The Employment Impact of a Green Fiscal Push: Evidence from the American Recovery and Reinvestment Act

David Popp, Syracuse University
Francesco Vona, OFCE-Sciences-Po
Giovanni Marin, University of Urbino
Ziqiao Chen, Syracuse University

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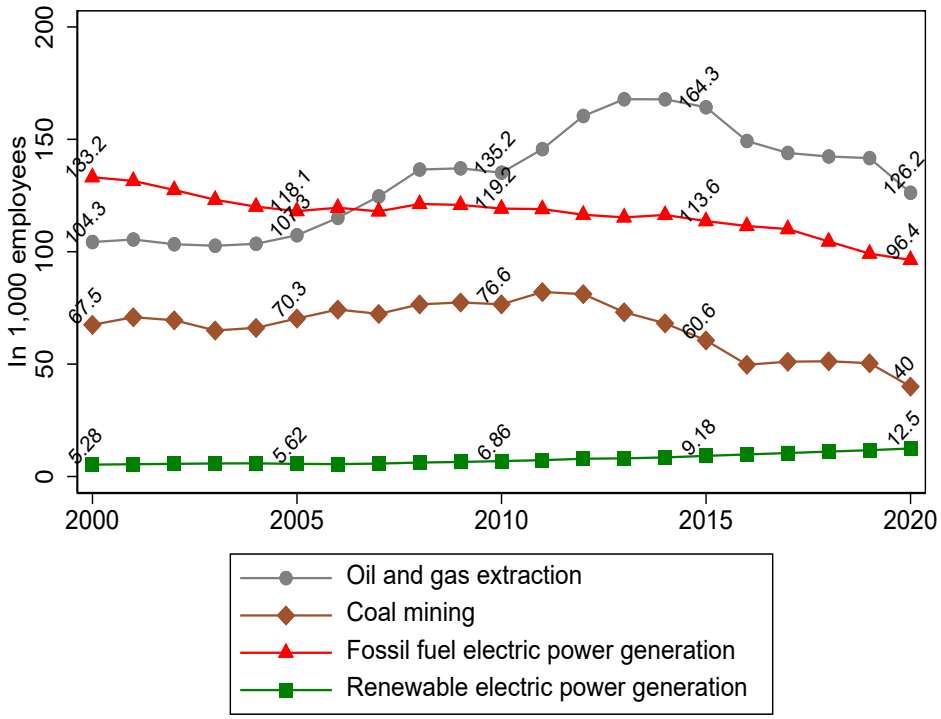
Introduction

- There is growing interest in green fiscal stimuli
  - US: American Jobs Plan
  - EU: European Green Deal
- Goals include creating new green jobs for workers potentially displaced by a green transition
  - Both short-run and long-run concerns



Introduction

- Our paper addresses three questions on the potential of green fiscal stimuli in a green energy transition:
  1. What does existing literature say about environmental policies and employment?
  2. What are the employment options for workers in polluting industries with declining job prospects?
     - What must we know to determine their ability to be re-employed?
  3. To what extent can green government investments be used to create new jobs?
     - Our paper estimates the effect of green stimulus from the American Recovery and Reinvestment Act (ARRA) of 2009 on local employment

Lessons from Existing Literature

David Popp

Maxwell | Syracuse University

What We Know: Lessons from Existing Literature

- Previous studies evaluate environmental policies imposing a cost on pollution (either through standards or prices)
  - No attention devoted to the **job creation effect** of **green subsidies**

- Many studies find small aggregated effects of environmental regulation on employment (Morgenstern et al., 2002; Hafstead and Williams, 2018; Metcalf and Stock, 2020)

- But workers in **polluting sectors** (Kahn and Mansur, 2013) and **low-skilled workers** experience job losses (Yip, 2018; Marin and Vona, 2019)
  - Adverse impacts on manual labor of particular concern, given the secular decline in their employability and wages driven by automation and trade (Autor et al., 2003; Autor et al., 2013)

- Importance of worker skills
  - Walker(2013): foregone earnings for workers displaced by US CAA larger for those changing sector
  - Reallocation costs and re-employability are proportional to the skill distance between jobs (Kambourov and Manovskii,2009; Gathmann and Schönberg, 2010)

Green Skills and Employment

David Popp

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Green employment and green skills

- Vona et al. (*JAERE* 2018) identified *Green General Skills* using data from the U.S. Department of Labor's O*NET database
  - Skills potentially used in all occupations, but particularly important for green jobs

- *Green General Skills* are mainly in science and engineering, and are often associated with high-skilled labor
  - Not exclusive to green jobs
    - » E.g. green skills important for physicians, mining machine operators, and some transportation workers

Characteristics of select green and brown occupations

	Brown 'fossil fuel' occupations	Green 'renewable' occupations	Green 'other' occupations	Benchmark
Hourly wage	25.8	37.51	24.35	19.69
Gini locational coefficient	0.98	0.89	0.9	0.51
Age	39.16	43.97	40.76	39.26
Share male	0.88	0.34	0.42	0.38
Educational attainment (yrs.)	12.11	12.76	12.37	12.73
Required months on-the-job training	8.98	12.62	12	6.48

Characteristics of select green and brown occupations

- LS brown energy wages comparable to green, better than benchmark LS jobs

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Characteristics of select green and brown occupations

- Geography matters: both LS brown and green jobs more concentrated geographically than benchmark LS jobs

	'fuel' occupations	'renewable' occupations	Green 'other' occupations	Benchmark
Hourly wage	25.8	37.51	24.35	19.69
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- LS brown energy workers predominately male

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Characteristics of select green and brown occupations

- LS green jobs require more on-the-job training

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Characteristics of select green and brown occupations

Green General Skills:	Brown 'fossil fuel' occupations	Green 'renewable' occupations	Green 'other' occupations	Benchmark
Engineering & technical	0.43	0.68	0.44	0.24
Operation management	0.42	0.55	0.46	0.39
Science	0.25	0.26	0.21	0.09
Monitoring	0.47	0.52	0.46	0.41

Characteristics of select green and brown occupations

- Green skill requirements for brown energy and green “other” occupations similar

Green General Skills:	Brown 'fossil fuel' occupations	Green 'renewable' occupations	Green 'other' occupations	Benchmark
Engineering & technical	0.43	0.68	0.44	0.24
Operation management	0.42	0.55	0.46	0.39
Science	0.25	0.26	0.21	0.09
Monitoring	0.47	0.52	0.46	0.41

Characteristics of select green and brown occupations

- Green energy jobs require more engineering and operations management skill

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Characteristics of select green and brown occupations

- In all cases, the benchmark jobs require fewer green skills

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The Effect of a Green Stimulus: Data

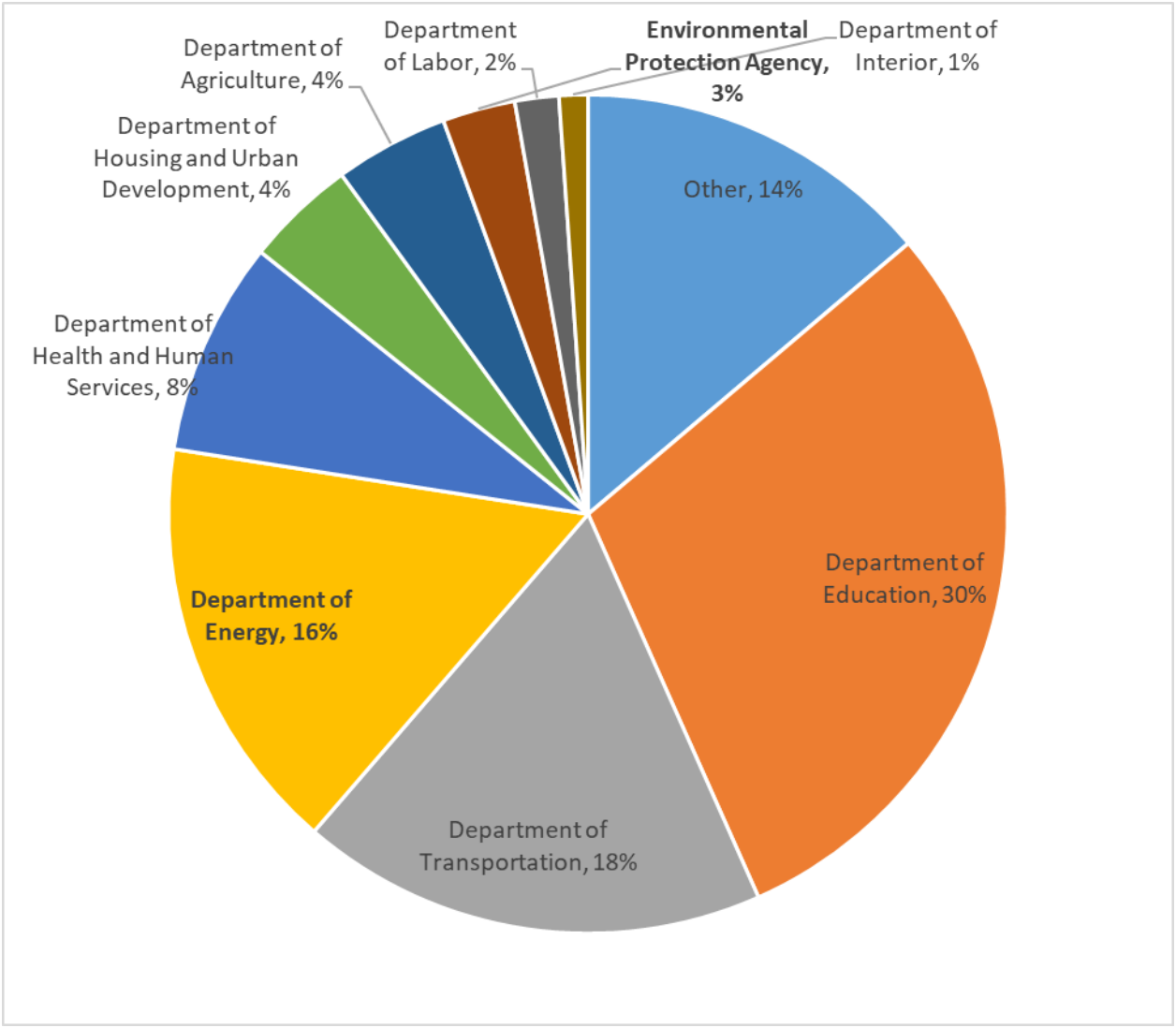
David Popp

Maxwell | Syracuse University

Green Stimulus

- The US American Recovery and Reinvestment Act (ARRA) of 2009 invested over $800 billion stimulate the US economy
  - Included several programs designed to promote clean energy and green jobs (Aldy, 2013)
  - We identify as “green” stimulus spending from the Department of Energy and Environmental Protection Agency
    - Major categories: cleanup of polluted sites, energy efficiency retrofits, or the development of renewable energy resources
    - Approximately ten percent of projects from EPA and DOE pertain to research
    - One percent for job training

ARRA spending by awarding Agency



Notes: own elaboration based on Recovery.gov data from NBER data repository.

Stimulus Data

- Stimulus data comes from FedSpending.org
  - We include the universe of contracts, grants and loans awarded under ARRA between 2009 and 2012
  - Recipients are required to submit reports through FederalReporting.gov,
    - Include information on expenses and the description of projects
  - We use the reported place of performance of prime and sub-prime recipients to allocate the dollar amount of awards to commuting zones based on the zip code

Other Data

- Combine ARRA data with data on employment and labor market conditions

- We assemble a longitudinal dataset of local labor markets in the U.S. from 2005 to 2017
  - 587 commuting zones in 50 states and DC w/pop > 25K
    - Consistent with evaluations of other types of ARRA spending (Dupor and Mehkari, 2016; Dupor and McCrory, 2018)

Data

- We use the share of green general skills in the local labor force to calculate FTE of workers performing green tasks in the local labor market

	Mean	SD	Min	Max
Per capita green employment	0.020	0.005	0.001	0.056
Per capita total employment	0.429	0.066	0.014	0.956
Per capita employment in manual occ.	0.095	0.022	0.003	0.348

Notes: Per capita levels calculated using population in 2008, in commuting zones with population > 25,000.

The Effect of a Green Stimulus: Methods

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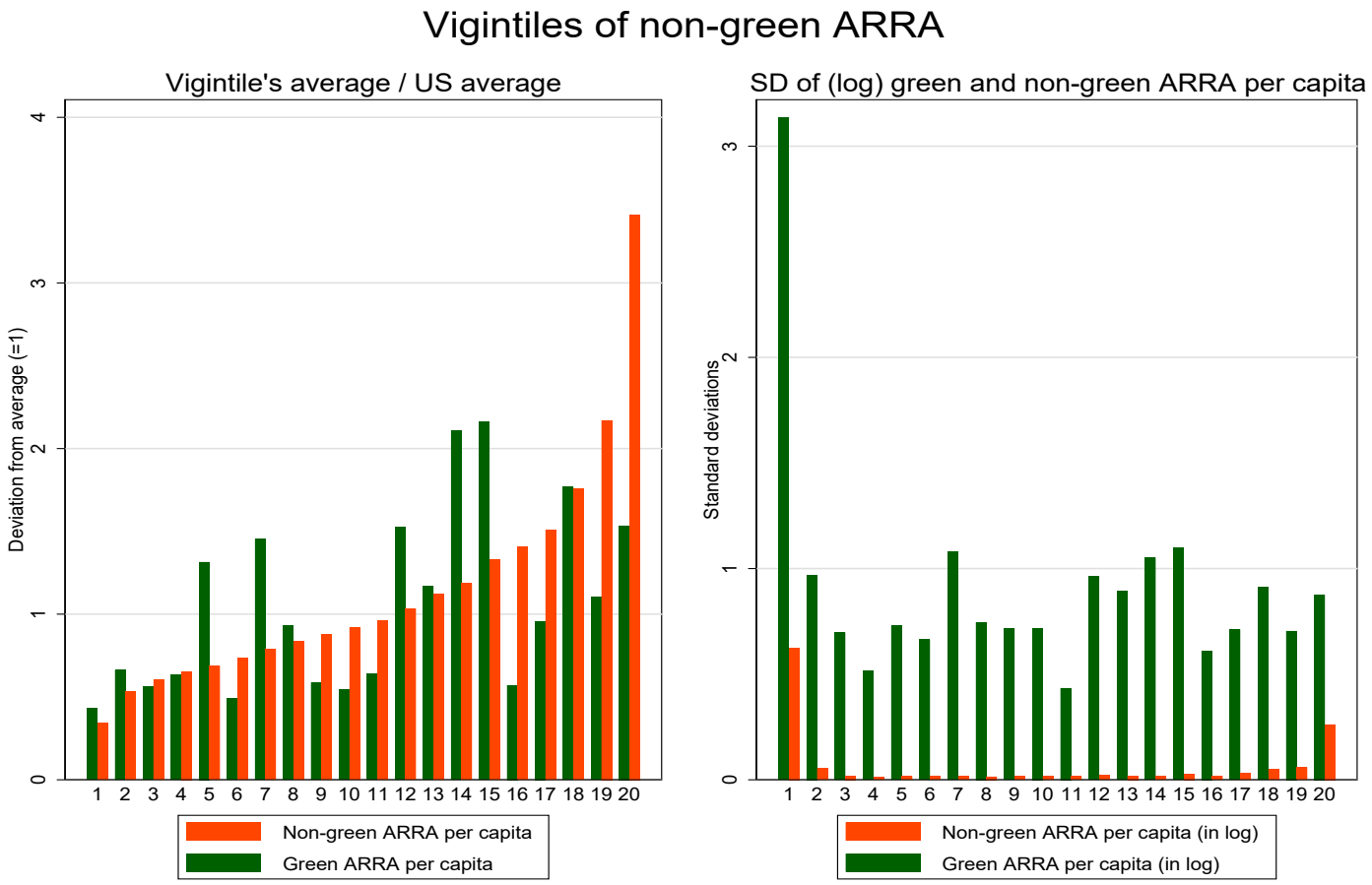
Estimation Issues

- ARRA spending targets areas hardest hit by the recession and is endogenous by construction
  - Previous studies address endogeneity using a formulaic (or shift-share IV) approach
  - More complicated here due to the persistent effect of pre-ARRA green spending, which is unobservable
    - Consistent with Jaeger et al. (2018) critique of shift-share instruments, which may conflate short- and long-term effects

Estimation Issues

- Solutions:
  1. Use twenty dummies for non-green ARRA vigintiles
     - Since non-green ARRA was directed to areas hardest hit by the recession, limits our identification to commuting zones receiving similar levels of non-green ARRA
     - Allows testing the robustness of our results to the exclusion of outlier vigintiles

Green ARRA per capita by vigintile of non-green ARRA per capita



Notes: unweighted vigintiles of non-green ARRA per capita across all CZ. Within-vigintiles average and SD is weighted by CZ population in 2008. CZ with pop > 25,000 only.

Estimation Issues

- Solutions:
  1. Use twenty dummies for non-green ARRA vigintiles
  2. We control for other factors affecting green stimulus spending
     - the likely **impact** of **stimulus spending**, such as:
       - initial employment levels and growth rates in multiple sectors
       - trade exposure
       - state capitals
     - the relative levels of **green versus non-green** employment, such as:
       - potential oil & gas resources and employment in the energy extraction sector
       - Presence of a federally funded Department of Energy lab
       - Environmental policy (varies over time)

Estimation Issues

- Solutions:
  1. Use twenty dummies for non-green ARRA vigintiles
  2. We control for other factors affecting green stimulus spending
  3. We check for pre-trends in our data
     - Did employment growth before the great recession differ depending on the level of green ARRA received (conditional on all controls)?
       - We observe pre-trends for total employment, but only when including state fixed effects
       - No pre-trends for the types of employment most affected by green ARRA: green employment and manual labor employment

Estimating equation

- Our main econometric model is an event-study model that jointly estimates the effects of green ARRA for years before and after the crisis :

$$\Delta ln(y_{it}) = \alpha + \sum_{\tau} \beta_{\tau} ln\left(\frac{GreenARRA_i}{pop_{i,2008}}\right) \times D_{\{t=\tau\}} + \sum_{\tau} \mathbf{X}'_{it_0} \boldsymbol{\varphi}_t \times D_{\{t=\tau\}} + \sum_{\tau} \mathbf{G}'_{it_0} \boldsymbol{\vartheta}_t \times D_{\{t=\tau\}} + \mu_{i\in v,t} + \eta_{i\in c,t} + \epsilon_{it}$$

where:

- y: long-difference of our measures of per-capita employment in year t relative to 2008
- $\mathbf{X}'_{it_0}$ and $\mathbf{G}'_{it_0}$: the two sets of controls described earlier
- $\mu_{i\in v,t}$: fixed effects for vigintiles of non−green ARRA spending
- $\eta_{i\in s,t}$: state or regional fixed effects

- We allow the coefficient of green ARRA and of all other covariates to vary across three periods (τ):
  - pre-ARRA (2005-2007)
  - short-run (2009-2012)
  - long-run (2013-2017)

- Standard errors clustered by state or region

Main estimation strategy: effect net of pre-trends

- We compute the long- and short-term effect of green ARRA by subtracting its effect before 2008
  - $\hat{\beta}_{short} - \hat{\beta}_{pre}$ and $\hat{\beta}_{long} - \hat{\beta}_{pre}$ can be interpreted as the average effect of green ARRA in the short- or long-run **when pre-trends are present**

- *Key assumption*: employment trends (and pre-trends) are affected by observable and unobservable covariates in a linear way
  - Intend to explore other assumptions in the final version of the paper

Baseline Results

- No evidence of pre-trends for green or manual employment
- Results with state fixed effects more precise

	OLS: State FE			***OLS: Census Region FE***		
Dep var: Change in log employment per capita compared to 2008	Total employment	Green occupations	Manual employment	Total employment	Green occupations	Manual employment
Green ARRA per capita (log) x D2005_2007	0.0026***	0.00001	0.0008	0.0016	-0.0003	-0.0004
	(0.0009)	(0.0043)	(0.0027)	(0.0011)	(0.0042)	(0.0028)
Green ARRA per capita (log) x D2009_2012	0.0026***	0.0040	0.0057**	0.0017*	-0.0015	0.0033
	(0.0008)	(0.0039)	(0.0022)	(0.0009)	(0.0048)	(0.0029)
Green ARRA per capita (log) x D2013_2017	0.0045***	0.0120**	0.0108**	0.0039*	0.0083	0.0102
	(0.0016)	(0.0050)	(0.0046)	(0.0022)	(0.0060)	(0.0061)
Jobs created, $1 million green ARRA:						
Pre-ARRA (2005-2007)	11.53***	0	0.92	7.35	-0.07	-0.47
	(3.85)	(0.87)	(2.98)	(4.94)	(0.85)	(3.10)
short term (2009-2012)	11.15***	0.78	5.48**	7.42*	-0.3	3.2
	(3.29)	(0.76)	(2.10)	(3.95)	(0.92)	(2.77)
long term (2013-2017)	20.8***	2.66**	11.34**	18.03*	1.84	10.76
	(7.37)	(1.11)	(4.80)	(10.15)	(1.34)	(6.46)
Short-pre	0.03	0.78	4.7	0.33	-0.24	3.61
	(3.49)	(1.49)	(3.39)	(4.05)	(1.58)	(3.84)
Long-pre	8.92	2.66	10.48*	10.45	1.92	11.2*
	(8.02)	(1.83)	(5.46)	(9.46)	(1.97)	(6.46)
R squared	0.7672	0.4159	0.5749	0.6819	0.3336	0.4907
Observations	7631	7631	7631	7631	7631	7631

Baseline Results

Pre-trends evident for total employment using state fixed effects
- Some ARRA funds allocated to states using pre-existing formulas
- Exogenous allocation across states lost when using state f.e.

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Baseline Results

- If pre-trends were absent the short-term effect of the green stimulus is in the mid-range of previous estimates (7.4-11.2 jobs created per $1 million)
- But we do not know if this is an effect of the green stimulus or simply reveal the greater resilience to crisis of greener areas
  - Effect for total employment is smaller and imprecisely estimated once we subtract the pre-trends

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The Effect of a Green Stimulus: Results

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Maxwell | Syracuse University

Main Results: (1) Reshaping the economy

- Green spending reshapes the economy

- Most jobs created are:
  - Manual labor
  - Green employment

Main Results: (1) Reshaping the economy

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Increases demand for green employment:

- While small number of jobs, green employment is small in general

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All employment gains are in manual labor

Main Results: (2) Green stimulus worked slowly

- The employment effect of a green stimulus **works more slowly** than other stimulus investments which generally lead to short-term job creation

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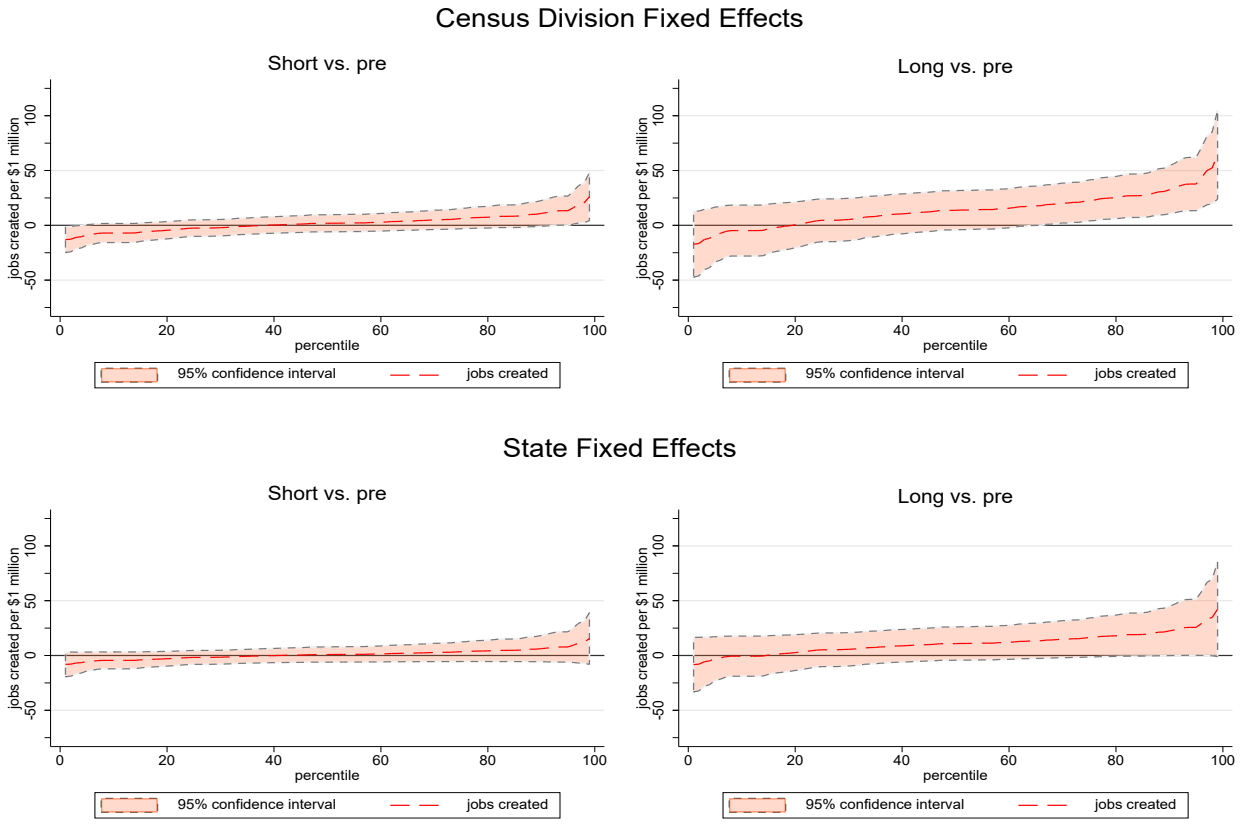
Pre-ARRA (2005-2007)	11.53***	0	0.92	7.35	-0.07	-0.47
	(3.85)	(0.87)	(2.98)	(4.94)	(0.85)	(3.10)
short term (2009-2012)	11.15***	0.78	5.48**	7.42*		
	(3.29)	(0.76)	(2.10)	(3.95		7)
long term (2013-2017)	20.8***	2.66**	11.34**	18.03		76
	(7.37)	(1.11)	(4.80)	(10.15)	(1.34)	(6.46)
Short-pre	0.03	0.78	4.7	0.33	-0.24	3.61
	(3.49)	(1.49)	(3.39)	(4.05)	(1.58)	(3.84)
Long-pre	8.92	2.66	10.48*	10.45	1.92	11.2*
	(8.02)	(1.83)	(5.46)	(9.46)	(1.97)	(6.46)
R squared	0.7672	0.4159	0.5749	0.6819	0.3336	0.4907
Observations	7631	7631	7631	7631	7631	7631

Gains in green and manual labor double in long-run

Main Results: (3) Skills Matter

- Having workers with the skills necessary to do green tasks is important
  - Green ARRA creates more jobs in commuting zones with more pre-existing green general skills (roughly top 1/3 of all communities in LR)



Robustness Checks

- Results are robust to:
  - Different samples
    - Drop 2009
    - Excluding 1st and 20th vigintiles
    - Excluding CZs hosting federal R&D labs
    - Including CZs with less than 25k residents
  - Different groupings for non-green ARRA (5-20 groups)
  - Different definitions of green ARRA
    - Include DOL job training
    - Exclude energy R&D
    - Drop DOE Loan Guarantee Program
    - Drop all loans
    - Drop contracts
    - Grants only

Policy Discussion & Conclusions

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Maxwell | Syracuse University

Policy Discussion & Conclusions

- 2009 green ARRA investments created jobs, but more slowly than other ARRA investments
  - A green stimulus can *reshape* the economy, but not *restart* the economy
  - Better suited for long-term policy goals, such as a green energy transition

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  - Employs workers often left behind by changing environmental regulations
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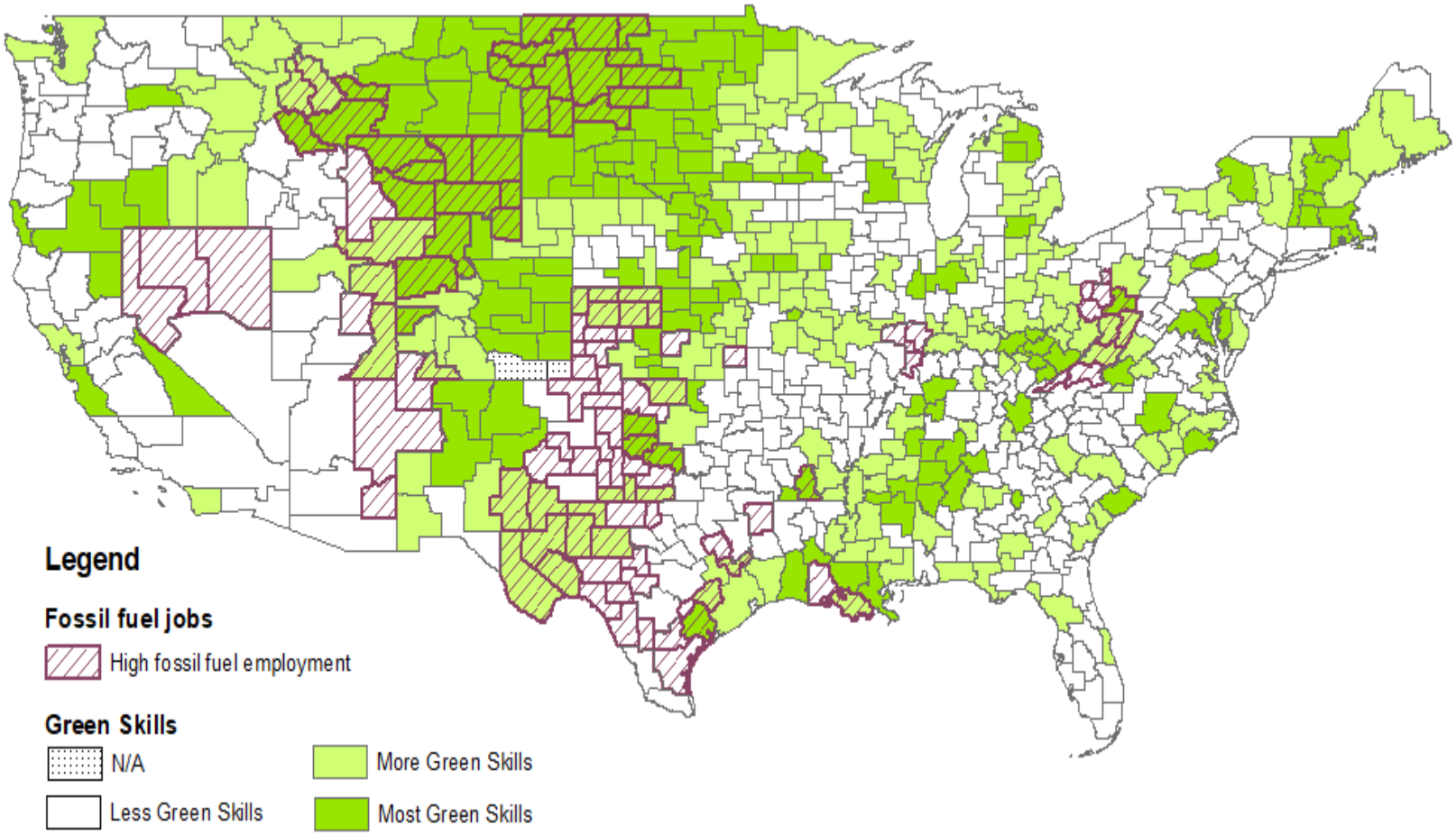
- Skills matter
  - Early pandemic job losses were not in occupations using green skills
  - Green stimuli may create spatial inequities



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Thank You!