Offshoring Bias:
The Effect of Import Price Mismeasurment on Manufacturing Productivity

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Motivation

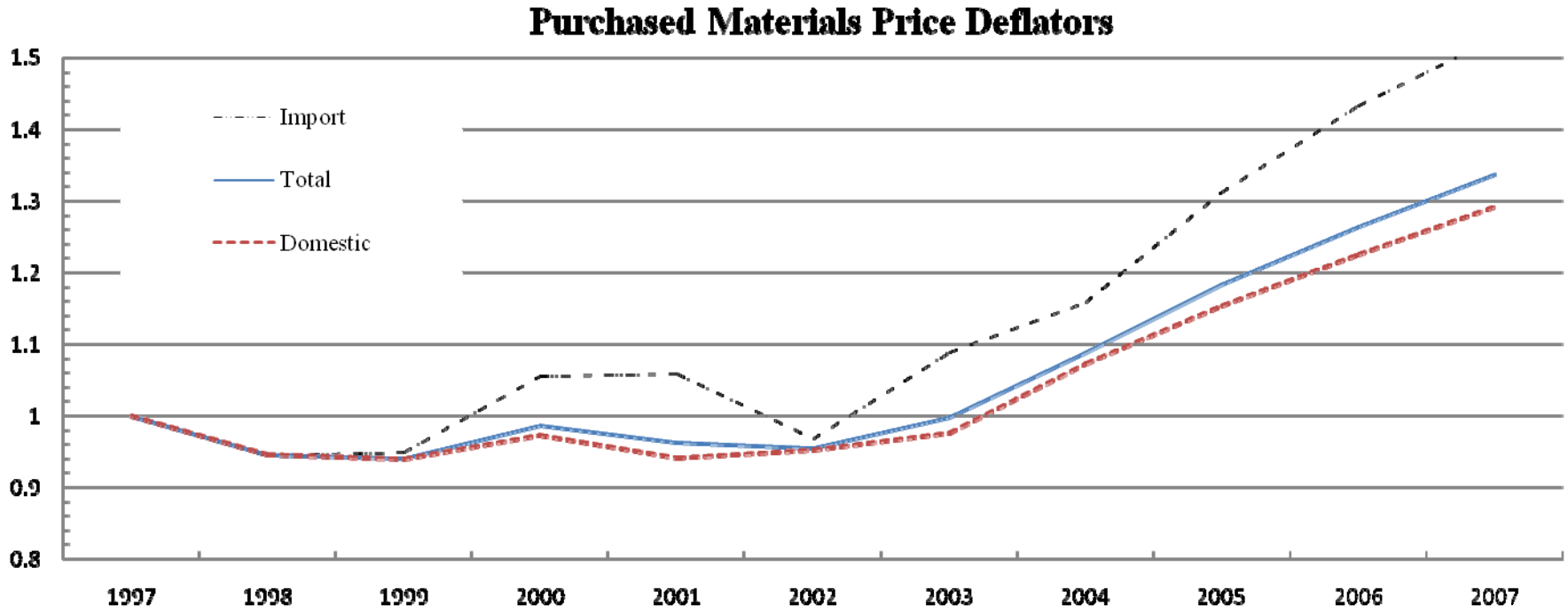
Price declines associated with the entry of a new, low-cost foreign suppliers and their expansion of market share are not captured in the import price statistics

Problem is analogous to outlet substitution bias in the literature on the CPI

Since it arises from shifts in sourcing to developing countries, we term it "*offshoring bias*"

Recent trends for materials price indexes in manufacturing illuminate the possibility of a systematic bias in import price statistics….

Motivation (continued)



Mismeasurement has a first-order effect on computed real output and productivity growth

If import price growth is overstated, then the real growth of imported inputs is understated, and industry value-added and productivity measures are overstated

Overview

We examine how biases to the import prices have affected measured productivity in U.S. manufacturing during the 1997-2007 period

Use the outlet substitution bias formula developed in Diewert (1998) and applied in Diewert and Nakamura (2009) to adjust import prices for sourcing shifts and the discount obtained by U.S. producers

Use IPP microdata to measure the relative price of U.S. imports from low-wage countries compared to prices from "advanced" nations

Adjusted import prices incorporated into a growth accounting framework that splits purchased materials inputs into domestic and foreign components

Key Findings

Offshoring bias has been substantial

The price "discount" for imports from developing and intermediate countries is large:

Unadjusted: 60 percent
Quality adjusted: 25 percent

Imported materials price growth overstated by 16 - 35 ppt

Manufacturing MFP growth overstated from 0.1 - 0.3 ppt per year

Preliminary work to further account for bias in input prices suggests MFP growth overstated another 0.1 - 0.2 ppt

Price Biases from offshoring and other sourcing shifts

"Offshoring bias" concerns the *levels changes* in input costs that are missed when producers offshore intermediate inputs or shift sourcing among foreign countries

Problem exacerbated in an environment of frequent product churning and persistent price differentials

Both conditions appear pervasive for imports

If prices register most of their change *after* entering the US much of this dynamic could be picked up…however, with frequent churning and price rigidity likely not

Quantifying the bias in import prices from shifts in sourcing

$$P_T = P_L - [(1+i)s_d d_d + (1+i)s_i d_i]$$

Bias reflects both the growth in the import share by suppliers from developing or intermediate countries and the price discount relative to suppliers in advanced countries

Price discount, *d*, constructed at the transactions level

The market share term, *s*, defined at the detailed commodity level

Formula also captures bias imparted from offshoring when shifts are to newly imported products

Measuring the import discount

We separate countries into three groups: advanced, developing, and intermediate based on 2008 per capita GDP relative to the U.S.

The import price discount for an individual item in the developing set is defined as

$$d_{iujt}^{ceD} = \ln p_{iujt}^{ceD} - \sum_{ceA} \sum_{u} \sum_{i} w_{ij} * \ln p_{iujt}^{ceA}$$

d can aggregated further using IPP item- and establishment-level weights

➔Our final *d* is the average discount for developing country *c* in product *j* at time *t*

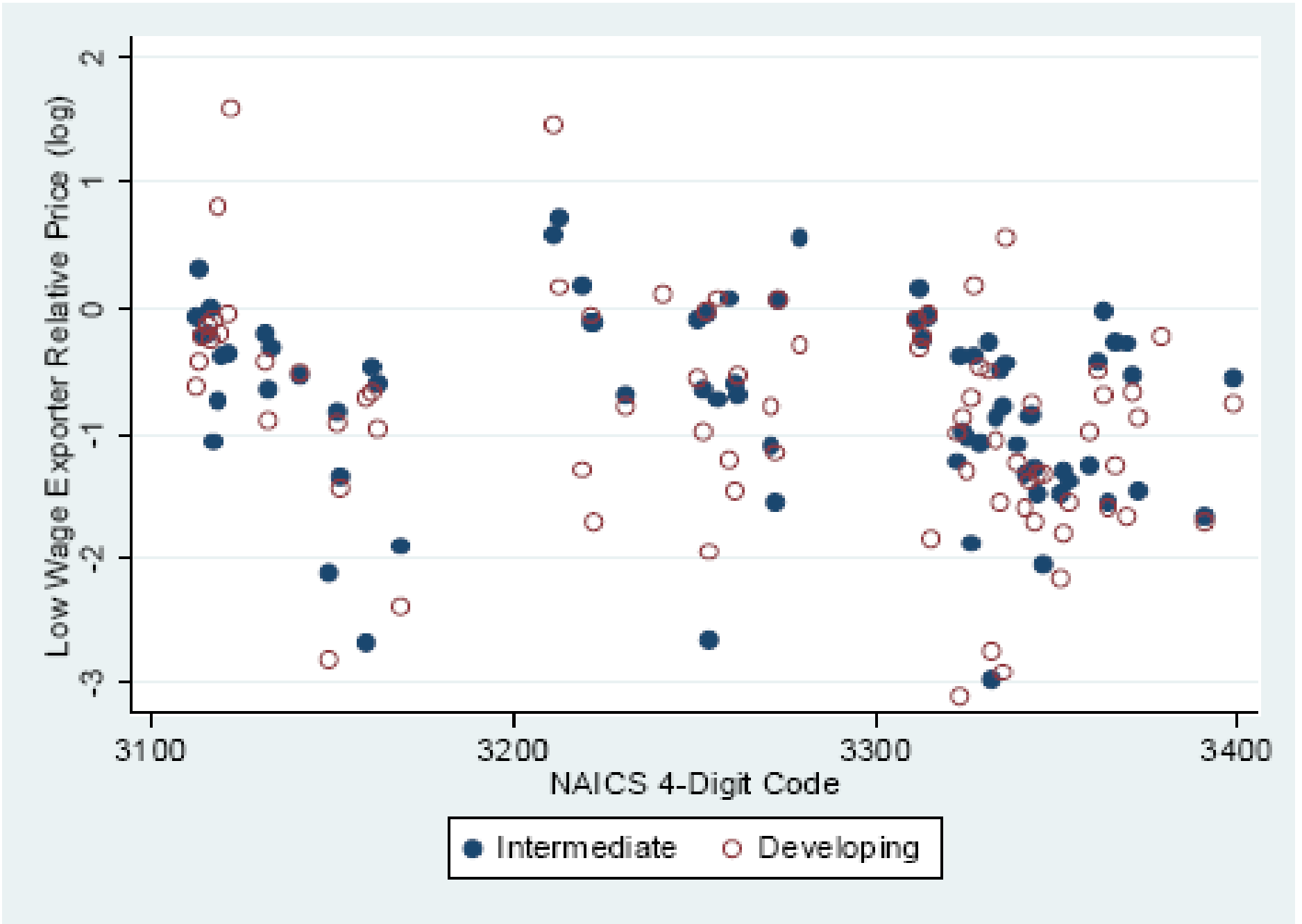


Figure 4a: The relative import price from low-wage countries

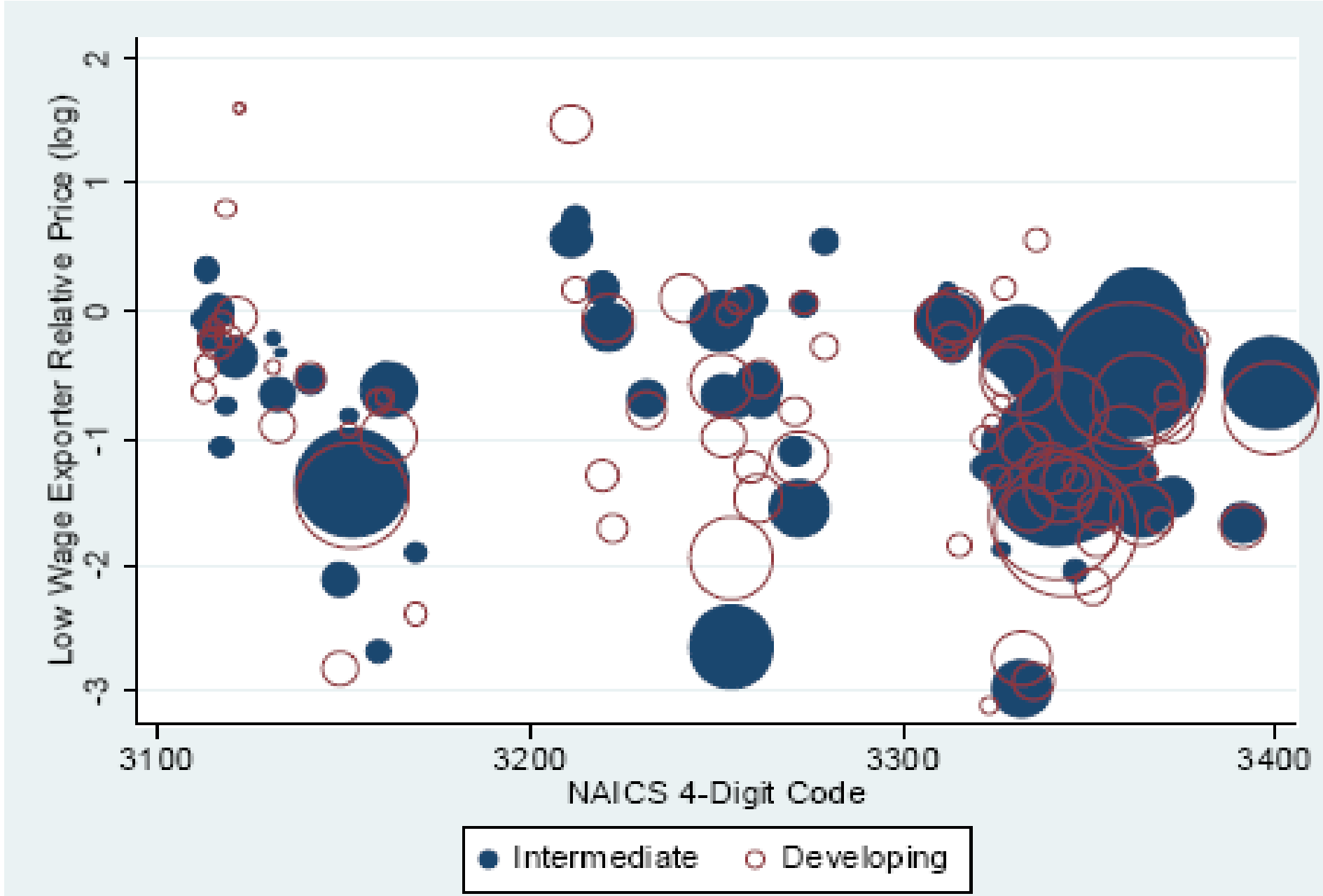


Figure 4b: The relative import price from low-wage countries, weighted by size

Adjusting the import price discount for quality

The relative prices ignore compositional differences in quality specifications of exports across countries

➔We use estimates of product quality scope from Mandel (2009) to approximate quality differences:

Key assumption: dispersion in observed item prices is proportional to the underlying dispersion in quality composition.

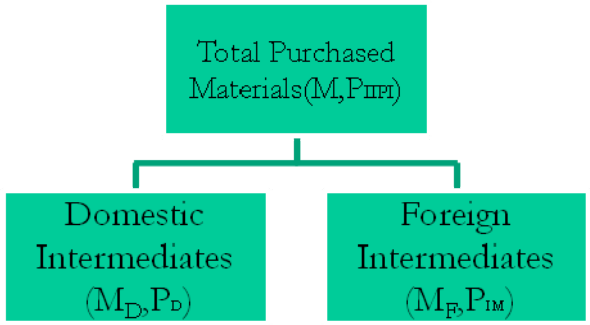
We choose the most conservative estimates, i.e. the specification which ascribed the most observed price variance to quality.

Adjusting the import price discount for quality (continued)

Developing		
Country	Relative Price	Quality-Adjusted Relative Price
BRAZIL	-0.60	-0.19
CHINA	-1.38	-0.43
COLOMBIA	-0.72	-0.21
INDIA	-1.44	-0.66
INDONESIA	-1.00	-0.09
THAILAND	-1.14	-0.42
Total Developing	-1.00	-0.29

Intermediate		
Country	Relative Price	Quality-Adjusted Relative Price
CHILE	-0.51	0.29
MEXICO	-0.79	-0.13
HONG KONG	-1.20	-0.40
KOREA	-0.73	0.12
SINGAPORE	-1.01	-0.30
TAIWAN	-1.17	-0.41
Total Intermediate	-0.88	-0.15

Decomposing BEA's Materials Input Price



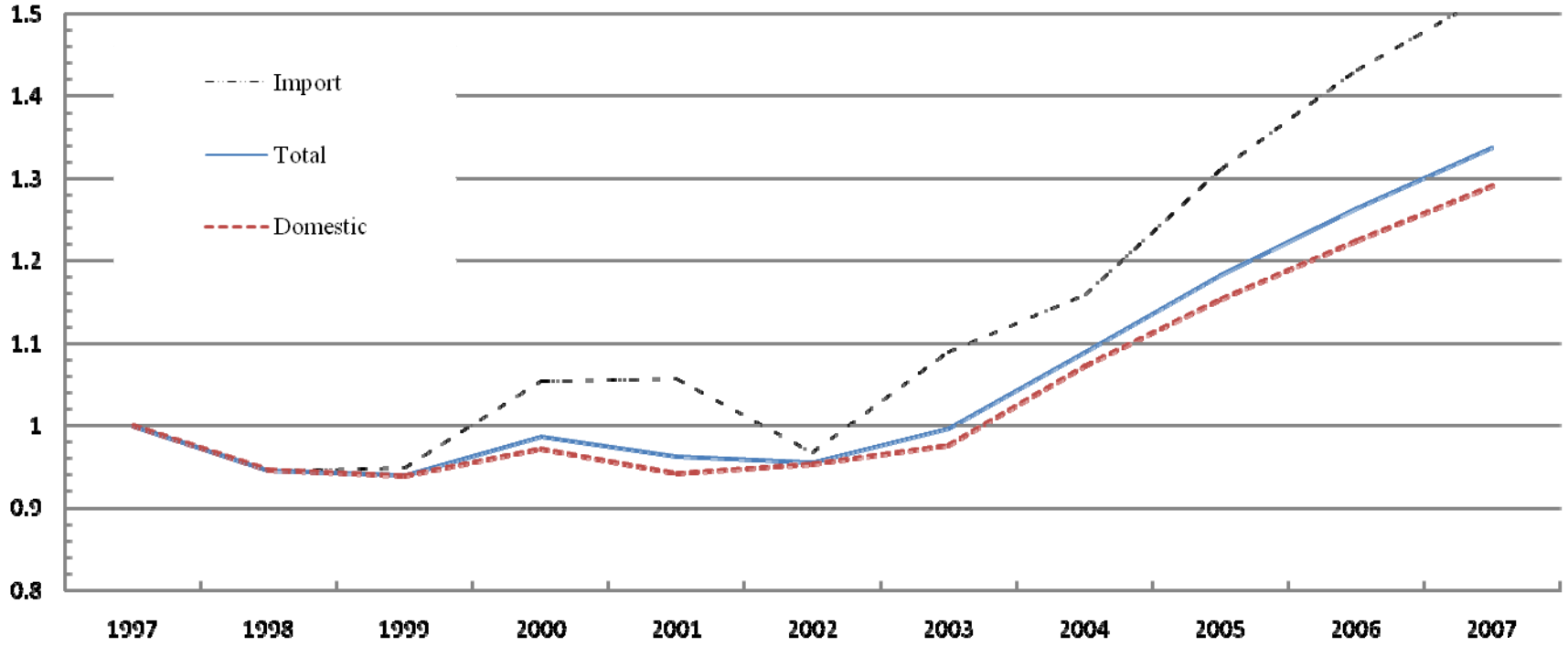
Total purchased materials prices and values from BEA's GDP-by-industry accounts

Unpublished, detailed import prices and values from BEA:

- BEA concords BLS IPP prices on an SITC basis to BEA commodity codes
- We use data for 386 commodities and 502 industries
- Create Fisher imported intermediate price indexes for the 65 industries in the published GDP-by-industry accounts

We then chain-strip using out prices and nominal values for domestic materials

Baseline Purchased Materials Price Deflators



Growth Rates for Materials Prices

Total MPI	Domestic	Imported
33.8	29.1	52.6

Growth Accounting: baseline results

	Gross Output	MFP	Capital	Labor	Energy	Services	Purchased Materials: Domestic	Purchased Materials: Foreign
Manufacturing	1.18	1.27	0.13	-0.51	-0.05	0.24	-0.18	0.27
Durable goods:	2.00	1.95	0.17	-0.63	-0.05	0.34	-0.14	0.36
Wood products	0.36	0.42	0.01	-0.33	-0.07	0.19	0.07	0.07
Nonmetallic mineral products	0.45	0.03	0.26	-0.25	-0.12	0.16	0.29	0.08
Primary metals	-0.76	0.75	-0.13	-0.78	-0.13	-0.24	-0.36	0.13
Fabricated metal products	0.48	0.74	0.11	-0.43	-0.06	-0.05	-0.01	0.19
Machinery	0.40	0.88	0.44	-0.76	-0.04	0.05	-0.58	0.40
Computer and electronic products	7.35	6.66	0.24	-1.10	-0.05	1.21	0.02	0.35
Electrical equipment, appliances, and components	-0.75	1.56	-0.09	-0.90	-0.05	-0.25	-1.13	0.10
Motor vehicles, bodies and trailers, and parts	1.36	1.05	0.09	-0.47	-0.02	0.28	-0.17	0.60
Other transportation equipment	1.35	0.84	0.31	-0.26	-0.02	0.27	-0.47	0.69
Furniture and related products	0.54	0.64	0.23	-0.60	-0.04	0.27	-0.21	0.25
Miscellaneous manufacturing	2.91	2.14	0.17	-0.73	-0.01	0.56	0.51	0.27
Nondurable goods:	0.16	0.45	0.07	-0.37	-0.04	0.14	-0.24	0.17
Food and beverage and tobacco products	0.76	0.12	0.00	-0.06	-0.03	0.56	0.05	0.12
Textile mills and textile product mills	-3.71	0.73	-0.19	-1.69	-0.21	-0.29	-2.03	-0.03
Apparel and leather and allied products	-9.45	0.92	-0.12	-3.05	-0.15	-1.59	-4.91	-0.55
Paper products	-1.32	0.04	-0.15	-0.71	-0.20	-0.06	-0.29	0.05
Printing and related support activities	-0.72	0.44	0.24	-0.83	-0.04	0.17	-0.74	0.04
Petroleum and coal products	1.01	0.20	0.10	-0.07	0.06	-0.17	0.36	0.53
Chemical products	0.97	1.32	0.16	-0.19	-0.07	-0.01	-0.35	0.11
Plastics and rubber products	0.72	0.37	0.16	-0.49	-0.04	0.18	0.23	0.30

- MFP is predominant contributor,
- followed by imported materials
- Further evidence of offshoring: domestic materials consistently negative

Alternative import price measure 1: IPP=PPI

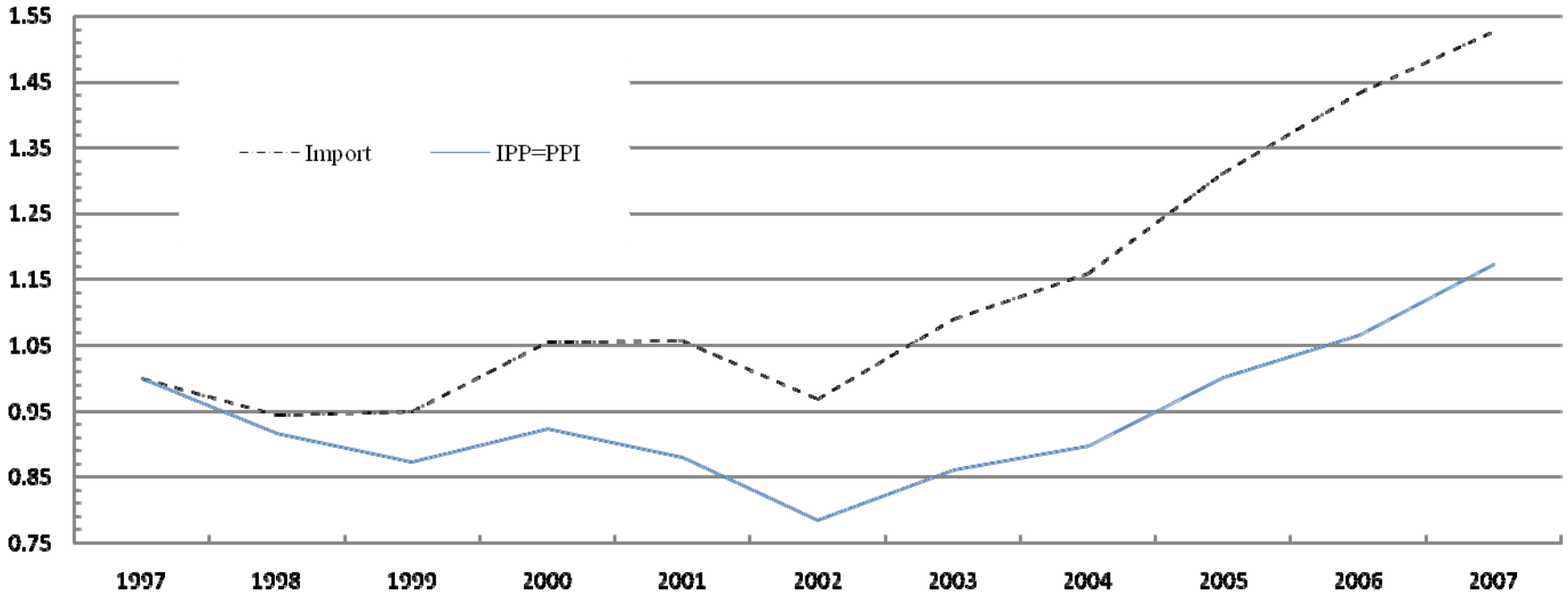
Based on an assumption of similar quality, no specialization, sustained relative cost advantage for imported intermediates

Set the 5-digit commodity level import prices indexes equal to their domestic counterparts in the PPI whenever domestic prices were found to grow at a slower rate over the entire 1997 – 2007 period.

Approach *arguably provides a lower bound estimate of the overall bias* to import prices from:

- Offshoring
- Shifts in sourcing from high to low-cost foreign producers
- Other problems associated with measuring import prices

Alternative import price measure 1: IPP=PPI



Growth Rates for Price Indexes

Total MPI	Domestic	Import IPP	IPP=PPI
33.8	29.1	52.6	17.3

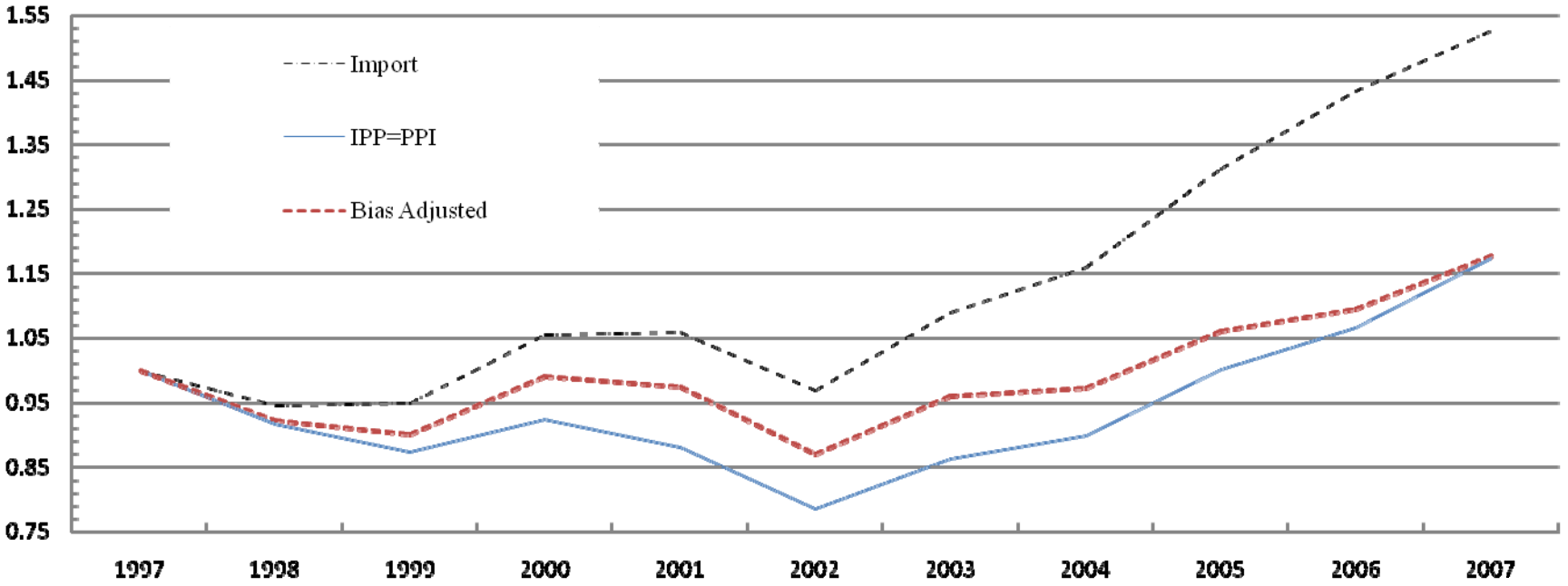
Growth Accounting: Alternative 1, IPP=PPI

	Baseline:		*IPP=PPI*	
	MFP	Foreign Materials	MFP	Foreign Materials
Manufacturing	1.27	0.27	1.03	0.51
Durable goods:	1.95	0.36	1.58	0.73
Wood products	0.42	0.07	0.37	0.13
Nonmetallic mineral products	0.03	0.08	-0.03	0.13
Primary metals	0.75	0.13	0.51	0.38
Fabricated metal products	0.74	0.19	0.62	0.31
Machinery	0.88	0.40	0.73	0.55
Computer and electronic products	6.66	0.35	5.36	1.65
Electrical equipment, appliances, a	1.56	0.10	1.28	0.39
Motor vehicles, bodies and trailers	1.05	0.60	0.91	0.74
Other transportation equipment	0.84	0.69	0.64	0.88
Furniture and related products	0.64	0.25	0.55	0.34
Miscellaneous manufacturing	2.14	0.27	1.96	0.45
Nondurable goods:	0.45	0.17	0.39	0.22
Food and beverage and tobacco pr	0.12	0.12	0.09	0.15
Textile mills and textile product m	0.73	-0.03	0.68	0.02
Apparel and leather and allied pro	0.92	-0.55	0.79	-0.43
Paper products	0.04	0.05	-0.03	0.13
Printing and related support activi	0.44	0.04	0.40	0.08
Petroleum and coal products	0.20	0.53	0.19	0.54
Chemical products	1.32	0.11	1.25	0.18
Plastics and rubber products	0.37	0.30	0.30	0.38

MFP growth reduced by 0.25 ppt per year or by 20 pct

➔bias equivalent to the *entire* contribution of purchased services and twice the the contribution of capital.

Alternative import price measure 2: bias correction with non-quality unadjusted *d's*



Growth Rates for Price Indexes

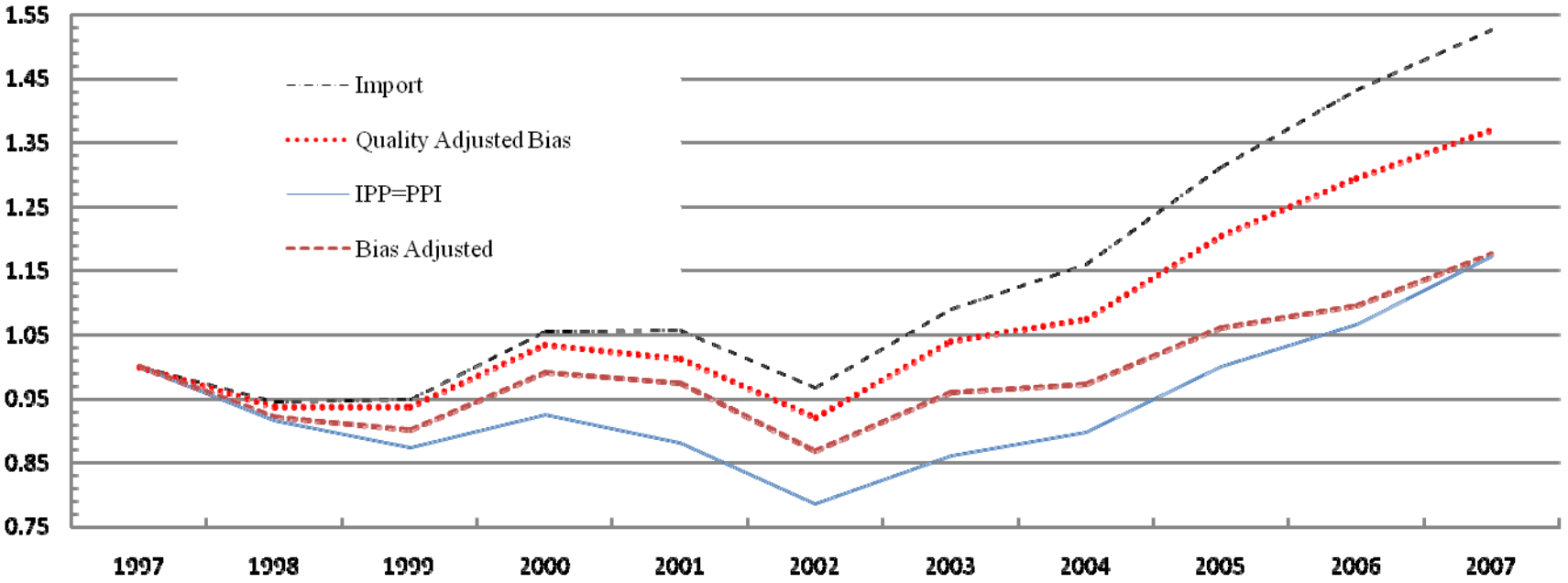
Total MPI	Domestic	Import IPP	IPP=PPI	Adjusted d's
33.8	29.1	52.6	17.3	17.7

Growth Accounting: Alternative 2

	Baseline:		*Subst bias correction*	
	MFP	Foreign Materials	MFP	Foreign Materials
Manufacturing	1.27	0.27	1.02	0.52
Durable goods:	1.95	0.36	1.58	0.73
Wood products	0.42	0.07	0.36	0.13
Nonmetallic mineral products	0.03	0.08	-0.02	0.13
Primary metals	0.75	0.13	0.73	0.16
Fabricated metal products	0.74	0.19	0.68	0.25
Machinery	0.88	0.40	0.68	0.60
Computer and electronic products	6.66	0.35	5.28	1.73
Electrical equipment, appliances, and c	1.56	0.10	1.26	0.41
Motor vehicles, bodies and trailers, an	1.05	0.60	0.80	0.84
Other transportation equipment	0.84	0.69	0.48	1.04
Furniture and related products	0.64	0.25	0.55	0.34
Miscellaneous manufacturing	2.14	0.27	2.03	0.38
Nondurable goods:	0.45	0.17	0.34	0.28
Food and beverage and tobacco produ	0.12	0.12	0.11	0.13
Textile mills and textile product mills	0.73	-0.03	0.63	0.06
Apparel and leather and allied product	0.92	-0.55	0.82	-0.45
Paper products	0.04	0.05	-0.02	0.11
Printing and related support activities	0.44	0.04	0.40	0.08
Petroleum and coal products	0.20	0.53	-0.14	0.87
Chemical products	1.32	0.11	1.25	0.18
Plastics and rubber products	0.37	0.30	0.22	0.46

Average MFP productivity growth again reduced by about 0.25 ppt or by 20 percent

Alternative import price measure 3: bias correction with quality adjusted *d's*



Source: BEA and BLS

Growth Rates for Price Indexes

Total MPI	Domestic	Import IPP	IPP=PPI	Adjusted d's	Quality Adj. d's
33.8	29.1	52.6	17.3	17.7	37.1

Growth Accounting: Alternative 3

	Baseline:		*Quality Adj. Prices*	
	MFP	Foreign Materials	MFP	Foreign Materials
Manufacturing	1.27	0.27	1.16	0.38
Durable goods:	1.95	0.36	1.85	0.46
Wood products	0.42	0.07	0.40	0.09
Nonmetallic mineral products	0.03	0.08	0.02	0.08
Primary metals	0.75	0.13	0.75	0.14
Fabricated metal products	0.74	0.19	0.72	0.21
Machinery	0.88	0.40	0.83	0.45
Computer and electronic products	6.66	0.35	6.27	0.74
Electrical equipment, appliances, and c	1.56	0.10	1.48	0.18
Motor vehicles, bodies and trailers, an	1.05	0.60	0.98	0.66
Other transportation equipment	0.84	0.69	0.75	0.78
Furniture and related products	0.64	0.25	0.62	0.28
Miscellaneous manufacturing	2.14	0.27	2.12	0.29
Nondurable goods:	0.45	0.17	0.33	0.28
Food and beverage and tobacco produ	0.12	0.12	0.12	0.12
Textile mills and textile product mills	0.73	-0.03	0.73	-0.03
Apparel and leather and allied product	0.92	-0.55	0.90	-0.53
Paper products	0.04	0.05	0.04	0.06
Printing and related support activities	0.44	0.04	0.44	0.04
Petroleum and coal products	0.20	0.53	-0.41	1.14
Chemical products	1.32	0.11	1.30	0.13
Plastics and rubber products	0.37	0.30	0.35	0.32

MFP growth reduced by 0.1 percentage point or 9 pct from 1997 to 2007

Bias *still* equivalent to the contribution of capital over our time period.

Preliminary extension: domestic to foreign sourcing shifts

Until now: correcting for substitution *within* the import price index

While domestic-to-foreign and within-import substitution bias are not mutually exclusive, the bias within the Laspeyres import price index is not equivalent to the one introduced into the composite Fisher *input* cost index

We nevertheless apply the bias adjustment formula directly to the total materials *input* price

➔ average annual MFP growth reduced another 0.1 - 0.2 ppt

Conclusion

1) Our (preliminary) results indicate biases to manufacturing productivity from shifts in sourcing to low-wage countries

2) Input price index proposed by Alterman (2009) could help address this problem

3) Although our empirical focus was on manufacturing, biases may also be important in other sectors and with services offshoring