

Factories on the Frontier:

Technology, skill, and risk in manufacturing

Ben Armstrong

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The 'Industrial Strategy' Hypothesis



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An Alternative: Industrial Learning



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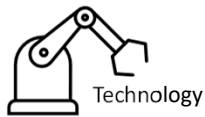
An Alternative: Industrial Learning



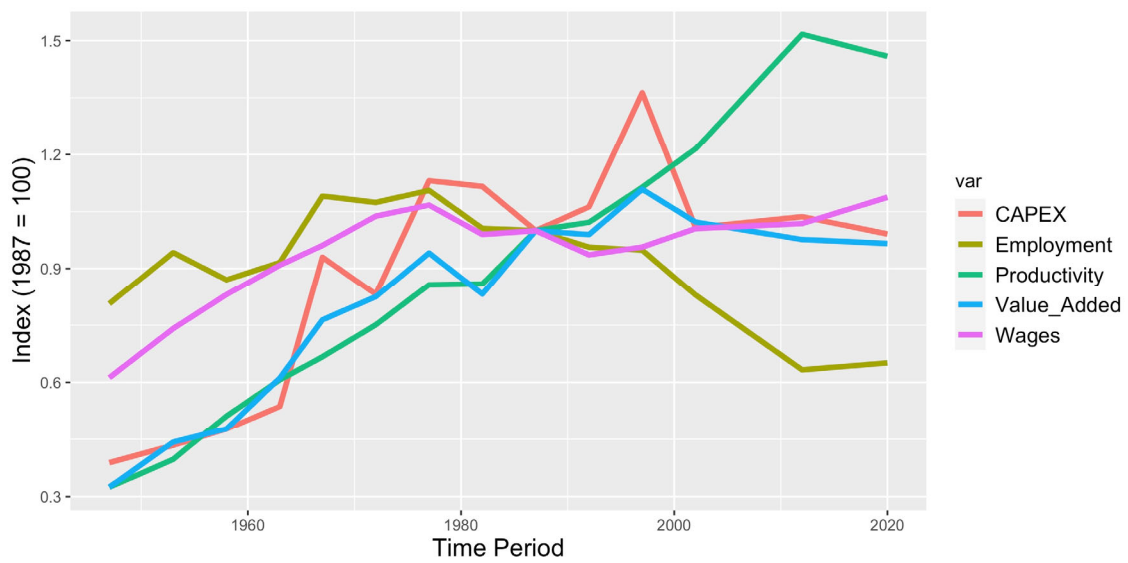
An Alternative: Industrial Learning



- Patient capital
- Growth orientation
- High-stakes experimentalism



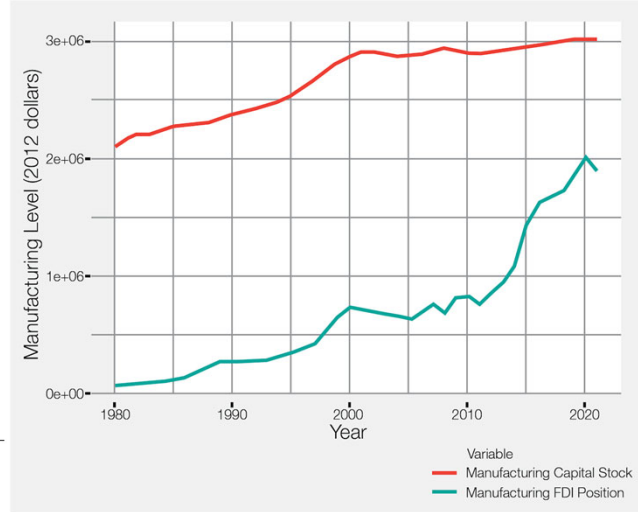
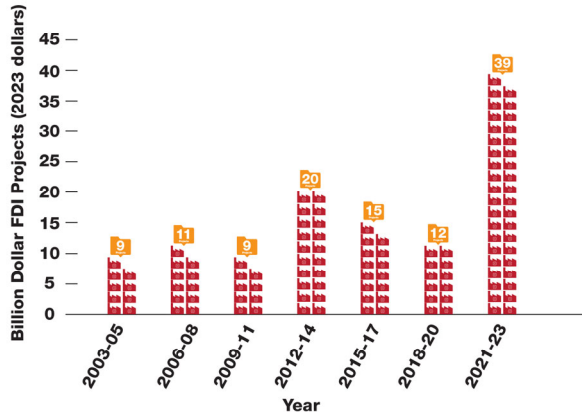
Evolution of U.S. Manufacturing



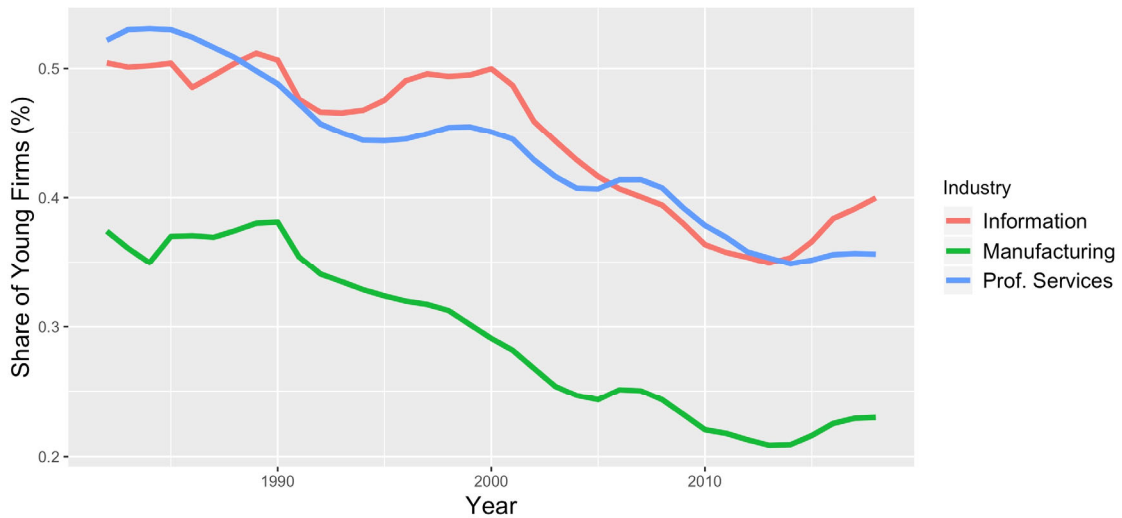
Patient Capital and Foreign Direct Investment

Billion Dollar Factories Over Time

Foreign Direct Investment (FDI) projects have spiked in the last three years.



Manufacturing Startups



An Alternative: Industrial Learning



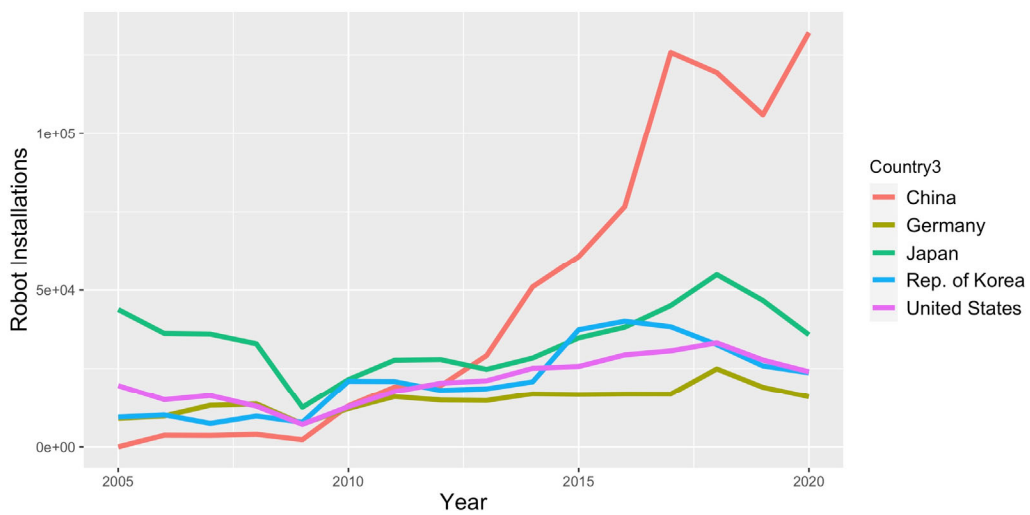
- Patient capital
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- Adoption, scale-up
- Flexibility, control
- Innovation – production loop



Correlates of Robot Adoption



Source: International Federation of Robotics (2005-2020)

Positive-Sum Automation

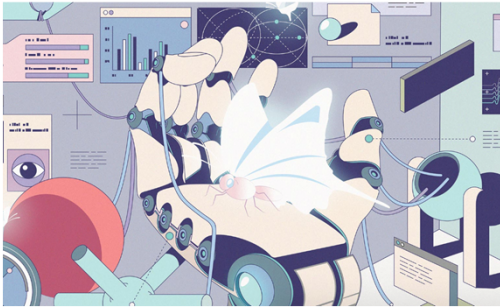
Harvard
Business
Review

Operations Strategy

A Smarter Strategy for Using Robots

by Ben Armstrong and Julie Shah

From the Magazine (March-April 2023)



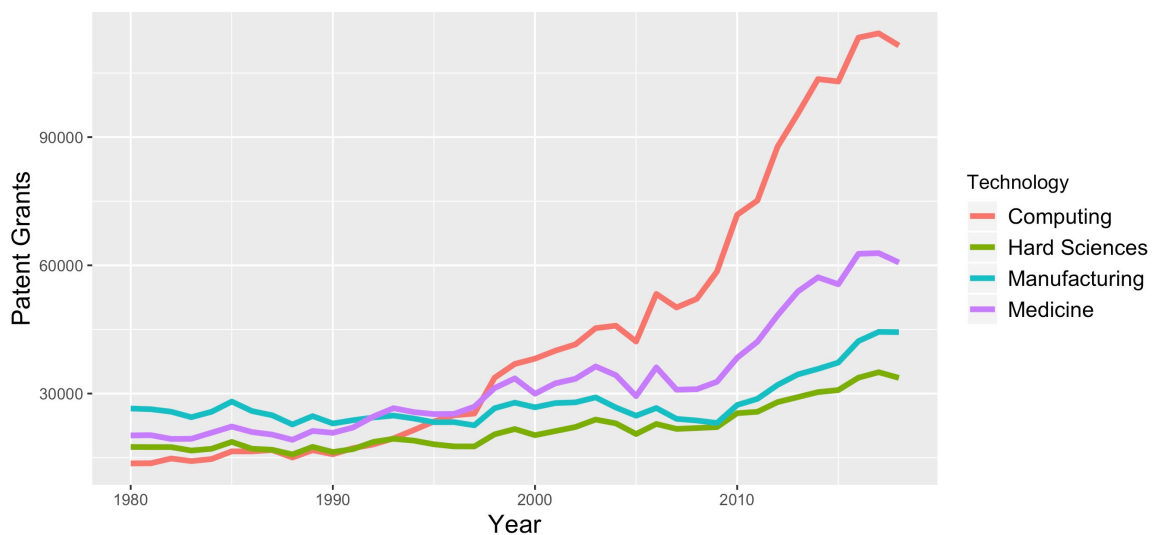
“Positive-sum automation requires

(i) **Designing technology** that makes it easier for line employees to train and debug robots;

(ii) using a **bottom-up approach** to identifying what tasks should be automated; and

(iii) choosing the right **metrics for success.**”

Manufacturing Innovation



Technology adoption and skill requirements

Technology in Manufacturing

Robots: ~12% of firms

Cloud applications: 29%

Specialized equipment: 39%

Specialized software: 42%

Digital skill requirements

Production: 18.6% of new jobs

Maintenance / repair: 14.6%

Administrative support: 46%

Business operations: 58.7%

Data source: U.S. Census (2018), Burning Glass (Q4 2019)

An Alternative: Industrial Learning



Risk

- Patient capital
- Growth orientation
- High-stakes experimentalism



Technology

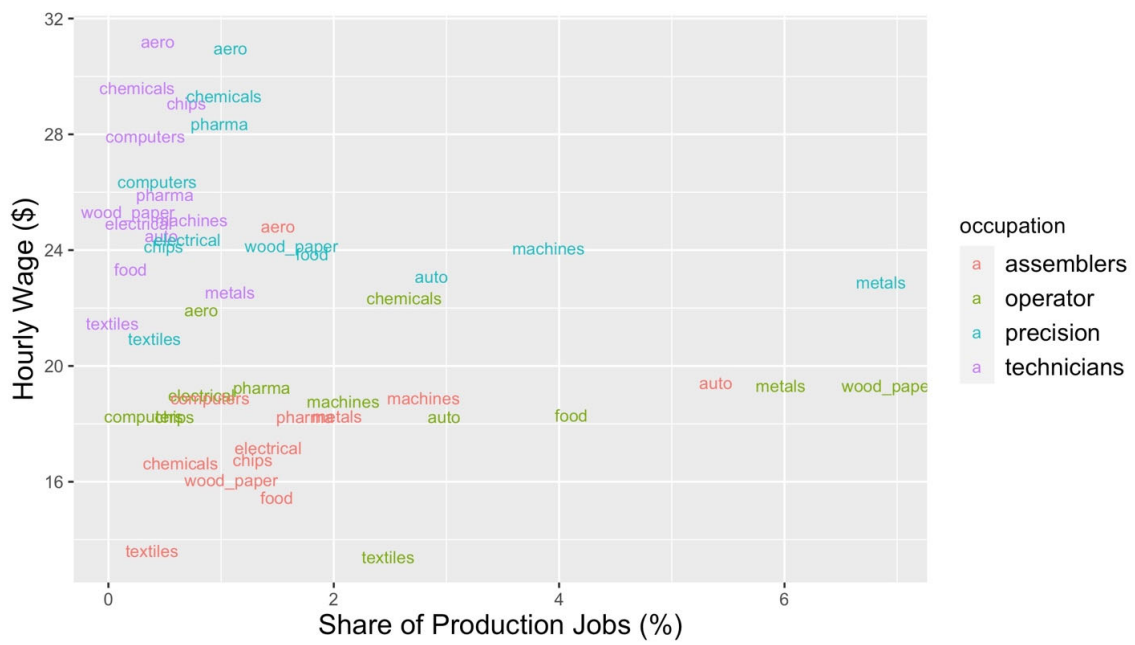
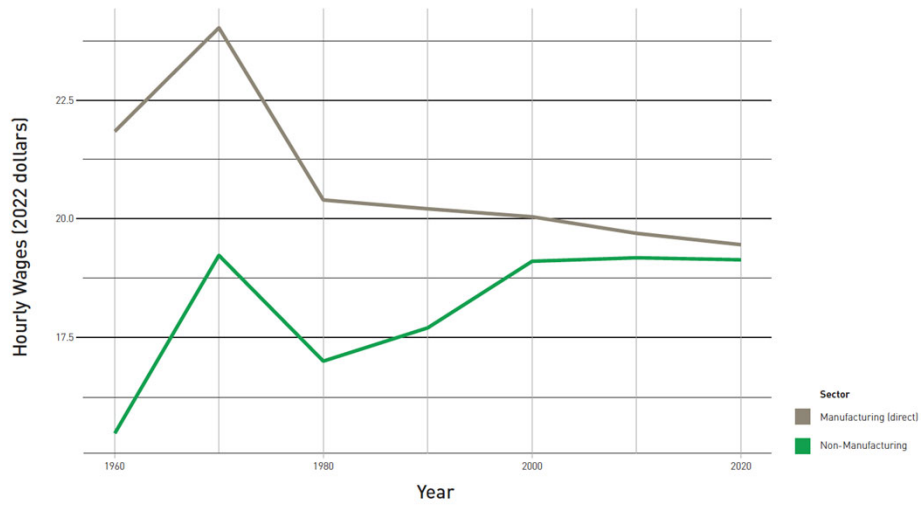
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Skills

- Missing middle
- Career ladders
- Regional networks

Figure 2.
The Shrinking Manufacturing Wage Premium



An Alternative: Industrial Learning



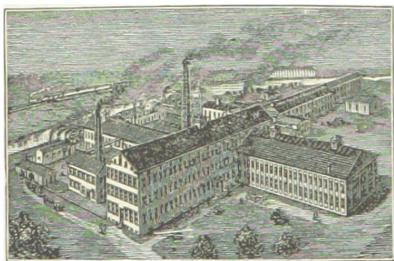
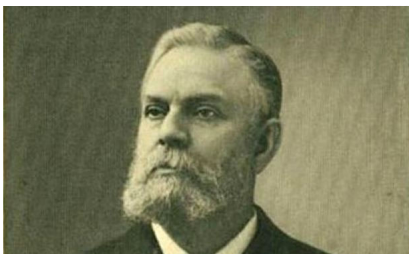
- Adoption, scale-up
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- Innovation – production loop

- Patient capital
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- Missing middle
- Career ladders
- Regional networks

What makes a 'critical industry'?



HARTFORD : POPE MANUFACTURING CO.

