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New PPI net inputs to industry indexes

This article describes the Producer Price Index program's recently expanded coverage of net inputs to industry indexes. It also presents improvements to the methodology used to calculate those indexes and a limited data analysis for two industries.

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Effective with the release of data for January 2015 on February 18, 2015, the Producer Price Index (PPI) program revised its methodology and broadened its scope for calculating net inputs to industry price indexes. The 28 newly published aggregate indexes measure price change for products consumed by selected industries as inputs to production (excluding capital investment, labor, and imports). These indexes are published in table 14 of the *PPI Detailed Report*.[1]

PPI first suggested calculating inputs to industry indexes as part of its comprehensive 1978 revision. This revision called for the development of a system of price indexes encompassing four major components: (1) industry net output indexes, (2) detailed commodity indexes, (3) stage-of-processing indexes, and (4) net inputs to industry indexes.[2] The system to be developed was meant to provide data users with a much more complete picture of producer inflation than was provided before the revision.

PPI has worked toward the goals of the 1978 revision. In 1986, the program completed the development of a set of industry net output price indexes covering the mining and manufacturing sectors of the economy.[3] Since the 1980s, it has expanded industry output index coverage to include over 71.5 percent of the services sector and 34 percent of the construction sector.[4] It completed the development of detailed commodity indexes in 2009, with the introduction of wherever-provided (i.e., commodity-based) services and construction indexes.[5] In 2014, PPI transitioned from the Stage of Processing (SOP) price index aggregation system to the Final Demand–Intermediate Demand (FD−ID) aggregation system. The FD–ID system expanded PPI aggregate index coverage beyond that of the SOP system (through the addition of services and construction

indexes) and introduced a new set of rigorously developed stage-based price indexes.[6] Also in 1986, the program introduced a set of inputs to industry price indexes; however, coverage was limited to goods inputs to the construction sector and the indexes were constructed from industry-based net output indexes.

Until recently, PPI has not expanded its coverage of inputs to industry indexes or improved the methodologies used to calculate those indexes. This article describes recent enhancements in both coverage and methodology and presents a limited data analysis for two industries. Coverage enhancements include the addition of more construction industries and expansion into the goods and services sectors of the economy. Among these new industries are those which produce no marketable output, such as membership associations and organizations. Although PPI cannot develop output price indexes for industries that produce no marketable output, it can develop input indexes for them. The new input indexes could potentially be used in deflating nonmarketable output. Methodological improvements include the construction of inputs to industry indexes from commodity-based PPIs, as opposed to industry-based PPIs, and the addition of services and construction inputs. Constructing input indexes from commodity-based price indexes is a methodological improvement, because industries actually consume commodities as inputs to production, irrespective of the commodities' industries of origin. The addition of services and construction inputs is also a methodological improvement, because it provides a more complete picture of industry input costs.

The article is organized into four sections. The first section explains the methodology used to construct the inputs to industry indexes and why the new indexes are an improvement over previous PPI input indexes. The second section describes the coverage and publication structure of the inputs to industry indexes. The third section analyzes historical input-index data for two industries. The analysis includes a comparison of the inputs to industry price indexes to their corresponding output price indexes. The last section illustrates inherent limitations of the PPI inputs to industry indexes and suggests areas for future research.

Methodology

PPI *net inputs to industry indexes* measure the average change in prices industries pay for inputs, excluding capital investment, labor, and imports. These indexes contrast with PPI's widely published industry *net output indexes*, which measure the average change in prices that industries receive for their output. For example, the PPI output index for paint and coating manufacturing (North American Industry Classification System (NAICS) 325510) measures the average change in prices paint and coating manufacturers receive for the outputs they sell, such as architectural coatings and finishes for original equipment manufacturers. The PPI input index for paint and coating manufacturing measures the average change in prices the industry pays for inputs, including products such as basic organic chemicals, paint colors, thermoplastic resins, industrial electric power, and legal services, as measured by PPI's commodity price indexes. It is important to note that net industry input indexes are not constructed from buyers' transaction prices. Because firms often sell their output to other firms as intermediate goods, these indexes are constructed from commodity output price indexes, which stand in for the prices that individual buyers pay.

Products, weights, and calculation. To determine the set of inputs to be included in an inputs to industry index, PPI analyzes the Bureau of Economic Analysis (BEA) "Use of commodities by industries" table (hereafter referred to as the "use table").[7] The use table provides, on an industry-by-industry basis, the set and dollar value of products consumed by each domestic industry as inputs to production. The main source of data employed by BEA to

construct the use table is the Economic Census.[8] Data in the table are presented in terms of BEA Input–Output (I–O) codes. From the use table, PPI determines the set of commodities, classified by I–O code, that a given industry or industry group consumes as inputs. The inputs are then translated from I–O classification to PPI commodity-code classification. This step is necessary because the input indexes are constructed from six-digit PPI commodity-based indexes. The translation is accomplished through a concordance between PPI commodity indexes and NAICS codes. BEA I–O data are generally classified according to NAICS, and BEA provides a concordance between the NAICS and I–O codes, which further enhances the match.

After the set of commodities consumed by an industry (classified in terms of PPI commodity codes) has been determined, PPI develops weights for each commodity included in the input index. The gross weight for a given commodity within an inputs to industry index reflects the value of the input commodity in relation to total industry inputs at a specific time. PPI constructs weights for inputs to industry indexes from both the use table and data for wherever-made value of shipments. These latter data—typically derived from U.S. Census Bureau information and other sources—provide the total domestically produced value of shipments of a commodity for a given reference year, regardless of which industry produced the commodity.[9] Currently, the weight reference year is 2007 for the inputs to industry indexes; however, the reference year will be updated as new Economic Census and I–O data become available.[10] The gross value weight of each commodity included in an industry input index is equal to the share of the total value of the commodity consumed by the industry multiplied by the wherever-made value of shipments for that commodity during the reference year. Since the weights for the PPI inputs to industry indexes are based on values, as opposed to quantities, the weights are considered value weights.[11] Assuming there are i = 1 through n industries and c = 1 through n commodities, the share of the commodity c consumed by industry i for reference year t is given by

$$S^{u}_{c,i,t} = \mathrm{Use}_{c,i,t} / \left(\sum_{i=1}^{n} \mathrm{Use}_{c,i,t}\right),$$

where

$\mathrm{Use}_{c,i,t}$ refers to the use of commodity c by industry i at time t, and

$\sum_{i=1}^{n} \mathrm{Use}_{c,i,t}$ is the total use of commodity c by all 1 through n industries included in the use table at time t.

The gross value weight of commodity c in the input index for industry i at time t can then be written as

$$\mathrm{GVW}_{c,i,t} = S^{u}_{c,i,t} \times \mathrm{VOS}_{c,t},$$

where $\mathrm{VOS}_{c,t}$ is the wherever-made value of shipments for commodity c at time t.

As one example of this calculation, consider the index for inputs to paint and coating manufacturing. According to the BEA use table, the industry consumes plastics material and resin (I–O commodity code 325211). In terms of dollar value, the use of this commodity by the industry is equal to $2,476,000.[12] According to the 2007 Economic Census value-of-shipments data, the total use of plastics material and resin by all industries is $95,880,000. Therefore, the paint and coating industry consumes 2.58 percent ($2,476,000/$95,880,000) of total plastics material and resin. Based on the concordance between I–O and PPI commodity codes, plastics material and resin (I–O code 325211) maps to two PPI commodities, thermoplastic resins and plastics materials (I–O code 066212) and thermosetting resins and plastics materials (I–O code 066306). The wherever-made value of shipments for thermoplastic resins and plastics materials is equal to $70,675,148 and the wherever-made value for thermosetting

resins and plastics materials is equal to $13,657,080. The respective final gross weights of these two commodities included in the PPI for inputs to paint and coating manufacturing are calculated as follows:

$$GVW_{TPR,PM,2007} = (\$2,476,000/\$95,880,000) \times \$70,675,148 = \$1,852,111$$

and

$$GVW_{TRS,PM,2007} = (\$2,476,000/\$95,880,000) \times \$13,657,080 = \$352,679.$$

After an input commodity's gross weight is determined, PPI converts it to a net weight by removing the portion of the commodity's value that was produced within the consuming industry. Net weighting removes multiple-counting bias from the overall input index. Such bias occurs when prices from several stages of production are included in an aggregate index.

To understand multiple-counting bias in the context of an input index, suppose that one firm classified as an automobile manufacturer purchases iron and steel to produce automobile engines and then, in turn, sells the engines to a second firm also classified as an automobile manufacturer. The second firm then uses the engines as an input to produce automobiles. An input index that included prices for both the iron and steel purchased by the first firm and the engines sold from the first to the second firm would suffer from multiple-counting bias. Assume, for example, that there was a large increase in the price of iron and steel—an increase that caused the price of engines to rise. The index for inputs to automobile manufacturing would go up as a result of the rise in price of both iron and steel purchased by the first firm and the automobile engines purchased by the second firm (produced by the first). In other words, the increase in iron and steel prices would be counted twice, once as the actual rise in iron and steel prices and again as the increase in automobile engine prices resulting from the rise in iron and steel prices.

A net weight is calculated by applying a net input ratio to the gross weight. The net input ratio represents the share of the commodity not produced by the consuming industry and is calculated with data from the BEA "Make of commodities by industry" table, which provides the set and dollar value of products made by each domestic industry.[13] The share of commodity *c* produced by industry *i* during reference year *t* is given by

$$S^{m}_{c,i,t} = \mathrm{Make}_{c,i,t} / \left(\sum_{i=1}^{n} \mathrm{Make}_{c,i,t}\right),$$

where

$\mathrm{Make}_{c,i,t}$ refers to the make of commodity *c* by industry *i* at time *t*, and

$\sum_{i=1}^{n} \mathrm{Make}_{c,i,t}$ is the total make of commodity *c* by industries 1 through *n* at time *t*.

The net input ratio of commodity *c* for industry *i* at reference year *t* is the share of commodity *c* not made by industry *i*. The ratio is calculated as follows:

$$\mathrm{NIR}_{c,i,t} = 1 - S^{m}_{c,i,t}.$$

Continuing with the paint and coating example, we calculate that the paint and coating industry makes 0.28 percent ($271,000/$95,880,000) of the total make value of I–O commodity 325211, plastics material and resin. The

net input ratio for this commodity—the ratio representing the proportion of plastics material and resin not made by the paint and coating industry—is therefore 0.9972 (1 − $271,000/$95,880,000).

The final net value weight for commodity *c* in the input index for industry *i* for reference year *t* is calculated as

$$\mathrm{NVW}_{c,i,t} = (1 - S^{m}_{c,i,t}) \times S^{u}_{c,i,t} \times \mathrm{VOS}_{c,t},$$

which can be rewritten as

$$\mathrm{NVW}_{c,i,t} = \mathrm{NIR}_{c,i,t} \times \mathrm{GVW}_{c,i,t}.$$

Again, net weighting eliminates multiple-counting bias from PPI inputs to industry indexes. Completing the paint and coatings example, we calculate that the respective net weights of the two commodities included in the index for inputs to paint and coating manufacturing—thermoplastic resins and plastics materials and thermosetting resins and plastics materials—are as follows:

$$\mathrm{NVW}_{TPR,PM,2007} = (0.9972) \times (\$2{,}476{,}000/\$95{,}880{,}000) \times \$70{,}675{,}148 = \$1{,}820{,}001$$

and

$$\mathrm{NVW}_{TRS,PM,2007} = (0.9972) \times (\$2{,}476{,}000/\$95{,}880{,}000) \times \$13{,}657{,}080 = \$351{,}692.$$

Once the products and weights for a net inputs to industry index are determined, the index is calculated with a modified Laspeyres index formula based on standard PPI methodology.[14]

Cutoff rule. The general methodology for determining the set of products included in a PPI inputs to industry index is outlined in the preceding section; however, PPI also implements a cutoff rule that removes commodities that account for less than 0.5 percent of total inputs.[15] The 0.5-percent cutoff considerably reduces the work required to build and maintain the inputs to industry indexes, while having a negligible effect on index movements.[16]

To determine the effect of the 0.5-percent cutoff rule on index movements, PPI compared changes in two versions of input indexes—a cutoff version developed with the cutoff rule and a full version built without it. Table 1 presents correlations for 1-month percent changes between the two index versions for three industries: paint and coating manufacturing, automobile manufacturing, and offices of health care practitioners.[17]

Table 1. Correlations in 1-month percent changes between the full and cutoff versions of PPI industry input indexes

Industry code	Industry title	Correlation
325510	Paint and coating manufacturing	.998
336111	Automobile manufacturing	.986
621A00	Offices of health care practitioners	.990

Source: U.S. Bureau of Labor Statistics.

The correlations for 1-month changes between the two versions of input indexes are very high, indicating that the 0.5-percent cutoff rule has little effect on index movements. Given this minimal effect, PPI chose to implement the cutoff rule when constructing the inputs to industry indexes.

Changes in methodology for indexes for inputs to construction. From 1986 through 2014, PPI published a set of indexes for net inputs to construction industries. The methodology used to develop those indexes was similar to the updated methodology described earlier; however, the updated methodology incorporates two substantial improvements and one simplification.[18]

The former PPIs for net inputs to construction industries were developed from industry-based, primary-product-level PPIs. These PPIs were used as proxies for PPI commodity-based indexes. PPI inputs to industry indexes are now constructed from commodity-based PPIs. Commodity indexes track price change for products—goods and services—regardless of their industry of origin. The use of commodity indexes is methodologically superior, because industries actually consume commodities as inputs to production, irrespective of the commodities' industries of origin. In addition, constructing inputs to industry indexes from commodity-based PPIs allows for the assignment of inputs at a more detailed level than that permitted by industry-based, primary-product-level indexes. Consequently, products that are clearly not consumed by the industry can be excluded. For example, developing an input index for a construction industry from detailed commodity-based indexes allows for the assignment of commercial electric power as an input. If the same index were instead constructed from industry-based, primary-product-level indexes, total electric power—which includes residential and commercial electric power—would be assigned. Regarding services inputs, the ability to assign inputs at a more detailed level permits PPI to drill down to business wired telecommunications and business loans, while excluding consumer sales.

The second methodological improvement to the indexes for net inputs to construction industries is the addition of services inputs and maintenance and repair construction inputs. Previously, these indexes included only goods inputs. The addition of new inputs provides a more complete picture of industry costs. In some cases, such as in the input index for membership associations and organizations, over 90 percent of the industry's inputs are services. For industries that rely heavily on services inputs, an input index including only goods would provide little analytical value.

Finally, as a methodological simplification, the 0.5-percent cutoff rule explained earlier was applied to all input indexes. Previously, no cutoff threshold was applied to the input indexes for construction industries.

Coverage and publication structure

Since the release of January 2015 data, PPI has been publishing net inputs to industry indexes for 28 industries and industry groupings. Of these, 19 are indexes for inputs to construction industries, 6 are indexes for inputs to goods-producing industries, and 3 are indexes for inputs to services industries. Industries were chosen on the basis of data-user feedback and analyses of usage statistics for the industries' corresponding output indexes. Table 2 presents the industries and industry groups for which PPI publishes input indexes.

Table 2. Coverage for PPI industry input indexes

Code	Title
	Inputs to construction industry indexes
IP230000	Inputs to construction industries, excluding capital investment, labor, and imports
IP231000	Inputs to new construction industries, excluding capital investment, labor, and imports
IP231100	Inputs to residential construction industries, excluding capital investment, labor, and imports

See footnotes at end of table.

Table 2. Coverage for PPI industry input indexes

Code	Title
IP231110	Inputs to single family residential construction, excluding capital investment, labor, and imports
IP231120	Inputs to multifamily residential construction, excluding capital investment, labor, and imports
IP231130	Inputs to other residential construction, excluding capital investment, labor, and imports
IP231200	Inputs to nonresidential construction, excluding capital investment, labor, and imports
IP231210	Inputs to commercial and healthcare structures, excluding capital investment, labor, and imports
IP231211	Inputs to commercial structures, excluding capital investment, labor, and imports
IP231212	Inputs to healthcare structures, excluding capital investment, labor, and imports
IP231220	Inputs to industrial structures, excluding capital investment, labor, and imports
IP231230	Inputs to other nonresidential construction, excluding capital investment, labor, and imports
IP231231	Inputs to highways and streets, excluding capital investment, labor, and imports
IP231232	Inputs to power and communication structures, excluding capital investment, labor, and imports
IP231233	Inputs to educational and vocational structures, excluding capital investment, labor, and imports
IP231234	Inputs to other misc. nonresidential construction, excluding capital investment, labor, and imports
IP232000	Inputs to maintenance and repair construction, excluding capital investment, labor, and imports
IP232100	Inputs to residential maintenance and repair, excluding capital investment, labor, and imports
IP232200	Inputs to nonresidential maintenance and repair, excluding capital investment, labor, and imports
	Inputs to manufacturing industry indexes
IP325510	Inputs to 325510, paint and coating manufacturing, excluding capital investment, labor, and imports
IP326100	Inputs to 326100, plastics products manufacturing, excluding capital investment, labor, and imports
IP333130	Inputs to 333130, mining and oil and gas field machinery manufacturing, excluding capital investment, labor, and imports
IP336111	Inputs to 336111, automobile manufacturing, excluding capital investment, labor, and imports
IP336411	Inputs to 336411, aircraft manufacturing, excluding capital investment, labor, and imports
IP336611	Inputs to 336611, ship building and repairing, excluding capital investment, labor, and imports
	Inputs to services industry indexes
IP484000	Inputs to 484000, truck transportation, excluding capital investment, labor, and imports
IP621A00	Inputs to 621A00, offices of health practitioners, excluding capital investment, labor, and imports
IP813000	Inputs to 813000, membership associations and organizations, excluding capital investment, labor, and imports

Source: U.S. Bureau of Labor Statistics.

For *each industry or industry grouping* included in table 2, PPI publishes an aggregate index measuring price change for all inputs consumed by the industry (excluding capital investment, labor, and imports). PPI also publishes separate subaggregate indexes measuring price change for goods, services, and construction inputs consumed by the industry. Final breakdowns are published by type of good or service consumed. Table 3 presents an example of the breakdowns PPI publishes *under each industry input index* from table 2. In cases where the industry does not consume a sufficient quantity of a specific good or service category (a determination made on the basis of the 0.5-percent cutoff rule), no index is produced for that grouping.

Table 3. PPI detailed publication structure for industry input indexes

Code	Title
IP621A00	Inputs to 621A00, offices of health practitioners, excluding capital investment, labor, and imports
IP621A001	Inputs to 621A00, goods
IP621A0011	Inputs to 621A00, foods

See footnotes at end of table.

Table 3. PPI detailed publication structure for industry input indexes

Code	Title
IP621A0012	Inputs to 621A00, energy
IP621A0013	Inputs to 621A00, goods less foods and energy
IP621A002	Inputs to 621A00, services
IP621A0021	Inputs to 621A00, trade services[(1)]
IP621A0022	Inputs to 621A00, transportation and warehousing services
IP621A0023	Inputs to 621A00, services less trade, transportation, and warehousing
IP621A003	Inputs to 621A00, maintenance and repair construction

Notes:

See footnotes at end of table.

(1) The PPI measures trade services as the change in margins received by wholesalers or retailers.

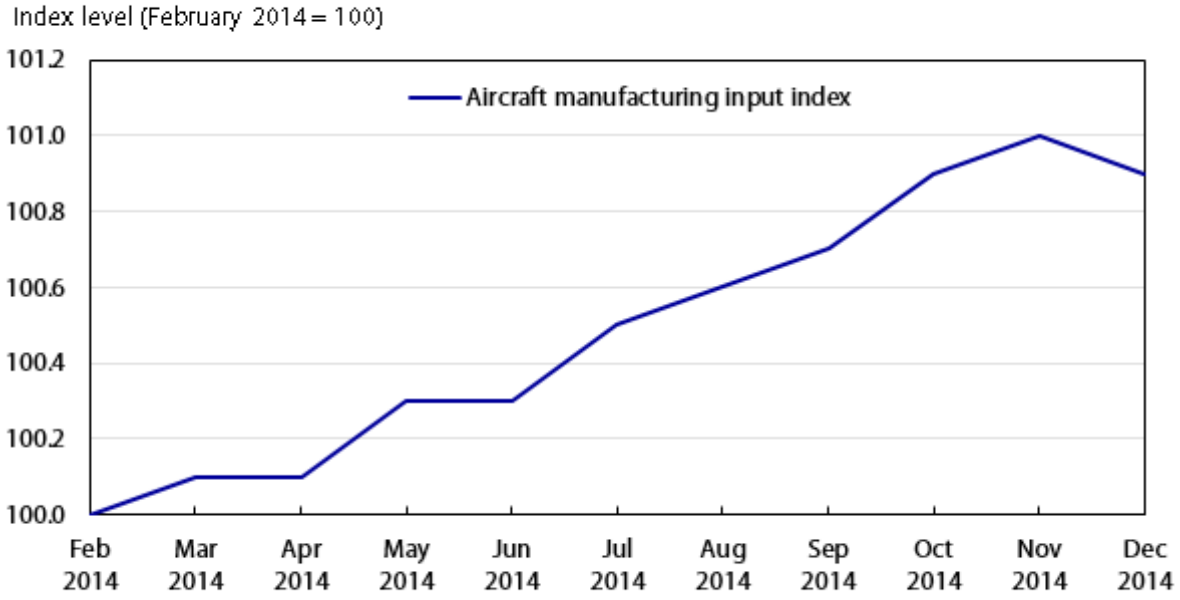
Source: U.S. Bureau of Labor Statistics.

Data analysis

This section examines 2014 monthly data for the input indexes of two industries—aircraft manufacturing (NAICS 336411) and plastics product manufacturing (NAICS 326100). The analysis begins by examining trends in the input indexes and determining the specific inputs that contributed most substantially to those trends. The analysis then compares movements in the industry input indexes with movements in their corresponding industry output indexes. Aircraft manufacturing and plastics product manufacturing were chosen for analysis because they are goods-producing industries. In general, labor, which is not included in PPI inputs to industry indexes, accounts for a smaller share of total industry inputs in goods-producing industries than in services or construction industries. The choice of goods-producing industries therefore allows for a more meaningful comparison between input and output indexes. An input index for a goods-producing industry generally covers more of total industry inputs than does an input index for a service or construction industry.

Inputs to aircraft manufacturing. The PPI for inputs to aircraft manufacturing (excluding capital investment, labor, and imports) measures price change for domestically produced inputs purchased by the aircraft manufacturing industry. The majority of inputs included in the industry's input index are goods, which account for approximately 77 percent of the overall index. Services make up the remaining 23 percent of the index. Within goods, products other than foods and energy account for 76 of the total 77 percent of inputs, and energy accounts for the remaining 1 percent. The most heavily weighted goods inputs are aircraft parts and equipment (other than engines) and aircraft engines and engine parts, each making up 26 percent of the overall index and one-third of goods inputs. Other important goods inputs include integrated microcircuits; aeronautical, nautical, and navigational instruments; metal valves (except fluid power); and hot and cold rolled steel. Among services, trade services account for 12 percent of the total 23 percent of services inputs, transportation services contribute 2 percent, and services less trade and transportation make up 9 percent. Within services inputs, parts and supplies for machinery and equipment wholesaling are the most heavily weighted, accounting for approximately 10 percent of overall inputs and about 85 percent of trade inputs. Other heavily weighted service inputs include legal services, long distance motor carrying, and engineering services.[19]

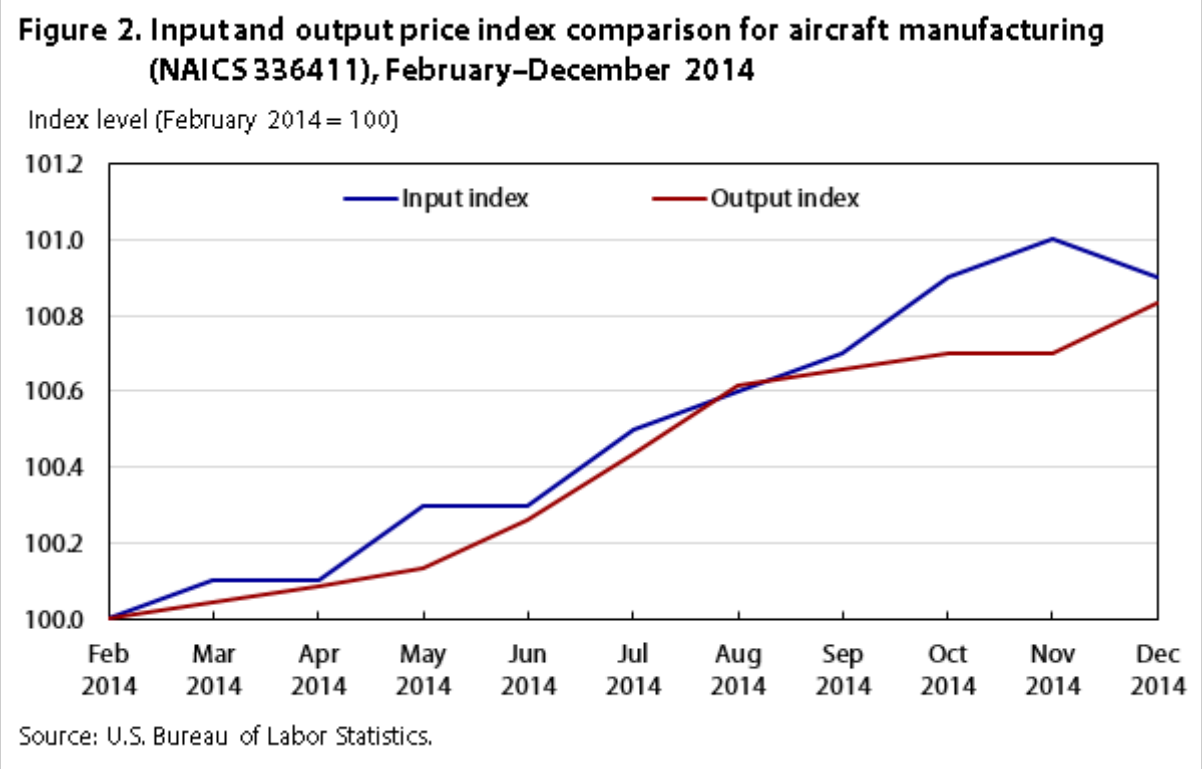
Figure 1. PPI for inputs to aircraft manufacturing (NAICS 336411), February–December 2014



Source: U.S. Bureau of Labor Statistics.

From February 2014 through December 2014, the PPI for inputs to aircraft manufacturing rose 0.9 percent. During this period, the index rose at a relatively linear rate, showing mostly small monthly increases and rising 0.09 percent per month, on average. The index fell only once within the sample period. (See figure 1.)

The 0.9-percent rise in the overall input index for aircraft manufacturing can be traced to increasing prices for both goods and services inputs. Prices for goods inputs moved up 0.5 percent, and prices for services inputs advanced 3.5 percent. The increase in goods input prices was due to a 0.5-percent rise in prices for goods less foods and energy. Rising prices for aircraft parts and equipment (other than engines), aircraft engines and engine parts, and aluminum mill shapes accounted for the majority of the increase. By contrast, energy input prices fell 4.1 percent. Among services inputs, prices for trade services advanced 4.0 percent, transportation and warehousing prices rose 0.9 percent, and prices for services less trade, transportation, and warehousing increased 1.2 percent. Increasing prices for parts and supplies for machinery and equipment wholesaling led the advance in the index for services inputs to aircraft manufacturing.



PPI input indexes can potentially be used to examine the relationship between input and output prices. Although the sample period for our industry example is too short for formal econometric analysis, an informal comparison of the prices is possible. Figure 2 displays the PPI input and output indexes for aircraft manufacturing. For comparison purposes, both indexes were rebased to equal 100 in February 2014.

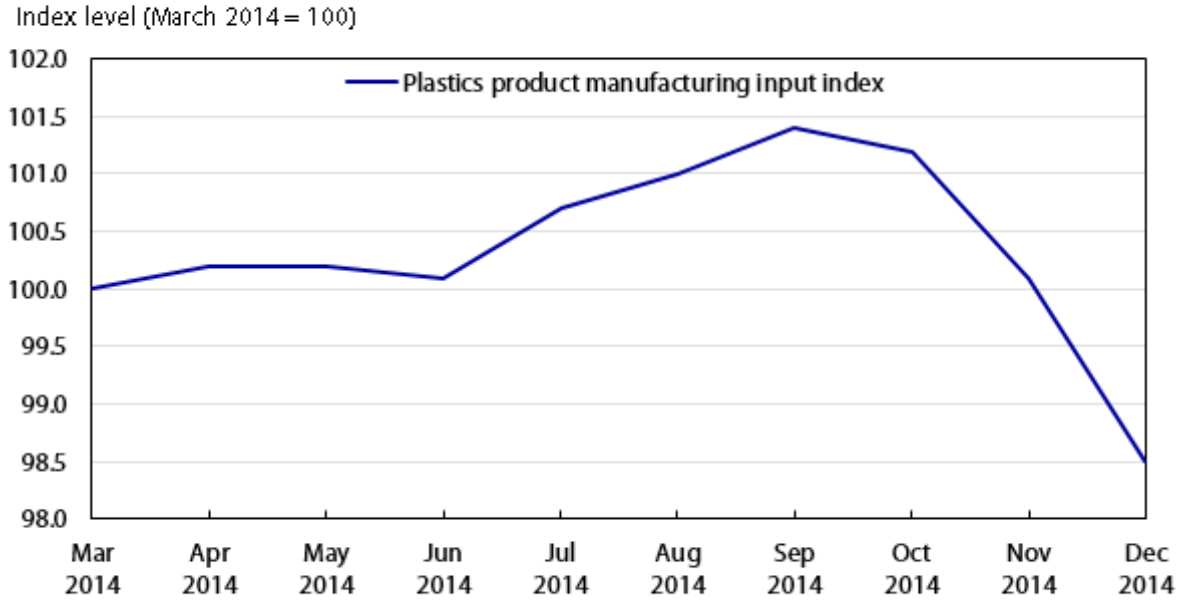
Figure 2 indicates that the trends in the input and output indexes for aircraft manufacturing were very similar over the entire sample period. From February 2014 through December 2014, the input index increased 0.9 percent and the output index rose 0.8 percent. It is important to note, however, that the sample period is short, and future trends in the input and output indexes may be less similar. The monthly movements in the indexes appear to be less related than the movements over the entire sample period. The input index experienced more volatility than the output index: the standard deviation in the 1-month percent change of the input index was 0.1 over the sample period, whereas the standard deviation in the output index was 0.06. The available data, albeit limited, support the hypothesis that there is a relationship between the input and output indexes for aircraft manufacturing. Once more data become available, further analysis examining the causal lag–lead relationship between the indexes could be conducted.

Inputs to plastics product manufacturing. The PPI for inputs to plastics product manufacturing (excluding capital investment, labor, and imports) measures price change for domestically produced inputs purchased by the plastics industry group. In contrast to the PPI for inputs to aircraft manufacturing, which measures price change for inputs to a single industry, the index for inputs to plastics product manufacturing measures price change for inputs to an industry group (NAICS 326100). PPI chose to calculate an input index for the group, as opposed to indexes for individual plastics product manufacturing industries, because inputs consumed across these individual industries are similar. The industry group includes the following 11 industries: plastics bag manufacturing (NAICS 326111); plastics packaging film and sheet (including laminated) manufacturing (NAICS 326112); unlaminated plastics film and sheet manufacturing (NAICS 326113); unlaminated profile shape manufacturing (NAICS 326121); plastics

pipe and pipe fitting manufacturing (NAICS 326122); laminated plastics plate, sheet (except packaging), and shape manufacturing (NAICS 326130); polystyrene foam product manufacturing (NAICS 326140); urethane and other foam product (except polystyrene) manufacturing (NAICS 326150); plastics bottle manufacturing (NAICS 326160); plastics plumbing fixture manufacturing (NAICS 326191); resilient floor covering manufacturing (NAICS 326192); and all other plastics product manufacturing (NAICS 326199).

Goods account for approximately 79 percent of the inputs included in the PPI for inputs to plastics product manufacturing. Services inputs account for approximately 20 percent of the index, and maintenance and repair construction contributes less than 1 percent. Within goods, goods less foods and energy account for 73 of the total 79 percent of inputs, and energy represents the remaining 6 percent. The most heavily weighted goods inputs are thermoplastic resins and plastics materials, thermosetting resins and plastics materials, industrial electric power, and paper boxes and containers. Within services, trade services account for 12 of the total 20 percent of services inputs, transportation services make up 5 percent, and services less trade and transportation account for 3 percent. The most heavily weighted services inputs include chemicals and allied products wholesaling, long distance motor carrying, and rail transportation of freight and mail.

Figure 3. PPI for inputs to plastics product manufacturing (NAICS 326100), March–December 2014



Source: U.S. Bureau of Labor Statistics.

Figure 3 presents the index for inputs to plastics product manufacturing (excluding capital investment, labor, and imports) from March 2014 through December 2014. In contrast to the index for inputs to aircraft manufacturing, which rose slowly over the period, the input index for plastics experienced periods of stability, increase, and decrease. For analysis purposes, the sample is subdivided into three periods: March through June, June through September, and September through December.

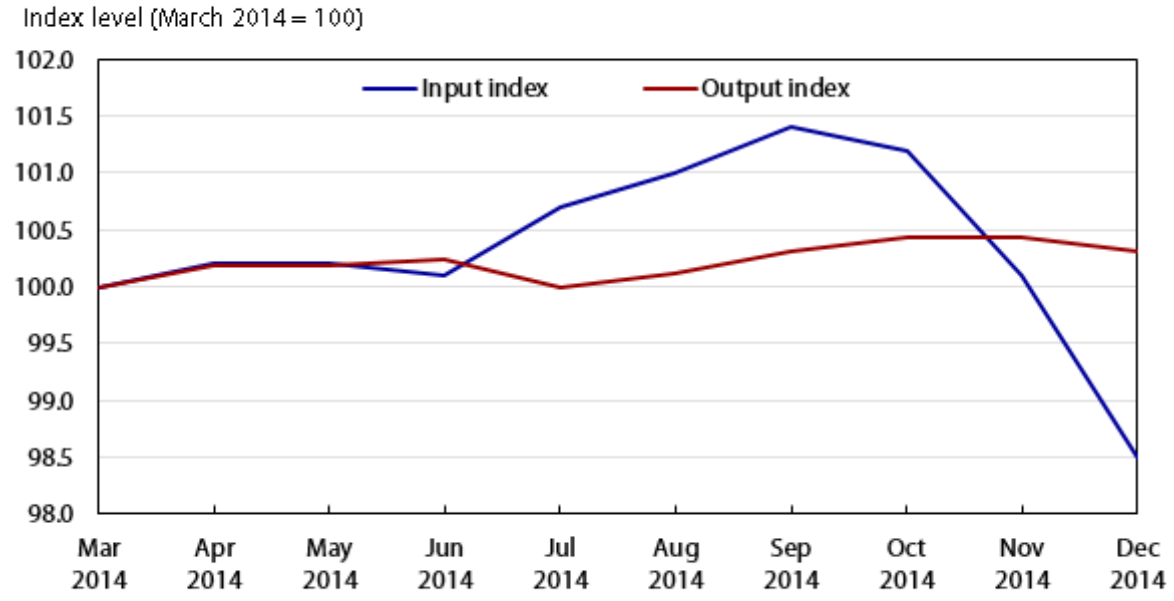
From March 2014 through June 2014, the index for inputs to plastics product manufacturing remained relatively stable, increasing 0.1 percent. Within the overall index, prices for goods remained unchanged, largely moderating a 0.8-percent rise in the services inputs index. Among goods input prices, rising prices for goods less foods and

energy were offset by falling prices for energy. Within services inputs, prices for trade services led the overall increase, rising 1.1 percent. Prices for transportation and warehousing services and prices for services less trade, transportation, and warehousing increased 1.0 percent and 0.2 percent, respectively. The increase in trade services was driven primarily by margins for chemicals and allied products wholesaling, which rose 3.2 percent from March 2014 through June 2014.

The index for inputs to plastics product manufacturing rose 1.3 percent from June 2014 through September 2014. The increase was primarily the result of goods prices, which rose 1.5 percent over the period. Prices for services inputs also increased, moving up 0.5 percent. Among goods, input prices for goods less foods and energy rose 1.8 percent. By contrast, energy input prices fell 1.4 percent. Prices for thermoplastic resins and plastics materials increased 2.8 percent and accounted for the majority of increase in prices for goods inputs to the plastics industry. Higher prices for thermosetting resins and plastics materials also contributed to the gain.

From September 2014 through December 2014, the index for inputs to plastics product manufacturing fell 2.9 percent. Over this period, prices for goods led the decline in the overall index, falling 3.6 percent. In contrast, the index for services inputs inched up 0.1 percent. Prices for goods less foods and energy and prices for energy both contributed to the decline in the goods input price index, falling 3.2 and 9.2 percent, respectively. Within goods, prices for thermoplastic resins and plastics materials fell 4.2 percent, the index for primary basic organic chemicals decreased 23.4 percent, and prices for unleaded regular gasoline declined 32.4 percent. Among services inputs, prices declined for trade services; transportation and warehousing services; and services less trade, transportation, and warehousing.

Figure 4. Input and output price index comparison for plastics product manufacturing (NAICS 326100), March–December 2014



Source: U.S. Bureau of Labor Statistics.

To conclude the analysis, figure 4 compares the input and output price indexes for plastics product manufacturing.

From March 2014 through December 2014, the input and output price indexes for the plastics industry group exhibited differing rates of change, as prices for outputs rose 0.3 percent and prices for inputs declined 1.5 percent. However, over the same period, there appears to be a relationship between the indexes' turning points (i.e., months in which an index changes direction). Both the input and output indexes remained relatively flat in the beginning of the sample period; however, in July 2014, the input price index began to rise and, 1 month later, the output index turned up. The input index continued to rise from July through September and turned down in October. The output index increased from August through October, leveled out, and turned down in December. While the sample period is clearly too short to draw any conclusions with respect to the causal relationship between input and output prices for plastics product manufacturing, the data presented in figure 4 support the notion that output prices follow input prices with a short lag. In addition, the correlation between the 1-month percent change in the output index and the lagged 1-month percent change in the input index is .65 over the sample period. The correlation in unlagged 1-month percent changes for the input and output indexes is only .26.

Conclusions

With the release of data for January 2015, the PPI program expanded its coverage of net inputs to industry indexes and updated the methodology used to calculate those indexes. Coverage enhancements include the addition of more construction industries and expansion into the goods and services sectors of the economy. Methodological improvements include the construction of inputs to industry indexes from commodity-based PPIs and the addition of services and construction inputs. These updates represent the first substantial changes to PPI inputs to industry indexes since the 1980s, when input indexes for construction were introduced.

When using PPI net inputs to industry indexes, data users should keep in mind two important limitations. First, these indexes do not include all inputs purchased by an industry; labor, capital investment, and imports are excluded. Second, the indexes are not constructed from buyers' prices, but from PPI output indexes used as proxies for buyers' prices. A buyers' price index measuring industry inputs would be constructed from prices collected directly from the purchasing industry. The main advantage of a buyers' price index is its ability to capture substitutions to cheaper input sources. For example, an automobile manufacturer may switch from using a domestically produced fuel injection system to using a comparable, and cheaper, imported fuel injection system. The input index for automobile manufacturing would not capture this price decrease, but a buyers' price index would. Note, however, that some evidence has shown that PPI's output price indexes respond to competitive pressures from cheaper inputs.[20] Buyers' price indexes would also capture buyer-born taxes and fees, which are not reflected in the current PPI inputs to industry indexes.

One potential area for future work is to combine PPI input indexes with wage and import data, an approach that would produce a more complete representation of industry input costs. A second area for future work is to further examine the relationships between industry input costs and output prices, especially after additional data on PPI input indexes become available.

SUGGESTED CITATION

Lori Hoglund, Jayson Pollock, and Jonathan C. Weinhagen, "New PPI net inputs to industry indexes," *Monthly Labor Review,* U.S. Bureau of Labor Statistics, October 2015, https://doi.org/10.21916/mlr.2015.40.

NOTES

1 Monthly issues of the *PPI Detailed Report* are available electronically at https://www.bls.gov/ppi/ppi_dr.htm. PPI data are also available through the Bureau of Labor Statistics data-retrieval tools, at https://www.bls.gov/ppi/getdata.htm.

2 John F. Early, "Improving the measurement of producer price change," *Monthly Labor Review*, April 1978.

3 See "Expansion of Producer Price Index," *PPI Detailed Report*, January 1986, pp. 4–5.

4 Coverage is based on 2007 Economic Census value of shipments.

5 Jonathan C. Weinhagen and Bonnie H. Murphy, "New wherever-provided services and construction price indexes for PPI," *Monthly Labor Review*, August 2009, https://www.bls.gov/opub/mlr/2009/08/art2full.pdf.

6 For information on the FD–ID aggregation system, visit https://www.bls.gov/ppi/fdidaggregation.htm.

7 The BEA use table is located at https://www.bea.gov/industry/io_annual.htm.

8 Ricky L. Stewart, Jessica Brede Stone, and Mary L. Streitwieser, "U.S. benchmark input–output accounts, 2002" *BEA Methodology Papers*, October 2007, p. 19, https://www.bea.gov/scb/pdf/2007/10%20October/1007_benchmark_io.pdf.

9 Value-of-shipments data can be downloaded from the Economic Census website at https://www.census.gov/programs-surveys/economic-census.html.

10 Currently, the reference year for both Economic Census and I–O data is 2007; however, because Economic Census data become available before I–O data, the Economic Census portion of the weight will be updated before the I–O portion. For the period between updates, the reference year will not match for the two portions of the weight.

11 For an overview of value weights and quantity weights, see "Producer Price Index manual: theory and practice," (International Monetary Fund, 2004), pp. 90–91, https://www.imf.org/external/np/sta/tegppi/con0.pdf.

12 PPI wherever-made weights are primarily based on Economic Census value-of-shipments data. Since PPI does not disclose its weight data, all examples of data for the wherever-made value of shipments in this article are based on publicly available data from the Economic Census. All Economic Census and BEA dollar values presented here are in thousands.

13 The BEA "Make of commodities by industries" table is located at https://www.bea.gov/industry/io_annual.htm.

14 For an overview of the PPI methodology, see chapter 14, "Producer prices," *BLS handbook of methods* (U.S. Bureau of Labor Statistics, 2014), https://www.bls.gov/opub/hom/pdf/homch14.pdf.

15 Cutoffs are based on percentage of total use of a commodity from the BEA use table.

16 PPI uses a similar 0.5-percent cutoff to construct the FD–ID indexes.

17 These three industries were the first analyzed by PPI. On the basis of this initial analysis, PPI decided to implement the cutoff rule in future analyses for other industries.

18 See page 190 of the July 1986 *PPI Detailed Report* for an overview of the previous methodology used for calculating indexes for material and supply inputs to construction. (The document is available upon request through email, at ppi-info@bls.gov, or by phone, at 202-691-7705.) These indexes are now calculated with the methods outlined in this article.

19 Relative importance data for PPI net inputs to industry indexes are available upon request through email, at ppi-info@bls.gov, or by phone, at 202-691-7705.

20 Maureen P. Doherty, "The behavior of the Producer Price Index in a global economy," *Monthly Labor Review*, August 2012, https://www.bls.gov/opub/mlr/2012/09/art2full.pdf.

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