

Measuring Price Change Along Supply Chains Using Industrial Price Data

Jonathan Weinhagen
Producer Price Index
Bureau of Labor Statistics



Overview

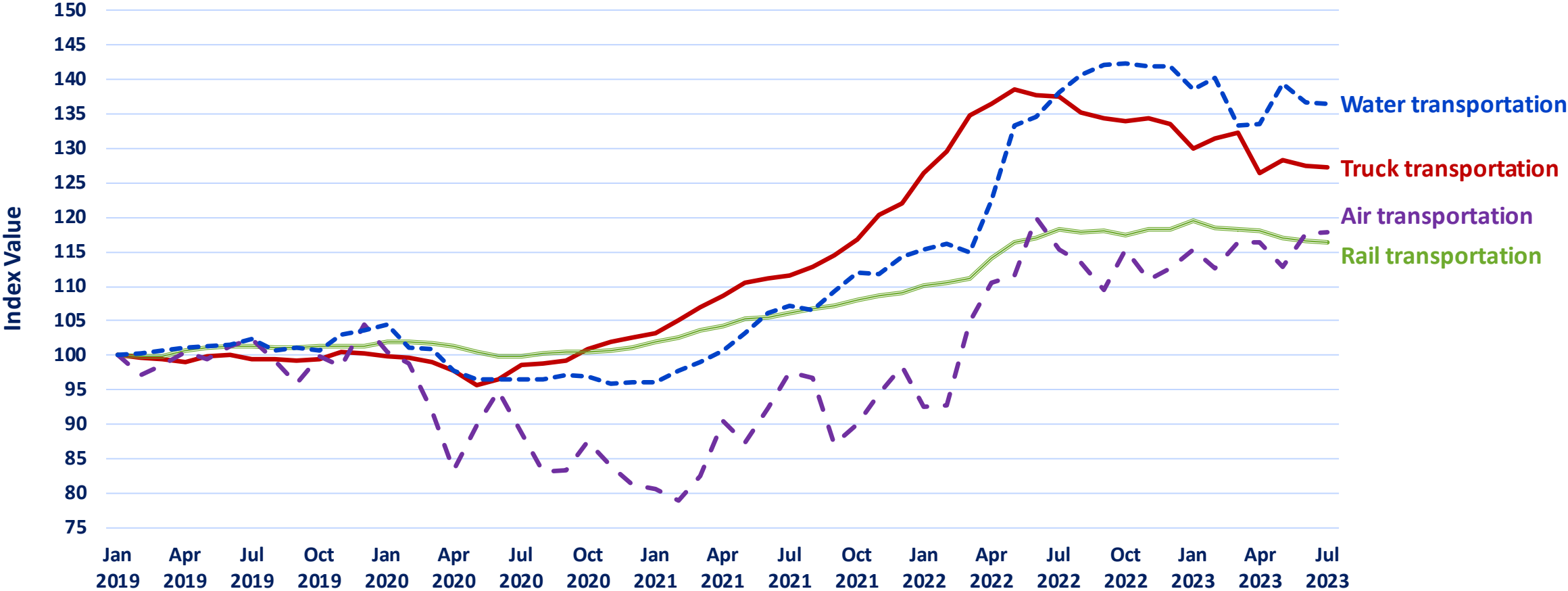
- Industrial price supply chain measures
 - ▶ Transportation price indexes
 - ▶ Inputs to industries price indexes
 - ▶ Intermediate demand by production flow



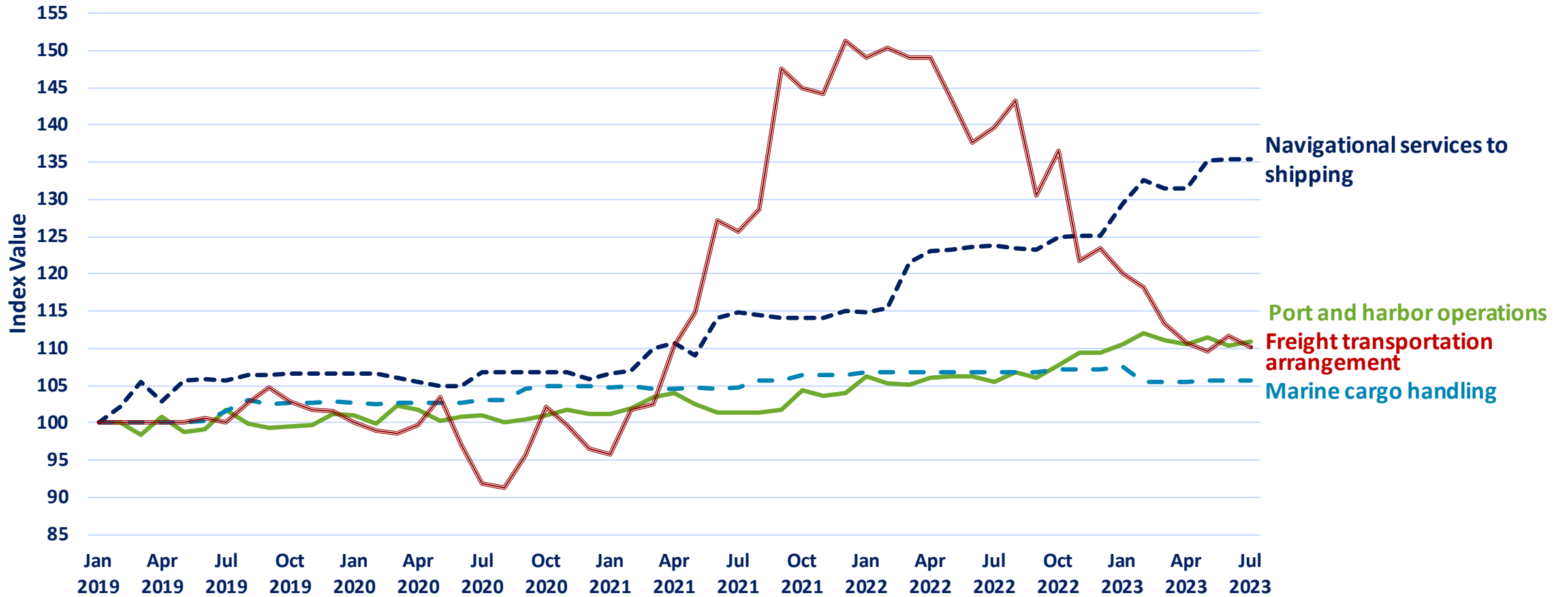
Transportation Price Indexes



Transportation PPIs



Transportation support PPIs



Inputs to Industry Price Indexes



Inputs to industries price indexes

- BLS introduced a set of satellite input indexes in September 2020
 - ▶ Coverage at 3-digit NAICS level
 - ▶ Includes both imported and domestically produced inputs



Input versus output indexes

- ▶ **Industry output price indexes:** measure the average change in prices for outputs produced by domestic industries

- ▶ **Inputs to industry price indexes:** measure the average change in prices for inputs consumed by domestic industries



Potential uses of industry input indexes

■ Potential uses include

- ▶ Industry level analysis
- ▶ Price transmission analysis
- ▶ Proxy deflator for industries with no output index coverage
- ▶ Contract price adjustment



Source data

- BLS PPI commodity indexes to measure price change for domestically produced industry inputs
- BLS NAICS-based import indexes (MPIs) to measure price change for imported industry inputs



Methodology: product selection

- Bureau of Economic Analysis (BEA) Input-Output “Use of Commodities by Industries” table used to determine inputs to an industry



Methodology: product selection – Use table, selected values

IO Industry code	IO Industry title	IO Commodity code	IO Commodity title	Use value
336	Transportation Equipment Manufacturing	221100	Electric power generation, transmission, and distribution	3214
336	Transportation Equipment Manufacturing	325510	Paint and coating manufacturing	3025
336	Transportation Equipment Manufacturing	326210	Tire manufacturing	3797
336	Transportation Equipment Manufacturing	327200	Glass and glass product manufacturing	4353
336	Transportation Equipment Manufacturing	331110	Iron and steel mills and ferroalloy manufacturing	29511
336	Transportation Equipment Manufacturing	33399B	Fluid power process machinery	4186
336	Transportation Equipment Manufacturing	334300	Audio and video equipment manufacturing	3231
336	Transportation Equipment Manufacturing	334413	Semiconductor and related device manufacturing	8999
336	Transportation Equipment Manufacturing	334511	Search, detection, and navigation instruments manufacturing	4108
336	Transportation Equipment Manufacturing	336310	Motor vehicle gasoline engine and engine parts manufacturing	20989
336	Transportation Equipment Manufacturing	336350	Motor vehicle transmission and power train parts manufacturing	28550
336	Transportation Equipment Manufacturing	336360	Motor vehicle seating and interior trim manufacturing	25043
336	Transportation Equipment Manufacturing	336412	Aircraft engine and engine parts manufacturing	27692
336	Transportation Equipment Manufacturing	423800	Machinery, equipment, and supplies	10762
336	Transportation Equipment Manufacturing	484000	Truck transportation	7844
336	Transportation Equipment Manufacturing	541100	Legal services	4818
336	Transportation Equipment Manufacturing	541610	Management consulting services	3496

Methodology: product selection

- IO data is matched with PPI commodity data for domestic portion of index, some “translation” is necessary
- IO data and MPI data are both NAICS-based, so translation between them is generally unnecessary in order to match up
- The PPI and MPI index data used are not necessarily published



Methodology: product selection – IO to MPI to PPI concordance

IO code	IO title	MPI code	MPI title	PPI code	PPI title
334413	Semiconductor and related device manufacturing	334413	Semiconductor and related device manufacturing	117839	Integrated microcircuits
				117847	Other semiconductor and related devices
326210	Tire manufacturing	326210	Tire manufacturing	071201	Tires
				071203	Tread rubber, tire sundries, and repair materials
541100	Legal services	NA	NA	451101	Legal services



Methodology: weights

- After the set of domestically-produced and imported commodities consumed by the industry are determined, BLS develops weights for each PPI and MPI index included in the industry input index
- The weight for a given commodity within the industry reflects the relative share of the commodity in relation to total industry inputs



Methodology: domestic weights

- Weights are derived from:
 - ▶ BEA's "Use of Commodities by Industries"
 - ▶ Census' wherever-made (WEM) value of shipments (VOS) data



Methodology: weights – domestic inputs

$$\text{DomesticWeight}_{c,i} = \text{Use}_{c,i} / (\sum_{i=1}^n \text{Use}_{c,i}) * \text{WEMVOS}_c$$

where

- ▶ *Domestic Weight*_{c,i} refers to the domestically produced weight of commodity c in the input index for industry i
- ▶ *Use*_{c,i} refers to use of commodity c by the industry i
- ▶ $\sum_{i=1}^n \text{Use}_{c,i}$ is the total use of commodity c by all 1 through n industries included in the use table
- ▶ *WEMVOS*_c is the domestic wherever-made value of shipments for commodity c.



Methodology: weights – domestic inputs

- Example: gross weight of domestically produced tires to inputs to transportation equipment manufacturing

$$DomWt_{t,te} = Use_{t,te} / \left(\sum_{i=1}^n Use_{t,i} \right) * WEMVOS_t$$

$$= 3,797 / 35,098 * \$18,468,070$$

$$= 0.1082 * \$18,468,070$$

$$= \$1,998,245$$



Methodology: imported weights

- Weights are derived from:
 - ▶ BEA's "Use of Commodities by Industries"
 - ▶ Census' import trade VOS



Methodology: weights – imported inputs

$$\text{Import Weight}_{c,i} = \text{Use}_{c,i} / (\sum_{i=1}^n \text{Use}_{c,i}) * \text{VOI}_c$$

where

- ▶ $\text{Import Weight}_{c,i}$ refers to the foreign produced weight of commodity c in the input index for industry i
- ▶ $\text{Use}_{c,i}$ refers to use of commodity c by the industry i
- ▶ $\sum_{i=1}^n \text{Use}_{c,i}$ is the total use of commodity c by all 1 through n industries included in the use table
- ▶ VOI_c is the value of imports for commodity c.



Methodology: weights – imported inputs

- Example: gross weight of imported produced tires to inputs to transportation equipment manufacturing

$$\begin{aligned} \text{ImptWt}_{t,te} &= \text{Use}_{t,te} / \left(\sum_{i=1}^n \text{Use}_{t,i} \right) * \text{VOI}_t \\ &= 3,797 / 35,098 * \$14,567,826 \\ &= 0.1082 * \$14,567,826 \\ &= \$1,576,239 \end{aligned}$$



Methodology: net weights

- As a final step, weights are converted to net weights by multiplying the gross weights by net input ratios
- Net input ratios reflect the portion of the value of commodity that is produced outside of the industry
- Applying net output ratio eliminates multiple counting by removing intra-industry transactions



Weight example: Inputs to transportation equipment manufacturing

Index	Relative importance
Inputs to 336, transportation equipment manufacturing	100.000
Domestically produced inputs	69.927
Imported inputs	30.073



Weight example: Inputs to transportation equipment manufacturing- selected PPI commodity indexes

Index code	Index title	Relative importance
054321	Industrial electric power	1.007
071201	Tires	0.715
101702	Semifinished steel mill products	1.083
101703	Hot rolled steel sheet and strip, including tin mill products	2.876
101704	Hot rolled steel bars, plates, and structural shapes	1.438
102802	Aluminum castings	1.722
107405	Fabricated structural metal	1.752
107407	Custom roll form products	1.065
108905	Other metal products	2.213
117606	Search, detection, navigation & guidance systems and equipment	1.022
119408	Diesel, semidiesel, and dual-fuel engines for automobiles, trucks, and buses	0.989
119505	Machine shop products	2.273
301202	Long-distance motor carrying	2.665
451101	Legal services	1.929
454101	Administrative and general management consulting services	0.530



Weight example: Inputs to transportation equipment manufacturing-selected MPIs

Index code	Index title	Relative importance
32621	MPI tire manufacturing	0.515
336340	MPI motor vehicle brake system manufacturing	0.637
334310	MPI audio and video equipment manufacturing	0.684
336330	MPI motor vehicle steering and suspension components (except spring) manufacturing	0.940
333618	MPI other engine equipment manufacturing	1.396
336320	MPI motor vehicle electrical and electronic equipment manufacturing	1.403
334413	MPI semiconductor and related device manufacturing	1.730
336413	MPI other aircraft parts and auxiliary equipment manufacturing	1.788
336360	MPI motor vehicle seating and interior trim manufacturing	2.046
331110	MPI iron and steel mills and ferroalloy manufacturing	2.103
336310	MPI motor vehicle gasoline engine and engine parts manufacturing	2.387
336350	MPI motor vehicle transmission and power train parts manufacturing	2.919
336390	MPI other motor vehicle parts manufacturing	3.383
336412	MPI aircraft engine and engine parts manufacturing	3.564

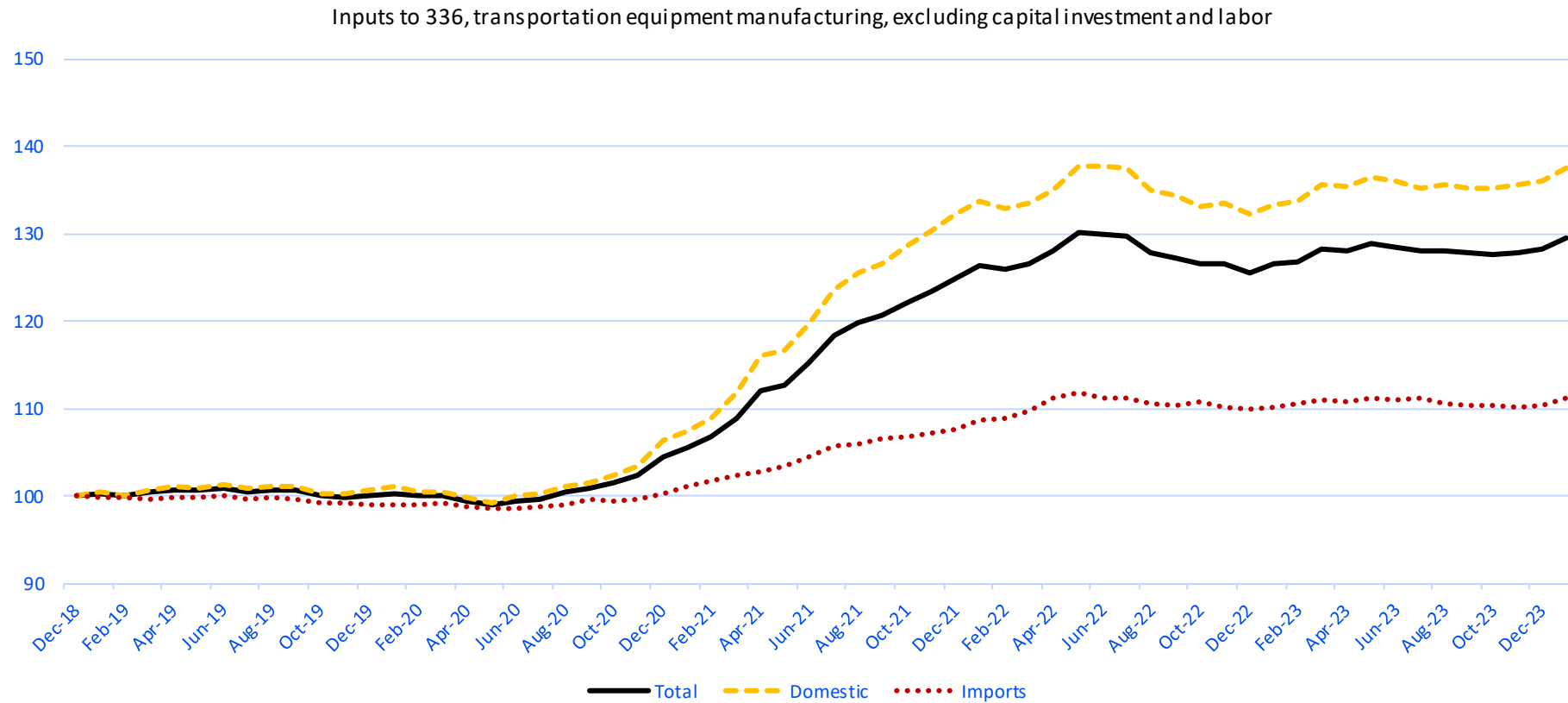


Publication structure

Title	Code
Inputs to 336, transportation equipment manufacturing, excluding capital investment and labor	IN336
Inputs to 336, domestically produced products	IN3361
Inputs to 336, domestically produced goods	IN33611
Inputs to 336, domestically produced services	IN33612
Inputs to 336, domestically produced maintenance and repair construction	IN33613
Inputs to 336, imported goods	IN3362

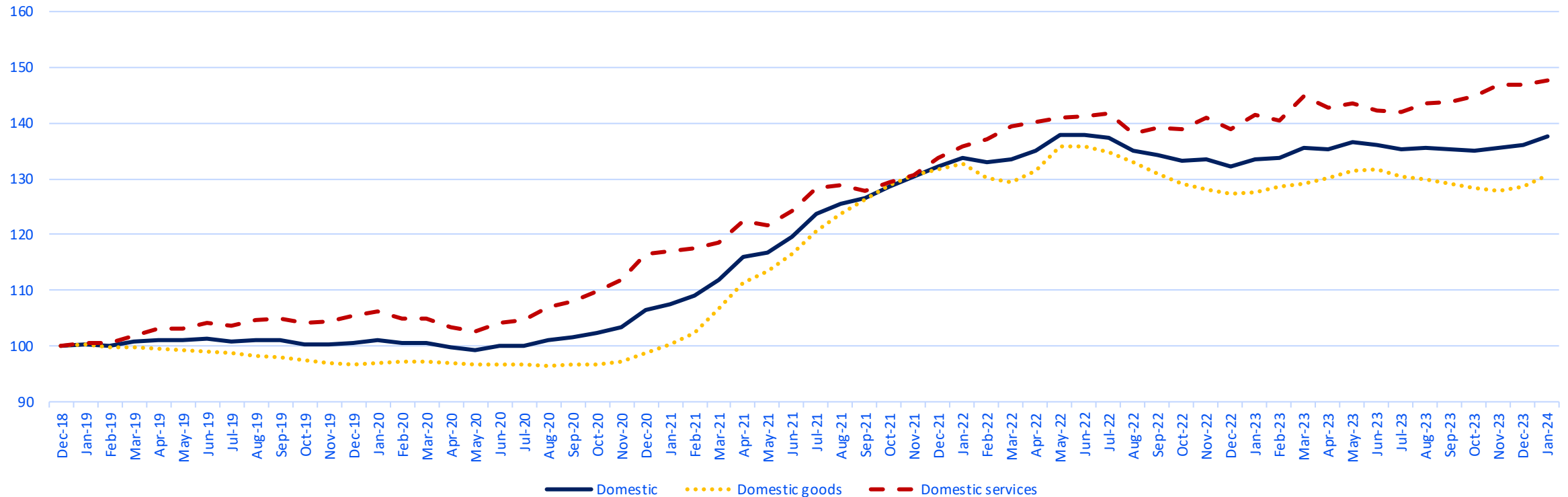


Example: inputs to transportation equipment manufacturing



Example: inputs to transportation equipment manufacturing

Inputs to 336, transportation equipment manufacturing, excluding capital investment and labor



Publication

- Available for most 3-digit NAICS categories
- Available on the PPI webpage in an excel table
- Updated monthly after both PPI and IPP release data



Index exclusions

- Excludes labor and capital investment
- Excludes imported services
- Excludes any non-published PPIs for domestically provided services



Intermediate Demand by Production Flow



Intermediate Demand by Production Flow

- Part of the PPI headline Final Demand-Intermediate Demand Price System
- Forward flowing model of price change
 - ▶ Four stages of intermediate demand
 - ▶ Final demand can be considered last stage



Intermediate Demand by Production Flow

- **Industries** are assigned to one of four stages of production

Stage 1 → Stage 2 → Stage 3 → Stage 4 → Final Demand

- **Example:**

Iron ore mining (S1) → Steel mills (S2) → Car parts Mfg (S3) → Car Mfg (S4) → FD



Intermediate Demand by Production Flow

- Assignments are made to stages with goal of maximizing net forward flow of system
- **Net forward flow** = (forward shipments of the industries + inputs received from prior stages of process) – (backward shipments of the industries + inputs received from forward stages of process)

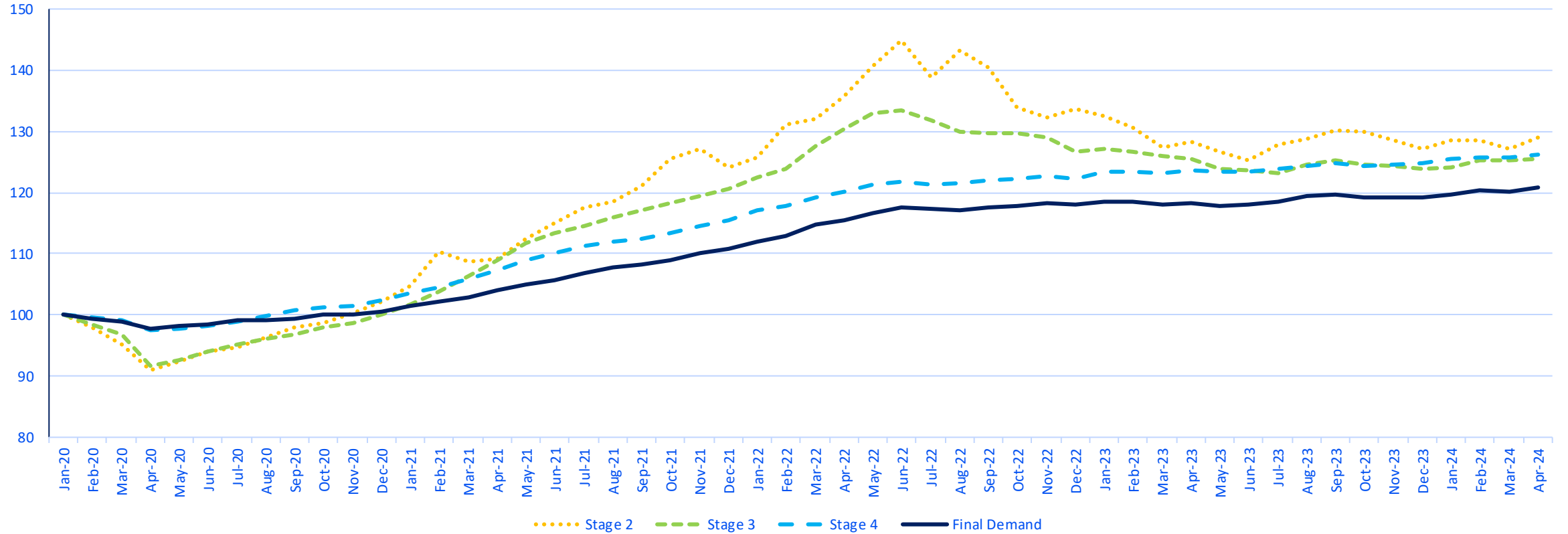


Intermediate Demand by Production Flow: Approach

- Indexes do not track prices for the output of the four industry stages
- Indexes track prices for the net inputs consumed by industries in each stage of production
 - ▶ Example: Car manufacturers are in stage 4. The stage 4 intermediate demand index does not track car prices, but instead tracks prices for inputs purchased by car manufacturers (car parts, etc)



Production flow indexes



Question for FESAC

The production flow indexes only include prices for domestically produced products. Would it be useful to apply the same methodology used in the input indexes to add imported prices?



Contact Information

Jonathan Weinhagen

Index Methods and Analysis Branch Chief

Producer Price Index

www.bls.gov/ppi

202-691-7709

weinhagen.jonathan@bls.gov

