# Structural Increases in Skill Demand after the Great Recession

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## Motivation

- Evidence of upskilling in MSAs hardest hit by great recession (Hershbein & Kahn 2018, Modestino et al 2019)
- Has upskilling persisted in the decade after the Great Recession? Is growing employer demand for education cyclical, or structural?
- How does this relate to growing demand for AI and data science skills?

## What we do

1. Replicate the upskilling result from HK (2018) and Modestino et al (2019), project out for a few more years after the GR
2. Show that upskilling fades, but overall demand for education continues to grow through 2019
3. Education requirements increasing more in professional occupations, high-wage MSAs
4. Rapid increase in demand for machine learning / AI skills

## Description of Data

- Burning Glass Technologies, near universe of online job postings 2007, 2010-2019
- About 80m unique ads after sample restrictions (non-missing firm/MSA/occ)
- Occupation, MSA, firm/industry, education and experience requirements
- > 10k unique job skills; create common groups following Deming & Kahn (2018)
- MSA characteristics from ACS, CPS; weight by 2006 occupation and MSA frequencies

## Structural & Cyclical Growth in BA Requirements

Define change over time in # occupations in an MSA requiring a BA degree: $\Delta Y_{m,o,t} \equiv Y_{m,o,t} - Y_{m,o,2007}$
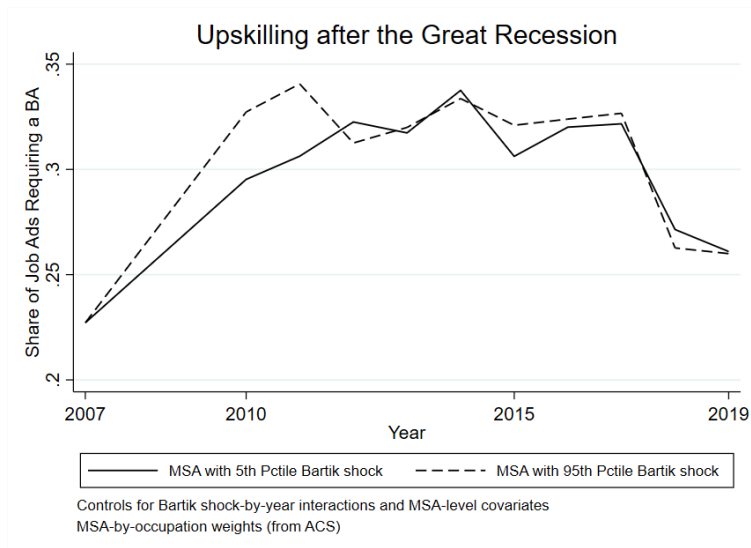
$$\Delta Y_{m,o,t} = \alpha_0 + \sum_t \mathbb{1}_t \times \overbrace{(\rho_t + \underbrace{\alpha_{1,t} \times shock_m}_{\text{Cyclical Term}})}^{\text{Total Growth}} + \beta X_m + \epsilon_{m,o,t}$$

- $shock_m$: predicted effect of Great Recession on employment using a Bartik instrument based on average 2004 & 2005 industry shares and national employment growth by industry[1]
- $X_m$: MSA-level covariates, SEs clustered at group level

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[1]Can also use local unemp. rate (Modestino et al 2019)

# Bartik shock less predictive after 2012



## Upskilling after the Great Recession

Share of Job Ads Requiring a BA

Year

| MSA with 5th Pctile Bartik shock | MSA with 95th Pctile Bartik shock |

Controls for Bartik shock-by-year interactions and MSA-level covariates
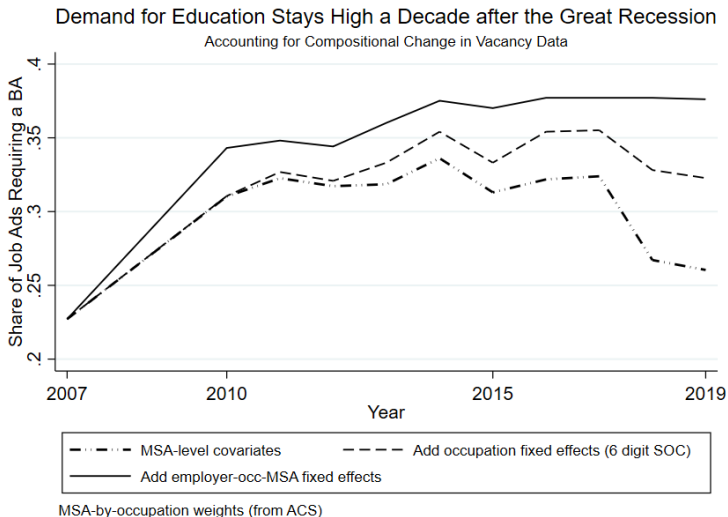MSA-by-occupation weights (from ACS)

## Accounting for Changing Composition of BG Data

Downward dip in growth of BA requirements is driven by the addition of new firms and vacancies to BG data over time
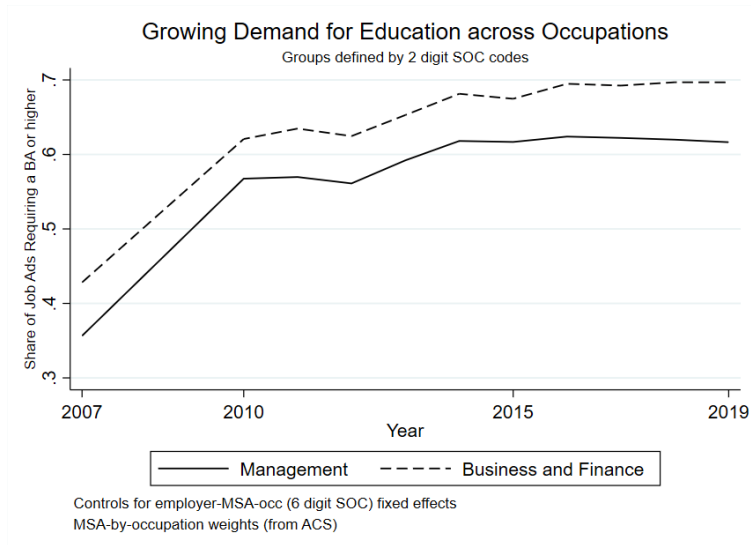
1. Control for occupation, firm-occupation-MSA fixed effects ($\phi_{m,o,f}$)
2. Skill upgrading in a balanced panel of employers/occupations/labor markets
3. Also control for polynomial in number of skills, since vacancies become more detailed with time ($n_{m,f,o,t}$)

$$\Delta Y_{m,f,o,t} = \alpha_0 + \sum_t (\mathbb{1}_t \times \rho_t) + \beta X_m + \phi_{m,o,f} + \eta s_{m,f,o,t} + \epsilon_{m,f,o,t}$$
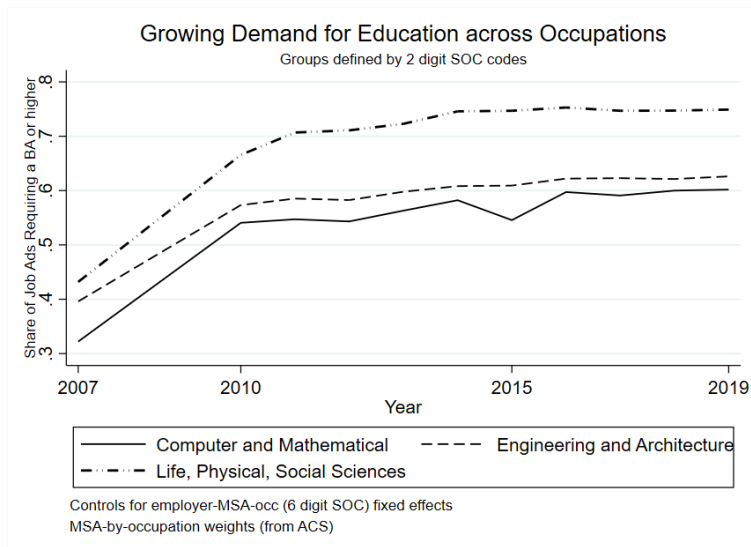
# Educational Upgrading Persists, a Decade after the Great Recession



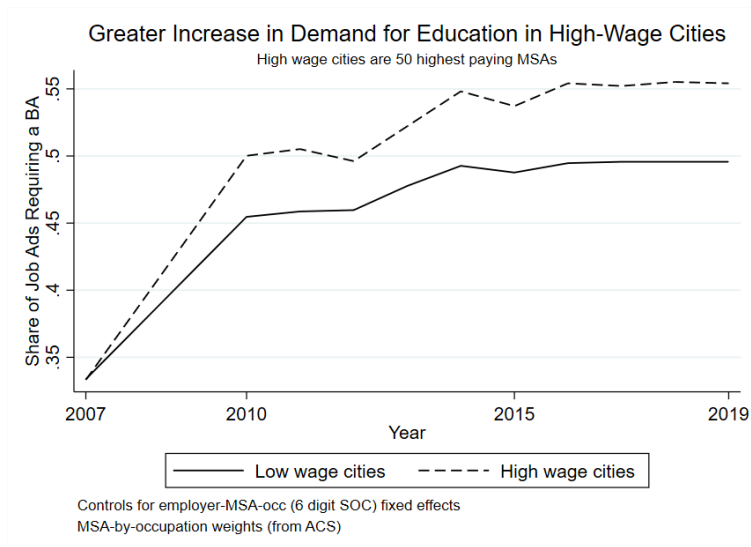Demand for Education Stays High a Decade after the Great Recession

Accounting for Compositional Change in Vacancy Data

Legend:
- MSA-level covariates
- Add occupation fixed effects (6 digit SOC)
- Add employer-occ-MSA fixed effects

MSA-by-occupation weights (from ACS)

# Management & Business Occupations



Growing Demand for Education across Occupations

Groups defined by 2 digit SOC codes

Controls for employer-MSA-occ (6 digit SOC) fixed effects
MSA-by-occupation weights (from ACS)

# Computer, Engineering and Science Occupations



## Growing Demand for Education across Occupations
### Groups defined by 2 digit SOC codes

Controls for employer-MSA-occ (6 digit SOC) fixed effects
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# High and Low Wage Cities



Greater Increase in Demand for Education in High-Wage Cities

High wage cities are 50 highest paying MSAs

Controls for employer-MSA-occ (6 digit SOC) fixed effects
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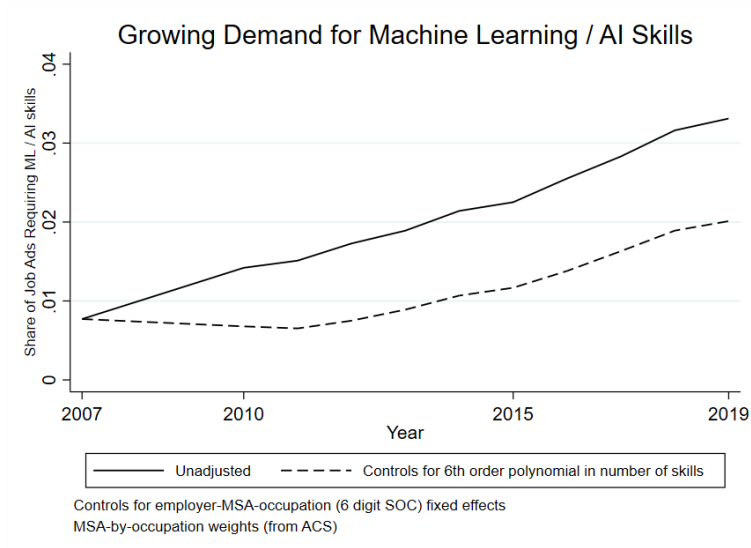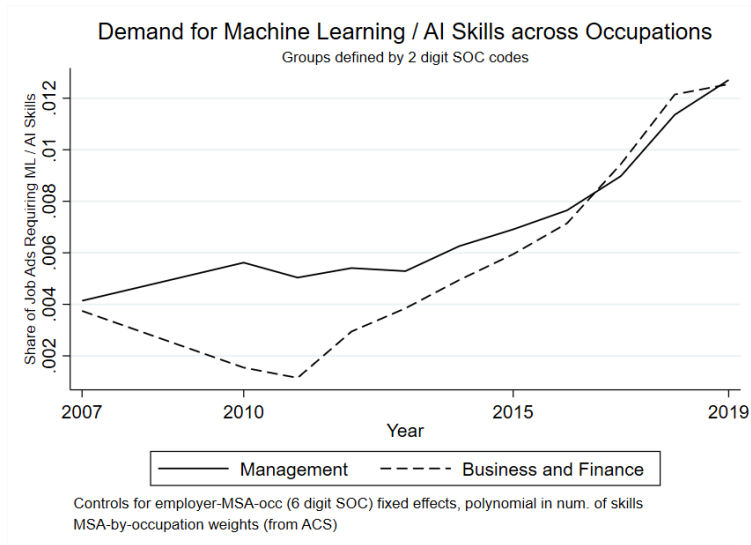
# Machine Learning & AI Skills

- Key Phrases (Machine Learning, AI, Neural Networks, Deep Learning)
- Specific Techniques (Bayesian Networks, CNNs, Text Mining, Machine Translation, Random Forest)
- Specific Software (TensorFlow, MapReduce, Sqoop, Apache Hadoop)
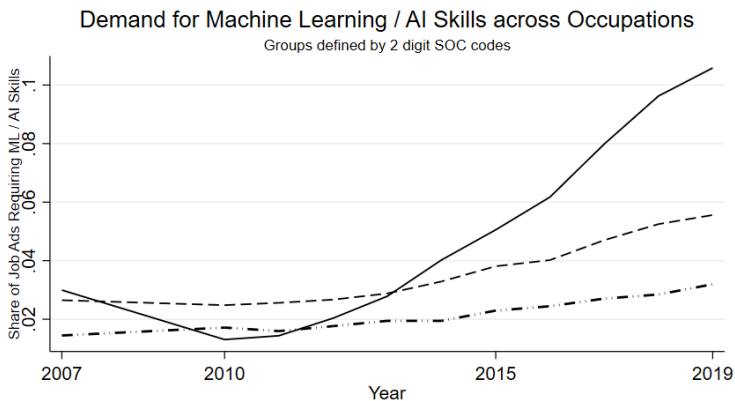- Lines up with Acemoglu et al (2019)

# Growing Demand for Machine Learning / AI Skills



Growing Demand for Machine Learning / AI Skills

Controls for employer-MSA-occupation (6 digit SOC) fixed effects
MSA-by-occupation weights (from ACS)

# ML/AI Skills in Business & Management Occupations



Demand for Machine Learning / AI Skills across Occupations
Groups defined by 2 digit SOC codes

Controls for employer-MSA-occ (6 digit SOC) fixed effects, polynomial in num. of skills
MSA-by-occupation weights (from ACS)

# Computer, Engineering and Science Occupations



Demand for Machine Learning / AI Skills across Occupations

Groups defined by 2 digit SOC codes

Controls for employer-MSA-occ (6 digit SOC) fixed effects, polynomial in num. of skills

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# High and Low Wage Cities



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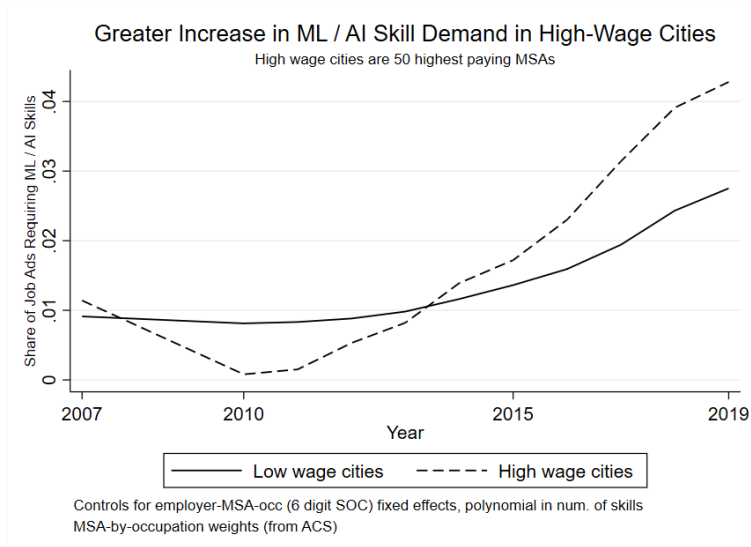
# Cognitive and General Computer / MS Office Skills



Trends in Demand for Other Skills

Controls for employer-MSA-occ (6 digit SOC) fixed effects, polynomial in num. of skills
MSA-by-occupation weights (from ACS)
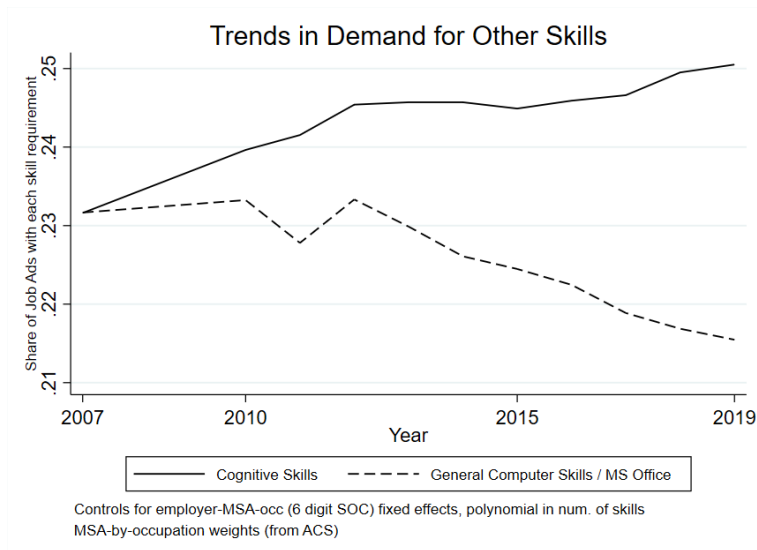
## Conclusion

Employer demand for education increased markedly during the GR, and then persisted or grew slightly over the last decade.

1. Cyclical upskilling in short-run, but broad-based growth in long-run
2. Larger increases for professional occupations, high-wage cities
3. Demand for ML/AI skills also increasing rapidly
4. Follows the same basic pattern (high-wage jobs, superstar cities)