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

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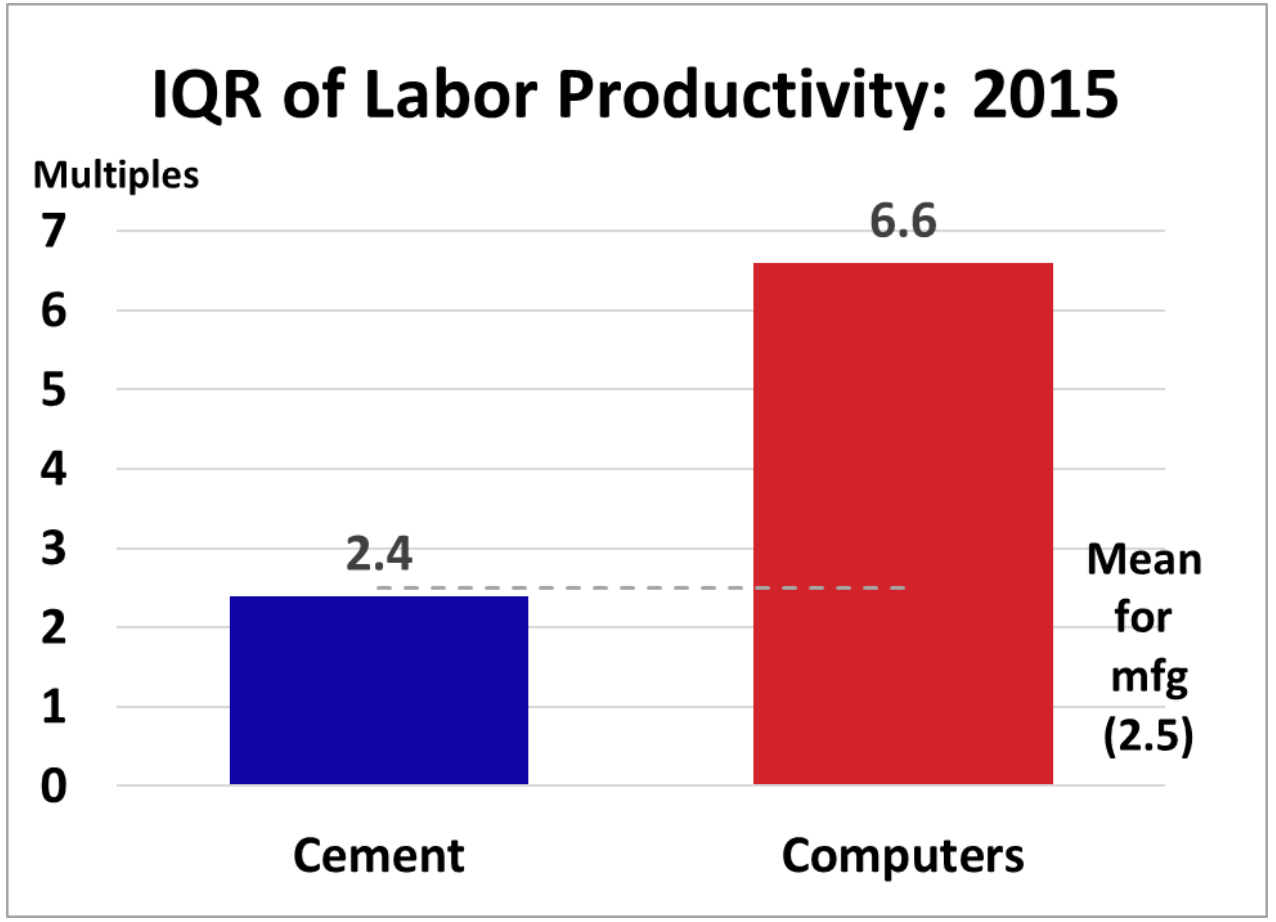
What do we know?

- 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**



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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 ≈ 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

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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

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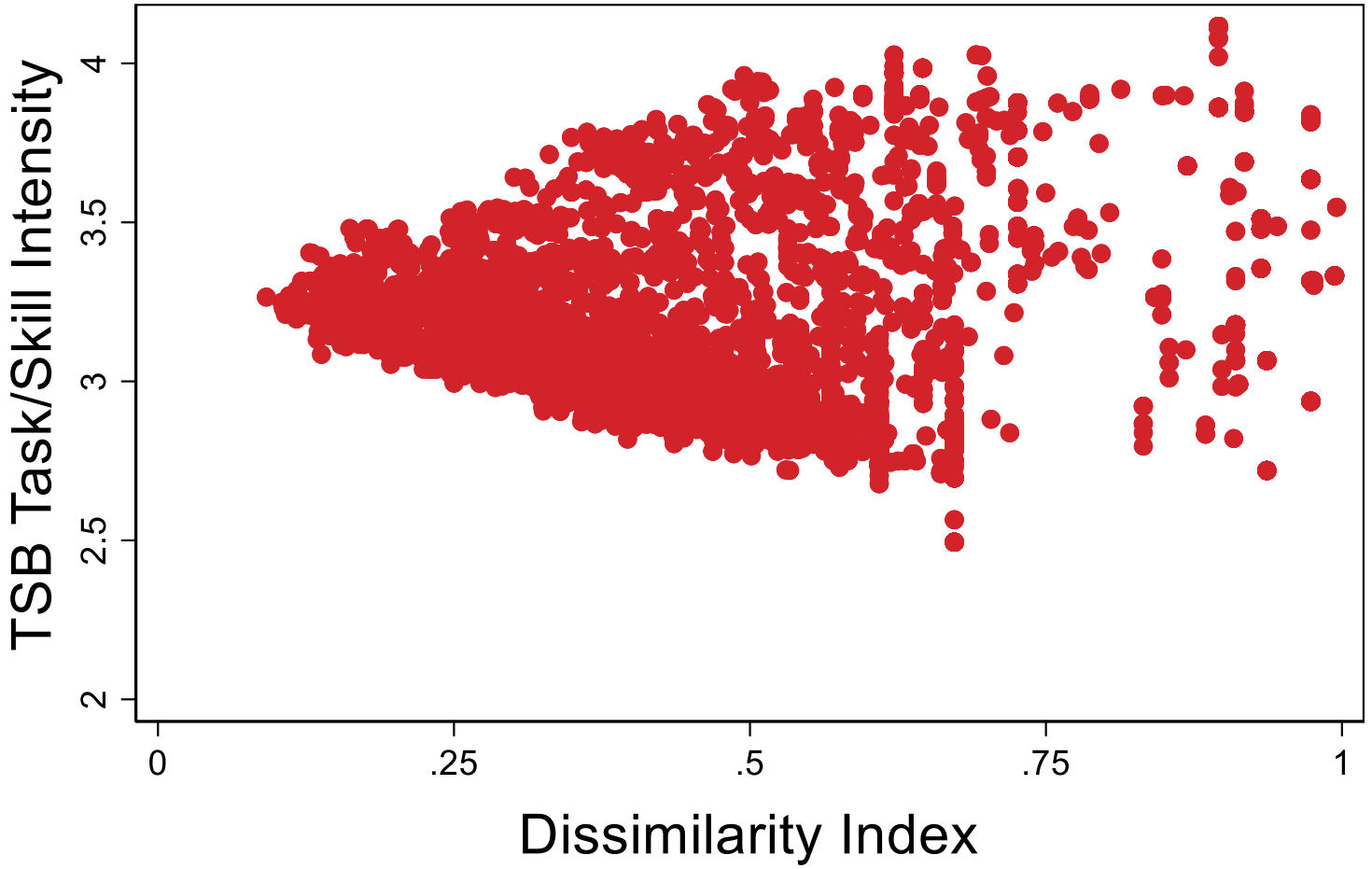
Task/Skill Intensity and Dissimilarity Indexes

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

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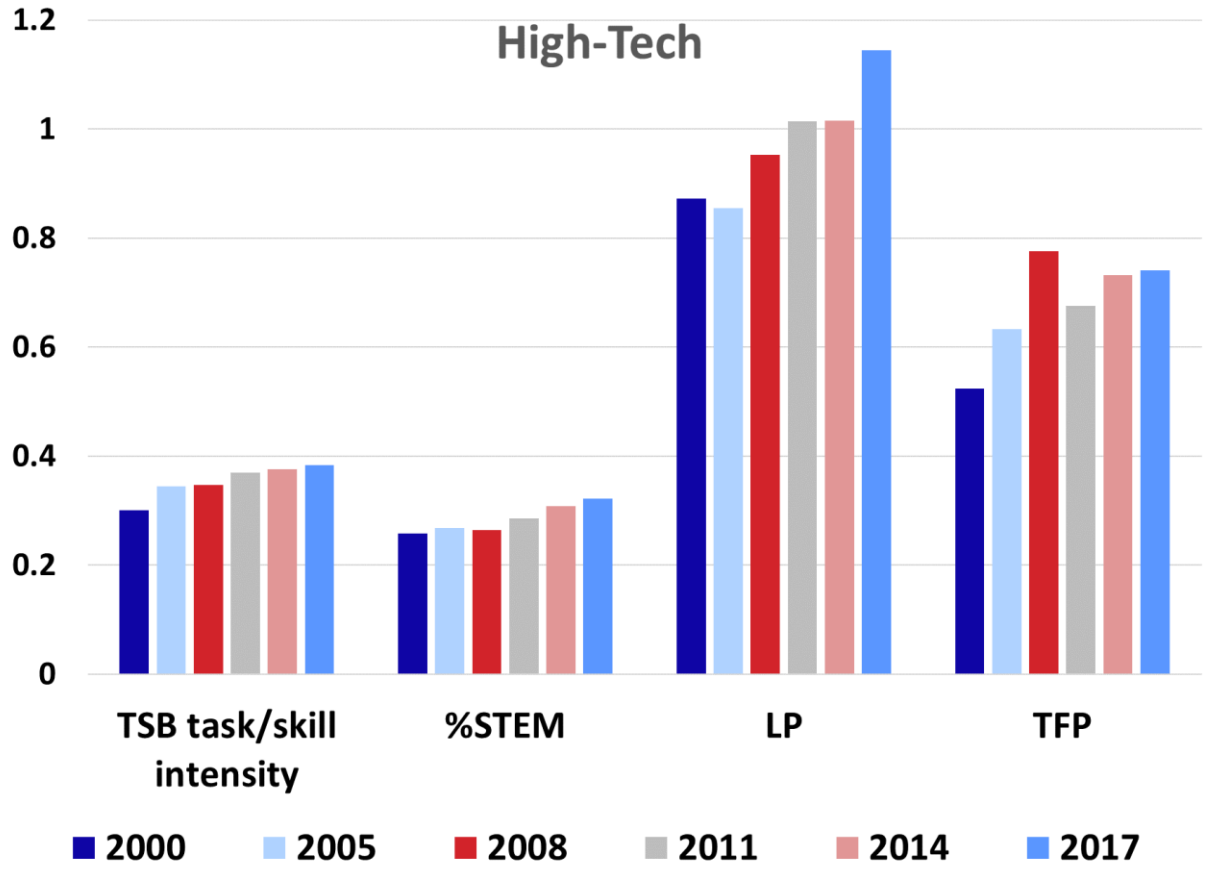
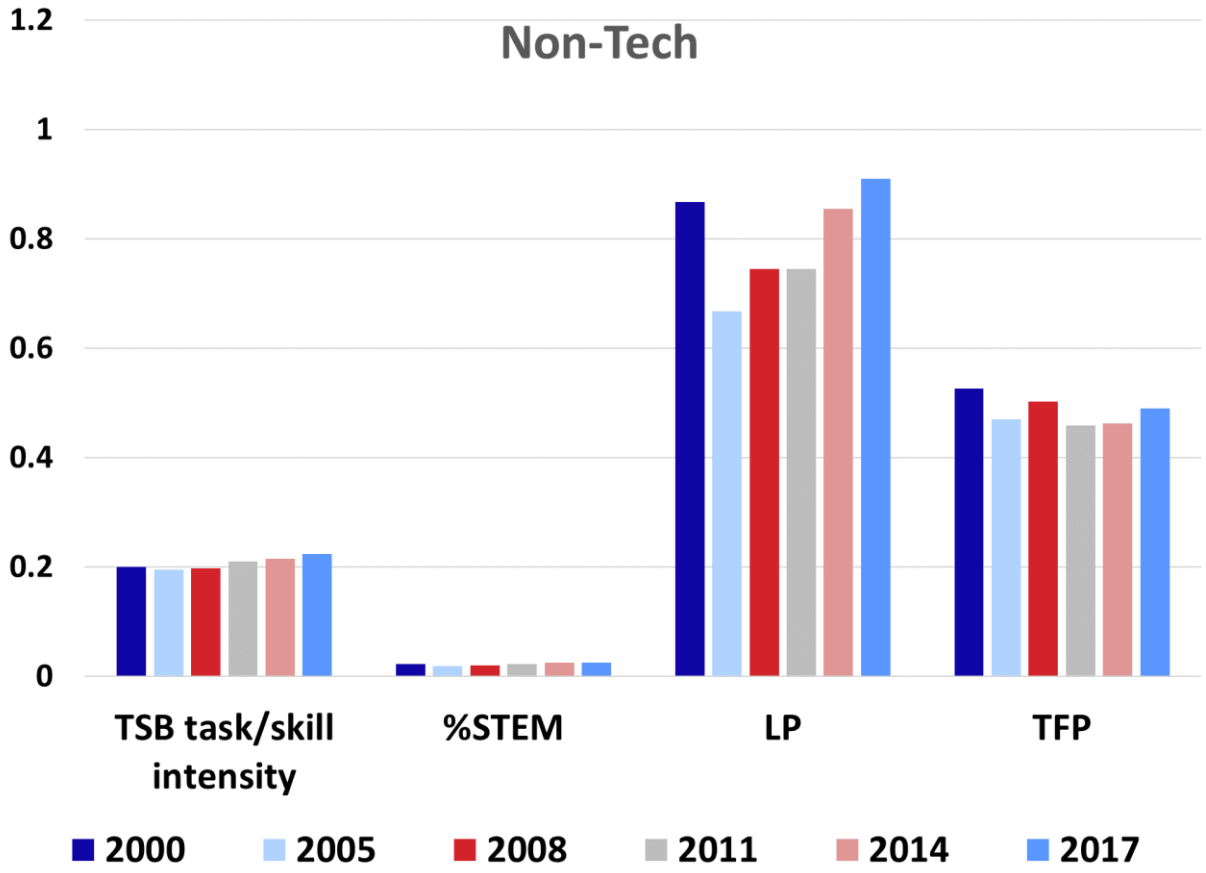
Mean IQR by Year and High-/Non-Tech





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

Bivariate regression results: Coefficient [R-squared]

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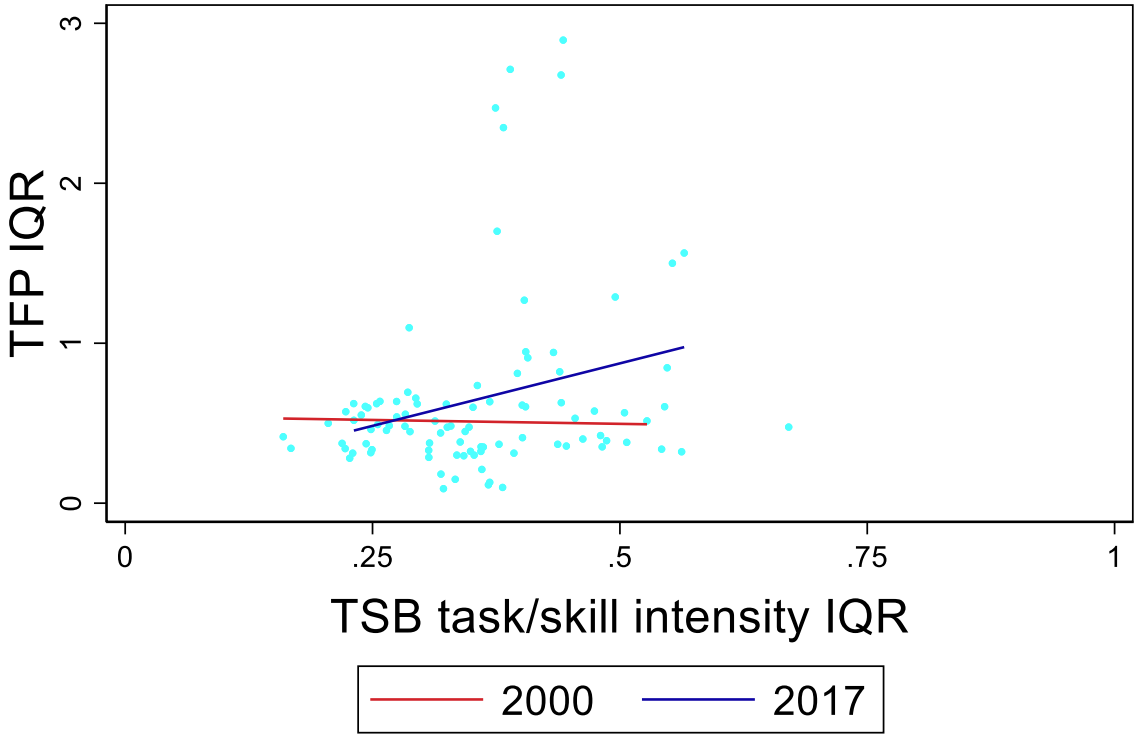
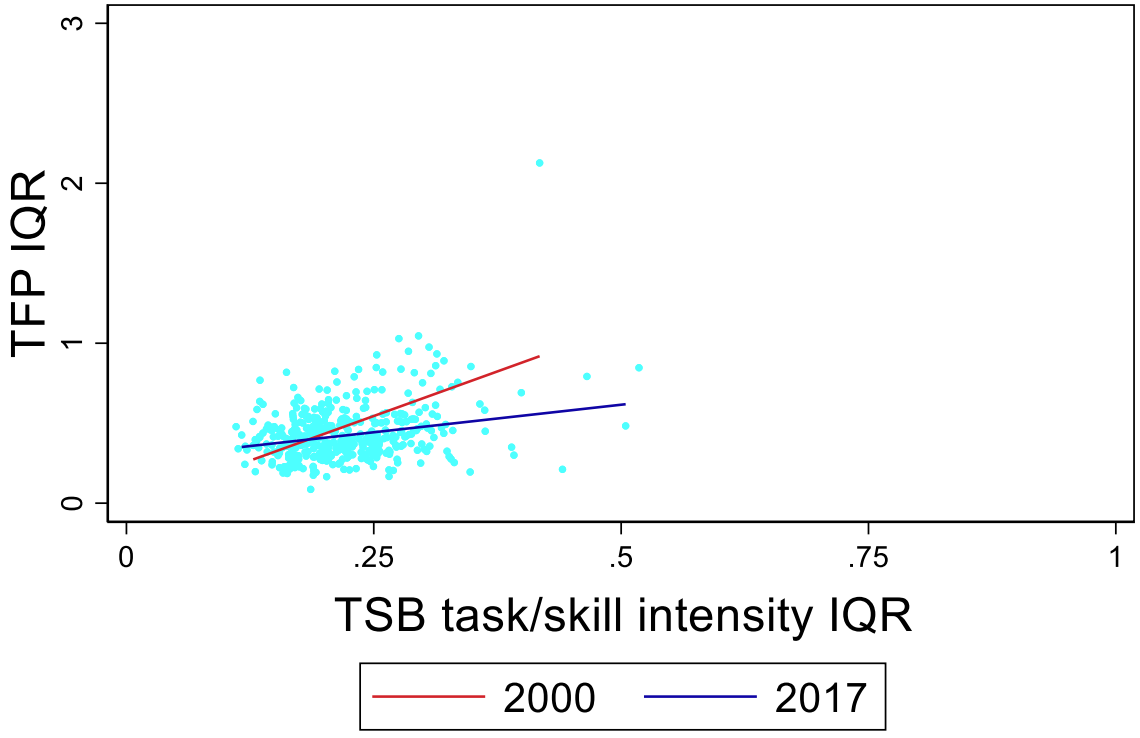
IQR: TFP and TSB Task/Skill Intensity

High-tech Industries



Non-tech Industries



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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

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