The Decline of the U.S. Rust Belt: A Macroeconomic Analysis

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The Rust Belt

Four Facts About Rust Belt Since WWII

1. Rust Belt share of economic activity fell about 35 percent - slow and persistent decline

2. Rust Belt wages higher than average

3. Weak productivity growth in Rust Belt industries

4. Rust Belt decline slowed, wage premia declined, & productvity increased, all around 1980s

Clues for a Theory

- Slow and persistent decline suggests slow moving state variable
- 1980s shift suggests change in state variable
- State variable: *Level of competitive pressure in Rust Belt*

Thesis

- *Lack of competition* key factor in Rust Belt decline
  - Output markets: *collusive oligopolists*
  - Labor markets: *unions that capture rents through hold-up* (e.g. UAW, United Steel Workers)

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  - Union power $\Rightarrow$ hold up problem
- Economic activity shifts to region with faster productivity growth (rest of country)

Related Literature

- **Competition and productivity**: Acemoglu & Akcigit (2011), Bloom, Draca and Van Reenan (2011), Cole & Ohanian (2004), Aghion et al (2005), Holmes (1998), Holmes & Schmitz (2010), Herrendorf & Texeira (2011), Schmitz (2005), Parente & Prescott (1999), Pavcnik (2002), others
- **Unions and economic performance**: Holmes (1998), Taschereau-Dumouchel (2012), Bridgman (2011), Dinlersoz and Greenwood (2012), Acikgoz and Kaymak (2012)

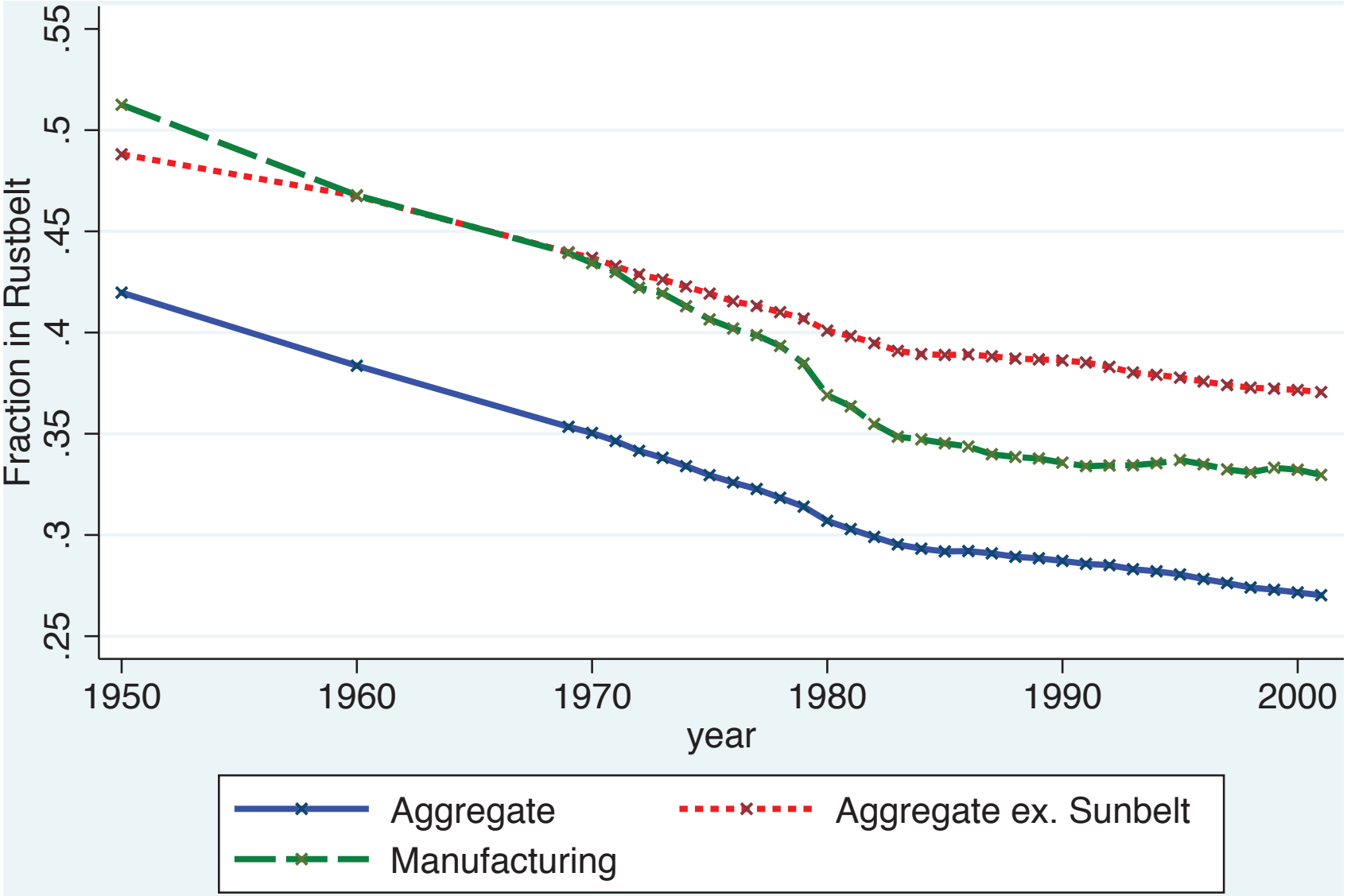
- **Rust Belt**; Blanchard & Katz (1992), Feyrer, Sacerdote and Stern (2007), Glaeser and Ponzetto (2007), Yoon (2012)

Four Facts

Data

- U.S. Censuses, 1950 through 2000 (IPUMS)
- State-level data on employment and GDP from BEA from 1960s
- Rust Belt: Illinois, Indiana, Michigan, New York, Ohio, Pennsylvania, West Virginia, and Wisconsin

Rust Belt Employment Share Declined



Rust Belt Wages High

Rust Belt Productivity Growth Low

Labor Productivity Growth

	Annualized Growth Rate, %		
	1958-1980	1980-1997	1958-1997
Blast furnaces & steel mills	0.8	5.5	2.8
Engines and turbines	2.4	2.3	2.3
Iron and steel foundries	1.3	2.2	1.7
Metal forgings and stampings	1.9	1.6	1.8
Metalworking machinery	0.8	2.8	1.6
Motor vehicles & equipment	2.0	4.8	3.2
Photographic equipment	4.9	4.8	4.9
Railroad equipment	3.2	0.4	2.0
Screw machine products	0.4	2.2	1.2
Rust Belt average	1.6	2.7	2.1
Manufacturing Sector average	2.5	3.1	2.8

Lack of Competition in Labor Markets

- Many Rust Belt industries had powerful unions (UAW, USW,...)
- Industry studies: earned rents through hold up/strikes
  - steel strikes of 1950s
  - GM strike of 1970, Caterpillar strikes
  - Bridgestone/Firestone recalls
- Broad agreement that union power declined in 1980s
  - Large shift in NLRB under Reagan (Patco...)

Lack of Competition in Output Markets

- Most Rust Belt industries highly concentrated
  - Big 3 in Steel: 66% of market until 1980s
  - Big 3 in Auto: 90% of market until 1980s
  - Big 4 in Rubber tires: 90% until 1970s
- Studies conclude collusive behavior, explicit charges by Senate

  Auto: prices are "outcome of a tacit bargain"

  Steel: "well-honed system of price leadership..."
- Broad agreement that product market competition increased around 1980
  - Antitrust focused on increasing competition
  - Entry costs fell - foreign competition increased substantially

Model

Households

Representative household

- supply labor inelastically
- preferences

$$\max \sum_{t=0}^{\infty} \delta^t C_t$$

Final Good

- Technology

$$Y_t = \left(\int_0^1 q_t(j)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}$$

- Use for consumption or technology investment
- Goods are gross substitutes: $(\sigma > 1)$

Intermediate Goods

- Rust Belt (R) produces intermediates $j \in [0, \lambda)$
- Rest-of-Country (S) makes $j \in [\lambda, 1]$
- Product and labor markets are less competitive in Rust Belt
  1. Rust Belt output market competion parameter is μ_t
  2. Rust Belt labor market competition parameter is β_t

Intermediate Goods

- One *leader firm* in each industry j
- Leader competes with *competitive fringe* (potential entrants)
- Leader's productivity is $z_t(j)$
- Two stages per period
  1. Technology investment: Leader raises productivity by amount x_t at cost $I(x_t)$
  2. Production: Leader hires quantity $l(j)$ of labor & produces ouput $= z_t(j)(1 + x_t)l(j)$

Competitive Fringe

- Initial productivities of leaders are $z_t^S(j)$ and $z_t^R(j)$
- Initial productivity of fringe in S and R
  - Rest of Country fringe productivity: $\phi \cdot z_t^S(j)$
  - Rust Belt fringe productivity: $\phi \cdot (1 - \mu_t) \cdot z_t^R(j)$
- ϕ is technology gap between leaders and competitive fringe
- μ_t is additional technology gap - blocked by Rust Belt leader

Production Stage

Given choice of x, firms maximize *quasi-rents* $\tilde{\pi}(x)$

$$\tilde{\pi}(x) = \max_{p,\, \ell} \left\{ py - \ell \right\}$$

subject to

$$y = z[1 + x]\ell$$
$$y = X \cdot P^{\sigma - 1} \cdot p^{-\sigma}$$

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In equilibrium, *limit price* is:

$$p = \begin{cases} \frac{1}{(1-\mu)\phi z^R} & \text{in Rust Belt, and} \\ \frac{1}{\phi z^S} & \text{in Rest-of-Country} \end{cases}$$

Labor Markets

- Firms in Rest-of-Country
  - Competitive - hire workers at wage $w = 1$
- Firms in Rust Belt pay wage premium
  - Pay competitive wage plus share of quasi-rents
  - Note: union jobs will be rationed

Union

- Covers only Rust Belt workers
- Preferences

$$\sum_{t=0}^{\infty} \delta^t R_t$$

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$$\sum_{t=0}^{\infty} \delta^t R_t$$
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- If firm accepts, union gets $R_t = b_t \cdot \tilde{\pi}_t^R$
- If firm rejects, union calls strike and
  - succeeds with probability β_t
    (i.e. production is halted for one period and $\tilde{\pi}_t^R = 0$)
  - fails with probability $1 - \beta_t$
    (i.e. production resumes but no wage premium)

State of Competition

- State of competition, $\theta_t \equiv (\beta_t, \mu_t)$
- θ_t evolves exogenously

Dynamic Firm Problem: Rust Belt

$$V_R(Z_R;\theta) = \max_{x_R} \Big\{ (\mathbf{1}-\mathbf{b})\tilde{\pi}_R(Z_R, X_R, \theta) - I(x_R, Z_R) + \delta \mathbb{E}\Big[V_R\big(Z'_R;\theta'\big)\Big]\Big\}$$

where

$Z_R \equiv (z_R, \tilde{z}_R, \tilde{z}_S)$

$\tilde{\pi}_R(Z_R, X_R;\theta)$ is period quasi-rents

$X_R \equiv (x_R, \tilde{x}_R, \tilde{x}_S)$

$z'_R = z_R(1 + x_R)$

Dynamic Firm Problem: Rest-of-Country

$$V_S(Z_S;\theta) = \max_{x_S} \left\{ \tilde{\pi}_S(Z_S, X_S, \theta) - I(x_S, Z_S) + \delta \mathbb{E}\Big[V_S\big(Z'_S;\theta'\big) \Big] \right\}$$

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Dynamic Union Problem

Union solves

$$V_U(Z_R;\theta) = \max_{b\in[0,\beta]} \left\{ \mathbf{b}\cdot\tilde{\pi}_R(Z_R,X_R,\theta) + \delta\mathbb{E}\Big[V_U\big(Z'_R;\theta'\big)\Big] \right\}$$

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- Consider case when $\delta = 0$

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$$\max_{x_R} \left\{ (\mathbf{1} - \mathbf{b}_t) \tilde{\pi}_R(Z_R, X_R, \theta) - I(x_R, Z_R) \right\}$$

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$$\max_{x_R} \left\{ (\mathbf{1} - \mathbf{b}_t)\tilde{\pi}_R(Z_R, X_R, \theta) - I(x_R, Z_R) \right\}$$

- First-order condition

$$(\mathbf{1} - \mathbf{b}_t)\tilde{\pi}'_R(Z_R, X_R, \theta) = I'(x_R, Z_R)$$

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- Investment decreasing in b_t

Dynamics of Investment, Productivity and Employment

- Suppose innovation lower in Rust Belt: than at some t. Then, from t to $t+1$:
- Productivity grows at slower rate in Rust Belt
- Household expenditure share of Rust Belt goods declines
- Employment share of Rust Belt declines

Quantitative Analysis

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- Data on markups and wage premia to calibrate extent of competition
  - Output market: estimated markups in Rust Belt, 1950-2000
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Quantitative Analysis

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- Data on markups and wage premia to calibrate extent of competition
  - Output market: estimated markups in Rust Belt, 1950-2000
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  - Recall: markups and premiums start high, fall in 1980s

Calibration

- 4% annual real interest rate
- Set $\sigma = 2.5$ (Broda and Weinstein (2006))
- Normalize initial z_R and z_S to be 1

State of Competition

- State of Rust Belt Competition, $\theta_t \equiv (\beta_t, \mu_t)$
- 3 states of competition: $\theta_t \in \{\theta_H, \theta_L, \theta_C\}$
  - $\theta_H = (\beta_H, \mu_H)$ is highest distortion state in Rust Belt
  - $\theta_L = (\beta_L, \mu_L)$ is lower distortion state in Rust Belt
  - $\theta_C = (0, 0)$ is perfect competition
- θ_t evolves exogenously

State of Competition

- Begin in θ_H
- Transition matrix

	θ_H	θ_L	θ_C
θ_H	$1-\epsilon$	ϵ	0
θ_L	0	$1-\epsilon$	ϵ
θ_C	0	0	1

Investment

- Investment cost function

$$I(x_i, Z_i) = \bar{c} \cdot x_i^{\gamma} \cdot \frac{z_i^{\sigma-1}}{\lambda \tilde{z}_R^{\sigma-1} + (1-\lambda)\tilde{z}_S^{\sigma-1}}$$

where $\bar{c} > 0$ and $\gamma > 1$

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- Delivers balanced growth in perfectly competitive state

Parameters to Calibrate

- ϕ - catch-up of competitive fringe
- λ - share of goods produced by Rust Belt
- $\overline{c}$ - linear (scale) parameter of cost function
- γ - curvature parameter of cost function

Calibration Targets

- Markup of 10% in ROC
- Initial Rust Belt employment share of 51%
- Long-run growth of 2% per year
- Innovation Investment/GDP of 5% (R&D, advertising, intangible expenditures)

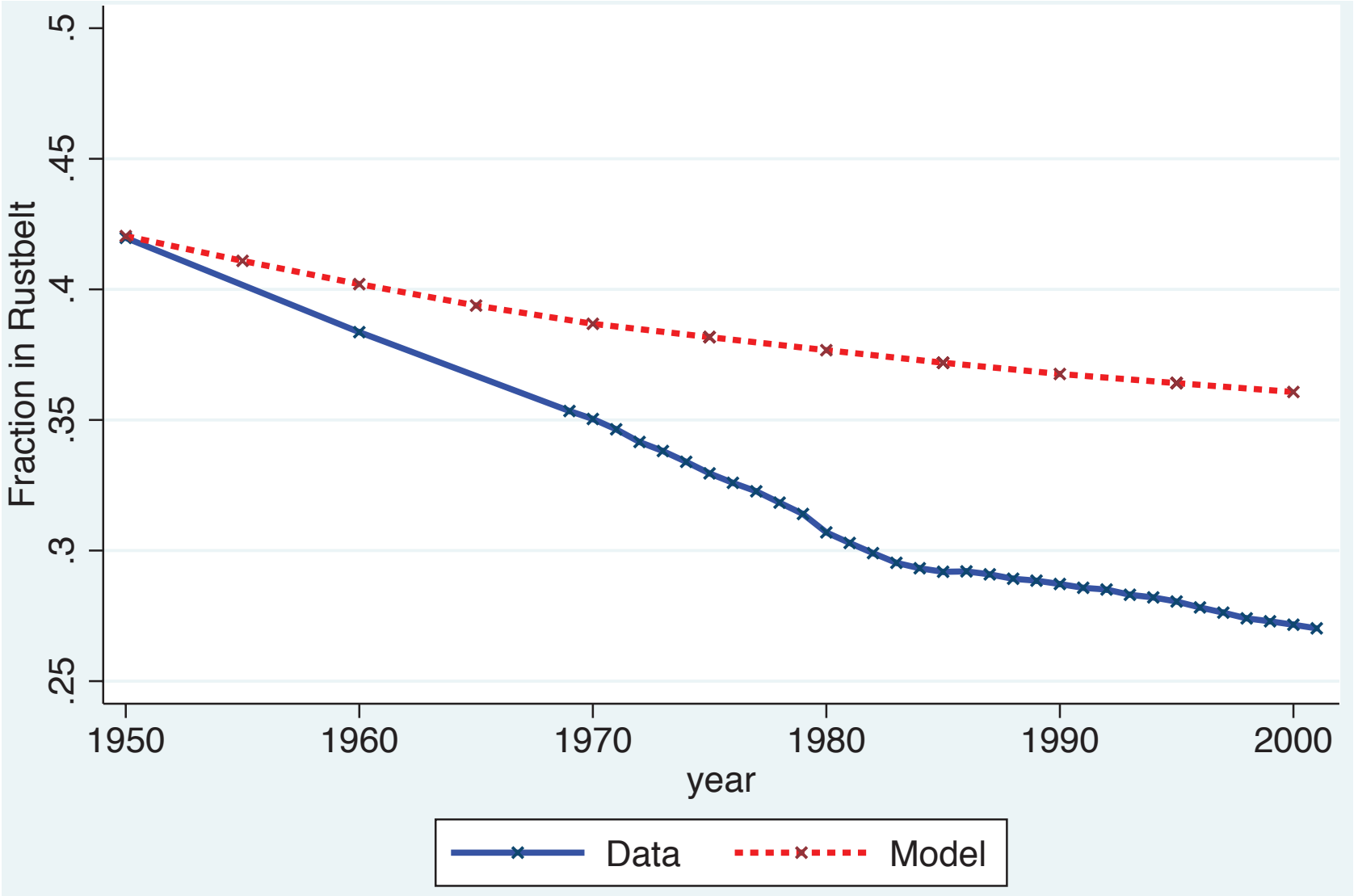
Extent of Competiition

- Targets

	Wage Premium	Markup
θ_H	0.12	0.22
θ_L	0.04	0.14

- Wage premiums: relative wages in Rust Belt pre & post 1980
- Markups: Collard-Wexler and De Loecker (2012), vertically-integrated steel industry, pre and post 1980s

Rust Belt Employment Share in Model and Data



Model's Other Predictions

- Innovation investment-to-output ratio
  - Rust Belt: 3.3%, ROC 6.5%
- Productivity growth (per year)
  - Rust Belt: 1.4%, ROC 2.3%
- Consistent with Y/N evidence from U.S. industries

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- More evidence
  - Estimates of R&D intensity by industry from 1970s ▸ R & D
  - TFP growth: Rust Belt vs. Japan ▸ TFP
  - Adoption rates for key technologies ▸ Adoption

▸ Post-1980 Growth ▸ Conclusion

R&D by Industry: Evidence

- Report of U.S. Office of Technology Assessment (1980)
- Average manufacturing industry: R&D to Sales of 2.5%
- Highest:
  -
  - Communications equipment 15.2%
  - Aircraft and parts 12.4%
  - Office and computing equipment 11.6%
- Rust Belt
  -
  - Autos 2.1%
  - Rubber and Plastics 1.2%
  - Steel 0.4%

Productivity Growth: United States versus Japan

- Steel (Lieberman and Johnson, 1999)

  US: TFP growth < 1 percent per year 1950 to 1970

  Japan: TFP *doubled* over same period

- Autos (Fuss and Waverman, 1991)

  US: 1.6 percent per year in 1970s

  Japan: 4.3 percent per year in 1970s

Technology Adoption: Evidence

- Industry studies: Rust Belt industries were slow adopters
- Two new technologies in steel of 1950s and 1960s
  - Basic oxygen furnace
  - Continuous casting methods

Fraction of Steel Made Using Continuous Casting Process

▸ Post-1980 Growth ▸ Conclusion

Signed Confession

From 1980 Annual Report of American Iron and Steel Institute: Inadequate capital formation in any industry produces meager gains in productivity, upward pressure on prices, sluggish job creation, and faltering economic growth. These effects have been magnified in the steel industry. Inadequate capital formation ... has prevented adequate replacement and modernization of steelmaking facilities, thus hobbling the industry's productivity and efficiency.

Did Productivity Growth Pick up After 1980s?

- Steel
  - US vertically integrated mills (mostly in Rust Belt)
  - 11 percent TFP growth from 1982 to 1987; 16 percent 1992 to 1997
  - Source: Collard-Wexler and De Loecker (2012), Lieberman and Johnson (1999)
- Autos
  - Pick up seen in cars per worker at GM, Ford and Chrysler
  - From annual reports; most operations in Rust Belt
  - Working on TFP numbers

Conclusion

- Rust Belt declined dramatically from 1950 to 2000
- Theory: lack of competition was key factor in decline of Rust Belt
  - Little competitive pressure reduced innovation
  - Union hold-up reduced innovation
- Lack of competition accounts for about half of decline
- Industry productivity data & historical evidence consistent with theory