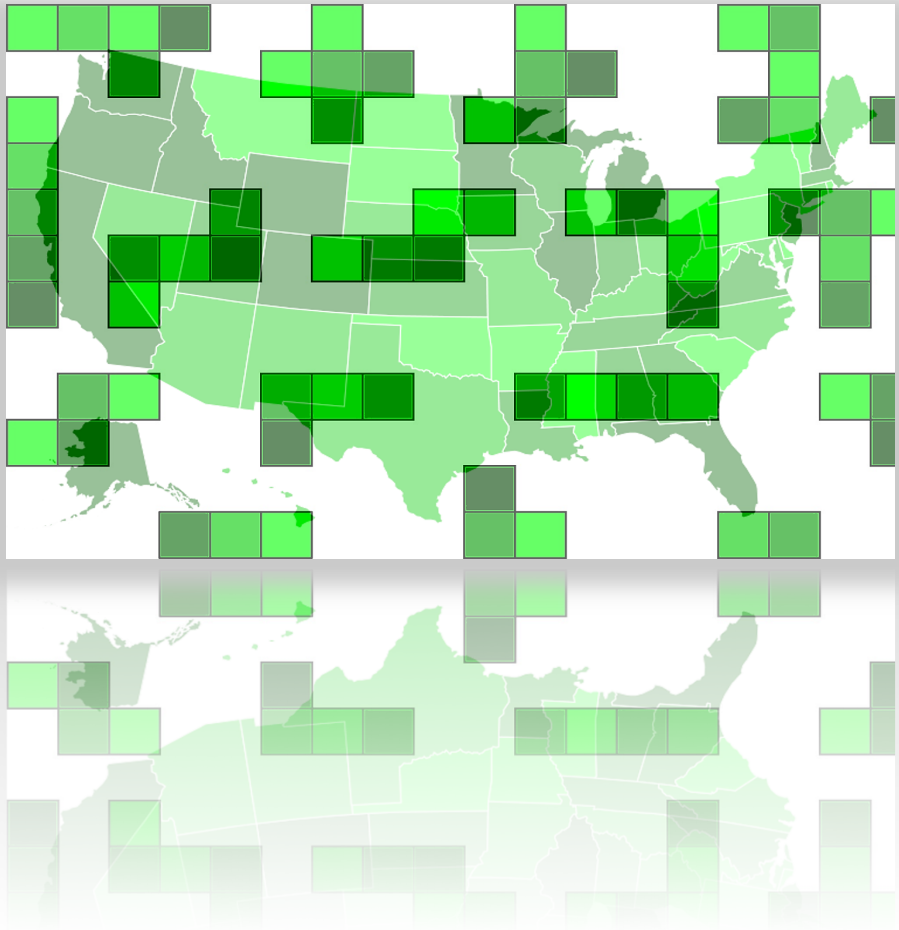

KID Summer School

Nice, 2015

Davide Consoli

Green Skills

ingenio
CSIC-UPV
Instituto de gestión de la innovación y del conocimiento

Plan of the talk

1. Environment, Knowledge and Innovation

Plan of the talk

1. Environment, Knowledge and Innovation
2. Empirical identification of Green Skills

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1. Environment, Knowledge and Innovation
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3. The effect of Environmental Regulation (ER) on the demand for Green Skills

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1. Environment, Knowledge and Innovation
2. Empirical identification of Green Skills
3. The effect of Environmental Regulation (ER) on the demand for Green Skills

Drawing on joint work with F. Vona, G. Marin, A. Marzucchi, D. Popp

ingenio CSIC-UPV
Instituto de gestión de la innovación y del conocimiento

ofce

Maxwell

Consiglio Nazionale delle Ricerche
IRCrES
ISTITUTO di RICERCA sulla CRESCITA ECONOMICA SOSTENIBILE
RESEARCH INSTITUTE on SUSTAINABLE ECONOMIC GROWTH

PART 1

Background

Why Green?

Climate Change

- Damages eco-system
- Threatens economic development
- Increases inequality
- Undermines Social cohesion

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Climate Change

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- Threatens economic development
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- Undermines Social cohesion

"(…) we only have three options: mitigation, adaptation, and suffering. It's really that simple"

J. Holdren (Top Science Advisor US President, 2010)

Why Green?

Environmental innovation (EI)

"Production, assimilation or exploitation of a product, production process, service or management or business methods that results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use compared to relevant alternatives"

(MEI Report, 2008)

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Why Green?

Determinants of EI (Environmental Economics):

1. Regulation and policy;
2. Supply side (Cost savings, productivity gains, R&D);
3. Demand side (consumer pressure, new market niches)

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Role of industry-specific factors (Innovation studies):

1. Knowledge base;
2. Technological opportunities;
3. Appropriability conditions;
4. Barriers

Why Green?

Transition towards low-carbon economy

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- Long-term, incremental

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- Recent policy talk: "decent jobs"
- Gap in Env Econ & Innov Econ

Why Skills?

Autor, Levy and Murnane (2003)

What is the effect of technology on the composition of employment?

Why Skills?

Autor, Levy and Murnane (2003)

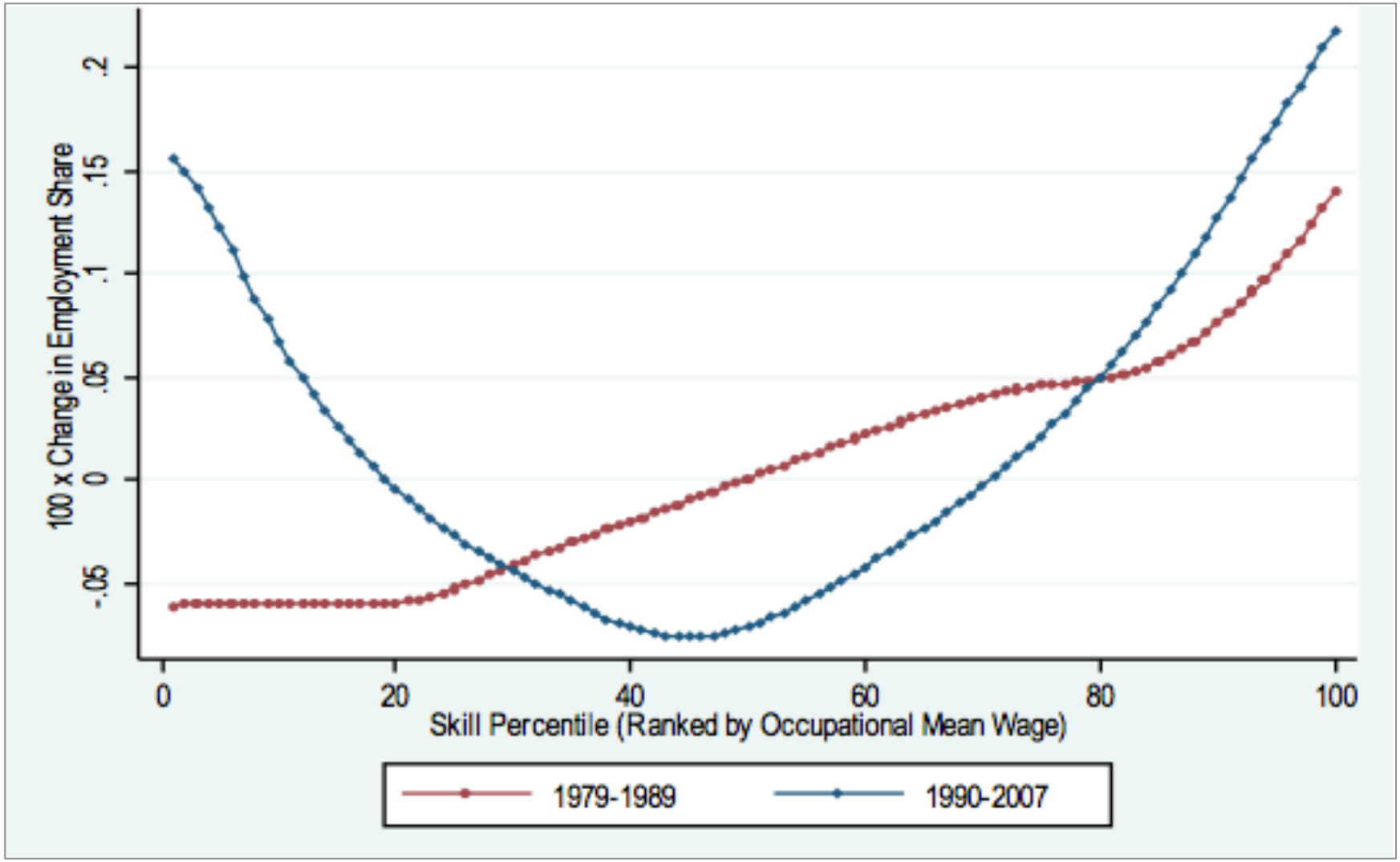
What is the effect of technology on the composition of employment?

Taxonomy: the task content of occupations

- Occupation: bundle of tasks
- Task: unit of work activity to produce output
- Skill: stock of abilities for performing tasks

(Goos & Manning, 2007; Michaels et al, 2014; Goos et al, 2014)

US Employment polarization



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Example: ICTs in the 1990s

	Routine tasks	Nonroutine tasks
	Analytic and interactive tasks	
Examples		
Computer impact		
	Manual tasks	
Examples		
Computer impact		

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	Routine tasks	Nonroutine tasks
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Examples	• Record-keeping • Calculation • Repetitive customer service (e.g., bank teller)	
Computer impact		
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Examples	• Picking or sorting • Repetitive assembly	
Computer impact		

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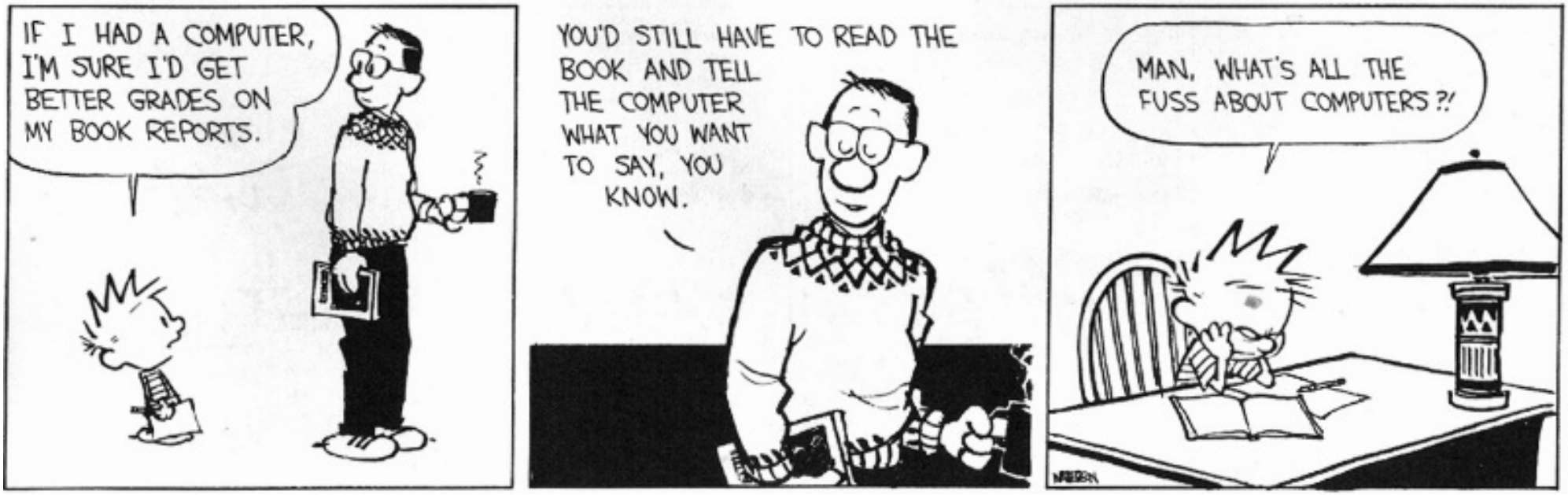
In a nutshell …



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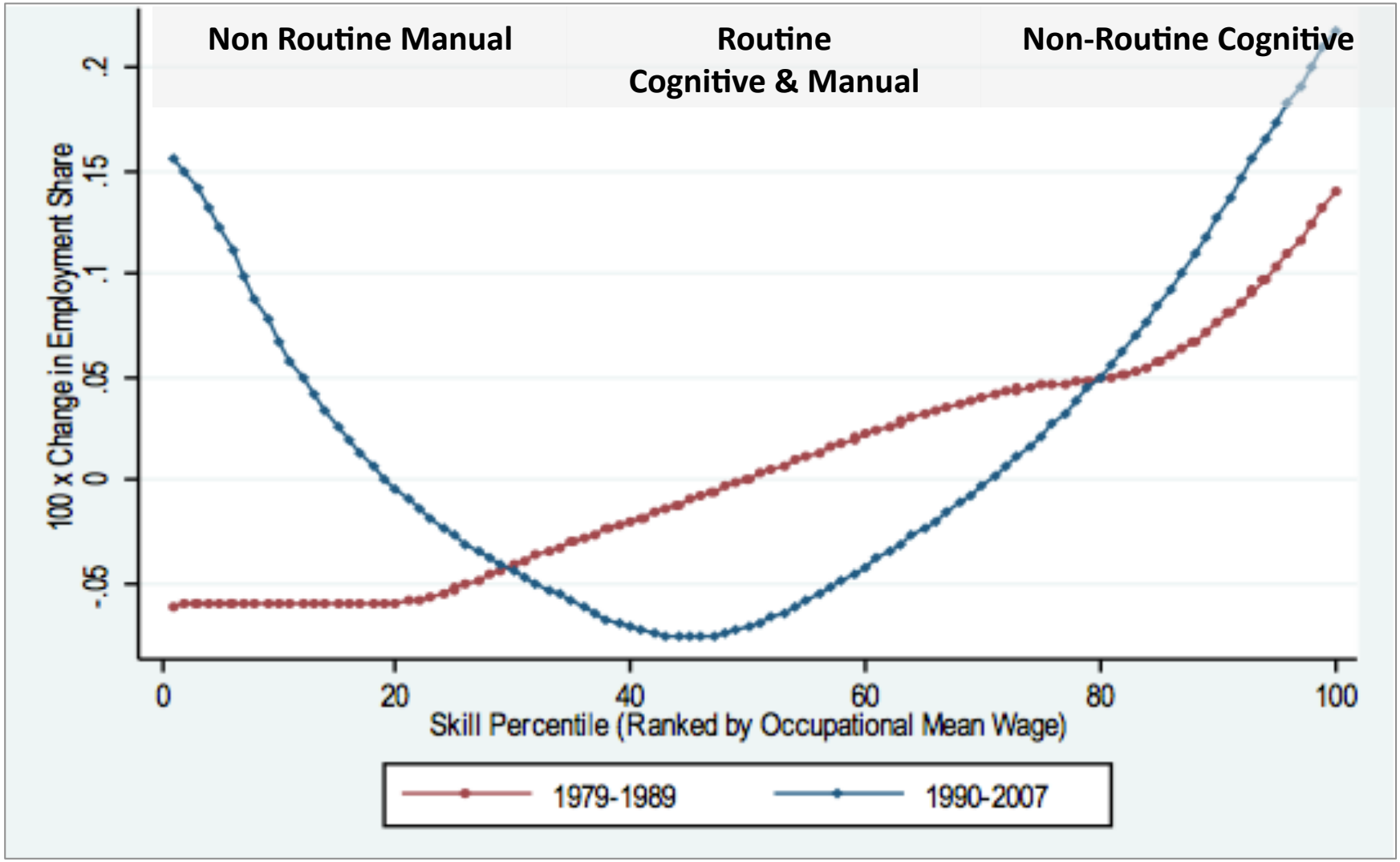

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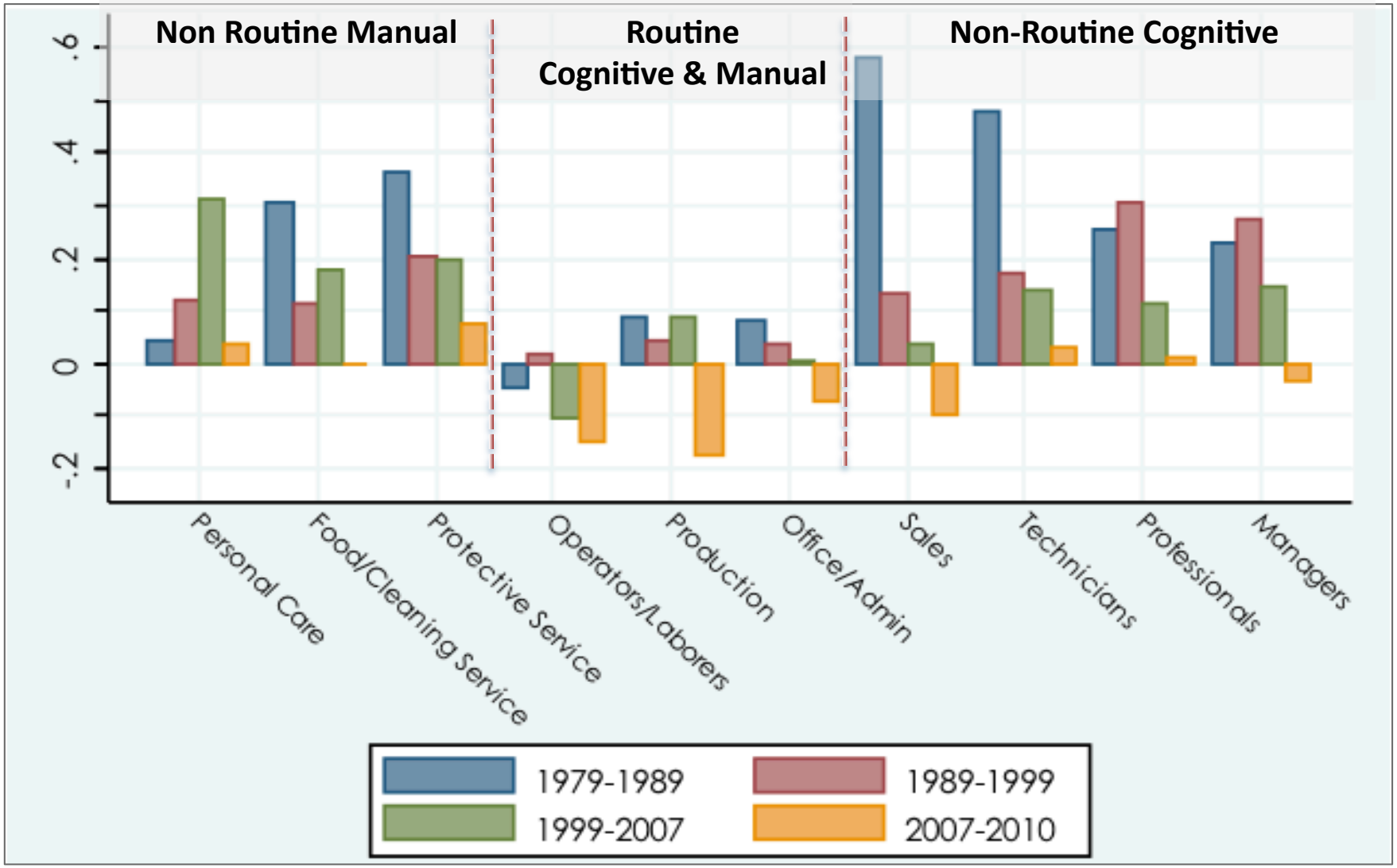
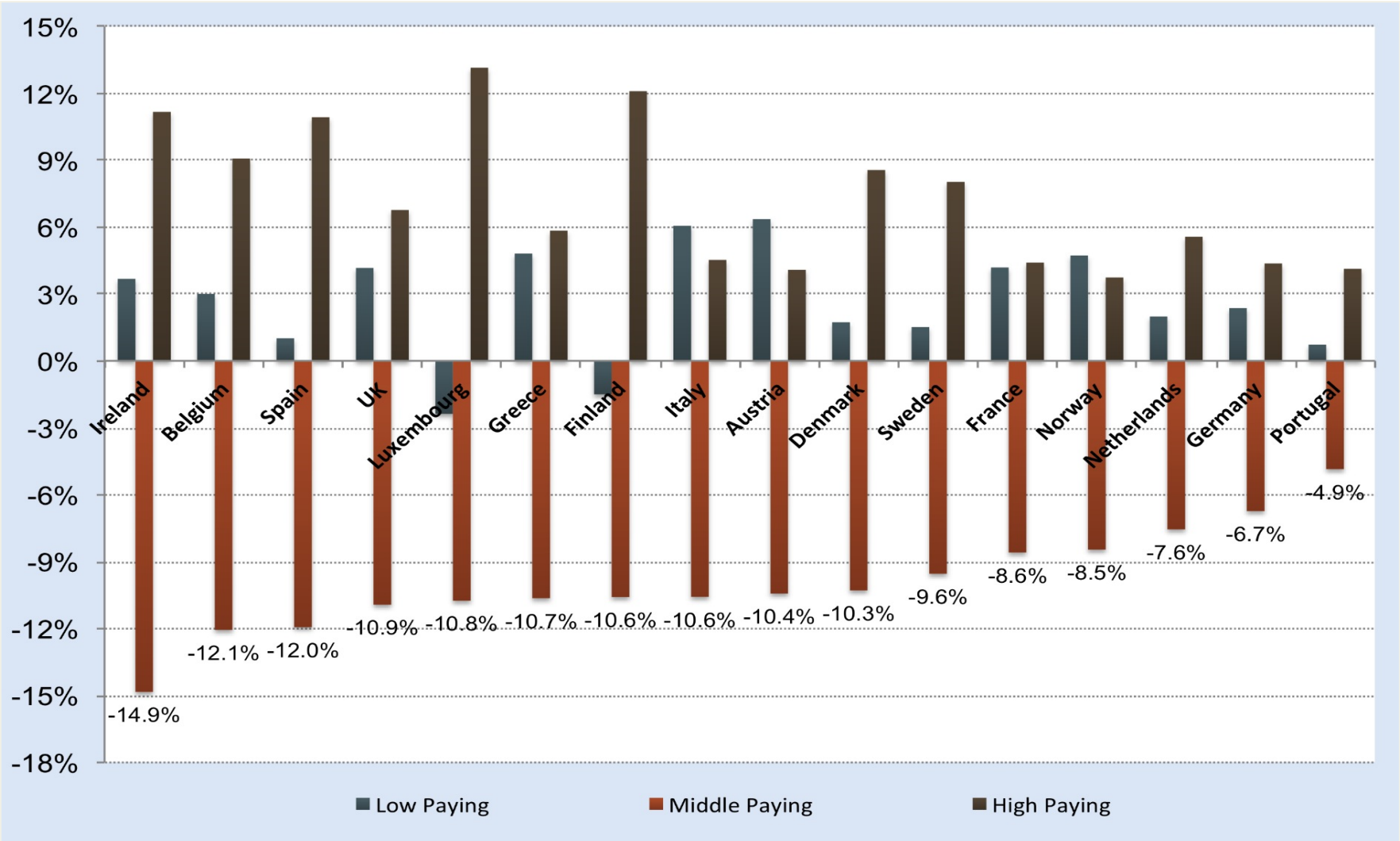


Acemoglu and Autor (2011)

EU Employment polarization



Goos, Solomons and Manning (2014)

Summing up (1)

Task-based model opens up the ‘black box’ of human capital: relation between technology and work activities

Summing up (1)

Task-based model opens up the 'black box' of human capital: relation between technology and work activities

Structural change:

- Obsolete occupations disappear
- New occupations emerge
- Continuing occupations change (e.g. their task content evolves)

A note of caution

If the ‘technological transition’ story works for GPTs (steam engine, electricity and ICTs) why not EI?

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If the 'technological transition' story works for GPTs (steam engine, electricity and ICTs) why not EI?

Classic GPTs	Green Technologies
1. Single body of physical technology	1. Sector-specific, particular problems
2. Widely applicable across sectors with minor adaptations	2. Pollution-intensive industries mostly in manufacturing and utilities
3. Amenable to many different contexts of use	3. Mono-purpose: low transfer of technology and know-how across sectors

Summing up (2)

1. **Climate Change**
2. Environmental innovation
3. Employment
   > Gap in innovation studies
   > Task Approach
      - Occupations
      - Skills

Summing up (2)

1. Climate Change
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PART 2

Empirical identification of green skills

Green job accounting: ambiguities

Grey literature: ILO, UNEP, CEDEFOP, OECD

1. "Green Skills" conflated with "Green Jobs"

   >> *Occupations easier as unit, skills as "bundles"*

Green job accounting: ambiguities

Grey literature: ILO, UNEP, CEDEFOP, OECD

1. "Green Skills" conflated with "Green Jobs"

   >> *Occupations easier as unit, skills as "bundles"*

2. Assumption: skills of green job radically new, unrelated to those of non-green jobs

   >> *Sharp (i.e. binary) distinction between green and non-green sectors, green and non-green jobs?*

Green job accounting 1: EGS

Eurostat and US Bureau of Labor Statistics:

"***Environmental Goods and Services (EGS)*** *are produced for the purpose of preventing, reducing and eliminating pollution and any other degradation of the environment, and for preserving and maintaining natural resources*"

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Workforce of EGS sectors >> Green Jobs

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Danger: **false positives**

e.g. Metal workers

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Workforce of EGS sectors >> Green Jobs

Danger: false positives & **false negatives**

e.g. Energy conservation activities within firms

Green job accounting 2: ONET

BLS Green Economy initiative

Based on O*NET: db of occupation-specific information covering various dimensions e.g. educational level, work tasks, job experience requirements, et cetera

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BLS Green Economy initiative

Based on O*NET: db of occupation-specific information covering various dimensions e.g. educational level, work tasks, job experience requirements, et cetera

- Occupations (not sector) unit of analysis
- Green jobs: include a series of specific green tasks
- Validated: questionnaires, literature, fieldwork

*Dierdorff et al (2009) Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations*

Green job accounting 2: ONET

Green Enhanced Skills: Existing occupations expected to undergo changes in terms of task content

I.e. Civil Engineers, Financial Analysts, Metal workers

Green Emerging: New occupations emerging as response to specific "green needs"

I.e. Wind Turbine Operator, Regulation Specialist

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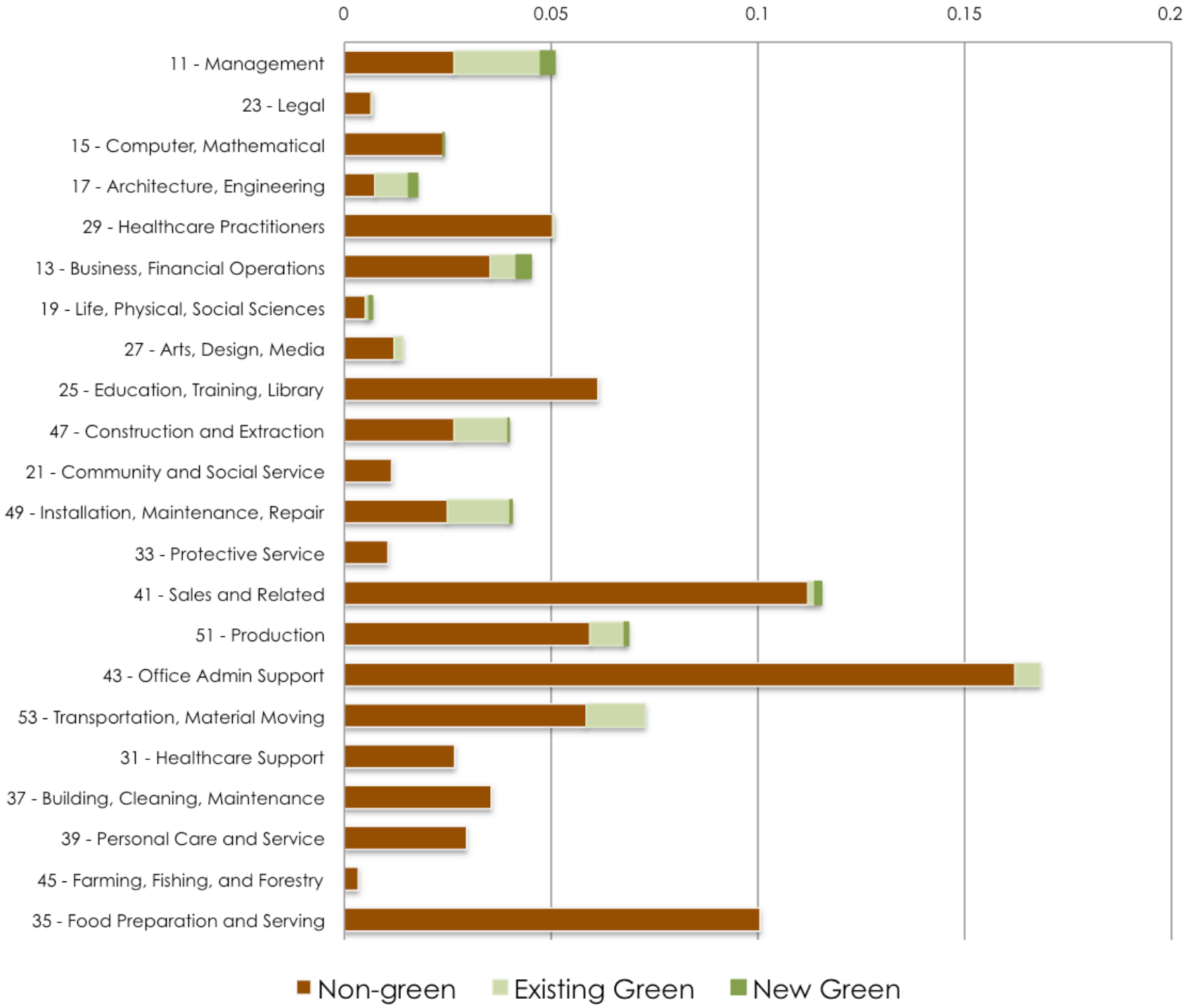
Green Employment, US 2008-2012

Non Green	Existing Green	New Green
88.9%	9.7%	1.4%


0
0.05
0.1
0.15
0.2
11 - Management
23 - Legal
15 - Computer, Mathematical
17 - Architecture, Engineering
29 - Healthcare Practitioners
13 - Business, Financial Operations
19 - Life, Physical, Social Sciences
27 - Arts, Design, Media
25 - Education, Training, Library
47 - Construction and Extraction
21 - Community and Social Service
49 - Installation, Maintenance, Repair
33 - Protective Service
41 - Sales and Related
51 - Production
43 - Office Admin Support
53 - Transportation, Material Moving
31 - Healthcare Support
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39 - Personal Care and Service
45 - Farming, Fishing, and Forestry
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Non-green
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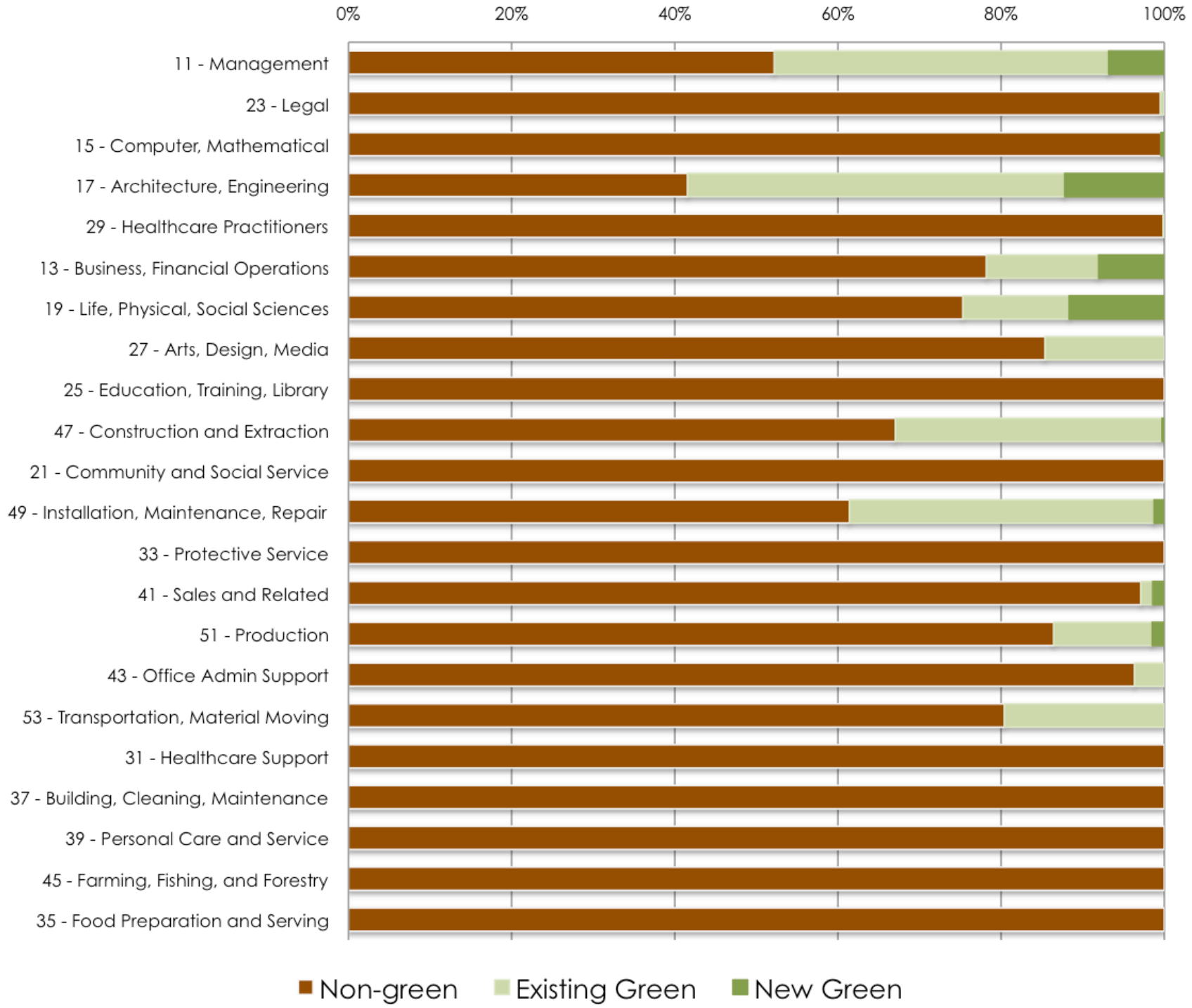
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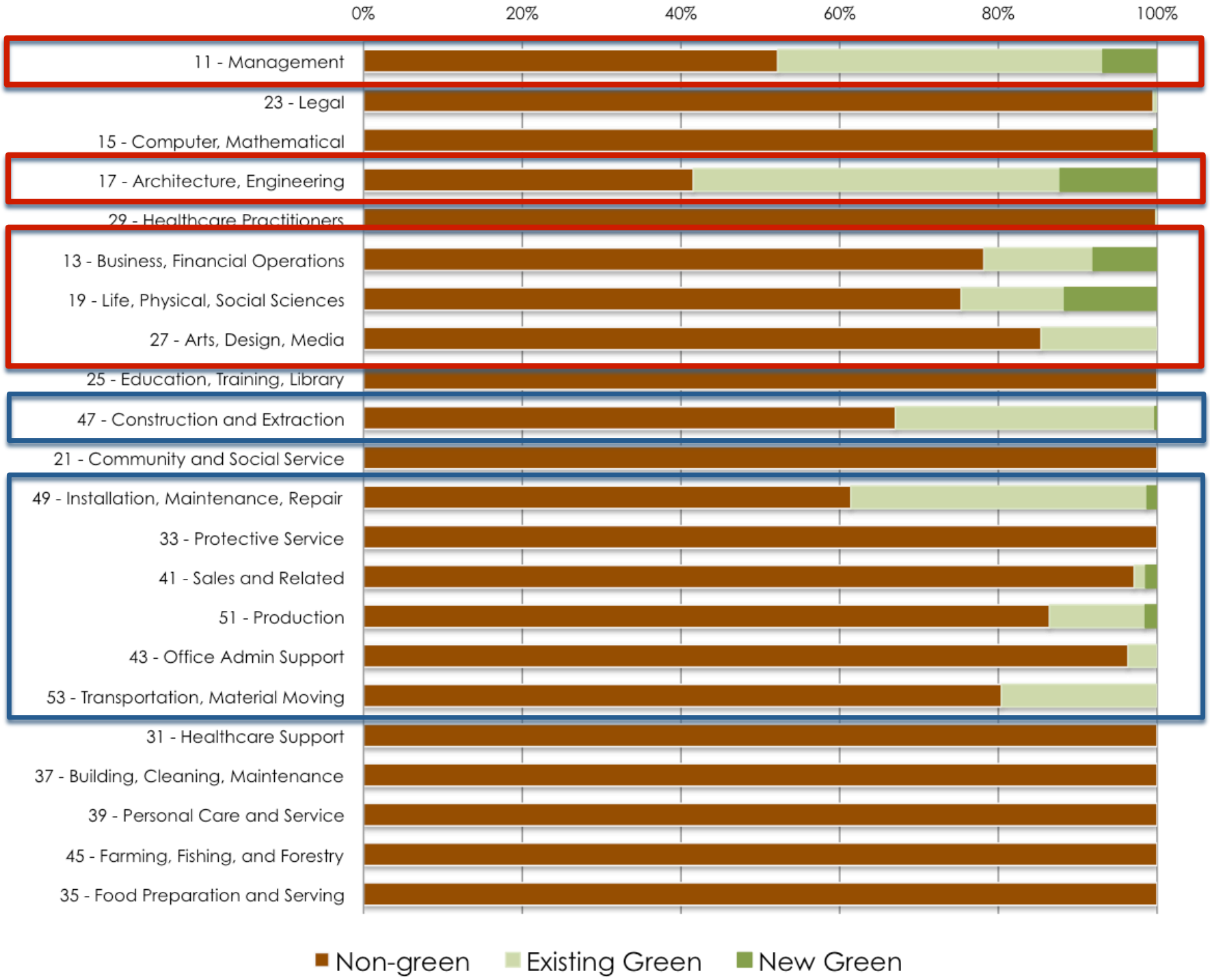
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New Green

Green jobs vs non-green jobs

Matching-like method to compare green and similar non-green occupations

E.g. "Environmental engineers" vs other engineers

$$HC_i = \beta^1 \, GrE_i^{0,1} + \beta^2 \, GrN_i^{0,1} + D_i^{SOC\ 3\ digit} + \varepsilon_i$$

HC_i = Education, Experience, On-the-job training;

GrE=1 if i=*Green Existing*, and zero otherwise;

GrN=1 if i=*Green New*, and zero otherwise;

D full set of 3-digit SOC dummy variables;

Consoli, Marin, Marzucchi, Vona (15) "Do green jobs differ from non-green jobs in terms of skills and human capital?" SPRU WP

Green jobs vs non-green jobs

	Log (years of educ)	Log (years of exp)	Log (years of train)
Green Existing	0.0191**	0.357***	0.341***
	(0.00861)	(0.113)	(0.129)
Green New	0.0205	-0.0515	0.168*
	(0.0221)	(0.124)	(0.0998)
F green occ dummies	2.609*	5.982***	3.815**
N	465	465	465

OLS estimates weighted by employment share. Robust standard errors in parenthesis.
* p<0.1, ** p<0.05, *** p<0.01. SOC 3-digit dummies included.
Occupations in SOC 3-digit categories with no green occupation have been excluded.

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Green jobs vs non-green jobs

	Log (years of educ)	Log (years of exp)	Log (years of train)
Green Existing	**0.0137***	**0.291*****	**0.301****
	(0.00778)	**(0.107)**	**(0.128)**
Green New	0.0102	-0.124	0.138
	(0.0230)	(0.133)	(0.110)
log(R&D non-env/L)	0.0294***	0.00216	-0.124
	(0.0111)	(0.0984)	(0.118)
log(R&D env/L)	-0.0118	0.641**	0.653**
	(0.0261)	(0.256)	(0.269)
log(ICT/L)	0.0241*	-0.108	-0.125
	(0.0139)	(0.0991)	(0.127)
log(investments)	-0.00131	0.227***	0.210**
	(0.00971)	(0.0796)	(0.0894)
F green occ dummies	1.557	5.188***	2.869*
N	465	465	465

Green job accounting 3.1: Greenness

Beyond the dichotomy green vs non-green …

O*NET includes detailed information on job-specific tasks for >900 occupations

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Beyond the dichotomy green vs non-green …

O*NET includes detailed information on job-specific tasks for >900 occupations

For each green occupation we calculate the share of green tasks …

$$Greenness_i = \frac{[\#\,Green\ Specific\_Tasks]_i}{[\#\,Specific\_Tasks]_i}$$

Examples (1)

Wind Turbine Service Technicians (49-9081.00)

Description

Inspect, diagnose, adjust, or repair wind turbines. Perform maintenance on wind turbine equipment including resolving electrical, mechanical, and hydraulic malfunctions

Green specific tasks (5)

- Diagnose problems involving wind turbine generators or control systems.
- Climb wind turbine towers to inspect, maintain, or repair equipment.

Non-green specific tasks (0)

Greenness => 5/5 = 1

Examples (2)

Regulatory Affairs Specialists (13-1041.07)

Description

Coordinate and document internal regulatory processes (e.g. internal audits, inspections). Compile and prepare materials for submission to regulatory agencies.

Green specific tasks (6)

- Obtain clearances for the use of recycled plastics
- Monitor national or international legislation on ozone-depleting substances or global warming

Non-green specific tasks (25)

- Coordinate, prepare, or review regulatory submissions for domestic or international projects.
- Participate in internal or external audits.

Greenness => 6/31 = 0.1935

Green Occupations by Greenness

	Greenness=1	Greenness btw 0.5 and 0.3	Greenness<0.3
Green Existing Occupations	Environmental Engineers, Environmental Sc Technicians, Hazard Material Removers		
Green New Occupations	Wind Energy Engineers, Fuel Cell Technicians, Recycling Coordinators		

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Green Existing Occupations	Environmental Engineers, Environmental Sc Technicians, Hazard Material Removers	**Aerospace Engineers,** **Atmospheric and Space Scientists,** **Automotive Technicians**	
Green New Occupations	Wind Energy Engineers, Fuel Cell Technicians, Recycling Coordinators	**Electrical Engin Technologists,** **Biochemical Engin,** **Supply Chain Managers**	

Green Occupations by Greenness

	Greenness=1	Greenness btw 0.5 and 0.3	Greenness<0.3
Green Existing Occupations	Environmental Engineers, Environmental Sc Technicians, Hazard Material Removers	Aerospace Engineers, Atmospheric and Space Scientists, Automotive Technicians	**Construction Workers,** **Maintenance & Repair Workers,** **Marketing Managers**
Green New Occupations	Wind Energy Engineers, Fuel Cell Technicians, Recycling Coordinators	Electrical Engin Technologists, Biochemical Engin, Supply Chain Managers	**Traditional Eng Occ,** **Transportation Planners,** **Compliance Managers**

Green job accounting 3.2: GGT

Greenness applies only to green occupations

>> Looking for a set of general tasks that are strongly related to green tasks across all occupations

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Greenness applies only to green occupations

>> Looking for a set of general tasks that are strongly related to green tasks across all occupations

$$GGT_{ji} = \beta_j \, Greenness_i + D_i^{SOC\ 3\ digit} + \varepsilon_i$$

A General Task is "green-related" if $\beta > 0.1$ and if statistically significant at 1%

The selected GGTs are grouped together with Principal Component Analysis

Green General Tasks: 4 constructs

Engineering & Technical	
2C3b	Engineering and Technology
2C3c	Design
2C3d	Building and Construction
2C3e	Mechanical
4A1b3	Estimating the Quantifiable Characteristics of Products, Events, or Information
4A3b2	Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment

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Science	
2C4b	**Physics**
2C4c	**Chemistry**
2C4d	**Biology**

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Science	
2C4b	Physics
2C4c	Chemistry
2C4d	Biology
Operation Management	
2B4g	**Systems Analysis**
2B4h	**Systems Evaluation**
4A2b3	**Updating and Using Relevant Knowledge**
4A4a1	**Interpreting the Meaning of Information for Others**
4A4b6	**Provide Consultation and Advice to Others**

Green General Tasks: 4 constructs

Engineering & Technical	
2C3b	Engineering and Technology
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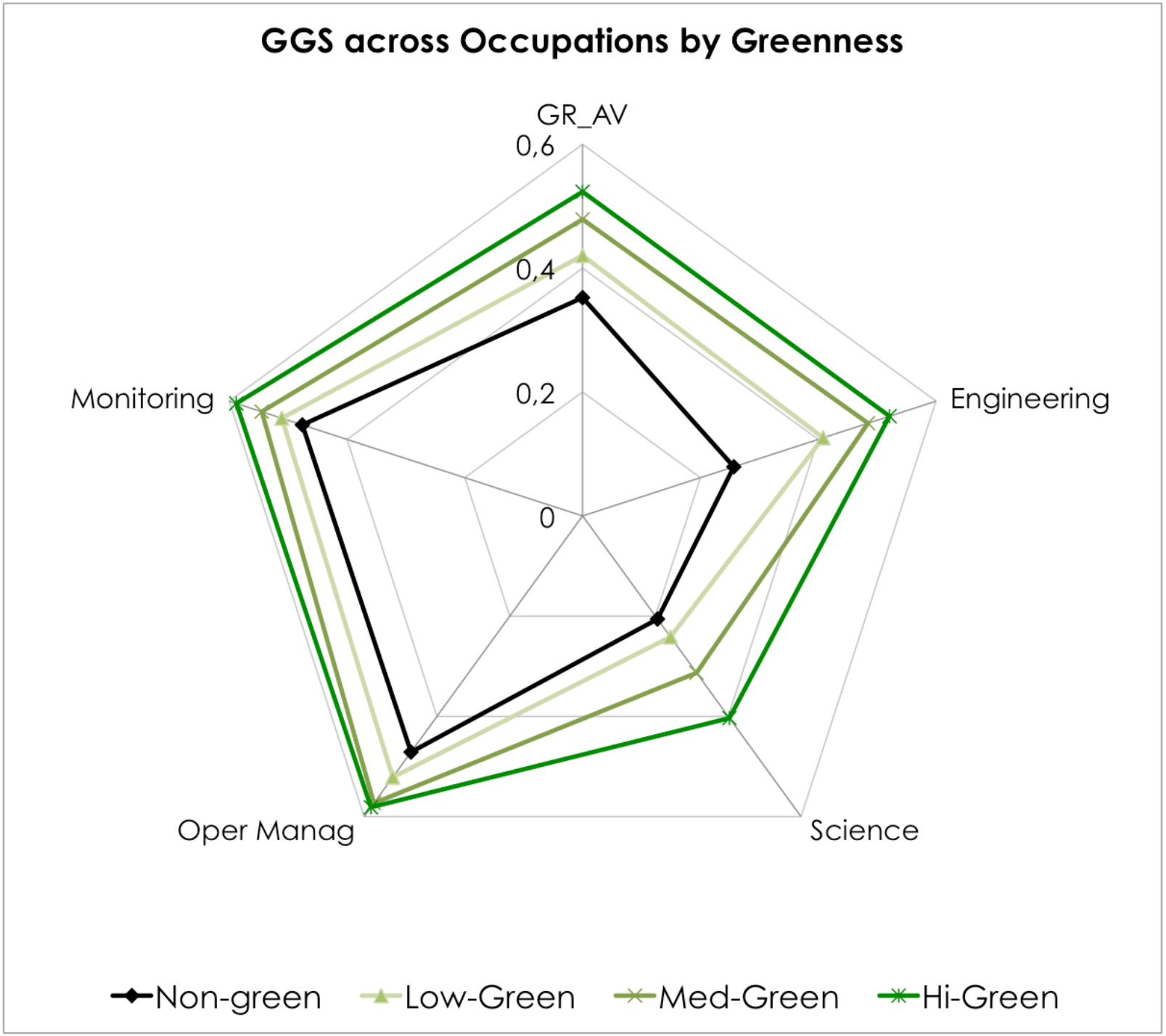
2B4g	Systems Analysis
2B4h	Systems Evaluation
4A2b3	Updating and Using Relevant Knowledge
4A4a1	Interpreting the Meaning of Information for Others
4A4b6	Provide Consultation and Advice to Others
Monitoring	
4A1a2	**Monitor Processes, Materials, or Surroundings**
4A2a3	**Evaluating Information to Determine Compliance with Standards**

Green General Tasks: validation

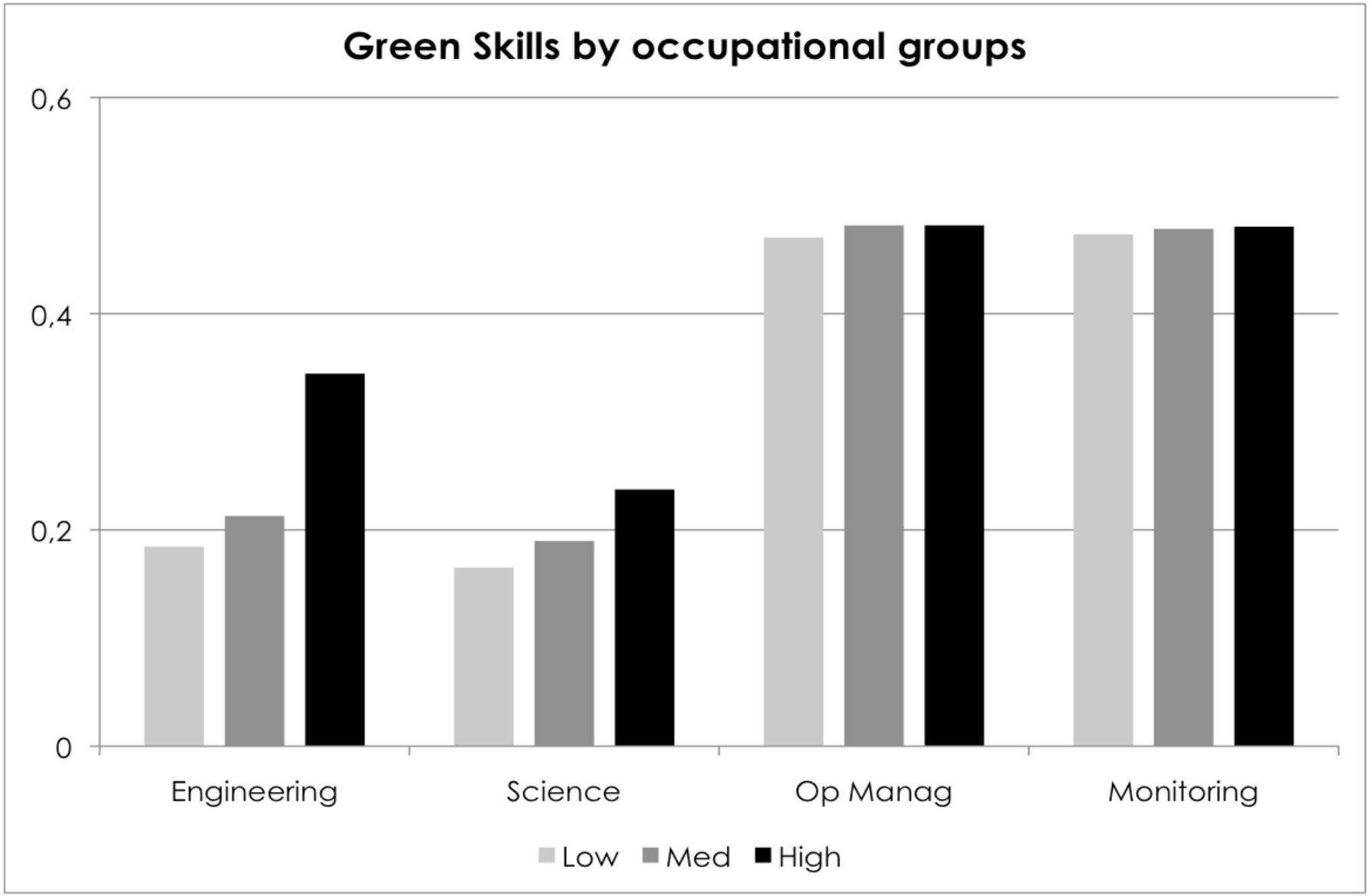
Engineering & Technical
Design, construction and assessment of technology (Ecorys, 2008)
Energy-saving R&D projects, lower environm impact of production (UKCES, 2010)
Science
Early stages of the value chain, especially in utilities sectors (Cedefop, 2009)
Highly transferable skills (Ecorys, 2008)
Operation Management
Managing through the entire product life cycle (Cedefop, 2009)
Adaptive management: stir dialogue across stakeholders (UNEP, 2007)
Monitoring
Assessing compliance with technical and legal standards (UNEP, 2008)
Assisting adaptation in changing regulatory environments (OECD, 2014)

Green General Skills: who and where?

GGS	Occupations	Industries
Engineering & Technical	Architects Civil, Agr, Water, Manuf, Wind Industrial Designers Technologists, Drafters	Building construction Specialty Trade Civil Engin construction Mining
Science	Bio-chemical –medical Eng Bio-physicists –chemists Hydrologists, Water Specialists Health professions	Utilities Oil & Gas Extraction Mining **Petroleum & Coal Product**
Operation Management	Industrial H&S, Logistic Engrs Operation Research Analysts Actuaries, Social workers Psychologists, Sustain Officers	Oil & Gas Extraction **Computer, Electronic Manuf** Utilities **Petroleum & Coal Product**
Monitoring	Legal Professions Inspectors, Officers Supervisors, Compliance Man Regulatory Specialists	Utilities Oil & Gas Extraction Building construction Mining


GGS across Occupations by Greenness
GR_AV
0,6
0,4
0,2
0
Monitoring
Engineering
Oper Manag
Science
Non-green
Low-Green
Med-Green
Hi-Green

Green General Skills – descriptives



Summing up

Steps	Key features
Green products & services	False positives/negatives
O*NET Green vs Non-Green	Binary set-up
Greenness	Continuous variable, GJ
Green General Tasks	4 constructs

Summing up

Green employment share about 10% in US but growing fast

<u>O*NET green jobs</u>

- Green existing and new jobs: mostly high-skill

<u>Green Skills</u>

- Resonate with grey literature
- Useful to identify skill gaps
- Strong technical orientation, “hands-on”
- No high-level dominated

PART 3

Effect of Environmental Regulation (ER) on the demand for Green Skills

Drivers of structural change

Labour market evolution based on skill content

- Technology (Autor ea, 2003; Goos & Manning, 2007; Autor & Dorn, 2013; Michaels ea, 2014)
- Trade (Lu and Ng, 2013; Autor ea, 2014)

Effect on …	Technology	Trade
Skill displacement	Mostly Routine	All
Labour Market	Between industries	Unemployment
Education	Intermediate	Low
Timing	Slow	Fast
Geography	Widespread	Concentrated

Determinants of green employment

Environmental regulation: US Clean Air Act

County-specific standards on concentration of pollutants and hazardous substances

States host to "non-attainment counties" enforce compliance actions

Emission intensity of CAA pollutants at state-by-sector (4-NAICS) level

1. Low emissions >> more stringent regulation (Brunel and Levinson, 2013; Carrion-Flores and Innes, 2011)
2. Emissions capture well within-sector changes affecting workforce composition (Levinson, 2015)

Previous work on ER and employment

Energy-intensive and polluting industries relocate in response to ER (Mulatu et al., 2010; Kahn & Mansur, 2013)

Employment effects generally negative (Greenstone, 2002; Walker, 2011)

Costs (e.g. wage losses) large and persistent but small when compared to social returns (e.g. environment) (Walker, 2013)

Gap: No studies on how ER and environmental technologies affects demand for skills

Empirical strategy

We estimate the following (by state and industry):

$$GGT_{ij} = \beta ER_{ij} + \sum_{ij} \eta X_{ij} + \mu_j + \phi_i + \varepsilon_{ij}$$

(*i*: sectors, *j*: states)

ER proxied by emissions per employee by state and sector 4-digit (National Emission Inventory)

Controls (X): log average plant size, employment growth , log # monitored facilities, 3-digit industry dummies, state dummies

Endogeneity issues

Reverse causality: industries or states with better (initial) endowment of skills more likely to reduce emission intensity

Measurement error: emission intensity just an indirect proxy of regulatory stringency (e.g. concentration of pollutants depends also on geographical features, pollution of neighbouring counties, etc)

Instrumental variable

Environmental enforcement activity (previous number of inspection and violations) as an instrument (Carrion-Flores & Innes, 2010)

Why:

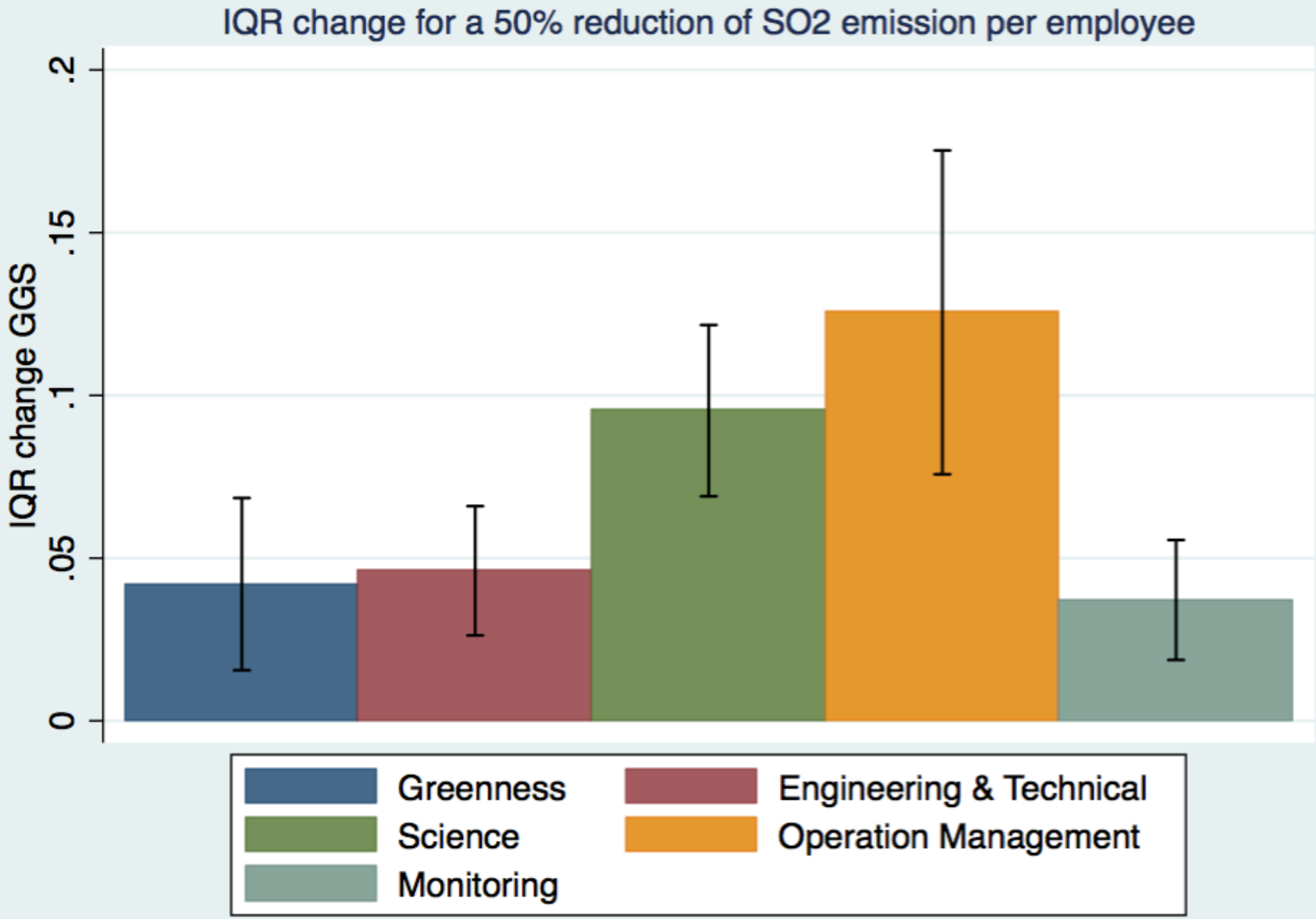
Likely to be strong in line with empirical literature showing that enforcement activities are a stimulus to abate emissions (Gray & Deily, 1996; Magat & Viscusi, 1990)

Likely to be uncorrelated with our skill measures other than through their effect on regulation

Baseline results

	Greenness	Engineering & Technical	Science
log(SO2/L)	-0.00303***	-0.00878***	-0.0110***
	(0.000974)	(0.00193)	(0.00155)
Hansen test (p-value)	0.241	0.699	0.250
	Green specific tasks	Operation Management	Monitoring
log(SO2/L)	-0.211***	-0.0134***	-0.00466***
	(0.0461)	(0.00271)	(0.00118)
Hansen test (p-value)	0.251	0.648	0.849

N=3328 industry-state pairs. Standard errors clustered by state and 3-digit NAICS in parenthesis. * p<0.10, **p<0.05, *** p<0.01. Regressions weighted by employment in 2012 at the state and NAICS 4-digit level. Controls not shown: growth rate of employees 2002-2012; log average establishment size (employees per establishment) in 2012; log of the count of facilities reporting to the NEI; NAICS 3-digit dummies, state dummies. IVs: log of violation (2000-2009) per employee (2012); log of full inspection (2000-2009) per employee (2012).


IQR change for a 50% reduction of SO2 emission per employee
IQR change GGS
0
.05
.1
.15
.2
Greenness
Engineering & Technical
Science
Operation Management
Monitoring

	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(ozone/L)	-0.00273*** (0.000845)	-0.00784*** (0.00161)	-0.00988*** (0.00127)	-0.0120*** (0.00227)	-0.00417*** (0.000996)	-0.189*** (0.0383)
Hansen test (p-value)	0.262	0.640	0.296	0.722	0.910	0.285
	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(CO/L)	-0.00299*** (0.000948)	-0.00880*** (0.00181)	-0.0110*** (0.00146)	-0.0134*** (0.00265)	-0.00465*** (0.00114)	-0.209*** (0.0442)
Hansen test (p-value)	0.214	0.889	0.146	0.487	0.702	0.206
	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(NOx/L)	-0.00295*** (0.000940)	-0.00874*** (0.00178)	-0.0109*** (0.00143)	-0.0133*** (0.00259)	-0.00462*** (0.00114)	-0.207*** (0.0433)
Hansen test (p-value)	0.198	0.948	0.115	0.438	0.659	0.177
	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(PM2.5/L)	-0.00314*** (0.000947)	-0.00885*** (0.00177)	-0.0112*** (0.00137)	-0.0136*** (0.00243)	-0.00472*** (0.00107)	-0.216*** (0.0435)
Hansen test (p-value)	0.325	0.464	0.517	0.969	0.916	0.409
	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(lead/L)	-0.00378*** (0.00121)	-0.0110*** (0.00237)	-0.0137*** (0.00190)	-0.0167*** (0.00357)	-0.00581*** (0.00147)	-0.263*** (0.0582)
Hansen test (p-value)	0.245	0.722	0.225	0.601	0.817	0.261
	Greenness	Engineering & Technical	Science	Operation Management	Monitoring	Green spec tasks
Log(TRI/L)	-0.00321*** (0.00111)	-0.00978*** (0.00207)	-0.0120*** (0.00188)	-0.0147*** (0.00303)	-0.00513*** (0.00137)	-0.227*** (0.0543)
Hansen test (p-value)	0.141	0.755	0.0717	0.193	0.435	0.105

Selection effect in contracting sectors?

	Greenness		Engineering & Technical		Science	
	Contracting	Growing	Contracting	Growing	Contracting	Growing
log(SO2/L)	-0.00345**	-0.00205	-0.0115***	-0.00597*	-0.00783***	-0.00662***
	(0.00137)	(0.00197)	(0.00255)	(0.00358)	(0.00185)	(0.00253)
Hansen test (p-value)	0.792	0.0263	0.978	0.370	0.745	0.226
	Operation Management		Monitoring		Log(Years of training)	
	Contracting	Growing	Contracting	Growing	Contracting	Growing
log(SO2/L)	-0.0159***	-0.00817**	0.00409+	0.00792***	-0.0645***	-0.0751***
	(0.00346)	(0.00368)	(0.00251)	(0.00296)	(0.0174)	(0.0259)
Hansen test (p-value)	0.469	0.497	0.448	0.0634	0.563	0.286

Contracting state-industy pairs: N=2381; growing state-industry pairs: N=945.
Standard errors clustered by state and 3-digit NAICS in parenthesis.
p<0.10, **p<0.05, *** p<0.01.
Regressions weighted by employment in 2012 at the state and NAICS 4-digit level.

Conclusions, limitations, way ahead

Sustainable economic growth and employment

Employment: vehicle through which know-how is embedded into the organization of production

Conclusions, limitations, way ahead

Sustainable economic growth and employment

Employment: vehicle through which know-how is embedded into the organization of production

Data-driven method to identify green skills

Applicability: skill gaps, cross sectoral skill transfer

Conclusions, limitations, way ahead

Sustainable economic growth and employment

Employment: vehicle through which know-how is embedded into the organization of production

Data-driven method to identify green skills

Applicability: skill gaps, cross sectoral skill transfer

GGS: strong analytical and technical content

- Operation Management and Monitoring: hands-on
- Science and Engineering: basic, formal education

Cross section >> limited grasp of dynamics

Conclusions, limitations, **way ahead**

Are educational systems prepared?

Established tradition in engineering disciplines that usually absorb skill mismatches (US)

System of vocational and on-the-job training lagging behind but necessary to match skill needs technical/non-routine manual jobs

Which occupations will be favoured by changes in the supply of skills?

What role for 'other' (no HEI) learning institutions?

Conclusions, limitations, **way ahead**

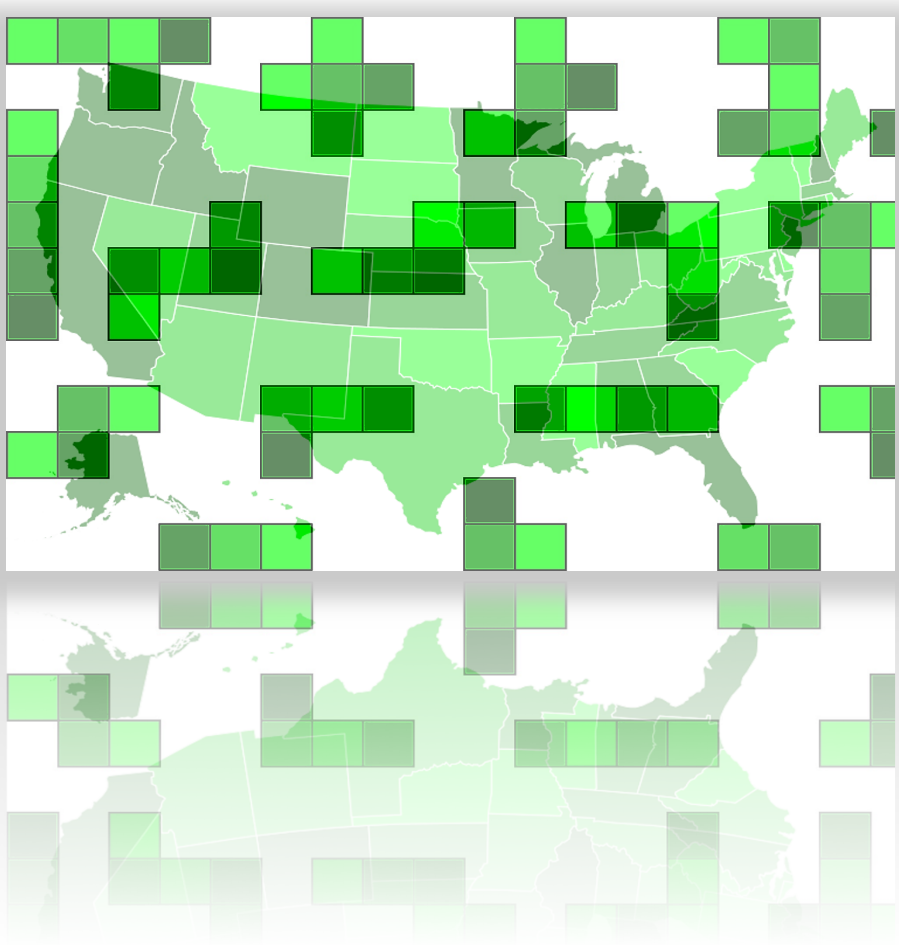
What role does geography play?

Evolution of green employment (proxy for specialization) across US MAs and NMAs

Is industry a good predictor of employment structure across geographical areas?

Are green activities more or less geographically concentrated than non-green ones?

What are the local drivers of green employment?



Thank you for your attention

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Suggested readings

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Walker, W. (2011) Environmental regulation and labor reallocation: Evidence from the Clean Air Act. American Economic Review, 101(3), 442-447.

Data structure

Emp. share occ-sector

Source: BLS

Occupation-Level:

Task measures
Green occupations
Green specific tasks

*Source: O*NET*

Emp. share occ-sect-state
Source: BLS

Sector-Level:

Measures of Patent
R&D,
Investments

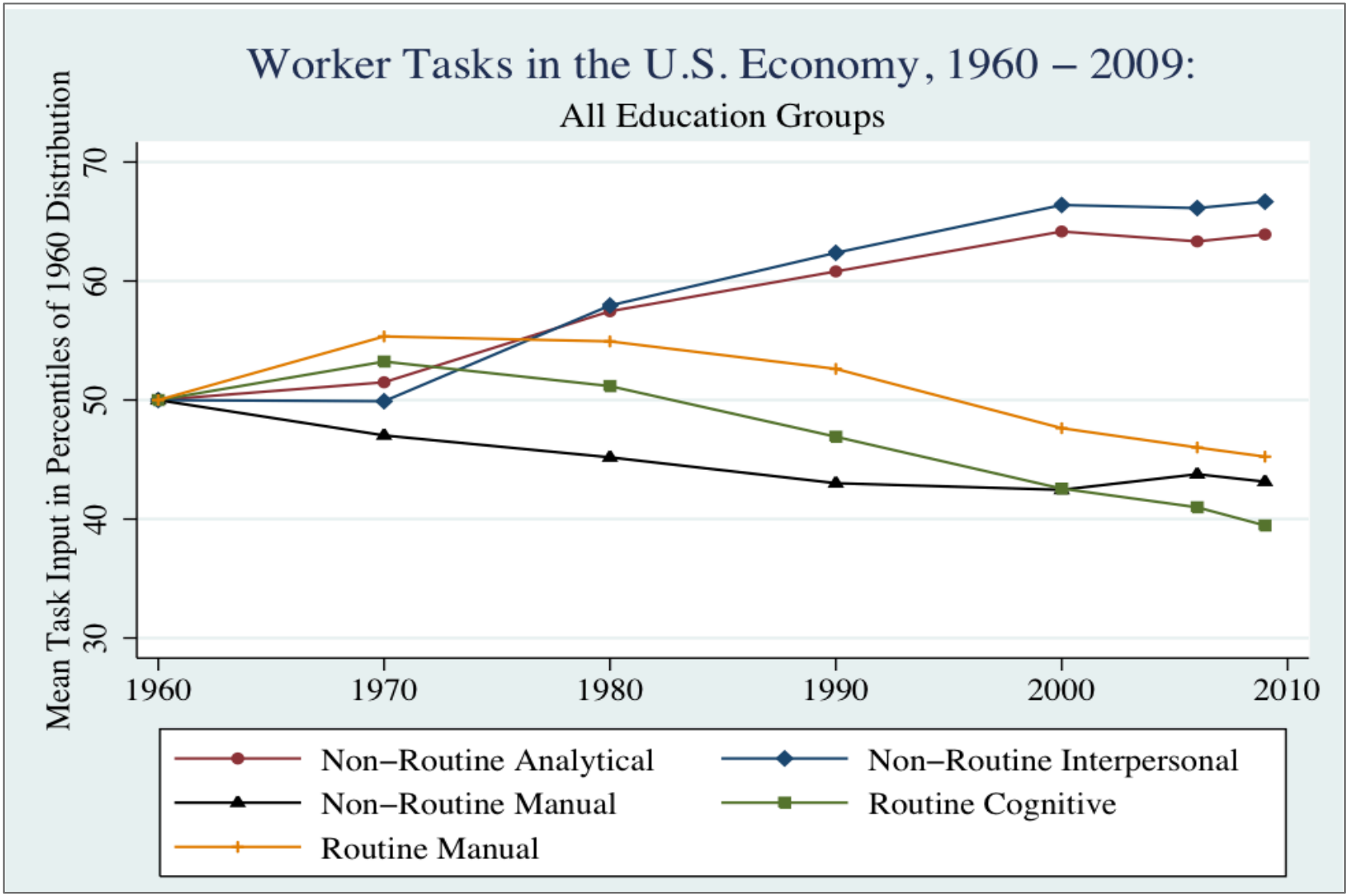
Sources: NSF, PATSTAT, Census

Sector-state:

Emission Intensity,
Pollution Abatement
Control Exp. (PACE)

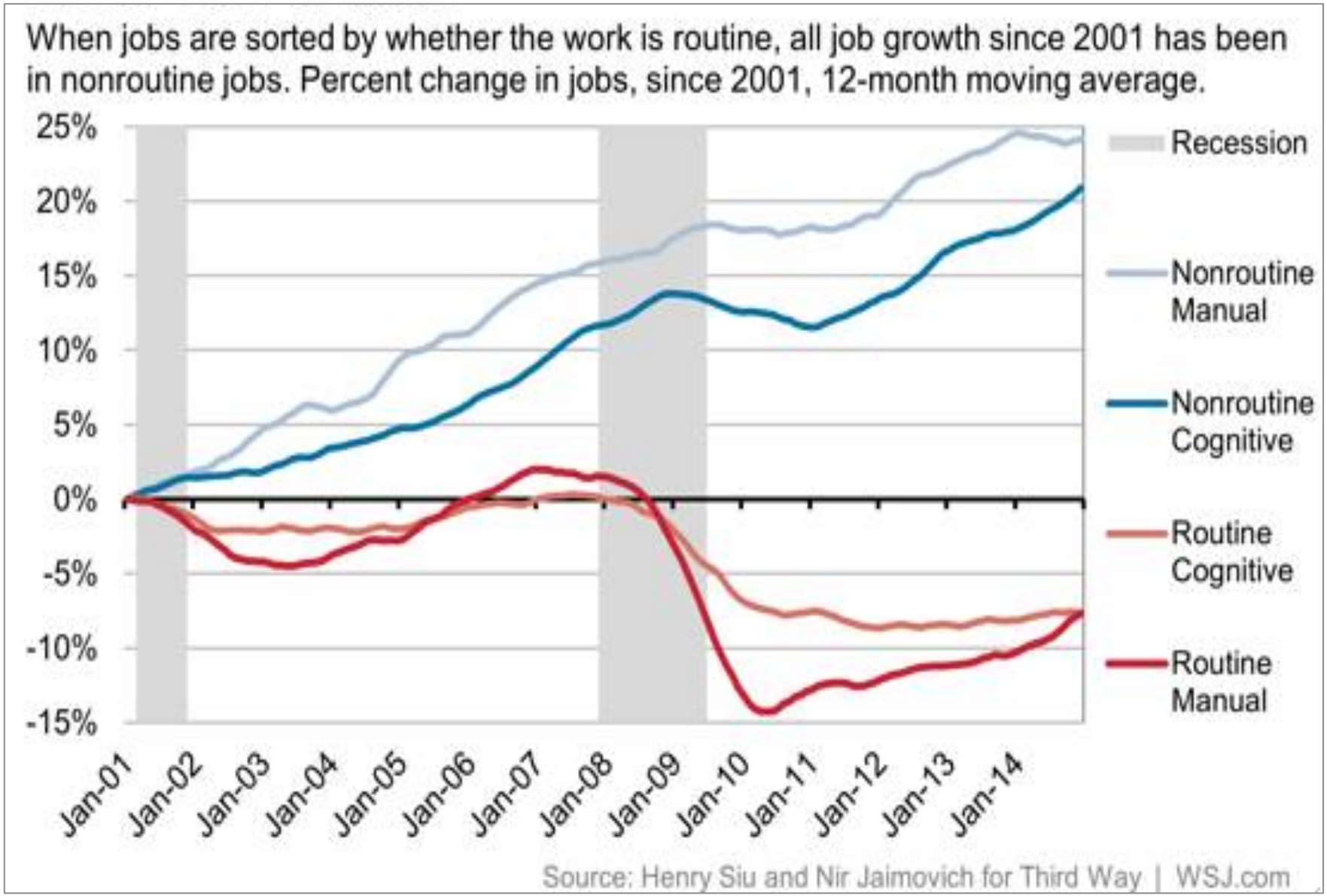
Source: Census, EPA

Long-term changes skill demand



Autor and Price (2013)

Long-term change occupations



Siu Jaimovich (2014)

Green employment: O*NET

SOC 2-digit	Tot Green occupations	Green Demand	Green Enhanced	Green Emerging
11 - Management	**46**	31	**6**	**9**
23 - Legal	6	5	1	0
15 - Computer and Mathematical	27	25	0	2
17 - Architecture and Engineering	**61**	29	**13**	**19**
29 - Healthcare Practitioners and Technical	**83**	**82**	1	0
13 - Business and Financial Operations	**45**	**35**	**4**	**6**
19 - Life, Physical, and Social Science	**58**	**41**	**10**	**7**
27 - Arts, Design, Entertainment, Sports, and Media	**43**	**41**	2	0
25 - Education, Training, and Library	**58**	**58**	0	0
47 - Construction and Extraction	**59**	**48**	**9**	2
21 - Community and Social Service	14	14	0	0
49 - Installation, Maintenance, and Repair	**54**	**48**	**4**	2
33 - Protective Service	25	25	0	0
41 - Sales and Related	22	20	1	1
51 - Production	**107**	**99**	**6**	2
43 - Office and Administrative Support	**58**	**57**	1	0
53 - Transportation and Material Moving	**50**	**47**	3	0
31 - Healthcare Support	17	17	0	0
37 - Building Cleaning and Maintenance	8	8	0	0
39 - Personal Care and Service	32	32	0	0
45 - Farming, Fishing, and Forestry	16	16	0	0
35 - Food Preparation and Serving Related	16	16	0	0
Total	905	794	61	50

Non-Green General Skills

2A1b	Active Listening	2C2a	Production and Processing
2A1d	Speaking	2C3a	Computers and Electronics
2A1f	Science	2C4e	Psychology
2A2b	Active Learning	2C5a	Medicine and Dentistry
2A2d	Monitoring	2C6	Education and Training
2B1b	Coordination	2C7b	Foreign Language
2B1d	Negotiation	2C7e	Philosophy and Theology
2B1f	Service Orientation	2C9a	Telecommunications
2B3a	Operations Analysis	4A1b1	Identifying Objects, Actions, and Events
2B3c	Equipment Selection	4A2b1	Making Decisions and Solving Problems
2B3e	Programming	4A2b6	Organizing, Planning, and Prioritizing Work
2B3j	Equipment Maintenance	4A3a3	Controlling Machines and Processes
2B3l	Repairing	4A3b5	Repairing and Maintaining Electronic Equipment
2B4e	Judgment and Decision Making	4A4a4	Establishing and Maintaining Interpersonal Relationships
2B5b	Management of Financial Resourc	4A4a7	Resolving Conflicts and Negotiating with Others
2B5d	Management of Personnel Resour	4A4b3	Training and Teaching Others
2C1b	Clerical	4A4b5	Coaching and Developing Others
2C1e	Customer and Personal Service	4A4c2	Staffing Organizational Units

Green jobs vs non-green jobs

O*NET Green initiative: focus on occupations

Green jobs vs non-green jobs

"*Do green jobs differ from non-green jobs in terms of skills and human capital?*"

Existing occ: education, experience, training

New occ: on the job training

'Green jobs' educational policy not sufficient

- Interindustry networks, consortia (Nelson, 1994)
- Skills-gap identification