employment - population growth deciles -time FE

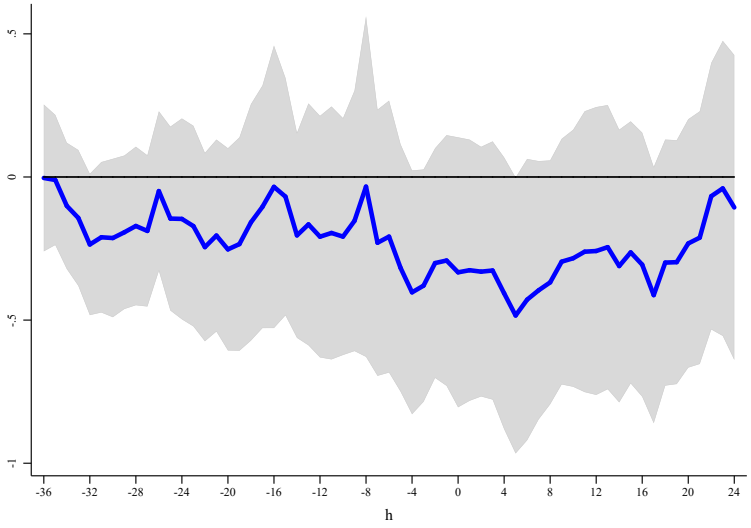
Baseline - solar



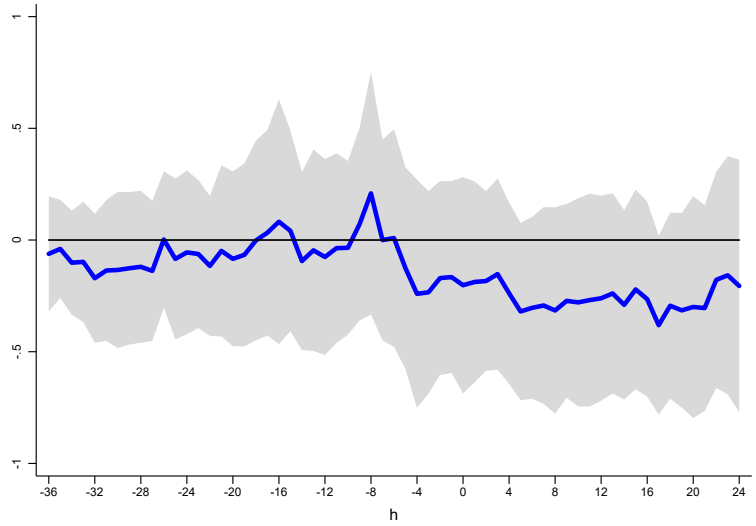
Population growth deciles-time FE - solar



Baseline - wind

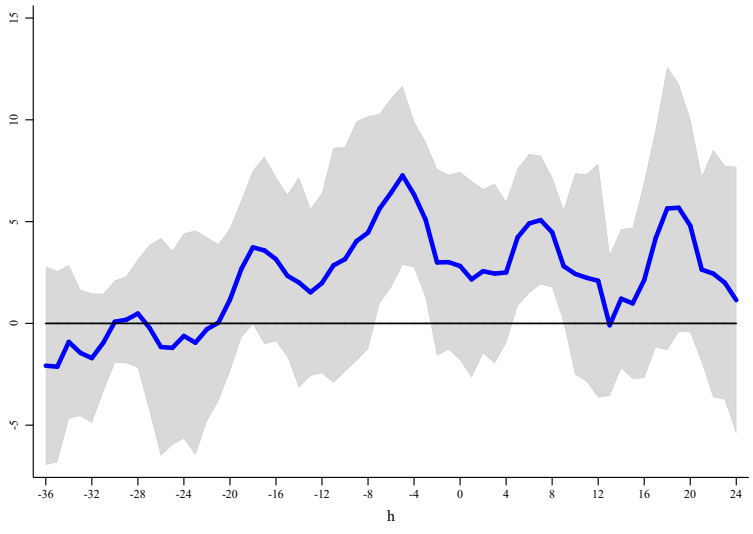


Population growth deciles-time FE - wind

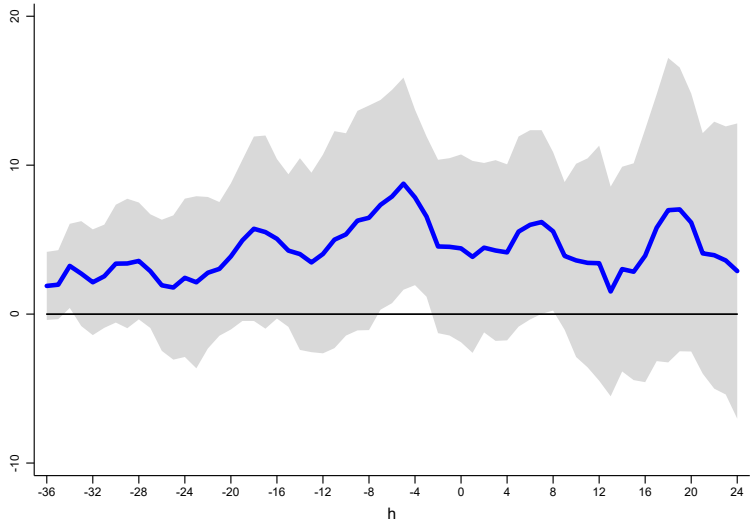


Employment - population deciles-time FE

Baseline - biomass



Population growth deciles-time fixed effects - biomass



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Employment effects - robustness/sensitivity - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	2.355***	2.512***	2.114**	1.842***	1.465**	2.749***	1.803***
	(0.656)	(0.714)	(0.897)	(0.584)	(0.679)	(0.709)	(0.638)
$y_{i,t-37}$	2.345***	2.611***	2.109**	1.933***	1.475**	2.805***	1.862***
	(0.638)	(0.721)	(0.864)	(0.587)	(0.653)	(0.709)	(0.628)
$y_{i,t-37}$ to $y_{i,t-48}$	2.295***	2.393***	2.015**	1.688**	1.332*	2.629***	1.645**
	(0.672)	(0.845)	(0.925)	(0.724)	(0.718)	(0.757)	(0.698)
$R_{i,t-1}$ to $R_{i,t-6}$	2.376***	2.544***	2.145**	1.881***	1.477**	2.768***	1.819***
	(0.627)	(0.704)	(0.898)	(0.567)	(0.676)	(0.695)	(0.628)
$R_{i,t-1}$ to $R_{i,t-24}$	2.340***	2.521***	2.099**	1.854***	1.449**	2.730***	1.789***
	(0.576)	(0.684)	(0.872)	(0.553)	(0.642)	(0.674)	(0.616)
Controlling for serial correlation	2.355***	2.544***	2.114**	1.698***	1.384**	2.749***	1.748***
	(0.656)	(0.704)	(0.897)	(0.562)	(0.679)	(0.709)	(0.617)
Region fixed-effects	2.625***	2.918***	2.721***	2.553***	2.308***	3.166***	2.529***
	(0.560)	(0.575)	(0.784)	(0.458)	(0.549)	(0.599)	(0.521)
Province fixed-effects	2.568***	2.837***	2.673***	2.470***	2.272***	3.100***	2.471***
	(0.571)	(0.593)	(0.782)	(0.484)	(0.567)	(0.600)	(0.526)
Population deciles fixed-effects	2.811***	3.153***	2.890***	2.802***	2.549***	3.359***	2.741***
	(0.629)	(0.670)	(0.860)	(0.575)	(0.681)	(0.650)	(0.612)
Population growth deciles fixed-effects	2.752***	3.111***	2.896***	2.764***	2.496***	3.336***	2.719***
	(0.570)	(0.626)	(0.827)	(0.546)	(0.631)	(0.594)	(0.566)

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Employment effects - robustness/sensitivity - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Baseline	-0.209	-0.208	-0.333	-0.428*	-0.259	-0.244	-0.353
	(0.215)	(0.242)	(0.241)	(0.251)	(0.257)	(0.205)	(0.220)
$y_{i,t-37}$	-0.182	-0.250	-0.287	-0.444*	-0.184	-0.225	-0.310
	(0.202)	(0.223)	(0.218)	(0.245)	(0.227)	(0.199)	(0.213)
$y_{i,t-37}$ to $y_{i,t-48}$	-0.068	-0.113	-0.155	-0.309	-0.070	-0.137	-0.220
	(0.206)	(0.210)	(0.207)	(0.216)	(0.200)	(0.184)	(0.183)
$R_{i,t-1}$ to $R_{i,t-6}$	-0.212	-0.217	-0.336	-0.430*	-0.253	-0.250	-0.354
	(0.226)	(0.254)	(0.250)	(0.258)	(0.264)	(0.216)	(0.228)
$R_{i,t-1}$ to $R_{i,t-24}$	-0.218	-0.216	-0.342	-0.435*	-0.272	-0.254	-0.364
	(0.217)	(0.244)	(0.246)	(0.257)	(0.263)	(0.208)	(0.227)
Controlling for serial correlation	-0.209	-0.217	-0.333	-0.392*	-0.224	-0.244	-0.311
	(0.215)	(0.254)	(0.241)	(0.230)	(0.233)	(0.205)	(0.195)
Region fixed-effects	0.330	0.335	0.158	0.059	0.142	0.284	0.111
	(0.240)	(0.260)	(0.259)	(0.237)	(0.269)	(0.223)	(0.235)
Province fixed-effects	0.432	0.390	0.303	0.157	0.327	0.373	0.247
	(0.265)	(0.281)	(0.272)	(0.240)	(0.284)	(0.247)	(0.249)
Population deciles fixed-effects	0.335	0.307	0.152	0.007	0.103	0.267	0.079
	(0.227)	(0.260)	(0.258)	(0.251)	(0.265)	(0.223)	(0.244)
Population growth deciles fixed-effects	-0.076	0.009	-0.202	-0.304	-0.261	-0.066	-0.251
	(0.224)	(0.248)	(0.247)	(0.208)	(0.234)	(0.208)	(0.209)

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Employment effects - robustness/sensitivity - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Biomass							
Baseline	1.985	6.416***	2.819	4.910***	2.095	4.437**	3.223*
	(2.258)	(2.369)	(2.356)	(1.740)	(2.927)	(2.255)	(1.755)
$y_{i,t-37}$	2.147	5.268**	3.102	3.864*	2.692	3.966*	2.894
	(2.337)	(2.277)	(2.474)	(2.003)	(3.142)	(2.251)	(1.830)
$y_{i,t-37}$ to $y_{i,t-48}$	2.157	9.159*	3.254	7.555*	2.330	5.019**	3.747**
	(2.155)	(4.801)	(2.113)	(4.156)	(2.685)	(2.434)	(1.816)
$R_{i,t-1}$ to $R_{i,t-6}$	1.829	6.272***	2.711	4.785***	1.976	4.306**	3.105*
	(2.200)	(2.313)	(2.296)	(1.673)	(2.869)	(2.189)	(1.687)
$R_{i,t-1}$ to $R_{i,t-24}$	2.061	6.645***	2.982	5.218***	2.249	4.595**	3.456*
	(2.304)	(2.436)	(2.402)	(1.890)	(3.031)	(2.311)	(1.856)
Controlling for serial correlation	1.985	6.272***	2.819	4.882***	2.295	4.437**	3.369*
	(2.258)	(2.313)	(2.356)	(1.704)	(3.089)	(2.255)	(1.935)
Region fixed-effects	3.868	7.233*	3.733	5.272	2.263	5.638	3.775
	(3.944)	(4.169)	(3.696)	(3.541)	(4.457)	(3.926)	(3.469)
Province fixed-effects	3.307	6.337	2.642	4.106	2.081	4.907	3.049
	(3.446)	(3.930)	(3.384)	(3.564)	(3.559)	(3.494)	(3.061)
Population deciles fixed-effects	4.432	8.314**	4.948	6.599**	4.459	6.661**	5.322*
	(3.392)	(3.373)	(3.323)	(3.180)	(4.158)	(3.243)	(3.059)
Population growth deciles fixed-effects	4.038	7.894**	4.414	5.994*	3.418	6.213*	4.613
	(3.404)	(3.653)	(3.216)	(3.242)	(4.025)	(3.294)	(2.981)

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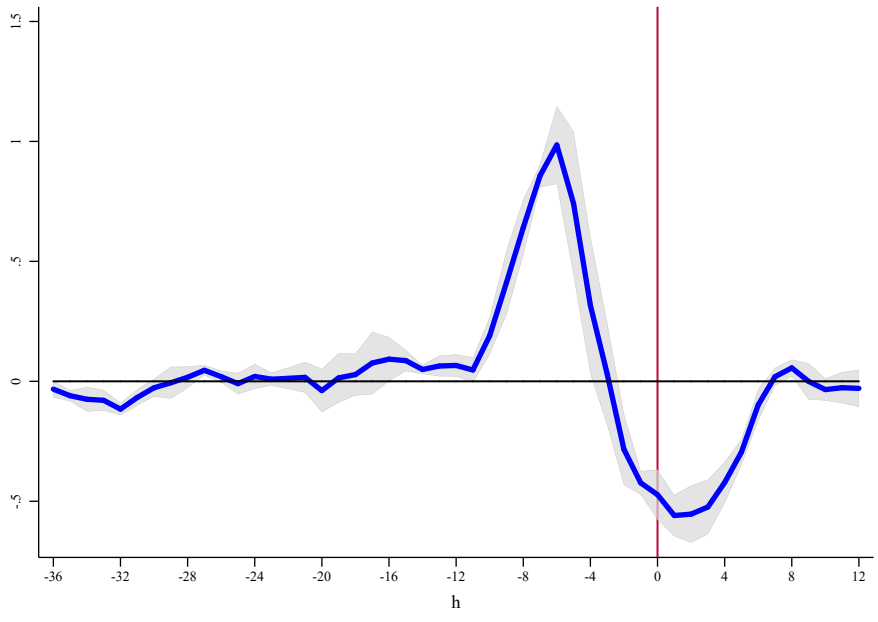
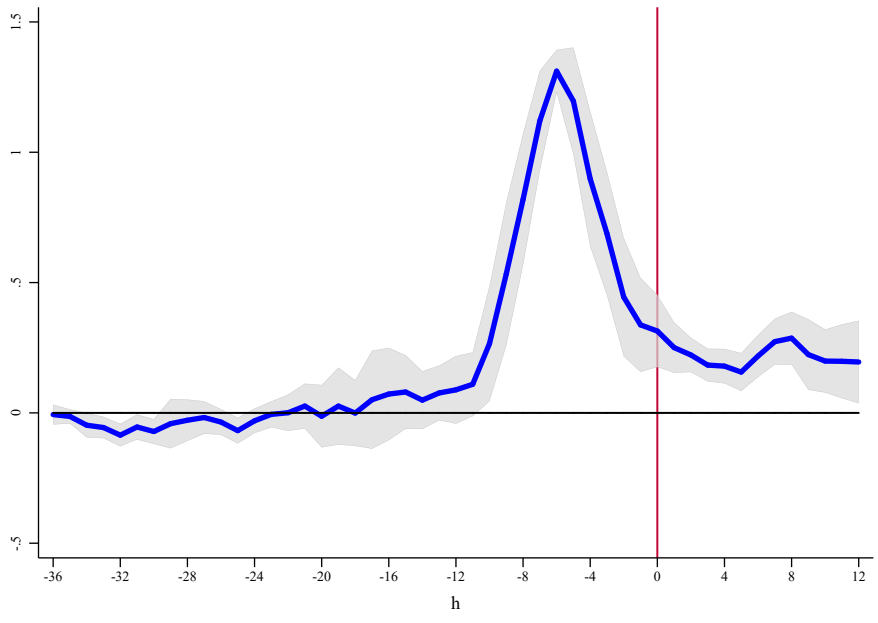
Employment effects - solar plants opened after 2019

Baseline specification



Province-date fixed effects



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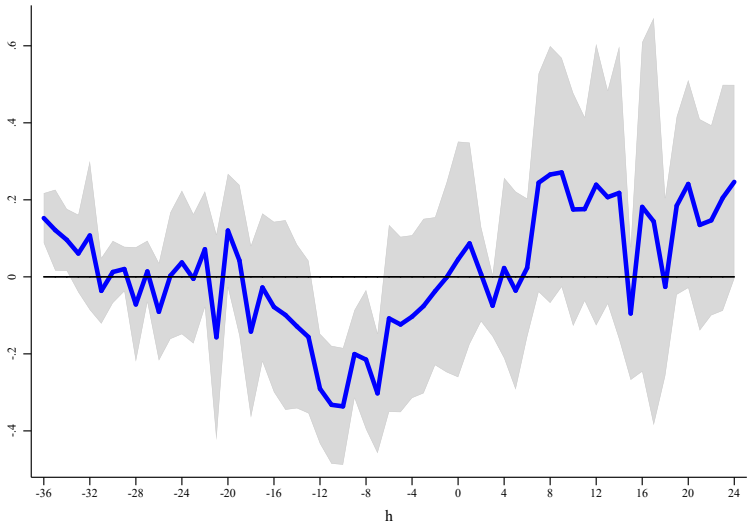
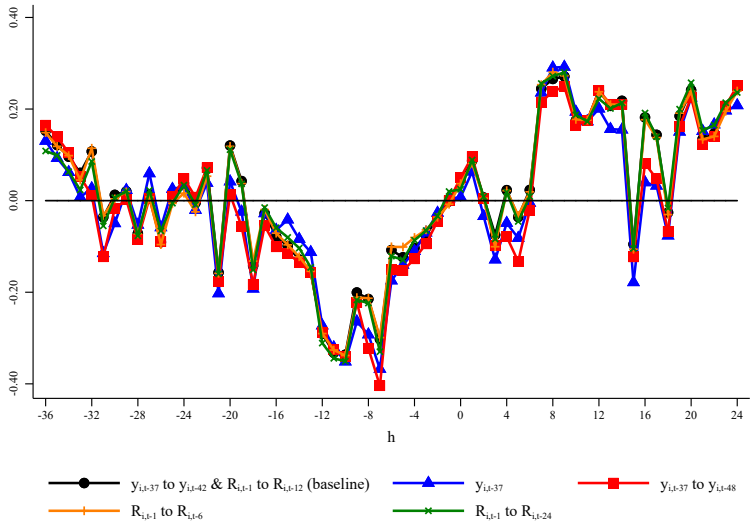
Unemployment - alternative dynamic structures

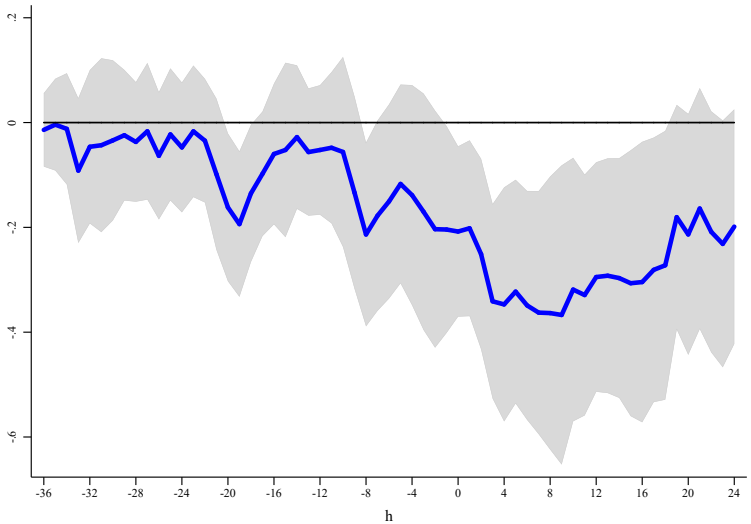
Baseline - solar



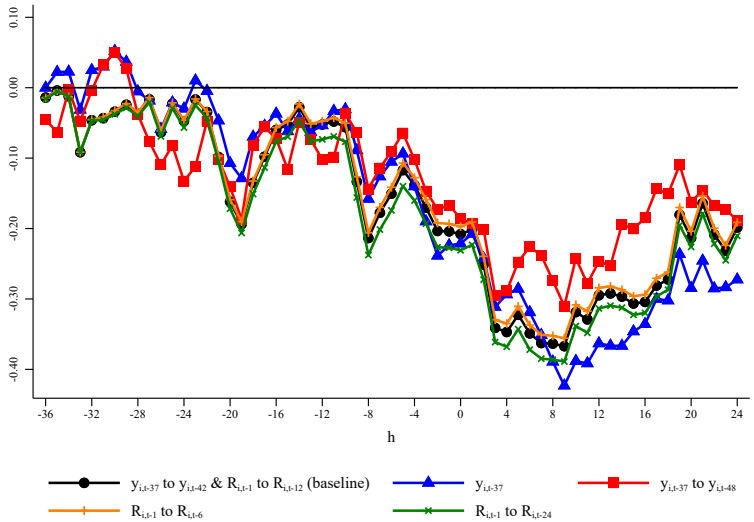
Alternative dynamic structures - solar



Baseline - wind



Alternative dynamic structures - wind



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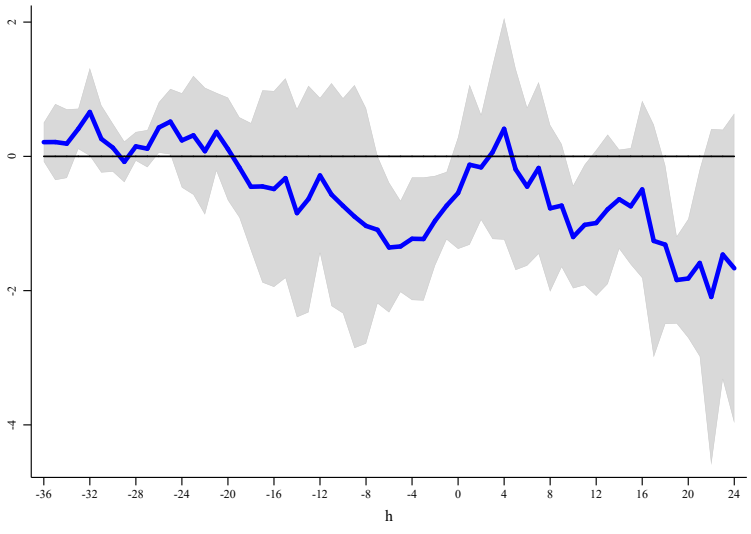
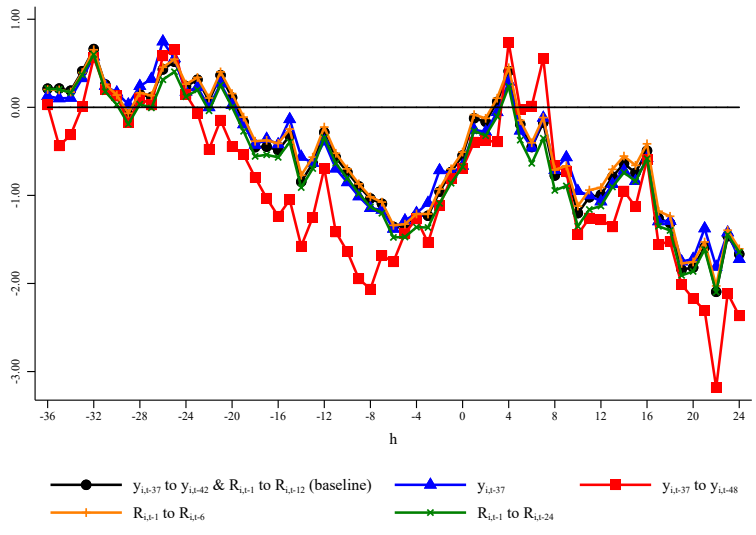
Unemployment - alternative dynamic structures

Baseline - biomass



Alternative dynamic structures - biomass



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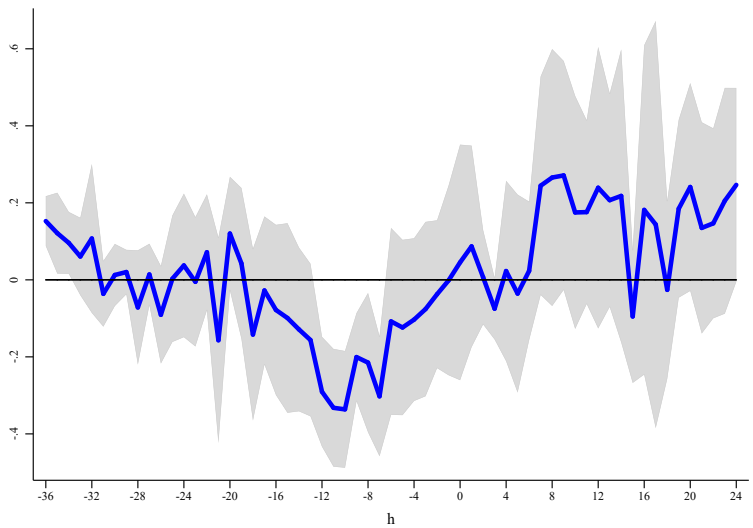
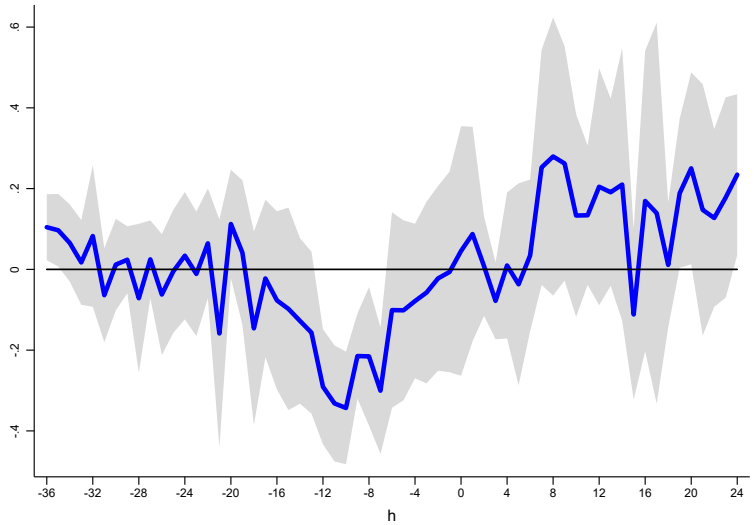
Unemployment - controlling for serial correlation in R_t

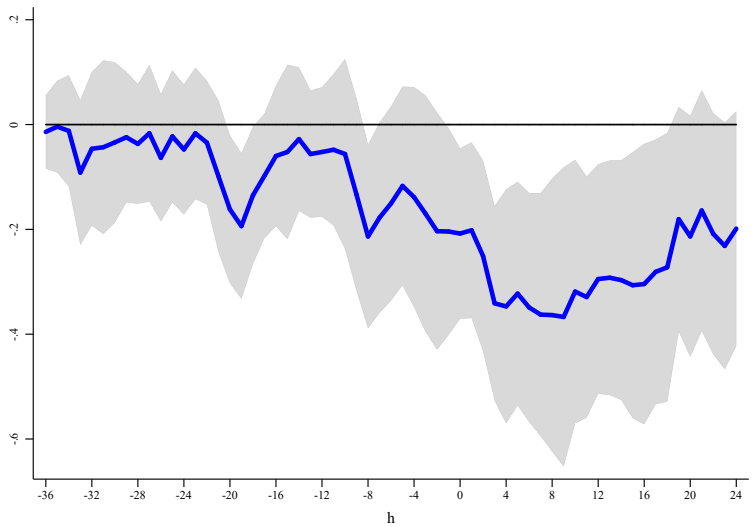
Baseline - solar



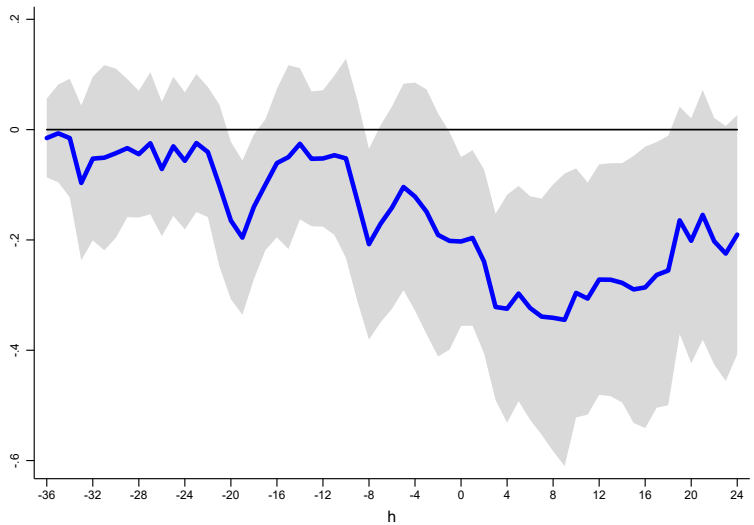
controlling for serial correlation - solar



Baseline - wind



controlling for serial correlation - wind



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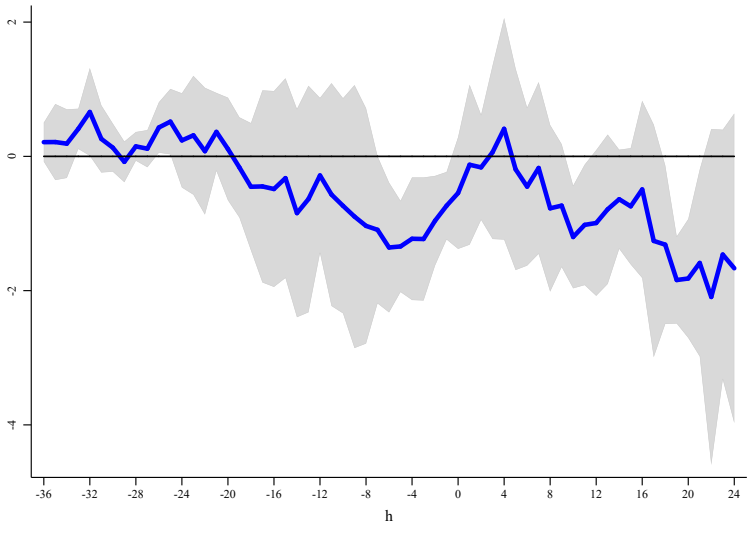
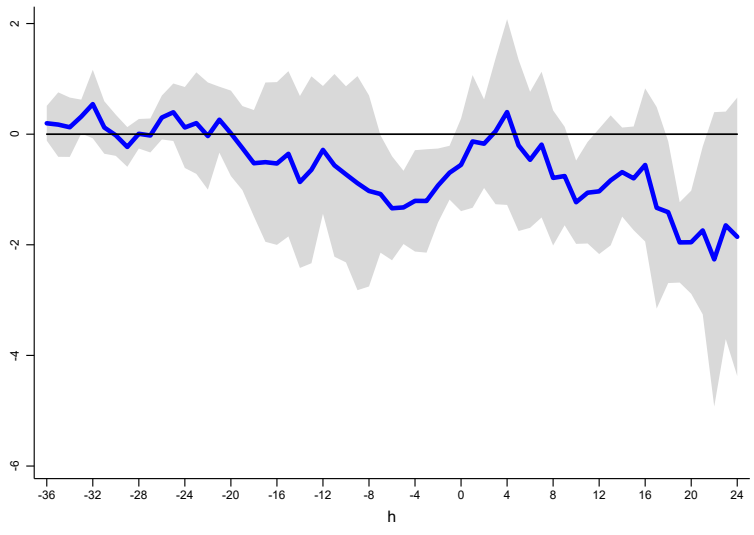
Unemployment - controlling for serial correlation in R_t

Baseline - biomass



controlling for serial correlation in R_t - biomass



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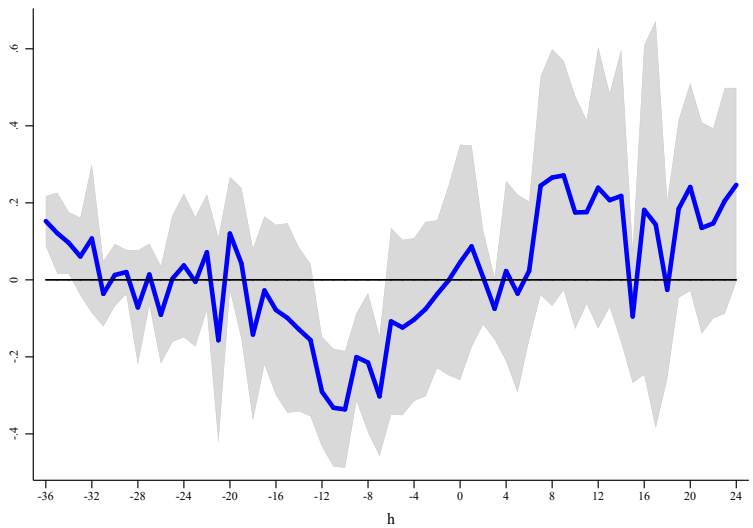
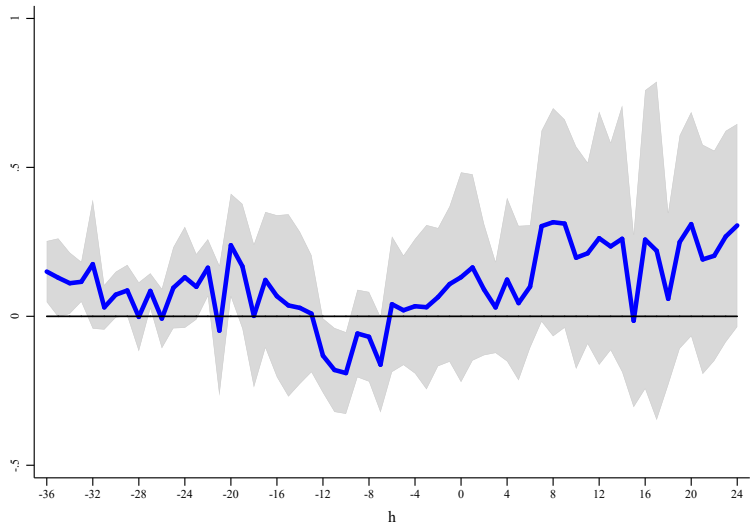
Unemployment - region-time fixed effects

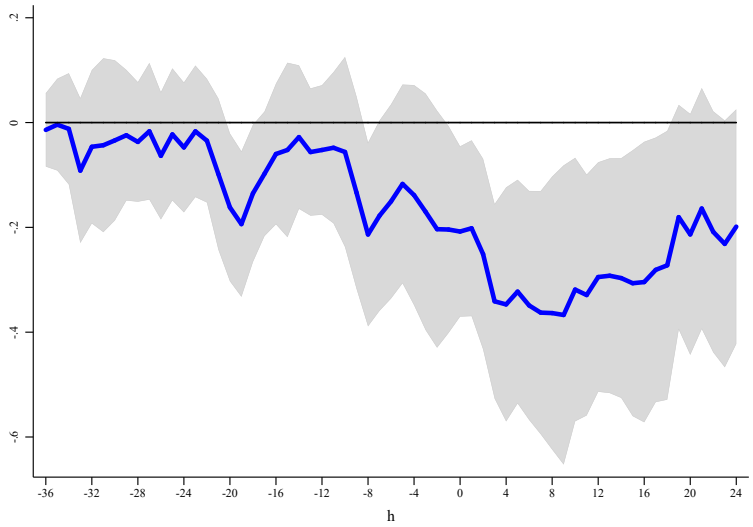
Baseline - solar



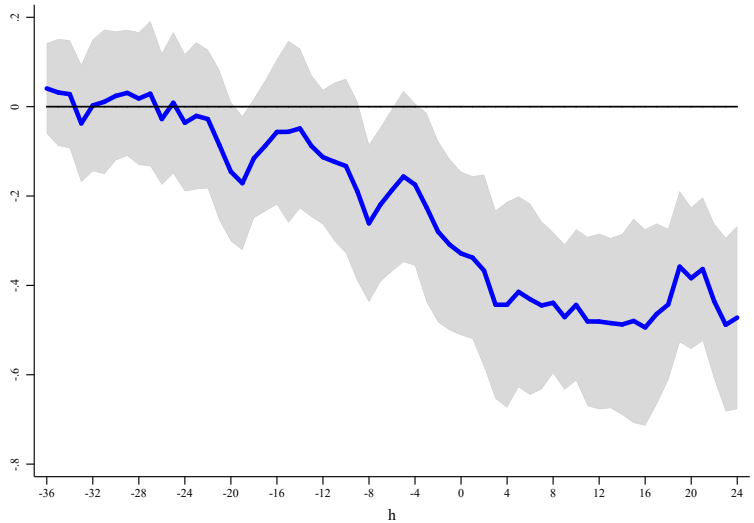
Region-time fixed effects - solar



Baseline - wind



Region-time fixed effects - wind



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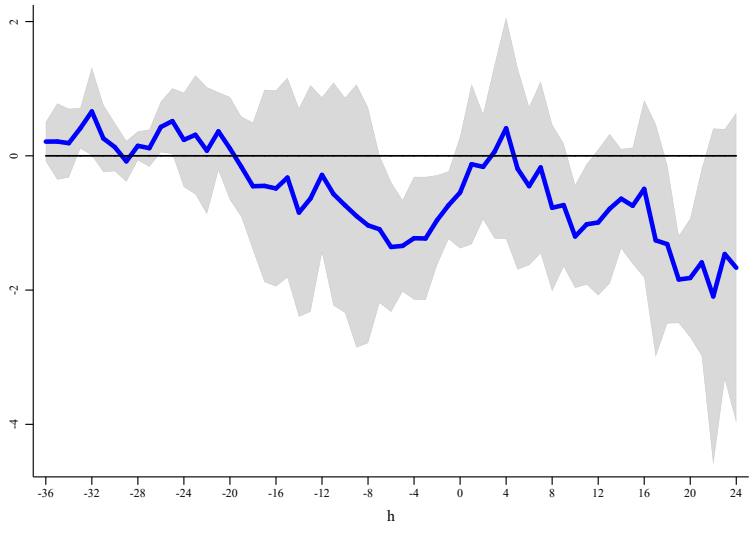
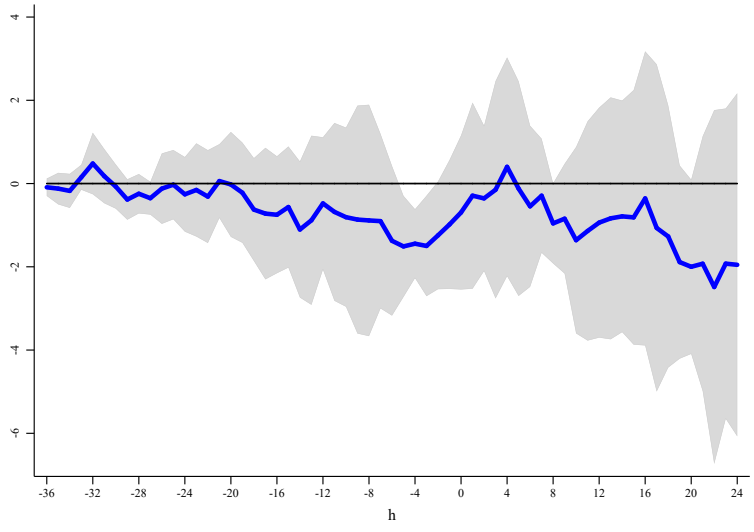
Unemployment - region-time fixed effects

Baseline - biomass



Region time fixed-effects - biomass



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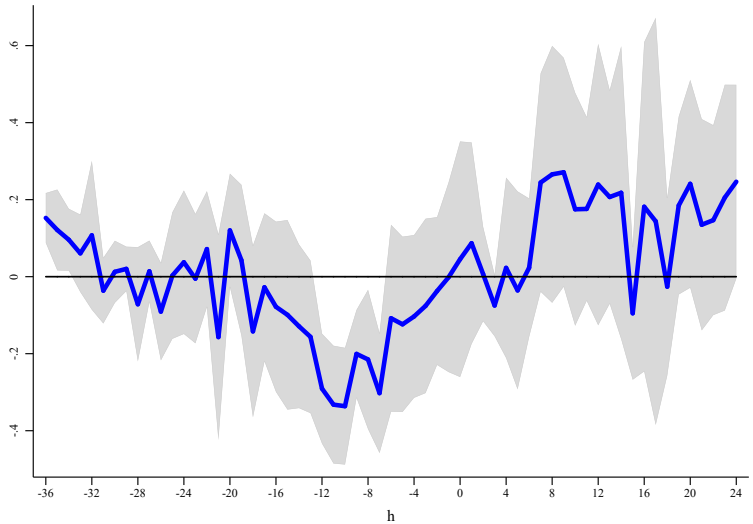
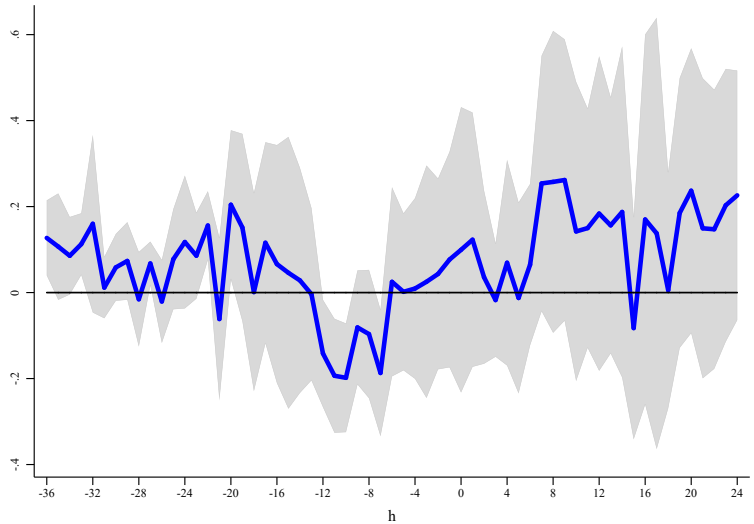
Unemployment - province-time fixed effects

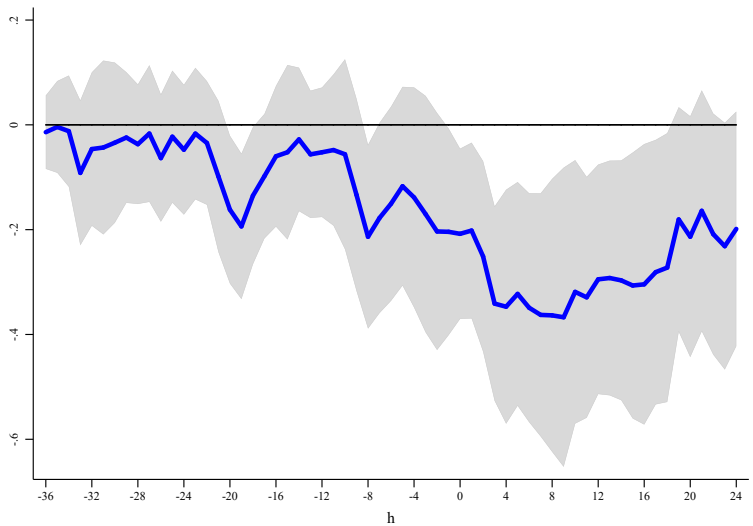
Baseline - solar



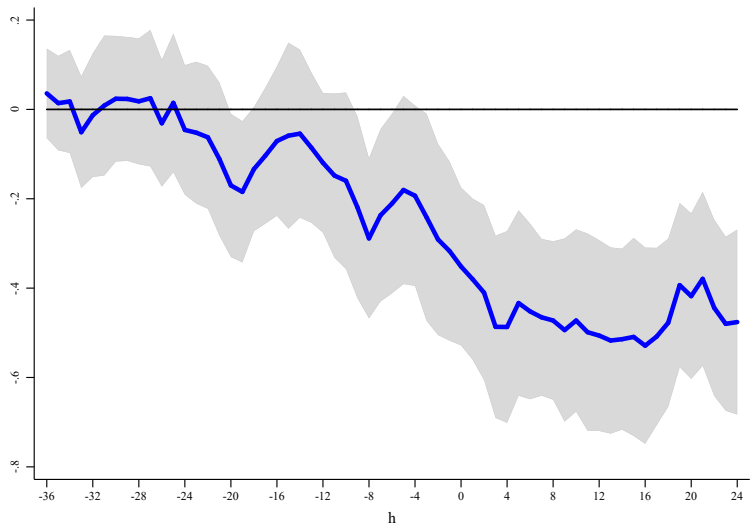
Province-time fixed effects - solar



Baseline - wind



Province-time fixed effects - wind



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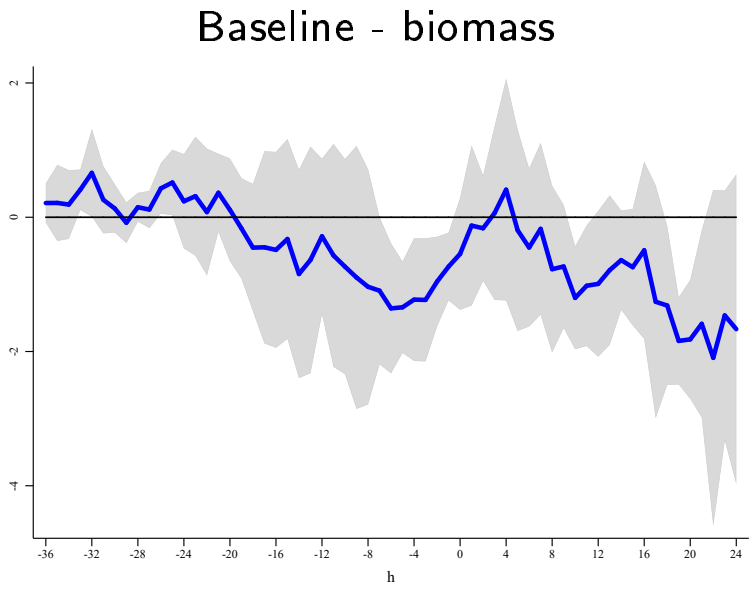
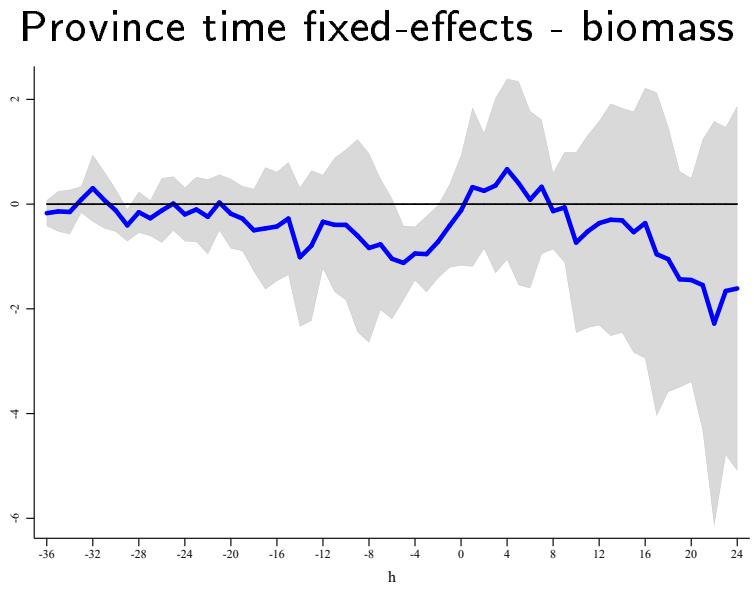
Unemployment - province-time fixed effects





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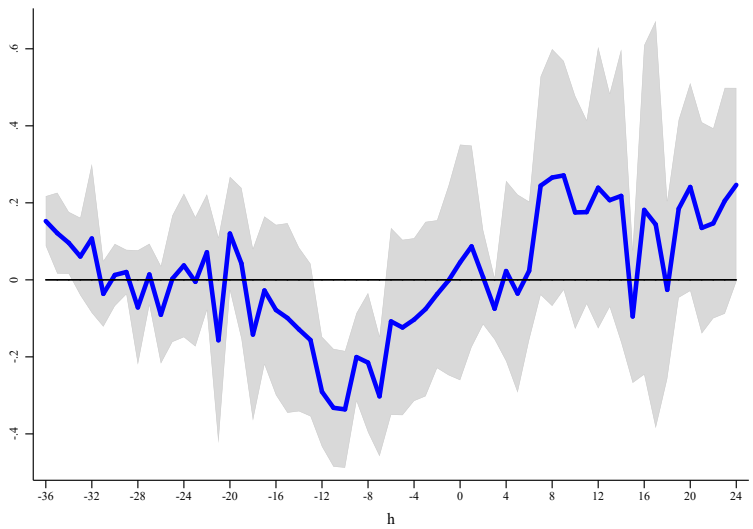
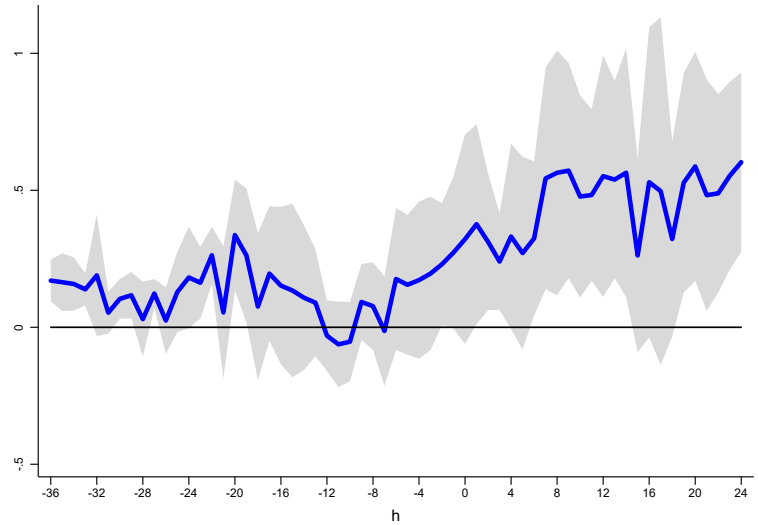
Unemployment - population deciles -time fixed effects

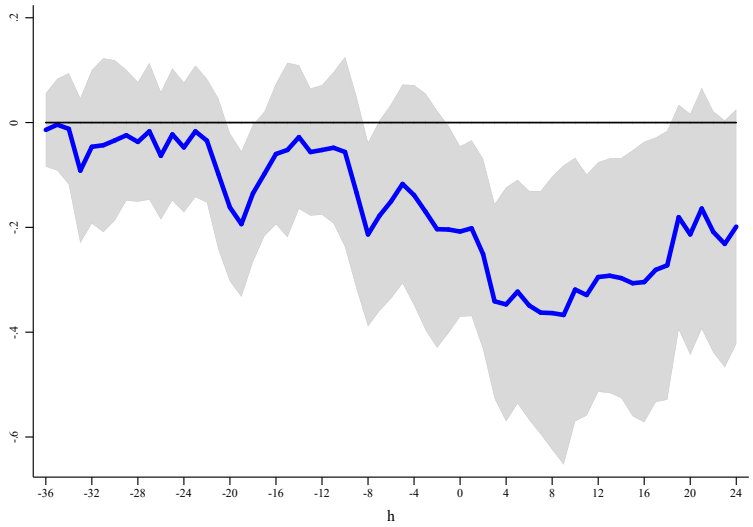
Baseline - solar



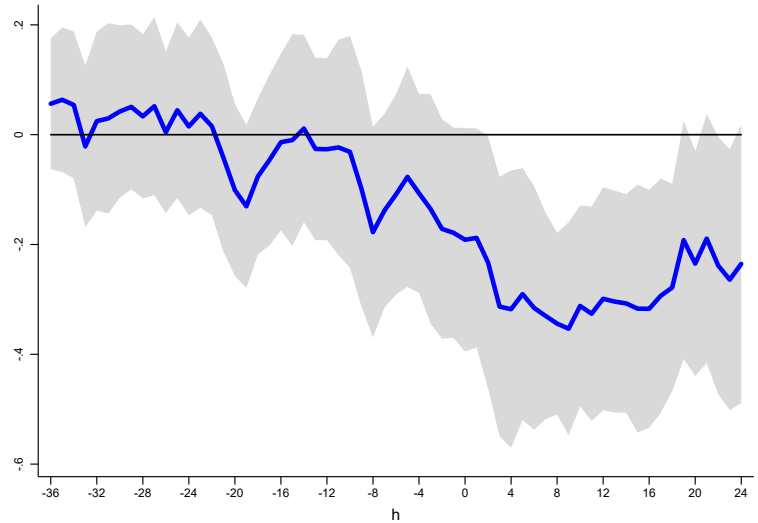
Population deciles-time FE - solar



Baseline - wind



Population deciles-time FE - wind



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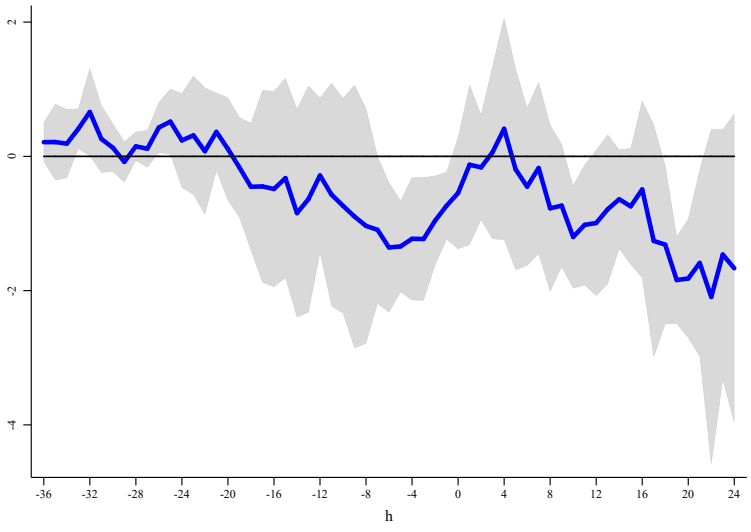
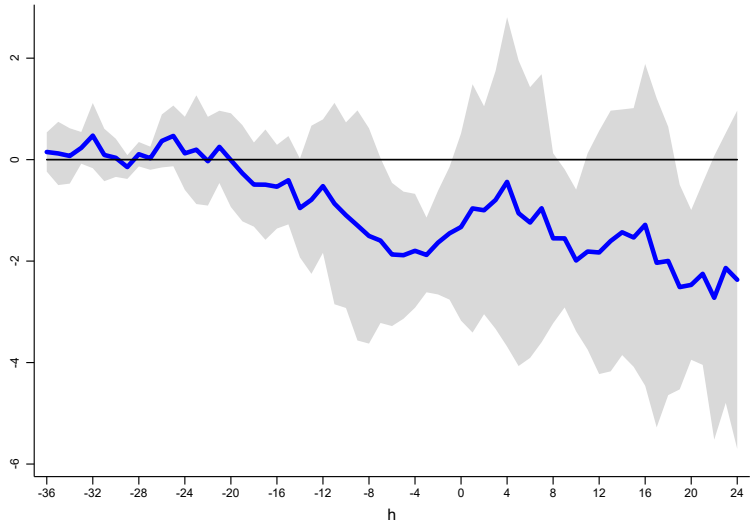
Unemployment - population deciles-time fixed effects

Baseline - biomass



Population deciles-time fixed effects - biomass



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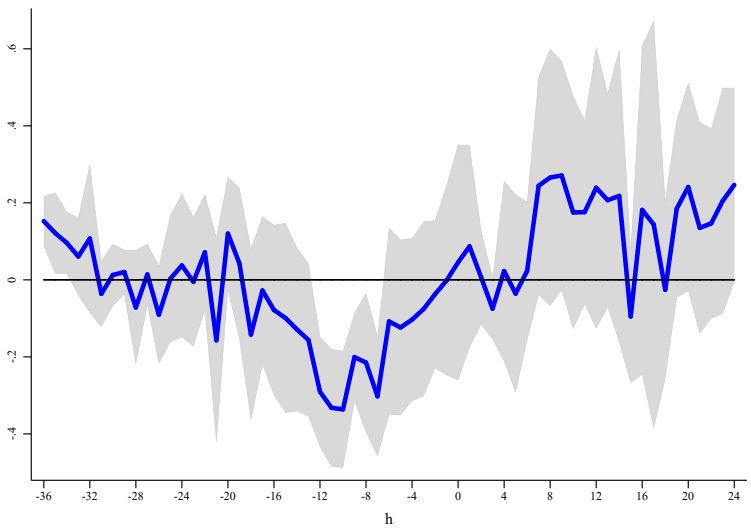
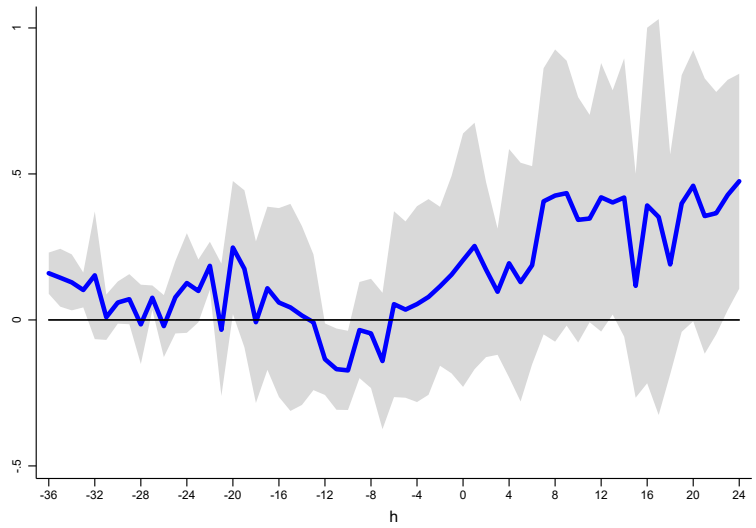
Unemployment - population growth deciles -time FE

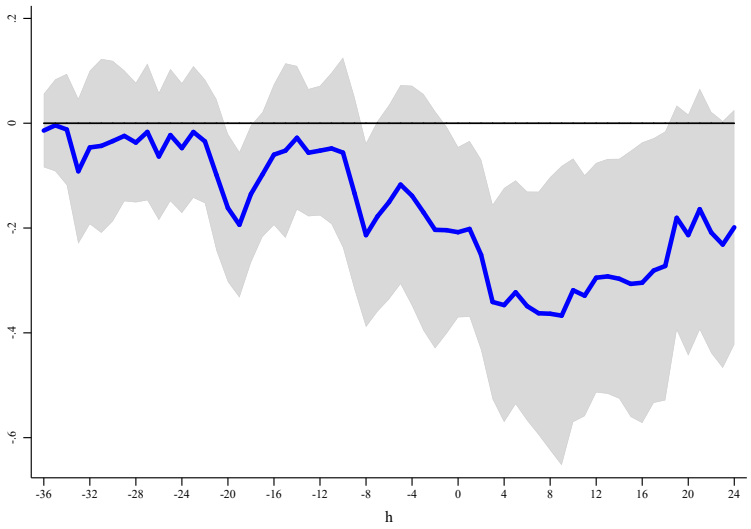
Baseline - solar



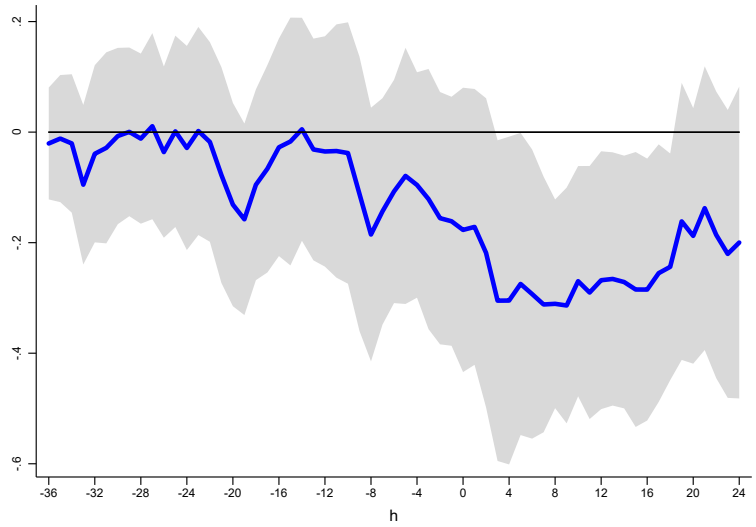
Population growth deciles-time FE - solar



Baseline - wind

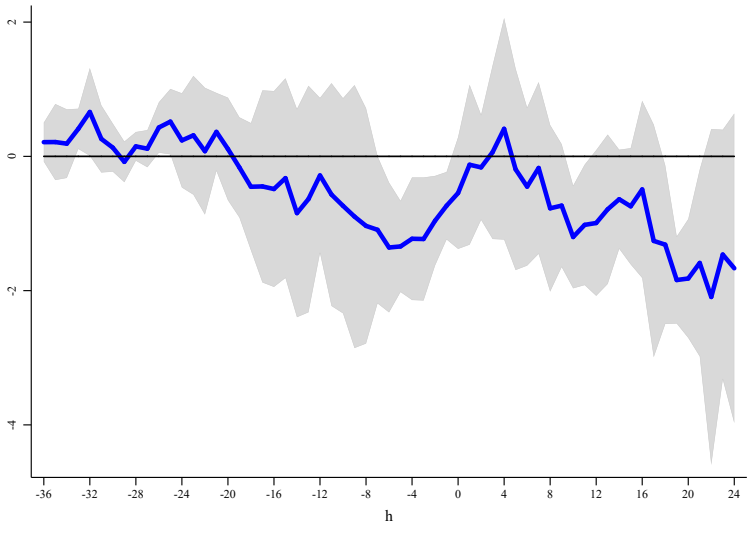


Population growth deciles-time FE - wind

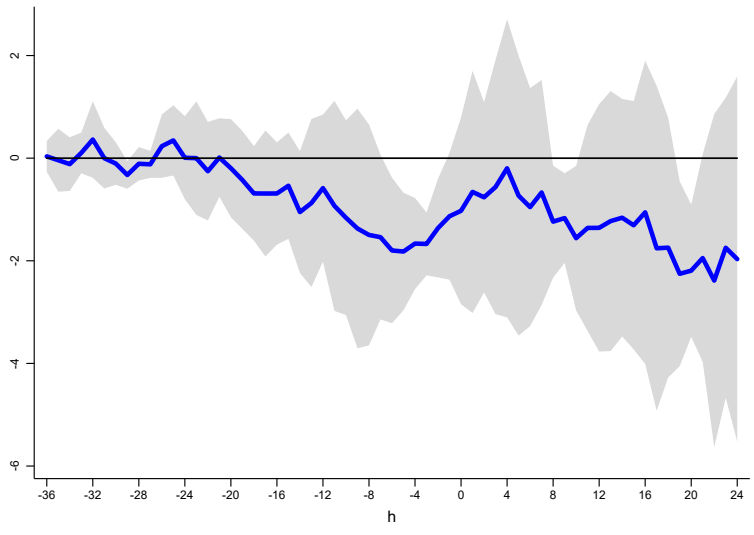


Unemployment - population deciles-time FE

Baseline - biomass



Population growth deciles-time fixed effects - biomass



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Unemployment effects - robustness/sensitivity - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Baseline	-0.291***	-0.108	0.045	0.023	0.239	-0.177***	0.101
	(0.073)	(0.124)	(0.156)	(0.092)	(0.186)	(0.060)	(0.109)
$y_{i,t-37}$	-0.273***	-0.175	0.007	-0.005	0.201	-0.199***	0.080
	(0.065)	(0.117)	(0.193)	(0.096)	(0.223)	(0.073)	(0.127)
$y_{i,t-37}$ to $y_{i,t-48}$	-0.287***	-0.151	0.050	-0.021	0.241	-0.206***	0.072
	(0.082)	(0.117)	(0.162)	(0.079)	(0.194)	(0.062)	(0.107)
$R_{i,t-1}$ to $R_{i,t-6}$	-0.290***	-0.101	0.037	0.019	0.238	-0.172***	0.099
	(0.066)	(0.123)	(0.154)	(0.093)	(0.183)	(0.061)	(0.109)
$R_{i,t-1}$ to $R_{i,t-24}$	-0.311***	-0.121	0.025	0.009	0.223	-0.183***	0.099
	(0.063)	(0.120)	(0.148)	(0.086)	(0.184)	(0.059)	(0.110)
Controlling for serial correlation	-0.291***	-0.101	0.045	0.034	0.205	-0.177***	0.083
	(0.073)	(0.123)	(0.156)	(0.096)	(0.149)	(0.060)	(0.104)
Region fixed-effects	-0.132**	0.041	0.131	0.100	0.262	-0.041	0.168
	(0.064)	(0.116)	(0.180)	(0.105)	(0.217)	(0.070)	(0.139)
Province fixed-effects	-0.142**	0.025	0.099	0.065	0.184	-0.060	0.119
	(0.064)	(0.112)	(0.169)	(0.096)	(0.187)	(0.065)	(0.127)
Population deciles fixed-effects	-0.031	0.176	0.322*	0.324**	0.552**	0.101	0.401**
	(0.066)	(0.132)	(0.195)	(0.143)	(0.225)	(0.080)	(0.164)
Population growth deciles fixed-effects	-0.134**	0.054	0.205	0.187	0.420*	-0.017	0.266
	(0.063)	(0.162)	(0.221)	(0.173)	(0.235)	(0.104)	(0.192)

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Unemployment effects - robustness/sensitivity - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Baseline	-0.052	-0.151	-0.208**	-0.349***	-0.295***	-0.139*	-0.313***
	(0.063)	(0.095)	(0.083)	(0.111)	(0.112)	(0.084)	(0.098)
$y_{i,t-37}$	-0.053	-0.105	-0.221***	-0.319***	-0.363***	-0.123*	-0.319***
	(0.060)	(0.093)	(0.067)	(0.095)	(0.088)	(0.075)	(0.081)
$y_{i,t-37}$ to $y_{i,t-48}$	-0.102	-0.090	-0.186**	-0.226**	-0.246*	-0.108	-0.248**
	(0.067)	(0.115)	(0.080)	(0.113)	(0.129)	(0.095)	(0.109)
$R_{i,t-1}$ to $R_{i,t-6}$	-0.048	-0.141	-0.197**	-0.337***	-0.284***	-0.130	-0.302***
	(0.063)	(0.094)	(0.083)	(0.109)	(0.110)	(0.083)	(0.097)
$R_{i,t-1}$ to $R_{i,t-24}$	-0.073	-0.174*	-0.231***	-0.372***	-0.313***	-0.161*	-0.335***
	(0.062)	(0.097)	(0.084)	(0.113)	(0.115)	(0.086)	(0.101)
Controlling for serial correlation	-0.052	-0.141	-0.208**	-0.323***	-0.272**	-0.139*	-0.294***
	(0.063)	(0.094)	(0.083)	(0.103)	(0.107)	(0.084)	(0.090)
Region fixed-effects	-0.113	-0.187**	-0.329***	-0.431***	-0.481***	-0.198**	-0.420***
	(0.077)	(0.093)	(0.093)	(0.109)	(0.100)	(0.085)	(0.085)
Province fixed-effects	-0.120	-0.211**	-0.352***	-0.452***	-0.506***	-0.217**	-0.450***
	(0.080)	(0.103)	(0.090)	(0.100)	(0.109)	(0.092)	(0.087)
Population deciles fixed-effects	-0.027	-0.109	-0.191*	-0.316***	-0.299***	-0.106	-0.293***
	(0.085)	(0.093)	(0.104)	(0.113)	(0.104)	(0.090)	(0.093)
Population growth deciles fixed-effects	-0.035	-0.107	-0.177	-0.293**	-0.268**	-0.106	-0.270**
	(0.106)	(0.103)	(0.131)	(0.133)	(0.119)	(0.106)	(0.116)

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Unemployment effects - robustness/sensitivity - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Biomass							
Baseline	-0.284	-1.357***	-0.546	-0.451	-0.993*	-0.955**	-0.409
	(0.589)	(0.493)	(0.425)	(0.600)	(0.554)	(0.451)	(0.325)
$y_{i,t-37}$	-0.387	-1.380***	-0.665	-0.458	-1.069	-0.973**	-0.420
	(0.669)	(0.522)	(0.495)	(0.640)	(0.676)	(0.464)	(0.330)
$y_{i,t-37}$ to $y_{i,t-48}$	-0.693	-1.754**	-0.690	0.014	-1.277	-1.446***	-0.389
	(0.574)	(0.702)	(0.701)	(0.836)	(0.877)	(0.488)	(0.554)
$R_{i,t-1}$ to $R_{i,t-6}$	-0.224	-1.340***	-0.509	-0.402	-0.911*	-0.927**	-0.355
	(0.587)	(0.480)	(0.423)	(0.586)	(0.527)	(0.445)	(0.315)
$R_{i,t-1}$ to $R_{i,t-24}$	-0.343	-1.477***	-0.676	-0.636	-1.120*	-1.060**	-0.570
	(0.587)	(0.519)	(0.468)	(0.601)	(0.624)	(0.473)	(0.358)
Controlling for serial correlation	-0.284	-1.340***	-0.546	-0.464	-1.034*	-0.955**	-0.470
	(0.589)	(0.480)	(0.425)	(0.627)	(0.578)	(0.451)	(0.352)
Region fixed-effects	-0.477	-1.376	-0.695	-0.547	-0.939	-1.056	-0.529
	(0.811)	(0.917)	(0.944)	(0.987)	(1.409)	(0.887)	(0.954)
Province fixed-effects	-0.337	-1.044*	-0.122	0.084	-0.364	-0.712	0.070
	(0.455)	(0.587)	(0.535)	(0.863)	(0.994)	(0.524)	(0.667)
Population deciles fixed-effects	-0.522	-1.869***	-1.328	-1.240	-1.830	-1.450**	-1.223
	(0.671)	(0.720)	(0.942)	(1.361)	(1.223)	(0.683)	(1.075)
Population growth deciles fixed-effects	-0.583	-1.799**	-1.026	-0.954	-1.358	-1.377**	-0.907
	(0.731)	(0.723)	(0.929)	(1.183)	(1.230)	(0.701)	(0.954)

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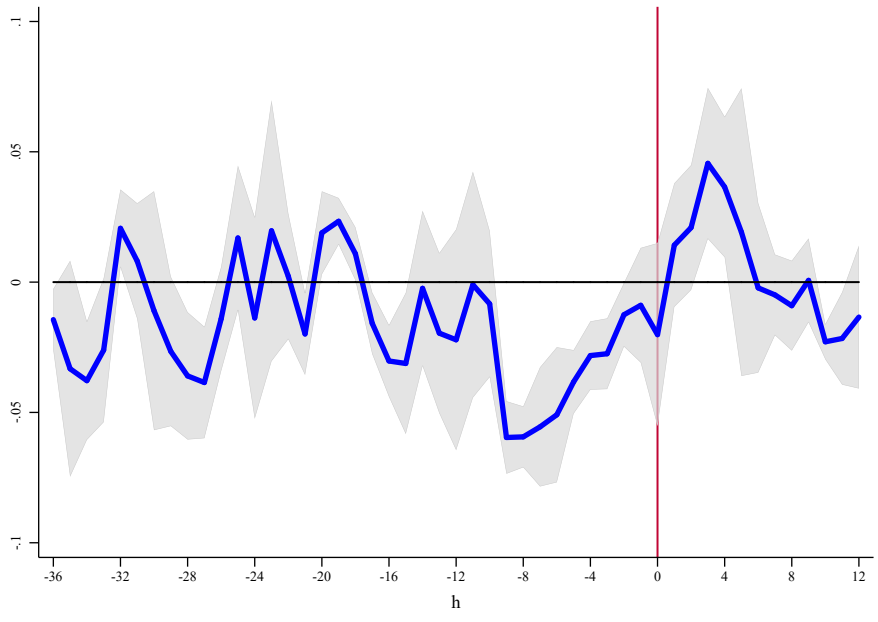
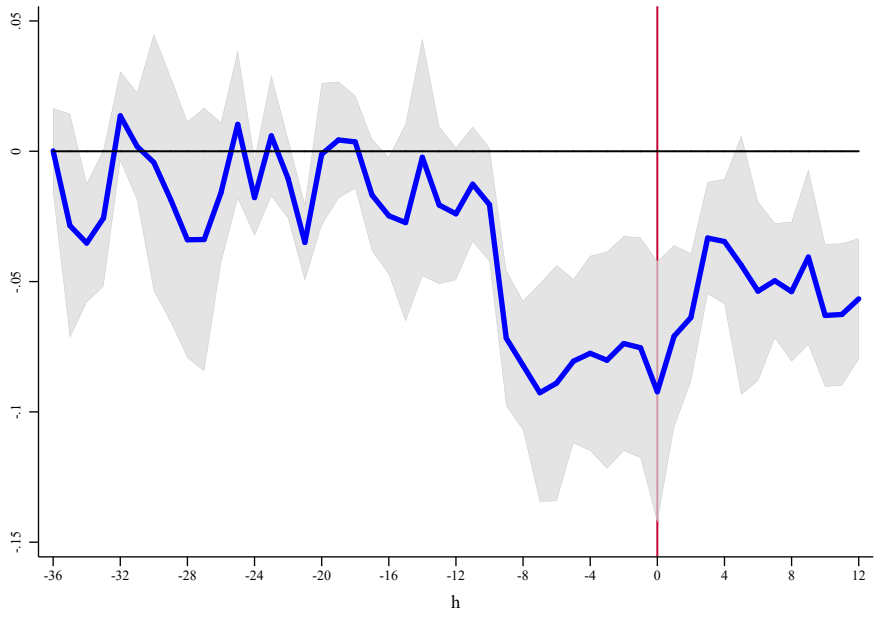
Unemployment effects - solar plants opened after 2019

Baseline specification



Province-date fixed effects



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Employment multipliers (increase per megawatt invested). Spatial effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
20 km	0.031	0.072**	0.077*	0.128**	0.116***	0.065**	0.102***
	(0.030)	(0.034)	(0.039)	(0.050)	(0.035)	(0.029)	(0.033)
30 km	0.016	0.052*	0.028	0.112**	0.111***	0.038	0.080**
	(0.031)	(0.030)	(0.042)	(0.045)	(0.034)	(0.028)	(0.034)
40 km	-0.004	0.070**	0.004	0.112**	0.111***	0.040	0.077**
	(0.035)	(0.034)	(0.044)	(0.044)	(0.039)	(0.032)	(0.036)
50 km	0.003	0.085**	-0.000	0.129***	0.116***	0.046	0.080**
	(0.036)	(0.033)	(0.040)	(0.040)	(0.037)	(0.030)	(0.033)
Wind							
20 km	-0.029**	-0.014	-0.014	-0.017	-0.009	-0.018	-0.016
	(0.012)	(0.016)	(0.015)	(0.022)	(0.021)	(0.014)	(0.020)
30 km	-0.014	0.001	0.001	0.004	0.004	-0.004	0.002
	(0.021)	(0.023)	(0.025)	(0.022)	(0.022)	(0.022)	(0.022)
40 km	-0.014	0.019	0.019	0.022	0.016	0.011	0.021
	(0.031)	(0.034)	(0.040)	(0.033)	(0.031)	(0.032)	(0.032)
50 km	-0.030	0.018	0.000	0.028	0.010	-0.001	0.016
	(0.028)	(0.030)	(0.037)	(0.032)	(0.033)	(0.029)	(0.032)
Biomass							
20 km	-0.337	0.105	0.093	0.389**	0.002	-0.018	0.203
	(0.305)	(0.229)	(0.239)	(0.189)	(0.154)	(0.247)	(0.175)
30 km	-0.168	0.190	0.192	0.415***	0.061	0.098	0.247**
	(0.184)	(0.144)	(0.143)	(0.127)	(0.122)	(0.146)	(0.108)
40 km	-0.135	0.312*	0.351**	0.592***	0.168	0.183	0.401***
	(0.206)	(0.175)	(0.174)	(0.146)	(0.130)	(0.174)	(0.127)
50 km	-0.114	0.235	0.330*	0.662***	0.181	0.143	0.445***
	(0.172)	(0.174)	(0.171)	(0.170)	(0.154)	(0.159)	(0.149)

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Employment spatial effects (30km) - rural-urban - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Local Effect	2.313***	2.453***	2.037**	1.709***	1.299**	2.694***	1.679***
	(0.661)	(0.721)	(0.905)	(0.576)	(0.655)	(0.715)	(0.632)
Spatial Effect	0.016	0.052*	0.028	0.112**	0.111***	0.038	0.080**
	(0.031)	(0.030)	(0.042)	(0.045)	(0.034)	(0.028)	(0.034)
Rural Local Effect	2.300***	2.426***	2.018**	1.690***	1.258*	2.683***	1.662***
	(0.669)	(0.726)	(0.913)	(0.585)	(0.664)	(0.723)	(0.640)
Rural Spatial Effect	-0.002	0.007	-0.001	0.027*	0.026**	0.004	0.017
	(0.011)	(0.010)	(0.014)	(0.015)	(0.011)	(0.010)	(0.011)
Urban Local Effect	3.398**	5.058***	1.789	1.869	1.172	3.861**	1.573
	(1.707)	(1.765)	(1.603)	(1.351)	(1.448)	(1.546)	(1.332)
Urban Spatial Effect	0.646***	0.755***	0.708***	0.593***	0.632***	0.719***	0.636***
	(0.188)	(0.185)	(0.218)	(0.198)	(0.222)	(0.173)	(0.196)

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Employment spatial effects (30km) - rural-urban - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Local Effect	-0.189	-0.185	-0.327	-0.426*	-0.275	-0.228	-0.354*
	(0.211)	(0.237)	(0.235)	(0.241)	(0.249)	(0.200)	(0.212)
Spatial Effect	-0.014	0.001	0.001	0.004	0.004	-0.004	0.002
	(0.021)	(0.023)	(0.025)	(0.022)	(0.022)	(0.022)	(0.022)
Rural Local Effect	-0.166	-0.154	-0.313	-0.419*	-0.278	-0.206	-0.350*
	(0.206)	(0.229)	(0.228)	(0.235)	(0.243)	(0.195)	(0.206)
Rural Spatial Effect	-0.005	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002
	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Urban Local Effect	-3.993	-4.296	-5.014**	-4.345	-4.888*	-4.190	-4.509
	(2.428)	(3.416)	(2.032)	(3.554)	(2.814)	(2.736)	(3.024)
Urban Spatial Effect	-0.059	0.022	0.047	0.080	0.088	0.020	0.087
	(0.079)	(0.100)	(0.095)	(0.110)	(0.103)	(0.085)	(0.099)

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Employment spatial effects (30km) - rural-urban - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Biomass							
Local Effect	1.846	6.283***	2.539	4.612***	1.728	4.279*	2.914*
	(2.229)	(2.296)	(2.370)	(1.688)	(2.929)	(2.210)	(1.751)
Spatial Effect	-0.168	0.190	0.192	0.415***	0.061	0.098	0.247**
	(0.184)	(0.144)	(0.143)	(0.127)	(0.122)	(0.146)	(0.108)
Rural Local Effect	1.844	5.960***	2.399	4.121***	1.624	4.211*	2.727
	(2.236)	(2.248)	(2.353)	(1.583)	(2.936)	(2.206)	(1.744)
Rural Spatial Effect	-0.038	0.060	0.075	0.138**	0.050	0.043	0.098**
	(0.083)	(0.066)	(0.064)	(0.054)	(0.044)	(0.067)	(0.047)
Urban Local Effect	-3.514	13.023	-1.977	14.653	-12.387	-3.150	-4.826
	(19.089)	(28.489)	(23.908)	(30.154)	(23.802)	(23.087)	(24.769)
Urban Spatial Effect	-0.491**	0.265	0.180	0.573*	-0.236	0.037	0.209
	(0.234)	(0.183)	(0.273)	(0.327)	(0.557)	(0.189)	(0.331)

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Unemployment multipliers (increase per megawatt invested). Spatial effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
20 km	-0.037***	-0.040**	-0.035***	-0.019	0.008	-0.038***	-0.009
	(0.010)	(0.016)	(0.013)	(0.018)	(0.017)	(0.012)	(0.014)
30 km	-0.037***	-0.031*	-0.025*	-0.013	0.033**	-0.033**	-0.001
	(0.011)	(0.016)	(0.015)	(0.017)	(0.014)	(0.013)	(0.014)
40 km	-0.049***	-0.056***	-0.029*	-0.015	0.037**	-0.050***	-0.004
	(0.015)	(0.019)	(0.017)	(0.019)	(0.016)	(0.017)	(0.017)
50 km	-0.067***	-0.075***	-0.035**	-0.019	0.040**	-0.065***	-0.010
	(0.017)	(0.020)	(0.017)	(0.019)	(0.017)	(0.017)	(0.017)
Wind							
20 km	-0.009	-0.018**	-0.019**	-0.023**	-0.013	-0.017**	-0.020**
	(0.006)	(0.009)	(0.008)	(0.011)	(0.010)	(0.007)	(0.009)
30 km	-0.008	-0.016**	-0.021***	-0.026***	-0.012	-0.015**	-0.022***
	(0.006)	(0.008)	(0.007)	(0.009)	(0.008)	(0.007)	(0.008)
40 km	-0.007	-0.017*	-0.025***	-0.032***	-0.017	-0.018**	-0.029***
	(0.006)	(0.009)	(0.008)	(0.012)	(0.010)	(0.008)	(0.010)
50 km	-0.007	-0.028***	-0.028***	-0.046***	-0.018*	-0.026***	-0.038***
	(0.007)	(0.010)	(0.009)	(0.012)	(0.011)	(0.008)	(0.010)
Biomass							
20 km	0.085**	-0.045	-0.139***	-0.224***	-0.257***	-0.036	-0.192***
	(0.042)	(0.028)	(0.050)	(0.043)	(0.060)	(0.034)	(0.047)
30 km	0.065	-0.045	-0.134***	-0.189***	-0.274***	-0.046	-0.181***
	(0.043)	(0.031)	(0.040)	(0.031)	(0.046)	(0.032)	(0.033)
40 km	0.078**	-0.039	-0.146***	-0.226***	-0.298***	-0.039	-0.212***
	(0.039)	(0.032)	(0.041)	(0.035)	(0.047)	(0.032)	(0.035)
50 km	0.114***	0.010	-0.107*	-0.220***	-0.276***	0.009	-0.191***
	(0.041)	(0.045)	(0.058)	(0.041)	(0.046)	(0.041)	(0.041)

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Unemployment spatial effects (30km) - rural-urban - solar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Solar							
Local Effect	-0.258***	-0.077	0.063	0.038	0.257	-0.143**	0.122
	(0.068)	(0.123)	(0.156)	(0.093)	(0.183)	(0.060)	(0.109)
Spatial Effect	-0.037***	-0.031*	-0.025*	-0.013	0.033**	-0.033**	-0.001
	(0.011)	(0.016)	(0.015)	(0.017)	(0.014)	(0.013)	(0.014)
Rural Local Effect	-0.235***	-0.052	0.081	0.058	0.268	-0.118**	0.140
	(0.066)	(0.115)	(0.156)	(0.090)	(0.186)	(0.053)	(0.106)
Rural Spatial Effect	-0.009***	-0.006	-0.006	-0.001	0.011**	-0.007*	0.002
	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Urban Local Effect	-1.244***	-1.358*	-1.006**	-1.100	-0.411	-1.357***	-0.809
	(0.407)	(0.710)	(0.495)	(0.871)	(0.610)	(0.447)	(0.595)
Urban Spatial Effect	-0.317***	-0.298***	-0.221**	-0.213**	0.035	-0.299***	-0.146
	(0.076)	(0.082)	(0.111)	(0.099)	(0.117)	(0.074)	(0.099)

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Unemployment spatial effects (30km) - rural-urban - wind

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-opening
Wind							
Local Effect	-0.024	-0.101	-0.152**	-0.279***	-0.247**	-0.093	-0.250***
	(0.062)	(0.090)	(0.076)	(0.105)	(0.110)	(0.079)	(0.092)
Spatial Effect	-0.008	-0.016**	-0.021***	-0.026***	-0.012	-0.015**	-0.022***
	(0.006)	(0.008)	(0.007)	(0.009)	(0.008)	(0.007)	(0.008)
Rural Local Effect	-0.012	-0.084	-0.130*	-0.255**	-0.228**	-0.079	-0.230**
	(0.061)	(0.091)	(0.074)	(0.103)	(0.108)	(0.080)	(0.090)
Rural Spatial Effect	-0.002	-0.003	-0.005**	-0.006**	-0.002	-0.003*	-0.005**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Urban Local Effect	-0.744	0.974	-0.801	0.318	-0.026	0.591	0.087
	(1.335)	(1.004)	(1.155)	(1.641)	(1.451)	(0.790)	(1.363)
Urban Spatial Effect	-0.061***	-0.130***	-0.085**	-0.166***	-0.079**	-0.112***	-0.139***
	(0.022)	(0.044)	(0.039)	(0.060)	(0.038)	(0.038)	(0.051)

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Unemployment spatial effects (30km) - rural-urban - biomass

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						cumulative	
	h=-12	h=-6	h=0	h=6	h=12	pre-opening	post-open
Biomass							
Local Effect	-0.232	-1.315***	-0.489	-0.388	-0.936*	-0.909**	-0.346
	(0.562)	(0.471)	(0.414)	(0.599)	(0.558)	(0.426)	(0.315)
Spatial Effect	0.065	-0.045	-0.134***	-0.189***	-0.274***	-0.046	-0.181**
	(0.043)	(0.031)	(0.040)	(0.031)	(0.046)	(0.032)	(0.033)
Rural Local Effect	-0.113	-1.107***	-0.340	-0.161	-0.741	-0.755**	-0.186
	(0.510)	(0.390)	(0.390)	(0.582)	(0.586)	(0.365)	(0.297)
Rural Spatial Effect	0.006	-0.023**	-0.043***	-0.058***	-0.095***	-0.022*	-0.057**
	(0.017)	(0.011)	(0.016)	(0.011)	(0.019)	(0.013)	(0.013)
Urban Local Effect	-8.471***	-13.359***	-8.693***	-10.813***	-10.803***	-9.981***	-6.985**
	(3.043)	(3.407)	(3.133)	(2.377)	(3.082)	(2.672)	(2.661)
Urban Spatial Effect	0.316***	0.033	-0.222**	-0.367***	-0.395***	0.025	-0.334**
	(0.094)	(0.089)	(0.103)	(0.112)	(0.135)	(0.073)	(0.102)

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