

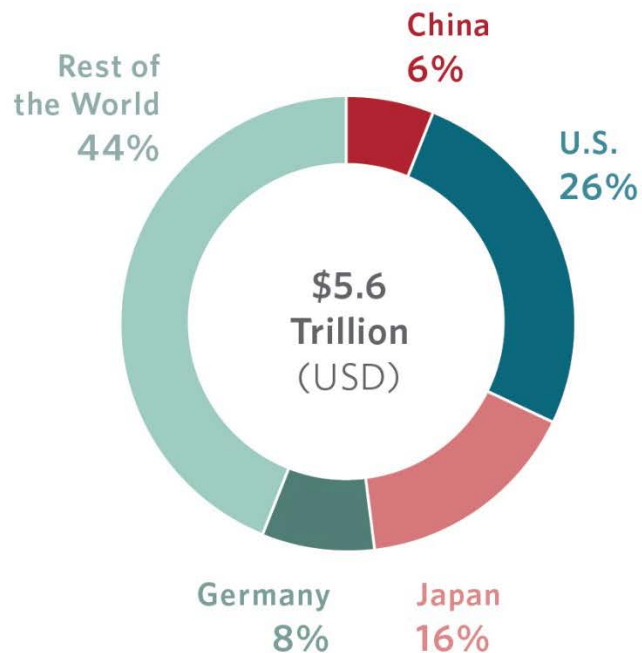


Global Manufacturing and the Future of Technology

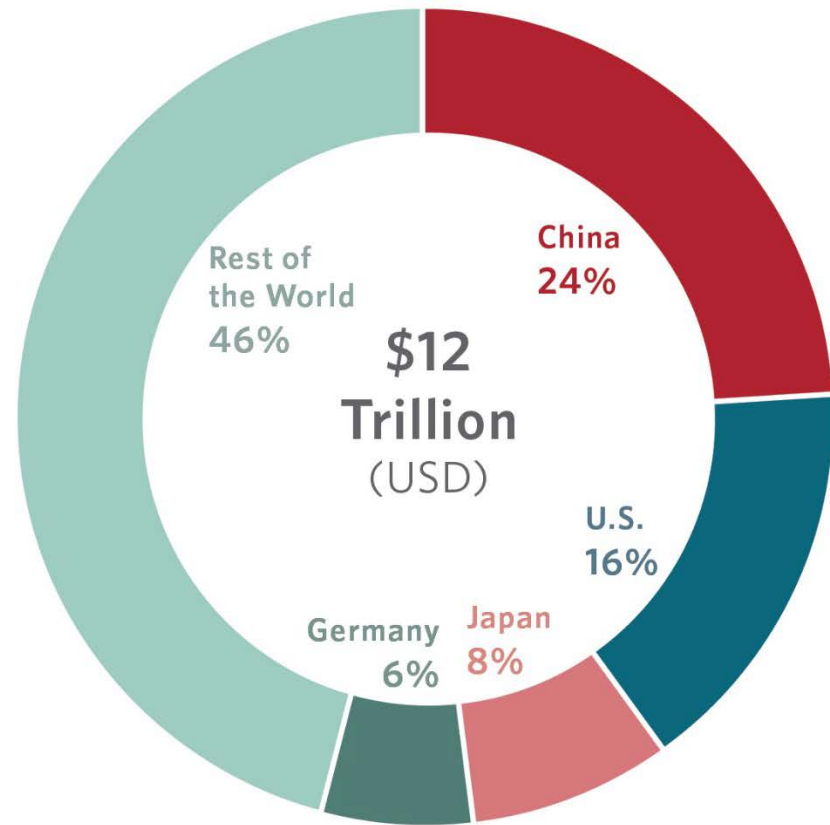
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Global Redistribution of Production

1999



2013



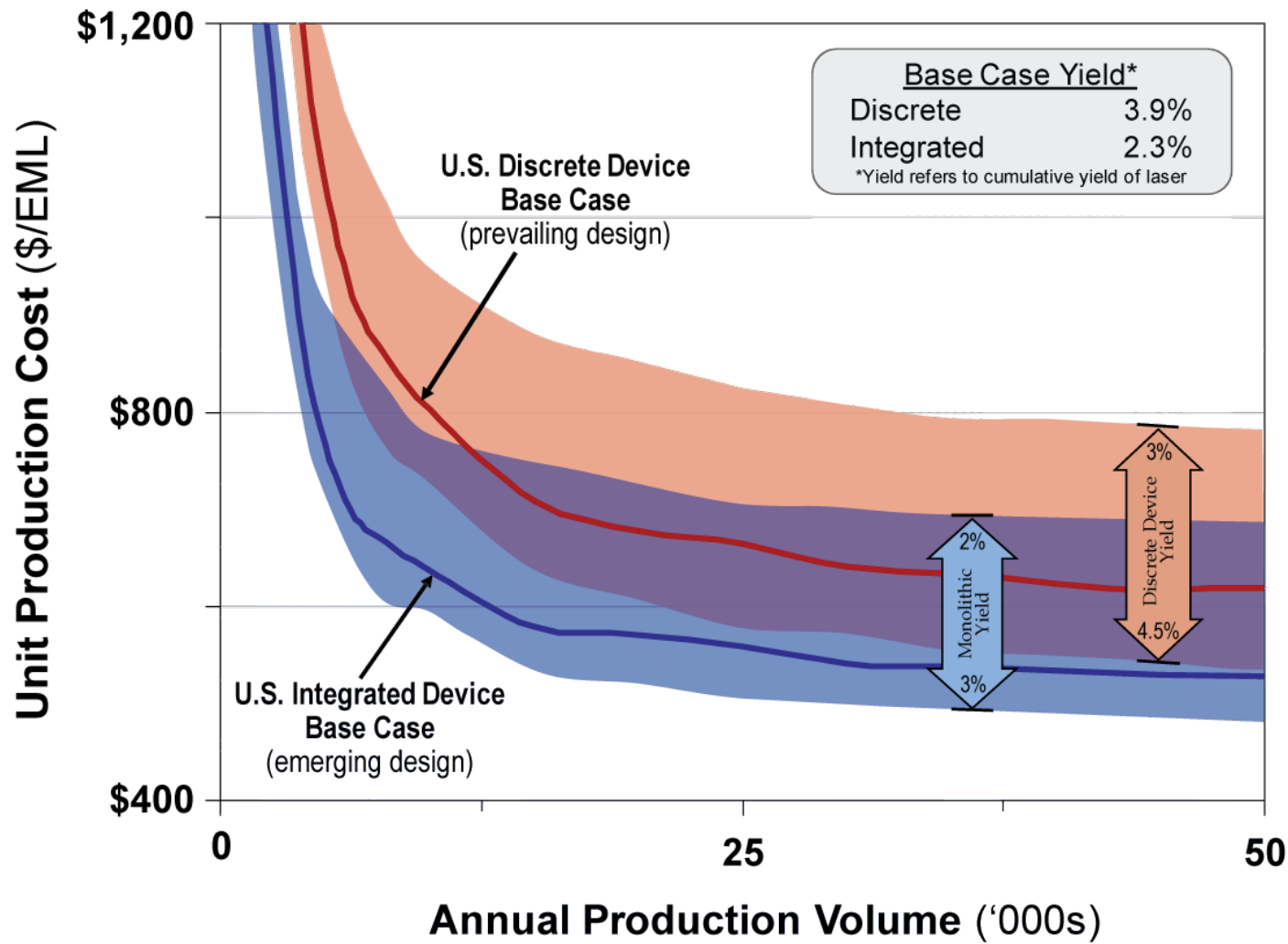
Two Industries: Automobiles, Communications

Does offshoring to developing East Asia change the innovation trajectory of the firm and the industry?

Two emerging technologies:

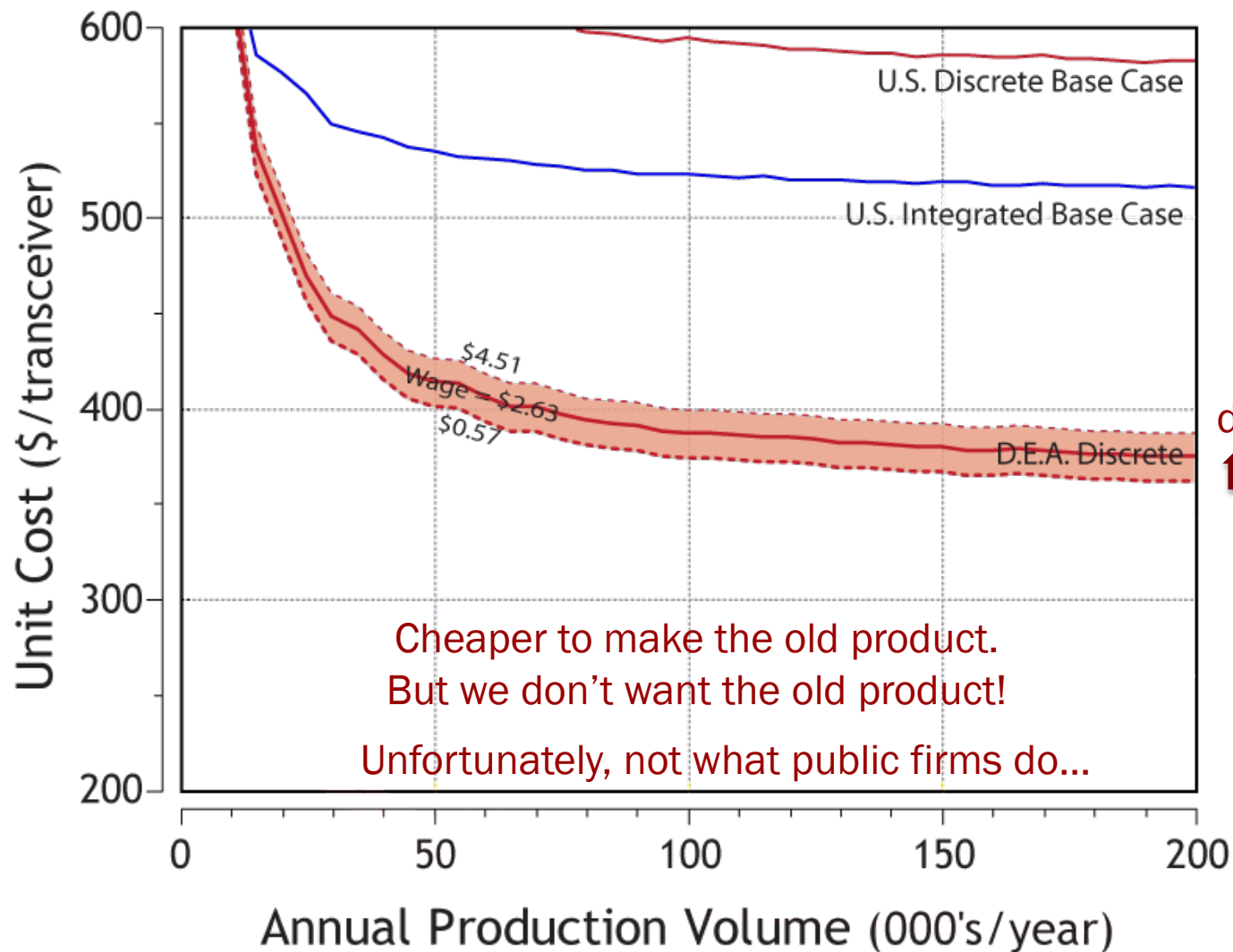
- ❑ Automotive Industry:
 - ❑ Fiber-reinforced Polymer Composite Unibody
 - ❑ Vehicle Light-weighting
- ❑ Telecommunications and Computing Industry:
 - ❑ Monolithic Integration of Optoelectronic Components
 - ❑ Originally small telecom firms
 - ❑ ITRS 2012: Moore's Law

U.S. Production: Emerging Wins



Fuchs, Bruce, Ram, Kirchain (2006) Process-Based Cost Modeling of Photonics Manufacture *Journal of Lightwave Technology*. 24(8): 3175-3186.

Global Production: Prevailing Wins



Fuchs and Kirchain (2010) Design for Location: The Impact of Manufacturing Offshore on Technology Competitiveness in the Optoelectronics Industry. *Management Science*. 56(12): 2323-2349.

Not all Technologies are Created Equal

- ❑ 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
 - ❑ Typical of small, process-based, high-tech firms? (Pisano 1997, Bohn 2005, Lecuyer 2006)
... 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

Fuchs, E., "Rethinking the Role of the State in Technology Development: DARPA and the Case for Embedded Network Governance", Lead article, Research Policy, 39(2010): 1133-1147, 2010

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

Khan, H., Hounshell, D. and Fuchs, E. 2014. Scaling Moore's Wall: A Public Private Partnership in Search of a Technological Revolution. Revise and Resubmit. Research Policy.

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?

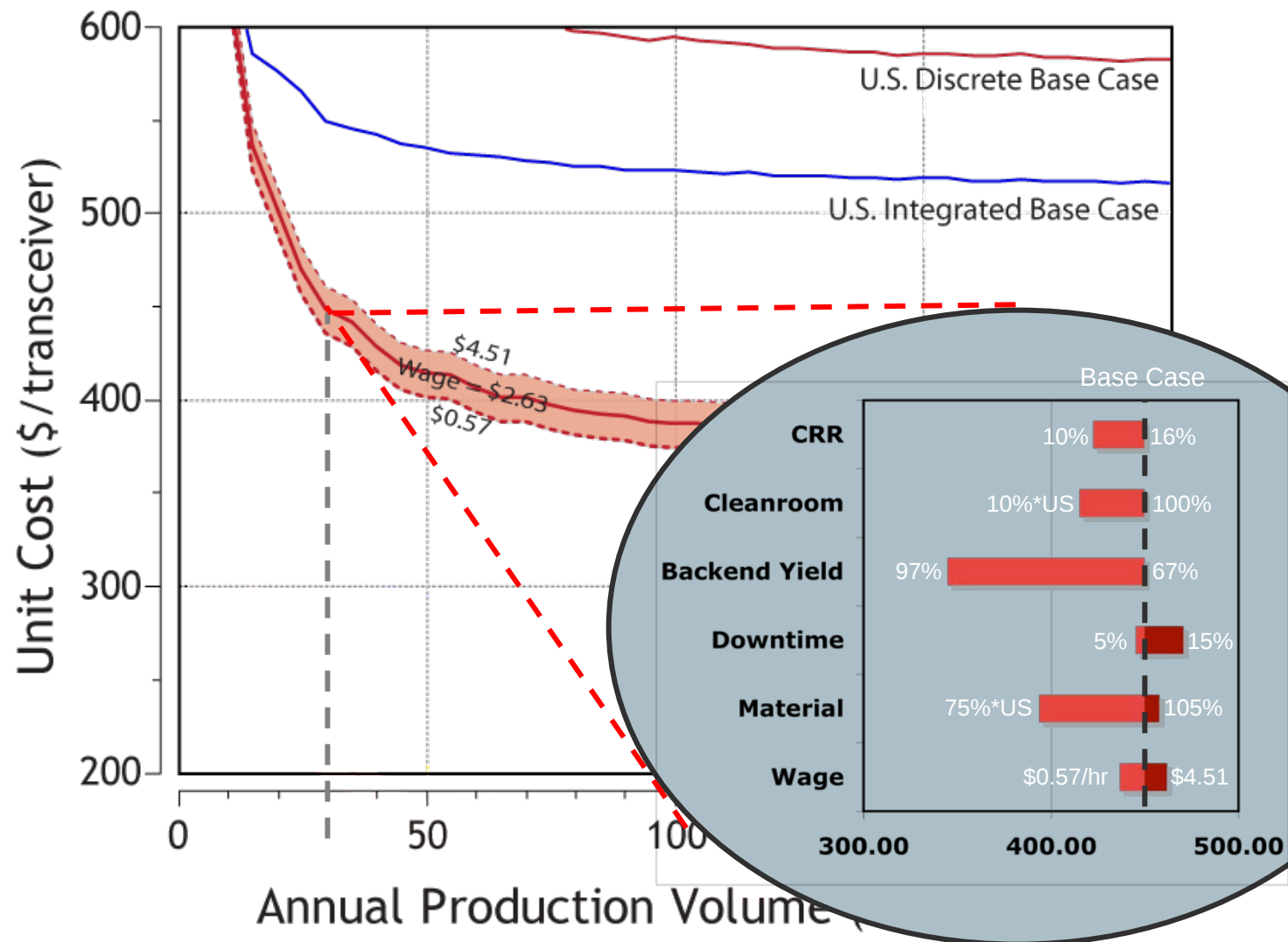
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Bonnin-Roca, J., Vaishnav, P., Morgan, M.G., Mendoca, J., Fuchs, E. When Risks Cannot be Seen" *Research Policy*. Accepted



Thank you.

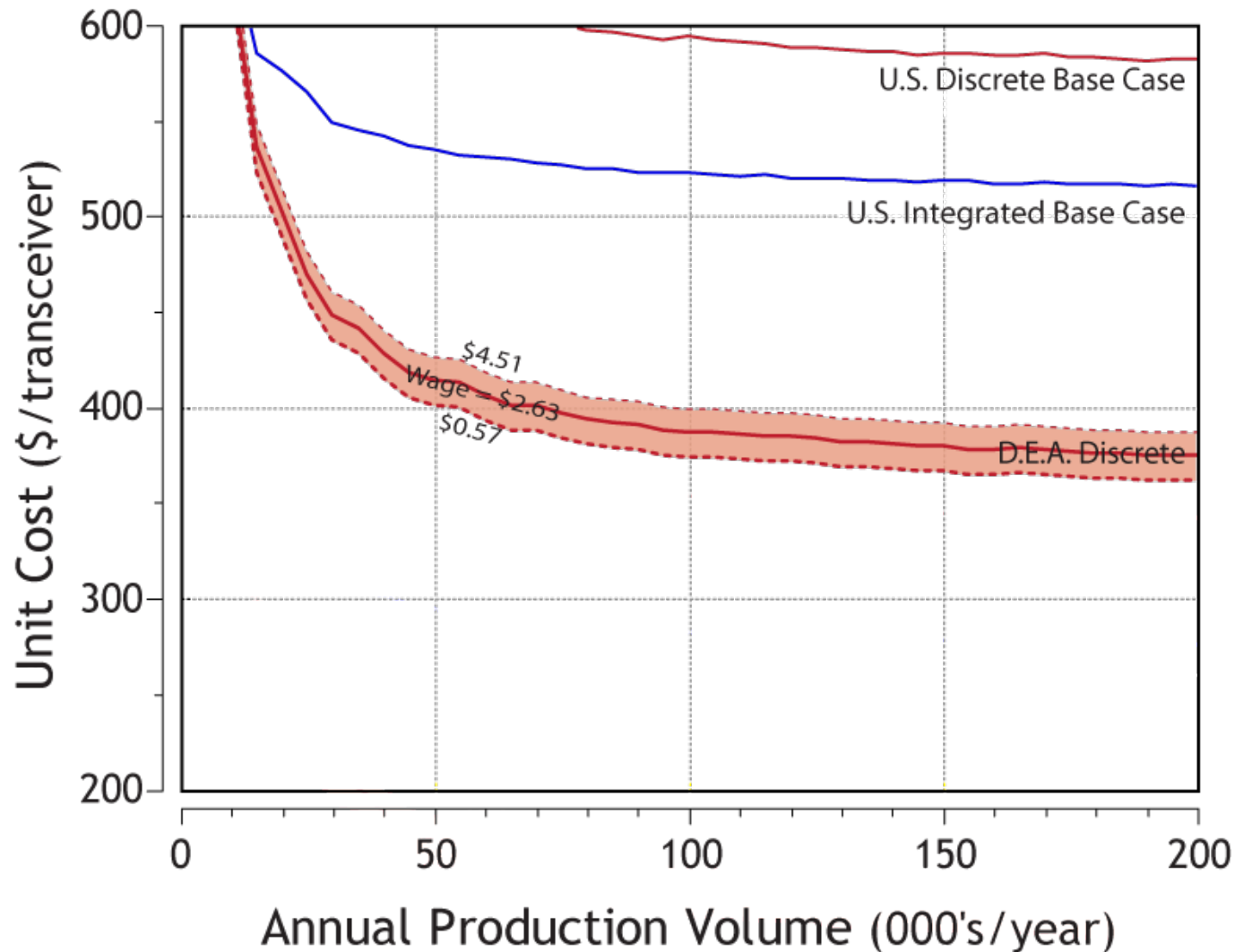
NSF Science of Science Policy
(CAREER, SBE, GOALI)
... NIST and many others...

Global Production: Location Matters



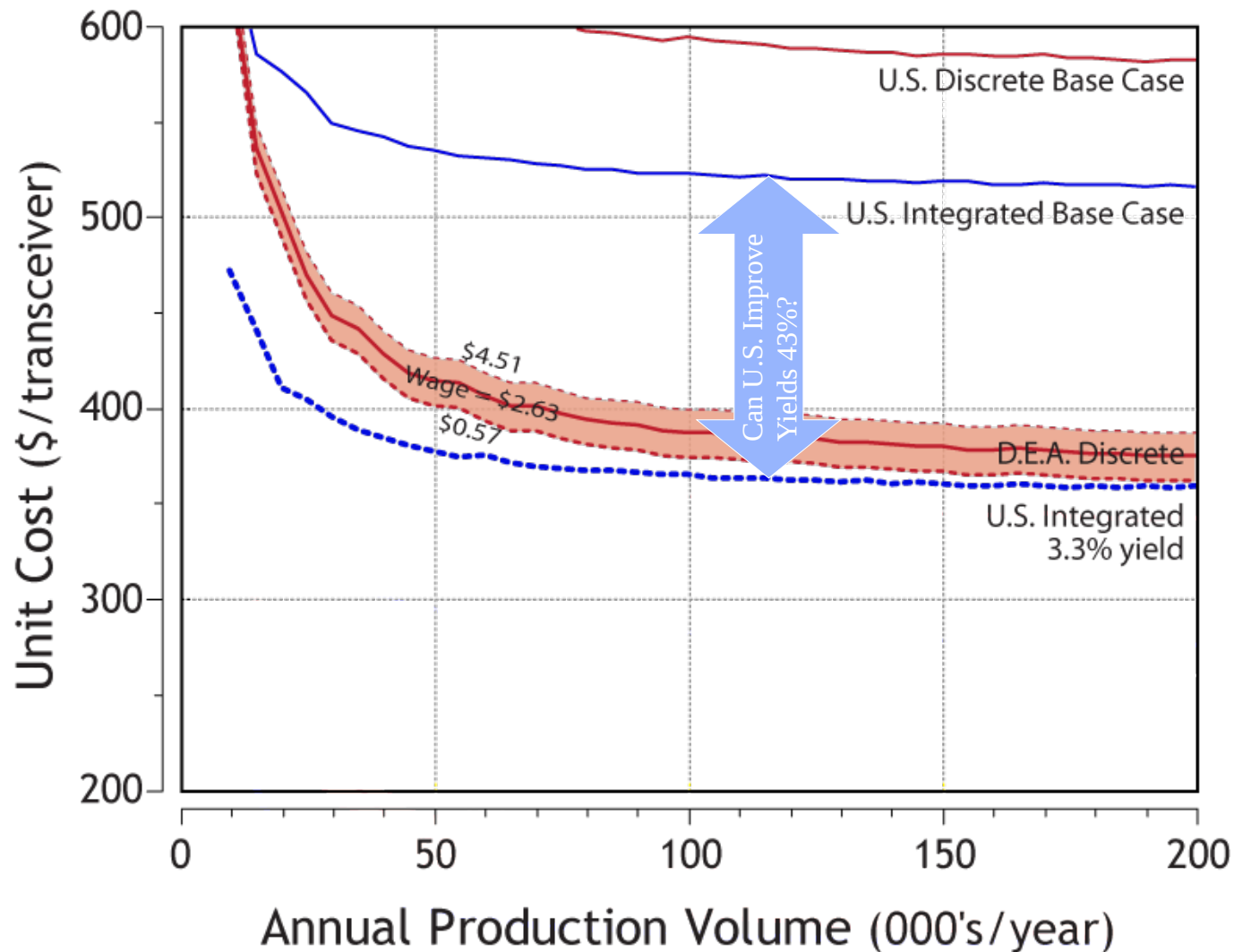
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Global Production: Prevailing Wins



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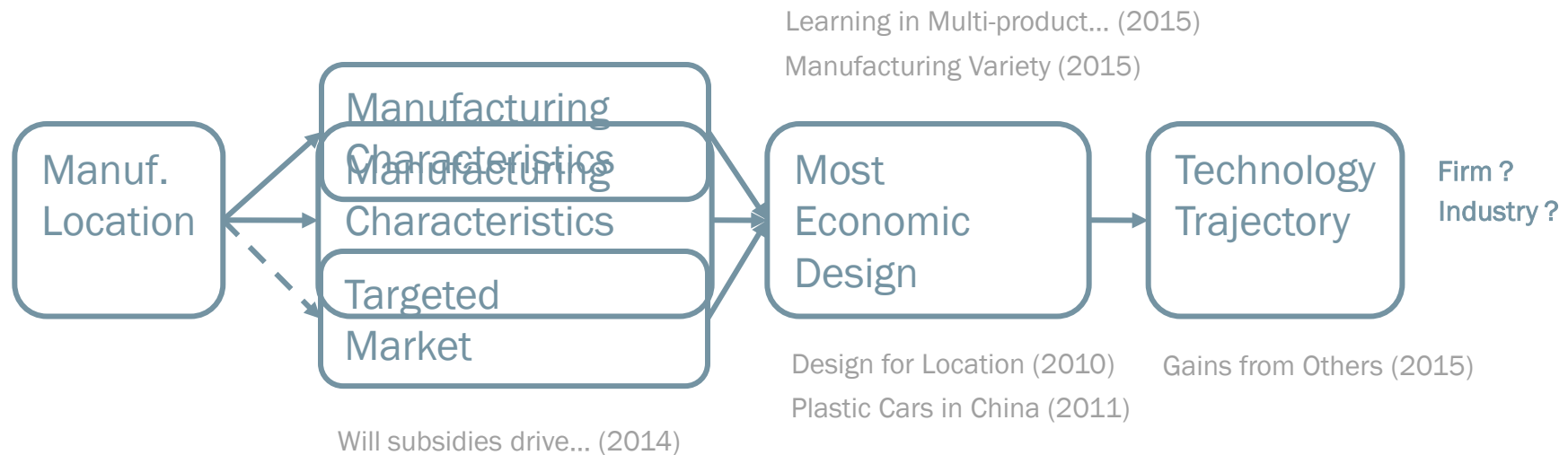
Can U.S.-Based Emerging Compete?



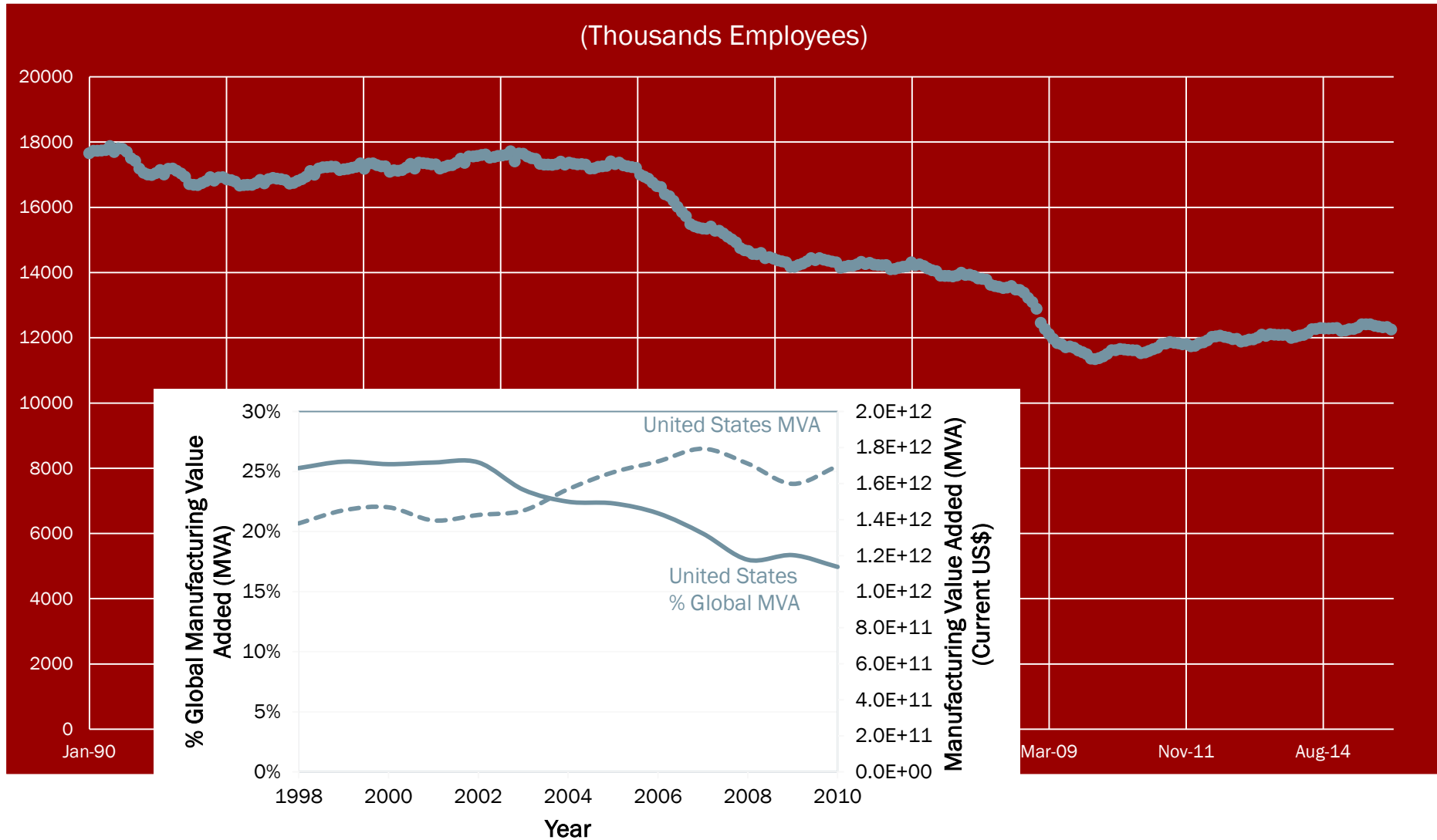
Fuchs and Kirchain (2010) Design for Location: The Impact of Manufacturing Offshore on Technology Competitiveness in the Optoelectronics Industry. *Management Science*. 56(12): 2323-2349.

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)

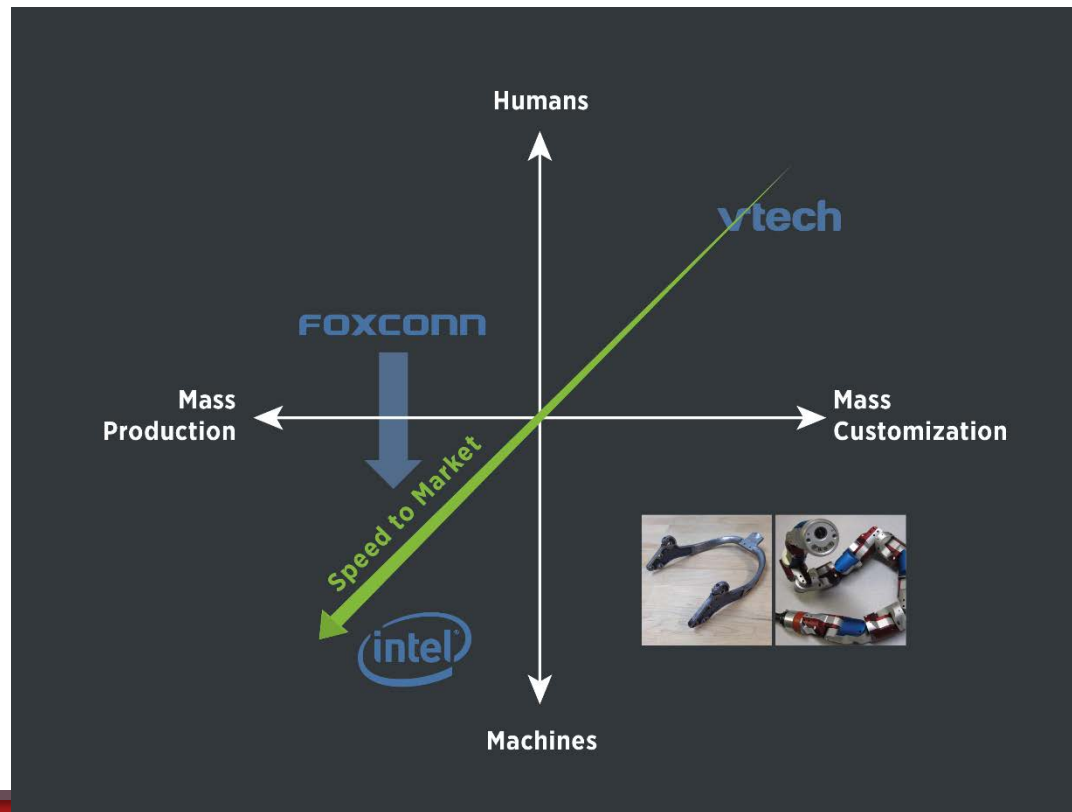


U.S. Manufacturing Employment Declines



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...