Offshoring, Terms of Trade and the Measurement of U.S. Productivity Growth

Benjamin R. Mandel
Federal Reserve Board of Governors

Based on: "Offshoring Bias in U.S. Manufacturing: Implications for Productivity and Value Added" (w/ Susan Houseman, Christopher J. Kurz, and Paul Lengermann).

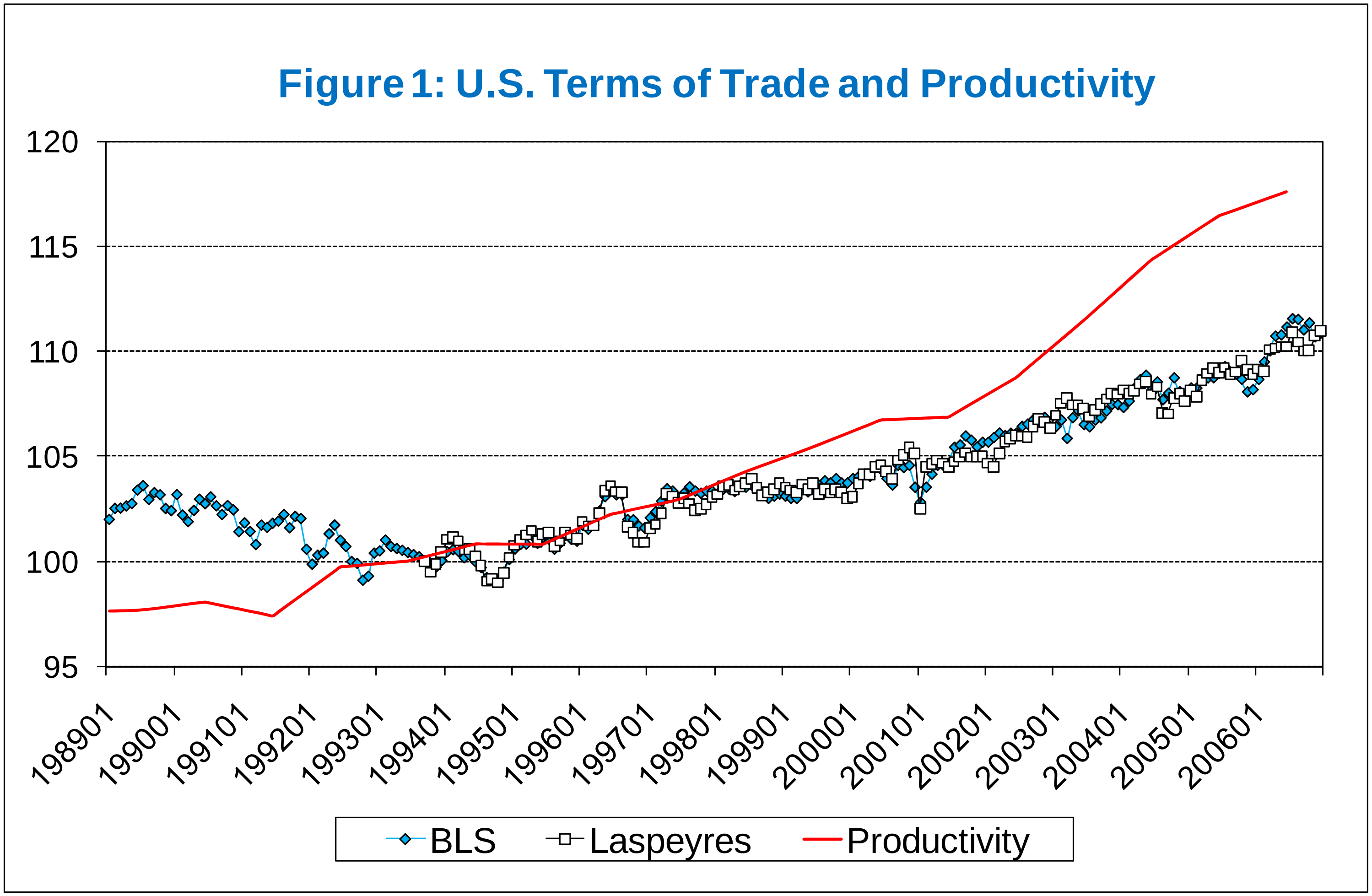
"Effects of Terms of Trade Gains and Tariff Changes on the Measurement of U.S. Productivity Growth" (w/ Robert C. Feenstra, Marshall B. Reinsdorf and Matthew J. Slaughter), and

The Role of Economic Research at the Federal Reserve

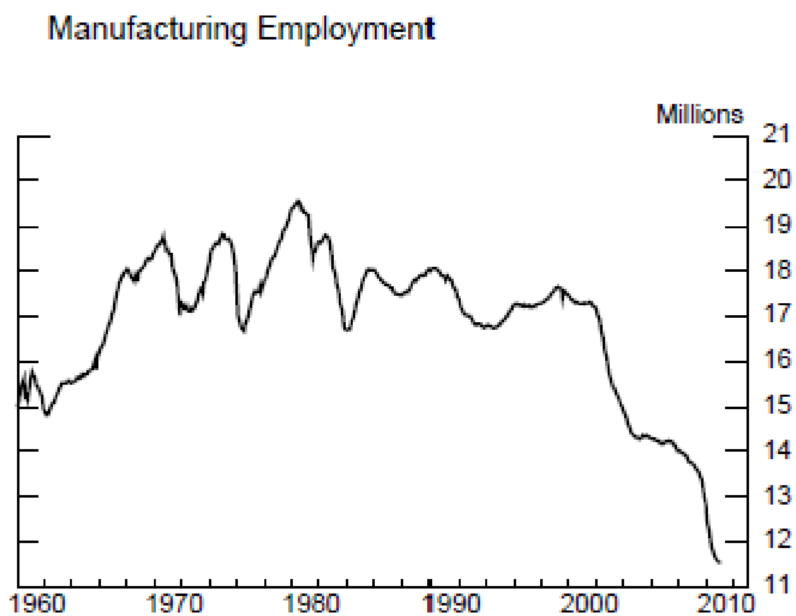
1. Policy relevance
2. Expertise in a part of the U.S. or global economy
3. Credibility of monetary policy

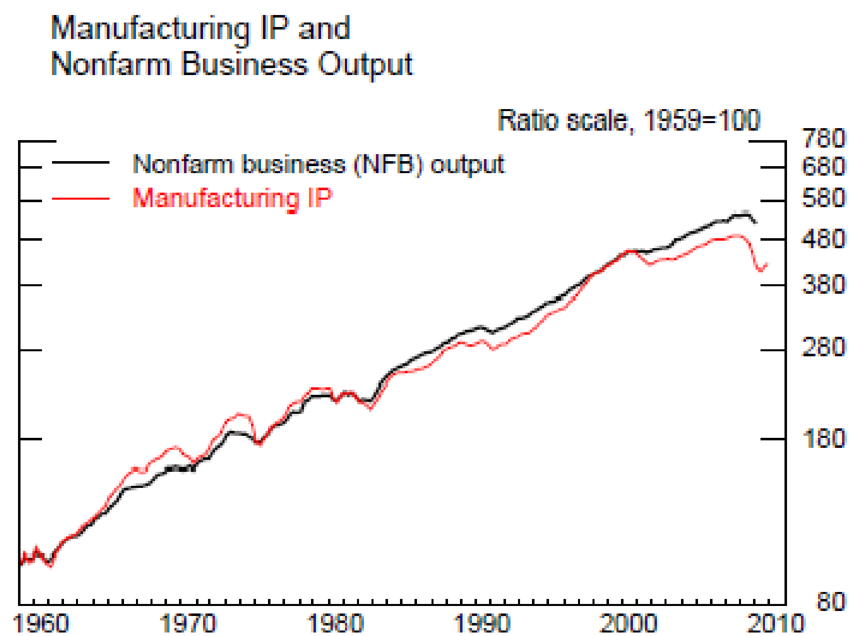
I. Motivation:

1. Acceleration in U.S. productivity growth after 1995, simultaneous with a major improvement in the U.S. terms of trade

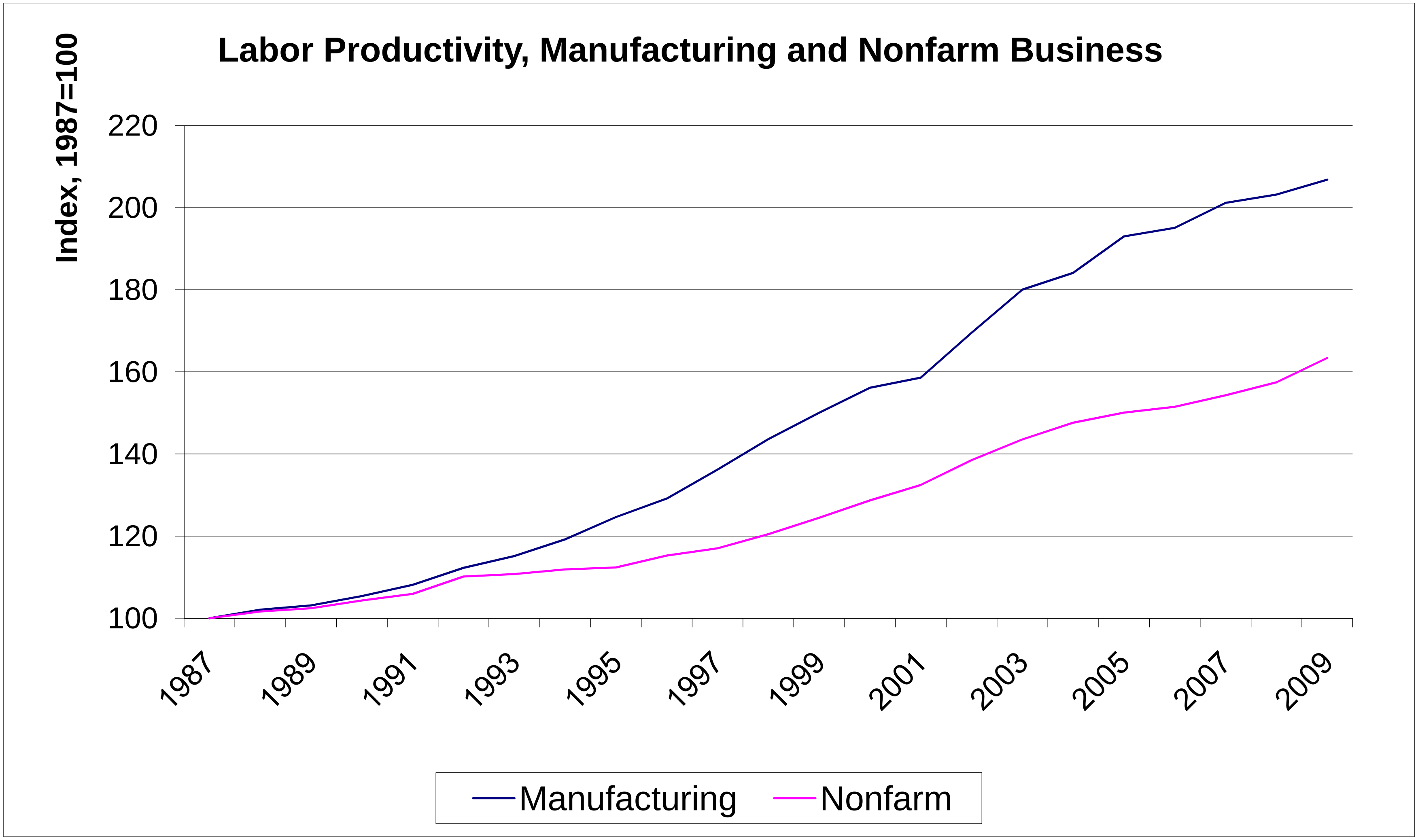


2. This productivity acceleration was particularly pronounced in the manufacturing sector.





These contrasting trends are reconciled through the lens of productivity. Labor productivity for manufacturing rose avg. annual rate 4.1 % compared to 2.7% all nonfarm business, 1997-2007.



3. But in suggesting a link between the terms of trade and productivity, we need to recognize that in theory, improvement the terms of trade *do not* have a first-order impact on value added or productivity when tariffs are small (e.g., Kehoe and Ruhl, 2007)

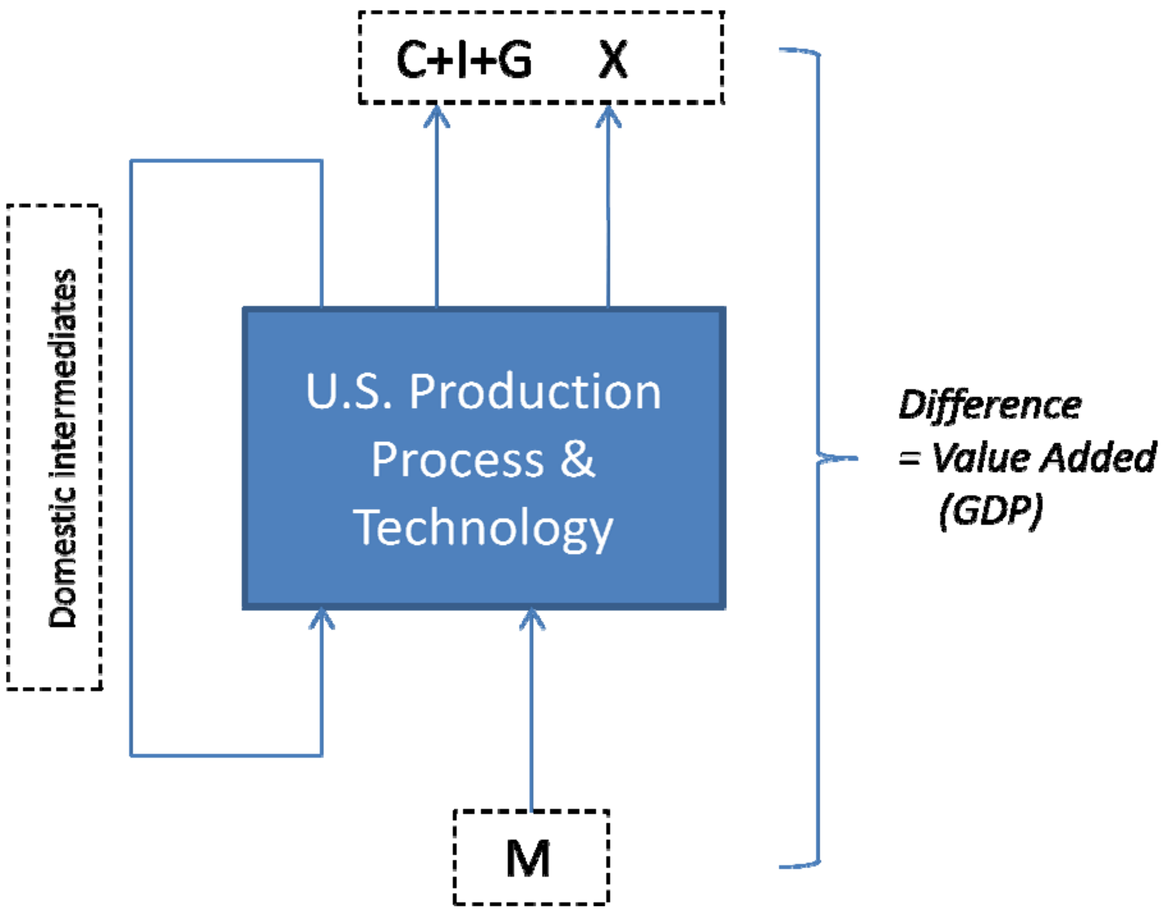
- Intuition: terms of trade affect both real output and real inputs in an offsetting manner, thus terms of trade effects do not have a large impact on real value added.

4. We illustrate the terms of trade – productivity link in two ways:

- In theory, real value added measures are affected by trade prices in the presence of ad valorem tariffs. We will extend Kehoe-Ruhl to a multi-sector setting and show this result.

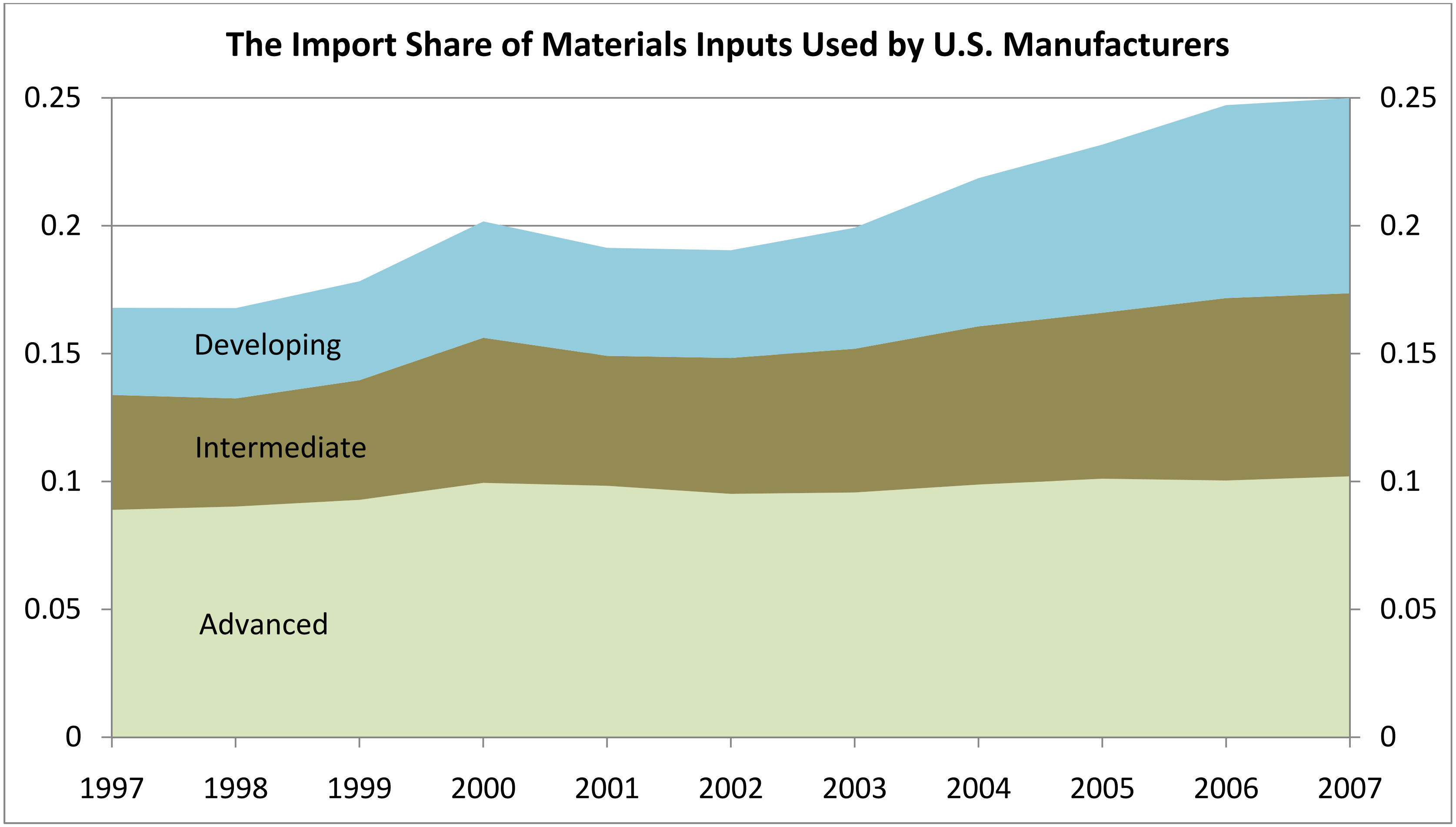
- What about if the terms of trade are mismeasured due to index number issues?

5. In that case, we will argue that the mismeasurement in the terms of trade spills over into productivity growth. If the improvement in the terms of trade is *understated*, then productivity is *overstated*.



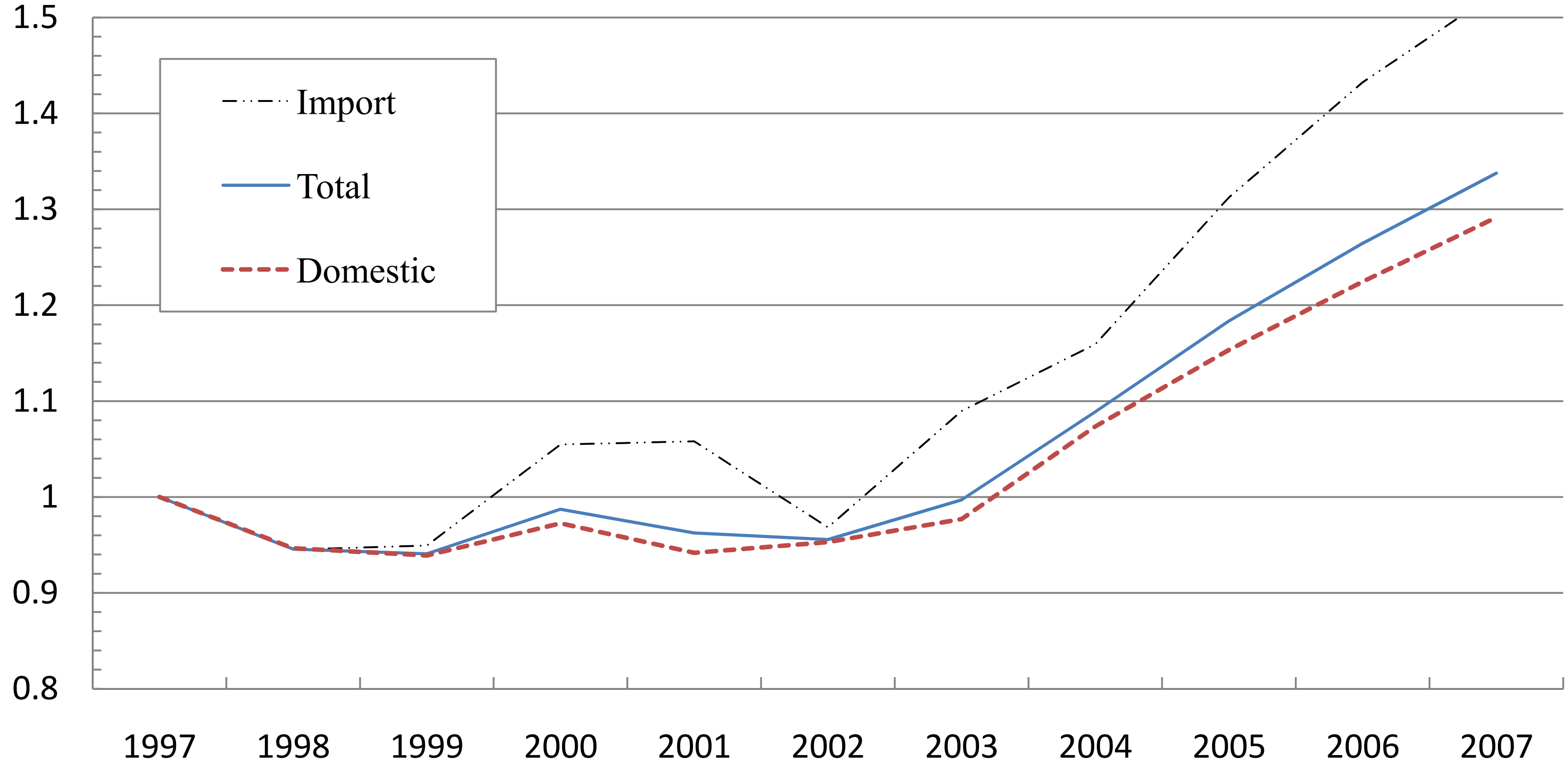
That is suggested by e.g. Michael Mandel, “The Real Cost of Offshoring.” *Business Week,* June 18, 2007.

6. Indeed, part of the reason that manufacturing employment is declining is the substitution of foreign-made inputs for those previously produced domestically.



7. One might expect that these large increases in foreign input shares corresponded to decreases in the relative price of imported intermediates, but official statistics actually indicate the opposite.

Purchased Materials Price Deflators for Manufacturing



8. We address this issue by:

- Identifying a bias to measured input price indexes from offshoring analogous to outlet substitution bias in CPI literature. Price indexes generally fail to capture price drops associated w/entry & market share expansion of low-cost supplier.

- Correcting for the bias using in input prices using a formula-based adjustment due to Diewert & Nakamura (2010) and estimating its quantitative importance in a growth accounting decomposition of manufacturing MFP.

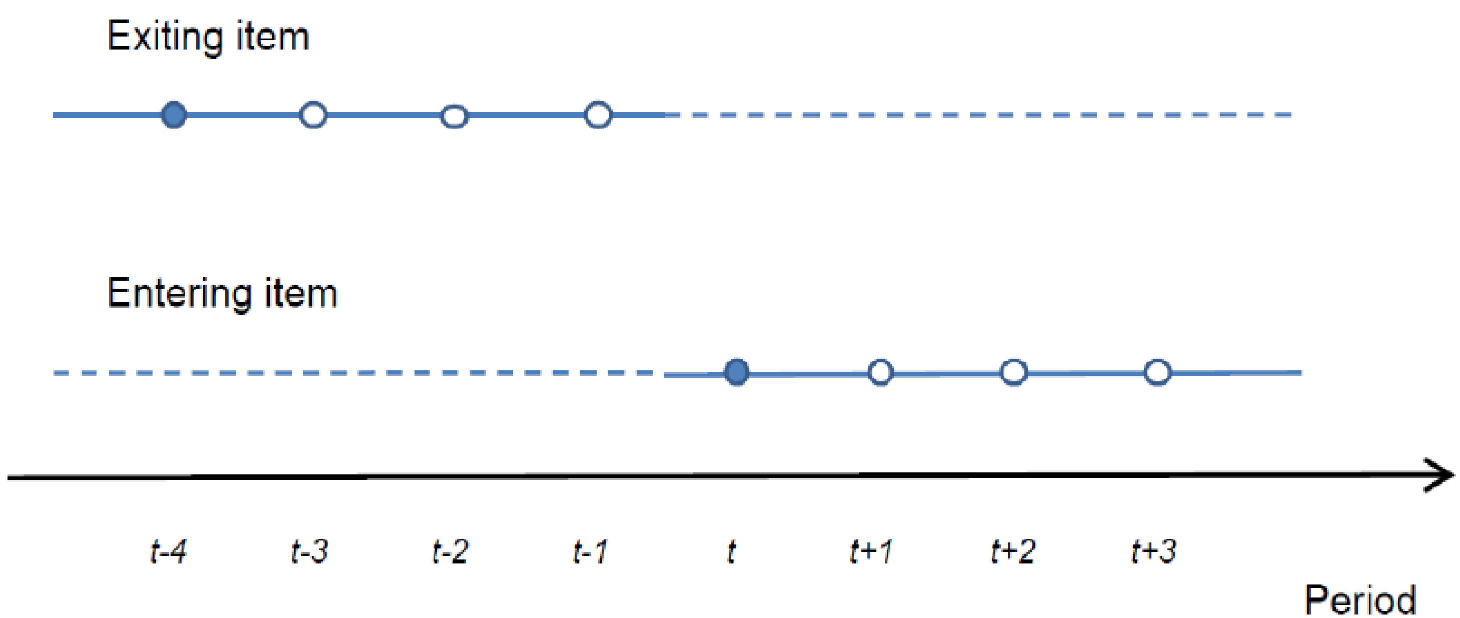
Conclusions:

- The growth rates of our alternative materials input price indexes are as much as 1 ppt. per year lower than the growth rate of official statistics.
- This mismeasurement can account for about 0.3 ppt. per year, or about 15% of the annual value added growth for the U.S. manufacturing sector over the past decade.

Broader Implications

- More balanced view of the performance of the U.S. manufacturing sector.
    - "Lean and productive" vs. "hollowed out"
- International trade is more important in driving the U.S. economy than official statistics suggest.
- Measurement errors in import prices are themselves a byproduct of globalization.

- Illustration of ‘offshoring bias’: The matched model index computes price changes for the same item in two adjacent periods. Since t-1 is unobserved from the perspective of IPP, the entering item is not included in (‘linked out of’) the index in its initial period.
- The level difference between exiting items in the PPI and entering items in the IPP is not observed.



- Example of ‘offshoring bias’:

Hypothetical Offshoring of Obtanium				
	t	**t+1**	**t+2**	**t+3**
Domestic supplier price	$10.00	$10.00	$10.00	$10.00
Domestic quantity sold	100	90	80	70
Chinese supplier price	$6.00	$6.00	$6.00	$6.00
Chinese quantity sold	0	10	20	30
Average price paid for obtanium	$10.00	$9.60	$9.20	$8.80
Domestic input price index	100	100	100	100
Import input price index	—	100	100	100
Input index, as computed	100	100	100	100
True input price index	100	96	92	88

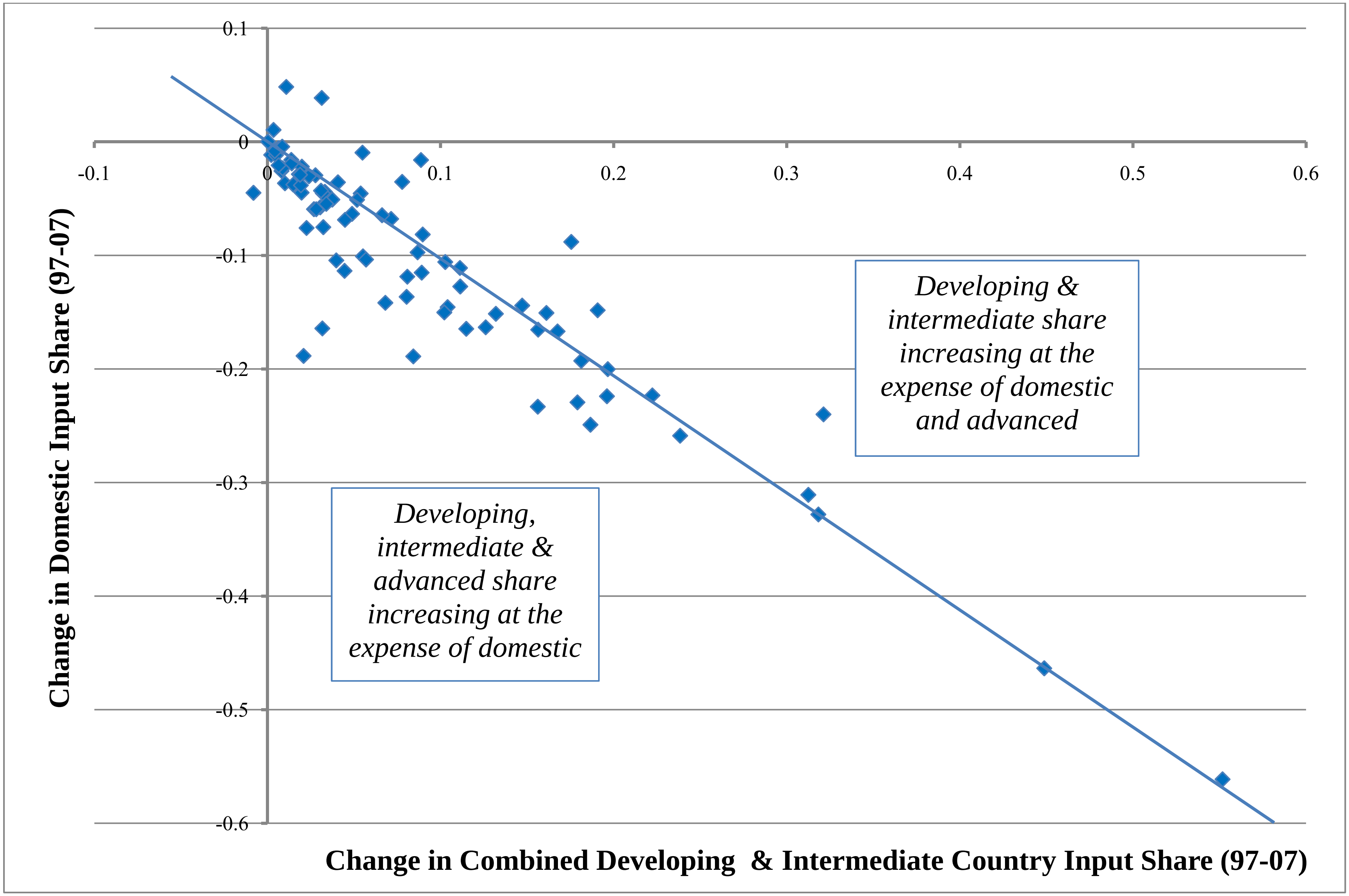
- Bias to input price index at elemental level from shifts in sourcing (Diewert and Nakamura, 2009):

$$\boldsymbol{Bias \approx (1 + i)^{*}\, s^{*}d}$$

Where *i* is the rate of price increase, *s* is share captured by new, low-cost supplier, and *d* is percent discount of the low-cost supplier (foreign) relative to the high-cost (domestic) supplier

- Characterization of bias to input price from offshoring identical to that of bias to CPI from outlet substitution (Diewert 1998)

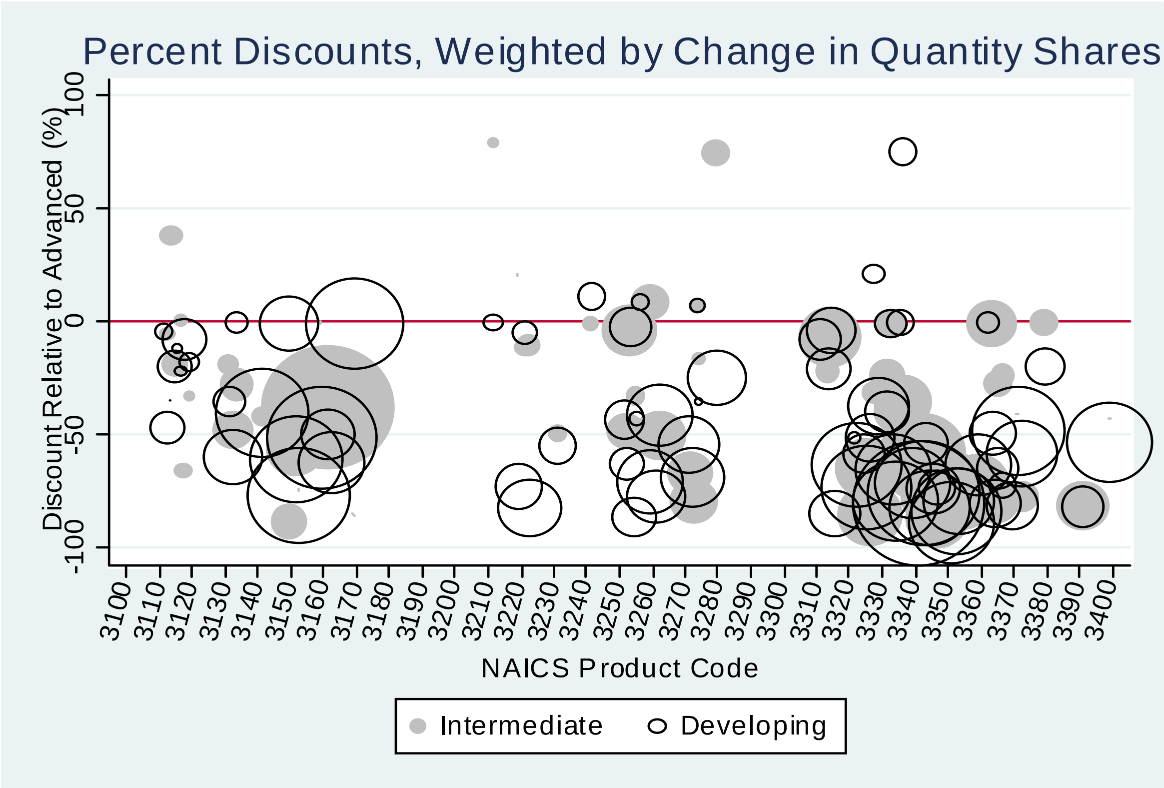
- Evidence of shifting shares (**s**):



- Evidence of the offshoring discount (**d**):
  - **Method 1 - Full Sample IPP Microdata:**
    - The import price discount for an individual item in the developing set is defined as:

$$\ln(1 + d(1)_{iujt}^{c\in D}) = \ln p_{iujt}^{c\in D} - \sum_{c\epsilon A}\sum_u \sum_i w_{\mathrm{ijt}} * \ln p_{iujt}^{c\in A}$$

    - Discount aggregated further using IPP item- and establishment-level weights



- Evidence of the offshoring discount (**d**), cont'd:
  - **Method 2 - Switching Sample:**
    - A closer empirical counterpart to the decision of U.S. producers to offshore is the decision of U.S. importing firms to switch among foreign source countries
    - Controls for cross-firm variation in import composition

		INCUMBENT		
1993-2007		Developing	Intermediate	Advanced
NEW	Developing	3%	4%	-44%
	N	391	315	182
	Intermediate	18%	-2%	-28%
	N	192	118	164
	Advanced	43%	35%	23%
	N	163	175	367

- Evidence of the offshoring discount (**d**), cont'd:
  - **<u>Method 3 - Full Sample: Adjusted Estimates</u>**
    - Estimate degree of unobserved compositional differences driving relative prices
    - Products with a high correlation of price skewness and firm size skewness are classified as high quality scope industries (Mandel, 2010)
    - Intuition:

$$var_j(\ln q_i) \cong var_j(\ln p_i) - var_j(\ln z_i)$$

    - Implementation:

$$\left|d(1)_{kjt}\right| = \alpha_0 + \alpha_1 * var_j(\ln z_i) + \alpha_2 * var_j(\ln z_i)^2 + \varepsilon_{kjt}$$

- Evidence of the offshoring discount (**d**), cont'd:

  - Unadjusted Full Sample
    63% for developing
    58% for intermediate

  - Switching Estimates
    44% for developing
    28% for intermediate

  - Adjusted Full Sample
    25% for developing
    14% for intermediate

  - Industry case studies:

	Case Study Estimates				Estimates using IPP Data			
	Country	Industry/product	Discount off U.S.	Source	NAICS	Unadjusted	Firm-Level	Quality-Adjusted
Developing	China	Electronic Equipment	20, 60, 60	McKinsey (2006)	334: Computer and Electronic Product Manufacturing	73	38	18
		Semiconductors	40	Byrne, Kovak, and Michaels (2009)	3344: Semiconductor and Other Electronic Components	82	54	47
		Circuit Boards	40-50	Business Week (2004)				
		General Manufactured Products	30-50, sometimes higher		31-33: Manufacturing	60	35	13
Intermediate	Mexico	Aluminum Wheels	19 (36% on processing costs)	Klier and Rubenstein (2009)	3361: Motor Vehicle Manufacturing	34	26	-60
		Auto Parts	20-30	Kennedy (2004)				
	Singapore	Semiconductors	24	Byrne, Kovak, and Michaels (2009)	334: Semiconductor and Other Electronic Components	72	40	34

- Bias-Corrected Intermediate Input Cost Inflation