# Measuring Manufacturing: Problems of Interpretation and Biases in U.S. Statistics

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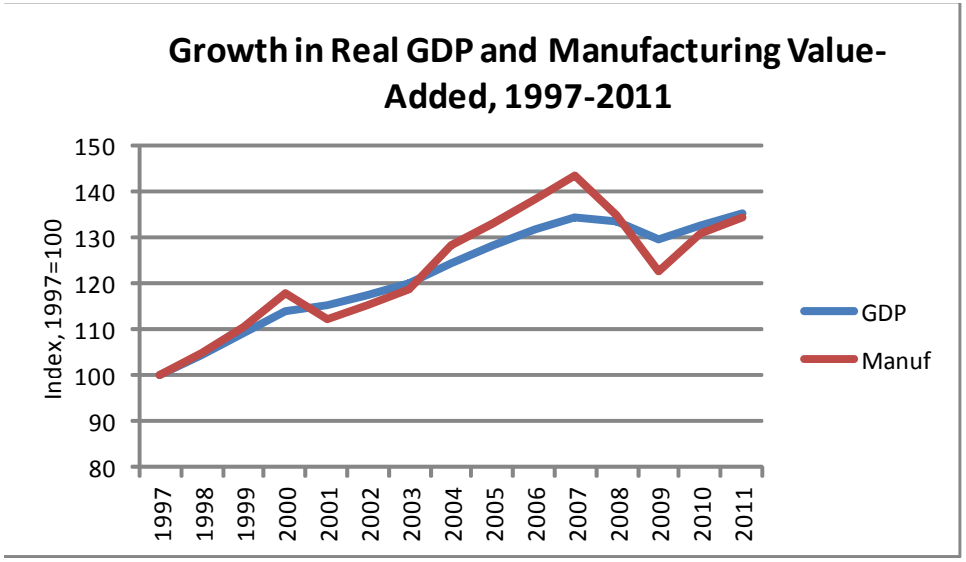
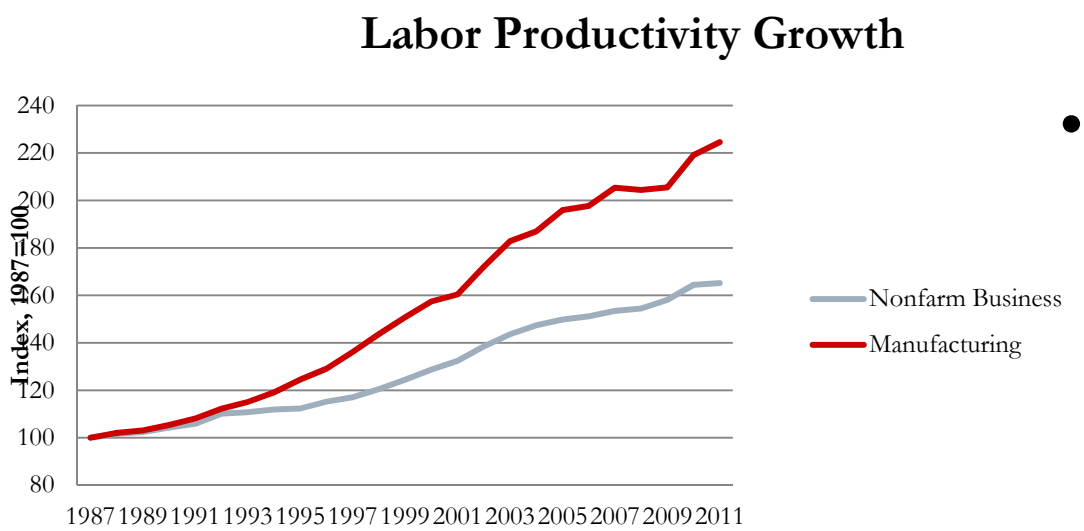
# Motivation: Debate over future role of manufacturing in United States

- **Sector lost 5.3 million mfg jobs—31% of employment since 2000**
  - Losses widespread—across mfg industries and states (not just confined to "rust belt")
- **Response to job losses, trade deficits, concerns that US losing competitiveness in manufacturing:**
  - Obama Administration established cabinet-level mfg policy office
  - Congress currently debating measures to help U.S. manufacturers
- **But policies controversial—many argue unnecessary**
  - U.S. mfg healthy—robust output & productivity growth
- **Official statistics play key role in shaping our understanding of economy & informing policy. Current debate over mfg illustrates challenges globalization poses to statistical agencies:**
  - Accurately constructing economic statistics
  - Communicating meaning to data users

# Output and productivity growth statistics depict health U.S. manufacturing sector



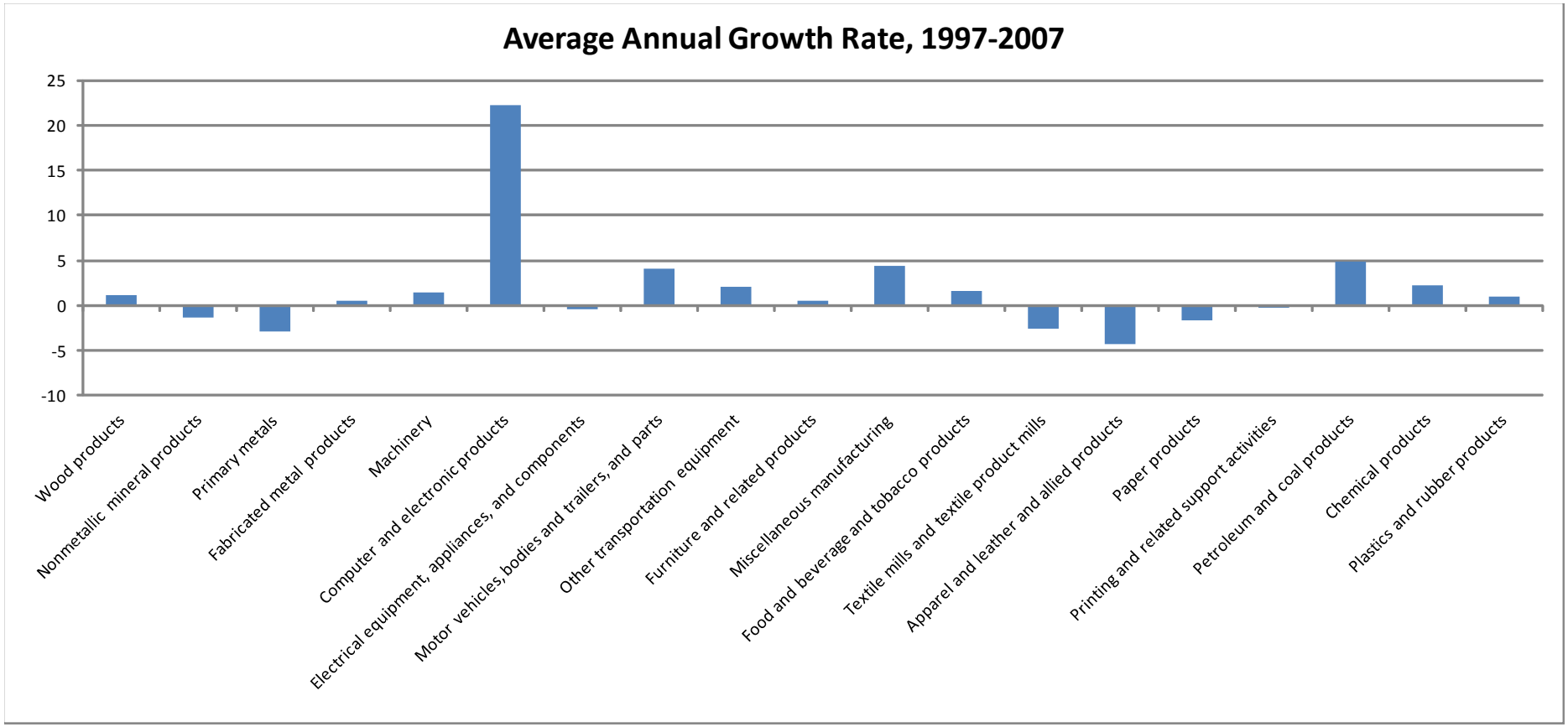

Sources: BEA and BLS

- Mfg GDP & productivity growth widely cited to argue:
  - US mfg sector healthy
  - Automation responsible for recent job losses
- But these statistics
  - Widely misinterpreted
  - Subject to significant bias

# Overview

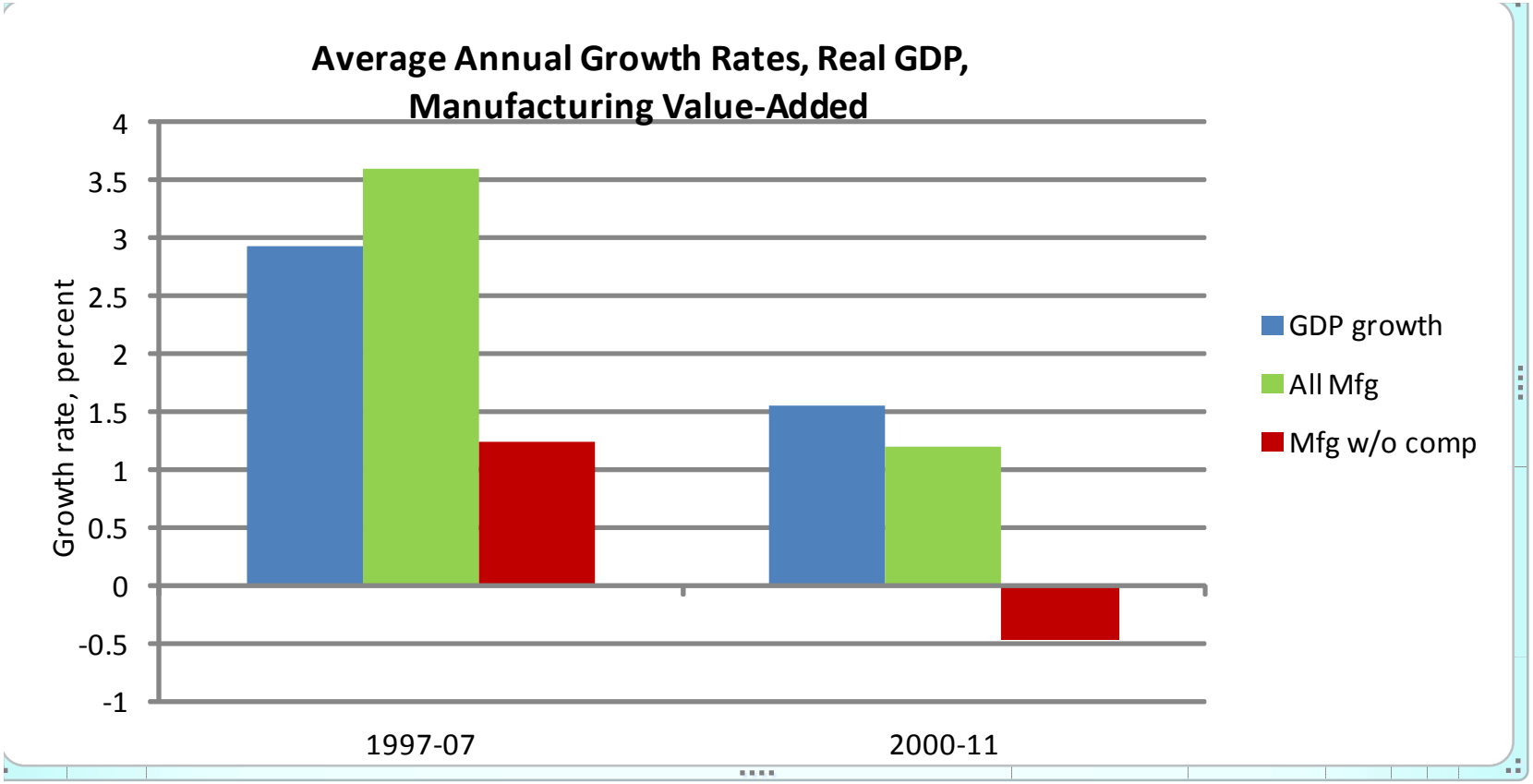
- **Build on Houseman, Kurz, Lengermann & Mandel (2011), which showed:**
  - Computer & electronic products industry driving real value added and MFP growth in mfg
  - Measured output & productivity growth in mfg subject to biases owing to shift toward low-cost imported intermediates (offshoring bias)
- **Extend empirical analyses to state mfg data, 1997-2007**
  - Show sensitivity of absolute and relative performance of state mfg sectors to inclusion of computer industry, offshoring bias
  - Test predictions of effect of output growth on employment growth, using different output measures
- **Consider other issues related to globalization & computer industry**
- **Implications for statistical agencies**

# Aggregate manufacturing statistics mask divergent trends in sector




**Extraordinary growth in computer & electronic products industry:**

- Largely credited to prices for certain computer & semiconductor products that when adjusted for quality improvements fall rapidly
- Does not reflect rapid growth in units shipped.




• Computer industry accounts for only 10-13% value added throughout period, but has outsized effect on aggregate mfg. statistics.

• Rapid growth real value added + decline employment (40% since 2000) resulted in rapid labor productivity growth.

• Labor productivity growth 40-50% less w/o computers.

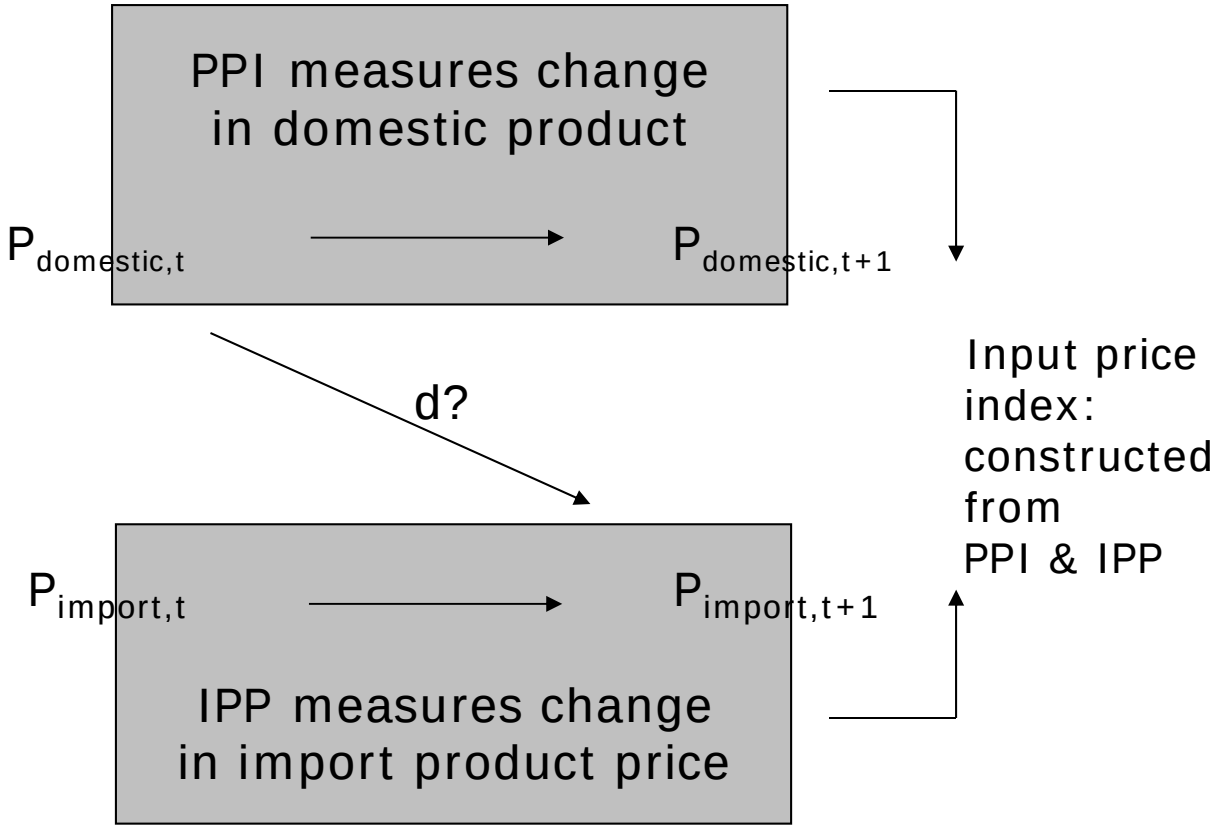
# Interpretation of Output and Productivity Growth in the Computer Industry

- **Labor productivity growth widely misinterpreted:**
  - Typically assumed that reflects automation—the substitution of capital for labor
  - In computer industry, largely reflects R&D innovations that result in product quality improvements
    - Not caused large-scale job losses in computer industry.
    - All losses in computer industry attributable to imports (McKinsey Global Institute 2012)
- **Real value-added growth in computer industry not a good indicator of competitiveness of U.S. as production location**
  - Trade deficit in these products relative to domestic consumption growing—U.S. production of computers & related electronics not kept pace w/demand
  - No high volume products produced in U.S. anymore (Sturgeon & Kawakami 2010)

# "Offshoring Bias": Nature of Problem

- **Methodologies for price index construction generally assume that "law of one price" holds:**
  - Price differences across suppliers for comparable products assumed to reflect quality differences.
  - BUT, entry & expansion of low-cost suppliers (domestic or foreign) important part of price dynamics
- **Shift by consumers & businesses from high to low-cost suppliers imparts upward bias to price indexes:**
  - Termed "outlet substitution bias" in CPI
- **Given growth of low-cost imported intermediates from emerging economies, bias to input price index ("offshoring" bias) may be significant in some industries. Implies:**
  - Growth real imports understated
  - Domestic real VA growth overstated
  - Some productivity measures overstated

# Overview of Bias to Input Price Index from Offshoring




Bias to input price index proportional to size of "discount" & gain in market share by low-cost supplier (Diewert & Nakamura 2009)

# Size of Bias from Offshoring in Manufacturing

- **HKLM (2011) estimated bias to mfg real value-added growth & MFP from growth imported materials inputs, 1997-2007**
  - Adjust for bias to *input* price index (Diewert & Nakamura 2009)
  - Captures bias from substitution from domestic to foreign & substitution among countries
  - Inklaar (2013), Howells et al. (2013)focus on bias to *import* price index from substitution among countries
- **Bias to average annual growth in real value added in mfg:**
  - 0.2 to 0.5 percentage point per year – depending on assumptions about size of discount
  - Magnitude of bias largest in computer industry: 0.5 to 1.4 percentage point per year (4 - 7% of growth)
  - Represents 21 to 49 percent of growth in manufacturing, excluding computers
- **Bias to annual growth rate of MFP ≈ 0.1 percentage point**

## Analyses with State-level Data

- **Attracting, retaining, growing manufacturing core of state & local economic development.**
- **Compute state-level mfg real value-added growth, 1997-2007**
  - Omitting NAICS 334
  - Adjusting for offshoring bias, using selected estimates from HKLM (2011)
- **Our estimates likely understate cross-state variation in offshoring bias:**
  - Import comparability assumption understates industry variation in imported intermediates. State variation comes from differences in industry structure.
  - Assume no within-industry variation among states in use of imported intermediates.

# Computer & Electronics Products Industry has Large Effect on State Mfg Growth and Rankings

- **Mfg real VA and employment growth in most states follow national patterns over 1997-07 period:**
  - Mfg real VA grew by at least 20% in 33 states—declined in 4
  - Mfg employment declined by at least 10% in 37 states + DC
- **Over 1997-07 period, when computer industry omitted, mfg real VA growth rates**
  - Fall by > 50% in 28 states and DC
  - Fall by > 25% in all but 10 states
- **State rankings based on mfg real VA growth largely capture size of computer industry in state:**
  - Substantially change when computer industry omitted
  - May affect performance US mfg in international rankings.

# Offshoring Bias – Potential Significant Additional Effect on State Manufacturing Growth

- 0.1 to 0.7 percentage point/year, depending on state industry mix and assumption about discount
- Adjustments largest in Michigan, Kentucky, Indiana, and Ohio
- Caveat: import proportionality assumption likely results in understatement of cross-state variation in bias

# Testing the Effect of State Mfg Real VA Growth on Employment Growth

- **Demand shocks to state manufacturing should be strongly associated with state employment growth.**
- **BUT, expect that computer industry will weaken relationship:**
  - Drives mfg real VA growth in many states
  - Largely measures product quality improvements –which has no implications per se for employment growth.
- **Regress state's employment growth on real GDP mfg growth, 1997-2007**
  - OLS estimates have no structural interpretation: state mfg output growth reflects state-level demand, supply, & productivity shocks
  - To capture demand shocks, instrument state mfg growth with weighted avg of natl ind growth rates. ("Bartik" instrument)
  - Use 3 measures of state mfg GDP growth

**The Effect of Manufacturing Output Growth on Employment Growth, 1997-2007**

| | 2SLS | 2SLS |
|---|---|---|
| Growth mfg real value added | **0.06** | **0.08** |
| | (0.11) | (0.08) |
| constant | -21.91 | -22.15 |
| | (4.47) | (3.51) |
| Growth mfg real value added w/o computers | **1.07** | **0.69**** |
| | (0.74) | (0.34) |
| constant | -33.35 | -27.90 |
| | (10.31) | (5.06) |
| Growth mfg real value added w/o computers, adj. offshoring bias | **0.99** | **0.70**** |
| | (0.62) | (0.30) |
| constant | -28.84 | -25.50 |
| | (6.62) | (3.53) |
| N | 51 | 48 |

- Disconnect between real output & employment growth in official data—elasticity estimates near 0
- Emp-output elasticity near 1 when growth measure omits computers.
- Growth measure that also adjusts for offshoring bias improves precision of estimates (s.e. lower)
- Demonstrates why aggregate mfg data, per se, don't show automation caused employment losses

# Computer & electronics products industry: Are the numbers right?

- **Outsized effect computer & electronics products industry has on manufacturing statistics naturally raises the question: Are the numbers right?**
- **Large impact this industry has on manufacturing (and aggregate GDP) may warrant greater scrutiny of numbers. We raise 3 broad questions:**
  - Is the input-output structure in NAICS 334 right?
  - Are the price deflators right?
  - Should adjustments for quality improvements in products be (solely) attributed to the hardware produced in manufacturing

# I-O Structure in Computer Industry

- **Puzzle: BLS sectoral output growth in NAICS 334 much lower than real value added growth: 7% v. 22% 1997-2007.**
  - Implies real inputs rising much less quickly than real outputs.
  - Possibly correct, but could reflect errors in measuring outputs & inputs in this critical industry
- **Measuring I-O structure difficult with growth of globalization:**
  - Rapid shifts in structure of production and location
  - Benchmark I-O data out-of-date
  - Are some fabless semiconductors misclassified (under current system) in manufacturing? (Bayard, Byrne, and Smith 2013)
  - Is input structure correct for production remaining in U.S. given substantial shift in products produced, hollowing out?

# Do Quality-Adjusted Price Deflators in Computer Industry Capture True Gains to Consumers?

- **Manufacturing and aggregate GDP highly sensitive to price deflators of small number of products in this industry.**
- **Current methodology may overstate true value to consumers & businesses from product improvements in the presence of network effects (Ellinson & Funderberg 2000, Linz 2006)**
  - Consumers & businesses use computers & related hardware to interact with each other and the Internet
  - Preferences heterogeneous
  - New models depreciate/render obsolete old models
  - Negative externalities not taken into account by existing methodologies (hedonic or matched models) for constructing price deflators

# Where Should Benefits from Technical Advances in Computer & Electronic Products be Attributed?

- **To physical hardware in manufacturing? To other embedded products such as software & communications services?**
- **Old question has new relevance w/ growth of globalization:**
  - U.S. moving away from making things toward specializing in services & product design (Corrado & Hulten 2010)
  - Continued offshoring of production may have major impact on measured growth in mfg, aggregate GDP. Is true effect on economy commensurate w/ effect on statistics?
- **One response: reclassify "factoryless goods manufacturing" in manufacturing sector—but problems of interpretation**
- **Measuring international flows of intangible assets—including R&D services—will be explored in last conference session**

# Implications for Statistical Agencies

- **Transparency and communication with data users**
  - Effect of computers—or any other industry with outsized effect—on aggregate statistics should be transparent.
  - Transparency important with move toward inclusion of factoryless goods producers in manufacturing sector
- **Prices data: collection and index construction:**
  - Entry & expansion of low-cost (domestic & foreign) suppliers important part of price dynamics not generally captured in price indexes
  - Collection of buyers' prices desirable, if feasible
  - Should capture price changes from <u>all</u> types of shifts in sourcing
  - Proposed input price index would begin to address problem in price indexes

# Implications for Statistical Agencies

- **Large effect of computer industry on mfg & aggregate statistics means important to address other sources of measurement error /conceptual issues in this industry:**
  - I-O structure in rapidly changing global supply
  - Methodology used to adjust prices for quality improvements
  - Consistent adjustment of import/export/domestic prices for quality improvements
  - Where consumer benefits from technical advances are counted: manufacturing v. services?