The Role of the Federal Government in Strengthening American Manufacturing

Securing Advanced Manufacturing in the US: the Role of Manufacturing USA
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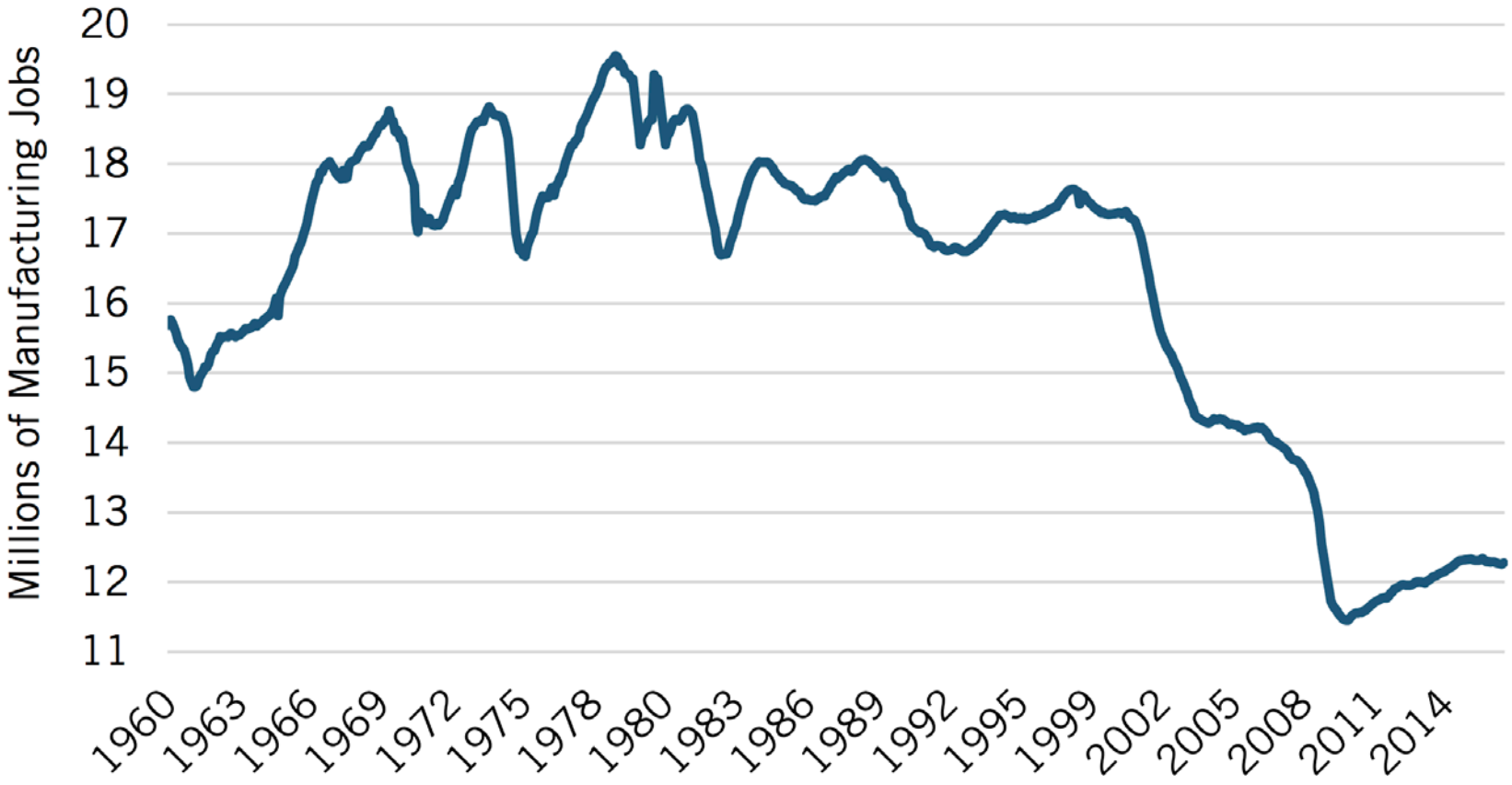
Outline

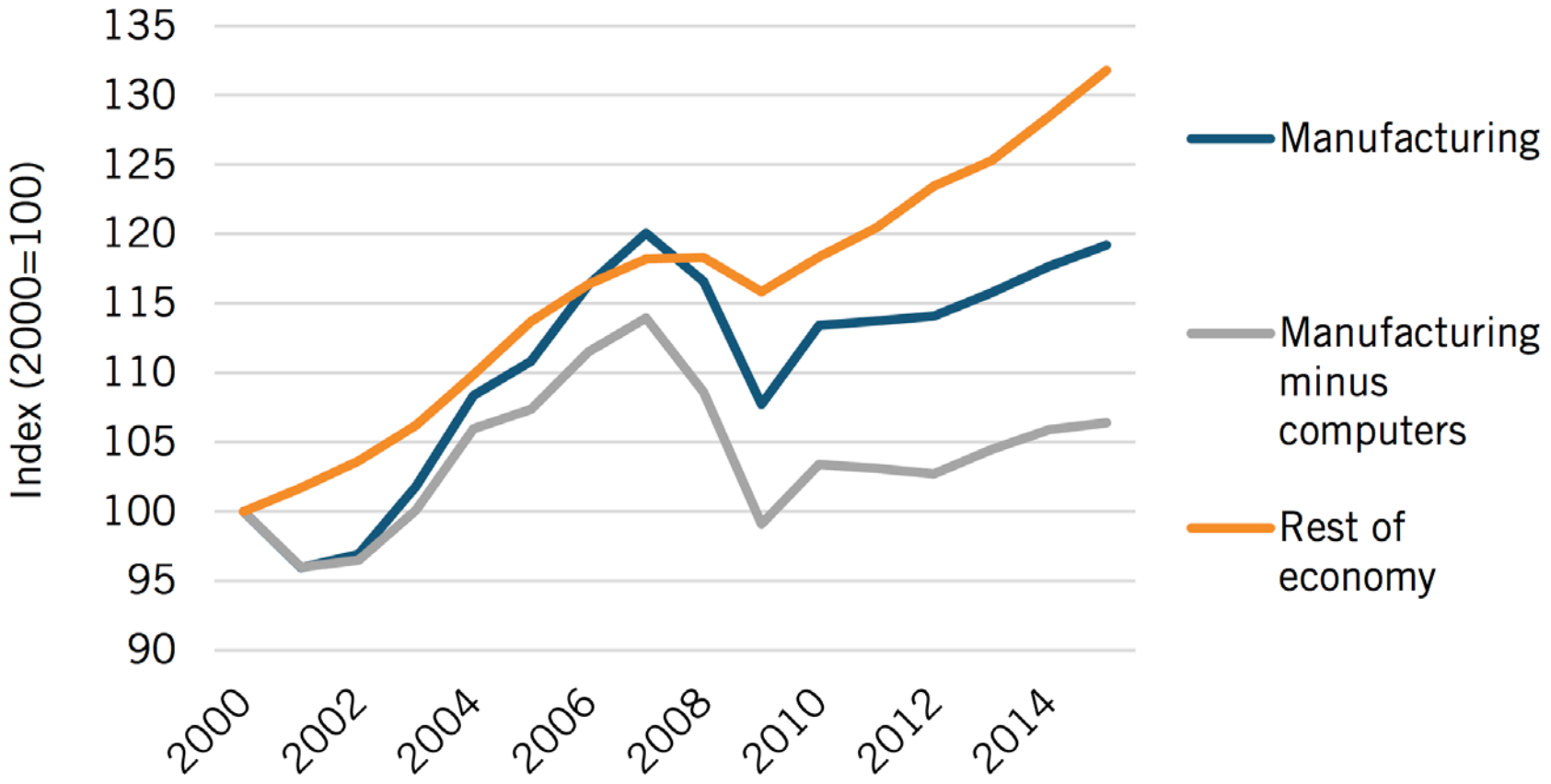
- What happened to U.S. manufacturing?
  - Could U.S. manufacturing have a resurgence?
- Will the market provide a socially-optimal manufacturing sector?
- What obstacles hinder a better U.S. manufacturing sector?
  - How could M*USA Institutes help overcome these obstacles?

Figure 1: Manufacturing Employment, 1960–2016[5]



http://www2.itif.org/2017-trade-vs-productivity.pdf

Figure 9: Manufacturing and Rest of Economy Real Value-Added, 2000–2015[41]

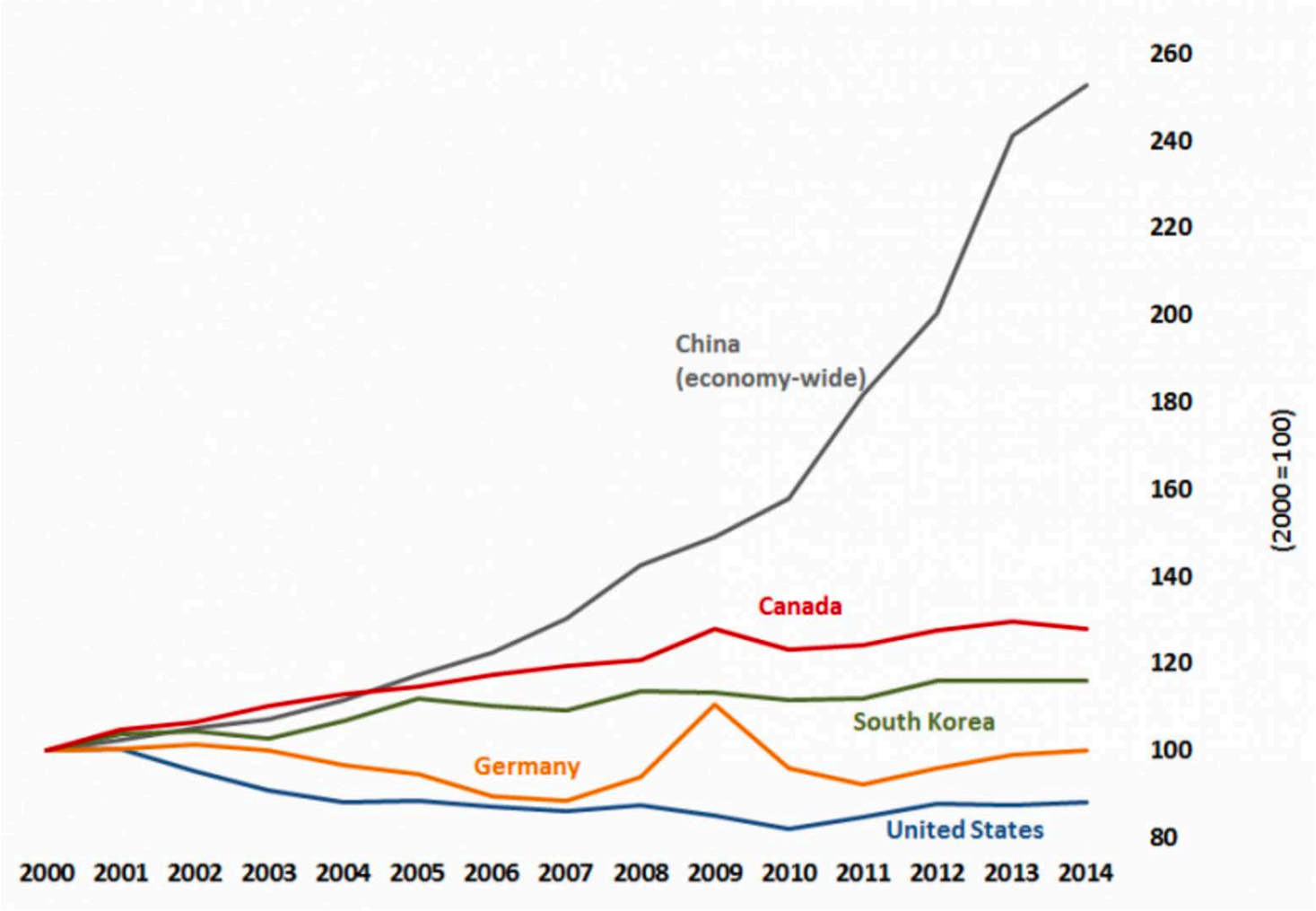


http://www2.itif.org/2017-trade-vs-productivity.pdf

This decline not inevitable

- Public, private policies reduced U.S. manufacturing employment
  - Globalization/trade agreements/strong dollar
  - Automation
  - Financialization
  - Lack of support for industrial commons
- Not all rich countries similarly affected
  - For example, Germany
    - higher wages than the U.S.
    - 19% of workforce is in mfg (U.S. is 9%)
    - more manufacturing workers than in 2005 (U.S. -15%)

Indexed Unit Labor Costs in the Manufacturing Sector of Selected Countries, 2000-2014



Source: Economics and Statistics Administration analysis of data from Bureau of Labor Statistics, International Labor Comparisons program and National Bureau of Statistics of China.

Hidden Inventory Costs Alone Often Exceed the Benefits of Offshoring

SOURCE: "COMPETITVE MANUFACTURING IN A HIGH-COST ENVIRONMENT" BY SUZANNE DE TREVILLE, MIKKO KETOKIVI, VINOD, SINGHAL

20-30%: The additional cost of stock-outs and liquidations due to farflung supply chain.

- Taking these costs into account, manufacturers may find that the U.S. has a cost basis just as competitive as any of the world's 25 largest exporters.

SOURCE: BCG "GLOBAL MANUFACTURING COST-COMPETITIVENESS INDEX", MCKINSEY "GAME CHANGERS: FIVE OPPORTUNITIES FOR US GROWTH AND RENEWAL"

- The ACE tool enables businesses to quantify inventory costs, and identify the profitability impact of reshoring.
- This estimate considers only the additional inventory costs of off-shoring– Does not include costs of poor quality, communication, IP risk, etc

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Market failure--theory

- Profit-maximizing investors don't take into account benefits from their investments that spill over to others
- If spillover benefits are large, then markets fail to make all socially optimal investments
- Spillover benefits in manufacturing are large
  - Thus, government involvement could improve welfare for society as a whole

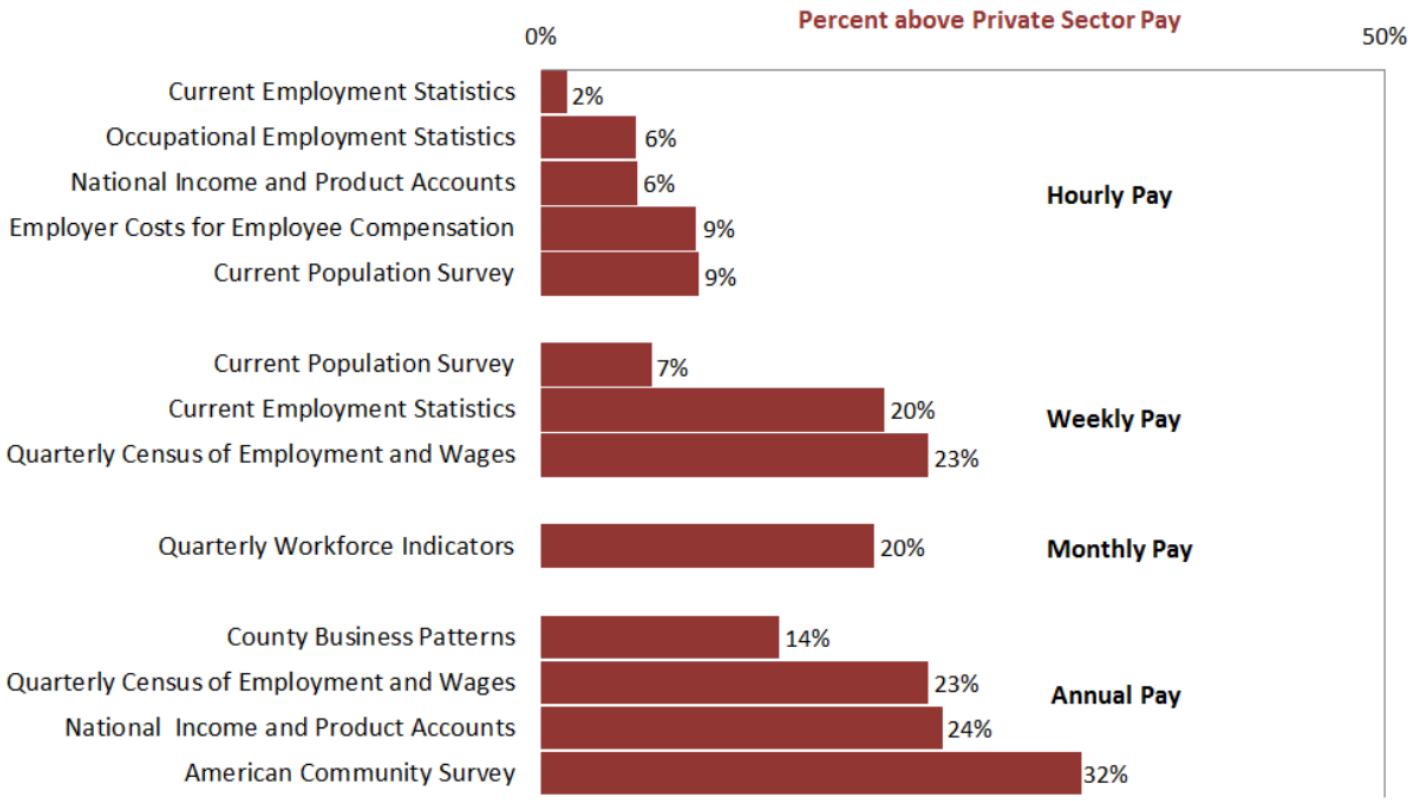
Manufacturing matters to the United States

…because it provides large spillover benefits

1. high-wage jobs
2. the nation's largest source of commercial innovation
3. key trade deficit reduction
4. a disproportionately large contribution to environmental sustainability

Manufacturing Pay Premium, 2013

Estimates from Federal Datasets



Note: Premiums are the ratio of wage and salary earnings for employees in the manfuaturing sector to earnings of employees in the private sector.
Source: Department of Commerce, Office of the Chief Economist analysis using data from the Bureau of Labor Statistics, the Census Bureau, and the Bureau of Economic Analysis.

http://esa.doc.gov/economic-briefings/manufacturing-pays

Production and Innovation

- Manufacturing accounts for 11% of GDP but 68% of private-sector R&D spending.
  - Much of this spending results from interaction with production
    - interaction between factories and R&D labs allows quick problem-solving, provides ideas for new products

- Helper, Krueger, Wial (Brookings 2012)

Manufacturing is key to building a low-carbon economy

- Need big changes in physical environment (houses, cars)
- Move to “manufactured” energy
  - $40,000 worth of fasteners in a wind turbine
- 26% of manufacturing jobs are green jobs
  - Only 9% economy wide (Brookings 2012)

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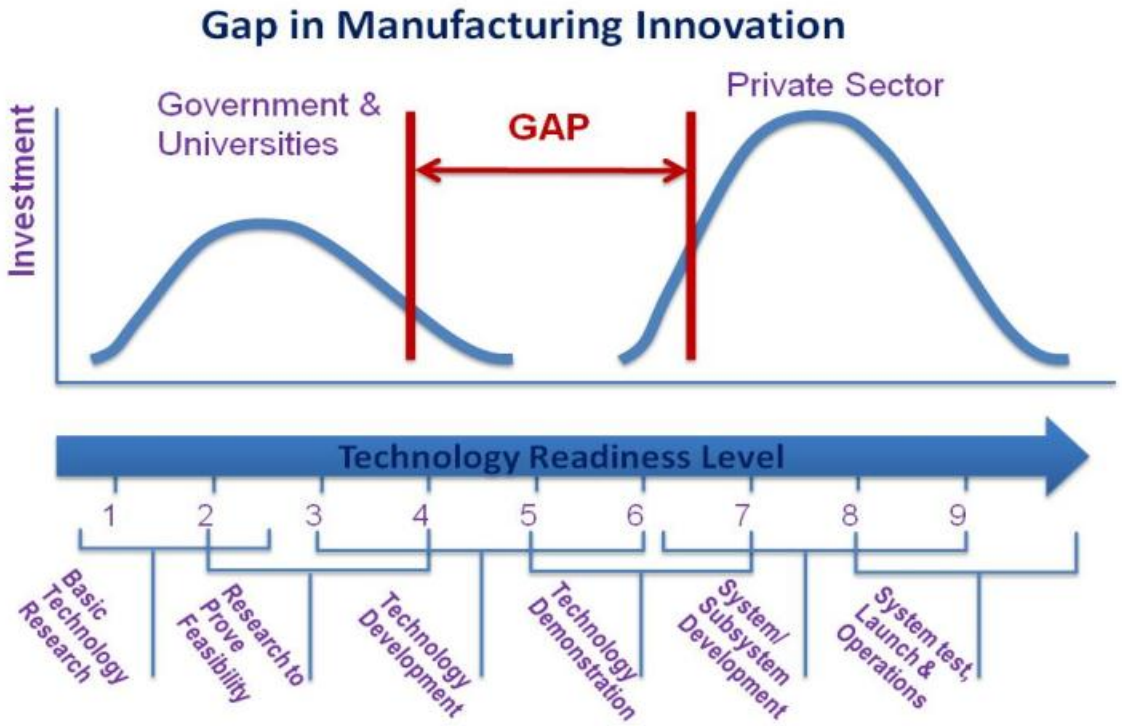
Obstacles

- “Missing middle” of innovation process
- Supply chain weakness
- Workforce

The Scale-up Gap or Missing Middle

Common terms
The "valley of death"
The "missing Bell Labs"
The "industrial commons"



Structural changes in US manufacturing

Large corporations have shifted from doing many activities in-house to a shared global supply chain of parts suppliers, R&D institutions, and assemblers.

Benefit: access to specialized suppliers

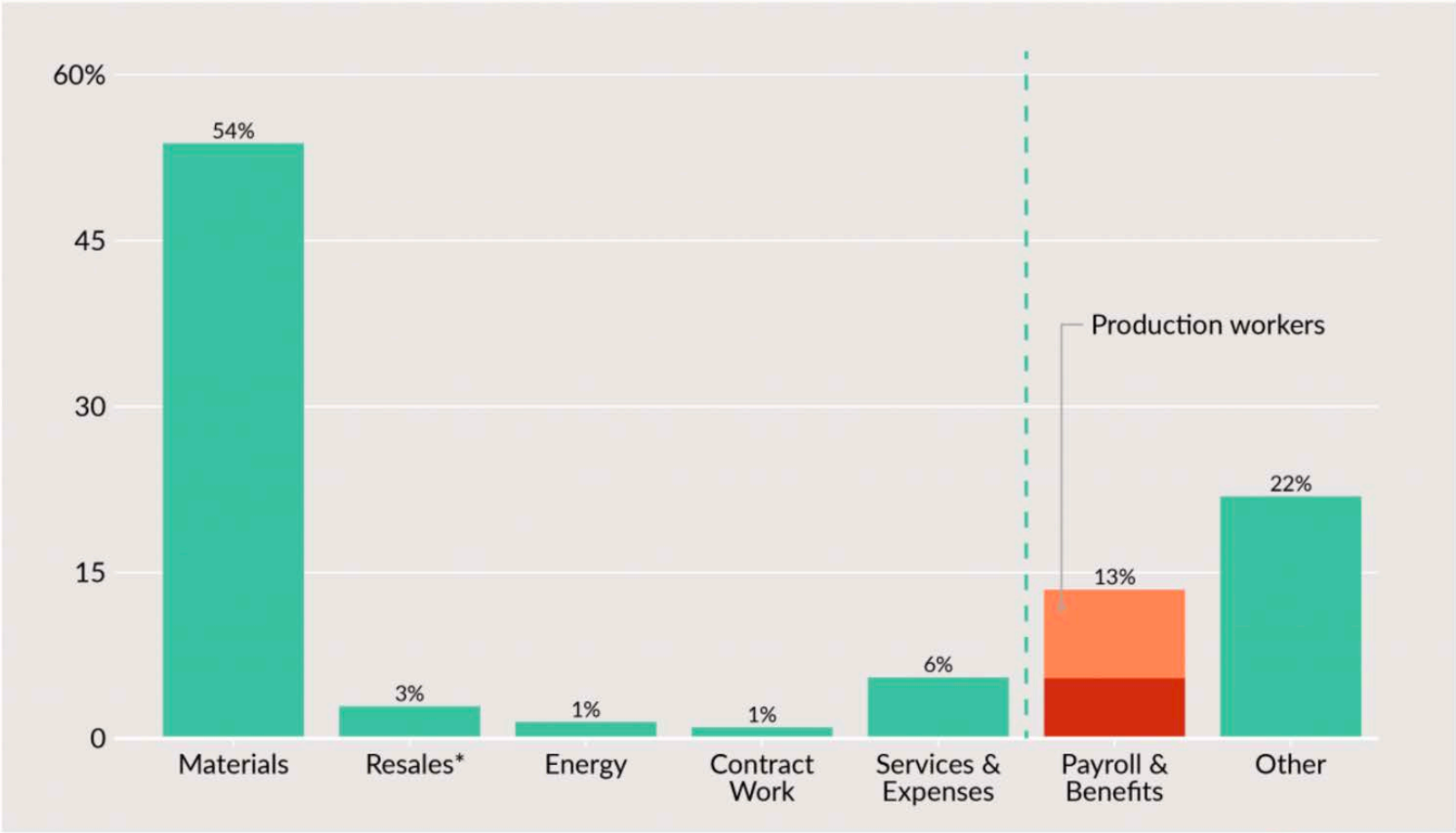
Cost: shared supply chains make it even harder for individual firms to capture the full benefits of their investment

Implications:

- Today, no one company can win by itself
  - Instead, success depends on healthy eco-systems
- Increased potential for government to act as catalyst
  - Convene, prime the pump with investments

Distribution of manufacturing input costs, 2012

Distribution of manufacturing input costs as a percentage of total value of shipments



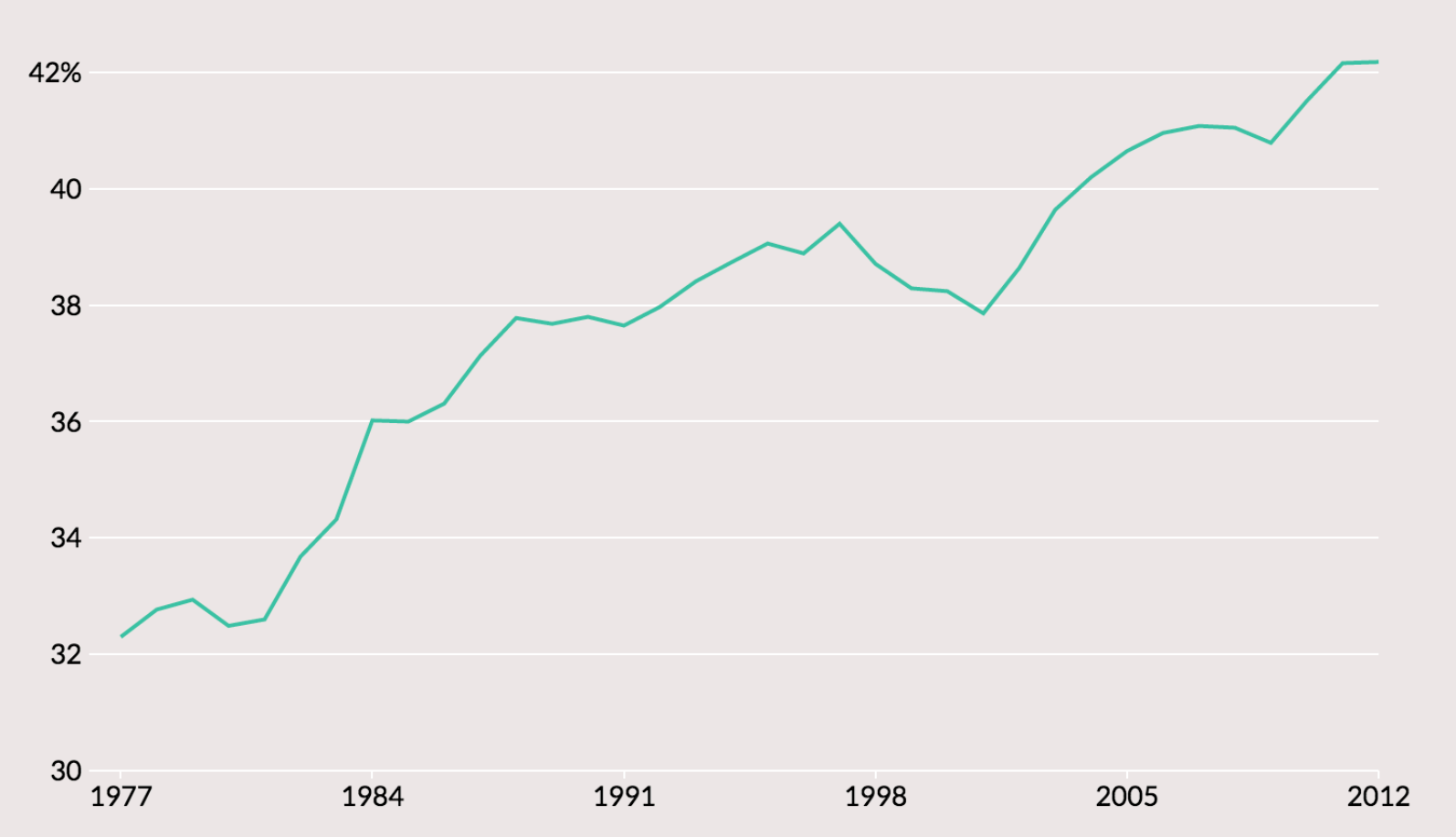
Source: Census Bureau, 2012 Economic Census

* Resales refers to products bought and sold in the same condition.

Equitable Growth

Small- and medium-sized firms employ an increasing share of U.S. manufacturing workers

SME employment as a percent of total U.S. manufacturing employment, 1977 to 2012



Source: U.S. Census Bureau Business Dynamics Statistics, 2014

Equitable Growth

Innovation Challenges for US Small Firms

- Invention
  - Small firms are 1/7 as likely to do R&D as large firms
  - Small manufacturers are 98% of mfg establishments and 42% of employees, but perform only 33% of R&D
- Commercialization
  - Difficulties in finance, getting info to customers
- Adoption
  - SMEs are 60% as productive as large firms

Underinvestment in small suppliers

- Low adoption of proven management innovations
  - Fewer than half of small auto suppliers have quality circles
  - Only 2/3 have consistent preventive maintenance
- 1/4 have no engineers
- Little support for small supplier investment
  - Small firms “home alone” (Berger, 2014)
  - Exacerbated by lead firms’ purchasing strategy (focus on unit price, not system value)
- Weak SMEs stymie innovation of whole supply chain
  - Only 1/3 engage in “value analysis” with major customer
  - Hence, lost access to info they gain from being close to production

» 2011 Case Western survey, drivingworkforcechange.org

Workforce challenges—and opportunities

- US mfrs face problems in transferring new technologies from lab to market.
- Workers face problems in finding jobs that pay a middle-class wage.
- M*USA could convene stakeholders to design jobs in new technologies so frontline workers contribute to production and innovation
  - training that helps them de-bug processes
  - mechanisms that allow them to share information they learn from monitoring processes closely.

Implications

- Other countries have more actively addressed these market failures, thus luring away production and eventually innovation in high-tech industries
- Policy should promote those aspects of manufacturing that provide spillover benefits
  - Not all manufacturing does so
    - 1/3 production workers eligible for Medicaid or food stamps
- To say manufacturing matters doesn't mean other sectors don't matter
  - "Sectoral policy" (policy that affect both supply & demand in a particular industry) helpful in other industries too
    - Health, agriculture, IT

Potential role of M*USA Institutes

- As external supply chains become more important, value of a coordinating hub rises
  - Avoid duplication of effort, free-rider problems in pre-competitive applied research
    - Not just in basic research
  - Convene stakeholders to develop industry roadmaps, design jobs and training programs

Conclusion

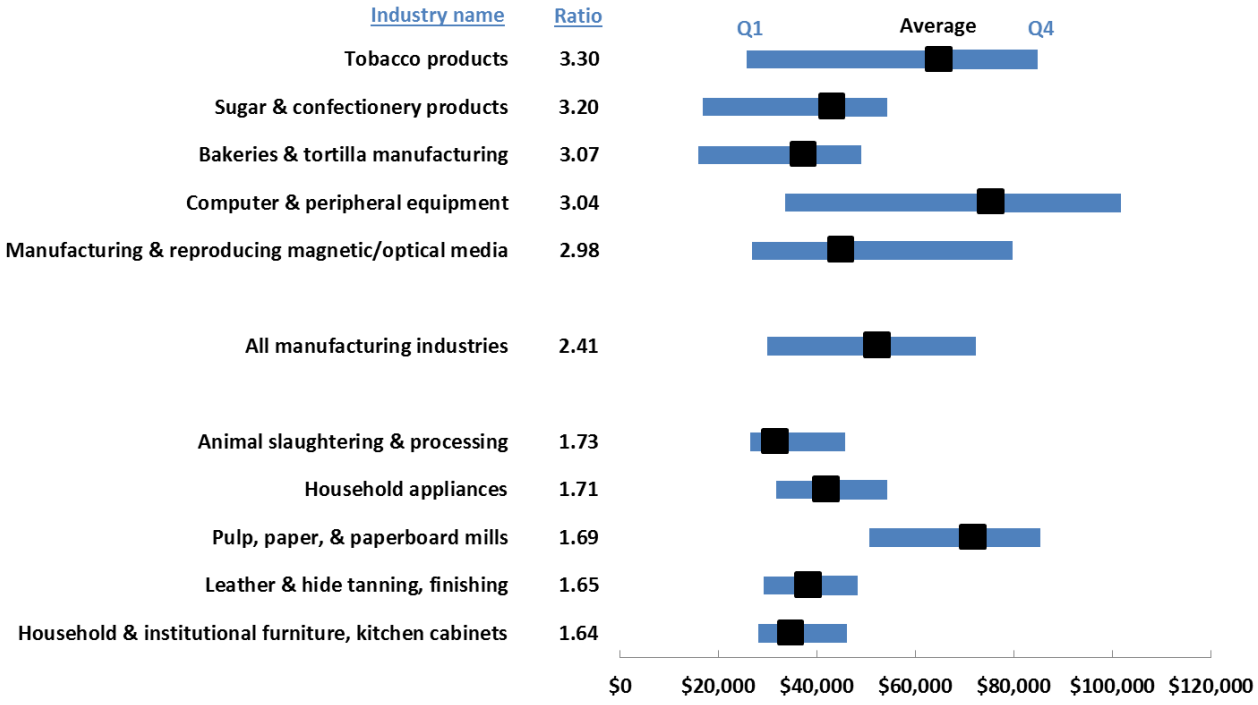
- What happened to U.S. manufacturing?
  - 1/3 of jobs lost 2000-2010, some recovery
  - More jobs could come back due to rising unit labor costs abroad, recognition of hidden costs
- Will the market provide a socially-optimal manufacturing sector?
  - Mfg provides spillover benefits in wages, innovation, environment
- What obstacles hinder a better U.S. manufacturing sector?
  - Fragmented eco-systems
  - M*USA could be key hub

- backup

- What was the state of US manufacturing leading up the establishment of the M*USA? (Helper)
- o Why does manufacturing matter?
- o What is the nature of the problem/market failure?
- o Why is there a need for a federal role? What is the federal role?
- o *Involving Supply Chains:* US manufacturing is largely organized around supply chains, which are critical to production efficiency.
- § Are the institutes able to engage supply chains as groups?
- § What are the best practices for improving and engaging supply chains in an institute's technology area?

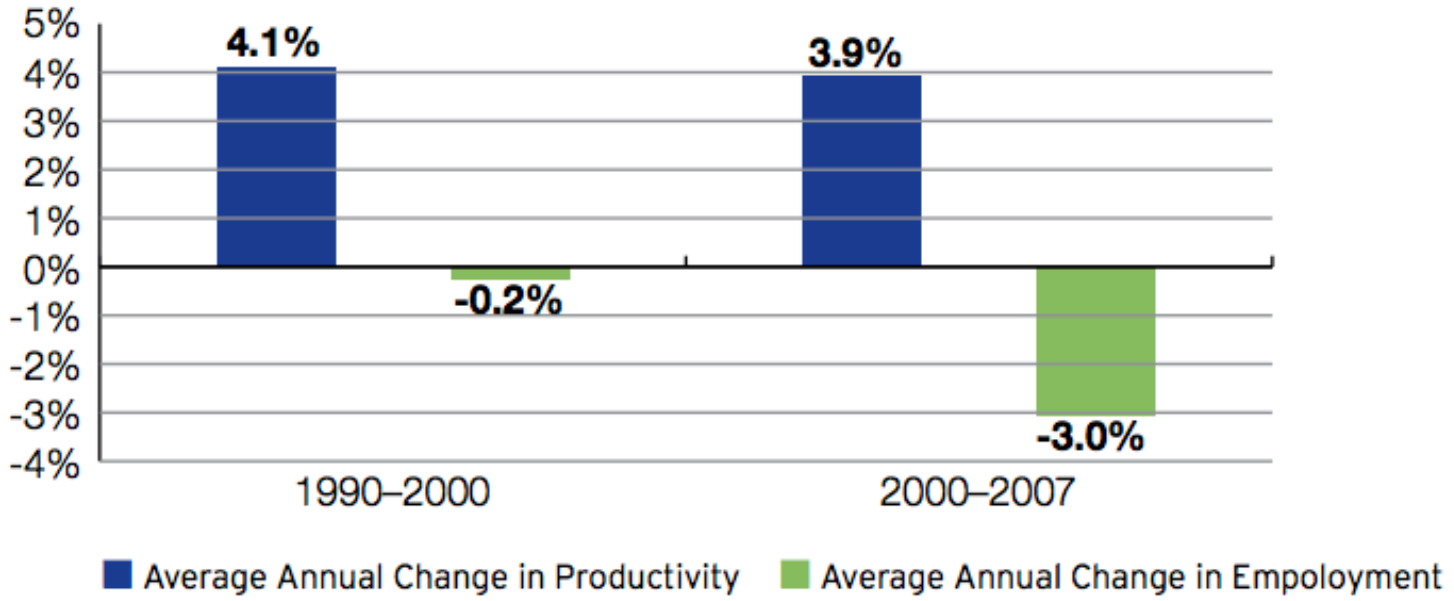
Big intra-industry wage ranges

Average Annual Payroll per Employee in Select Manufacturing Industries, 2011
(high, low, and average, overall dispersion ratio, top five and bottom five industries)



Note: Average annual payroll per employee presented for first (Q1) and fourth (Q4) quartiles. Ratio is average for Q4 divided by average for Q1.
Source: Economics and Statistics Administration analysis using special tabulation data from the Census Bureau, Annual Survey of Manufactures

Figure 3. Productivity and Employment Change in U.S. Manufacturing, 1990-2000 and 2000-2007

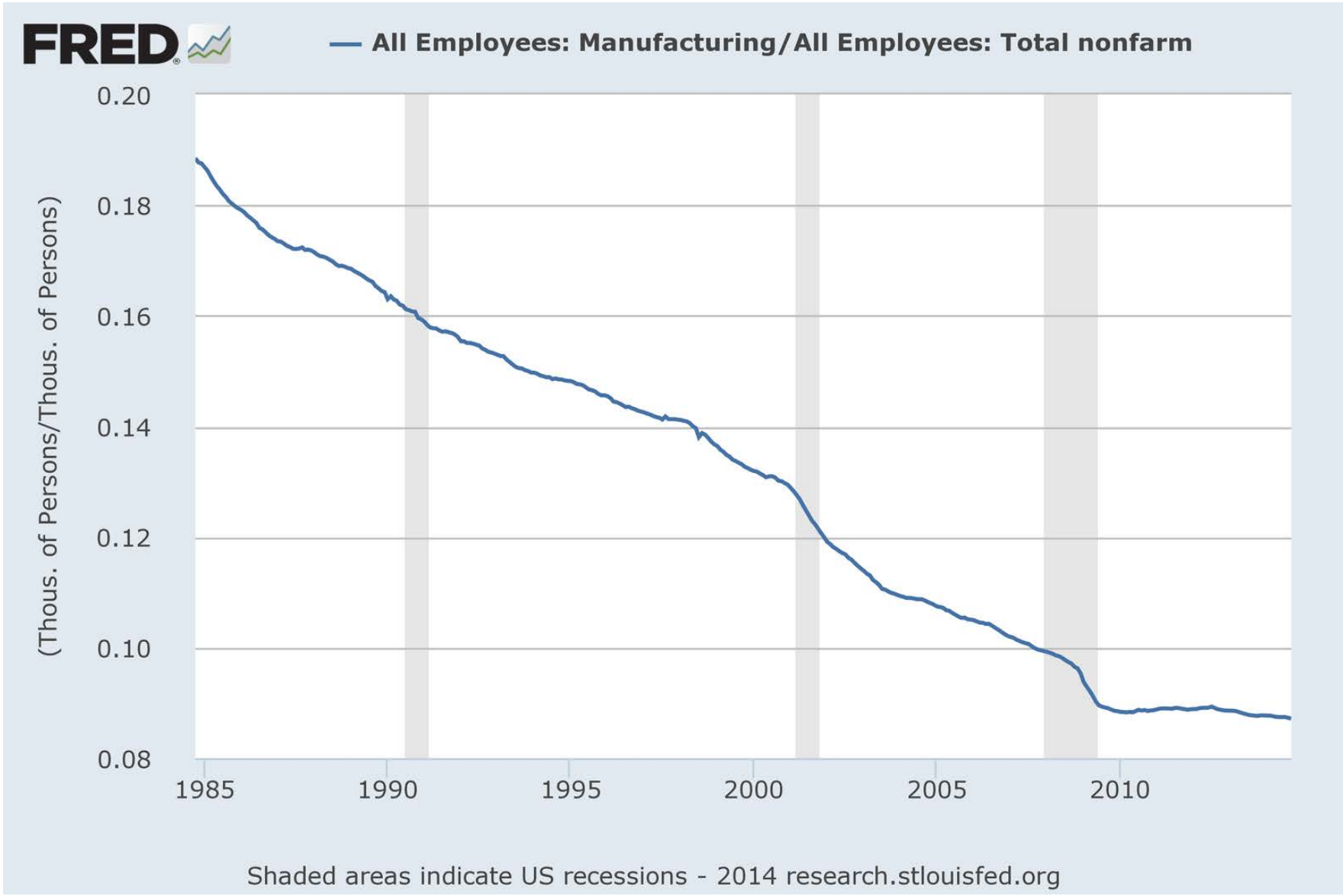


Source: Authors' analysis of Bureau of Labor Statistics Major Sector Productivity and Costs data (productivity) and Current Employment Statistics data (employment).

https://www.brookings.edu/wp-content/uploads/2016/06/0222_manufacturing_helper_krueger_wial.pdf

Spillovers in manufacturing

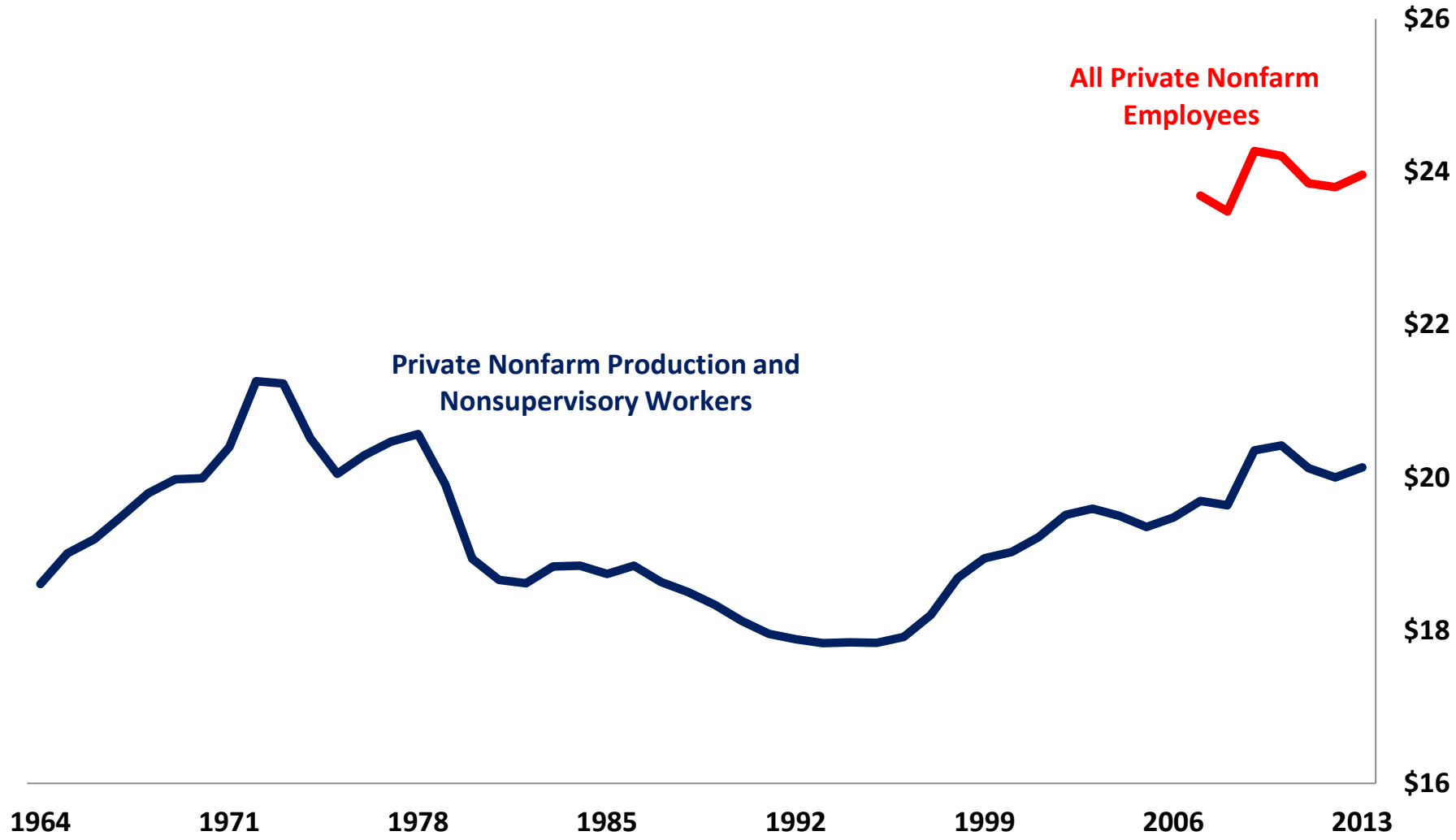
Point of Market Failure	Explanation
Investment in Basic Research	R&D has spillover benefits for innovation and productivity than cannot be captured by any single private actor – without policy support, this could lead to significant under-investment.
Technology Transitions	Firms going from lab to market in a new technology must solve similar problems. Pre-competitive collaboration among companies avoids duplication and saves time.
Supply Chain Health	Lead firms sharing suppliers face a dilemma if they act individually: if they invest in suppliers, they risk giving away the fruits of the investment to their competitors—without sharing the costs. Thus, these large companies have a disincentive to independently invest in their suppliers.
Training	A key to building an economy that provides profits for business and rebuilds the middle class is to have highly productive firms and workers. The US needs to increase training levels, both to maintain the skill levels we have and to build the highly-productive, IT-driven economy we would like to have in the future. Firms paying for training face “free-rider problems” similar to those above


FRED
All Employees: Manufacturing/All Employees: Total nonfarm
(Thous. of Persons/Thous. of Persons)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
1985
1990
1995
2000
2005
2010
Shaded areas indicate US recessions - 2014 research.stlouisfed.org

Real Average Hourly Earnings

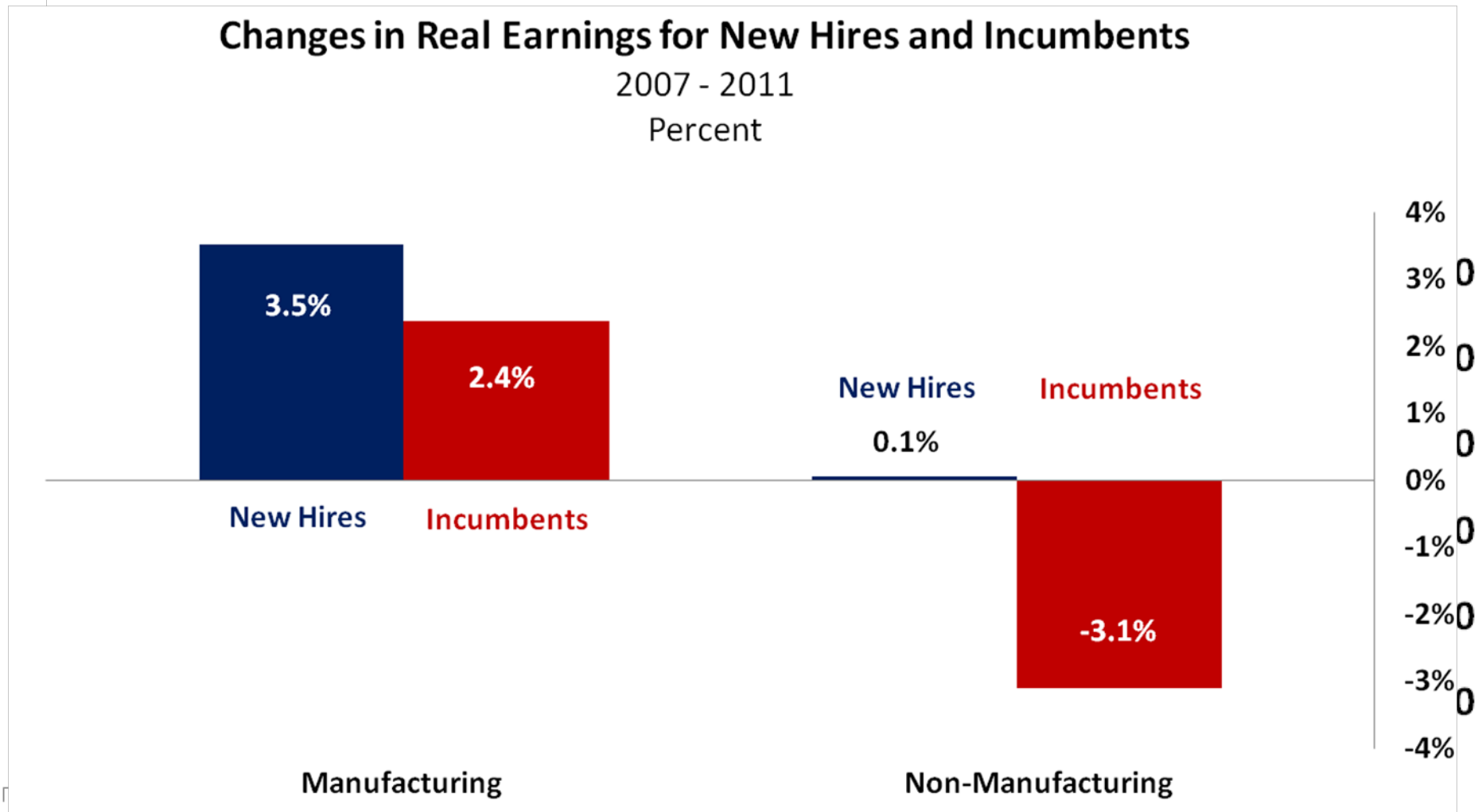
1964 - 2013

2013 CPI-W adusted dollars



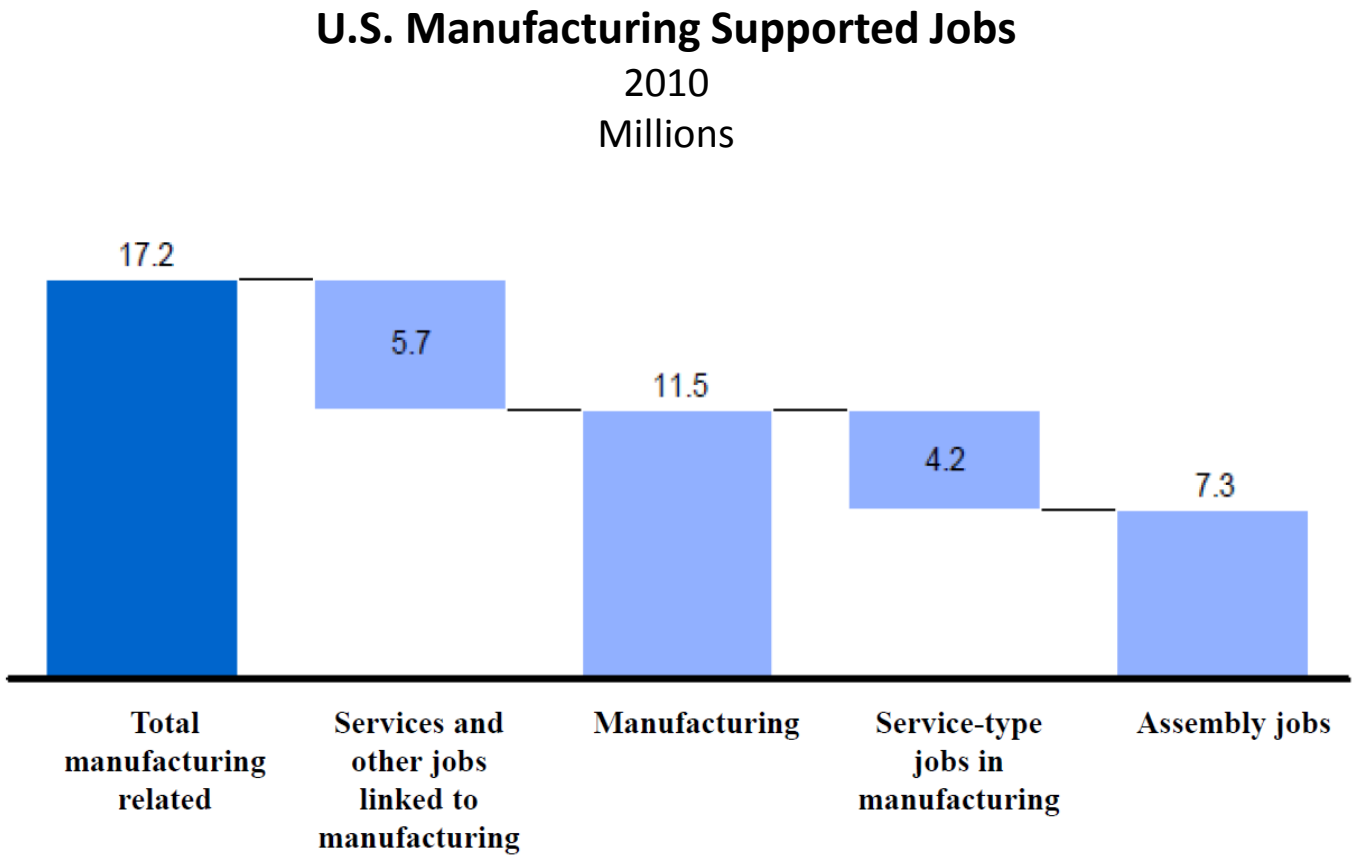
Source: Bureau of Labor Statistics

Manufacturing provides important "spillover benefits"



Source: ESA calculations of 4-quarter moving averages from the Quarterly Workforce Indicators for a 34-state panel, adjusted using the CPI-U published by the Bureau of Labor Statistics. Changes are calculated between Q4 2007 and Q4 2011.

Manufacturing provides important "spillover benefits"
Service jobs



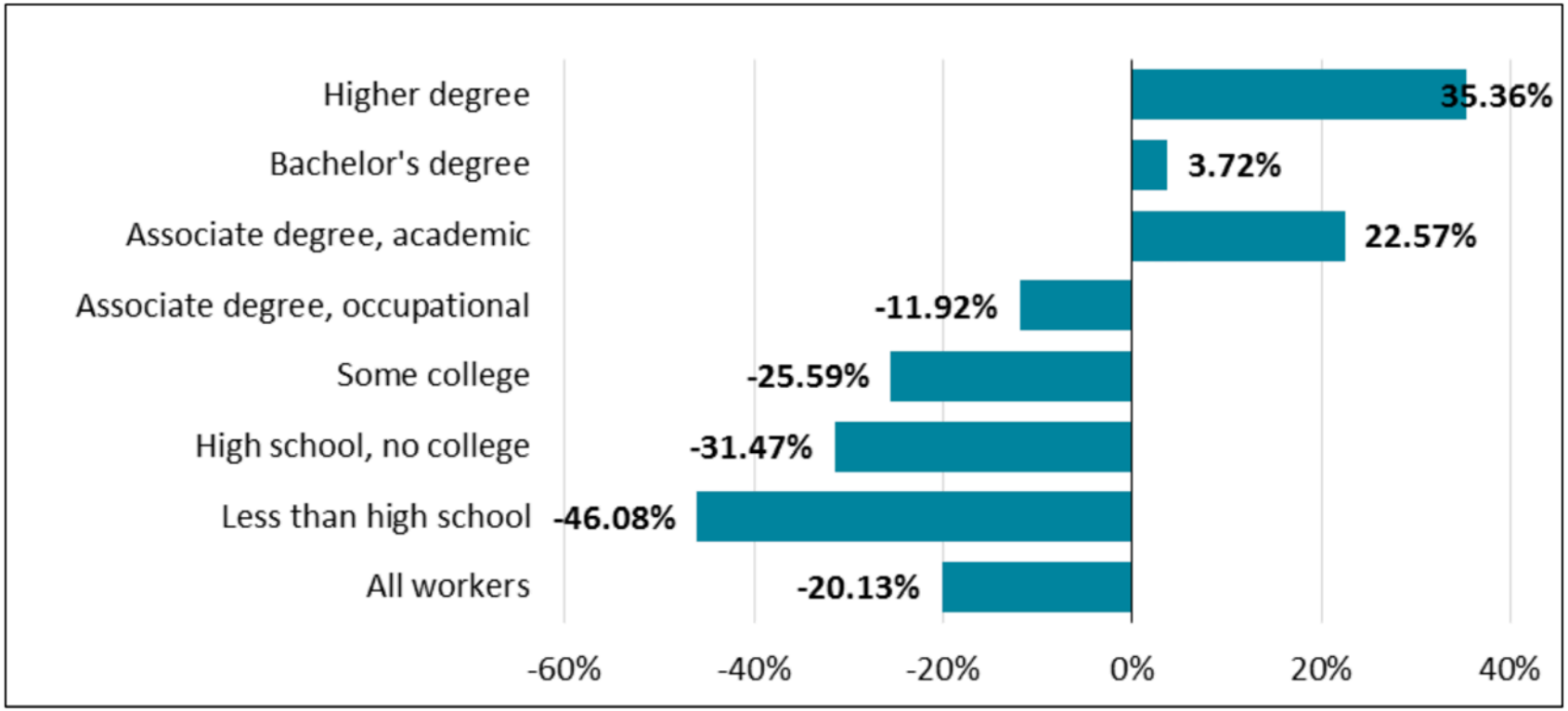
Source: McKinsey Global Institute, *Manufacturing the Future*, 2013

Gain to finance/speculators

- Delphi
  - 2009 inversion
  - Meeting hedge fund demands → pension cuts for 20,000 white collar workers, closure of all Delphi UAW plants
- GM 2015 $5B stock buyback
  - Led by Harry Wilson, of Obama auto team
  - "GM did $20.4 billion worth of buybacks from 1986 through 2002. If it had saved that money and earned a modest 2.5% on it, the company would have had $35 billion on hand [in 2008] ; probably would not have had to file for bankruptcy protection" HBR

Figure 4. Manufacturing Employment by Worker Education

Percentage change, 2000-2016



Source: Bureau of Labor Statistics, Current Population Survey.

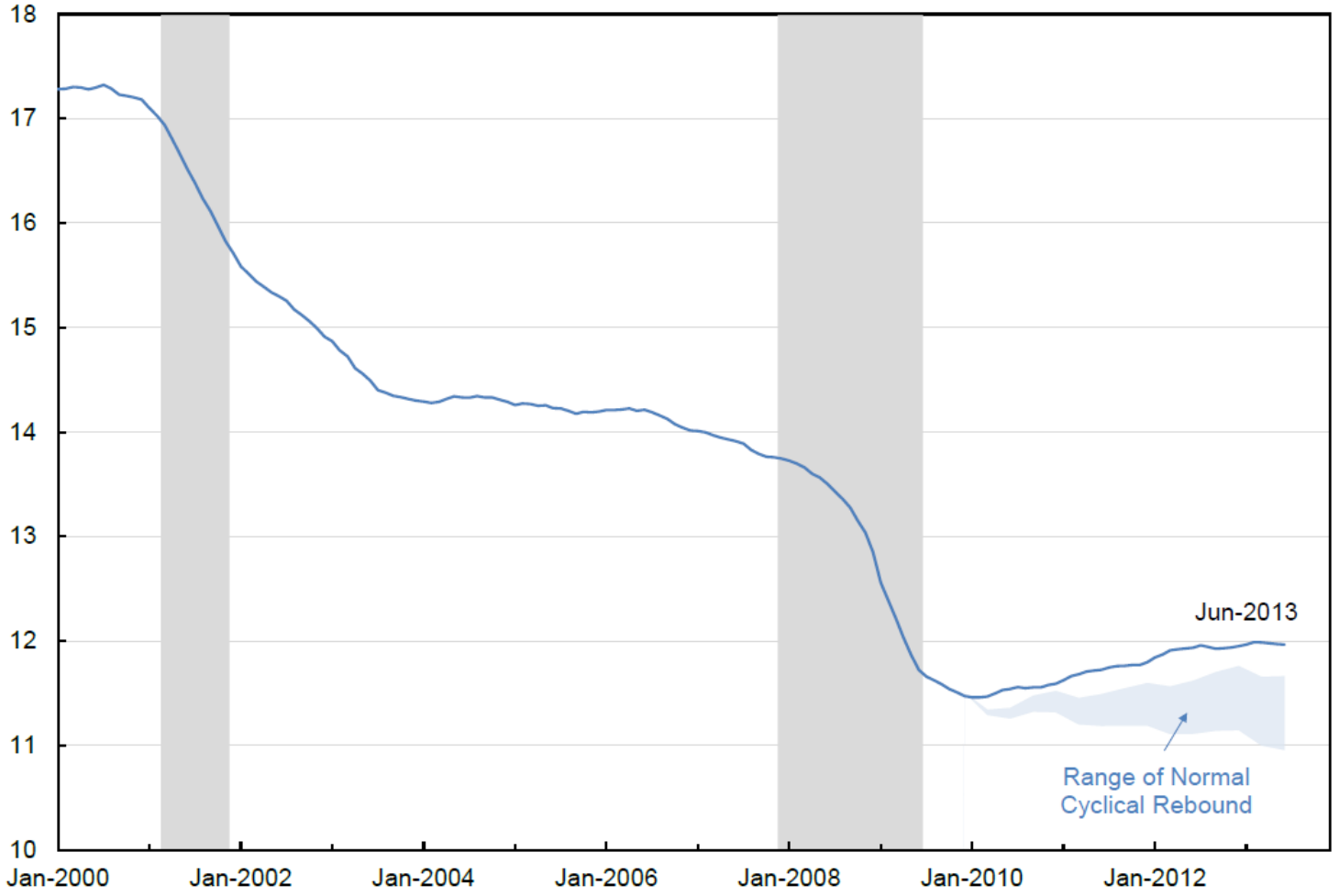
https://fas.org/sgp/crs/misc/R41898.pdf

Current State

Manufacturing Employment

January 2000 – June 2013

Millions, seasonally adjusted



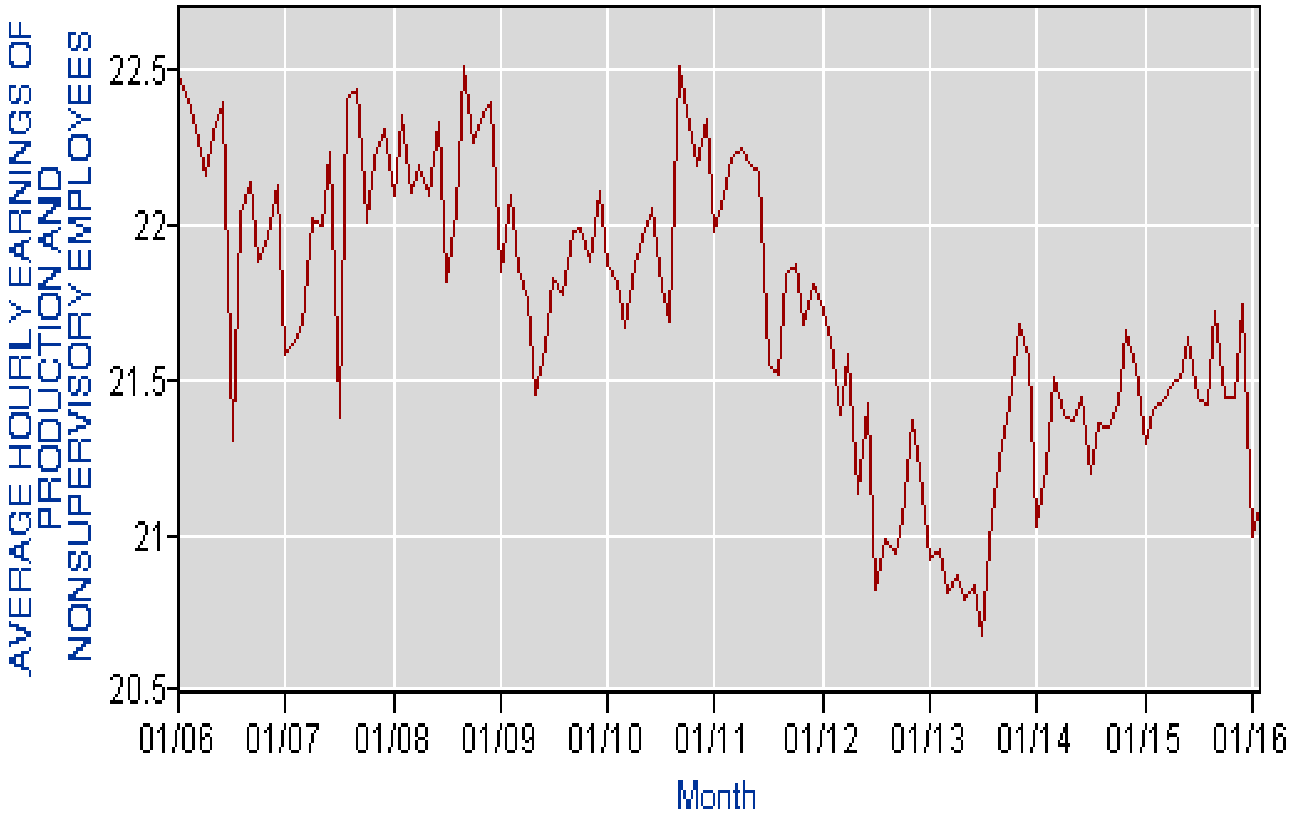
Source: BLS, CEA calculations

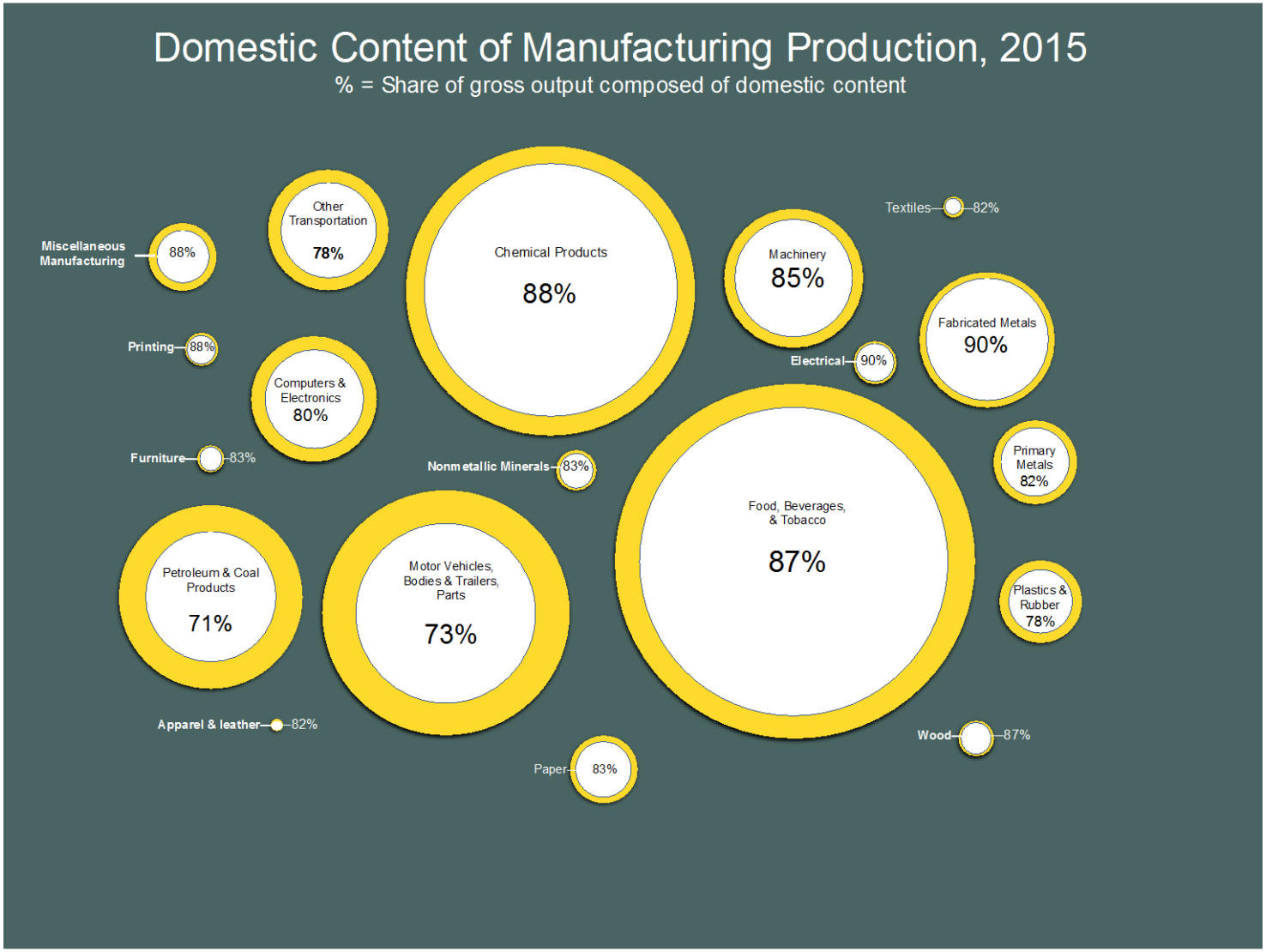
Note: Shading indicates recession.

- Productive eco-systems are hard to sustain thru private action alone.
  - When firms invest in their suppliers, they do not capture all of the benefits of doing so; firms that do not invest also benefit.
  - Due to this “free rider problem”, firms will underinvest in activities to upgrade suppliers by helping them invest in training, new products or processes
- These problems often exacerbated by “siloes” within firms
  - internal conflicts can mean a focus on suppliers with low piece price rather than those providing high quality and innovation
    - Quality and innovation are harder to measure, and their benefits often accrue to departments other than purchasing

Industry: Motor vehicles and parts

Data Type: AVERAGE HOURLY EARNINGS OF PRODUCTION AND NONSUPERV

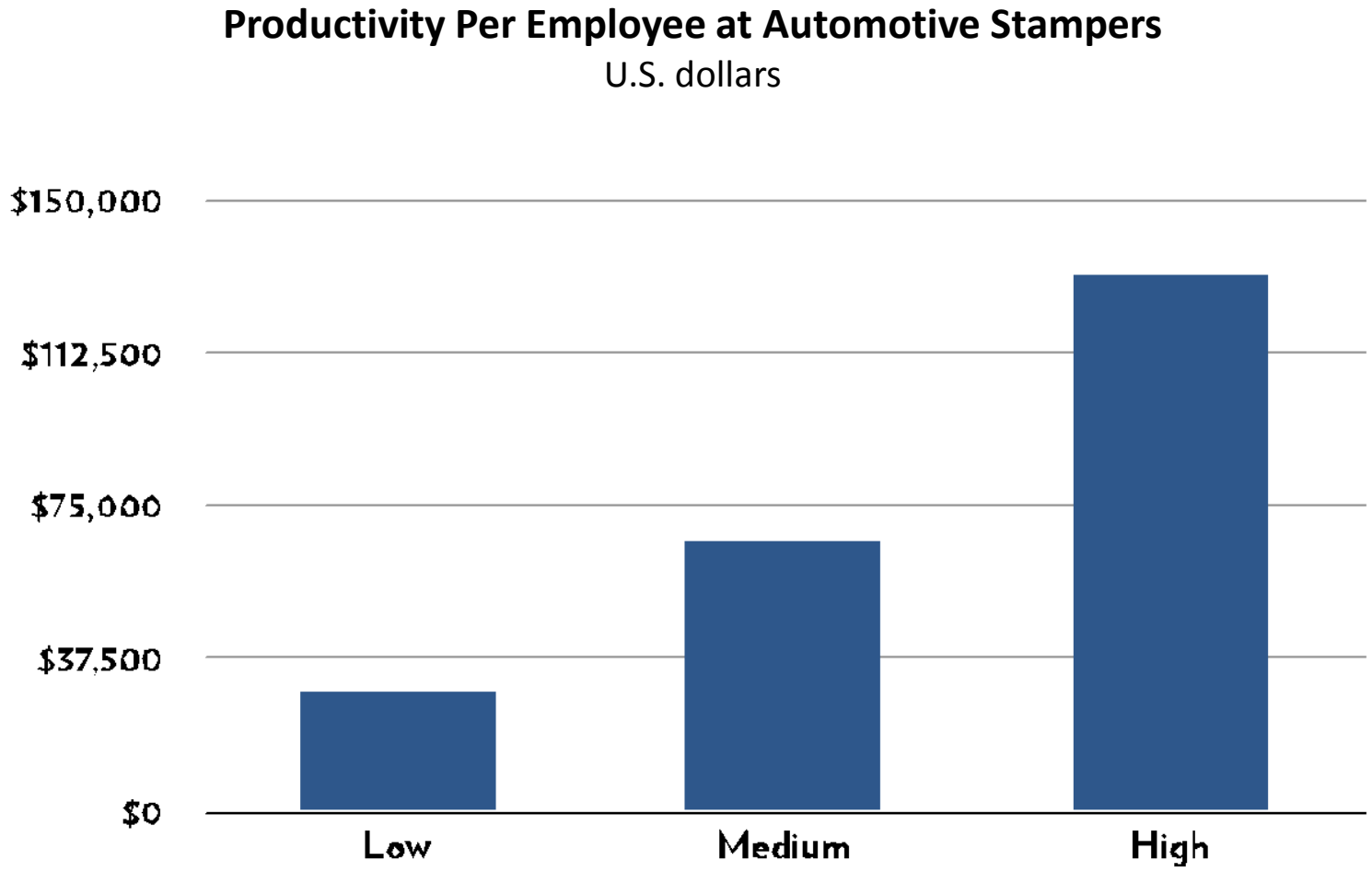




Source: Mforesight, calculated from http://www.esa.doc.gov/reports/2015-what-made-america

- U.S. manufacturers sold $5.6 trillion of goods, $4.4 trillion (79 percent) of which was "Made in the U.S.A."
- Value added directly by the manufacturing sector accounted for $1.9 trillion (indirect: $2.5 trillion).

Policy can promote these spillover benefits
Promote “high-road” production

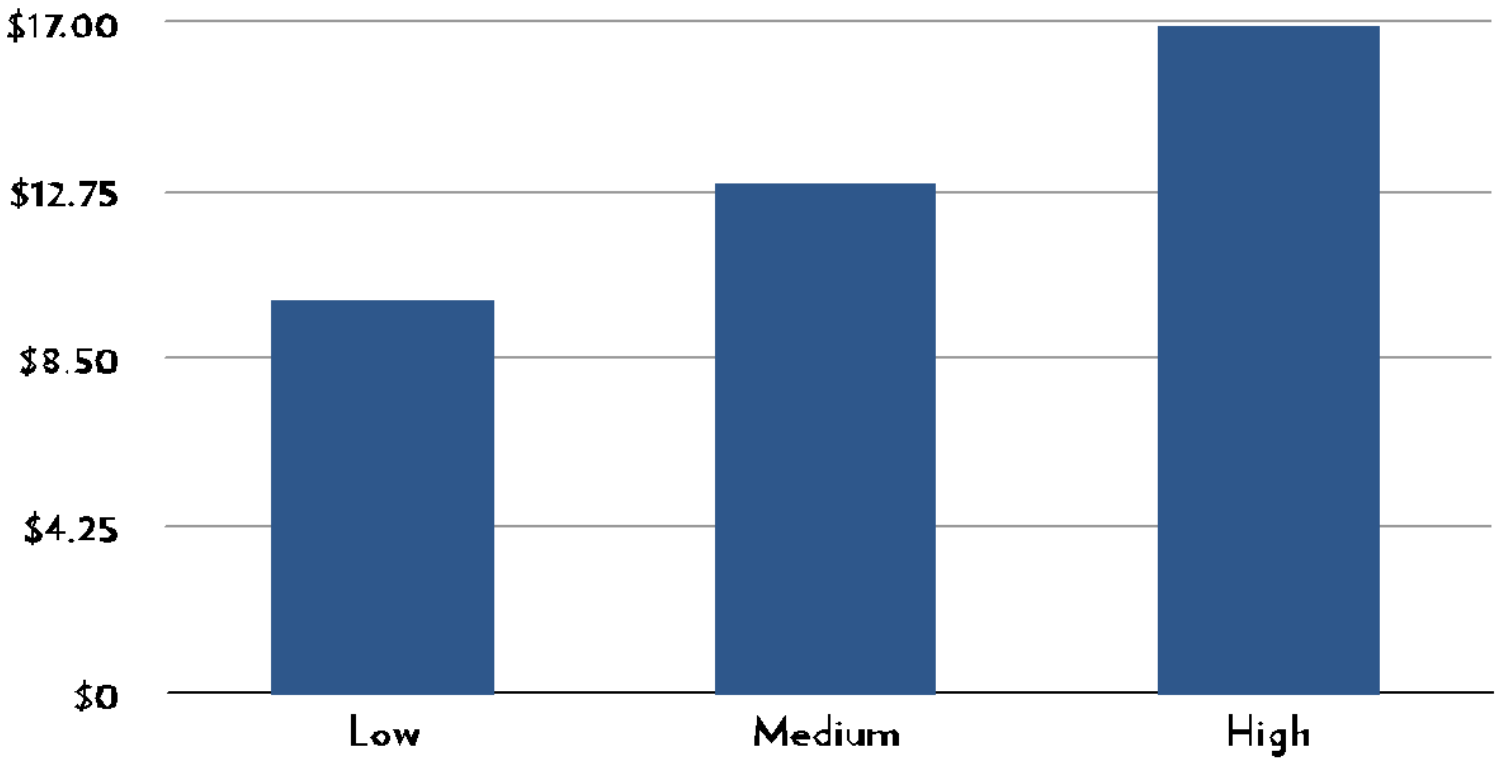


Source: Case Western Reserve Auto Supplier Survey

3. Policy can promote these spillover benefits
Promote “high-road” production

Hourly Wages of Production Workers at Automotive Stampers

U.S. dollars



Source: Case Western Reserve Auto Supplier Survey

Promote “high-road” production

In “high-road” production, well-paid workers make cost-effective, sustainable products for consumers, and profits for owners

How?

High road techniques harness everyone’s knowledge—not just top executives’ -- to achieve innovation, quality, and variety

Example: “agile production”

Firms design, set up, produce a variety of products quickly

Because product mix changes constantly, a fixed division of labor is not practical

High-productivity, high-wage stamping firms:

- Consistently performed preventive maintenance
- Were more likely to have employees participate in quality circles
- Had higher % of sales from products designed by firm
- Had trusting relationship with major customer

Features of U.S. manufacturing supply chains

- Key input in manufacturing
- Interconnected networks of independent firms
  - Relationships are intermediate between “captive” (vertically integrated) and “arm’s-length”
- Largely domestic
- Small firms play an important role
- Potential key role for policy

- Key role of supply chains and “eco-systems”
  - Ford CEO testimony
    - “Ours is in some significant ways an industry that is uniquely interdependent—particularly with respect to our supply base, with more than 90% commonality. Should one of the other domestic companies declare bankruptcy, the effect on Ford’s production operations would be felt within days—if not hours.”
- Key role of intermediaries
- Advancing beyond “picking winners” (somewat)

Insights gained

- Help overcome market failures by:
  - Better leveraging federal technology assets to promote innovation in supply chains
  - Highlighting private sector models that increase small-firm capability, and improve collaboration for innovation in supply chains

White House Supply Chain Innovation Initiative

- Firm trajectories and performance result from interaction of government policies, 'product policy', 'productive organisation ' and 'employment relationship‘.
- There is no one best way
- No one factor drives the others

3. Regions can promote spillovers: Compete on value, not price

acetool.commerce.gov

Why have we lost production and innovation in these industries?

1. Globalization: Firms moved production to other countries, not taking into account impact on innovation

   Result: loss of interaction between factories and R&D labs that allows quick problem-solving, provides ideas for new products

2. De-verticalization: Instead of doing many activities in-house, firms now buy from specialized suppliers. Thus, adoption of new technology requires coordination among materials suppliers, parts-makers, equipment providers

   Result: This shift to shared global supply chains makes it hard for individual firms to capture the full benefits of their investments, meaning that many socially valuable investments are not made

Other countries more actively addressed these market failures, thus luring away production and eventually innovation in high-tech industries

Overview of U.S. Innovation Policy

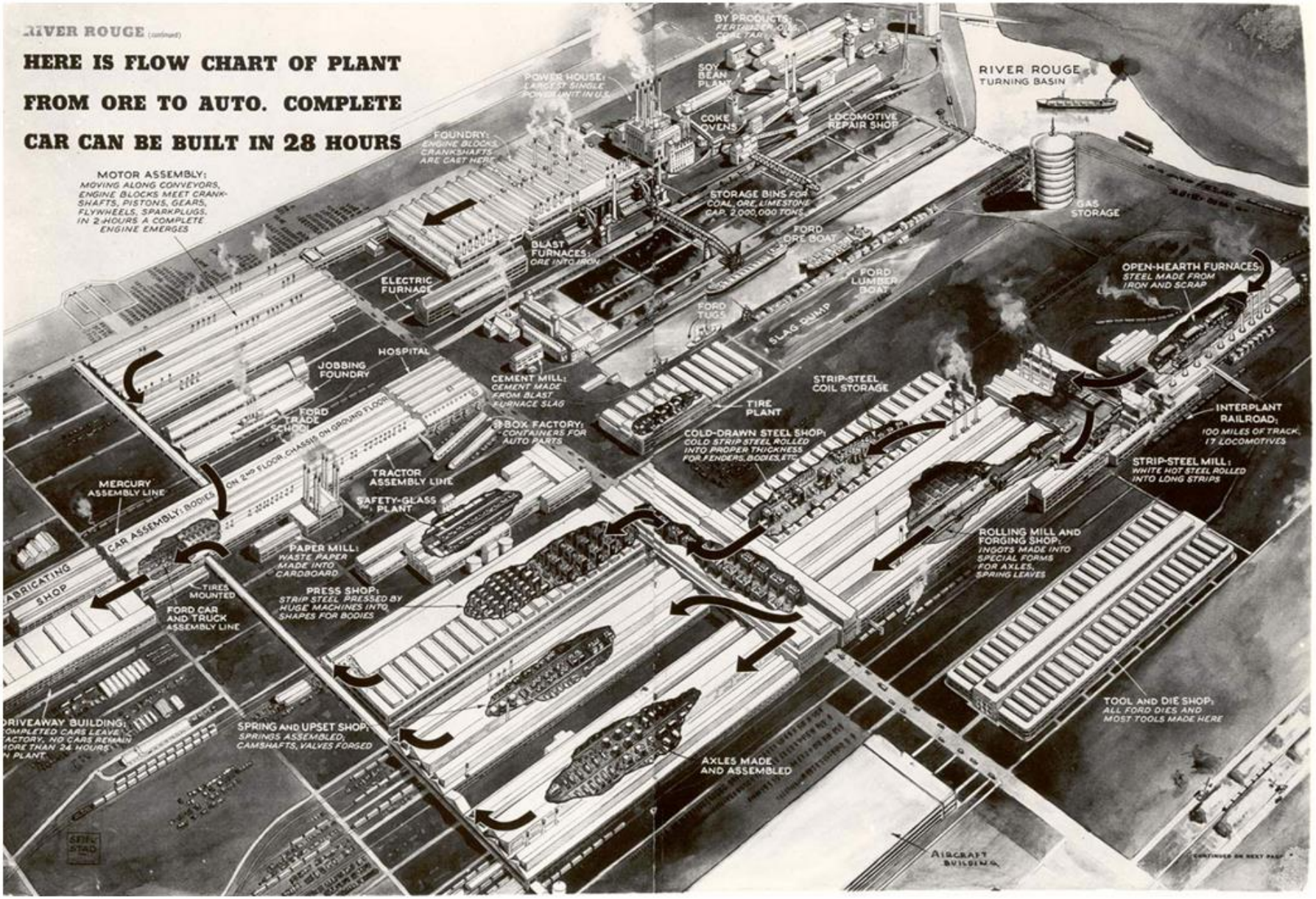
- **Targeted resourcing**: government identifies important technological challenges and provide funding for solutions which open up important economic possibilities
  - Top down
  - E.g., Broadband
- **Opening windows**: government creates multiple windows to which scientists and engineers can bring ideas for innovation and receive funding and other types of support
  - Bottom up
  - E.g., NNMI (fusion with targeted resourcing)
- **Brokering**: encompasses technological brokering and business brokering
  - Convening
  - E.g., IMCP
- **Facilitation**: obstacles have to be cleared away to create viable markets for the new technology
  - CAFE – Autos and truck
  - ACE Tool – “high-wage labor”

Potential Market Failures: Supply Chain Health

Supply Chains Health

- Issue: Each OEM acting individually faces a dilemma: if they invest in suppliers, they risk giving away the fruits of the investment to their competitors—without sharing the costs. Thus, these large companies have a disincentive to independently invest in their suppliers.
- A variety of indicators suggest that this has put U.S. suppliers in a fragile state:
  - Aging equipment. According to April 2013 Council of Economic Advisors analysis, "The age of equipment and software in manufacturing sector has risen substantially to reach its highest level since 1940."
  - Maintenance. Suppliers do not have adequate time or capital to invest in equipment maintenance. A Case Western survey of automotive suppliers found that barely half of this pool of companies was performing such preventative maintenance.
  - Innovation capacity. Nearly half of auto suppliers in the same survey said they can spend less than 1% of sales on R&D, and that less than 10% of sales come from products or processes where they innovated in some way. But automotive is not the only sector where this is occurring.

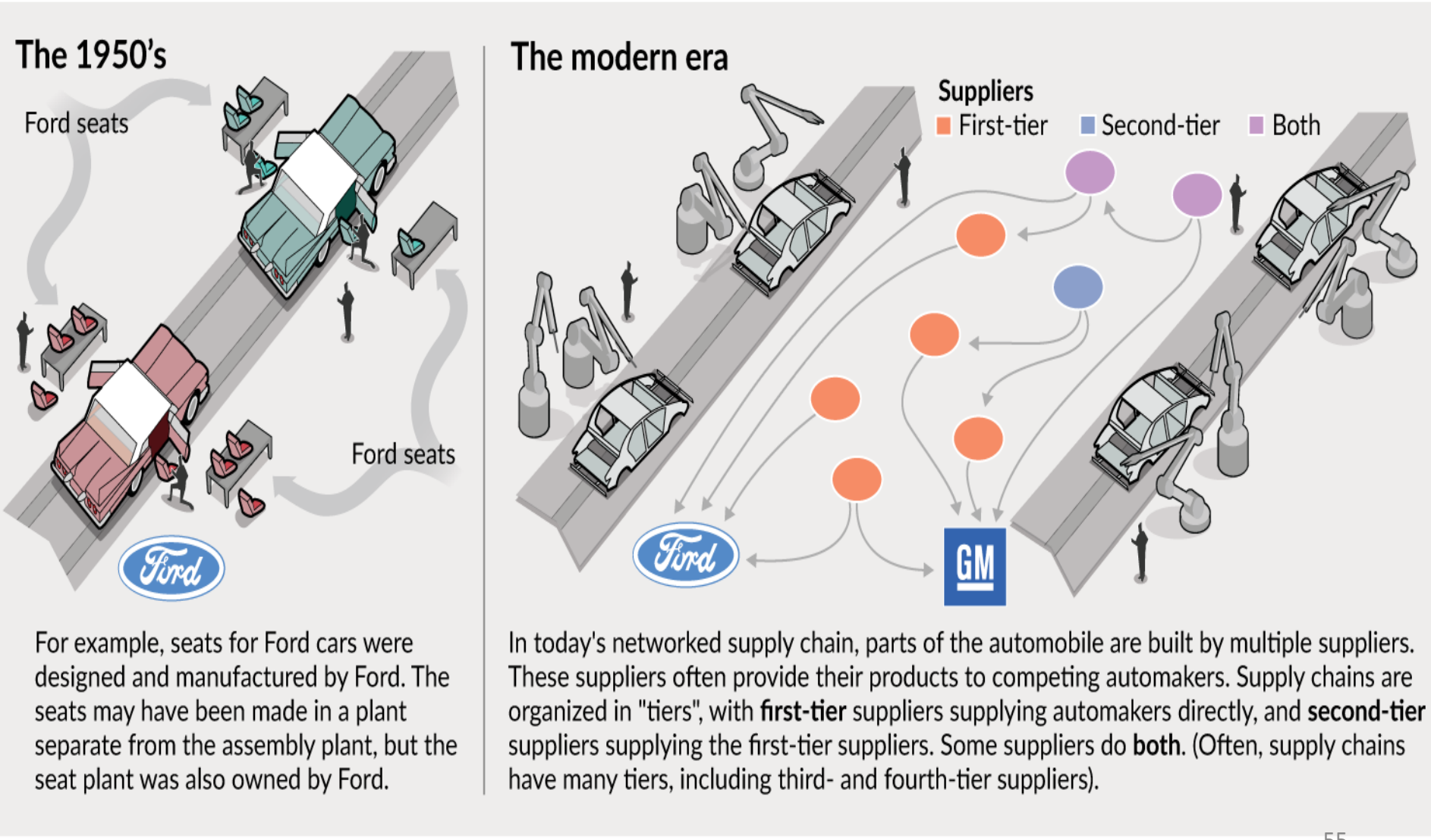
Historical Example of Vertical Integration: The Ford River Rouge Plant in 1941



Source: University of Michigan – Dearborn and Benson Ford Research Center

Supply chains and networks—Then and now

The difference between the supply chains of vertically integrated companies in the mid-20th century and the networked supply chains of the 21st century



For example, seats for Ford cars were designed and manufactured by Ford. The seats may have been made in a plant separate from the assembly plant, but the seat plant was also owned by Ford.

In today's networked supply chain, parts of the automobile are built by multiple suppliers. These suppliers often provide their products to competing automakers. Supply chains are organized in "tiers", with **first-tier** suppliers supplying automakers directly, and **second-tier** suppliers supplying the first-tier suppliers. Some suppliers do **both**. (Often, supply chains have many tiers, including third- and fourth-tier suppliers).

Source: The Washington Center for Equitable Growth

“Perfect Competition” & Supply Chains

- Perfect competition:
  - Many buyers & sellers of a homogeneous product
  - Prices are the only info shared across firms
  - If farmer Jones’s wheat is not available, can substitute farmer Smith’s wheat instantly
- Modern supply chains:
  - Products modified for different customers
  - Benefits to discussion about how to jointly optimize supplier’s equipment, customer’s design
  - Firms often incur significant costs of switching suppliers

Supply chains: definitions

- A supply chain is a network of firms involved in designing, producing inputs for, assembling, and distributing a good or service.
- The structure of today's supply chains differs both from vertical integration, and from economists' models of perfect competition.
- Supply chains account for an important, and growing, share of firms' costs.

Interconnected Supply Chains

Example: Five Wind Turbine Manufacturers and their Suppliers

Turbine maker	Rotor Blades	Gearboxes	Generators	Towers	Controllers
Vestas	Vestas, LM	Bosch Rexroth, Hansen, Winergy, Moventas	Weier, Elin, ABB, LeroySomer	Vestas, NEG, DMI	Cotas (Vestas), NEG (Dancontrol)
Siemens Wind	Siemens, LM	Winergy	ABB	Roug, KGW	Siemens, KK Electronic
GE Energy	LM, Tecsis	Winergy, Bosch Rexroth, Eickhoff, GE	Loher, GE	DMI, Omnical, SIAG	GE
Gamesa	Gamesa, LM	Echesa (Gamesa), Winergy, Hansen	Indar (Gamesa), Cantarey	Gamesa	Ingelectric (Gamesa)
Enercon	Enercon	Direct drive	Enercon	KGW, SAM	Enercon

Adapted from Alt Energy Stocks, "Major Wind Manufacturers and their Suppliers," *Supply Chain: The Race to Meet Demand*, 2007, p. 28, http://www.altenergystocks.com/assets/Wind%20Directions.pdf.

What is made in America?

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Why should we care?

- To promote equitable growth, it is important to understand how the economic pie is created—not just how it is divided.
- Rise of supply chains with small, weak firms→ increased role of firms that innovate less, pay less
  - Supply chain structure and relationships → key determinant of viability of "good jobs strategies"
- Fragility of supply chains creates potential for crisis – and opportunity
- Supply chain firms could do better with better public and private policies
  - "race to the bottom" vs "collaborative" supply chain strategies

Conclusions

- To take advantage of opportunity for resurgence of U.S. manufacturing, the US needs to reinvest in supply chains
- Small manufacturers face barriers in innovation, commercialization and diffusion
- Networks of small manufacturers are key to taking a product from concept to market
  - Unique info from being close to production
- We can do better
  - Better leverage federal technology assets to promote innovation in supply chains
  - Highlight private sector models that increase small-firm capability, improve collaboration for innovation in supply chains

Hidden developmental state?

- Manufacturing spillovers
  - Desire to rebuild eco-systems and supply chains
  - NNMI, SCII
- Problem of failures
  - Solyndra and ATVM
- Financialization
- Lack of integrated understanding of economics, engineering, production, finance

Insights gained

- Key role of supply chains and "eco-systems"
  - Ford CEO testimony
    - "Ours is in some significant ways an industry that is uniquely interdependent—particularly with respect to our supply base, with more than 90% commonality. Should one of the other domestic companies declare bankruptcy, the effect on Ford's production operations would be felt within days—if not hours."
- Key role of intermediaries
- Advancing beyond "picking winners" (somewat)

Market failures in supply chains

- Between firms
  - "free-rider" problem: fear of strengthening small businesses that may also serve their competitors.
- Within firms
  - "siloes": internal conflicts can mean a focus on suppliers with low piece price rather than those providing high quality and innovation
    - Quality and innovation are harder to measure, and their benefits often accrue to departments other than purchasing

Policies for fair, innovative supply chains

- General “good jobs” / high road strategies
  - Reduce attractiveness of sweatshop-type outsourcing
- Specific policies for supply chains
  - Raise subcontractor productivity
  - make them less interchangeable by promoting collaborative strategies (instead of “race to the bottom” strategies)

White House Supply Chain Innovation Initiative

- Help overcome market failures by:
  - Better leveraging federal technology assets to promote innovation in supply chains
  - Highlighting private sector models that increase small-firm capability, and improve collaboration for innovation in supply chains

Role of customer firms

- Offer suppliers assurance that they will receive a return on investments they make in new technologies and in upgrading their capabilities.
  - Bruno Independent Living Aids and Ad-tech: E-coat
- 2. Promote information-sharing and make changes in their own operations as a result of supplier suggestions.
  - Itron: terminals for electric meters
- 3. Use a “Total Cost of Ownership” approach in making purchasing decisions.