Combined PPI and IPP Input to Industry Indexes November 2016

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Abstract

This paper presents a newly developed methodology that combines Bureau of Labor Statistics Producer Price Index and International Price Index data to construct indexes that measure price changes for inputs to production consumed by domestic industries. Producer Price Index data are used to measure price changes for industry purchases of domestically purchased inputs, while International Price Index data are used to measure price changes for imported inputs. Bureau of Economic Analysis Input-Output data are used to determine the set of commodities a given industry consumes as inputs. Weights for the indexes are developed from both Bureau of Economic Analysis Input-Output data and US Census data. The paper also applies the methodology to the domestic automobile manufacturing industry by developing an index measuring price changes for both domestically produced and imported inputs to the automobile manufacturing industry.

Key Words: Producer Price indexes, Inflation

In January 2015, the Producer Price index (PPI) division of the Bureau of Labor Statistics (BLS) introduced a set of inputs to industry indexes. These indexes measure price change for net inputs consumed by industries, excluding capital investment, labor, and imports. As part of an outreach effort, PPI presented the new input to industry indexes to the BLS Data Users Advisory Committee (DUAC). The committee suggested that for certain industries PPI should explore the addition of imported inputs to the indexes. The committee pointed out that inclusion of imports is especially important in cases where the industry is a heavy user of imports, such as automobile manufacturing. PPI therefore undertook a project to examine the feasibility of combining PPI and International Price Program (IPP) data to develop inputs to industry indexes that include prices for both domestically produced and imported inputs. This document explains the methodology PPI developed to construct combined PPI-IPP inputs to industry indexes and presents an application of the methodology to the industry for automobile manufacturing.

Methodology

To construct an inputs to industry index that includes prices for both domestically produced and imported inputs, PPI first creates two separate indexes: one measuring price change for domestically produced inputs and the other measuring price change for imported inputs. PPI then aggregates the domestic and imported input indexes into an overall price index that measures price change for both domestically produced and imported inputs to the industry.

Domestic input to industry index

For the domestic portion of the index, the set of inputs included is determined from the Bureau of Economic Analysis (BEA) "Use of Commodities by Industries" table (hereafter referred to as the Use table).[ii] The Use table provides, on an industry basis, the set and dollar value of products consumed by each domestic industry as inputs to production. From the Use table, PPI determines the set of commodities, classified by BEA Input-Output (IO) code, a given industry or industry group consumes as inputs.[iii] It is important to note that the Use table includes both inputs produced domestically and abroad, but does not differentiate between them. For example, the Use table shows that the automobile industry consumes a certain dollar value of tires, and this value includes both domestically produced and imported tires. Since the Use table does not differentiate between domestically produced or imported inputs, the set of domestic inputs included in a given industry input index will be the same as imported inputs included in the index. However, for each commodity consumed by the industry, the weights assigned to the domestically produced commodity will differ from those assigned to the imported commodity. The domestic weight for a given input commodity reflects the value of the commodity produced in the US, whereas the imported weight reflects the value of the input produced abroad.

After the inputs consumed by an industry are determined from the Use table, they are translated from IO classification to PPI commodity code classification. This step is necessary since the domestic input indexes are constructed from 6-digit PPI commodity-based price indexes.[iv] (Commodity-based PPIs measure price change for domestically produced goods, services, or construction products regardless of the product's industry or origin.) The translation is accomplished through a concordance between the PPI commodity indexes and the North American Standard Industrial Classification System (NAICS). BEA IO data are generally classified according to NAICS, and BEA provides a concordance between the NAICS and the IO codes, which further enhances the match.

PPI then develops weights for each commodity included in the input index. The gross weight of each commodity included in the domestic portion of the industry input index is equal to the share of the total value of the commodity consumed by the industry multiplied by the Census wherever-made value of shipments number for that commodity during the base period. The Census wherever-made value of shipments figure reflects total value of domestic production for a given commodity. Multiplying the share of the commodity used by the Census wherever-made value of shipments for a commodity results in the weight reflecting only the domestically produced portion of the input commodity's value. Assuming there are i=1 through n industries and c=1 through m commodities, the share of the commodity c consumed by industry i for base period b is:

$$S^{u}_{c,i,b} = Use_{c,i,b} / (\sum_{i=1}^{n} Use_{c,i,b})$$

where

- $Use_{c,i,b}$ denotes use of commodity c by the industry i at base period b
- $\sum_{i=1}^{n} Use_{c,i,b}$ is the total use of commodity c by all industries in the Use table in base period b.

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

$$GW_{c,i,b} = S^{u}_{c,i,b} * VOS_{c,b}$$

where

- $VOS_{c,b}$ is the wherever-made value of shipments for commodity c in base period b.

After the gross weight of a commodity is determined, PPI converts the gross weight to a net weight by removing the portion of the input commodity's value that was produced within the industry from the gross weight. Net weighting removes multiple counting bias from the overall input index, which occurs when prices from several stages of production are included in an aggregate index. Net weighting removes multiple counting bias by excluding the weight of transactions for commodities that are both produced and consumed within a given industry.

A net weight is calculated by applying a net input ratio to the gross weight. The net input ratio is calculated using data from the BEA "Make of Commodities by Industry" table, which provides the set and dollar value of products made by each domestic industry.[v] The net input ratio represents the share of the commodity not produced by the consuming industry. The share of commodity c produced by industry i during the base period b is:

$$S^{m}_{c,i,b} = Make_{c,i,b} / (\sum_{i=1}^{n} Make_{c,i,b})$$

where

- $Make_{c,i,b}$ denotes make of commodity c by industry i at base period b
- $\sum_{i=1}^{n} Make_{c,i,b}$ is the total make of commodity c by industries 1 through n at base period b.

The net input ratio of commodity c for industry i at base period b is the share of commodity c not made by industry i and is calculated as follows:

$$NIR_{c,i,b} = 1 - S^{m}_{c,i,b}$$

The final net value weight for commodity c in the input index for industry i for base period b is calculated as:

$$NW_{c,i,b} = (1 - S^{m}_{c,i,b}) * S^{u}_{c,i,b} * VOS_{c,b}$$

which can be rewritten as:

$$NW_{c,i,b} = NIR_{c,i,b} * GW_{c,i,b}$$

Once the products and weights are determined for a net inputs to industry index, the index is calculated using a modified Laspeyres index formula based on standard PPI methodology. [vi] An approximation of the PPI aggregate index formula for month t follows:

$$I_{a,t} = I_{a,t-1} * [\sum_{c=1}^{m} (I_{c,t} / I_{c,b}) * NW_{c,b}] / [\sum_{c=1}^{m} (I_{c,t-1} / I_{c,b}) * NW_{c,b}]$$

where

- $I_{a,t}$ is aggregate price index at time t
- $I_{a,t-1}$ is aggregate price index a at time t-1
- $I_{c,t}$ is commodity price index c in period t
- $I_{c,t-1}$ is commodity price index c in period t-1
- $I_{c,b}$ is commodity price index c in base period b
- $NW_{c,b}$ is the net weight for commodity index c in base period b

Imported input index

As with the domestic portion of the index, the set of inputs to be included in the imported portion of the index is determined from the BEA Use table. After the set of imported inputs are determined, they are translated from IO classification to NAICS code classification. This step is necessary since the import portion of the input index is constructed from NAICS based IPP import price indexes. (In contrast to the domestic portion, which is constructed from PPI commodity-based price indexes). The translation is accomplished through a concordance between the NAICS and IO codes. In general, the translation is conducted at the level of detail included in the IO code. In some cases, this may be at a level of detail not currently published by IPP. (For example, 6-digit NAICS). [vii]

Once the set of import commodities consumed by an industry (classified in terms of NAICS codes) has been determined, PPI develops weights for each commodity included in the index. The gross weight of each import commodity is equal to the share of the total value of the commodity consumed by the industry multiplied by the Census import trade value of shipments for that commodity during the base period. Multiplying the share of the commodity used by the Census import trade value of shipments for the commodity, results in the weight reflecting only the foreign produced portion of the input commodity's value. Assuming there are i=1 through n industries and c=1 through m commodities, the share of the commodity c consumed by industry i for base period b is:

$$S^{u}_{c,i,b} = Use_{c,i,b} / (\sum_{i=1}^{n} Use_{c,i,b})$$

where

- $Use_{c,i,b}$ denotes use of commodity c by the industry i at base period b
- $\sum_{i=1}^{n} Use_{c,i,b}$ is the total use of commodity c by all 1 through n industries included in the Use table at base period b.

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

$$GW_{c,i,b} = S^{u}_{c,i,b} * VOI_{c,b}$$

where

- $VOI_{c,b}$ is the value of imports for commodity c in base period b.

In contrast with the domestic portion of the index, for the imported portion of the index net weights and gross weights are identical. Net weights are equal to gross weights because by definition domestic industries cannot produce imports. The share of a domestic industry's production of the import commodity is therefore 0 ($S^{m}_{c,i,b} = 0$) and the net input ratio is 1.

Once the products and weights are determined for a net inputs to industry index, the index is calculated using a modified Laspeyres index formula based on standard PPI methodology. (See the index aggregation formula presented in the previous section.)

Aggregating the domestic and import indexes

To create the final domestic and imported inputs to industry index, excluding capital investment and labor, the domestic and imported indexes are aggregated into a total index. [viii] An approximation of the aggregation formula follows:

$$I_{a,t} = I_{a,t-1} * [\sum_{c=1}^{m}(I_{cd,t}\,/I_{cd,b}) * NW_{cd,b} + \sum_{c=1}^{m}(I_{cf,t}\,/I_{cf,b}) * NW_{cf,b}]/$$

$$[\sum_{c=1}^{m}(I_{cd,t-1}\,/I_{cd,b}) * NW_{cd,b} + \sum_{c=1}^{m}(I_{cf,t-1}\,/I_{cf,b}) * NW_{cf,b}]$$

Where,

- $I_{a,t}$ is aggregate price index at time t
- $I_{a,t-1}$ is aggregate price index at time t-1
- $I_{cd,t}$ is domestic commodity price index c in period t
- $I_{cd,t-1}$ is domestic commodity price index c in period t-1
- $I_{cd,b}$ is domestic commodity price index c in base period b
- $NW_{cd,b}$ is the net weight for domestic commodity price index c in base period b
- $I_{cf,t}$ is foreign commodity price index c in period t
- $I_{cf,t-1}$ is foreign commodity price index c in period t-1
- $I_{cf,b}$ is foreign commodity price index c in base period b
- $NW_{cf,b}$ is the net weight for foreign commodity price index c in base period b

Inputs to the automobile manufacturing industry example

PPI implemented the methodology described in the previous section for the automobile manufacturing industry. Automobile manufacturing was chosen since a relatively high share of automobile manufacturer inputs are imported. An overview of the process PPI used to develop the domestic and imports inputs to automobile manufacturing index, excluding capital investment and labor and an analysis of the data follows.

Table 1 presents the BEA Use table data for the automobile manufacturing industry. The first and second columns show the IO code and title for the commodity being consumed. The third column presents the current dollar value (in millions) of use of the commodity by the automobile manufacturing industry. The fourth column displays the total value of use of the commodity, and the last column shows the proportion of use of the commodity by the automobile industry. For example, the Use table indicates that the automobile industry purchases 3.29 percent of total value of produced tires.

Table 1: IO Use data for NAICS, Automobile manufacturing

IO code	IO title	Industry Use	Total Use	Industry Use/total Use
322210	Paperboard container manufacturing	358	50000	0.0072
326190	Other plastics product manufacturing	1613	99768	0.0162
326210	Tire manufacturing	888	27020	0.0329
327200	Glass and glass product manufacturing	1688	29548	0.0571
332720	Turned product and screw, nut, and bolt manufacturing	408	28136	0.0145
333415	Air conditioning, refrigeration, and warm air heating equipment manufacturing	332	35833	0.0093
333618	Other engine equipment manufacturing	1444	36420	0.0397
334300	Audio and video equipment manufacturing	1202	56247	0.0214
334413	Semiconductor and related device manufacturing	512	85600	0.0060
334514	Totalizing fluid meter and counting device manufacturing	516	6624	0.0779
336211	Motor vehicle body manufacturing	1098	7161	0.1533
336310	Motor vehicle gasoline engine and engine parts manufacturing	9128	42524	0.2147
336320	Motor vehicle electrical and electronic equipment manufacturing	1101	29594	0.0372
336350	Motor vehicle transmission and power train parts manufacturing	8081	48315	0.1673
336360	Motor vehicle seating and interior trim manufacturing	5328	24831	0.2146
336370	Motor vehicle metal stamping	6222	28437	0.2188
336390	Other motor vehicle parts manufacturing	6305	73956	0.0853
3363A0	Motor vehicle steering, suspension component (except spring), and brake systems manufacturing	3540	29820	0.1187
420000	Wholesale trade	7024	1215173	0.0058
484000	Truck transportation	906	280244	0.0032

Domestic inputs to automobile manufacturing index

Table 1 shows commodities (classified in terms of IO codes) consumed by the automobile industry. The use data was translated from IO code to PPI commodity codes to establish the set of 6-digit commodity-based PPIs included in the domestic portion of the inputs to automobile manufacturing index. Table 2 presents selected 6-digit commodity based PPIs that comprise the domestic portion of the overall index. The commodities selected represent approximately 90 percent of the industry's domestically produced inputs. The table also includes the relative importance of each commodity to the domestic portion of the index.

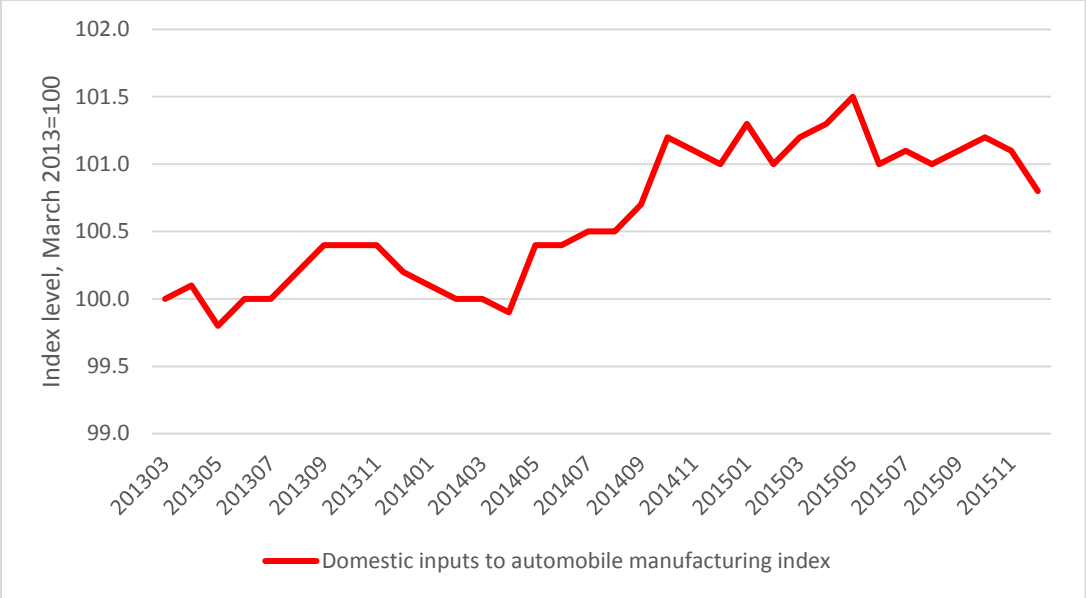
Table 2. Selected PPI commodities included in inputs to automobile manufacturing index

PPI code	PPI title	Relative importance (domestically produced)
141205	Motor vehicles parts	44.365
571102	Parts and supplies for machinery and equipment wholesaling	23.147
108905	Other metal products	12.088
141301	Truck and bus bodies sold separately	3.406
301202	Long-distance motor carrying	1.527
119408	Diesel, semidiesel, & dual-fuel engines, automotive	1.277
573101	Building materials, paint, and hardware wholesaling	1.115
117906	Other motor vehicle electrical and electronic equipment	1.018
071201	Tires	1.016
131107	Specialty glass	0.935

Once the commodities included in the index for domestically produced inputs to automobile manufacturing were determined, weights were developed using the procedure described in the previous section. Again, the gross weight of each commodity is calculated by multiplying the share of the commodity used by the automobile industry by the Census wherever-made value of shipments for that commodity. For example, table 1 shows that the automobile industry consumes 3.29 percent of tires and the Census wherever-made value of shipments for tires is $15,841,959,000. The gross weight of tires to the inputs to automobile industry index is therefore: 0.0329*$15,841,959,000 = $52,100,451. Since the automobile industry makes no tires, its net input ratio for tires is 1 and the gross weight and net weight of tires are the same. The relative importance of the value of a commodity to the overall domestic index (shown in table 2) is the weight of the commodity divided by the sum of the weights of the commodities in the index. For example, tires comprise 1.016 percent of the domestic portion of the inputs to automobile manufacturing index.

Chart 1 presents the domestic inputs to automobile index from March 2013 through December 2015. Over that period, the domestic inputs index increased 0.8 percent. Within the overall domestic inputs index, goods input prices fell 0.5 percent and prices for service inputs rose 2.8 percent.

Chart 1. Domestically produced inputs to automobile manufacturing index



Imported inputs to automobile manufacturing index

The use data presented in table 1 were employed to determine the imported commodities (classified in terms of IO codes) consumed by the automobile industry. The use data were translated from IO code to NAICS codes to establish the set of IPPs in the imported portion of the inputs to automobile manufacturing index. Table 3 presents the NAICS based IPPs that comprise the imported portion of the input index as well as their relative importance values.

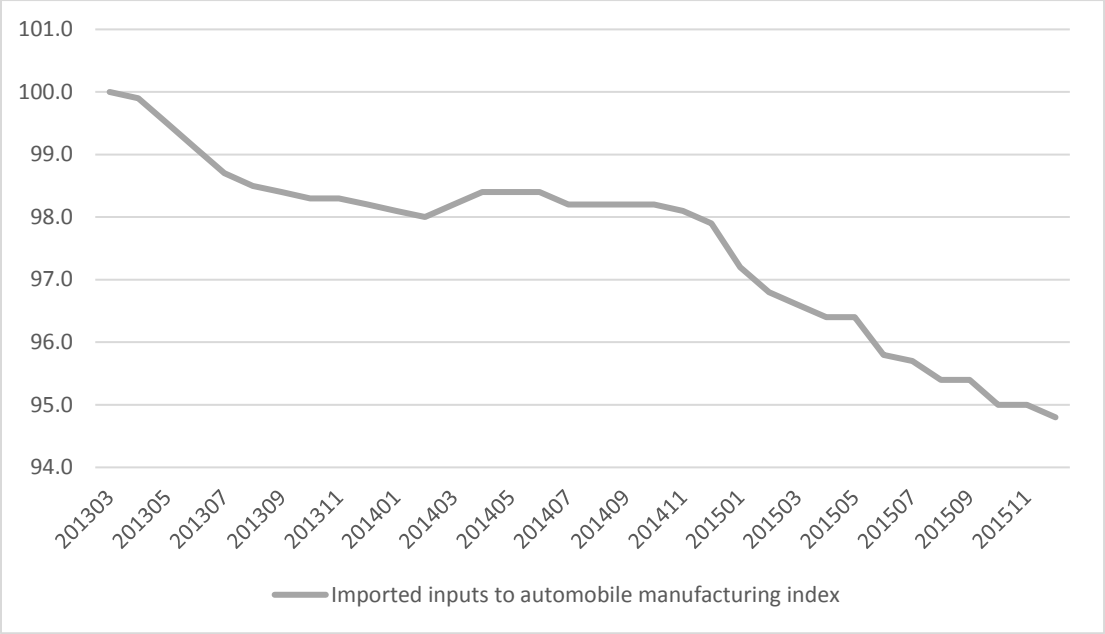
Table 3. IPP indexes included in inputs to automobile manufacturing index

IPP code	IPP title	Relative importance (imported)
Z33631	Motor vehicle gasoline engine and engine parts	21.366
Z33635	Motor vehicle transmission and power	17.107
Z33639	Other motor vehicle parts manufacturing	16.418
Z33636	Motor vehicle seating and interior trim	9.391
Z3343	Audio and video equipment manufacturing	8.713
Z33634	Motor vehicle brake system manufacturing	4.168
Z33633	Motor vehicle steering and suspension	3.850
Z333618	Other engine equipment manufacturing	3.508
Z33632	Motor vehicle electrical and electronic	3.452
Z32621	Tire manufacturing	2.695
Z3272	Glass and glass product manufacturing	2.350
Z32619	Other plastics product manufacturing	1.903
Z334413	Semiconductor and related device	1.366
Z336211	Motor vehicle body manufacturing	1.032
Z334514	Totalizing fluid meter and counting	0.791
Z33637	Motor vehicle metal stamping	0.780
Z333415	Air-conditioning and warm air heating	0.522
Z33272	Turned product and screw, nut, and bolt	0.510
Z32221	Paperboard container manufacturing	0.079

After the set of IPPs included in the imported portion of the inputs to automobile manufacturing index was determined, weights were constructed using the methodology described in the previous section. The weight, for example, of motor vehicle engines and engine parts was calculated by multiplying the use share for that commodity (0.2147) by the Census import value ($11,726,469,850). The weight of imported motor vehicle engines and engine parts to the index for imported inputs to automobile manufacturing is 0.2147*$11,726,469,850 = $2,517,673,077. In terms of relative importance, motor vehicle engines and engine parts account for 21.366 percent of the imported portion of the inputs to automobile manufacturing index.

Chart 2 presents the imported inputs to automobile index from March 2013 through December 2015. In contrast to the domestic input index which rose slightly over the sample period, the imported inputs to automobile index fell 5.2 percent from March 2013 through December 2015.

Chart 2. Imported inputs to automobile manufacturing index



Aggregate domestic and imported inputs to automobile manufacturing index

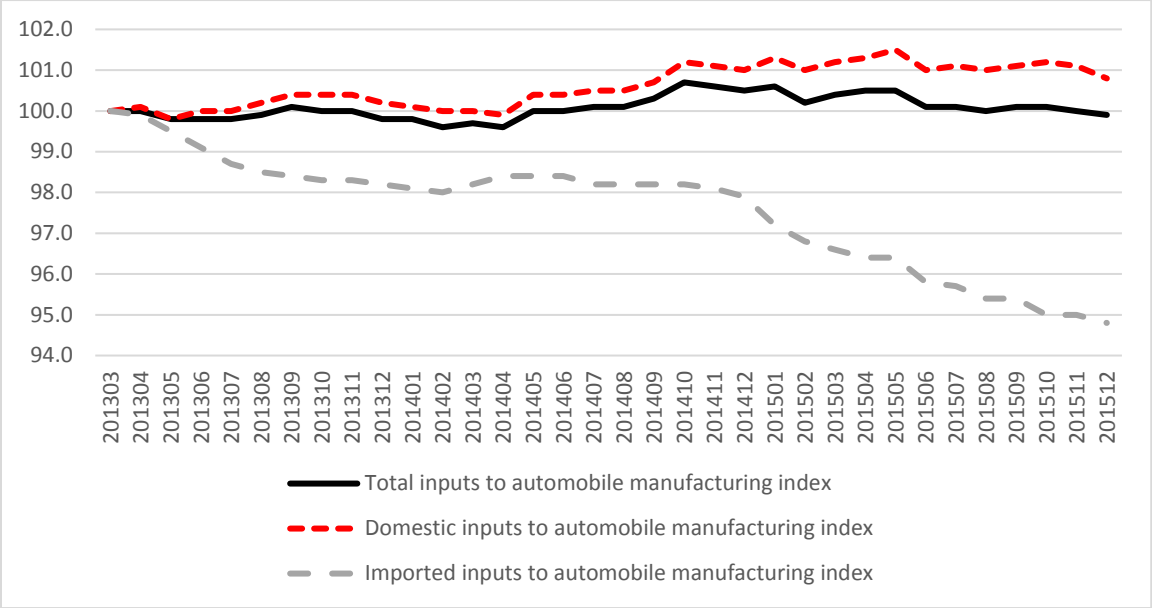
As a final step, the domestic and imported inputs to automobile indexes were aggregated using the method outlined in the methodology section. After aggregation, domestically produced inputs comprise approximately 82.5 percent of the overall inputs to automobile industry index and imports account for the remaining 17.5 percent. Table 4 provides approximate relative importance values for selected IPP and PPI indexes included in the overall index. The selected commodities represent approximately 90 percent of tot industry inputs.

Table 4. PPI and IPP indexes included in inputs to automobile manufacturing index

Code	Title	Relative importance
PPI141205	Motor vehicles parts	36.601
PPI571102	Parts and supplies for machinery and equipment wholesaling	19.096
PPI108905	Other metal products	9.973
IPPZ33631	Motor vehicle gasoline engine and engine parts	3.739
IPPZ33635	Motor vehicle transmission and power	2.994
IPPZ33639	Other motor vehicle parts manufacturing	2.873
PPI141301	Truck and bus bodies sold separately	2.810
IPPZ33636	Motor vehicle seating and interior trim	1.643
IPPZ3343	Audio and video equipment manufacturing	1.525
PPI301202	Long-distance motor carrying	1.260
PPI119408	Diesel, semidiesel, & dual-fuel engines, automotive	1.054
PPI573101	Building materials, paint, and hardware wholesaling	0.920
PPI117906	Other motor vehicle electrical and electronic equipment	0.840
PPI071201	Tires	0.838
PPI131107	Specialty glass	0.771
IPPZ33634	Motor vehicle brake system manufacturing	0.729
IPPZ33633	Motor vehicle steering and suspension	0.674
PPI118401	Fluid meters and counting devices	0.666
IPPZ333618	Other engine equipment manufacturing	0.614
IPPZ33632	Motor vehicle electrical and electronic	0.604

Chart 3 presents the combined domestically produced and imported inputs to automobile manufacturing industry index, excluding capital investment and labor from March 2013 through December 2015. The chart also contains the separate domestic and import component indexes.

Chart 3: Inputs to automobile manufacturing indexes



The total inputs to automobile manufacturing industry index edged down 0.1 percent from March 2013 through December 2015. Prices for domestically produced inputs increased 0.8 percent. This increase in domestic input prices was offset by a 5.2-percent decline in imported input prices from March 2013 through December 2015. The difference in price movements between imported and domestic produced automobile inputs highlights the importance of including both types of inputs industry input indexes.

Conclusion

This document has outlined the methodology developed by PPI to construct inputs to industry indexes that include prices for both domestically produced and imported inputs. The methodology relies on combining price index data from PPI and IPP. PPI data is used to measure domestic input prices, while IPP data is used to measure imported input prices. BEA Use of Commodities by Industries data is used to determine both imported and domestically produced inputs consumed by industries. Weights for the domestic portion of indexes are derived from BEA use data in combination with Census wherever-made value of shipments data, whereas weights for the imported component are constructed from BEA use data in conjunction with Census trade import value data.

The methodology described in this document was then applied to the automobile manufacturing industry and an index that measures both domestically produced and imported inputs to automobile manufacturing was developed. Examination of the index movements highlights the importance of including both types of inputs, as domestic input prices rose slightly over the sample period, whereas imported inputs prices declined.

[i] Any opinions in this paper are those of the author and do not constitute policy of the Bureau of Labor Statistics.

[ii] The BEA "Use of Commodities by Industries" is located at http://www.bea.gov/industry/io_annual.htm.

[iii] PPI implements a cutoff rule that removes commodities that account for less than 0.5 percent of total inputs to the industry from the industry input indexes. The 0.5 percent cutoff significantly reduces the work required to build and maintain the inputs to industry indexes, while having a negligible effect on index movements.

[iv] Cases in which the IO code is out of scope or not currently covered by PPI are omitted from the industry input index.

[v] The BEA "Make of Commodities by industries" table is located at http://www.bea.gov/industry/io_annual.htm.

[vi] For an overview of PPI index methodology see the chapter 14, "Producer Price Indexes", of the *BLS Handbook of Methods* at http://www.bls.gov/opub/hom/pdf/homch14.pdf.

[vii] Cases in which the IO code is out of scope or not currently covered by IPP are omitted from the industry input index.

[viii] For an overview of PPI index methodology see the chapter 14, "Producer Price Indexes", of the *BLS Handbook of Methods* at http://www.bls.gov/opub/hom/pdf/homch14.pdf.