Measures, Drivers and Effects of Green Employment: Evidence from US Local Labour Markets, 2006-2014

Francesco Vona[1] Giovanni Marin[2] Davide Consoli[3]

[1]OFCE-SciencesPo, France; SKEMA, France
[2]IRCrES-CNR, Italy; OFCE-SciencesPo, France
[3]Ingenio CSIC-UPV, Spain

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Green Jobs in the political debate

- **National Environmental Technology Strategy** (Clinton's administration)
  - Foster **green industry** and promote its **export**
- **America Recovery and Reinvestment Act** (Obama's administration, 2009)
  - **Energy efficiency** and **renewable** energy research and investment ($27.2 billion)
  - Of which $500 million for **training** for **green collar** workers
- **Optimistic view**
  - Demand for green goods and services can provide **new impetus** to sluggish growth in OECD countries
- **Pessimistic view**
  - **Jobless recovery** after the great recession raised concerns that **environmental regulation** could entail higher **compliance costs**
  - Possible **crowding out** of private and public **investments** from other sector with greater multipliers

Open issues

- How to **define** green jobs?
- **Where** do green jobs locate?
- Is there a green **wage premium**?
- What are the **drivers** of green jobs?
- Do green jobs **generate** other jobs?

Goals of the paper

- **Overview** of Green Employment
  - **New measure** based on **occupation**-specific information ⇒ degree of engagement with **green** work **tasks**
  - Evidence **over time** (2006-2014) and **space** (US metropolitan and non-metropolitan areas)
- Analysis of key **drivers** of Green Employment
  - **Local** characteristics
  - Environmental **regulation**
- Evidence of the **impact** of Green Employment on **local economies**
  - **Multiplier** of Green Employment on employment in the non-tradable sector

Measuring green employment: 'classic' industry-based approaches

- Jobs in **green industries** (products or processes)
  - **Eurostat** and **BLS** approach ⇒ Environmental Goods and Services Sector and Green Goods and Service Sectors (Deschenes 2013; Becker and Shadbegian 2009)
  - The **industry** is green, the **jobs** (e.g. occupations) **not necessarily**
  - **Unclear definition** of environmental/green sectors ⇒ Little environmental pressures? Positive contribution to resource saving or improved environmental quality?
- **Sharp distinction** between green and non-green sectors **not easy**: green technologies are pervasive and entail incremental changes within different sectors (i.e. construction, chemicals, metals, power generation, etc.)

Measuring green employment: occupation/task-based approach

- **Green occupations**
  - **Unit** of analysis is the **occupation** (Autor et al., 2003), **not** the **sector**
  - Occupations performing **green tasks** or affected by the green economy, employed in **any industry** (Dierdroff et al., 2009; 2011)

Green jobs in O*NET

- The **Green Economy Program** of **O*NET** identifies two types of green jobs
  - **Existing** occupations that are expected to undergo **significant changes** in terms of task content (*Green Enhanced Skills*)
  - **New occupations** that emerge as a response to **specific needs** of the green economy (*Green Emerging*)
- O*NET **taxonomy** is sometimes **too broad and misleading** $\Rightarrow$ some green occupation are fully involved in green tasks while for other green occupations green tasks are only marginal

Examples of green occupations and green tasks

- **Wind Turbine Service Technicians (49-9081.00)**
  - Diagnose problems involving wind turbine generators or control systems.
  - Climb wind turbine towers to inspect, maintain, or repair equipment.
- **Regulatory Affairs Specialists (13-1041.07)**
  - Obtain clearances for the use of recycled plastics in product packaging.
  - Monitor national or international legislation on ozone-depleting substances or global warming.
  - NON-GREEN *Coordinate, prepare, or review regulatory submissions for domestic or international projects.*
  - NON-GREEN *Participate in internal or external audits.*

Our measure of green employment

- We compute the **Greenness** of an occupation as:

$$Greenness_i = \frac{\text{Weighted importance of green-specific tasks}_i}{\text{Weighted importance of total specific tasks}_i}$$

- The greenness is a **continuous measure** that **proxies** the **relative** amount of **time** a worker in occupation *i* devotes to **green tasks**

Not a 'binary' definition of GE...

	Greenness=1	Greenness btw 0.5 and 0.3	Greenness<0.3
Green Enhanced Occupations	Environmental Engineers, Environ Science Technicians, Hazardous Material Removers	Aerospace Engineers, Atmospheric and Space Scientists, Automotive Speciality Technicians, Roofers	Construction Workers, Maintenance & Repair Workers, Inspectors, Marketing Managers
Emerging & New Green Occupations	Wind Energy Engineers, Fuel Cell Technicians, Recycling Coordinators	Electrical Engineering Technologists, Biochemical Engineers, Supply Chain Managers, Precision Agriculture Technicians	Traditional Engineering Occupations, Transportation Planners, Compliance Managers

Green employment in metropolitan and nonmetropolitan areas

We use the occupational greenness to **weight BLS employment** data for 2006-2014 and build a measure of green employment that varies at the metro and non-metro area level j, the lower geo-level at which detailed occupational information is available

$$GE_{jt} = \sum_i Greenness_i \times \frac{L_{ijt}}{L_{jt}}$$

where L_{ijt} is employment in occupation i, area j and year t and L_{jt} is total employment of area j and year t

Other (complementary) measures of green employment

'Core' Green Employment $\Rightarrow$ only considers **'core' specific tasks** and excludes supplemental tasks

$$CGE_{jt} = \sum_i Greenness\_core_i \times \frac{L_{ijt}}{L_{jt}}$$

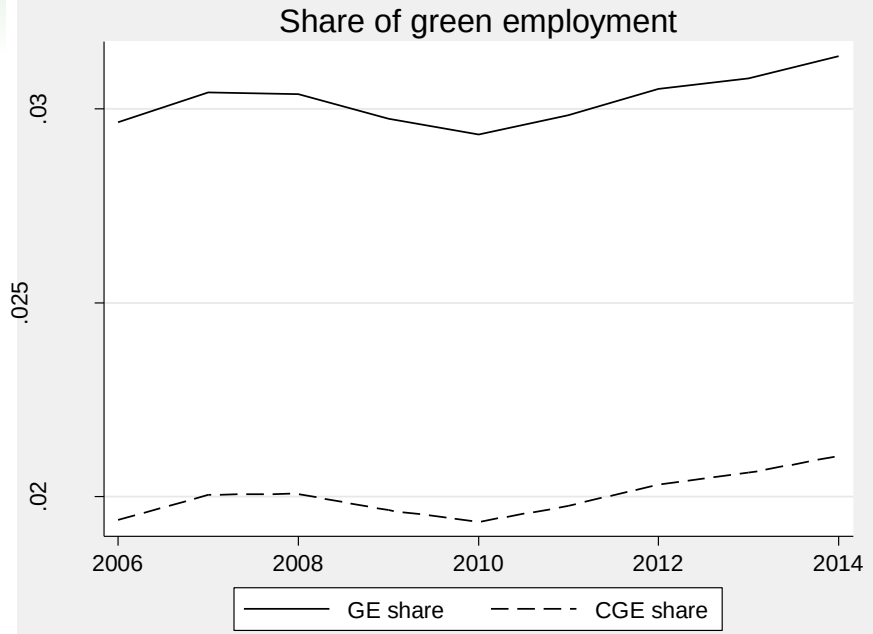
'Industry' Green Employment $\Rightarrow$ green employment **predicted** by the **industry structure** of the area

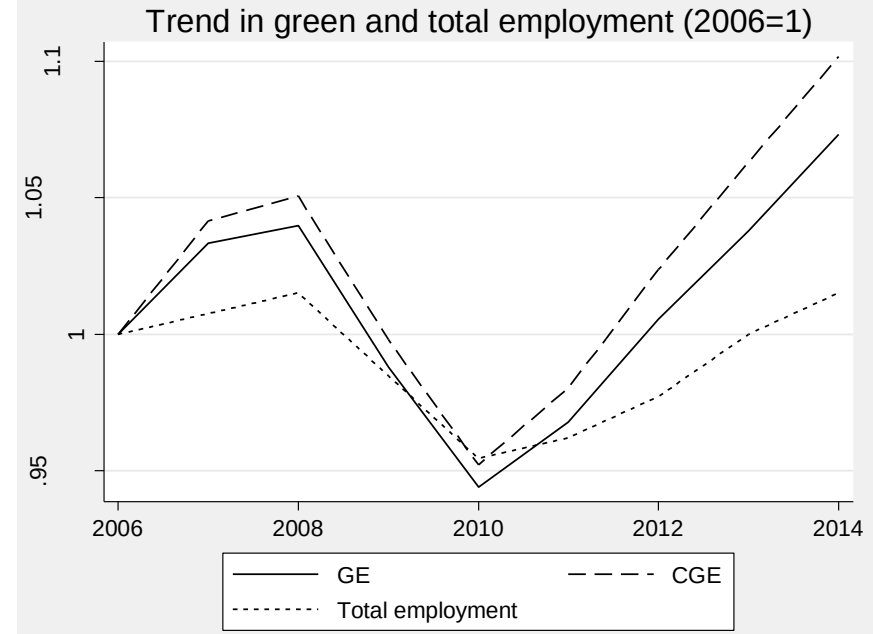
$$GIE_{jt} = \sum_k Greenness_{kt} \times \frac{L_{kjt}}{L_{jt}}$$

where $Greenness_{kt}$ is national average Greenness of industry k (4-digit NAICS) and year t, L_{kjt} is employment in industry k, area j and year t (from County Business Patterns) and L_{jt} is total employment of area j and year t

Facts on green employment

1. **Trend** in green employment share
2. **Wage premium** for green occupations
3. **Convergence** in green employment across areas
4. Geographical **concentration** of green employment
5. **Profiling** of areas by green employment and top areas


Share of green employment
.03
.025
.02
2006
2008
2010
2012
2014
GE share
CGE share


Trend in green and total employment (2006=1)
1.1
1.05
1
.95
2006
2008
2010
2012
2014
GE
CGE
Total employment

Evidence by macro-occupational group

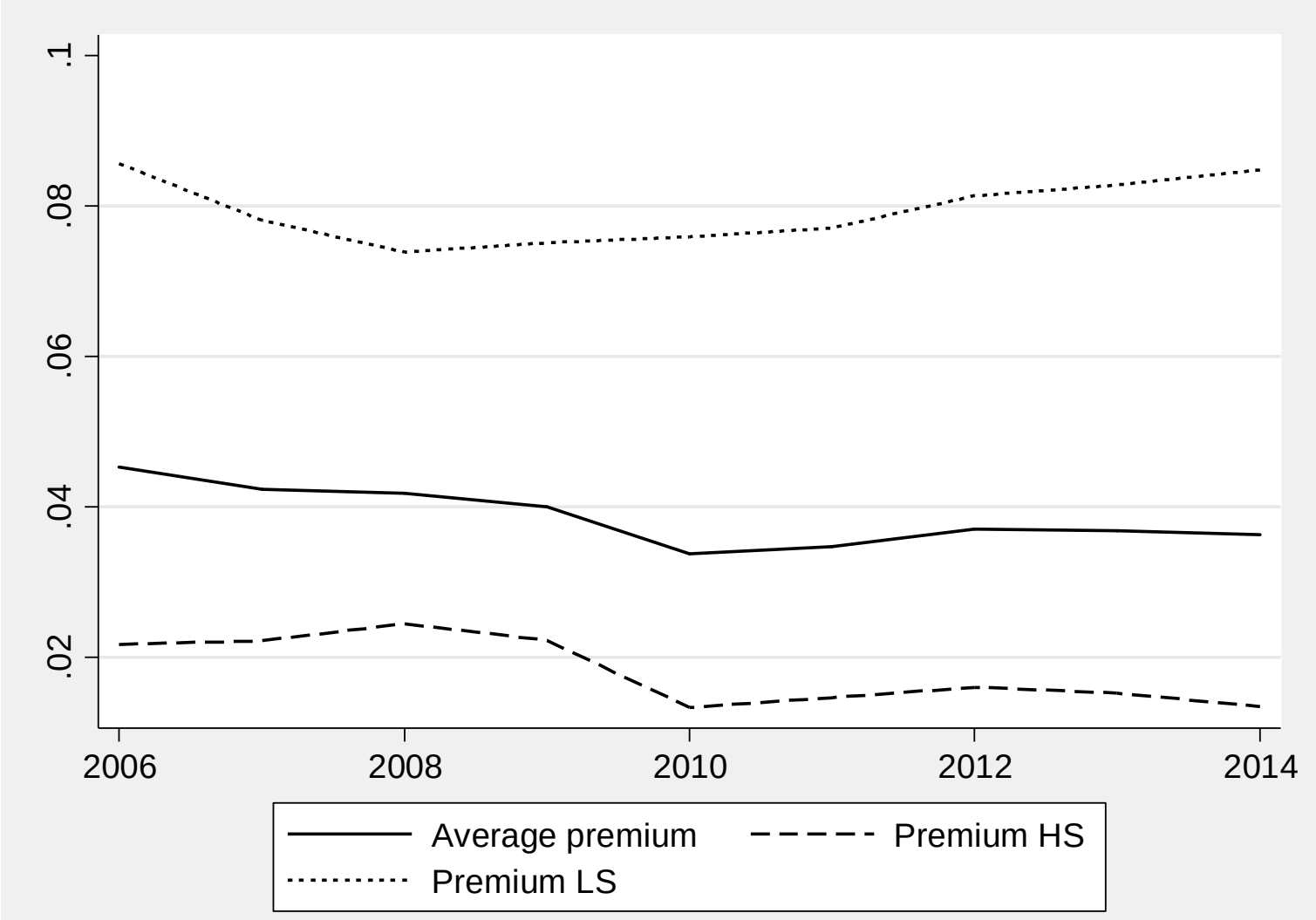
Occupational group	GE share (2006)	Growth GE (2006-2014)	Average years of education of Green occ	Average years of education of non-Green occ
11 Management	0.0917	0.1315	15.52	15.32
13 Business and Financial Operations	0.0789	0.0610	15.45	15.37
15 Computer and Mathematical	0.0012	0.1762	15.57	15.43
17 Architecture and Engineering	0.2115	0.0139	15.90	15.50
19 Life, Physical, and Social Science	0.1487	0.1147	16.28	16.93
21 Community and Social Services	-	-	-	-
23 Legal	0.0003	-0.1719	16.48	17.70
25 Education, Training, and Library	-	-		
27 Arts, Design, Entertainment, Sports, and Media	0.0290	-0.0448	15.66	14.60
29 Healthcare Practitioners and Technical	0.0005	0.3961	14.83	15.65
31 Healthcare Support	-	-	-	-
33 Protective Service	-	-	-	-
35 Food Preparation and Serving Related	-	-	-	-
37 Building and Grounds Cleaning and Maintenance	-	-	-	-
39 Personal Care and Service	-	-	-	-
41 Sales and Related	0.0395	0.5717	14.66	12.41
43 Office and Administrative Support	0.0028	-0.1288	11.97	12.97
45 Farming, Fishing, and Forestry	-	-	-	-
47 Construction and Extraction	0.0778	-0.2502	11.81	11.96
49 Installation, Maintenance, and Repair	0.1188	-0.1917	12.74	12.73
51 Production	0.0381	-0.1851	12.62	11.88
53 Transportation and Material Moving	0.0284	-0.0579	12.15	11.72

Summing up I

- Green employment is about **2-3%** of total employment
- Green employment is strongly **pro-cyclical**
- Green employment grew **6-8% faster** than total employment
- **High-skill** green jobs have the **largest share of GE increase** $\Rightarrow$ are environmental technologies **skill-biased**?

Wage premium in green occupations

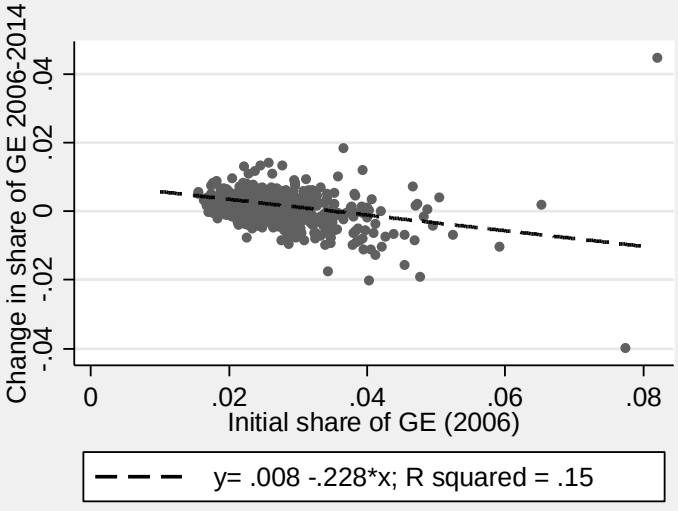
- Average difference in average hourly wage of green occupations and non-green occupations within the same 3-digit SOC group

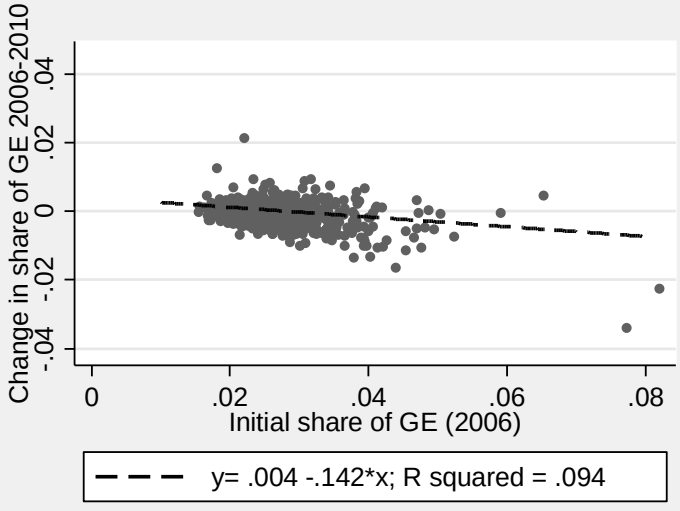


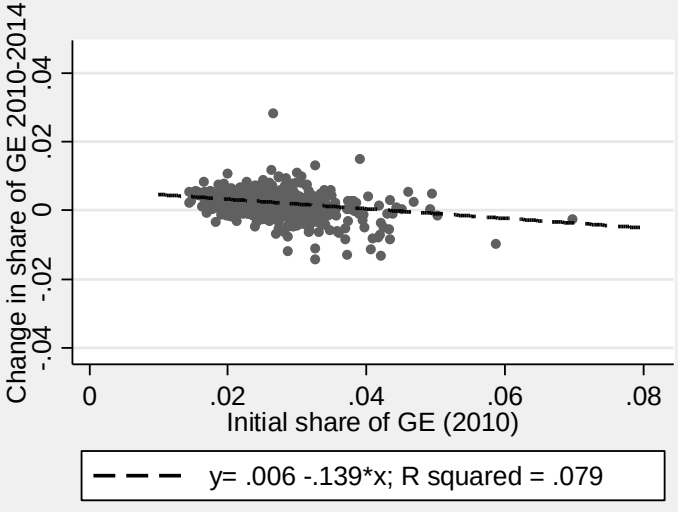
Summing up II

- Green jobs yield a **wage premium** compared to similar non-green jobs
- Green wage premium is **higher** and more sensitive to the business cycle for **low-skilled** green workers relative to high-skilled ones

Catching-up in green employment share

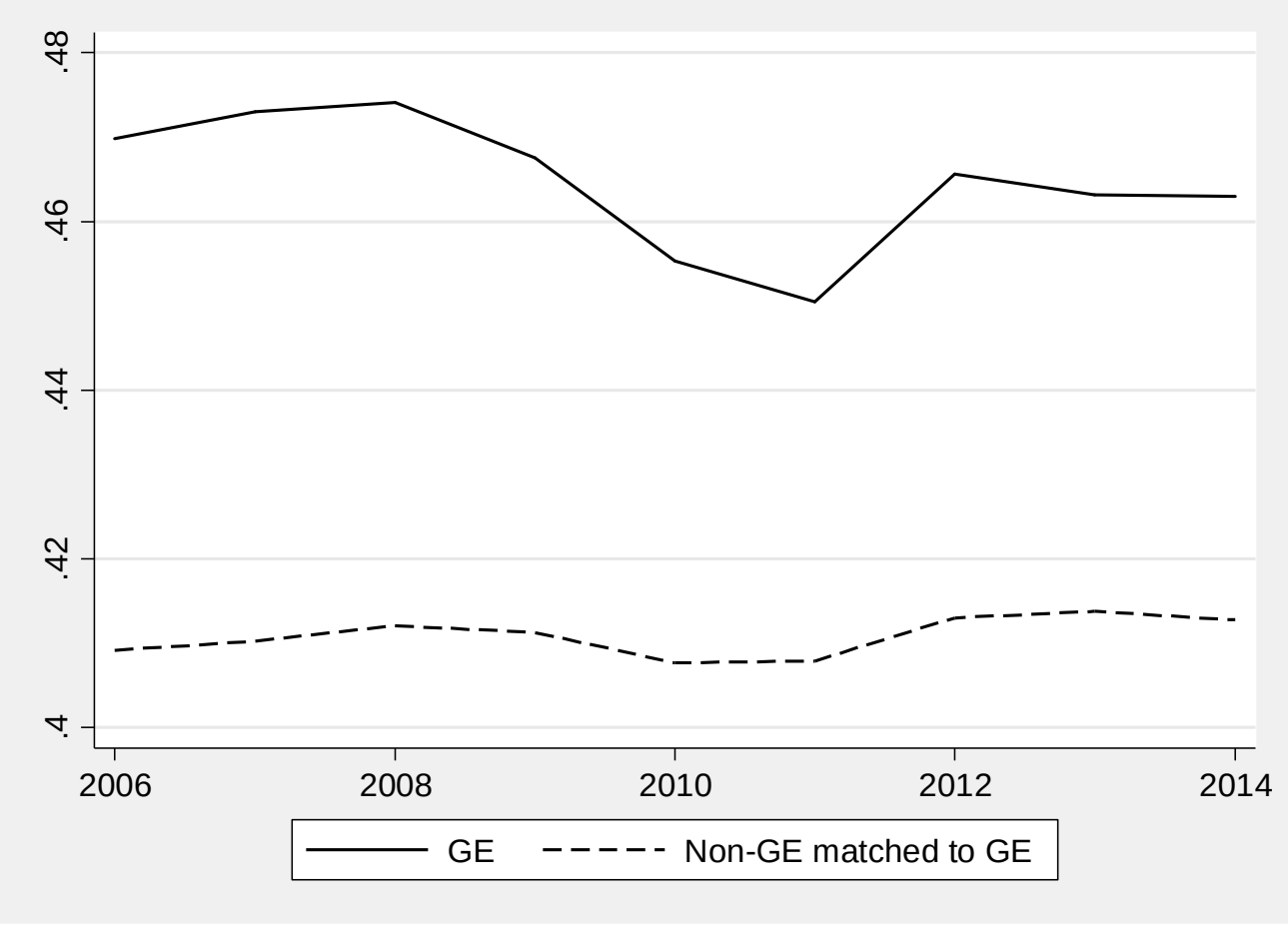






Geographical concentration of green employment

- Average concentration of green occupations and non-green occupations in 3-digit SOC groups with at least one green occupation (Non-GE matched to GE)



Summing up III

- Moderate **catching up** across areas over the period
- Green employment remains **more concentrated** compared to matched non-green jobs
- **Catching up** may have been **just temporary** and due to the recession

Profiling of areas by quintile of initial GE share

Quintile of GE share (2006)	1	2	3	4	5	Total
GE share (2006)	0.0216	0.026	0.0294	0.0329	0.0395	0.0298
Growth in GE share (2006-2014)	0.1181	0.1056	0.0776	0.0127	-0.0075	0.0617
Number of areas	218	105	81	61	72	537
Total empl growth 2006-2014	0.0022	0.0151	0.0286	0.0384	0.0239	0.022
Unemployment rate	0.0712	0.0692	0.0666	0.0714	0.0677	0.0693
Pop density (2006)	208.4	1143.8	489.9	1024.9	689.8	718.7
Exposure to crisis	-0.049	-0.045	-0.0484	-0.0491	-0.0489	-0.0481
Import penetration (2006)	0.0677	0.0646	0.0623	0.063	0.0631	0.0641
Empl share in manufacturing (2006)	0.1329	0.1058	0.1029	0.101	0.0996	0.1084
Empl share in utilities (2006)	0.0047	0.0046	0.0037	0.0045	0.0035	0.0042
Empl share in construction (2006)	0.0508	0.0501	0.0563	0.0573	0.0597	0.0548
Empl share in mining (2006)	0.0065	0.0028	0.0017	0.0058	0.0017	0.0038
Empl share high-tech manuf (2006)	0.0333	0.0319	0.0321	0.0335	0.0391	0.0339
Empl share KIBS, NAICS 54 (2006)	0.0288	0.0549	0.0553	0.0624	0.0839	0.0566
Number of areas with R&D labs	4	2	3	4	11	24
Green patent stock per capita	0.0233	0.0449	0.0329	0.0363	0.051	0.0374
Total patent stock per capita	0.2307	0.6257	0.4244	0.4714	0.7292	0.4909

Top areas in terms of green employment (2006)

Area name	GE	R&D lab	Green pat stock per capita (2006)	Empl share in KIBS	Empl share in high-tech manuf
Los Alamos County, New Mexico nonmetropolitan area	0.082	1	0.3616	0.4865	0
Holland-Grand Haven, MI	0.0773	0	0.0118	0.0271	0.1233
St. Mary's County, Maryland nonmetropolitan area	0.0652	0	0.0273	0.1942	0.0004
Kennewick-Pasco-Richland, WA	0.0591	1	0.0373	0.0972	0.0142
San Jose-Sunnyvale-Santa Clara, CA	0.0524	1	0.0606	0.1172	0.1376
Portsmouth, NH-ME	0.0504	0	0.0747	0.0532	0.0477
Fairbanks, AK	0.0495	0	0	0.0313	0.0005
Huntsville, AL	0.0487	0	0.0121	0.1464	0.0868
Other Nevada nonmetropolitan area	0.0482	0	0	0.0471	0.0034
Blacksburg-Christiansburg-Radford, VA	0.0476	0	0.0206	0.0323	0.1212
Bremerton-Silverdale, WA	0.0473	0	0.0009	0.0473	0.0314
Warner Robins, GA	0.047	0	0	0.0701	0.0027
Palm Bay-Melbourne-Titusville, FL	0.0469	0	0.0035	0.0569	0.0769
Cleveland, TN	0.0466	0	0.0129	0.0219	0.0735
Pocatello, ID	0.0454	0	0.016	0.0341	0.029
Crestview-Fort Walton Beach-Destin, FL	0.0454	0	0	0.0751	0.0434
Kankakee-Bradley, IL	0.0439	0	0.008	0	0.0547
Corvallis, OR	0.0426	0	0.0302	0.0503	0.051
Jackson, MI	0.0421	0	0.0187	0.0254	0.0728
Detroit-Warren-Livonia, MI	0.042	0	0.0937	0.0835	0.0824
National average	0.0298		0.0373	0.0538	0.0368

Top areas in terms of green employment (2014)

Area name	GE	R&D lab	Green pat stock per capita (2006)	Empl share in KIBS	Empl share in high-tech manuf
Los Alamos County, New Mexico nonmetropolitan area	0.1266	1	0.3616	0.6458	0
St. Mary's County, Maryland nonmetropolitan area	0.0672	0	0.0273	0.2133	0.0017
Columbus, IN	0.0548	0	0.2616	0.0332	0.2342
Portsmouth, NH-ME	0.0545	0	0.0747	0.0555	0.0436
Cleveland, TN	0.0539	0	0.0129	0.0184	0.0918
Boulder, CO	0.0513	1	0.0724	0.1515	0.055
Huntsville, AL	0.0494	0	0.0121	0.1542	0.0675
Bremerton-Silverdale, WA	0.0493	0	0.0009	0.0518	0.0629
Kennewick-Pasco-Richland, WA	0.0489	1	0.0373	0.0889	0.0147
Warner Robins, GA	0.0487	0	0	0.0547	0.0035
Other Nevada nonmetropolitan area	0.0466	0	0	0.0309	0.0016
Midland, TX	0.0458	0	0	0.0512	0.0228
San Jose-Sunnyvale-Santa Clara, CA	0.0454	1	0.0606	0.1328	0.1105
Fairbanks, AK	0.0452	0	0	0.0382	0.0008
Denver-Aurora-Broomfield, CO	0.0442	1	0.0207	0.0902	0.0131
Washington-Arlington-Alexandria, DC-VA-MD-WV	0.0433	1	0.0218	0.1549	0.0069
Trenton-Ewing, NJ	0.0429	1	0.1198	0.095	0.0203
Detroit-Warren-Livonia, MI	0.042	0	0.0937	0.0963	0.0787
Chattanooga, TN-GA	0.0411	0	0.0158	0.036	0.048
San Francisco-Oakland-Fremont, CA	0.041	1	0.0413	0.1176	0.0218
National average	0.0313		0.0375	0.0586	0.0329

Summing up IV

- High **persistence** of top areas
- 6 out of 8 of the 'new' top areas host **federal R&D labs**
- Majority of top areas are **high-tech**

Drivers of green employment

- Environmental **regulation**
- **Structural** factors

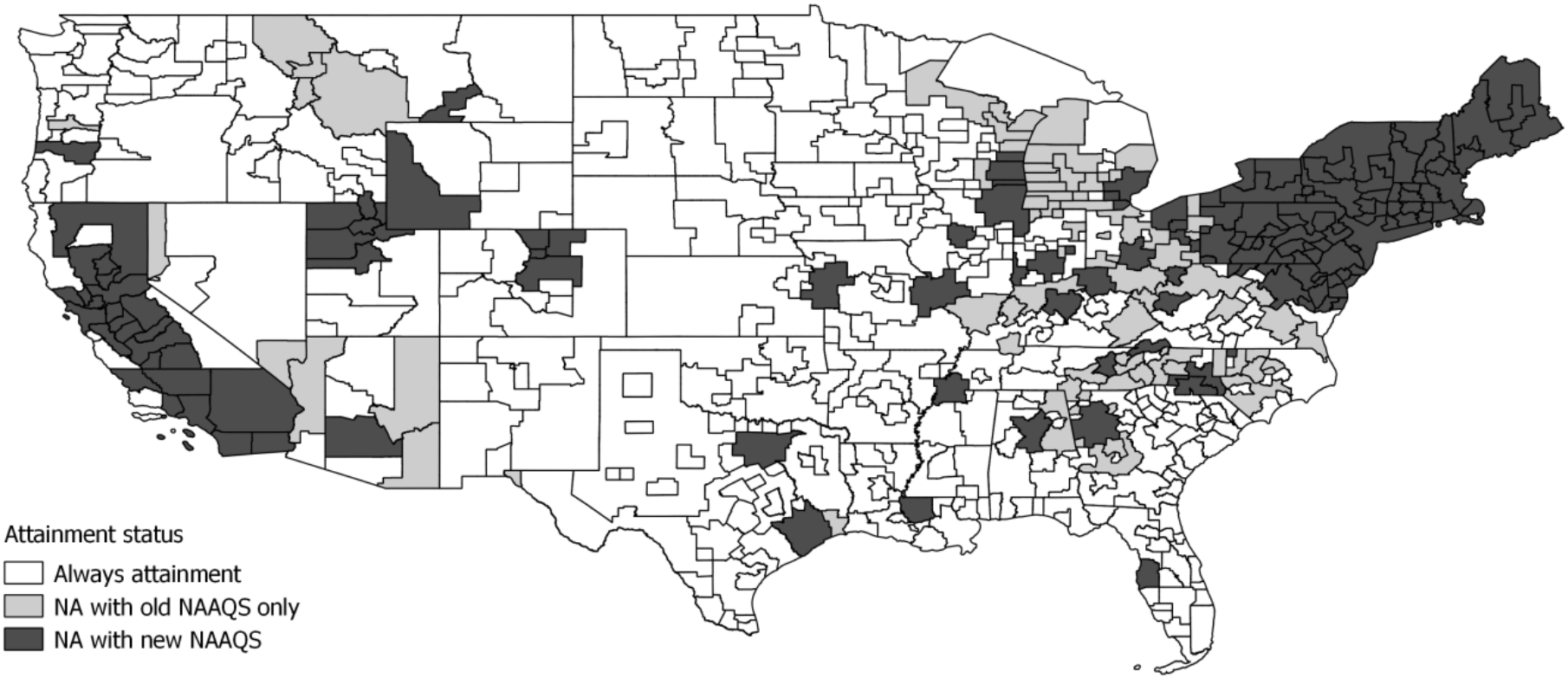
Environmental regulation: related literature

- Literature on **labour market effects** of environmental **regulation** and carbon leakage
  - Energy-intensive and **polluting industries relocate** in response to environmental regulation (Mulatu et al., 2010; Kahn and Mansur, 2013)
  - **Employment effect** generally **negative** although **modest** and concentrated in polluting industries (Greenstone, 2002; Walker, 2011; Curtis, 2014)
  - **Wage losses** large and persistent (Walker, 2013)

Environmental regulation: CAA

- The **Clean Air Act** (CAA) sets county-specific **attainment standards** (NAAQS) for six **criteria pollutants**
- **Counties** that **fail** to meet concentration levels for one or more **designated** as **nonattainment** (NA) areas
- Dates of EPA's new standards attainment designation
  - Particulate Matter (PM 2.5): **2009**
  - Lead: **2010**
  - Ozone: **2012**
  - Sulfur Dioxide (SO2): **2011**
- **Quasi-experimental** research design: **exogenous variation in regulatory stringency** at local level due to new emission standards
- We also **account** for **previous nonattainment** designation by allowing a differential time trend for areas that were nonattainment according to 'old' NAAQS

Nonattainment status by metropolitan and non-metropolitan area



Structural drivers of green employment

- **Resilience** to the **crisis** ⇒ What the growth of employment would have been given the initial industrial composition and the aggregate trends of employment by industry
- **Technology** endowment ⇒ stock of patents (green and non-green) per capita, presence of federally-funded R&D laboratories
- Exposure to **trade** ⇒ import penetration

- To limit **endogeneity** concerns we take the **initial value** of these variables (except for 'Resilience to crisis') and we **interact** them with a time **trend** ⇒ we allow for different trends for initial values of the covariates
- We also **condition** on **state-year** and **NMA-year** dummies

Baseline results

	GE share	CGE share	GIE share	log(tot_emp)
Resilience crisis x trend	0.00793	0.00729	0.00152	0.100
	(0.00283)***	(0.00295)**	(0.00101)+	(0.0302)***
	[0.00257]***	[0.00259]***	[0.000945]+	[0.0259]***
R&D lab x trend	0.0000930	0.0000584	-0.0000192	0.00216
	(0.0000589)+	(0.0000560)	(0.0000579)	(0.00112)*
	[0.0000567]+	[0.0000507]	[0.0000418]	[0.000904]**
Green patent stock per capita (2006) x trend	0.00265	0.00196	0.000959	-0.00611
	(0.00104)**	(0.000826)**	(0.000540)*	(0.0128)
	[0.00115]**	[0.000941]**	[0.000429]**	[0.0146]
Total patent stock per capita (2006) x trend	-0.000140	-0.0000990	-0.0000728	0.00258
	(0.0000993)	(0.0000860)	(0.0000382)*	(0.00111)**
	[0.000121]	[0.000105]	[0.0000440]*	[0.000965]***
Trade exposure (2006) x trend	-0.00113	-0.000580	-0.00131	-0.0544
	(0.00121)	(0.00112)	(0.000867)+	(0.0222)**
	[0.00127]	[0.00122]	[0.000698]*	[0.0220]**
Initially NA x trend	0.000103	0.0000977	-0.0000112	0.000453
	(0.0000688)+	(0.0000742)	(0.0000250)	(0.00110)
	[0.0000574]*	[0.0000545]*	[0.0000310]	[0.00110]
Switch to NA	0.000521	0.000457	0.0000224	-0.00251
	(0.000301)*	(0.000291)+	(0.000105)	(0.00477)
	[0.000245]**	[0.000232]**	[0.0000994]	[0.00371]
N	4833	4833	4296	4833

Fixed effect model weighted by total employment in 2006. Standard errors clustered by state in parenthesis and by area in brackets.
+ p<0.15, * p<0.1, ** p<0.05, *** p<0.01. Other control variables: year-by-state dummies, year-by-nma status dummies.

Drivers during crisis and post-crisis

	△GE share 2006-2010	△GE share 2010-2014
Resilience crisis	0.0305	0.0159
	(0.0166)*	(0.0109)+
	[0.0160]*	[0.00966]+
R&D lab	0.00155	-0.000224
	(0.000494)***	(0.000545)
	[0.000429]***	[0.000354]
Green patent stock per capita (2006)	-0.000130	0.0252
	(0.00910)	(0.0124)**
	[0.00823]	[0.0122]**
Total patent stock per capita (2006)	-0.000282	-0.00107
	(0.000805)	(0.000536)*
	[0.000787]	[0.000593]*
Trade exposure (2006)	0.00742	-0.0109
	(0.0126)	(0.00849)
	[0.00961]	[0.00838]
Initially NA	0.000588	0.000509
	(0.000450)	(0.000447)
	[0.000389]+	[0.000426]
Switch to NA	-0.000286	0.000553
	(0.000757)	(0.000655)
	[0.000561]	[0.000448]
N	537	537

OLS model weighted by total employment in 2006. Standard errors clustered by state in parenthesis and by area in brackets. + p<0.15, * p<0.1, ** p<0.05, *** p<0.01. Other control variables: state dummies, year-nma status dummy.

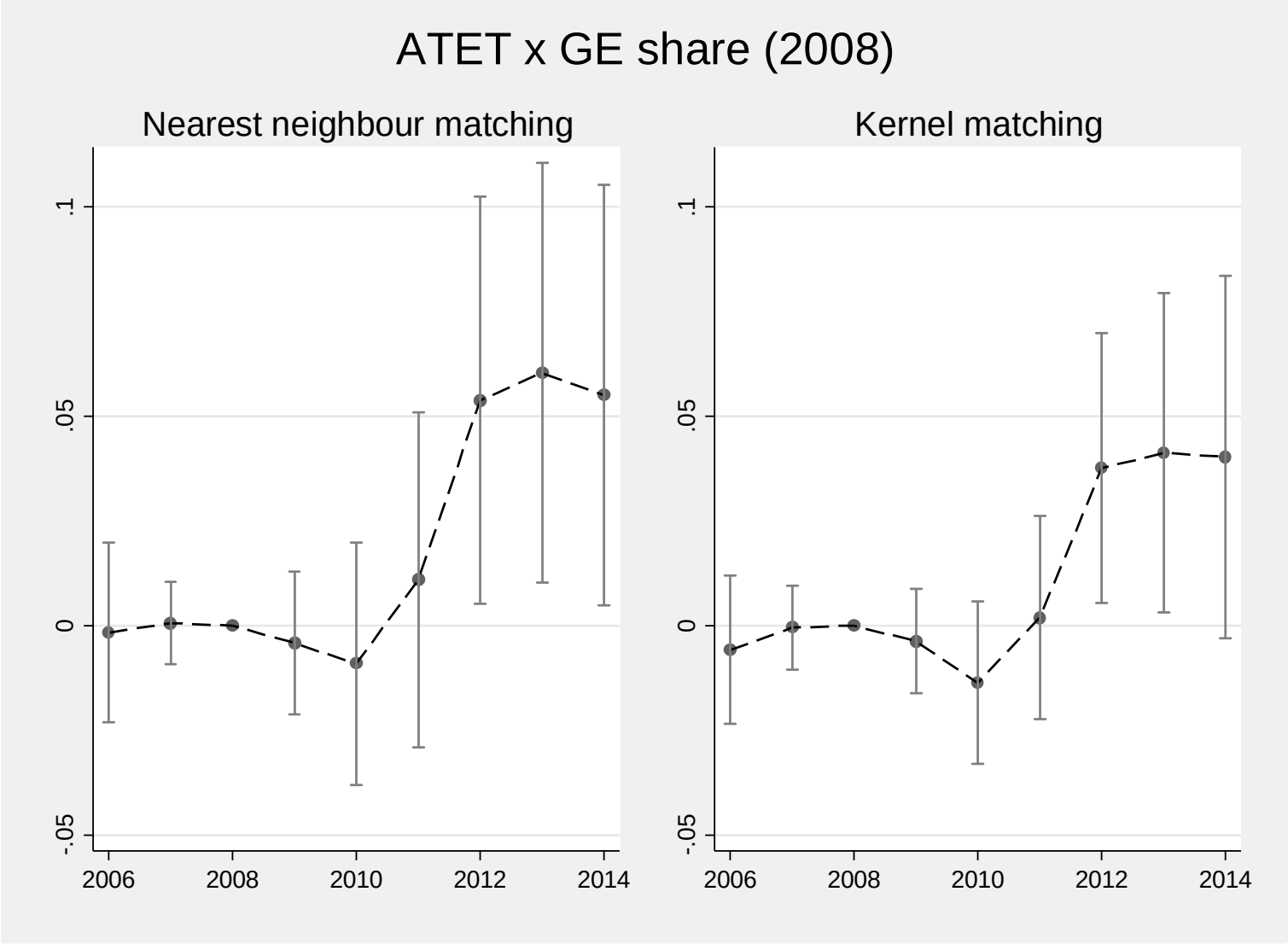
Focus on environmental regulation

- New **nonattainment** designation **cannot** be considered as **randomly** assigned if **systematic differences** in the factors upon which attainment status is set (population density, old NA designation, etc.) are **correlated** with the level and dynamics of **green employment**
- We build a proper **counterfactual** of attainment areas that mirrors the observable features of treated areas using the **difference-in-differences semi-parametric matching** estimator (Heckman et al., 1997; Heckman et al., 1998)
- We compute the **treatment effect for each** of the N_T treated **areas** j at year t ($\hat{\alpha_{jt}}$) as the difference between in the change of the outcome variable Y (with respect to the base year t^0) between the treated area j and the untreated area k that is matched to area j.
- The average treatment effect in year t is thus the average of the $\hat{\alpha_{jt}}$:

$$ATET_t = \frac{1}{N_T \sum_{j \in T} L_j^{t^0}} \sum_{j \in T} \left(\hat{\alpha_{jt}} \times L_j^{t^0} \right)$$

where the treatment effect for each treated area is weighted by its total employment in 2008 ($L_j^{t^0}$).

Results for environmental regulation



Local multiplier effect of green employment

- **How many jobs** does a positive **demand shock** contribute to create in the **tradable** part of the economy?
- **Total local multiplier** effect ⇒ effect on **non-tradable** (NT) sector + part of **tradable unaffected** by the shock
  - **NT sector** ⇒ benefits from **increased demand** of **local goods and services** (a **pecuniary** externality)
  - **Tradable sector** ⇒ **negative** effect due to higher local **labour costs** (a **general equilibrium** effect) and **positive** effect due to **agglomeration** and **localized supply chain** effects (**technological** externality)
- **Magnitude** of local multipliers **depends** on the type of **tradable** activities (e.g. Marchand, 2012; Moretti and Thulin, 2012)
  - **High-tech manufacturing** generates **larger multipliers** than **oil and mining** because they are a source of **stronger agglomeration and pecuniary** (via higher wages) externalities
- **Our goal** ⇒ **position green activities** in this ranking

Estimating local multiplier effect

$$\triangle log(Emp\_NT_j)_{2006}^{2014} = \beta \triangle log(GE_j)_{2006}^{2014} + \eta_s + \theta_{NMA} + \varepsilon_j$$

- **Identification** issues
  - **Cannot measure** the number of green jobs in **local tradable** and **non-tradable** sector
  - Possible **correlation** between the growth of **green employment** and **unobservable local shocks**
- IV approach
  - We use a standard **shift-share IV**
  - For each area we multiply **aggregate** (net of the employment of the same area) **growth** rate of employment in **green** occupations by the **initial** occupational **composition** of the area
    - The IV isolates the **share of green employment attributed to aggregate shocks**, such as subsidies to clean energy or the green stimulus package, **as opposed to that due to local shocks**(Moretti, 2010)

Local multiplier effect of GE - non-tradable

- Local Multiplier Effect $\Rightarrow \hat{\beta} \times \overline{\left(\frac{NT\_empl_{2014}}{GE_{2014}} \right)}$

Panel A - All NT (excluding NAICS 54)		
	OLS	IV
Elasticity of growth in empl in NT wrt growth in GE	0.232***	0.223**
	(0.0400)	(0.105)
GE multiplier	4.324	4.164
Panel B - NT depurated by GIE in NT		
	OLS	IV
Elasticity of growth in empl in NT wrt growth in GE	0.234***	0.308***
	(0.0427)	(0.0679)
GE multiplier	3.918	5.154

Local multiplier effect of GE - manufacturing

Table: Multiplier of GE for manufacturing employment

	All manufacturing (excluding GIE in manuf)		Manufact high-tech (excluding GIE in HT manuf)		Manufact low-tech (excluding GIE in LT manuf)	
	OLS	IV	OLS	IV	OLS	IV
Elasticity of growth in empl in NT wrt growth in GE	0.254***	0.0643	0.353***	0.262	0.223***	-0.00344
	(0.0582)	(0.135)	(0.0923)	(0.208)	(0.0616)	(0.142)
GE multiplier	0.640	0.162	0.338	0.250	0.355	-0.00548

Local multiplier effect of GE - during/post crisis

Panel A - All NT (excluding NAICS 54)				
	Crisis		Post-crisis	
	OLS	IV	OLS	IV
Elasticity of growth in empl in NT wrt growth in GE	0.114***	0.118	0.229***	0.510***
	(0.0291)	(0.0881)	(0.0445)	(0.117)
GE multiplier	2.132	2.196	4.276	9.531
Panel B - NT depurated by GIE in NT				
	Crisis		Post-crisis	
	OLS	IV	OLS	IV
Elasticity of growth in empl in NT wrt growth in GE	0.0939***	0.142***	0.226***	0.632***
	(0.0231)	(0.0517)	(0.0488)	(0.113)
GE multiplier	1.571	2.377	3.778	10.57

Local multiplier effect - discussion

- **Each new green job** contributes to generate **4.2 new NT** jobs in the local economy
- The **local multiplier effect** increases up to **5.1** new NT jobs when we **depurate** NT employment from the predicted number of **green jobs in NT industries**
- Considering **elasticity** of **NT employment** to **green employment** between **0.223-0.308** (ratio between green jobs and NT jobs is 1:18)
- **Ranking** by type of tradable activity $\Rightarrow$ green jobs at the **top of the list** just below the highest value (5) for high-tech manufacturing (Moretti, 2010)

Summing up I

- What is **green employment**
  - New measure based on the notion that jobs are defined by their **task content**, and by the set of capabilities that are needed to accomplish those tasks
- What are the key **trends** in US local labour markets?
  - **Share** of total workforce employed in green occupation is between 2%-3%
  - Green employment is strongly **pro-cyclical** $\Rightarrow$ contracts during recession, grows during recovery
  - Green jobs pay a positive **wage premium** of around 4% relative to comparable occupations
  - Green jobs are **spatially concentrated** in spite of **moderate catching up** across areas

Summing up II

- What are the key drivers?
  - Changes in **environmental regulation** a **secondary** driver compared to
    - local endowment of **green knowledge** (especially in the recovery phase) and **federally-funded R&D lab** (especially during the recession)
    - **resilience** to the great recession
  - Partially due to **short timespan** available to evaluate change in Ozone standards
- **Local multiplier** effect?
  - One additional green job yields the creation of **4.2 new jobs** in non-tradable activities
  - Magnitude of this effect **closer to high-tech manufacturing** than mining
  - Local multiplier is **large** and significant also in the peak of the **recession** (2006-2010)

The way ahead

Issues for further reflection

- Greening **widespread phenomenon beyond "flagship" sectors** (i.e. renewables, electric vehicle production)
- What is the effectiveness of **command and control regulations** for green growth?
- What **policy mix** for transition towards a greener economy?
- The policy template of the **Green stimulus package** $\Rightarrow$ would a a **win-win strategy** have been possible in the **absence** of the massive investments of the **Job Recovery Act**?

THANK YOU FOR YOUR ATTENTION

francesco.vona@sciencespo.fr