Skill-Biased Technical Change and Regional Convergence

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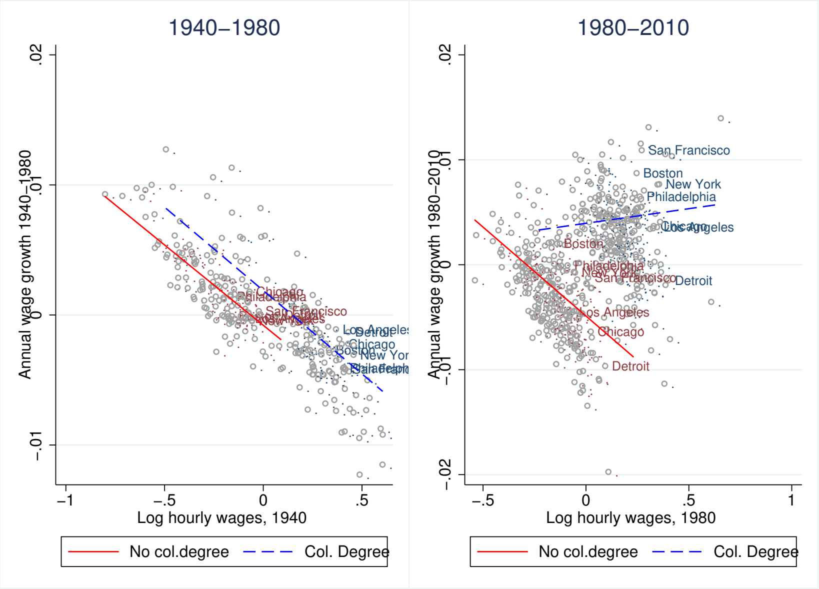
Wage Convergence and the Decline after 1980 Robustness

This Paper: Wage Convergence by Skill Group

Robustness



This Paper

Research Question: What is the Role of **Skill-Biased Technical Change** *(SBTC) on the* **End** *of Cross-Cities* **Wage Convergence***?*

- Novel Facts: Skill premium and migration patterns support differential ends of convergence by skill group
- Model: Spatial equilibrium model with heterogeneous skill workers
  - Skill-Biased Technical Shock
  - Agglomeration
  - Migration
- Structural Estimation: SBTC explains the majority of the end of wage convergence
- Other Results: Implications on *quantities* $\Longrightarrow$
  "Great Divergence" of skills
  Secular Migration Decline

Contributions Literature

Empirical

- Novel set of **facts** on the evolution of:
  - regional convergence
  - skill premium
  - migration patterns

Theoretical

- Introduction of **heterogeneous skill** and endogenous agglomeration in a long-run spatial equilibrium model
  - **Structural estimation** and identification in a dynamic macro model
  - **Quantification** of the decline in wage convergence across US cities between 1980 and 2010 due to skill-biased technology and agglomeration forces

RELATED WORK [CONTRIBUTIONS]

CONVERGENCE - NORTH/SOUTH Caselli and Coleman (2002), Barro and Sala-i-Martin (1992), Brown (1993), Berry and Glaeser (2005); Ganong and Shoag (2015); $\Longrightarrow$ **Quantitative spatial model**

SKILL-BIASED TECHNICAL CHANGE (SBTC) Katz and Murphy (1992), Autor and Dorn (2013), Autor and Dorn (2014), Baum-Snow *et al.* (2015), Burstein *et al.* (2016); $\Longrightarrow$ **Application to cities and agglomeration forces**

ECONOMIC GEOGRAPHY AND LONG-RUN Diamond (2015), Allen and Arkolakis (2014), Desmet and Rossi-Hansberg (2014), Nagy (2016), Desmet *et al.* (2016); $\Longrightarrow$ **Explain several stylized facts**

SKILL SORTING, AGGLOMERATION AND SKILL PREMIUM Duranton (2007), Moretti (2012), Baum and Pavan (2012), Davis and Dingel (2013), Behrens *et al.* (2012), Moretti and Hsieh (2015), Diamond (2015), Baum *et al.*, (2016) $\Longrightarrow$ **Long-Run implications**

Outline

Empirical Regularities

Model

Estimation

Counterfactuals

Other Results

Novel Empirical Regularities Data

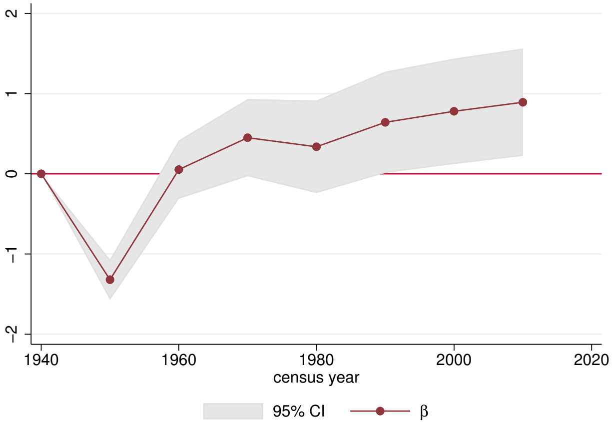
Fact 1: Cross-Cities Wage Convergence decreased only among high-skill workers after 1980

- **Fact 2**: $\uparrow$ share of high skilled workers $\uparrow$ **skill premium** post 1980, $\downarrow$ **skill premium** pre 1990 Fact 2
- **Fact 3**: $\uparrow$ initial share of high skill workers $\uparrow$ probability of getting high skill **migrants** over time Fact 3

TAKE-AWAY: *Supply* forced dominated by *demand* forces over time

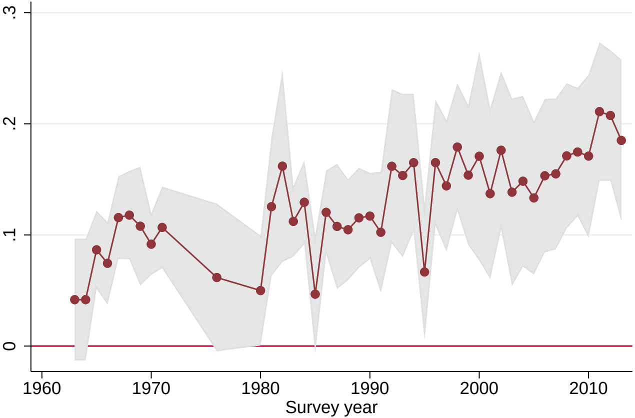
Fact 2: Skill Premium Over Time and Across Space

$$\ln\left(\frac{\hat{w}_{jt}^{H}}{\hat{w}_{jt}^{L}}\right) = \alpha_t + \sum_{t=1970}^{2010} \beta_t \ln\left(\frac{H_{jt}}{L_{jt}}\right) + fe_{MSA} + fe_{year} + \epsilon_{jt}$$



Fact 3: High-Skill Migrants to High-Skill Locations

$$1\left(Migrant\right)_{ijt} = \alpha_t + \beta 1\left(H_{ijt}\right) + \gamma \frac{H_{jt}}{L_{jt}} + \sum_{t=1963}^{2013} \delta_t 1\left(\mathrm{H}_{ijt}\right) * \left(\frac{H_{jt}}{L_{jt}}\right) + \Gamma X_{ijt} + \mu_{ijt}$$



Main Idea

- Before 1980, technology diffusion was skill neutral $\Longrightarrow$ push for convergence
- **Skill-biased technology** shifted the demand for skills nationally
- Endogenous **agglomeration** economies of skill pushed sorting where the concentration of initial skills was higher
- High-skill migrate more to high skill places
- Higher match of high skilled workers to high-skilled locations
- Wages diverge

Example

Outline

Empirical Regularities

Model

Estimation

Counterfactuals

Other Results

Key Ingredients

- Heterogeneous Demand for skills
- Migration
- Agglomeration

Other Mechanisms

- Housing Here

Model Environment Housing/Migr. Cost

Space

- J locations

Workers

- 2 types: high-skilled and low-skilled
- Workers decide in which location to live
- Preferences over:
  - tradable and non-tradable housing
  - exogenous amenities and endogenous amenities
  - utility loss from moving
  - i.i.d. preference shock
- Supply labor inelastically

Firms

- Tradable : CES production with intermediates inputs
- A set of non-tradable intermediates
  - CES production function with high and low-skilled workers
- Housing sector
- Productivities depend on:
  - skill and population agglomeration
  - skill-biased technology
  - technology diffusion process

Outline

Empirical Regularities

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Intuition for Estimation

- Objective: Identifying agglomeration and amenities
- Challenges:
  - Separate endogenous agglomeration and amenities from local productivity and local amenities
  - Keep into account the path dependence in technology diffusion
- Solution: Instrumental approach isolating local changes in supply from changes in demand
  - Changes in supply through housing regulation and land unavailability
  - Changes in demand through routinization shock by skills

Parameters estimated and used for calibration

Supply		
Moments	Parameter	Estimates
$E[\Delta\xi_{kdjt}\Delta Z_{jt}] = 0$	spillover on skill for H: γ^H	0.616[0.231]
	spillover on skill for L: γ^L	-0.185[0.117]
	spillover on population for H: ϕ^H	-0.137[0.088]
	spillover on population for L: ϕ^L	-0.111[0.047]
	$\frac{1}{1-\rho}$ elasticity of substitution between H and L: ρ	0.531[0.310]
	elasticity on SB: λ	-0.014[0.062]
Demand		
$E[\Delta A_{kdjt}\Delta Z_{jt}] = 0$	Elasticity to local prices: θ	0.503[0.107]
	Elasticity to population: γ^p	0.679[0.130]

Externally Calibrated Parameters

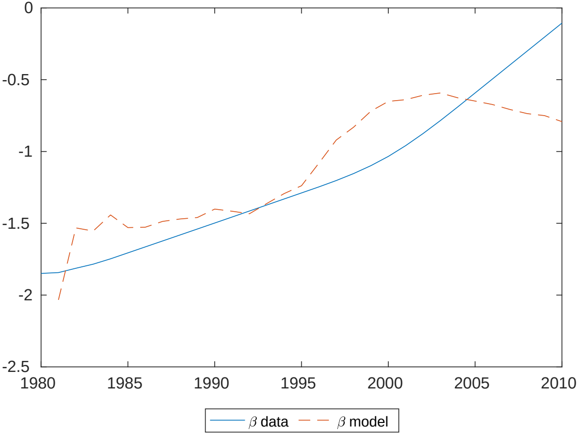
Parameter	Value	Literature
Share of Services : ν	0.2	Serrato and Zidar (2016)
Subsistance level of Housing: $\bar{O}$	0.25	Ganong and Shoag (2015)
Elasticity of Supply Housing: μ	0.4	Ganong and Shoag (2015)
Share of technology: γ_2	0.99	Desmet et al. (2016)
Migration costs: σ^L and β^L	-.065 and -.861	Notowididgo (2013)
Migration costs: σ^H and β^H	-.066 and -1.044	Notowididgo (2013)

Migration Costs

Model vs Data: Wage Convergence β β_H β_L

Estimate rolling 30-year window β_t for the following equation:

$$\Delta w_{jt} = \alpha + \hat{\beta}_t w_{jt-30} + \epsilon_{jt}$$

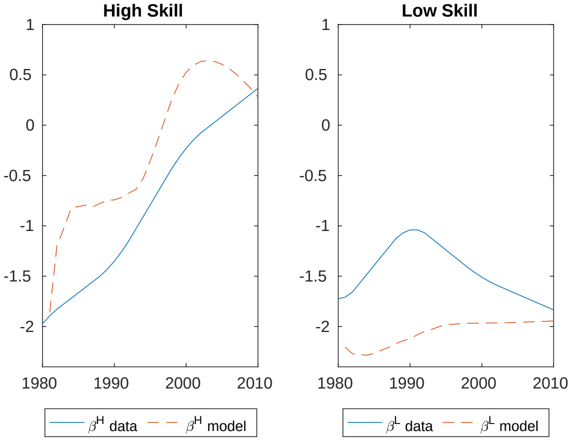


Model vs Data: Wage Convergence β_H and β_L

β_L

Estimate rolling 30-year window β_{Ht} for the following equation for H:

$$\Delta w_{kjt} = \alpha + \hat{\beta}_{kt} w_{kjt-30} + \epsilon_{kjt}, \ \forall k \in \{H, L\}$$



Outline

Empirical Regularities

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Other Results

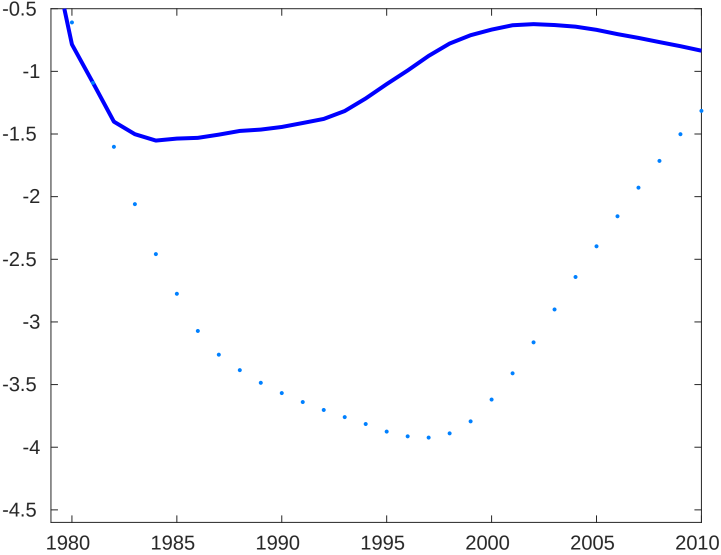
Decomposing the Decline in Wage Convergence β

Proceed stepwise:

1. Simulate counterfactual convergence rate with no agglomeration;
2. Remove SBTC;
3. Remove Housing;
4. Remove Migration Costs;

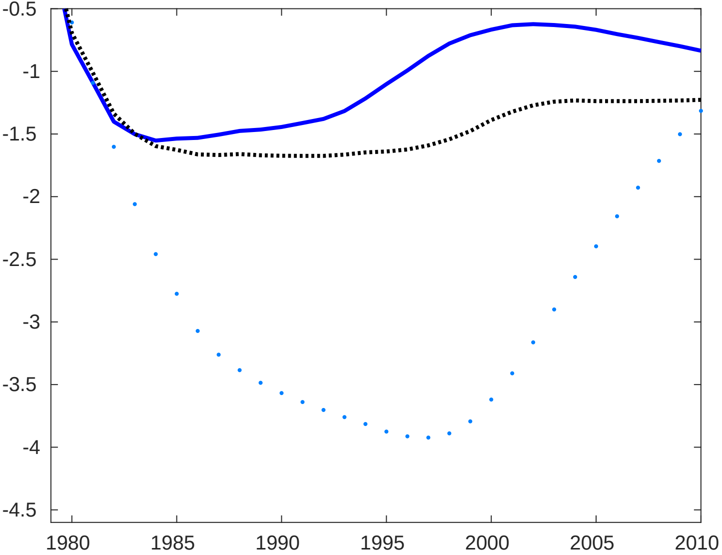
Decomposing the Decline in Wage Convergence β

No Agglomeration



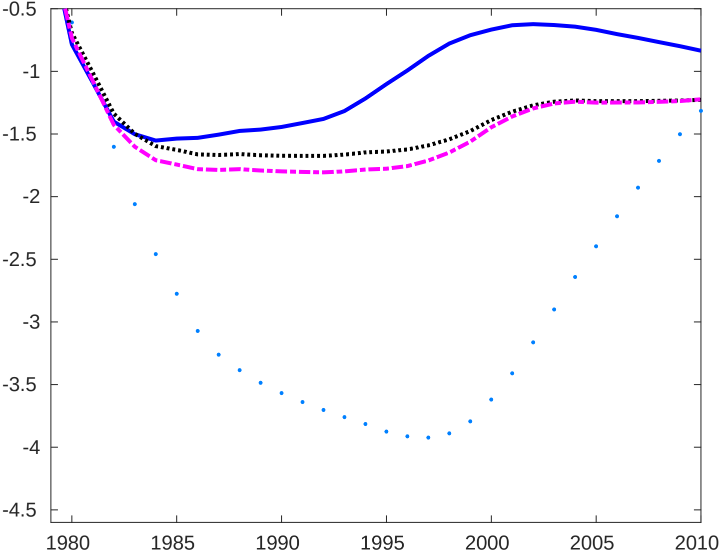
Decomposing the Decline in Wage Convergence β

No SBTC



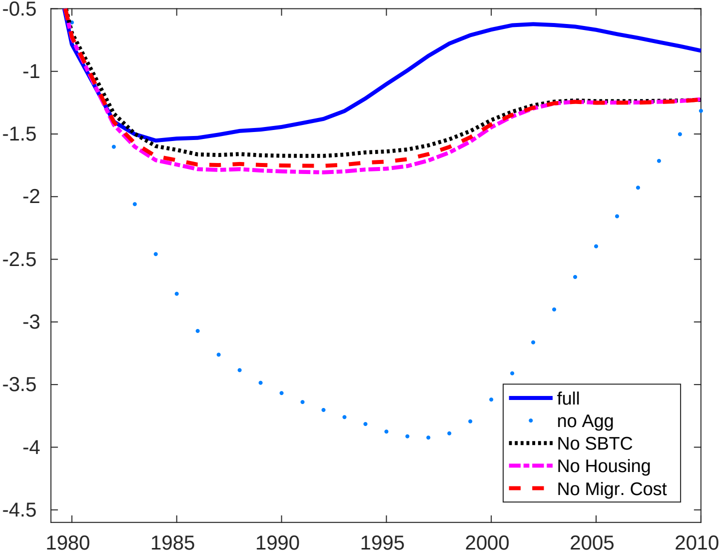
Decomposing the Decline in Wage Convergence β

No Housing



Decomposing the Decline in Wage Convergence β

No Migration



Outline

Empirical Regularities

Model

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Other Results

Other Results

Wages

- Wage Dispersion
- Real Wage Convergence

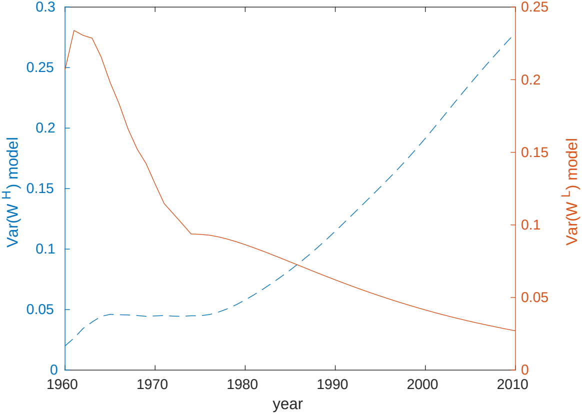
Migration

- "Great Divergence" in Skill Ratio
- Sorting of Migrants
- Migration Decline

Cities' Wage Dispersion in the Last 30 Years

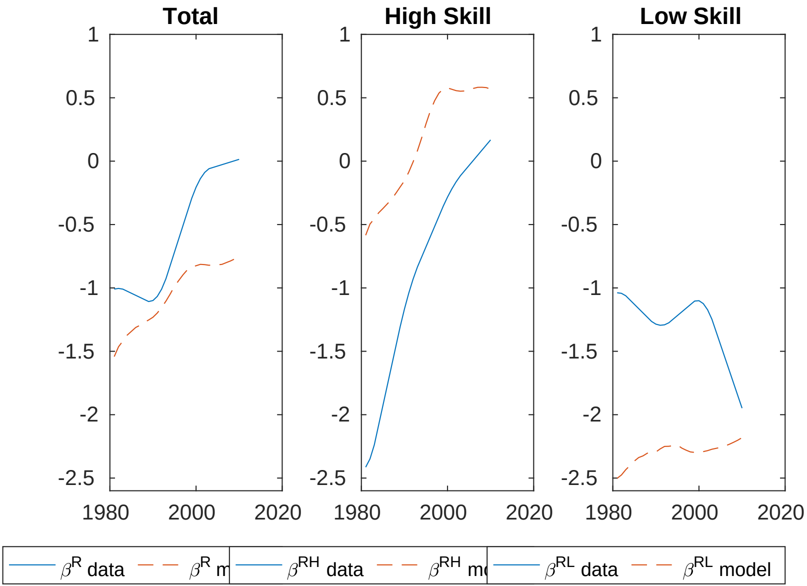
Data: Cities' Wage dispersion increased **100%** from 1969 to 2009 (Hsieh and Moretti (2015))

Model: Cities' Wage dispersion increased by:

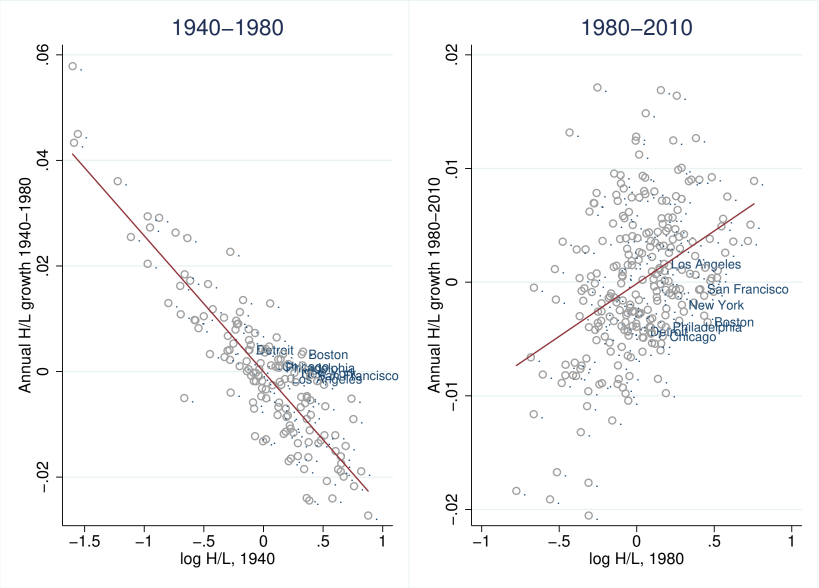


Take-away: Cities' Wage dispersion increased only among high-skilled workers and mostly because of SBTC.

REAL WAGES CONVERGENCE



"The Great Divergence" in the Skill Ratio $\frac{H}{L}$: Data



"The Great Divergence" in the Skill Ratio $\frac{H}{L}$: Model vs Data

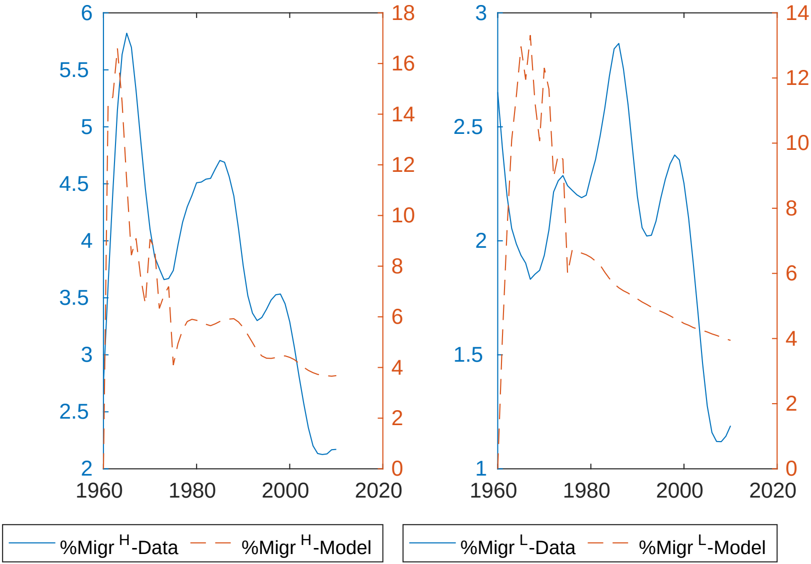
Migration

$$\log\left[\frac{H_{jt}}{L_{jt}} / \frac{H_{j\tau}}{L_{j\tau}}\right]\frac{1}{(t-\tau)} = \alpha + \hat{\beta}_t^{skill} \log\frac{H_{j\tau}}{L_{j\tau}} + \epsilon_{jt}$$

Model: Extra Sorting over Time

$$\Delta H_{jt} = \alpha + \sum_{t=1941}^{1970} \delta_t^H \ln W_{Hjt} + \epsilon_{jt}$$

Migration Rates



What is happening to regional convergence in other countries and across countries over time?

Average Regional Convergence Within Other Countries

- Estimate rolling 20 and 30-year window β_t for the following equation in GDP per capita in each country:

$$\Delta GDP_{jt} = \alpha + \hat{\beta}_t GDP_{jt-30} + \epsilon_{jt}$$

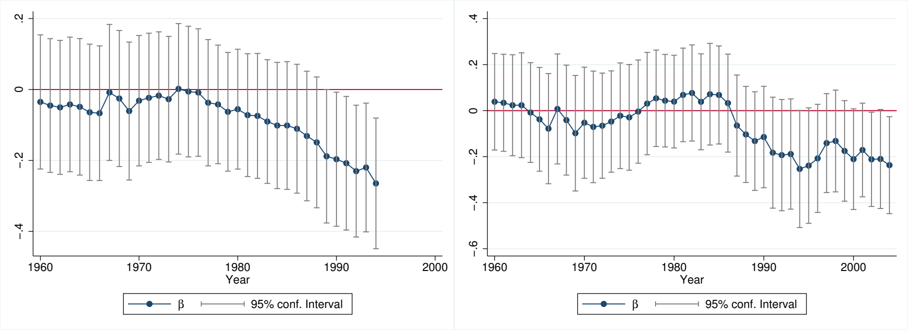
- Plot average $\hat{\beta}_t$

Note: This figure shows the average of the β estimates for the countries in the

Regional Convergence Across Countries

- Estimate rolling 20 and 10-year window β_t for the following equation in GDP per capita:

$$\Delta GDP_{jt} = \alpha + \hat{\beta}_t GDP_{jt-30} + \epsilon_{jt}$$



Conclusions and Future Directions

- Spatial Equilibrium Model that several key moments and changes in the last 30 years:
  - Regional Convergence in wages
  - Increase in wage dispersion
  - *Great Divergence* of skills
  - Secular decline of migration
- *Key elements*: Interaction Skill-biased technical change and agglomeration
  - explain jointly 80% of the decline in regional convergence
- What happens across countries? Preliminary results suggest:
  - regional wage convergence decreasing within countries;
  - *but* increasing across countries

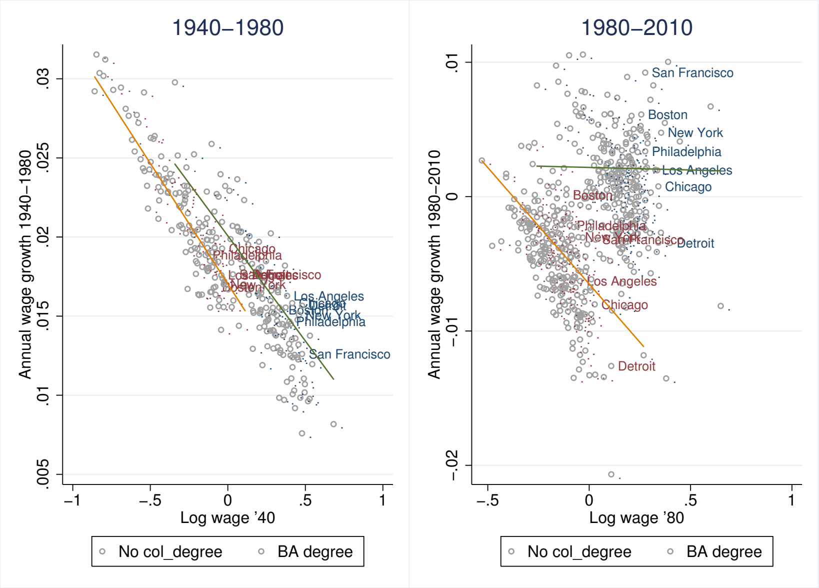
  Extension to *Cross-country* convergence and decline Cross-country

Robustness Convergence

- Adjusted Wages Adjusted
- Rent Adjusted Rent
- Table Convergence Table
- Rolling Convergence Rolling
- Rent adjusted Convergence Rent
- Adjusted Convergence by Skill Composition
- Table Convergence by Skill Table
- Rolling skill convergence RollingH RollingL
- Industry control Industry

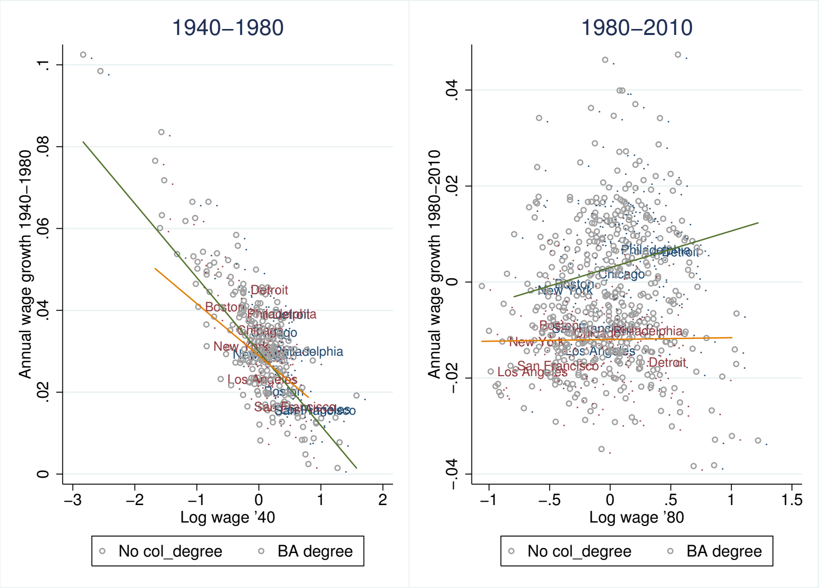
Compositionally Adjusted Wages
Convergence

Convergence



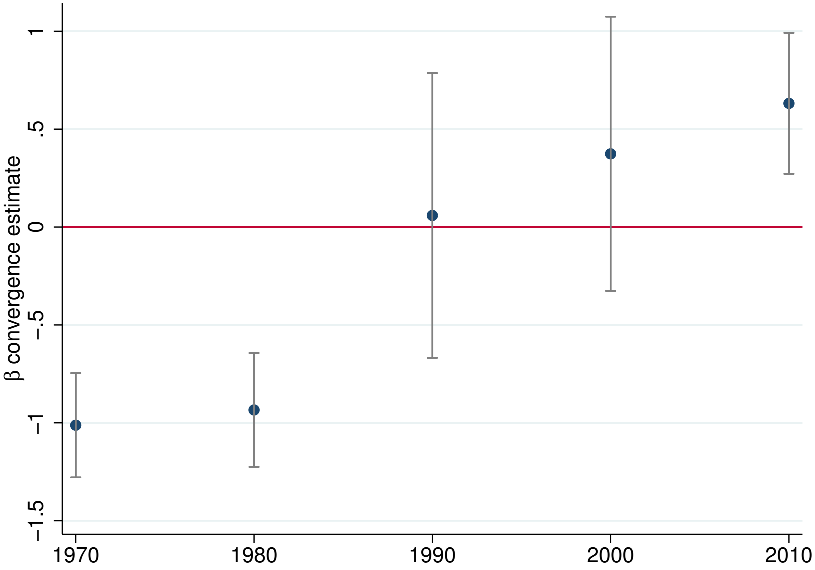
Rent Adjusted Wages Convergence

Convergence



Rolling Wages Convergence

Convergence



Rolling Wages Convergence by Skill Group

Convergence

Figure: High Skill

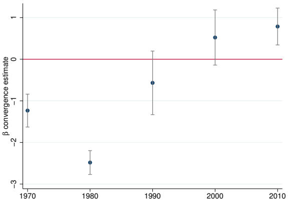
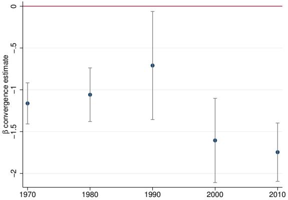


Figure: Low Skill



Wage Convergence over Time

Convergence

Table: Wage Convergence Rates

	(1) Δw^{40-80}_pw	(2) Δw_pw^{80-10}	(3) Δw^{40-80}	(4) Δw^{80-10}
Log wages, 1940	-0.0112***		-0.0144***	
	(-10.90)		(-16.81)	
Log wages, 1980		-0.0000389		-0.00852*
		(-0.02)		(-2.57)
Constant	0.000360*	0.00145***	-1.37e-09	-0.0000229
	(2.29)	(4.90)	(-0.00)	(-0.09)

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Wage Convergence over Time by Skill Group

Convergence

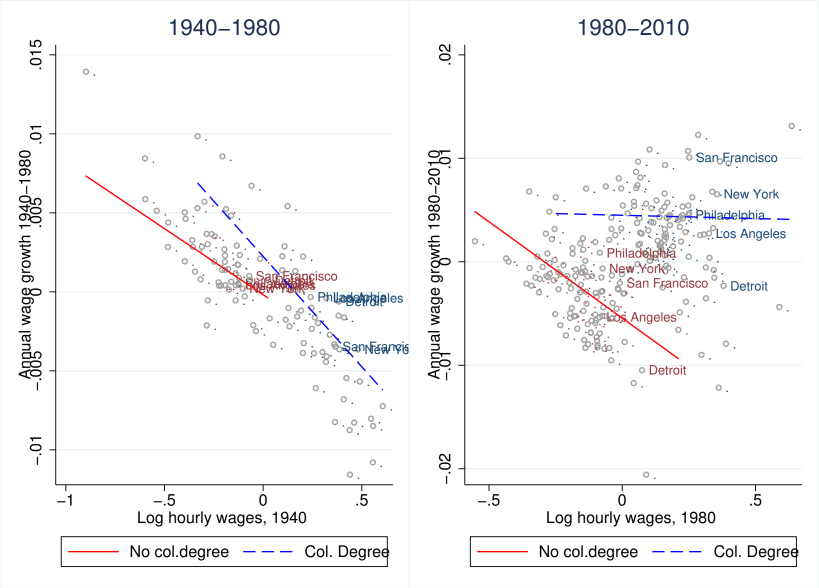
	(1) No,'40-'80	(2) Yes,'40-'80	(3) No,'80-'10	(4) Yes,'80-'10
Panel A				
Log hourly wage, 1940	-0.0123***	-0.0141***		
	(0.000862)	(0.00117)		
Log hourly wage, 1980			-0.0169***	0.000609
			(0.00174)	(0.00212)
	No,'40-'80	Yes,'40-'80	No,'80-'10	Yes,'80-'10
Panel B				
Log hourly wage, 1940	-0.0143***	-0.0205***		
	(0.000866)	(0.00106)		
Log hourly wage, 1980			-0.0200***	-0.00791***
			(0.00163)	(0.00203)
N	132	131	247	246

Fact 2

$$\ln\left(\frac{\hat{w}^H_{jt}}{\hat{w}^L_{jt}}\right) = \alpha_t + \sum_{t=1940}^{2010} \beta_t \ln\left(\frac{H_{jt}}{L_{jt}}\right) 1\left(\text{time} = t\right) + fe_{MSA} + fe_{year} + \epsilon_{jt}$$

Convergence for Low Housing Elasticity Cities

Main Ingredients



Workers Utility Maximization

Model Worker of type $k \in \{H, L\}$ that lives in i decides which location j to pick and solve the following problem:

$$V_k(j, \zeta_i') = \max_{j'} \left[\frac{V_{ikj'}}{m_k(j,j')} + \beta E \left(\frac{V(j', \zeta_i'')}{m_k(j,j')} \right) \right]$$

where $m(j, j')$ are the migration costs assumed to be *separable* such that

$$m_k(s, j) = m_{k1}(s) * m_{k2}(j)$$

$$V_k(j, \zeta_i') = \frac{1}{m_{k1}(j)} \max_{j'} \left[\frac{V_{ikj'}}{m_{k2}(j')} \right]$$

Workers Utility Maximization

Indirect utility function for agent i of type k that lives in city j at time t:

$$V_{ikjt} = \max_{T_j, N_j}[\theta \log(T_{kjt}) + (1-\theta)(\nu \log(N_{kjt} + (1-\nu)\log(O_{kjt} - \bar{O}_{kjt}) + A_{jt} + \gamma^p(H_{jt} + L_{jt}) + \zeta_{ijt}]$$

$$\text{s.t. } T_{jt} + N_{jt}P_{jt} + O_{jt}R_{jt} = W_{kjt}$$

Assumption: ζ_{ij} follows a Gumbell distribution (Mc Fadden [1973]) $\implies$

$$H_{jt} = \frac{\exp(\delta_{Hjt}/m_{H2}(j))}{\sum_s^S \exp(\delta_{Hst}/m_{L2}(s))}$$

$$L_{jt} = \frac{\exp(\delta_{Ljt}/m_{L2}(j))}{\sum_s^S \exp(\delta_{Lst}/m_{L2}(s))}$$

where

$$\delta_{kjt} = \Big[\theta \log(W_{kjt} - R_{jt}\bar{H}) + (1-\theta)(1-\nu)[\log((1-\theta)(1-\nu)\frac{W_{kjt}}{R_{jt}} + \bar{O}] + (1-\theta)\nu \log((1-\theta)\nu \frac{W_{kjt} - R_{jt}\bar{O}}{P_{Njt}}] + A_j + \gamma^p \log(H_{jt} + L_{jt})\Big]$$

Change in Variable for Y^T

$$Y_j^{T\rho} = \frac{\left(H_j^{\gamma_H+\rho-1}(L_{Nj} + L_{Tj})^{-\gamma_H} W_{Lj} L_j^{T\rho} + W_{Hj} L_j^{\gamma_H}(L_{Nj} + L_j^T)^{-\gamma_H} W_{Lj} L_j^{T\rho-1}\right)(H_j + L_j)^{\gamma}}{W_{Hj}(L_{Nj} + L_j^T)^{\rho-1+\gamma_H-\gamma_L} + W_{Lj} H_j^{\rho-1+\gamma_H-\gamma_L}}$$

Wage-Equations.

Model with Housing Market Model

- Housing *HD* (following Ganong and Shoag (2015)):

$$HD_{jt} = R_{jt}^{\mu}$$

Migration Costs Calibration

$$m_{k2} = \frac{\sigma^k exp(\beta^k x_j) - 1}{\beta^k}$$

where x_j relates to MSA characteristics such as population

Estimation Results with Housing

Supply		Demand		Housing	
α	0.820^{***}	β^w	4.4^{***}	γ^{geo} 0.02***	
γ^H	0.285^{***}	β^r	-0.6^{***}	γ^{reg}	0.05***
γ^L	0.004	β^A	5.9^{***}	α_O	-.81***
ρ	0.447^{***}	β^{HL}	-4.1^{***}		
γ^p	0.312^{***}				

Estimation

ELEL

Get residuals $\Delta w_{Hjt,TFP}$, $\Delta w_{Ljt,TFP}$ of the equation:

$$\Delta w_{Hjt,res} =$$
$$\Delta w_{Hjt} - \underbrace{\left((1-\hat{\rho})\Delta \ln \hat{Y}_{Tjt} + (\hat{\rho}-1)\Delta \ln H_{jt} + \hat{\gamma_H}\Delta \ln\left(\frac{H_{jt}}{L_{jt}}\right) + \hat{\gamma}\Delta \ln\left(H_{jt}+L_{jt}\right) + \hat{\lambda}^H \Delta S_{Hj,t-10}\right)}_{\Delta \hat{w}_{Hjt}}$$

$$\Delta w_{Ljt,res} = \Delta w_{Ljt} -$$
$$\underbrace{\left((1-\hat{\rho})\Delta \ln \hat{Y}_{Tjt} + (\hat{\rho}-1)\Delta \ln L_{jt} + \hat{\gamma_L}\Delta \ln\left(\frac{H_{jt}}{L_{jt}}\right) + \hat{\gamma}\Delta \ln\left(H_{jt}+L_{jt}\right) + \hat{\lambda^L} \Delta S_{Lj,t-10}\right)}_{\Delta \hat{w}_{Ljt}}$$

$$\Delta w_{Ljt,res} = \Delta w_{Ljt} - \Big(\hat{\alpha}\Delta \ln Y_{Njt} + \hat{\lambda^L}\Delta S_{Lj,t-10}$$

Model Estimation: Location Decision

- Estimate average utility v_j^H and v_j^L with log-likelihood estimation (BLP [2002]);
- Generate moment conditions:

$$\Delta\alpha_{jt}^k = \Delta\delta_{jt}^k - \beta^{kw}\Delta w_{jt}^k - \beta^{ks}\Delta p_{jt}^s - \beta^{kA}\Delta A_{jt} - \gamma^p\Delta(H_{jt} + L_{jt}), \qquad \forall k \in \{H, L\}$$

- Identification:

$$\mathrm{E}[\Delta\alpha_{jt}^k \Delta Z_{jt-10}^k] = 0, \qquad \forall\ k \in \{L, H\}$$

Model Estimation: GMM

Moment Conditions

$$\Delta\xi_{jt}^{H} = \Delta w_{jt}^{H} - ((1-\rho)\Delta\ln Y_{jt}^{g} + (\rho-1)\Delta\ln H_{jt} + \gamma_H \Delta\ln\left(\frac{H_{jt}}{L_{jt}}\right) +$$
$$\gamma\Delta\ln\left(H_{jt}+L_{jt}\right) - \beta^{HH}\Delta SB_{jt-10}^{H} - \beta^{HL}\Delta SB_{jt-10}^{L})$$
$$\Delta\xi_{jt}^{L^g} = \Delta w_{jt}^{H} - ((1-\rho)\Delta\ln Y_{jt}^{g} + (\rho-1)\Delta\ln L_{jt}^{g} + \gamma_L \Delta\ln\left(\frac{H_{jt}}{L_{jt}}\right) +$$
$$\gamma\Delta\ln\left(H_{jt}+L_{jt}\right) - \beta^{LH}\Delta SB_{jt-10}^{H} - \beta^{LL}\Delta SB_{jt-10}^{L})$$

$$\Delta\xi_{t}^{L^s} = \Delta w_{jt}^{L} - \alpha\Delta\ln Y_{jt}^{s} - \beta^{LS}\Delta SB_{jt-10}^{L}$$

- Identification:

$$\mathrm{E}[\Delta\xi_{jt}^{k}\Delta Z_{jt-10}^{k}] = 0 \qquad \forall\ k \in \{L^g,\ L^s,\ H\}$$

Change-in-Measure

$$\Delta\hat{\hat{\xi}}_{kjt} = constant + \beta\hat{\hat{\xi}}_{kjt} + \epsilon_{jt}, \ \forall k \in H, \ L$$

1940-1980 State level

1980-2010 City Level

Structural Residual Convergence

$\hat{\beta}^{1940-1980}$	(-0.014***)			
	SBTC	Bartik	≥Coll. Deg.	<Coll. Deg.
No SBTC	-0.0126***	-0.0033***	-0.0136***	-0.0106***
No Spillover	-0.0145***	-0.0012***	-0.0165***	-0.0125***

Estimation

DECOMPOSING THE WAGE CONVERGENCE

$\hat{\beta}$ convergence (not population weighted)	$\geq$Coll. Degree	$<$Coll. Degree
Data		
Wage Convergence rate: $\hat{\beta}^{1980-2010}$	-0.00243	-0.0189***
Wage Convergence rate: $\hat{\beta}^{1940-1980}$	-0.0196***	-0.0142***
Model 1980-2010		
Full Model	0.00123	-0.01548***
No SBTC	-0.0112***	-0.0128***
No Spillover	-0.0192***	-0.01695***

Reduced Form Conditional Convergence on the Shock

$$\Delta^{1980-2010} w_{jt} = \beta^{o} + \beta w_{jt} + \alpha^{Z} \Delta Z_{jt}^{RSH}$$

Counterfactual Convergence Pattern

Reduced Form

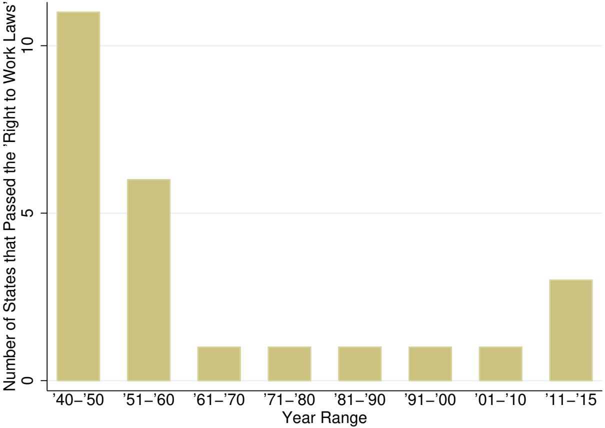
Table: Convergence Rates and SBTC

	(1) A	(2) B	(3) C	(4) D	(5) E
Log hourly wages 1980	-0.0000389	-0.00657*	-0.00802*	-0.00912*	-0.0105*
	(-0.02)	(-2.59)	(-2.16)	(-2.13)	(-2.30)
*RSH_H*1980		0.0160*	0.0188	0.0182	0.0201
		(2.40)	(1.62)	(1.39)	(1.47)
*RSH_L*1980		0.0406***	0.0220	0.0258	0.0233
		(4.44)	(1.12)	(1.22)	(1.07)
*RSH_H*1970			0.0183*	0.0184*	0.0200*
			(2.41)	(2.25)	(2.37)
*RSH_L*1970			0.0342*	0.0411*	0.0464*
			(2.00)	(2.13)	(2.22)
*RSH_H*1950				-0.00162	-0.00258
				(-0.51)	(-0.78)
*RSH_L*1950				-0.000279	0.00213
				(-0.03)	(0.23)

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Right to Work Laws by State



Adjusted

Convergence Controlling for Industry

Table: Convergence Rates by College Degree and IT

	(1) A	(2) B	(3) C
Log hourly wages 1980	-0.0000389	0.00593**	-0.0126***
	(-0.02)	(2.95)	(-10.58)
IT		0.00656***	0.00538***
		(13.49)	(16.54)
col_degree			0.0106***
			(19.85)

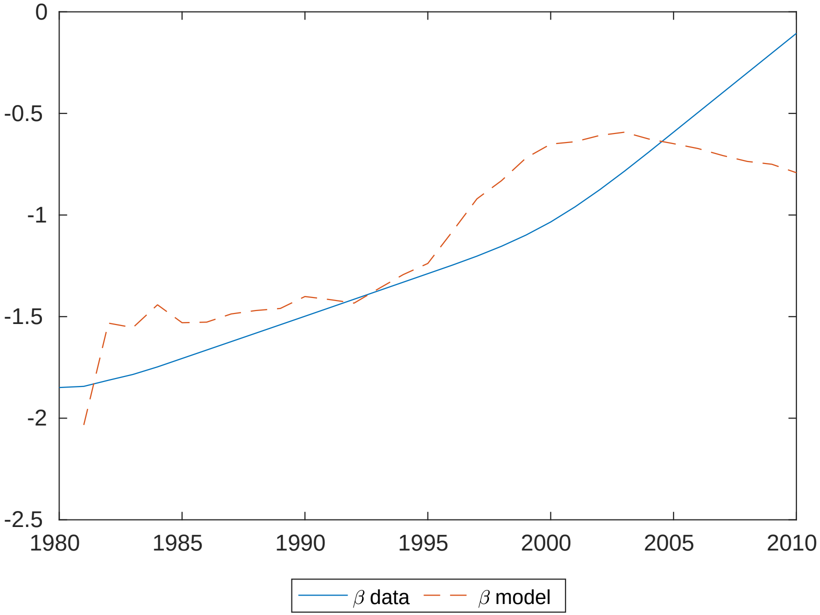
t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

First-Stage Instrumental Regression SBTC

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
$\Delta\hat{Z}^H{}_{-}j, t-10$	3.046***	3.643***	2.852***	4.418***	3.062***	3.043***
	(0.620)	(1.024)	(0.632)	(1.118)	(0.719)	(0.737)
Panel B						
$\Delta\hat{Z}^L{}_{-}j, t-10$	1.021***	0.891**	0.850***	2.483***	2.535***	2.511***
	(0.341)	(0.344)	(0.285)	(0.531)	(0.527)	(0.591)
N	144	119	270	249	283	283

Model vs Data: Wage Convergence β β



Model VS Data Wage Convergence β_H and β_L

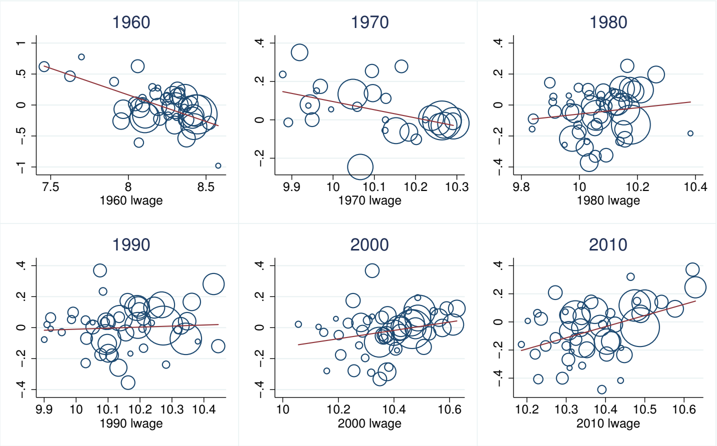
β_H.pdf β_H.png β_H.jpg β_H.mps β_H.jpeg β_H.jbig2 β_H.jb2 β_H.PDF β_H.PNG β_H.JPG

Fact 1 Facts

$$\ln\left(\frac{\hat{w}_{jt}^{H}}{\hat{w}_{jt}^{L}}\right) = \alpha_t + \sum_{t=1940}^{2010} \beta_t \ln\left(\frac{H_{jt}}{L_{jt}}\right) 1\left(\text{time} = t\right) + fe_{MSA} + fe_{year} + \epsilon_{jt}$$

Fact 4 Facts

Migration Premium over time



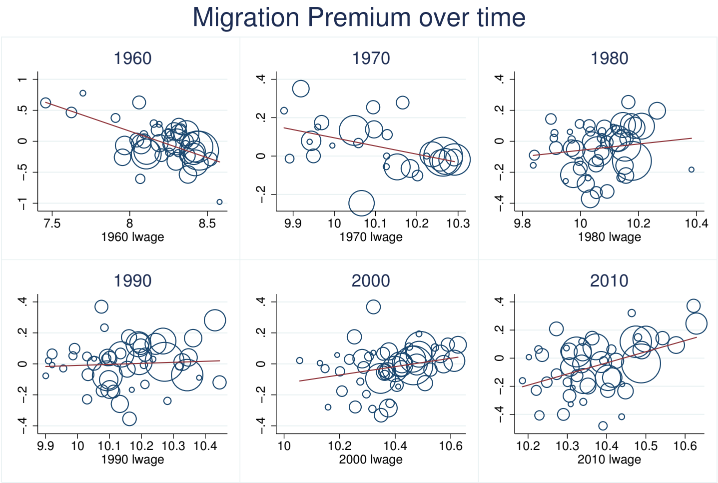
This figure reports the standardized coefficient β of the regression
Migration Premium$_{\{t,i\}}=\alpha+\beta(\ln(wage))_{t,i}+\varepsilon$ run for each MSA

First Stage Regression SBTC

SBTC

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
$\Delta\hat{Z}^{H}{}_{-j}, t-10$	3.046***	3.643***	2.852***	4.418***	3.062***	3.043***
	(0.620)	(1.024)	(0.632)	(1.118)	(0.719)	(0.737)
Panel B						
$\Delta\hat{Z}^{L}{}_{-j}, t-10$	1.021***	0.891**	0.850***	2.483***	2.535***	2.511***
	(0.341)	(0.344)	(0.285)	(0.531)	(0.527)	(0.591)
N	144	119	270	249	283	283

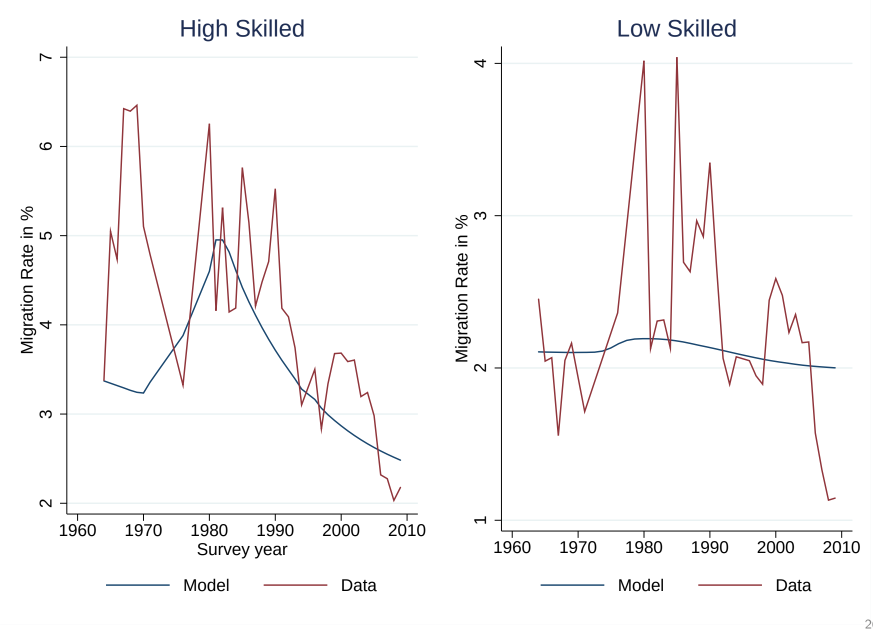
FACT 3



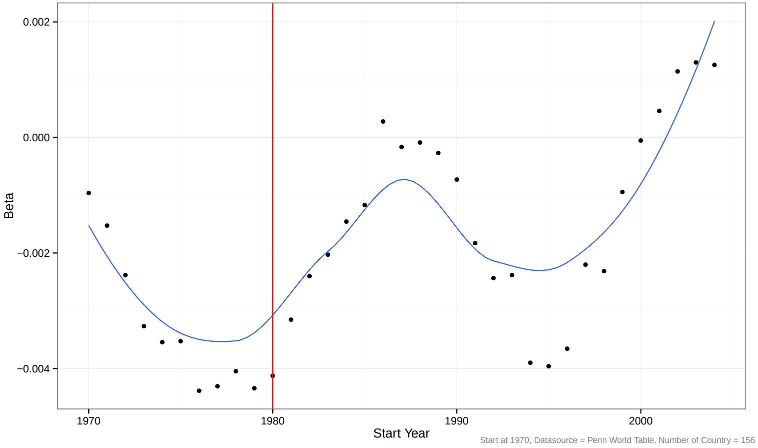
This figure reports the standardized coefficient β of the regression Migration Premium$_{\{t,i\}}$=$\alpha+\beta(\ln(wage))_{t,i}+\varepsilon$ run for each MSA

Back to Facts.

Model vs Data: Migration Rates H/L

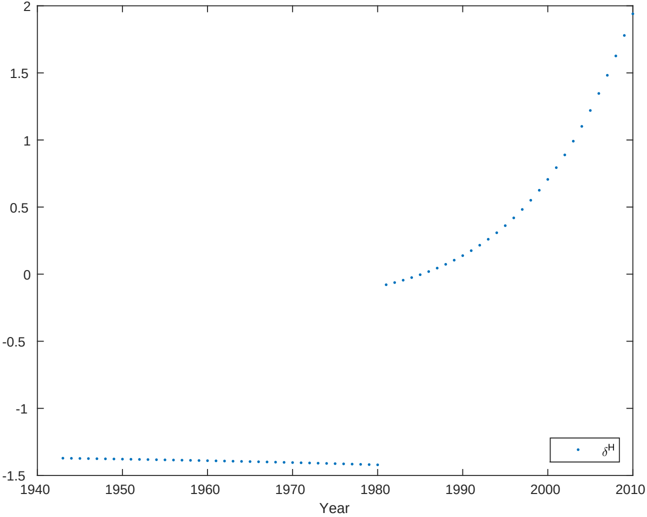


Cross-country Convergence and the Decline

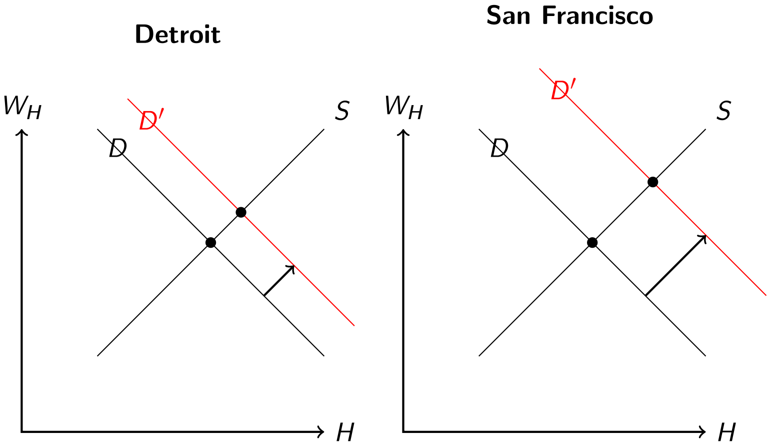


Model: Sorting Implications

$$\Delta H_{jt} = \alpha + \sum_{t=1941}^{1970} \delta_t^H \ln W_{Hjt}$$

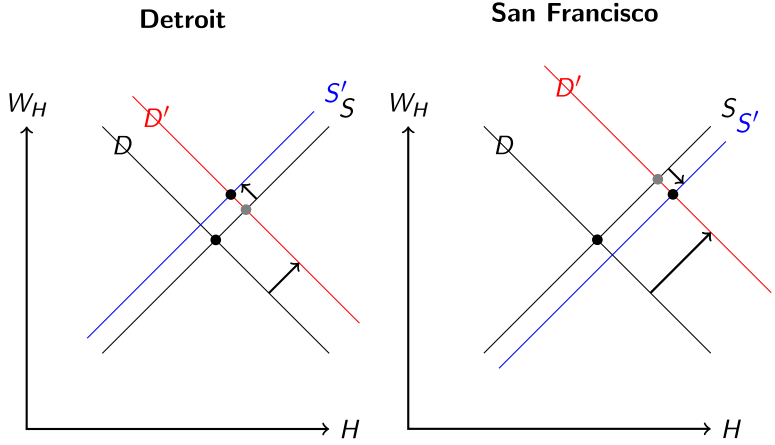


Mechanism with 2 Cities Main Idea

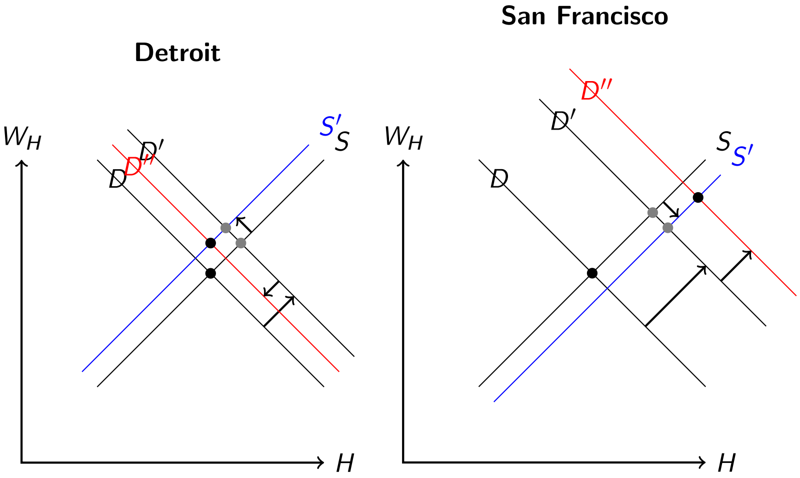


Mechanism with 2 Cities

Main Idea



Mechanism with 2 Cities Main Idea



Workers Utility Maximization

Worker of type $k \in \{H, L\}$ that lives in j decides which location j' to pick and solve the following problem:

$$V_k(j, \zeta_i') = \max_{j'}\left[\frac{V_{ikj'}}{m_k(j,j')} + \beta E\left(\frac{V(j', \zeta_i'')}{m_k(j',j'')}\right)\right]$$

Indirect utility function for agent i of type k that lives in city j at time t:

$$V_{ikj't} = \max_{T_{kj't}, O_{kj't}}[\theta \log(T_{kj't}) + (1-\theta)(\log(O_{kj't} - \bar{O}_{kj't}) +$$

$$+ \mathrm{A}_{j't} + \gamma^p(H_{j't}/L_{j't}) + \zeta_{ij't}]$$

$$\text{s.t. } T_{kj't} + N_{kj't}P_{Nj't} = W_{kj't}$$

Workers Utility Maximization

Assumption: $m_k(j, j')$ are *separable* such that

$$m_k(j, j') = m_{k1}(j) * m_{k2}(j')$$

Assumption: ζ_{ij} follows a Type-I Extreme Value distribution (McFadden [1973]) $\implies$

$$H_{jt} = \frac{\exp(\delta_{Hjt})}{\sum_s^S \exp(\delta_{Hst})}$$

$$L_{jt} = \frac{\exp(\delta_{Ljt})}{\sum_s^S \exp(\delta_{Lst})}$$

where

$$\delta_{kjt} = \theta \log(W_{kjt} - R_{jt}\bar{O}) + (1-\theta)[\log((1-\theta)\frac{W_{kjt}}{R_{jt}} + \bar{O}] + A_{kjt} + \gamma^p \log(H_{jt}/L_{jt})$$

Production of Tradables and Intermediates

Tradable T sector:

$$T_{jt} = \Big(\sum_j \mu_d Y_{djt}^{\alpha} \Big)^{1/\alpha}$$

Production of Non-tradable Intermediates

$$Y_{djt} = [\eta_{Ldjt} L_{djt}^{\rho} + \eta_{Hdjt} H_{djt}^{\rho}]^{\frac{1}{\rho}}, \qquad \forall j = \{1, ..., N\}$$

- Productivity Process:

$$\eta_{Hdjt} = \left(\frac{H_{jt}}{L_{jt}}\right)^{\gamma^H} (L_{jt} + H_{jt})^{\phi^H} S_{Ht}^{\lambda^H} \exp(\xi_{Hdjt}) \tag{1}$$

$$\eta_{Ldjt} = \left(\frac{H_{jt}}{L_{jt}}\right)^{\gamma^L} (L_{jt} + H_{jt})^{\phi^L} S_{Lt}^{\lambda^L} \exp(\xi_{Ldjt}) \tag{2}$$

$$\xi_{kdjt} = \underbrace{\xi_{kdjt-1}^{\gamma_2} \left(\int_s \omega(j,s) \xi_{kdst-1}\right)^{1-\gamma_2}}_{\text{convergence force}}$$

MODEL: WAGE EQUATIONS

Wages for H and L are given by:

$$W_{Hjt} = p_{djt}\eta_{Hdjt}[\eta_{Ldjt}L_{djt}^{\rho} + \eta_{Hdjt}H_{djt}^{\rho}]^{\frac{1}{\rho}-1}H_{djt}^{\rho-1} \quad (3)$$

$$W_{Ljt} = p_{djt}\eta_{Ldjt}[\eta_{Ldjt}L_{djt}^{\rho} + \eta_{Hdjt}H_{djt}^{\rho}]^{\frac{1}{\rho}-1}L_{djt}^{\rho-1} \quad (4)$$

Firms' Problems

Housing Sector

- Housing HD (following Ganong and Shoag (2015)):

$$HD_{jt} = R_{jt}^{\mu}$$

Equilibrium Definition

Definition The equilibrium consists of a set of allocations $\{\{L_{djt}, H_{djt}\}_{d=1}^{D}\}_{j=1}^{J}$ and a set of prices $\{\{P_{djt}\}_{d=1}^{D}, R_{jt}\}_{j=1}^{J}$, wages$\{W_{Hjt}, W_{Ljt}\}_{j=1}^{J}$, such that given $\{\{\xi_{Ldj0}, \xi_{Hdj0}\}_{d=1}^{D}\}_{j=1}^{J}$, a set of parameters normalizing $P_{jt} = P_t = 1$ and $\sum_j (L_{jt} + H_{jt}) = 1$ in each time period t:

1. Given a set of migration costs and idyosincratic preferences, workers choose location and consumption to maximize utility;
2. Firms maximize profits;
3. Labor markets clear;
4. The non-tradable intermediates markets clear in every city, $\forall j \in J$ and $\forall d \in D$;
5. Final good market T clears;
6. Housing market clears.

Data and Estimation Strategy

- Data: IPUMS Census data for 1940, 1950, 1960, 1970, 1980, 1990, 2000; ACS for 2010;
  - Wages, Education, City, Rents, Population;
- Estimation method: GMM Estimation
- Parameters:
  1. parameters of labor demand $p^d = \{\rho, \gamma^H, \gamma^L, \phi^H, \phi^L, \lambda^H, \lambda^L\}$;
  2. parameters of labor supply $p^s = \{\theta, \gamma^p\}$;
  3. productivity shocks $\xi_{kjt}, \forall\, k$;
  4. amenities $A_{kjt}, \forall k$;
- Moment Construction:
  1. Exploit geographic variation in S_{kt}, ΔS_{kjt} ,$\forall k$ using "routinization" index as in Autor and Dorn [2013]
  2. Wages Changes Residual: $\Delta\xi_{kdjt} = \Delta w_{kdjt} - \Delta w^{model}_{kdjt}, \forall\, k$;
  3. Utility Changes Residuals: $\Delta A_{kjt} = \Delta\hat{\delta}_{kjt} - \Delta\delta^{model}_{kjt}, \forall\, k$;

SBTC MEASURE AND INSTRUMENTS FIRST STAGE

- **Measure** ΔS_{kjt} : Local Effect of Technology (Autor and Dorn [2013]) based on Routinization task intensity RTI of the occupations ω:

$$\Delta S_{kjt-10} = \sum_{\omega=1}^{\Omega} \left(\frac{k_{\omega jt}}{k_{jt}} - \frac{k_{\omega,j,t-10}}{k_{j,t-10}} \right) 1\left(RTI_{\omega} > RTI_{P66}\right) \; \forall k \in \{H,\, L\}$$

- **Instruments:**
  1. "Bartik-like" (Autor and Dorn [2013])

$$\Delta \tilde{S}_{kj,t-10} = \sum_{d} \left(k_{d,-j,t} - k_{d,-j,t-10}\right) \left(R_{d,j,t-10}\right) \; \forall k \in \{H,\, L\}$$

     - *Intuition*: national component interacted with local component of routinization at industry level $R_{d,j,t-10}$
  2. Housing regulations and land availability: (Saiz [2010])
     - land use regulation index: reg_{jt}
     - land unavailability index: $uvan_{jt}$
- Define the set of instruments Z:

$$\Delta Z_{jt} = \begin{bmatrix} \Delta \tilde{S}_{Lj,t-10} & \Delta \tilde{S}_{Lj,t-10} reg_{jt} & \Delta \tilde{S}_{Lj,t-10} unav_{jt} \\ \Delta \tilde{S}_{Hj,t-10} & \Delta \tilde{S}_{Hj,t-10} reg_{jt} & \Delta \tilde{S}_{Lj,t-10} unav_{jt} \end{bmatrix}$$