Urban-Biased Growth

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DISCLAIMER:

“Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed.”

Motivation

- Spatial wage gaps tended to close in the US economy
  - “Convergence” by Barro and Sala-i-Martin (1992)
- Since 1980: large US cities saw fastest wage growth, leading to
    - More exclusive economic growth
    - Pressure on urban real estate markets
    - Political polarization
- This paper offers an empirical and theoretical explanation

UBG = Urban-Biased Growth

Part I: UBG in the Data

UBG in the Data

- Wages are higher in large cities — the “urban wage premium”
- Classic urban wage premium regression:

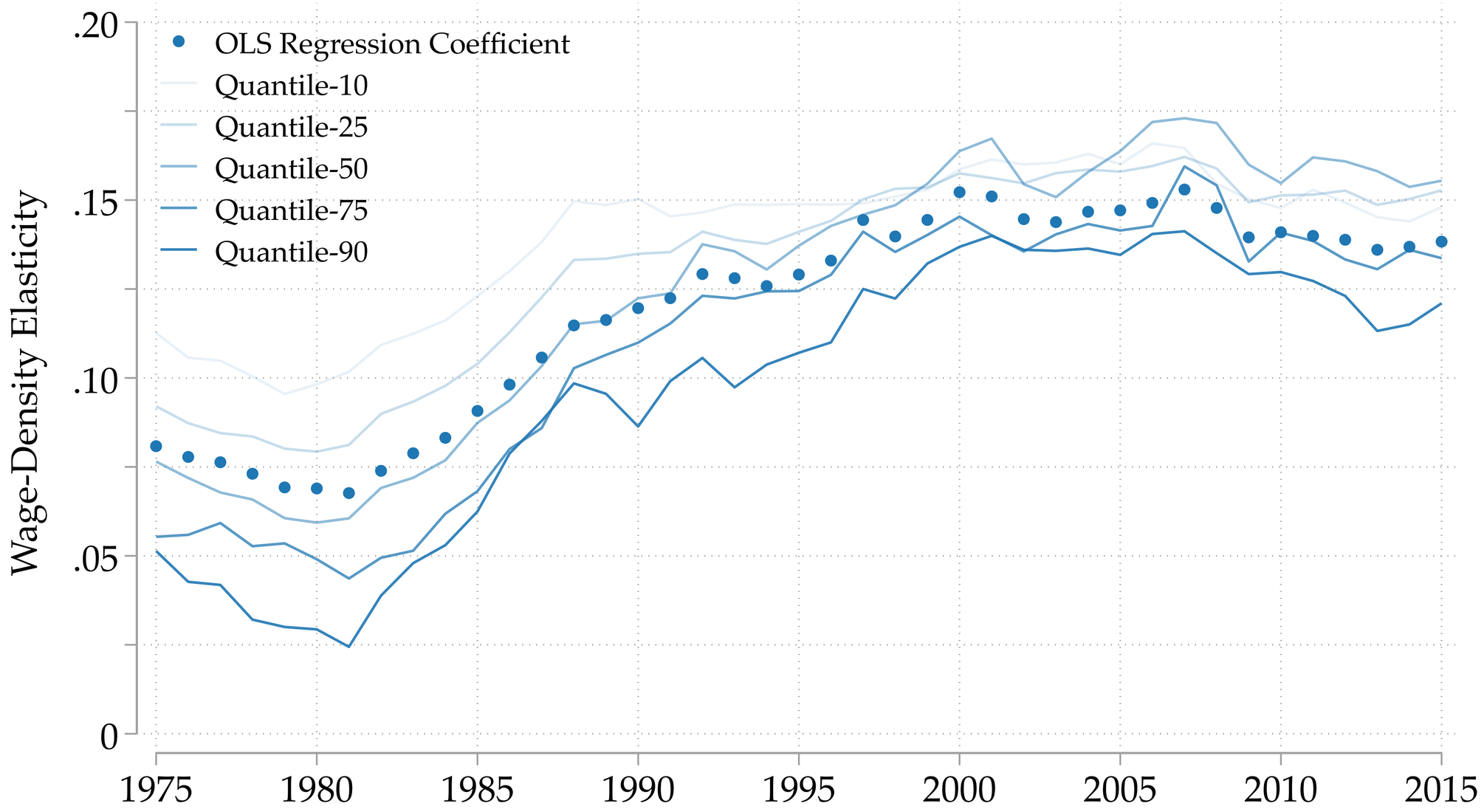
$$\log w_r = \alpha + \beta \log \textbf{PopDensity}_r + \epsilon_r$$

UBG in the Data

- Wages are higher in large cities — the “urban wage premium”
- Classic urban wage premium regression:

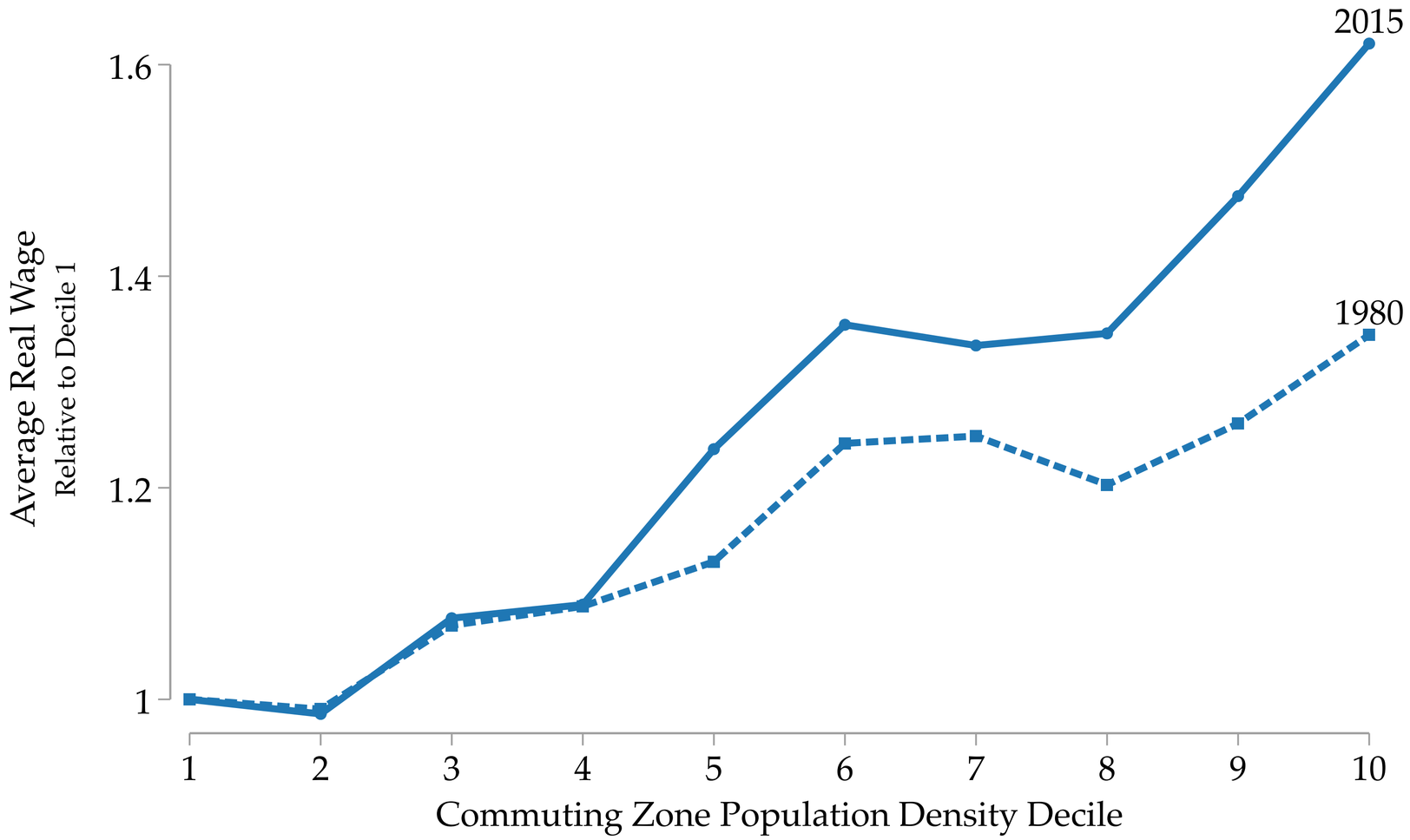
$$\log w_{rt} = \alpha + \delta_t + \beta_t \log \textbf{PopDensity}_{rt} + \epsilon_{rt}$$

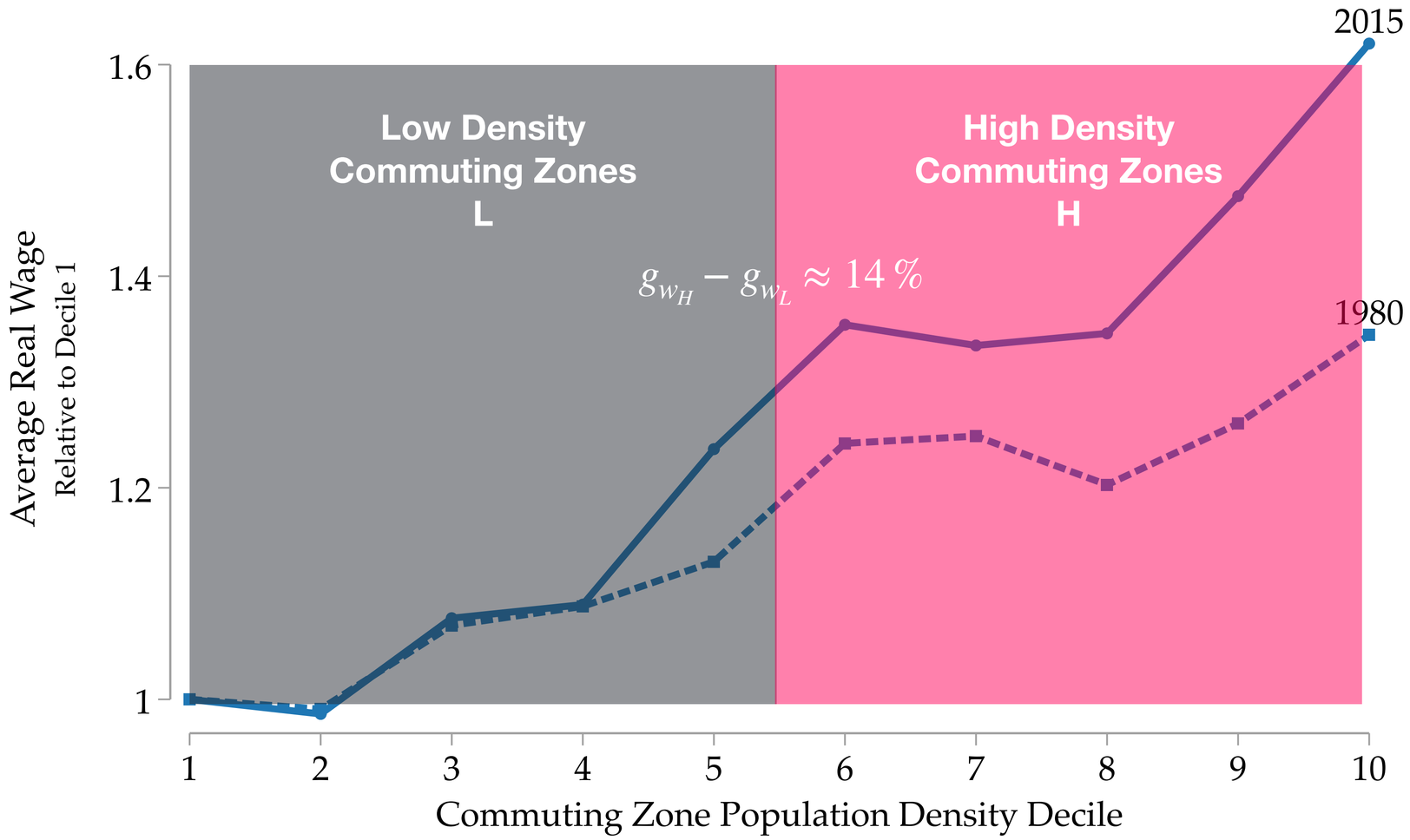
- Compute yearly wage-density elasticity β_t for 1975 to 2015
  - Across US Commuting Zones (CZs)
    - LHS: total annual payroll per worker
    - RHS: 1980 CZ population divided by area


.20
.15
.10
.05
0
Wage-Density Elasticity
OLS Regression Coefficient
Quantile-10
Quantile-25
Quantile-50
Quantile-75
Quantile-90
1975
1980
1985
1990
1995
2000
2005
2010
2015

Urban-Biased Growth

- The wage-density elasticity doubled between 1980 and 2015
- Fact is robust across…
  - *Data sets*: QCEW, LBD, CBP, IRS, US Decennial Census
  - *Density Definitions*: time-varying, employment-weighted, …
  - *Countries*: document similar doubling in European data
  - *Geographies*: counties


2015
1980
1.6
1.4
1.2
1
Average Real Wage
Relative to Decile 1
1
2
3
4
5
6
7
8
9
10
Commuting Zone Population Density Decile


2015
1980
1.6
1.4
1.2
1
Low Density
Commuting Zones
L
High Density
Commuting Zones
H
$g_{w_H} - g_{w_L} \approx 14\,\%$
Average Real Wage
Relative to Decile 1
1
2
3
4
5
6
7
8
9
10
Commuting Zone Population Density Decile

The Role of Sectors

- Wage changes in location r:

$$\Delta w_r = w'_r - w_r = \sum_s \mu'_{r,s} w'_{r,s} - \sum_s \mu_{r,s} w_{r,s} = \sum_s \left(\mu'_{r,s} w'_{r,s} - \mu_{r,s} w_{r,s} \right) \equiv \sum_s \delta_{r,s}$$

  - where s is sector, r is region, $\mu_{r,s}$ is employment share, $w_{r,s}$ is wage

The Role of Sectors

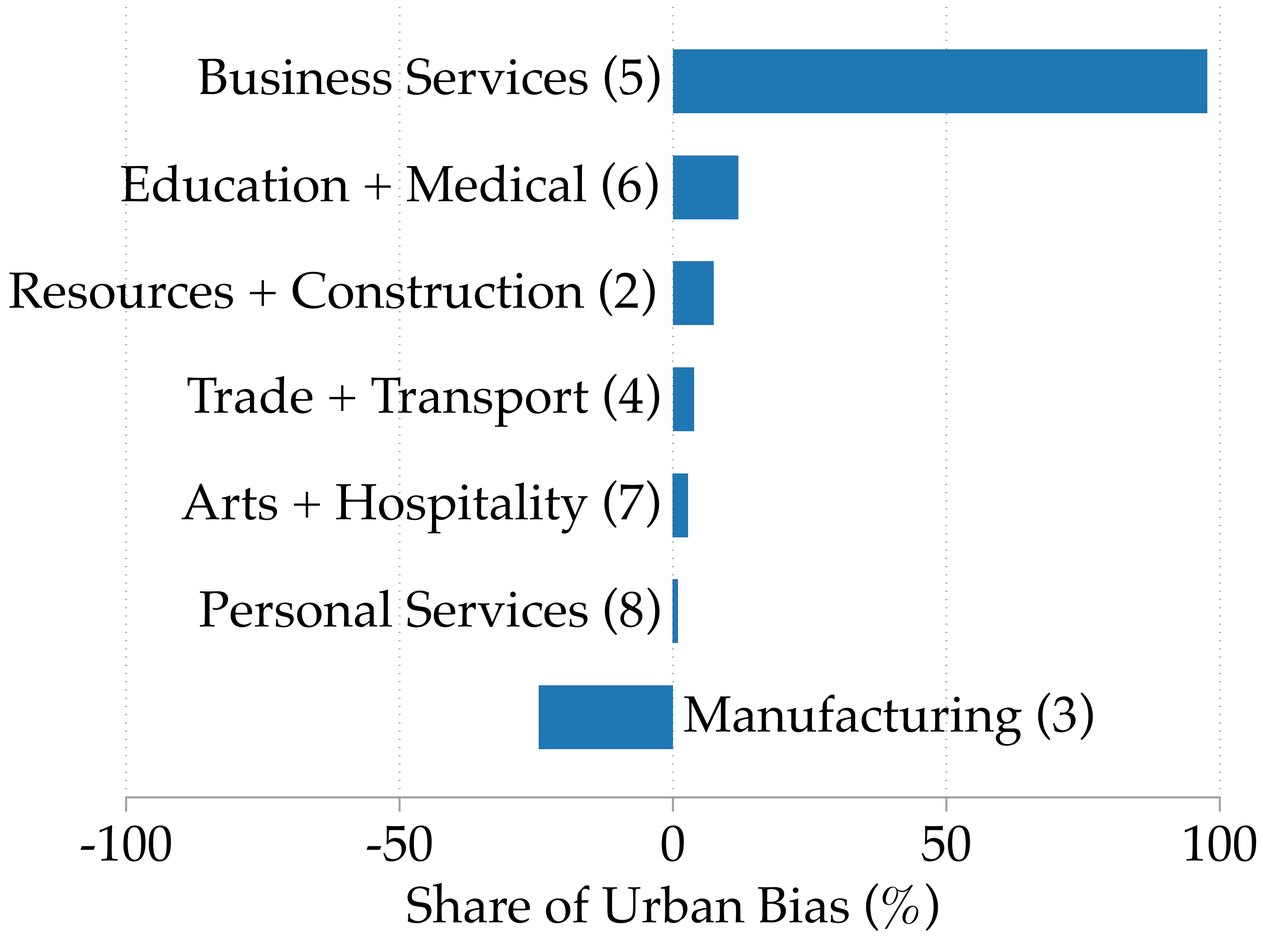
- Wage changes in location r:

$$\Delta w_r = w'_r - w_r = \sum_s \mu'_{r,s} w'_{r,s} - \sum_s \mu_{r,s} w_{r,s} = \sum_s \left(\mu'_{r,s} w'_{r,s} - \mu_{r,s} w_{r,s} \right) \equiv \sum_s \delta_{r,s}$$

  - where s is sector, r is region, $\mu_{r,s}$ is employment share, $w_{r,s}$ is wage

- Then consider wage growth difference across groups:

$$\Delta w_H - \Delta w_L = \sum_s \left(\delta_{H,s} - \delta_{L,s} \right); \qquad \phi_s \equiv \frac{\delta_{H,s} - \delta_{L,s}}{\Delta w_H - \Delta w_L}$$


Business Services (5)
Education + Medical (6)
Resources + Construction (2)
Trade + Transport (4)
Arts + Hospitality (7)
Personal Services (8)
Manufacturing (3)
-100
-50
0
50
100
Share of Urban Bias (%)

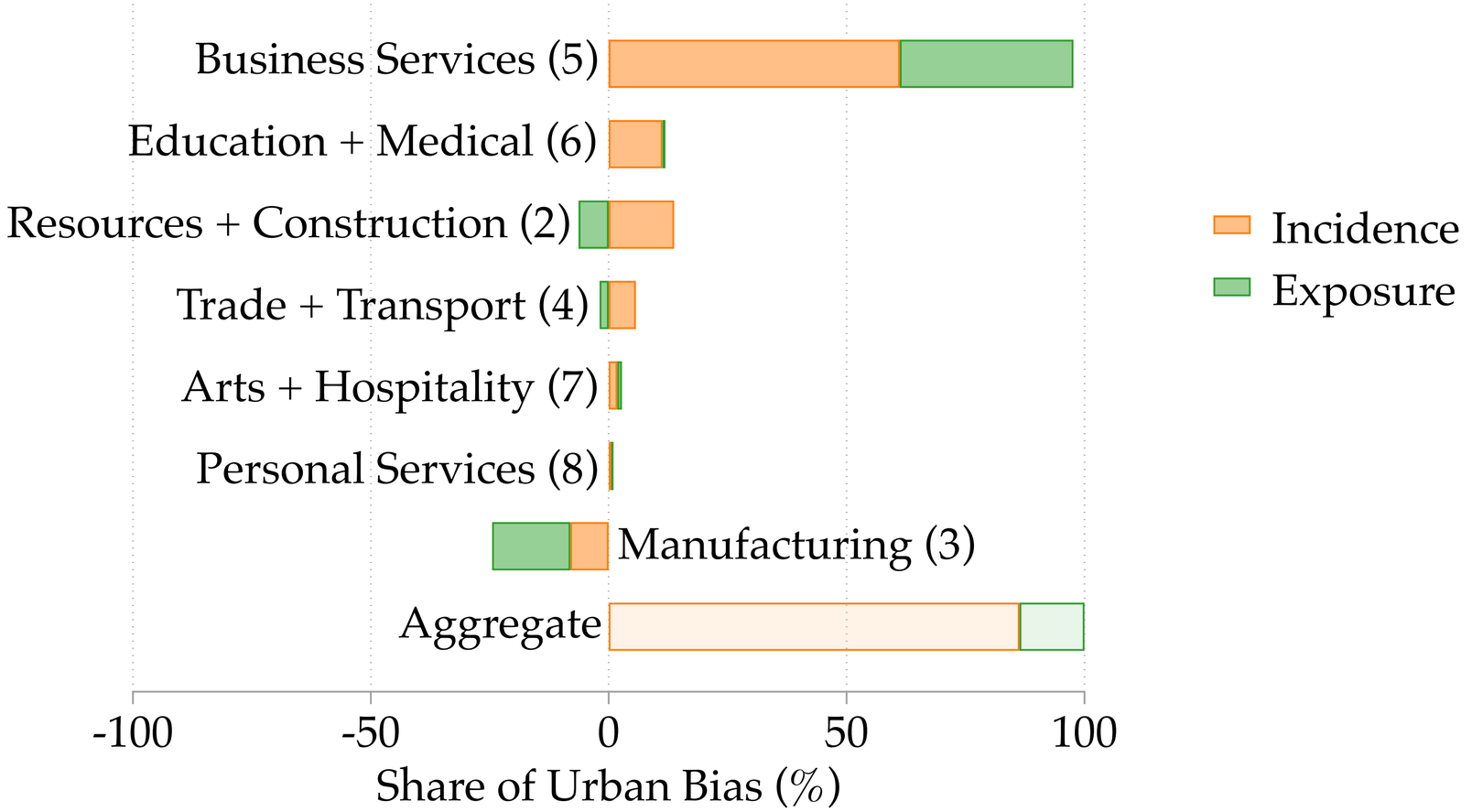
Exposure vs Incidence

- Business Services account for a large share of big-city employment
  - Aggregate Business Services growth hence benefits big cities more

- Decompose location r's wage growth

$$\delta_{r,s} = \mu_{r,s}\Delta\bar{w}_s + w_{r,s}\Delta\bar{\mu}_s + \xi_{r,s} \qquad \phi_s \equiv \frac{\delta_{H,s} - \delta_{L,s}}{\Delta w_H - \Delta w_L}$$

- Exposure Differences
  - What fraction of UBG is due to differences in exposure?
  - Label the residual term $\xi_{r,s}$ "Incidence"


Business Services (5)
Education + Medical (6)
Resources + Construction (2)
Trade + Transport (4)
Arts + Hospitality (7)
Personal Services (8)
Manufacturing (3)
Aggregate
-100
-50
0
50
100
Share of Urban Bias (%)
Incidence
Exposure

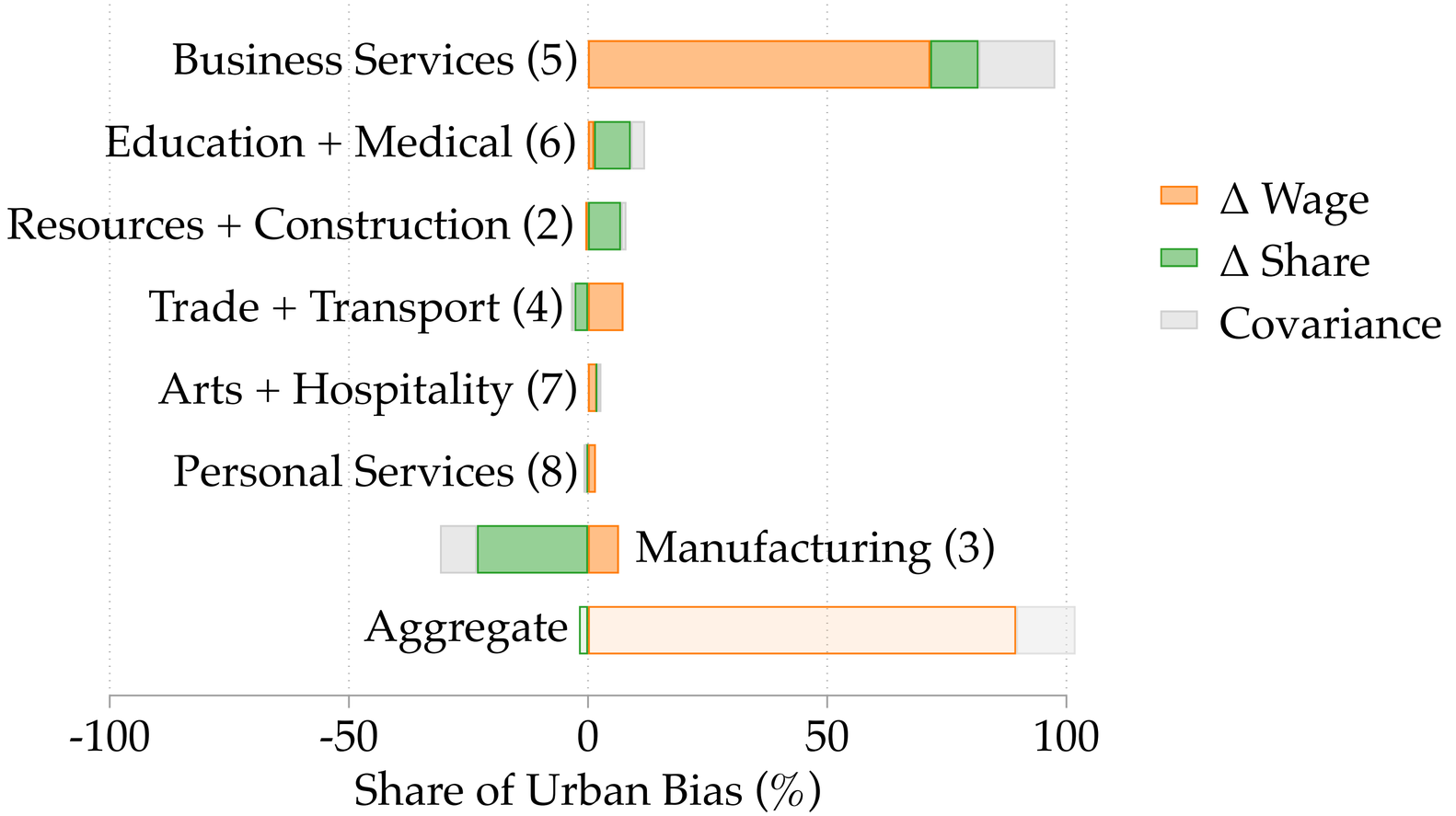
Wage Growth vs Sectoral Change

- Business Services employment has become more important in big cities
  - Is the average wage growth difference due to compositional changes?

- Decompose location r's wage growth

$$\delta_{r,s} = w_{r,s}\Delta\mu_{r,s} + \mu_{r,s}\Delta w_{r,s} + \Delta\mu_{r,s}\Delta w_{r,s} \qquad \phi_s \equiv \frac{\delta_{H,s} - \delta_{L,s}}{\Delta w_H - \Delta w_L}$$

- Changes in Cities' Industrial Structure
  - What fraction of UBG is due to differences in sectoral change?


Business Services (5)
Education + Medical (6)
Resources + Construction (2)
Trade + Transport (4)
Arts + Hospitality (7)
Personal Services (8)
Manufacturing (3)
Aggregate
-100
-50
0
50
100
Share of Urban Bias (%)
Δ Wage
Δ Share
Covariance

Education Deepening

- Big cities have seen large inflows of educated workers since 1980
  - Business Services wage growth = education deepening?

- Decompose location r's wage growth

$$\delta_{r,s} = \mu'_{r,s}(w^C_{r,s} - w^N_{r,s})\Delta\mu^C_{r,s} + \zeta_{r,s} \qquad \phi_s \equiv \frac{\delta_{H,s} - \delta_{L,s}}{\Delta w_H - \Delta w_L}$$

- Education Deepening
  - How much UBG comes from increases in college share of employment?

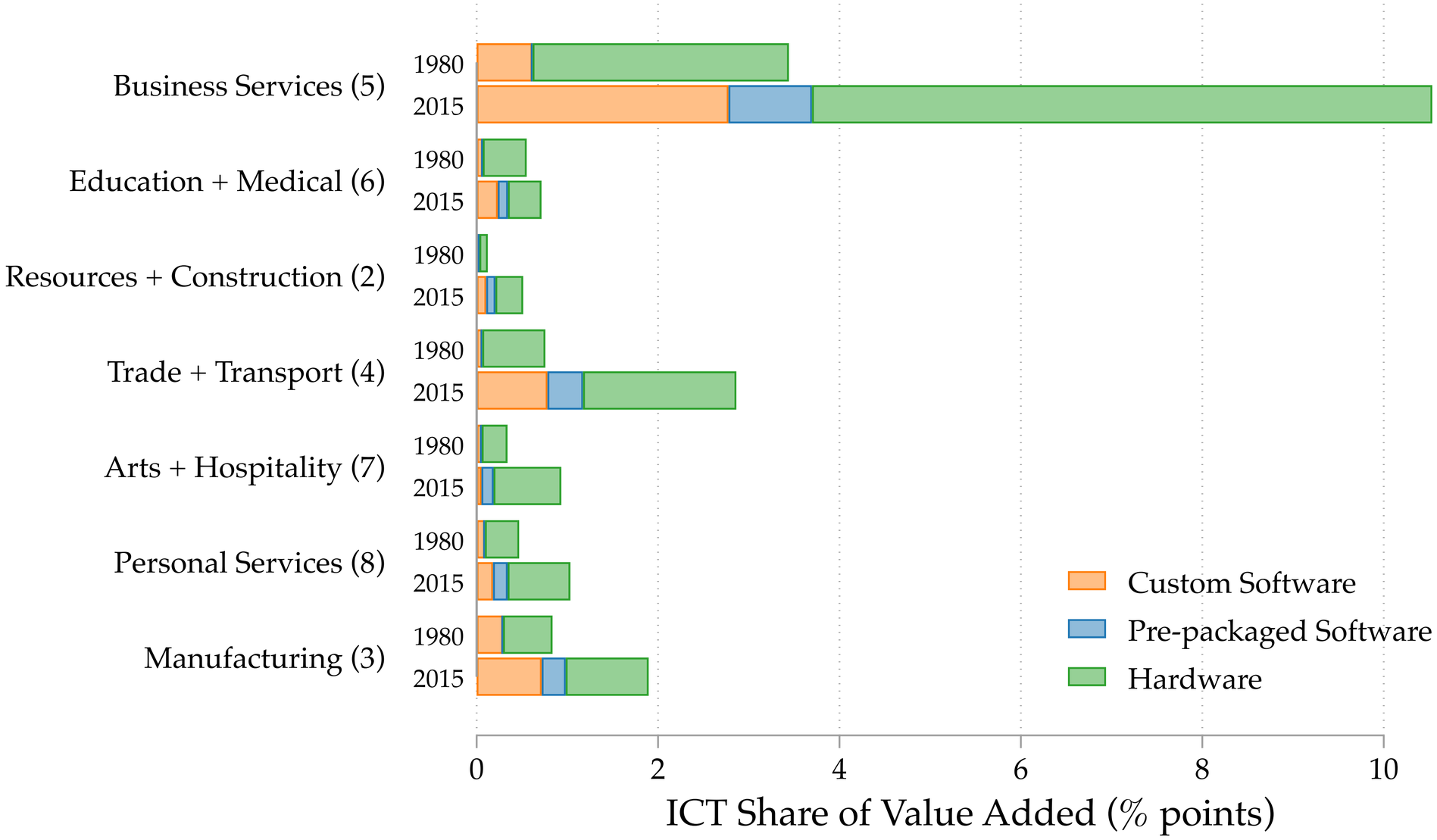
	Share of Urban-Biased Growth				
	Education		Occupation		
Sector	Deepening	Residual	Deepening	Residual	Total
Resources + Construction (2)	0.5	11.3	-0.2	12.0	11.8
Manufacturing (3)	4.2	-32.5	2.3	-30.5	-28.2
Trade + Transport (4)	3.4	-9.6	0.4	-6.5	-6.1
Business Services (5)	18.9	76.6	13.2	82.3	95.5
Education + Medical (6)	3.9	15.4	0.4	19.0	19.4
Arts + Hospitality (7)	1.4	3.5	-0.0	4.9	4.9
Personal Services (8)	0.5	2.2	0.2	2.5	2.7
Total	33.0	67.0	16.3	83.7	100.0

Note this table uses US Census data. The QCEW data does not have demographic information.

	Growth in Average Commuting Zone Wage between 1980 and 2015			
	Business Services		All Other Sectors	
Education Group	College	Non-College	College	Non-College
Commuting Zone Population Density (1980, Logs)	0.0653***	0.0195*	0.00321	-0.0193*
	(0.00992)	(0.00769)	(0.00424)	(0.00853)
adj. R^2	0.312	0.053	0.002	0.069
Occupation Group	CNR	Non-CNR	CNR	Non-CNR
Commuting Zone Population Density (1980, Logs)	0.0556***	0.0903***	0.00924*	-0.00705
	(0.00843)	(0.00930)	(0.00446)	(0.00934)
adj. R^2	0.283	0.460	0.023	0.007
N	722	722	722	722

Taking Stock

- UBG is…
  - Mainly occurring in Business Services
  - Mainly due to local changes instead of aggregate changes+exposure
  - Driven by faster wage not employment growth in big cities
  - Strong across all Business Services workers; only some skill-bias
- Our interpretation:
  - A skill- and urban-biased labor demand shock in Business Services


Business Services (5)
Education + Medical (6)
Resources + Construction (2)
Trade + Transport (4)
Arts + Hospitality (7)
Personal Services (8)
Manufacturing (3)
1980
2015
Custom Software
Pre-packaged Software
Hardware
0
2
4
6
8
10
ICT Share of Value Added (% points)

	(1)	(2)	(3)	(4)	(5)	(6)
	ICT/Employee (x $1,000)					
Log(Density)	0.469***	0.155***			0.00140	0.101*
	(0.0299)	(0.0224)			(0.0520)	(0.0442)
Log(Employees)			0.352***	0.181***	-0.170**	0.167***
			(0.0158)	(0.0132)	(0.0607)	(0.0450)
Log(Employees) x Log(Density)					0.0889***	0.00201
					(0.0115)	(0.00848)
Business Services Emp. Share		-0.741		0.568**		1.696*
		(0.539)		(0.211)		(0.764)
x Log(Density)		0.651***				-0.182
		(0.0943)				(0.140)
x Log(Employees)				0.539***		-0.456*
				(0.0452)		(0.198)
x Log(Employees) x Log(Density)						0.163***
						(0.0346)

Capital-Skill Complementarity in Space

- Discrete regions r. Homogeneous Good. Free Trade. Representative firm in each location.

- Neoclassical CRS technology with capital-skill complementarity

$$y = F_r(K, L) \quad \textbf{with} \quad \sigma_r \equiv \frac{d \log K/L}{d \log \frac{\partial F_r}{\partial L} / \frac{\partial F_r}{\partial K}} < 1$$

- As price of ICT capital — p — declines:

$$\frac{d \log w_r}{d \log p} = -\frac{\Theta_r}{1 - \Theta_r} < 0 \quad \textbf{but, in the cross-section} \quad \frac{d \log \frac{\Theta_r}{1 - \Theta_r}}{d \log w_r} = \sigma_r - 1$$

The Neoclassical Channel

- Capital and labor are complements, i.e., $\sigma_r < 1$
  - Capital cost share (Θ_r) high where labor is cheap
  - Capital price decline lowers cost most where Θ_r is highest
  - Labor demand rises fastest where cost is reduced most

- Missing: Large firms use ICT most intensively and tend to be in big cities

	(1)	(2)	(3)	(4)	(5)	(6)
	ICT/Employee (x $1,000)					
Log(Density)	0.469***	0.155***			0.00140	0.101*
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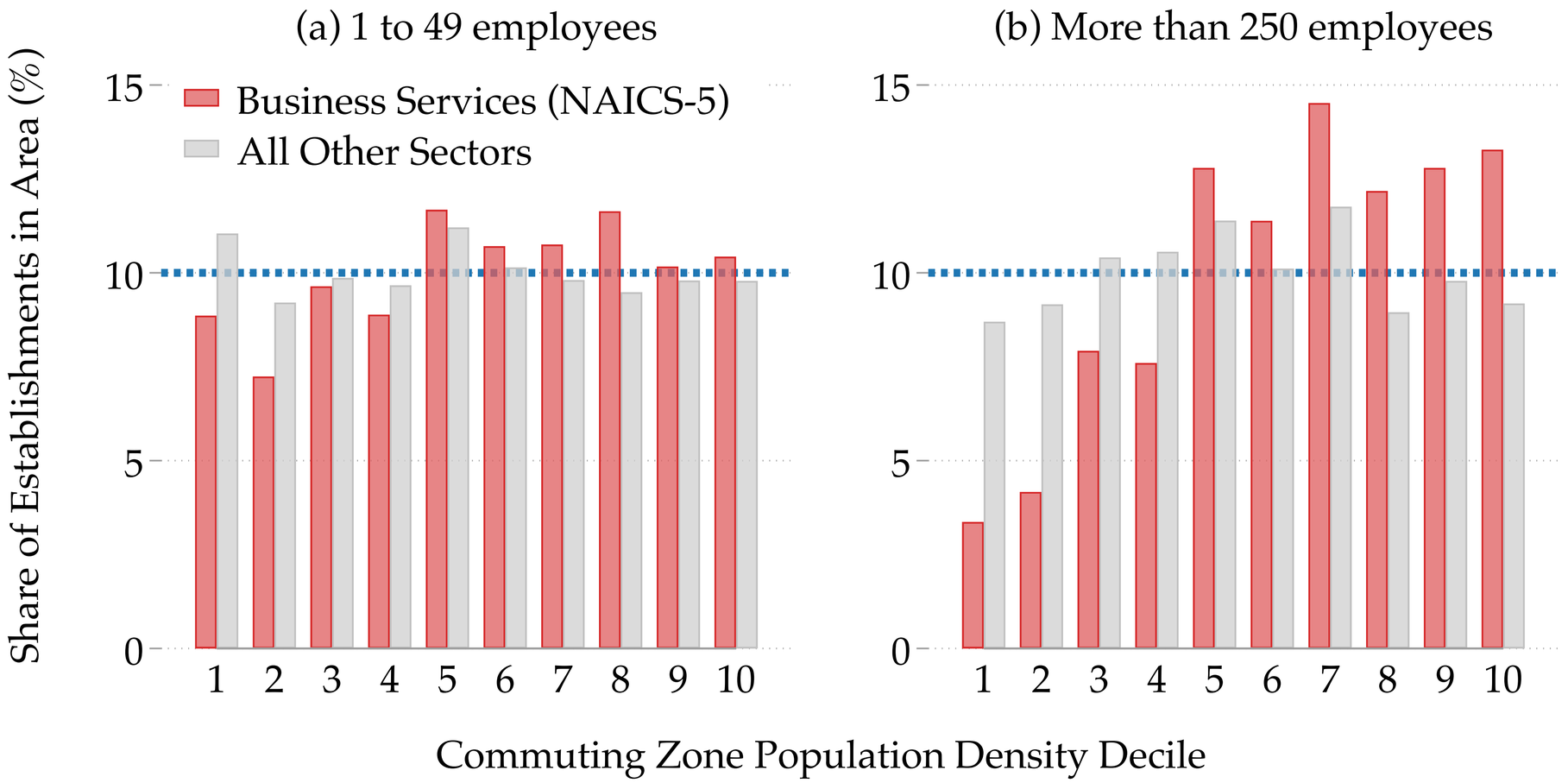
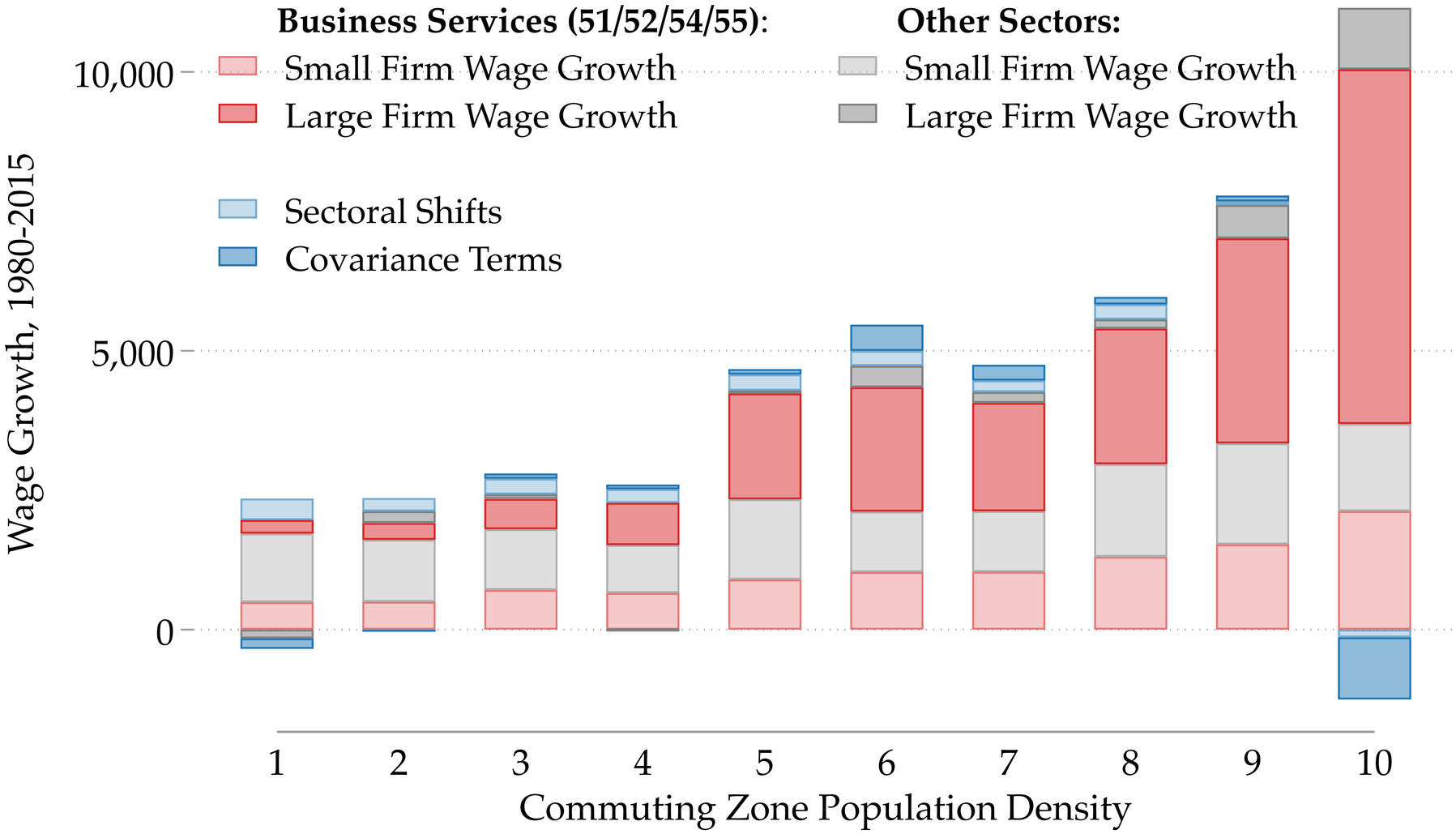
						(0.0346)


(a) 1 to 49 employees
(b) More than 250 employees
Business Services (NAICS-5)
All Other Sectors
Share of Establishments in Area (%)
15
10
5
0
1
2
3
4
5
6
7
8
9
10
Commuting Zone Population Density Decile


Business Services (51/52/54/55):
Small Firm Wage Growth
Large Firm Wage Growth
Other Sectors:
Small Firm Wage Growth
Large Firm Wage Growth
Sectoral Shifts
Covariance Terms
10,000
5,000
0
Wage Growth, 1980-2015
1
2
3
4
5
6
7
8
9
10
Commuting Zone Population Density

Part II: Theory

Setup

- Discrete regions r differ in amenities (A_r) and productivities (Z_r)
- Homogeneous workers; a single final good
- Final good combines intermediate input varieties
  - Produced by firms
  - Production function that allows capital-scale complementarity
- Result: If neoclassical channel < novel scale channel get UBG

Representative Firms

- A representative final good firm CES-combines intermediate inputs
  - Revenue of intermediate input producer: $r(y) = \mathscr{D} y^{\zeta}$
    - $\mathscr{D}$: aggregate demand shifter; $\zeta \in (0,1)$ elasticity of subs.
- A representative capital firm transforms final good into capital at rate $\mathscr{Z}$
- Final good serves as the numeraire
  - Price of a unit of capital is simply $p = 1/\mathscr{Z}$

Intermediate Input Firms

- Intermediate input firms operate a non-homothetic CES technology:

$$\left(\frac{l}{y}\right)^{\frac{\sigma-1}{\sigma}} + \left(\frac{k}{y^{1+\epsilon}}\right)^{\frac{\sigma-1}{\sigma}} = Z_r^{\frac{1-\sigma}{\sigma}}$$

- Where
  - l, k are a firm's demand for labor and capital
  - y is a firm's total output, or its "scale"
  - σ indexed the elasticity of substitution of capital and labor
  - ϵ is the "scale elasticity"

Assumption

- The marginal rate of substitution between capital and labor:

$$\frac{\partial y/\partial l}{\partial y/\partial k} = (\frac{k}{l})^{\frac{1}{\sigma}} \; y^{-\frac{1-\sigma}{\sigma}\epsilon}$$

- For $\epsilon > 0$, large firms produce more capital-intensively than small firms

- We assume such a capital scale-complementarity:
  - **Assumption**: *Capital and labor are complements and this complementarity is increasing in firm scale, i.e.,* $\sigma < 1$ *and* $\epsilon > 0$

Firm Supply and Labor Supply

- Firm Supply: Firms pay a labor-denominated fixed cost $\mathscr{E}$ to enter
  - The free entry condition:

$$\mathscr{E} w_r = \pi^\star(Z_r, w_r, p, \mathscr{D}) = \max_y \left[\mathscr{D} y^\zeta - c(y; Z_r, w_r, p)\right]$$

- Labor Supply: Workers spend α on local housing, remainder on final good.
  - Utility maximization implies the following labor supply function:

$$L_r = A_r^{1/\alpha} w_r^{\frac{1-\alpha}{\alpha}} \mathscr{G} \quad \textbf{where} \quad \mathscr{G} \equiv \left(\sum_r A_r^{1/\alpha} w_r^{\frac{1-\alpha}{\alpha}}\right)^{-1}$$

  - Where A_r is a local labor supply shifter ("amenity")

Cross-Sectional Implications

- **Proposition:** In general equilibrium, in the cross-section of locations, (i) wages, w_r, and (ii) firm scale, y, are increasing in location productivity, Z_r. If $\epsilon > \zeta$, then (iii) capital cost shares, Θ_r, are also increasing in Z_r.

- Intuition for results (i) and (ii) comes directly from free-entry condition:

$$\mathscr{E} w_r = \pi^\star(Z_r, w_r, p, \mathscr{D})$$

  - More productive firms pay higher wages, else free-entry violated
  - More productive firms have lower marginal cost, else they would not pay higher wages. As a result they operate at larger scale.

Intuition for Result (iii)

- An important implication of our theory:

$$\frac{\Theta_r(y)}{1-\Theta_r(y)} = \left(\frac{p}{w_r}\right)^{1-\sigma} y^{\epsilon(1-\sigma)}$$

  - Where Θ_r are firm-level capital cost shares

- Two Channels:
  - Neoclassical (ζ): productive locations, higher wages, *lower* cost shares
  - Scale (ϵ): productive locations, bigger firms, *higher* cost shares

Price Change

- The effect of a decline in the price of ICT:

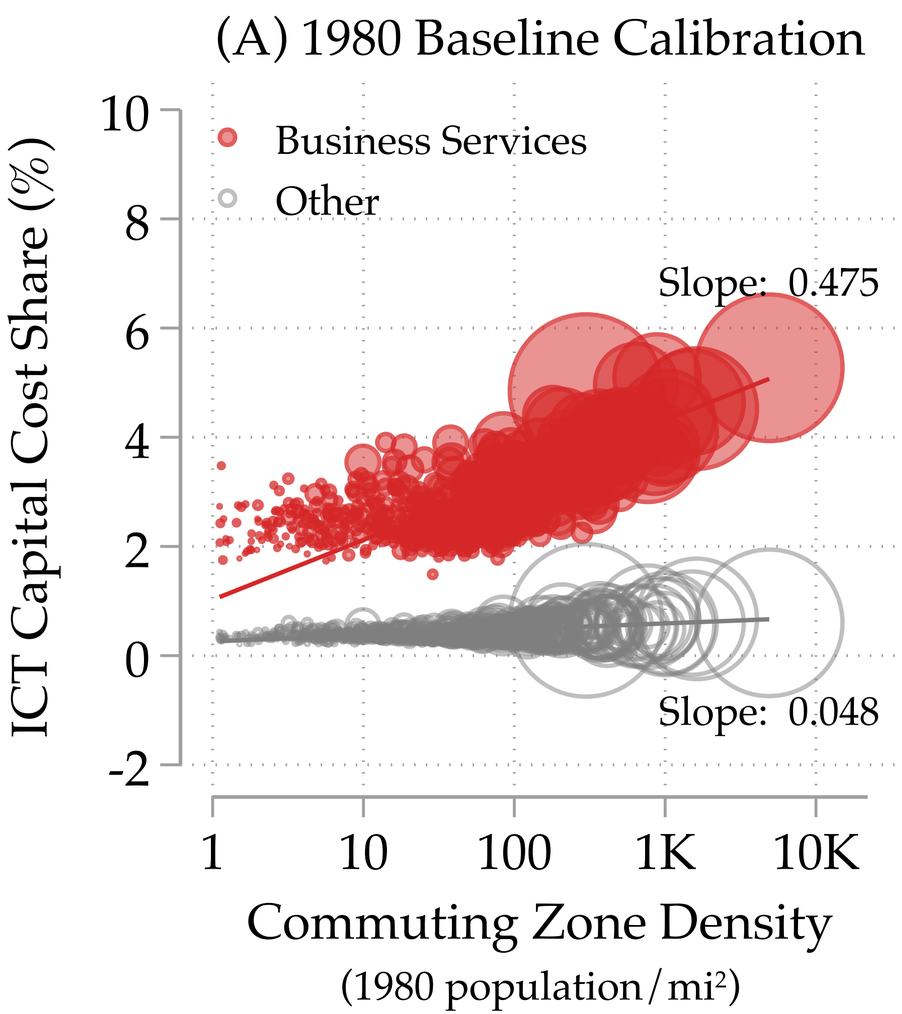
$$\frac{d \log w_r}{d \log p} = - \frac{\zeta}{1 + \Theta_r(\epsilon - \zeta)} \left(\Theta_r - (1 + \Theta_r \epsilon) \frac{d \log \mathscr{D}}{d \log p} \right) < 0$$

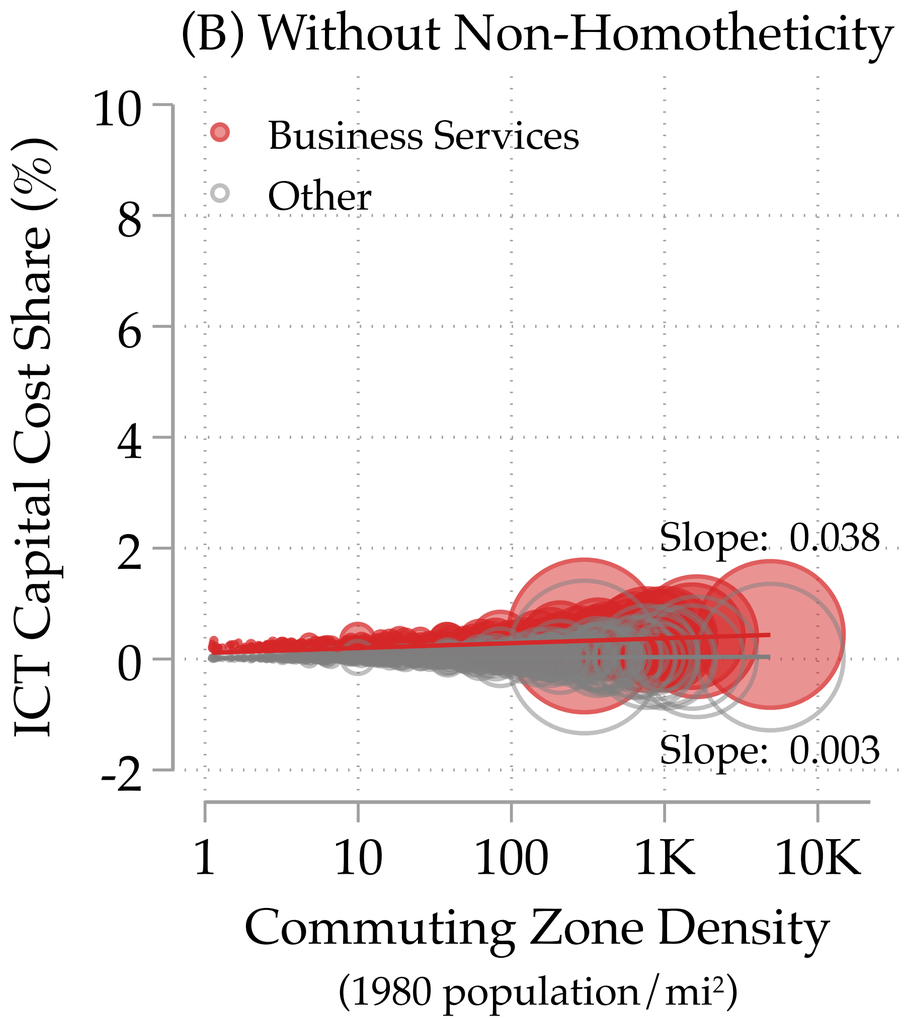
- A *decline* in the price of ICT raises wages and demand everywhere
- It raises wages *more* in locations with a *higher* capital cost share
  - Intuition: decline in prices leads to larger cost savings in these places
  - Larger cost savings lead to demand expansion, and more labor demand

Part III: Quantification

Quantitative Model Overview

- **Additions to framework**:
  - Two sectors that differ in productivity of ICT capital and labor
  - High- and low-skill labor in production of intermediate input
  - Preference shocks of workers for location and sectors
- **Calibrate** model to 1980 data: cross-section of 722 commuting zones
  - Infer productivities & amenities as “structural residuals”
    - Match data on wages+employment by location, sector, education
      - Wage-Density gradient in 1980 matched exactly by construction


(A) 1980 Baseline Calibration
ICT Capital Cost Share (%)
10
8
6
4
2
0
-2
Business Services
Other
Slope: 0.475
Slope: 0.048
1
10
100
1K
10K
Commuting Zone Density
(1980 population / mi²)


(B) Without Non-Homotheticity
ICT Capital Cost Share (%)
10
8
6
4
2
0
-2
Business Services
Other
Slope: 0.038
Slope: 0.003
1
10
100
1K
10K
Commuting Zone Density
(1980 population / mi²)

Calibrating Elasticities

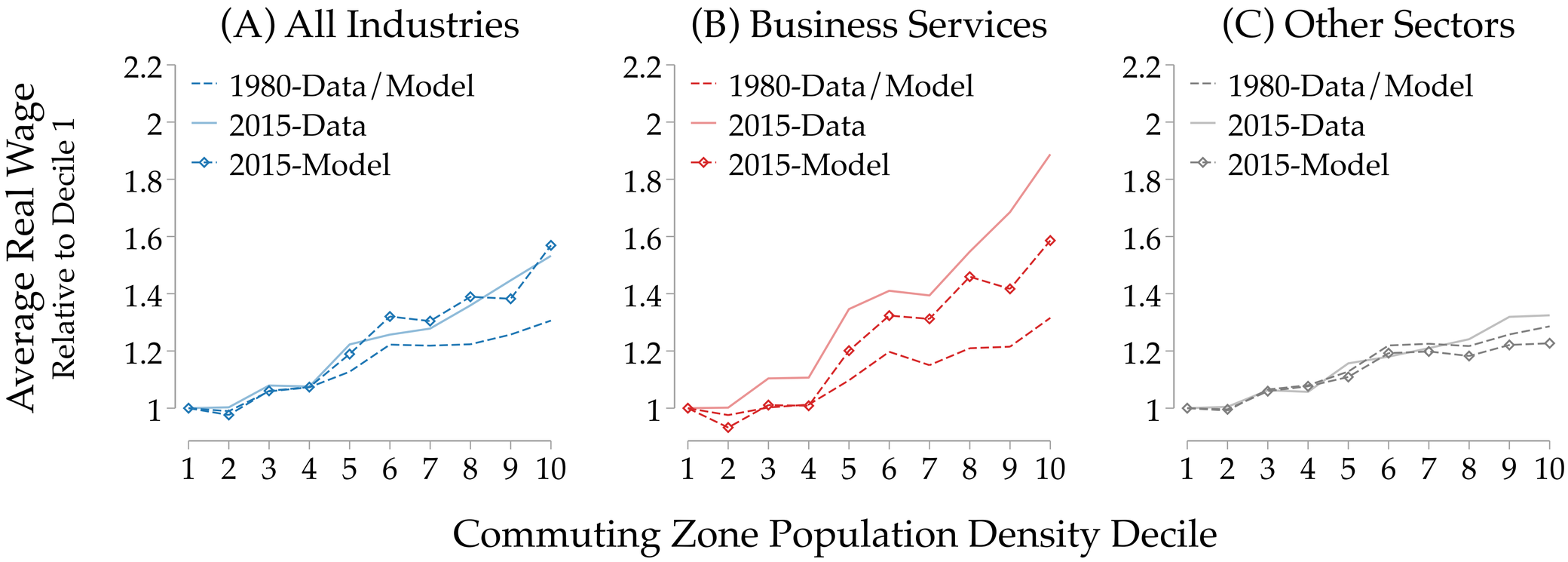
- Scale Elasticities: If $\epsilon = 0$, ICT cost shares same for differently-sized firms
  - Choose to match gradient of ICT/worker across firms of different size
- Substitution Elasticities: match two "macro substitution elasticities"

$$\tilde{\kappa} \equiv \frac{d \log(\bar{w}^H / \bar{w}^L)}{d \log(\bar{L}^H / \bar{L}^L)} \quad \textbf{and} \quad \tilde{\sigma} \equiv \frac{d \log(\bar{w}^H / p)}{d \log(\bar{L}^H / \bar{L}^L)}$$

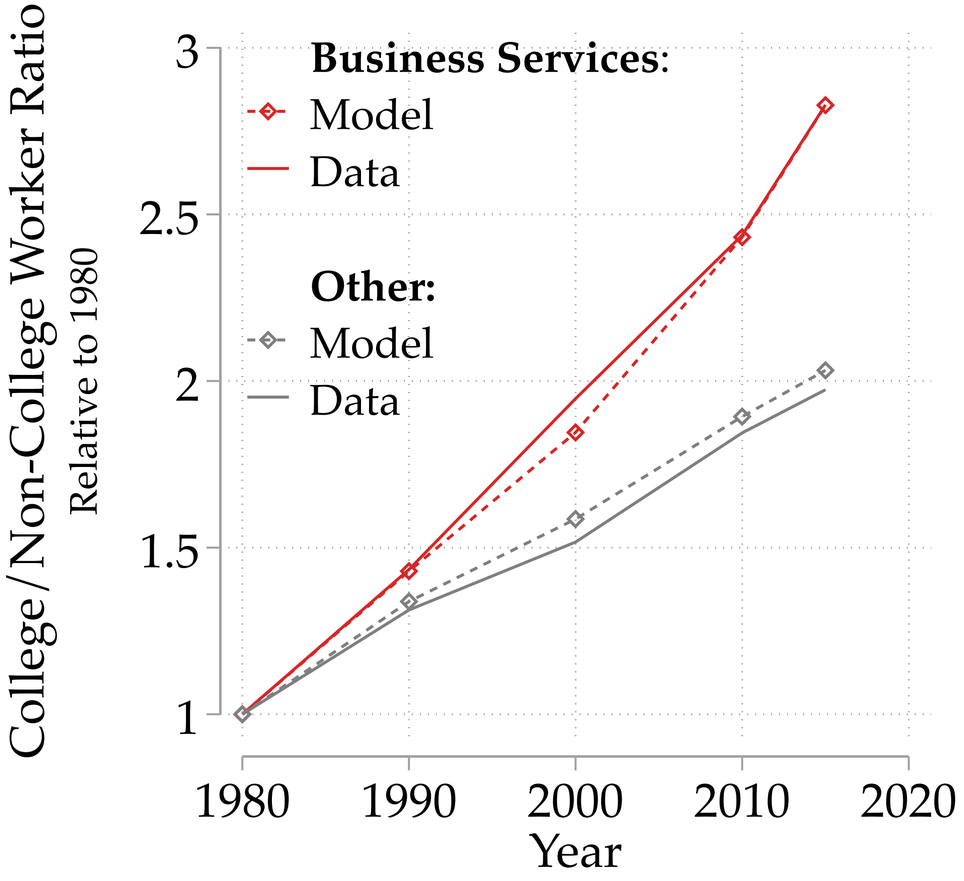
  - which we calculate by perturbing the ratio of high- to low-skill workers
    - Strategy borrowed from Burstein and Vogel 2017

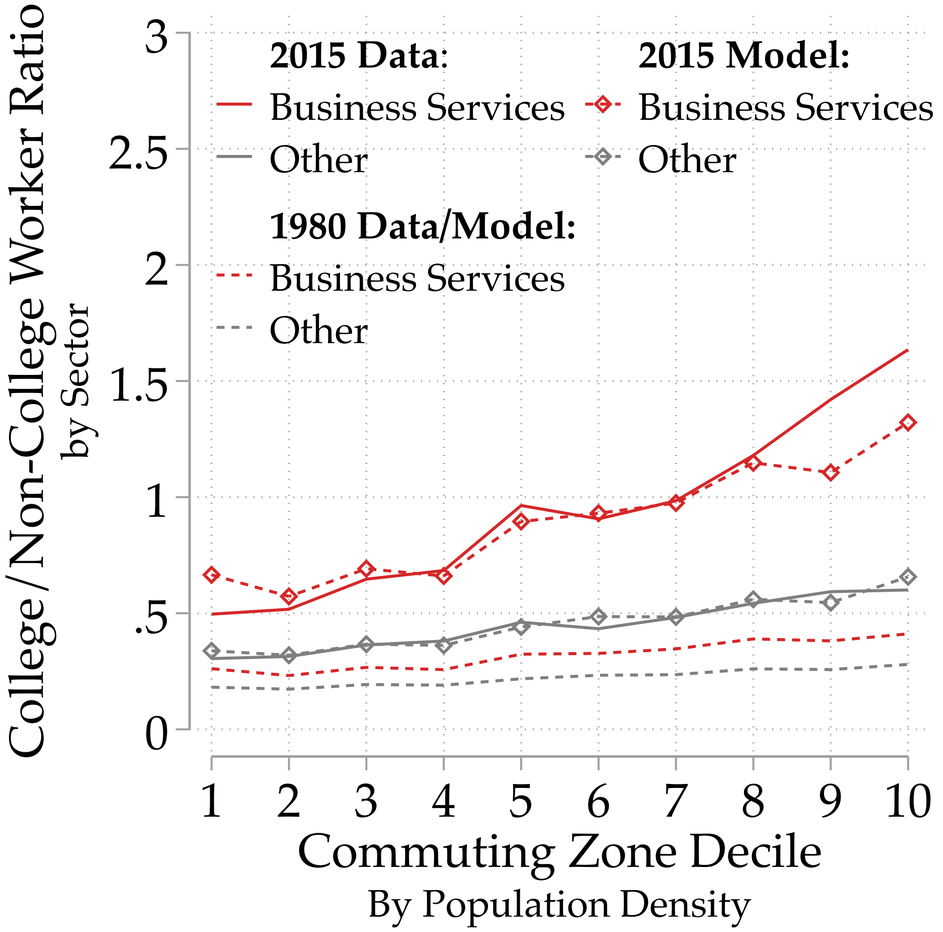
Counterfactual Exercise

- Choose capital productivity in each sector to match capital cost shares
  - Normalize $\mathscr{Z} = 1$ in 1980
- Counterfactual:
  - Raise $\mathscr{Z}$ to trace out decline in ICT price in BEA data
    - Hold all parameters fixed at 1980 level
    - Adjust relative college/non-college shares
  - Recompute 2015 wage-density gradient in model-generated data


(A) All Industries
(B) Business Services
(C) Other Sectors
Average Real Wage
Relative to Decile 1
1980-Data/Model
2015-Data
2015-Model
2.2
2
1.8
1.6
1.4
1.2
1
1 2 3 4 5 6 7 8 9 10
Commuting Zone Population Density Decile

		2015				
	1980	Data	Baseline	Homothetic	A Spillover	Z Spillover
Business Services	0.067	0.151	0.133	0.072	0.122	0.130
Other Sectors	0.056	0.068	0.049	0.049	0.031	0.046
Aggregate	0.060	0.099	0.105	0.059	0.109	0.120
Δ Aggregate		0.039	0.045	-0.001	0.049	0.059


College/Non-College Worker Ratio
Relative to 1980
3
2.5
2
1.5
1
Business Services:
Model
Data
Other:
Model
Data
1980
1990
2000
2010
2020
Year


College/Non-College Worker Ratio
by Sector
3
2.5
2
1.5
1
.5
0
2015 Data:
Business Services
Other
2015 Model:
Business Services
Other
1980 Data/Model:
Business Services
Other
1
2
3
4
5
6
7
8
9
10
Commuting Zone Decile
By Population Density

FIN