Which Jobs Scale and Why?

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NBER Megafirms and the Economy
Cambridge, Fall 2024

Introduction: Scalability and Firm Size

- CEO's tasks can be decomposed into two parts (Baker and Hall, 2004):
  - **'Scalable'** part: marginal product of the task increases with firm size
    - *Example:* CEO decides firm will adopt a GenAI tool
  - **'Non-scalable'** part : additive, marginal product of the task not increase with firm size
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- Gabaix and Landier (2008) find CEO compensation increases about 20% with doubling of firm size.
  - CEO's marginal product is proportional to firm size
  - In a competitive market, CEO's compensation reflect their marginal product

Introduction: Scalability and Firm Size

In theory, *all* occupations conduct these two types of tasks. But the ratios may vary.

Occupations	**Scalable tasks**	**Non-scalable tasks**
Salespersons	Closing a large B2B sales	Checkout at the counter
Doctors	Writing a guide for residents	Treating a patient
Factory Workers	Discovering a dangerously faulty part	Installing a windshield

Research Questions

- Do occupations beyond CEO experience wage scaling?
- If so, which jobs scale and why?
  - Ranking of worker
    - Top vs. median
  - Nature of tasks
  - Type of technology

What we do

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- Analyze a large-scale, high-frequency administrative payroll dataset of over 15 million U.S. workers of 898 occupations 2017-2023.
- Measure how wages scale with firm size and across occupations, jobs, and industries

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4. Firms with more intensive IT investment in previous years
5. Results are robust for establishment vs. firm size; including firm-fixed effects, individual fixed effects; and using job-level features

Theories of Task Scalability

- **Informational economy of scale**:
  - Innovation
  - Span-of-control
- **O-Ring-Style Complementarity**:
  - Production functions heavily dependent on the quality of the weakest link input.

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    - Positions requiring leadership or decision-making skills; higher-wage earners in their occupation-firm group.
    - The employees and divisions of the firm that a worker can directly command, guide, or otherwise help or hinder in their pursuit of company goals (Drucker, 2007)

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Theories Driving Task Scalability

- **O-Ring-Style Complementarity**:
  - Production functions heavily dependent on the quality of the weakest link input.
  - If the most complex firms are the most productive, then all workers might have very high marginal products.

Theoretical Framework

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$$log(w_{i,j,o,t}) = log(S_{i,t})C_{i,o,p}T_{i,j,o} + D_{o,i,t} \quad (1)$$

- o: the occupation type
- j: the individual potential job/worker
- $T_{i,j,o}$: the individual's talent
- $C_{i,o,p}$: how complementary the talent is to firm size for this occupation
- p: skill percentile the worker is in at their occupation at the firm.
- $D_{o,t}$: the average *direct* contribution to output of a worker at a given occupation and time to a firm of size 0.

Theoretical Framework

That model motivates the following reduced form regression:

$$log(w_{i,j,o,t}) = \beta log(S_{i,t}) + \eta X_{o,i,j,t} + \alpha \tag{2}$$

This regression asks how wage in a firm scales with firm size after controlling for a vector of fixed effects $X_{o,i,t}$. We sometimes restrict attention to specific occupation o or firm-occupation wage percentiles p.

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We also investigate interactions between job characteristics and firm size in predicting wage

$$log(w_{i,j,o,t}) = \beta_0 log(S_{i,t}) + \eta Y_{o,i,j,t} + \beta_1 Y_{o,i,j,t} log(S_{i,t}) + \alpha \tag{3}$$

- Y: job characteristic that might effect scalability
- β_1: how much stronger or weaker scaling is for occupations with the characteristics Y

Data

- **ADP Payroll Data:**
  - One of the world's leading payroll processing firms
  - Covers about 20% of the U.S. workforce
  - Key variables:
    - Monthly total taxable income for each employee
    - 6-digit O*NET occupation code and job description; 2-digit NAICS industry code
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    - Zip code of employees and establishments
- **Sample Selection:**
  - Full-time workers with above minimum wage, aged 18-70
  - Firms with at least 10 employees, 2017-2023
  - Over 15 million employees, 128,376 unique firms, about 75k - 77k firms every year, 36,049 firms in the balanced sample
  - Analysis conducted at the *occupation-firm-year* level
  - Approximately 11 million observations

Data

- **Additional Data Sources:**
  - Over 200 O*NET descriptors
    - Work context - impact of decisions on co-workers or company results, etc.
  - Business Dynamics Statistics (BDS) dataset
    - Number of firms/establishments at the 2-digit NAICS level as the weight for regression

Baseline Empirical Strategy

Complementarity between skill and size motivates:

$$log(Wage_{j,i,t}) = \alpha + \beta log(Size_{i,t}) + Fixed\ Effects + \varepsilon_{j,i,t} \quad (4)$$

- $log(Wage_{j,i,t})$: An occupation-firm-year measure of wage for:
  - Highest-paid worker
  - Median worker
  - Workers at other percentiles
- $log(Size_{j,i,t})$: An occupation-firm-year measure of firm size
  - Firm payroll
  - Firm employment
- Year, 2-digit NAICS industry, and occupation fixed effects depending on specification

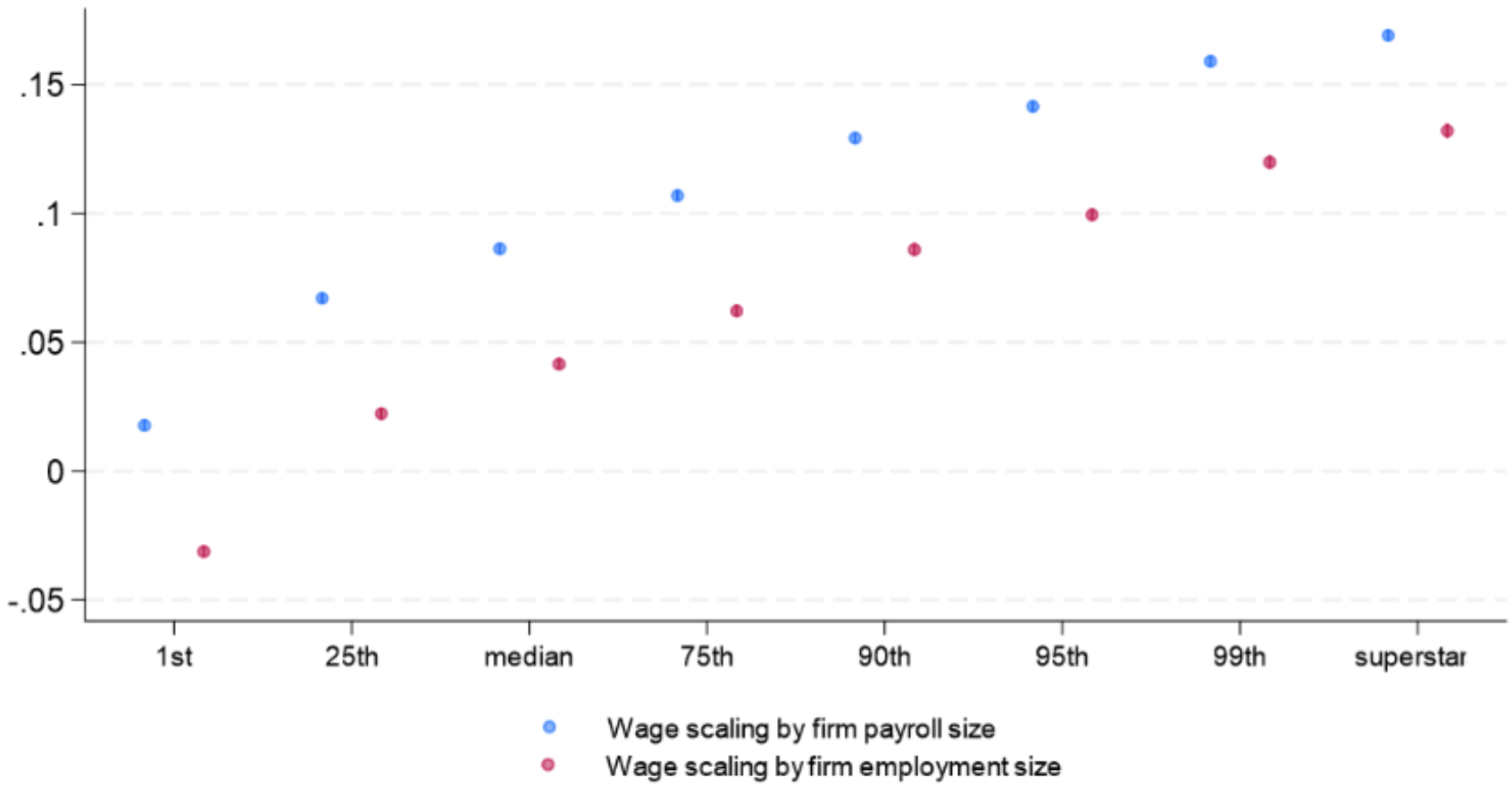
Baseline Results

- Positive scaling for all size measures
- Stronger scaling for highest-paid workers than median workers

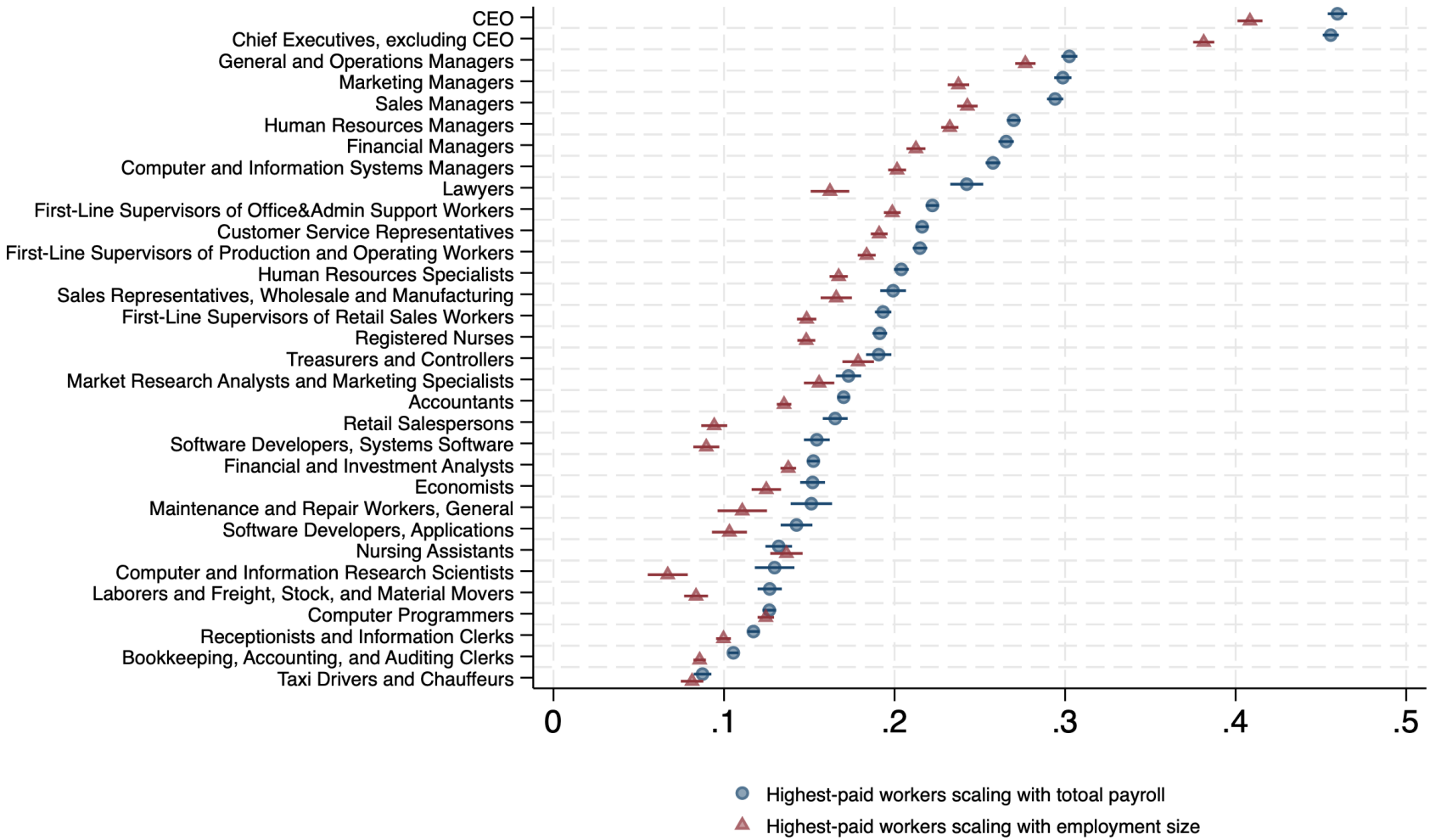
	(1)	(2)	(3)	(4)
	log(wages for highest-paid workers)		log(wages for median workers)	
Log of firm payroll size	0.169***		0.086***	
	(0.001)		(0.001)	
Log of firm employment size		0.132***		0.041***
		(0.001)		(0.001)
Observations	9,606,243	9,606,243	9,606,243	9,606,243
Adj.R^2	0.495	0.448	0.473	0.446
Year FE	Y	Y	Y	Y
2-digit NAICS FE	Y	Y	Y	Y
O*NET occupational FE	Y	Y	Y	Y

Baseline Results

Stronger positive scaling for workers at higher wage percentile in their firm-occupation

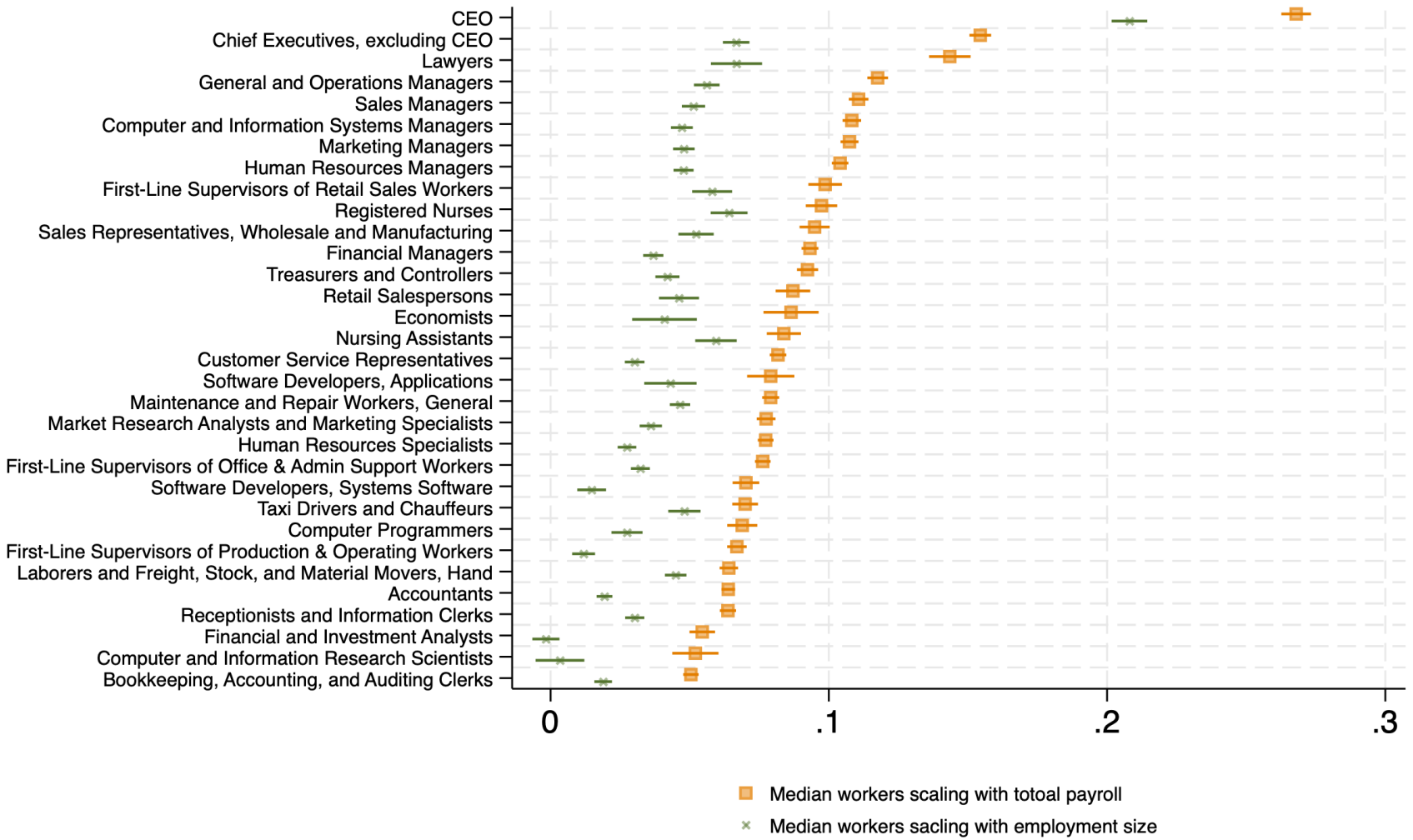


Scaling for Selected Occupations - Highest-paid workers



Horizontal lines indicate 95% confidence intervals

Scaling for Selected Occupations - Median workers



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What Characteristics Drive Scaling?

$$\log(Wage_{ijsmt}) = \alpha + \beta_0 \log(Size_{ismt}) + \eta OccChar_j + \beta_1 \log(Size_{ismt}) \times OccChar_j + \delta_t + \mu_s + \varepsilon_{ijsmt} \quad (5)$$

- *OccChar* is some characteristic of the occupation-firm-year
  - Belonging to a specific occupation
  - The IT exposure of the firm or industry
  - Occupational or job-level characteristics

We're primarily interested in β_1, which reports the effect of an occupational characteristic on scaling.

Scaling as a Function of Occupational Task Type

	(1)	(2)	(3)	(4)
***Panel A:* Log of Wages for highest-paid Workers**				
Log of firm size	0.174***	0.134***	0.220***	0.194***
	(0.001)	(0.001)	(0.001)	(0.001)
Log of firm size × Abstract task score		0.085***		
		(0.002)		
Log of firm size × Routine task score			-0.157***	
			(0.001)	
Log of firm size × Manual task score				-0.287***
				(0.004)
Observations	9,974,733	9,673,093	9,673,093	9,673,093
Adj.R^2	0.492	0.497	0.501	0.497
***Panel B:* Log of Wages for Median Workers**				
Log of firm size	0.086***	0.074***	0.102***	0.090***
	(0.001)	(0.001)	(0.001)	(0.001)
Log of firm size × Abstract task score		0.025***		
		(0.001)		
Log of firm size × Routine task score			-0.054***	
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Log of firm size × Manual task score				-0.053***
				(0.003)
Observations	9,974,733	9,673,093	9,673,093	9,673,093
Adj.R^2	0.474	0.476	0.477	0.476
Year FE	Y	Y	Y	Y
2-digit NAICS FE	Y	Y	Y	Y
O*NET occupational FE	Y	Y	Y	Y

Notes: "routine/manual/abstract" categorization of Autor and Handel (2013)

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Scaling and Firm IT

- Firms with intensive IT investments experience stronger scaling
- But only among workers at higher wage percentiles

Dependent variable is log of wages for:	(1) **Highest paid**	(2) 99th	(3) 95th	(4) 90th	(5) 75th	(6) **Median**	(7) 25th	(8) 1st
Log of firm size	0.172***	0.162***	0.144***	0.131***	0.108***	0.086***	0.067***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
IT investment (lagged)	-2.172***	-2.232***	-1.630***	-1.137***	-0.425	0.113	0.486*	1.244***
	(0.356)	(0.367)	(0.363)	(0.349)	(0.322)	(0.297)	(0.285)	(0.319)
Log of firm size×IT investment (lagged)	0.166***	0.171***	0.137***	0.108***	0.065***	0.033*	0.010	-0.035*
	(0.022)	(0.023)	(0.023)	(0.022)	(0.020)	(0.018)	(0.018)	(0.020)
Observations	7,986,870	7,986,870	7,986,870	7,986,870	7,986,870	7,986,870	7,986,870	7,986,870
Adj.R^2	0.501	0.499	0.498	0.502	0.511	0.512	0.473	0.435
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
2-Digit NAICS FE	Y	Y	Y	Y	Y	Y	Y	Y
6-Digit O*NET FE	Y	Y	Y	Y	Y	Y	Y	Y

"IT Workers" are any employee in the "Computer and Mathematical" family of occupations;

"IT Developers" are Computer Programmers, Software Developers, and Web Developers

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What Characteristics Drive Scaling?

For the remainder we focus on

- Wage = highest-paid wage in a given occupation-firm-year
- Size = Firm payroll

R&D and creative workers

- Occupations in the creative, science, and engineering fields do not see much difference in scaling with firm size

Dependent variable is the log of wages for highest-paid workers	(1)	(2)	(3)
Log of firm size	0.137***	0.138***	0.137***
	(0.001)	(0.001)	(0.001)
R&D workers	0.060**		
	(0.030)		
Log of firm size × R&D workers	0.003*		
	(0.002)		
Creative workers		-0.226***	
		(0.034)	
Log of firm size × Creative workers		0.001	
		(0.002)	
Creative workers			-0.151***
			(0.024)
Log of firm size × R&D or creative workers			0.008***
			(0.001)
Observations	9,974,736	9,974,736	9,974,736
Adj.R^2	0.121	0.122	0.120
Year FE	Y	Y	Y
2-digit NAICS FE	Y	Y	Y

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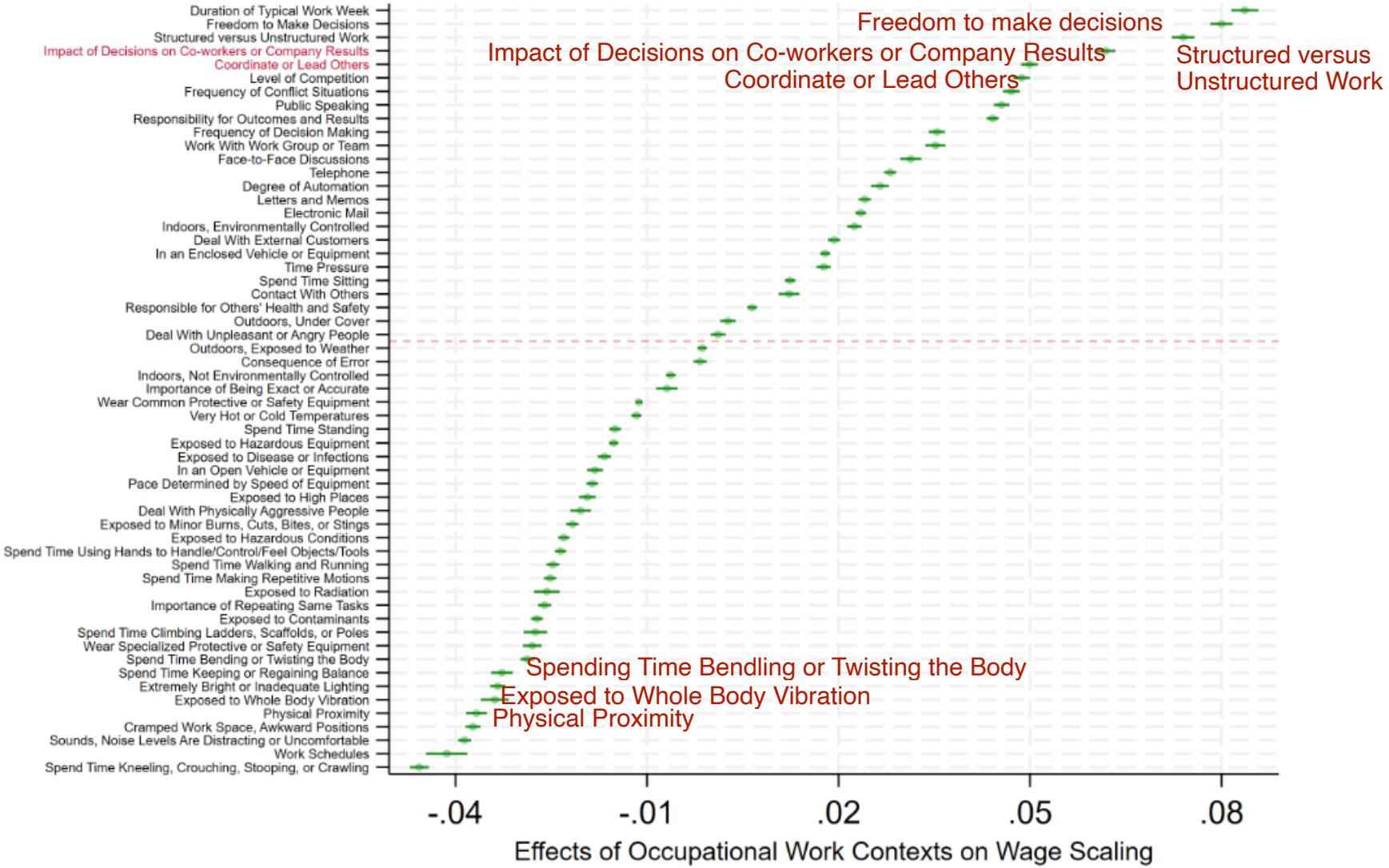
Scaling and O*NET Characteristics



Year and occupation fixed effects included.

Scaling, O*NET Characteristics, and IT

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Log of firm size	0.141***	0.216***	0.191***
	(0.001)	(0.001)	(0.001)
IT investment (lagged)	-4.620***	-6.484***	-7.197***
	(0.675)	(0.556)	(0.564)
Log of firm size×IT investment (lagged)	0.299***	0.466***	0.490***
	(0.042)	(0.035)	(0.035)
Log of firm size×Abstract task score	0.068***		
	(0.002)		
Abstract task score×IT investment (lagged)	-0.317		
	(0.778)		
Log of firm size×Abstract task score×IT investment (lagged)	**0.108****		
	(0.048)		
Log of firm size×Routine task score		-0.154***	
		(0.002)	
Routine task score×IT investment (lagged)		3.565***	
		(0.621)	
Log of firm size×Routine task score×IT investment (lagged)		**-0.235*****	
		(0.038)	
Log of firm size×Manual task score			-0.278***
			(0.004)
Manual task score×IT investment (lagged)			23.979***
			(2.220)
Log of firm size×Manual task score×IT investment (lagged)			**-1.233*****
			(0.136)
Observations	7,847,602	7,847,602	7,847,602
Adj.R^2	0.502	0.507	0.503
Year FE	Y	Y	Y
2-Digit NAICS FE	Y	Y	Y
6-Digit O*NET FE	Y	Y	Y

Year and occupation fixed effects included.

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			(0.136)
Observations	7,847,602	7,847,602	7,847,602
Adj.R^2	0.502	0.507	0.503
Year FE	Y	Y	Y
2-Digit NAICS FE	Y	Y	Y
6-Digit O*NET FE	Y	Y	Y

Year and occupation fixed effects included.

Robustness Checks

- Individual-level analysis
- Job feature- extract scores from text descriptions for 6,494 jobs
- Wage scaling with establishment size, with additional controls for local market (commuting zone)

Robustness 1: Individual-level Results

	(1)	(2)	(3)
log of wages for each worker	with Individual FE		
Log of firm size	0.028***	0.039***	0.034***
	(0.004)	(0.002)	(0.003)
Log firm size×Abstract task score	0.026**		
	(0.010)		
Log firm size×Routine task score		−0.022***	
		(0.003)	
Log firm size×Manual task score			0.001
			(0.009)
Num. obs.	169,365,043	169,365,043	169,365,043
Adj. R^2	0.630	0.630	0.630
O*NET FE:	Y	Y	Y
2-digit NAICS FE:	Y	Y	Y
Year FE:	Y	Y	Y
Individual FE:	Y	Y	Y

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			(0.009)
Num. obs.	169,365,043	169,365,043	169,365,043
Adj. R^2	0.630	0.630	0.630
O*NET FE:	Y	Y	Y
2-digit NAICS FE:	Y	Y	Y
Year FE:	Y	Y	Y
Individual FE:	Y	Y	Y

Robustness 2: Job-level Features

- Extract job features from 6,949 distinct job titles and text descriptions
- Example prompt: To what extent are the negative consequences if someone makes a mistake in this job? (Answer 1-10)

Conclusion

1. Most occupations, not just CEOs, scale with firm size
   - Significant heterogeneity in scalability
2. Stronger scaling:
   - Leadership and decision making occupations
   - Abstract task occupations
   - Top percentile workers in a firm-occupation
3. Weaker scaling:
   - Routine task occupations
   - Manual task occupations
   - Low-percentile workers
4. Little or no effects:
   - R&D workers
   - Creative workers

Conclusion

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   - R&D workers
   - Creative workers
5. IT increase scaling directly and amplifies the above

Interpretation:

Informational Economies of Scale are associated with wage scaling. O-ring complementarity appears to be less important