Re-investing in America’s Supply Chain Innovation

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Chief Economist
Agenda

• Need for re-investment in U.S. supply chains
• What is a supply chain?
• How can government help?
  – Market failures mean private sector investment alone not sufficient
    • Unrecognized synergies between and within firms
  – DOC has a key role in improving supply chains: diffusing information, pump priming, convening
    • DOC Office of the Chief Economist role
      – White House Supply Chain Innovation Initiative
      – “Assess Costs Everywhere” Tool
      – Helping improve data collection
Definitions of Supply Chain

• broad meaning
  – the linkages between firms that work together to take a particular product from idea to production to market

• narrow meaning
  – the logistics involved in moving the products
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 harder for individual firms to capture the full returns to 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
DOC supply chain initiatives: Overview

• “Making it”
  – White House Supply Chain Innovation Initiative
    • Focused on improving innovation capabilities of small manufacturers and their linkages with larger customers, to benefit whole supply chain
    • DOC-White House report: http://www.esa.gov/economic-briefings/reinvesting-americas-supply-chain-innovation

• “Moving it”
  – DOC Advisory Council on Supply Chain Competitiveness (ACSCC) focused on logistics
    http://trade.gov/td/services/oscpb/supplychain/acsccc
White House Supply Chain Initiative

SUPPLY CHAIN INNOVATION: STRENGTHENING AMERICA'S SMALL MANUFACTURERS

The Executive Office of the President and the U.S. Department of Commerce

March 2015
Supply Chain Evolution

Then: Vertically-integrated supply chain

Now: Supply chains have evolved to be complex networks of suppliers

Source: Economics and Statistics Administration
Historical Example of Vertical Integration: The Ford River Rouge Plant in 1941

Source: University of Michigan – Dearborn and Benson Ford Research Center
“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
Features of US Supply Chains

- Key input in manufacturing
- Interconnected
- Largely domestic
- Small firms play an important role
- Potential key role for policy
Distribution of Manufacturing Input Costs, 2012
(as a percentage of total value of shipments)

Supply chain inputs = 62% of total value of shipments

Materials: 54%
Services & Expenses: 6%
Contract Work: 1%
Energy: 1%
Payroll & Benefits: 13%
Other: 25%

Source: Census Bureau, 2012 Economic Census
Most costs come from the Supply Chain

Final U.S. Manufactured Product Cost from Supply Chain Costs
% final manufactured product cost, 1992 to 2012

Source: Census Bureau’s Economic Census (1992 to 2012)
## Interconnected Supply Chains
### Example: Five Wind Turbine Manufacturers and their Suppliers

<table>
<thead>
<tr>
<th>Turbine maker</th>
<th>Rotor Blades</th>
<th>Gearboxes</th>
<th>Generators</th>
<th>Towers</th>
<th>Controllers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestas</td>
<td>Vestas, LM</td>
<td>Bosch Rexroth, Hansen, Winery, Moventas</td>
<td>Weier, Elin, ABB, LeroySomer</td>
<td>Vestas, NEG, DMI</td>
<td>Cotas (Vestas), NEG (Dancontrol)</td>
</tr>
<tr>
<td>Siemens Wind</td>
<td>Siemens, LM</td>
<td>Winery</td>
<td>ABB</td>
<td>Rough, KGW</td>
<td>Siemens, KK Electronic</td>
</tr>
<tr>
<td>GE Energy</td>
<td>LM, Tecsis</td>
<td>Winery, Bosch Rexroth, Eickhoff, GE</td>
<td>Loher, GE</td>
<td>DMI, Omnical, SIAG</td>
<td>GE</td>
</tr>
<tr>
<td>Gamesa</td>
<td>Gamesa, LM</td>
<td>Echesa (Gamesa), Winery, Hansen</td>
<td>Indar (Gamesa), Cantarey</td>
<td>Gamesa</td>
<td>Ingelectric (Gamesa)</td>
</tr>
<tr>
<td>Enercon</td>
<td>Enercon</td>
<td>Direct drive</td>
<td>Enercon</td>
<td>KGW, SAM</td>
<td>Enercon</td>
</tr>
</tbody>
</table>

What is made in 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).
Domestic Content of Production in Manufacturing, 2012

(billions of dollars)

- Food and beverage and tobacco products: Domestic content 86%
- Chemical products: Domestic content 86%
- Petroleum and coal products: Domestic content 57%
- Motor vehicles, bodies and trailers, and parts: Domestic content 71%
- Machinery: Domestic content 79%
- Computer and electronic products: Domestic content 88%
- Fabricated metal products: Domestic content 83%
- Other transportation equipment: Domestic content 79%
- Primary metals: Domestic content 75%
- Plastics and rubber products: Domestic content 81%
- Miscellaneous manufacturing: Domestic content 88%
- Paper products: Domestic content 82%
- Electrical equipment, appliances, and components: Domestic content 81%
- Nonmetallic mineral products: Domestic content 88%
- Printing and related support activities: Domestic content 88%
- Wood Products: Domestic content 87%
- Furniture and related products: Domestic content 82%
- Textile mills and textile product mills: Domestic content 82%
- Apparel and leather and allied products: Domestic content 87%

Share of gross output composed of domestic content

Source: Economics and Statistics Administration analysis using data from the Bureau of Economic Analysis.
Role of Small Manufacturing Firms

Small and medium enterprises (SMEs)
• make up 98% of manufacturing firms
• employ 42% of manufacturing employees
  (up from under a third in 1980’s)
• and comprise 72% of new manufacturing jobs
Manufacturing Employment Share from Small and Medium Sized Manufacturers

% of total U.S. manufacturing employment, 1977 to 2012

Source: Census Bureau Business Dynamics Statistics (2014)
Innovation Challenges for Small Firms

• Invention
  – Small firms are 1/7 as likely to conduct R&D as large firms
  – Small manufacturers are 98% of mfg establishments, but perform only 33% of R&D

• Commercialization
  – Difficulties in finance, getting information to customers

• Adoption
  – SMEs are 60% as productive as large firms
Research and Development

Share of Manufacturing Firms vs. Share of Manufacturing R&D

<table>
<thead>
<tr>
<th></th>
<th>Percent of Firms Performing R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small and Medium-Sized Firms (less than 500 employees)</td>
<td>Large Firms (500 employees or more)</td>
</tr>
</tbody>
</table>

- Share of Manufacturing Firms: 98 vs. 33
- Share of Total Manufacturing R&D Spend: 66 vs. 2
- Percent of Small and Medium-Sized Firms Performing R&D: 2
- Percent of Large Firms Performing R&D: 14

Underinvestment in autos

- 1/3 of auto supply chain employment is in firms with < 500 employees
- Low adoption of proven management innovations
  - Fewer than half of these auto suppliers have quality circles
  - Only 2/3 have consistent preventive maintenance
- 1/4 have no engineers
- Weak SMEs stymy innovation of whole supply chain
  - Only 1/3 of small suppliers engage in “value analysis” with major customer
  - Hence, lost access to info that small suppliers have from being close to production
    - Itron: reducing use of silver/cadmium in terminals for electric meters
      - 2011 Case Western survey, drivingworkforcechange.org
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
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

• Promote information-sharing and make changes in their own operations as a result of supplier suggestions.
  – Itron: terminals for electric meters

• Use a “Total Cost of Ownership” approach in making purchasing decisions.
Overcoming market failures

• Diffusing information
  – Acetool.commerce.gov
  – Value of collaboration

• Pump-priming
  – Creating spaces for interaction
  – Providing shared access to equipment expertise

• Convening (overcoming transaction costs)
  – Coalition for automotive light-weighting
  – Building coalitions for collaboration
    • Coordination game
Key Opportunity: Sensors

• Connecting sensors to internet allows firms to engage in “smart manufacturing”
• Real-time data allows manufactures to reduce lead times and analyze how well their processes are operating
• However, small firms face barriers to adoption:
  – Technical
    • Knowledge of which sensors to adopt
    • Standards for data transfer across equipment, firms
  – Managerial
    • Trust for data transfer
    • Capability to interpret data
      – Skilled, empowered workforce can integrate local knowledge with data, for continuous improvement
DOC policies that help improve supply chains

• Making it better: Promoting Innovation
  – White House Supply Chain Innovation Initiative
  – National Network for Manufacturing Innovation (NNMI)
  – Investing in Manufacturing Communities Partnership (IMCP)
  – Manufacturing Extension Partnership (MEPs)
  – The Manufacturing Council

• Moving it faster: Facilitating Trade
  – Single window (a single electronic import-export system)
  – Advisory Committee on Supply Chain Competitiveness (ACSCC)
  – Secretary Pritzker helping with West Coast Port negotiations
  – “Assess Costs Everywhere” tool for calculating cost of lead time
Consider All the Advantages of Manufacturing or Sourcing in the U.S.A.

Assess Costs Everywhere (ACE) provides manufacturers with the top reasons for investing and sourcing in the United States. With its analytic framework, links to public and private resources, and case studies, ACE is now available to help businesses assess total costs more accurately and enable informed decision-making.
Key ideas on Costs of a Far Flung Supply Chain

• When suppliers are far away, they must produce to a forecast, rather than to a known order. As lead time increases, the possible range of demand levels becomes wider.

• A product’s scrap value is usually far less than its full price.

• Thus, firms want to ensure that they do not have a “stock out”, so they order much more than they expect to sell.
  – Often they order > twice median demand → huge waste (and outlet malls)

• Producing locally to order avoids these costs.

• *Savings from offshoring may need to be > 20% to offset the cost of uncertainty in forecasts with long lead times*
If relative lead time = 1 (a very long supply chain – e.g., China), cost savings would have to be 32.5% to make up for the cost of demand forecast uncertainty!
lead time emerges. In the absence of information to the contrary, it is reasonable to begin by assuming constant volatility, hence the standard Brownian motion framework. However, in many practical cases, the assumptions are not met. In these cases, it is advisable to employ parametric or nonparametric approaches that substitute for the Brownian motion framework. For example, the Ornstein-Uhlenbeck process is a nonparametric model that can be used to model the evolution of lead time.

Fig. 2. As the relative lead time increases, the associated marginal density becomes wider, increasing the expected mismatch cost for a given target quantile.
Future work

• White House Supply Chain Innovation Initiative
  – Leveraging federal innovation assets
  – Holding up private sector models

• Supply Chain Statistics
  – Work with Census, BEA, others to gather data that reflects increasing role of supply chains
Conclusions

• To take advantage of opportunity for resurgence of U.S. manufacturing, the US needs to reinvest in supply chains
• Networks of small manufacturers are key to taking a product from concept to market
  – Unique info from being close to production
• Small manufacturers face barriers in innovation, commercialization and diffusion
• Market fails to overcome these barriers
• Government can help
  – by diffusing info, pump-priming, convening
  – DOC plays a key role in each of these areas
backup
Manufacturing Employment
January 2000 – June 2013
Millions, seasonally adjusted

Source: BLS, CEA calculations
Note: Shading indicates recession.
New Employment in Small Firms

Share of New Jobs Created in Manufacturing
% 2010 to 2012 (latest available)

<table>
<thead>
<tr>
<th>Year</th>
<th>Small and Medium Sized Firms (Less than 500 employees)</th>
<th>Large Firms (500 or more employees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>2011</td>
<td>58</td>
<td>42</td>
</tr>
<tr>
<td>2012</td>
<td>54</td>
<td>46</td>
</tr>
</tbody>
</table>

Source: Census Bureau’s Business Dynamics Statistics
What is made in 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).
Domestic Content

• The portion of domestic content in U.S. production differs from the domestic content on store shelves.

Ex. Although the United States imported most of the apparel that consumers purchased, the apparel that was made in the United States contained 87% domestic content.
Made in America, 2012 continued

• Domestic content accounted for 51% manufactured goods bought in the U.S.
• Industries with the largest dollar values of American content:
  • food, beverage, and tobacco products
  • chemicals
  • petroleum and coal products
  • motor vehicles and parts
Gross Output in Manufacturing, 2012

(billions of dollars)

- Food and beverage and tobacco products: $895.2
- Petroleum and coal products: $807.3
- Chemical products: $744.9
- Motor vehicles, bodies and trailers, and parts: $522.4
- Machinery: $379.5
- Fabricated metal products: $335.3
- Computer and electronic products: $328.8
- Primary metals: $298.2
- Other transportation equipment: $285.6
- Plastics and rubber products: $206.8
- Paper products: $171.9
- Miscellaneous manufacturing: $161.0
- Electrical equipment, appliances, and components: $117.5
- Nonmetallic mineral products: $93.0
- Printing and related support activities: $85.2
- Wood Products: $75.8
- Furniture and related products: $61.0
- Textile mills and textile product mills: $51.7
- Apparel and leather and allied products: $20.4

Source: Bureau of Economic Analysis
Value added in Manufacturing, 2012

(billions of dollars)

<table>
<thead>
<tr>
<th>Category</th>
<th>Value added share of gross output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical products</td>
<td>45%</td>
</tr>
<tr>
<td>Food and beverage and tobacco products</td>
<td>26%</td>
</tr>
<tr>
<td>Computer and electronic products</td>
<td>65%</td>
</tr>
<tr>
<td>Petroleum and coal products</td>
<td>22%</td>
</tr>
<tr>
<td>Machinery</td>
<td>35%</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>37%</td>
</tr>
<tr>
<td>Motor vehicles, bodies and trailers, and parts</td>
<td>22%</td>
</tr>
<tr>
<td>Other transportation equipment</td>
<td>39%</td>
</tr>
<tr>
<td>Miscellaneous manufacturing</td>
<td>50%</td>
</tr>
<tr>
<td>Plastics and rubber products</td>
<td>32%</td>
</tr>
<tr>
<td>Primary metals</td>
<td>21%</td>
</tr>
<tr>
<td>Paper products</td>
<td>30%</td>
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<tr>
<td>Electrical equipment, appliances, and components</td>
<td>42%</td>
</tr>
<tr>
<td>Printing and related support activities</td>
<td>46%</td>
</tr>
<tr>
<td>Nonmetallic mineral products</td>
<td>38%</td>
</tr>
<tr>
<td>Wood Products</td>
<td>30%</td>
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<tr>
<td>Furniture and related products</td>
<td>36%</td>
</tr>
<tr>
<td>Textile mills and textile product mills</td>
<td>30%</td>
</tr>
<tr>
<td>Apparel and leather and allied products</td>
<td>51%</td>
</tr>
</tbody>
</table>

Source: Economics and Statistics Administration analysis using data from the Bureau of Economic Analysis.
Domestically-Sourced Inputs of Production in Manufacturing, 2012

(billions of dollars)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Domestically-sourced inputs</th>
<th>Gross output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and beverage and tobacco products</td>
<td>92%</td>
<td>94%</td>
</tr>
<tr>
<td>Chemical products</td>
<td>91%</td>
<td>92%</td>
</tr>
<tr>
<td>Petroleum and coal products</td>
<td>82%</td>
<td>91%</td>
</tr>
<tr>
<td>Motor vehicles, bodies and trailers, and parts</td>
<td>87%</td>
<td>86%</td>
</tr>
<tr>
<td>Machinery</td>
<td>85%</td>
<td>86%</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>89%</td>
<td>91%</td>
</tr>
<tr>
<td>Computer and electronic products</td>
<td>88%</td>
<td>91%</td>
</tr>
<tr>
<td>Primary metals</td>
<td>85%</td>
<td>86%</td>
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<tr>
<td>Other transportation equipment</td>
<td>86%</td>
<td>86%</td>
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<tr>
<td>Plastics and rubber products</td>
<td>88%</td>
<td>91%</td>
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<tr>
<td>Paper products</td>
<td>91%</td>
<td>93%</td>
</tr>
<tr>
<td>Miscellaneous manufacturing</td>
<td>88%</td>
<td>94%</td>
</tr>
<tr>
<td>Electrical equipment, appliances, and components</td>
<td>88%</td>
<td>94%</td>
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<tr>
<td>Nonmetallic mineral products</td>
<td>94%</td>
<td>94%</td>
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<tr>
<td>Printing and related support activities</td>
<td>94%</td>
<td>94%</td>
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<tr>
<td>Wood Products</td>
<td>93%</td>
<td>93%</td>
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<tr>
<td>Furniture and related products</td>
<td>89%</td>
<td>89%</td>
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<tr>
<td>Textile mills and textile product mills</td>
<td>89%</td>
<td>89%</td>
</tr>
<tr>
<td>Apparel and leather and allied products</td>
<td>91%</td>
<td>91%</td>
</tr>
</tbody>
</table>

Share of gross output produced by domestically-sourced inputs (value added + intermediate inputs)

Source: Economics and Statistics Administration analysis using data from the Bureau of Economic Analysis.
Meeting Domestic Demand for Manufactured Goods, 2012

<table>
<thead>
<tr>
<th>Industry</th>
<th>Domestic Content</th>
<th>Foreign Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and beverage and tobacco products</td>
<td>43%</td>
<td>79%</td>
</tr>
<tr>
<td>Motor vehicles, bodies and trailers, and parts</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>Petroleum and coal products</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Chemical products</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Computer and electronic products</td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>Apparel and leather and allied products</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous manufacturing</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Electrical equipment, appliances, and components</td>
<td>38%</td>
<td></td>
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<tr>
<td>Other transportation equipment</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>Furniture and related products</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td>Plastics and rubber products</td>
<td>50%</td>
<td></td>
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<tr>
<td>Paper products</td>
<td>74%</td>
<td></td>
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<tr>
<td>Fabricated metal products</td>
<td>53%</td>
<td></td>
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<tr>
<td>Textile mills and textile product mills</td>
<td>40%</td>
<td></td>
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<tr>
<td>Nonmetallic mineral products</td>
<td>49%</td>
<td></td>
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<tr>
<td>Wood Products</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Printing and related support activities</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>Primary metals</td>
<td>52%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Final domestic demand includes consumption and investment.
Source: Economics and Statistics Administration analysis using data from the Bureau of Economic Analysis.
Supply Chain Initiative

• U.S. manufacturing industry is poised for resurgence: 877,000 new jobs since 2010 after a decade of decline
  – 70,000 new manufacturing jobs in Ohio alone

• Initiative focuses on building public-private partnerships to strengthen the 230,000 small U.S. manufacturers that anchor the nation’s supply chains.
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.