

# Opening the Black Box: Task and Skill Mix and Productivity Dispersion

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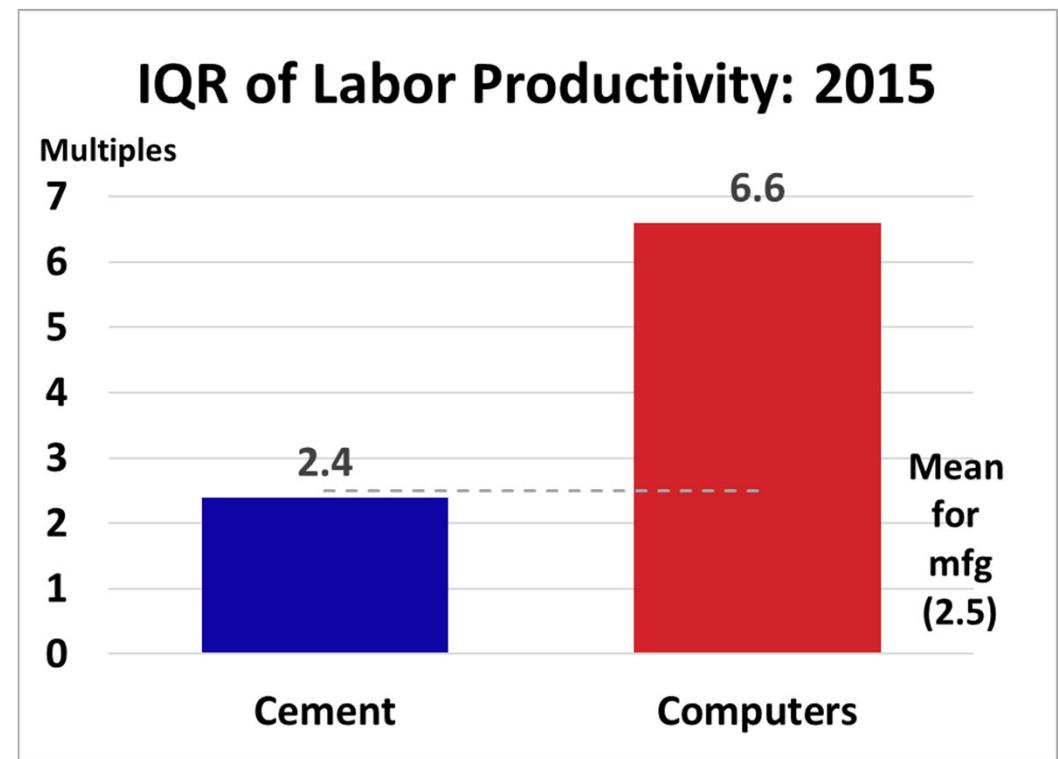
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# What do we know?

- Common finding in literature: productivity differences across establishments are large
- Many potential sources
  - Differences in technical efficiency and demand factors
  - Frictions and distortions
  - **Heterogeneity in production technology**
  - **Different degrees of technology adoption**



# Inside the Black Box – Two Approaches

- Technology module in 2019 Annual Business Survey
  - AI, robotics, dedicated equipment, specialized software, and cloud computing
  - Acemoglu et al. (tomorrow)
- BLS Occupational Employment and Wage Statistics (OEWS) survey
  - Occupational mix (establishment-level)
  - Task/skill intensity (establishment-level)
  - Requires linking OEWS to Census microdata (started)

# Occupational Employment and Wage Statistics

- Semi-annual survey—samples about 200,000 establishments each May and November
  - Wage and employment data on  $\approx$  800 occupations
  - Full- and part-time wage and salary workers
  - Number of workers in each of 12 wage intervals
- Cross-section that is nationally representative on a 3-year basis, but includes “certainty” units, which are sampled every 3 years
- Our sample: 2000, 2005, 2008, 2011, 2014, 2017
- See paper for details of dataset construction

# O\*NET Data

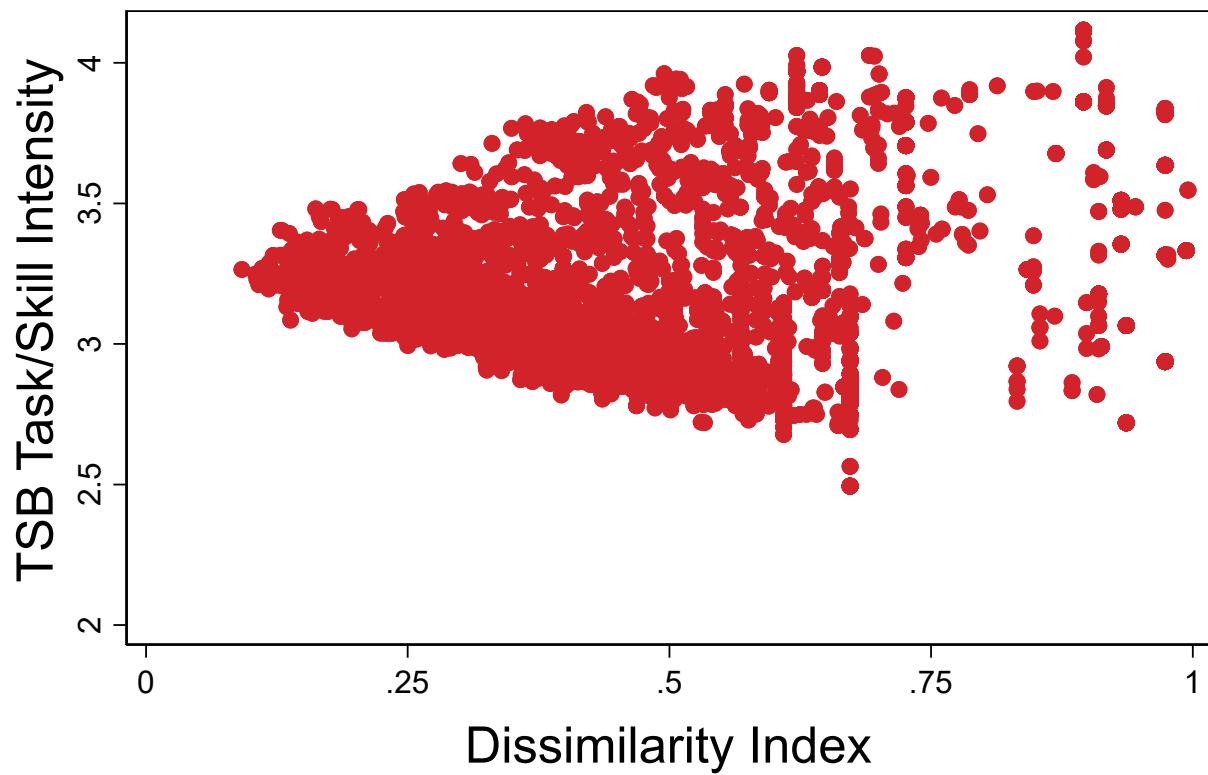
- Information on tasks performed by each occupation (updated periodically)
- 5 composite tasks ala Acemoglu and Autor (2011)
  - Non-routine cognitive: analytical
  - Non-routine cognitive: interpersonal
  - Routine cognitive
  - Routine manual
  - Non-routine manual physical

# Establishment-Level Task/Skill Intensity

- OEWS measure (TSB) = the average wage for the establishment if the establishment paid the national average wage for each occupation it employs
  - Tasks are bundled into occupations
  - Assumes that bundling matters
- O\*NET measure (TSU) = the per worker average amount of each task (A&A, 2011) times the price of that task (based on a hedonic regression of national occupation wage (from OEWS) on task content
  - Task/skill intensity is simply the sum of tasks times the price of the tasks
  - Assumes that it does not matter who does what task
- Both measures combine tasks and skills

# Task/Skill Intensity and Dissimilarity Indexes

## Semiconductor Manufacturing



# Task Measures

- Five composite tasks (Acemoglu and Autor, 2011)
  - Non-routine cognitive: analytical
  - Non-routine cognitive: interpersonal
  - Routine cognitive
  - Routine manual
  - Non-routine manual physical
- %STEM occupations in the establishment

# Correlations Between Task/Skill Measures

Correlation of TSB task/skill intensity (OEWS) with:	Manufacturing			
	All	High-Tech	Non-Tech	Non-Mfg
TSU task/skill intensity (O*NET)	0.77	0.91	0.74	0.70
Non-routine cognitive: Analytical	0.75	0.90	0.72	0.70
Non-routine cognitive: Interpersonal	0.58	0.57	0.58	0.48
Routine cognitive	-0.36	-0.57	-0.31	-0.18
Routine manual	-0.65	-0.83	-0.61	-0.33
Non-routine manual physical	-0.57	-0.83	-0.51	-0.29
%STEM workers	0.61	0.82	0.56	0.36

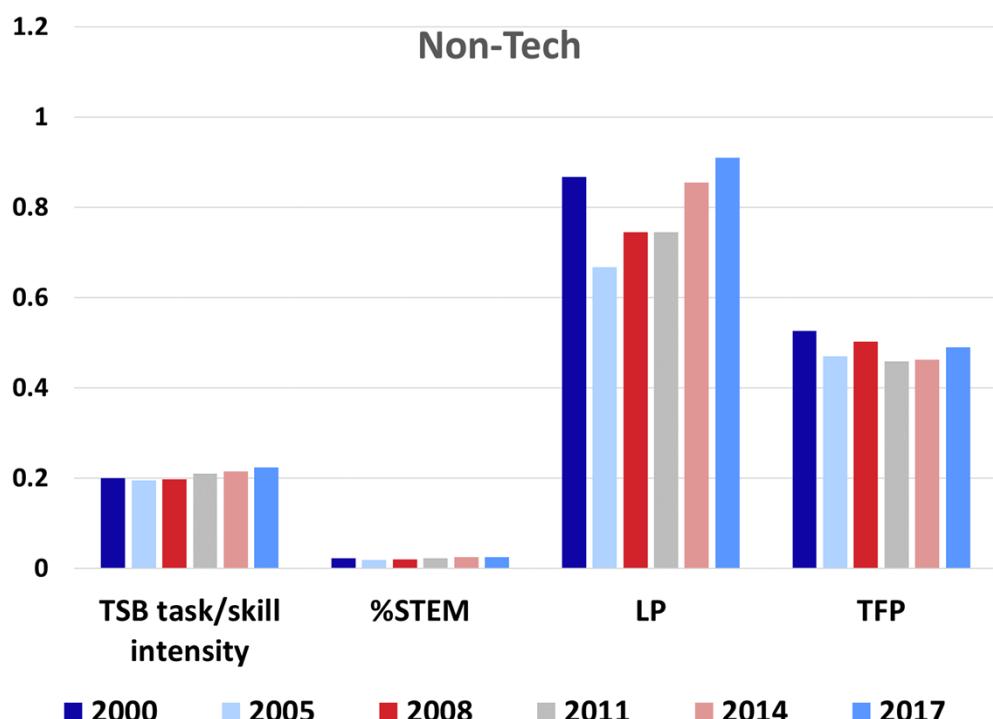
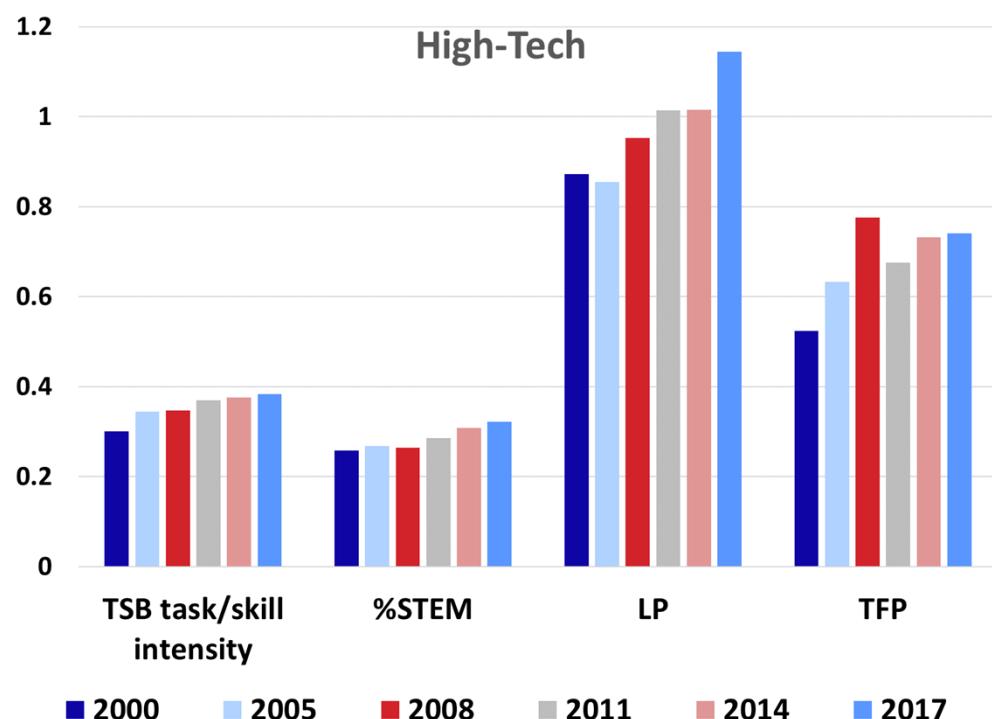
# Dispersion Measures

- Using establishment task/skill measures, calculate employment-weighted dispersion measures for each industry and each year in our sample
  - Interquartile Range (IQR)
  - 90-10 range (in paper—not presented here)
- Dataset of IQRs for each dispersion measure, where each observation is an industry-year
- Productivity dispersion measures are from DiSP
  - Employment weighted IQRs
  - Industry-year observations

## Within-Industry Dispersion

	Mean IQR		
	All Mfg	High-Tech	Non-Tech
TSB (OEWS)	0.24	0.35	0.21
TSU (O*NET)	0.15	0.19	0.14
%STEM workers	0.08	0.28	0.02
Labor prod.	0.84	0.97	0.80
TFP	0.53	0.67	0.49

# Mean IQR by Year and High-/Non-Tech



# Correlations Between IQRs of T/S Measures

IQR correlations between TSB (OEWS) and:	Manufacturing		
	All	High-Tech	Non-Tech
TSU task/skill intensity (O*NET)	0.75	0.86	0.59
Non-routine cognitive: Analytical	0.75	0.87	0.56
Non-routine cognitive: Interpersonal	0.06	0.21	0.23
Non-routine manual physical	0.57	0.55	0.37
%STEM workers	0.82	0.84	0.25

# IQR Correlations: T/S Measures and Productivity

	Labor Productivity			Total Factor Productivity		
	All Mfg	High-Tech	Non-Tech	All Mfg	High-Tech	Non-Tech
<i>Panel A. IQR dispersion</i>						
TSB task/skill intensity (OEWS)	0.52	0.40	0.33	0.45	0.32	0.26
TSU task/skill intensity (O*NET)	0.42	0.31	0.31	0.31	0.23	0.14
Non-routine cognitive: Analytical	0.44	0.32	0.37	0.31	0.18	0.21
Non-routine cognitive: Interpersonal	-0.09	-0.08	-0.03	-0.08	-0.21	0.10
Non-routine manual physical	0.28	0.12	0.13	0.24	0.04	0.17
%STEM workers	0.44	0.24	0.01	0.45	0.29	-0.05

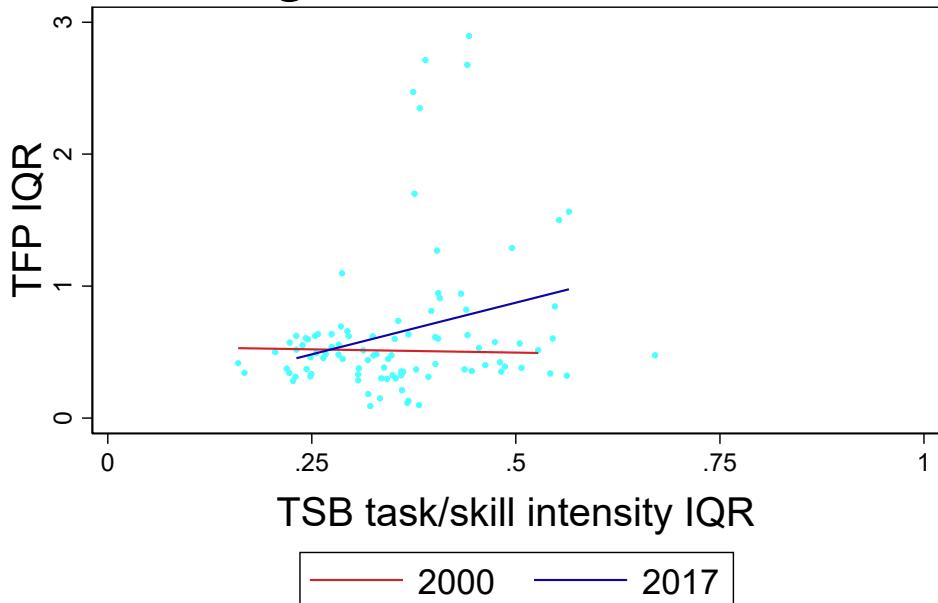
# IQR Associations

	Labor Productivity			Total Factor Productivity		
	All Mfg	High-Tech	Non-Tech	All Mfg	High-Tech	Non-Tech
TSB task/skill intensity (OEWS)	2.40 [0.27]	2.82 [0.17]	1.37 [0.11]	1.98 [0.21]	2.30 [0.11]	0.77 [0.07]
TSU task/skill intensity (O*NET)	3.25 [0.17]	3.87 [0.11]	1.53 [0.1]	2.30 [0.10]	2.82 [0.06]	0.49 [0.02]
Non-routine cognitive: Analytical	1.07 [0.20]	1.24 [0.12]	0.58 [0.14]	0.72 [0.10]	0.69 [0.05]	0.23 [0.05]
Non-routine cognitive: Interpersonal	-0.44 [0.03]	-1.38 [0.06]	-0.11 [0.01]	-0.30 [0.01]	-2.33 [0.09]	0.14 [0.01]
Non-routine manual physical	0.67 [0.08]	0.52 [0.05]	0.18 [0.02]	0.57 [0.07]	0.10 [0.02]	0.17 [0.03]
%STEM	1.34 [0.20]	0.99 [0.09]	0.03 [0.01]	1.30 [0.21]	1.32 [0.10]	-0.24 [0.00]

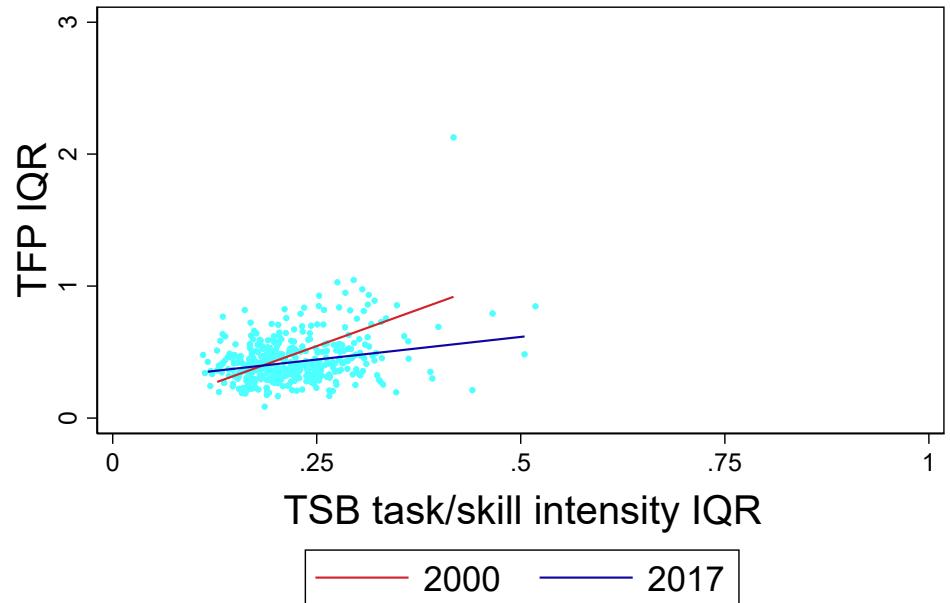
Bivariate regression results: Coefficient [R-squared]

# IQR: TFP and TSB Task/Skill Intensity

## High-tech Industries



## Non-tech Industries



# Summary of Main Findings

- Considerable dispersion in both task/skill intensity measures
  - More dispersion in the TSB (OEWS) measure
  - More dispersion in high-tech industries
  - Dispersion in high-tech industries has increased over time
- Strong positive relationship between IQRs of task/skill intensity and labor productivity and TFP
  - Correlation is stronger for the TSB (OEWS) measure
  - Correlations are higher in high-tech industries
  - Dispersion in the TSB measure explains about 25 percent of the variation in LP dispersion and 20 of the variation of TFP dispersion

# Next Steps – Linking OEWS and ASM

- Joint distribution of productivity and task/skill intensity
- Can we identify clusters of technology types by looking at differences in occupation mix?
- Incorporate occupation data into measures of establishment-level TFP
  - Task/skill intensity (TSB vs. TSU – does bundling matter?)
  - Occupations as factors of production