Global Manufacturing and the Future of Technology

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Global Redistribution of Production

1999
- Rest of the World: 44%
- China: 6%
- U.S.: 26%
- Germany: 8%
- Japan: 16%
- Total: $5.6 Trillion (USD)

2013
- Rest of the World: 46%
- China: 24%
- U.S.: 16%
- Germany: 6%
- Japan: 8%
- Total: $12 Trillion (USD)
Does offshoring to developing East Asia change the innovation trajectory of the firm and the industry?

Two emerging technologies:
- Automotive Industry:
  - Fiber-reinforced Polymer Composite Unibody
  - Vehicle Light-weighting
- Telecommunications and Computing Industry:
  - Monolithic Integration of Optoelectronic Components
  - Originally small telecom firms
  - ITRS 2012: Moore’s Law
$1,200

$800

$400

0

25

50

Annual Production Volume (‘000s)

U.S. Production: Emerging Wins

Base Case Yield*
Discrete 3.9%
Integrated 2.3%
*Yield refers to cumulative yield of laser

U.S. Discrete Device
Base Case
(prevailing design)

U.S. Integrated Device
Base Case
(emerging design)

Global Production: Prevailing Wins

Cheaper to make the old product. But we don’t want the old product! Unfortunately, not what public firms do...

Not devaluing Yuan wages in PRC
Global redistribution of manufacturing changing what products profitable for firms to pursue

Can’t use “one-size-fits-all” policy: Relationship between manufacturing and innovation varies by technology

Optoelectronics Case: Extremely Constrained!
- Difficulty separating manufacturing from R&D
- Small market, only able to afford one manufacturing facility

... Only private, venture- and govt-supported firms stay...

In less constrained cases, global manufacturing footprint can support diversifying product portfolio

What role for the State?

Manufacturing
Extraordinary challenges
Critical in certain sectors
Technological nuance
Example 1: DARPA

- DARPA program manager: embedded network agent
  - Not “picking winners”
  - Not the one’s with the ideas, but rather the central node to which ideas flow
  - And yet, need “vision”
- To orchestrate the research community
  - Understanding emerging themes
  - Matching themes to military needs
  - Betting on the right people
  - Connecting disconnected communities
  - Standing up competing technologies against each other
  - Maintaining critical birds-eye perspective

Example 2: Semiconductor Research Corporation

- 1982: founded by SIA
  - Horizontal industry collaboration
  - Fund research at universities (Silicon IC)
  - Industry seeks government (local and national) funds
  - **Not** SEMATECH (1987; vertical collab.; 3-5 yr upgrading)

- Extraordinary success coordinating research within existing technological paradigm

- For what technological challenges is a PPP not the right organizational form?
  - Scaling Moore’s Law: New tech. paradigm
  - SRC’s Nanoelectronics Research Initiative
  - Fragmentation of collaborative incentives, GPT
Matching Organizational Form to Goals

- DARPA: Prevent technological surprise
- NSF: Advancement of peer-reviewed science
- PPP:
  - SRC: 5-7 yr advancement w/in paradigm (horizontal)
  - SEMATECH: 3-5 yr upgrading (vertical)
  - NNMI: TR 4-7; Platform technologies???
    - Technology selection by embedded network agents?
    - Aligned concentrated interests?

- With the importance of manufacturing for economic growth, national security... is toolkit right? Enough?

Fuchs, E., "Rethinking the Role of the State in Technology Development:" Research Policy, 39(2010): 1133-1147, 2010
Bonnin-Roca, J., Vaishnav, P., Morgan, M.G., Mendoca, J., Fuchs, E. When Risks Cannot be Seen” Research Policy. Accepted
Thank you.

NSF Science of Science Policy
(CAREER, SBE, GOALI)
... NIST and many others...
Global Production: Location Matters

Global Production: Prevailing Wins

Can U.S.-Based Emerging Compete?

Offshoring & Innovation (More?)

- Automobile bodies: Opportunities missed? (Fuchs et al 2011)
- Innovative low-volume, high-mix production (Egelman et al. 2015, Treado & Fuchs 2015)
- China: Largest demand, production of automobiles
- Consumers more willing to pay for electric vehicles in China than the U.S. (Helveston et al 2014)

- Manufacturing Characteristics
  - Manufacturing Characteristics
  - Targeted Market

- Most Economic Design
  - Design for Location (2010)
  - Plastic Cars in China (2011)

- Technology Trajectory
  - Gains from Others (2015)

- Will subsidies drive... (2014)
  - Learning in Multi-product... (2015)
  - Manufacturing Variety (2015)

- Firm ?
- Industry ?
U.S. Manufacturing Employment Declines

(Thousands Employees)

Manufacturing Value Added (MVA) (Current US$)

% Global Manufacturing Value Added (MVA)

Year

United States MVA

United States % Global MVA

Mar-09 Nov-11 Aug-14

0% 5% 10% 15% 20% 25% 30%

0 2.0E+12 4.0E+11 6.0E+11 8.0E+11 1.0E+12 1.2E+12 1.4E+12 1.6E+12 1.8E+12 2.0E+12

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000

Jan-90 Jul-92 Apr-95 Nov-98 Aug-01 May-04 Dec-07
Who will produce what, where?

- Workforce policy informed by inadequate data
- Can we leverage insights from engineering models based on industrial data to inform the link between technology and workforce changes?
Four categories of technology change

- **Automation (Robots)**
  - H: more net jobs, more bottom and top?

- **Component Integration**
  - H: fewer net jobs, more middle?

- **Product Variety (Customization)**
  - H: more net jobs, more middle?

- **Artificial Intelligence**
  - H: more net jobs, only at the top

... in all cases also changing what products are possible...