A New, Experimental System of Indexes from the PPI Program

In its monthly news releases of Producer Price Index (PPI) data, the Bureau of Labor Statistics currently highlights the stage-of-processing (SOP) system as its key structure for analyzing producer prices. The SOP system aggregates price indexes for processed and unprocessed goods. Over the past 20 years, PPI coverage has expanded to include price indexes for many service and construction activities, but the SOP system continues to include only goods. The PPI program recently developed an experimental aggregation system that includes goods price indexes as well as service and construction price indexes for products sold to all portions of final demand (personal consumption, capital investment, government use, and export) and to intermediate demand (business inputs, excluding capital investment). The experimental aggregation system was introduced with the release of January 2011 data in February 2011. This article presents the new, experimental index aggregation system.

Developing the experimental aggregation

Criteria for a potential PPI aggregation system. In developing the experimental aggregation system, two main criteria were considered. First, the system should be designed in such a way as to alleviate or minimize problems resulting from multiple counting. Second, the system should be analytically useful.

Multiple counting can lead to overstated or understated measures of inflation. Multiple counting occurs when the price for a specific commodity and the inputs to production for that same commodity are included in an aggregate index. Before 1978, for example, the PPI program highlighted the all commodities index as its primary aggregate index. This index aggregates prices for all goods sold in the economy, using weights that reflect sales to all portions of intermediate and final demand. The all commodities index was the subject of serious criticism when petroleum prices spiked in the 1970s. Price change, as measured by the all commodities index, was seen as exaggerated because the index included both gasoline sold for final demand and crude petroleum, the primary input used in the production of gasoline. Multiple counting was an important factor in the decision for the PPI program to move from highlighting the all commodities index to calculating, publishing, and highlighting SOP indexes.[1]

The SOP system substantially reduced multiple counting by separating goods into three stages: crude, intermediate, and finished. The system does, however, still have some multiple counting, specifically in its intermediate goods index.

The second criterion is that the aggregation system be analytically useful. The SOP system is more analytically useful than the all commodities index, as the system potentially allows price changes to be tracked through the various segments of the economy. In developing an aggregation system that incorporates prices for services and construction, the possible analytical functions of the system were considered.

The new PPI aggregation system was designed to satisfy the two criteria identified earlier. To avoid multiple counting, the system separates final-demand transactions from intermediate-demand transactions and, in some cases, voids instances of multiple counting. One of the reasons the system is useful for analysis is that it combines commodity indexes into meaningful final-demand and intermediate-demand aggregates. The aggregates convey information about the types of commodities contributing to inflation at both the final-demand level and at earlier stages of production, and can be used to track price change through the economy.

Experimental PPI aggregation system. The new PPI experimental aggregation system tracks price change for goods, services, and construction sold to all portions of final demand and intermediate demand. The final-demand portion of the experimental aggregation system is discussed first, followed by the intermediate-demand portion. It should be noted that the PPI program does not currently calculate price indexes for all domestically produced commodities because of incomplete coverage in some portions of the economy. The experimental aggregation system therefore does not include price indexes for commodities not currently covered by the PPI. The majority of commodities that the PPI program does not have price indexes for are services and construction commodities. Educational services, residential construction and rentals, restaurants, research and development services, and computer design services are among the commodities that the PPI does not cover.[2]

Final demand

The final-demand segment of the new PPI experimental aggregation system tracks price change for commodities sold for personal consumption, capital investment, government purchase, and export. The segment is composed of six main price indexes: final demand goods, final demand construction, final demand traditional services, final demand transportation services, final demand trade services, and overall final demand.

The final-demand segment of the system can be presented in terms of exhibit A, which is a simplified version of the actual input–output (I–O) "Use of Commodities by Industries" table constructed by the Bureau of Economic Analysis (BEA). The actual 2002 BEA I–O table includes a total of 423 commodities and indicates the segments of the economy in which the consumption of these 423 commodities occurs. Consumption of commodities can be by any of the 427 industries included in the table or within any of 14 separate categories of final demand. Although the BEA table includes 14 categories of final demand, all of these categories can be classified under one of four primary components of final demand: personal consumption, capital investment, government purchase, or net exports. Commodities and industries are both classified according to North American Industry Classification System code within the BEA I–O table.

The simplified version of the I–O table that appears as exhibit A contains only 12 commodities that can be consumed by any of 12 industries or within any of four segments of final demand. The leftmost column of exhibit A indicates the type of commodity being used. The commodity types are unprocessed goods, processed goods, construction, traditional services, transportation services, and trade services. Unprocessed goods are defined as goods that have not been altered or transformed from their original state. Fresh fruit is an example of an unprocessed good. Processed goods are goods that have undergone some fabrication. Examples of processed goods are motor vehicles and canned vegetables. Construction is the erection of buildings or the creation of other engineering products, such as highways and utility systems. Traditional services are defined as all services other than trade and transportation services, such as publishing, banking, accommodation, and health care. Transportation services involve providing transportation for passengers and cargo, warehousing and storage of goods, and scenic and sightseeing transportation. Trade services include retailing and wholesaling goods, generally without transformation. The column headed "detailed commodity" designates the specific commodity being used. Domestic commodities are numbered 1 through 12, and "imports" is the entry in the bottom cell of the column. (However, imports are currently considered out of scope for the PPI. Imports are therefore not included in any of the aggregation structures presented in this article.) In exhibit A, commodities are valued in terms of producer prices; hence, goods and traditional services are valued in terms of the actual commodity sold, but transportation services and trade services are valued in terms of margins, not the value of the commodity transported or sold. The sum of the producer's value, transportation costs, and trade margin is equal to the purchaser's value.

Spanning the headers "intermediate demand" and "final demand" is the header "consumed for." Commodities can be consumed for either intermediate demand or final demand. Consumption for intermediate demand occurs when a commodity is consumed by an industry as an input to production, whereas consumption for final demand occurs when a commodity is consumed as part of personal consumption, capital investment, government purchase, or exports. Also spanned by "consumed for" are the column heads denoting the specific industries within intermediate demand and the segments of final demand in which the commodity is consumed. Consuming industries (under the heading "intermediate demand") are numbered 1 through 12; the primary commodity produced by each industry corresponds to the commodity with the same number. For example, the primary production of industry 1 is commodity 1. The columns under the "final demand" header denote the four ways in which commodities can be used for final demand: personal consumption (PC), capital investment (CI), government purchase (Gov), and export (Exp). Cell E, for example, indicates the consumption of commodity 1 by industry 5, whereas cell M shows the personal consumption of commodity 1. The total consumption of commodity 1 includes cells A through P. The total consumption by industry 5 is represented by cells E through AB.

Exhibit A. Final demand in the experimental PPI system

Commodity produced		Consumed for:															
Commodity type	Detailed commodity	Intermediate demand (ID)												Final demand (FD)			
		1	2	3	4	5	6	7	8	9	10	11	12	PC	CI	Gov	Exp
Unprocessed goods	1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	2					Q											
	3					R											
Processed goods	4					S											
	5					T											
	6					U											
Construction	7					V											
Traditional services	8					W											
	9					X											
Transportation services	10					Y											
Trade services	11					Z											
	12					AA											
	Imports					AB											

NOTE: PC = personal consumption, CI = capital investment, Gov = government purchase, and Exp = export.

FD goods | FD construction | FD traditional services | FD transportation services | FD trade services

Final demand goods price index. The final demand goods price index measures price change for all processed and unprocessed goods consumed as part of personal consumption expenditures, capital investment, exports, or government purchases. Fresh fruits sold to consumers and computers sold as exports are examples of transactions included in the final demand goods price index. The index covers the same transactions as the current finished goods index in the SOP system but adds government purchases and exports of goods. In exhibit A, the coverage of the final demand goods index is represented by the dark-gray area.

Final demand construction price index. This index tracks prices for construction sold for personal consumption, capital investment, export, or government purchase. The orange area of the exhibit represents the transactions covered by the final demand construction price index. The majority of construction is consumed in the final-demand portion of the economy and would be included in the final demand construction index, given that BEA defines new construction as capital investment.

Final demand services price indexes. The new aggregation system includes final demand price indexes for three types of services—traditional services, transportation services, and trade services. These indexes track price changes for such services sold for personal consumption, capital investment, export, or government purchase.

The coverage of the index for final demand for traditional services is shown in purple in exhibit A. Medical care and accounting services purchased by consumers are examples of final demand traditional services. The index for final demand transportation services accounts for the blue area of the exhibit. Rail transportation for individuals and shipment of final-demand goods are examples of final-demand transportation services. The index for final demand trade services tracks prices of transactions represented by the dark-green portion of the exhibit. The service of selling groceries to consumers is an example of a final-demand trade service. It is important to note, however, that the type of prices used by the PPI program to construct its trade indexes is different from the type of prices typically included in PPIs. As explained earlier, the value of trade services is measured in terms of trade margins, which are calculated by subtracting the price paid by a trade establishment to acquire a specific good or set of goods from the price received by the establishment for selling the same good or set of goods. Thus, the indexes for trade should be interpreted as measuring changes in the price margins received by producers of trade services.

Overall final demand index. In addition to the detailed final demand indexes for goods, services, and construction described in this article, the experimental system also includes an index for overall final demand. That index comprises all goods, services, and construction sold for personal consumption, for capital investment, for export, or to government. The overall final demand index tracks price change for transactions shown in all the shaded areas of exhibit A.[3]

Intermediate demand

The intermediate-demand portion of the PPI experimental aggregation system tracks price change for goods, services, and construction products sold to businesses as inputs to production (excluding capital investment). In order to meet the needs of different data users, the experimental aggregation system includes two separate treatments of intermediate demand, each designed to address a different analytical use. The first approach organizes intermediate-demand commodities by commodity type just as the current PPI SOP system does but with more types of commodities included. The resulting intermediate demand indexes provide value to data users by supplying specific information pertaining to the type(s) of commodities creating inflationary pressure in the economy. The second approach organizes intermediate-demand commodities into stages by production flow with the explicit goal of developing a forward-flow model of production and price change. A forward-flow model assigns commodities to stages in such manner that the commodities included in each sequential stage are the inputs used to produce commodities in the next stage, with the last stage in the system composed of final-demand goods. The goal of the indexes of intermediate demand by production flow is to allow data users to better study price transmission through the various stages of the economy.

Intermediate demand by commodity type. The intermediate-demand-by-commodity-type organization of intermediate demand is similar in its underlying methods to the treatment of final demand in the experimental aggregation system. The relevant indexes track price change for intermediate-demand commodities grouped by type of commodity, where commodity types include unprocessed goods, processed goods, construction, traditional services, transportation services, and trade services. The indexes of intermediate demand by commodity type are presented in terms of the I–O table shown as exhibit B.

Exhibit B. **Intermediate demand by commodity type in the experimental PPI system**

Commodity produced		Consumed for:															
Commodity type	Detailed commodity	Intermediate demand (ID)												Final demand (FD)			
		1	2	3	4	5	6	7	8	9	10	11	12	PC	CI	Gov	Exp
Unprocessed goods	1																
	2																
	3																
Processed goods	4																
	5																
	6																
Construction	7																
Traditional services	8																
	9																
Transportation services	10																
Trade services	11																
	12																
	Imports																

NOTE: PC = personal consumption, CI = capital investment, Gov = government purchase, and Exp = export.

Unprocessed goods for ID; Processed goods for ID; ID construction; ID traditional services; ID transportation services; ID trade services

The intermediate demand by commodity type portion of the system includes two main goods price indexes: unprocessed goods for intermediate demand, and processed goods for intermediate demand. These indexes track price changes for the areas of the economy represented by the light-gray and medium-gray areas, respectively, of exhibit B. The unprocessed goods for intermediate demand index measures price change for unprocessed goods purchased by businesses as inputs to production, and the processed goods for intermediate demand index tracks price change for fully or partially processed goods purchased by firms as inputs to production. These two indexes are identical, respectively, to the crude and intermediate goods indexes in the current PPI SOP system.

The intermediate-demand-by-commodity portion of the system includes a price index for intermediate-demand construction; the index measures price change for construction purchased by firms as inputs to production. The light-orange area of the exhibit represents the transactions covered by the intermediate demand construction price index. Since BEA defines new construction as a part of the final-demand portion of the economy, this index tracks price change for maintenance and repair construction purchased by firms.

The experimental system includes intermediate demand price indexes for three types of services: traditional services, transportation services, and trade services. The intermediate traditional services index measures price change in traditional services purchased by firms as inputs to production. Legal and accounting services purchased by businesses are examples of intermediate-demand traditional services. This index measures price change for the transactions shown in the light-purple area of exhibit B. The intermediate demand transportation services index measures price change in transportation-related services sold to businesses. This index tracks prices for transactions depicted by the light-blue area of exhibit B. Trucking of intermediate-demand goods and business travel are examples of intermediate transportation services. The index for intermediate trade services measures price change in the service of retailing or wholesaling goods purchased by businesses as inputs to production. The index for intermediate-demand trade tracks prices from transactions depicted by the green portion of exhibit B. The service of selling car parts to an automobile manufacturer is an example of an intermediate trade service.

Although the experimental system contains an overall final demand index, it does not include an overall intermediate demand index. An overall intermediate demand index would have severe multiple counting problems and therefore would not accurately measure price change for intermediate demand.

Intermediate demand by production flow. The intermediate-demand-by-production-flow treatment of intermediate demand organizes commodities into a number of stages and measures price changes for the commodities in each stage. As stated earlier, the goal of the production-flow-based treatment is to assign commodities to sequential stages such that commodities in one intermediate stage are used as inputs to produce commodities in the next intermediate stage until the last intermediate-demand stage, which contains commodities used as inputs to the production of final-demand commodities.

The intermediate-demand stages were developed by using both BEA commodity-consumption and industry-production data. Although the PPI does not cover all industries in the economy, all the data included in the BEA tables were used to develop the stages. A four-step process was used by the PPI program to assign commodities to stages and develop the intermediate-demand-by-production-flow system.

The first step in the process of developing stages was to determine the total production of each industry in the economy. In general, industries are classified as primary producers of specific goods or services; however, industries may also be secondary producers of other goods or services. A

firm classified in the automobile industry, for example, produces primarily automobiles, but the same firm may also produce and sell additional commodities, such as car parts, scrap metal, or car rentals. These additional commodities are classified as secondary production. The first step therefore requires determining both the primary production and secondary production of each industry in the economy. The 2002 BEA "Make of Commodities by Industries" table was used for this purpose.[4]

The second step in developing stages was to ascertain where the total output of each industry is consumed. This step requires determining, for each industry, the portion of the industry output consumed as final demand and the portion consumed as intermediate demand. For the intermediate-demand portion, determining which specific industries are consuming the industry's output also is required. BEA 2002 "Use of Commodities by Industry" data were employed to make this determination.

The third step in developing stages was to assign industries to stages of production. Within a stage-based system, transactions can be classified as forward flow, backflow, or internal flow. Forward flow occurs when an industry sells its output to an industry classified in a forward stage of production (to be used as an input) or to final demand. Internal flow occurs when an industry sells its output to another industry classified within the same stage of production to be used as an input. Backflow occurs when an industry sells its output to an industry classified in an earlier stage of production in the system to be used as an input. In order to successfully develop a forward-flowing system of price change, industries should be assigned to stages in a manner that minimizes backflow and internal flow while maximizing forward flow within the system.

A simple way to minimize backflow and maximize forward flow would be to attempt to assign industries to stages such that industries assigned to the final stage produce commodities consumed for final demand, industries assigned to the next-to-last stage produce commodities consumed by last-stage industries, and so on, until the first stage of production is reached. For example, car manufacturers would be assigned to the final stage of production, as they sell their output to final demand. Automobile parts manufacturers would be assigned to the next-to-last stage, since their output is consumed by car manufacturers. Steel mills would be assigned to the stage before that one, since their output is used to make car parts, and, finally, iron-ore manufacturers would be assigned to the first stage, as their output is used to make steel products.

Unfortunately, the flow of transactions in the actual economy is considerably more complex than in the simple example just described. Even in the simple automobile example, it is easy to imagine how backflow or internal flow might occur. If, for example, the steel mill industry purchased car parts (to service automobiles that are used as part of the steel production process), backflow would result.

Because of the complexity of the U.S. economy, the PPI program chose the criterion of maximizing net forward flow within the system to assign industries to stages. Net forward flow is defined as (forward shipments of the industry stage + inputs received from previous stages of process) – (backward shipments of the industry stage + inputs received from forward stages of process).

The PPI program implemented a two-step procedure to attempt to maximize net forward flow. In the first step, a set of rules was used to assign industries to stages and select the appropriate number of stages for the system. The system that the PPI program eventually chose is a four-stage system. The set of rules used to assign industries to the four stages is summarized as follows:

- Assign industry to stage 4 if shipments sold to final demand $\geq$ 75 percent of industry production.

- Assign industry to stage 3 if shipments sold to final demand and to stage 4 $\geq$ 65 percent of industry production and shipments sold to final demand < 75 percent of production.

- Assign industry to stage 2 if shipments sold to final demand, to stage 4, and to stage 3 $\geq$ 65 percent of industry production; and shipments sold to final demand and to stage 4 < 65 percent of production; and shipments sold to final demand < 75 percent.

- Assign industry to stage 1 if it does not meet the conditions of stage 4, 3, or 2.

Before selecting the number of stages and set of rules just described, the PPI program examined many different sets of rules and numbers of stages. It eventually chose the aforementioned system because it performed very well in terms of maximizing net forward flow and minimizing internal flow.

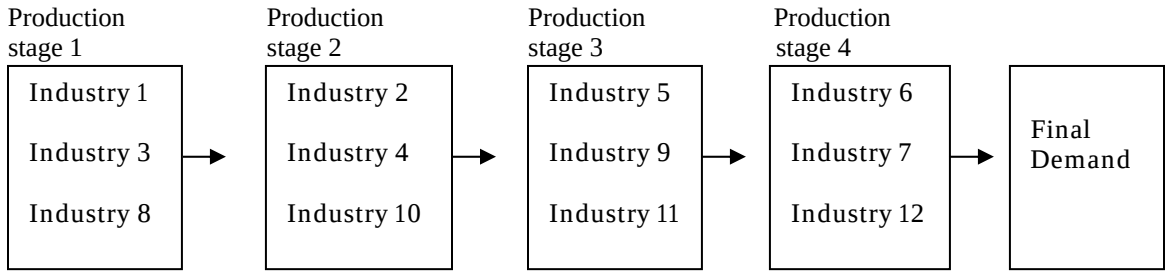
After the assignment of industries to stages by use of the aforementioned rules, the second step in the procedure to maximize net forward flow was to examine the effects on net forward flow of moving individual industries to stages to which they were not originally assigned. In cases in which there were substantial gains to net forward flow, industries were left in the new stage.

The PPI production-flow-based system exhibits strong forward flow and little backflow. After weighting, 83.6 percent of transactions in the system are forward flowing, 5.7 percent are back flowing, and 10.7 percent are internally flowing.[5]

The final step in constructing stages for the production-flow-based intermediate demand indexes was to determine the commodities to be included and weights to be used in the intermediate demand indexes. It is important to understand that these indexes track prices for inputs consumed by industries in each of the four stages of production, as opposed to prices for the output produced by industries in each of the four stages of production. These indexes also exclude prices for inputs both produced and consumed within an industry production stage, thereby eliminating any multiple counting of price change. The fourth intermediate demand index, for example, tracks price change for inputs consumed, but not produced, by industries included in the fourth stage of production. Recall that industries classified in the fourth stage

of production mostly produce goods sold to final demand. The stage 4 intermediate demand index therefore measures price change in the inputs to production of industries that produce primarily final-demand goods (stage 4 producers).

Exhibit B can be extended to clarify this procedure. Recall that in the exhibits the economy contains 12 commodities and 12 industries, and each industry produces primarily one commodity. Industry 1, for example, produces primarily commodity 1. Industry 1, however, may also produce any of the other 11 commodities as secondary production. According to the intermediate-demand-by-production-flow approach, each of the 12 industries would be assigned to one of the four stages of production. Hypothetically, the assignments may be as follows:



where the output of industries in production stage 4 is consumed primarily for final demand,
the output of industries in production stage 3 is consumed primarily by stage 4 industries as intermediate demand,
the output of industries in production stage 2 is consumed primarily by stage 3 industries as intermediate demand,
and the output of industries in production stage 1 is consumed primarily by stage 2 industries as intermediate demand.

Exhibit C presents the intermediate-demand-by-production-flow portion of the experimental aggregation system within an I–O framework. This I–O table is a modified version of the earlier tables that is virtually the same as the others except that it reorganizes the consuming industries into four stages. Cell "a," for example, represents the portion of commodity 1 consumed by industry 3, which is classified in the first stage of production. Cell "b" represents the portion of commodity 5 consumed by industry 4, which is classified in the second stage of production.

Exhibit C. Intermediate demand by production flow in the experimental PPI system

Commodity produced		Consumed for:															
		Intermediate demand (ID)												Final demand (FD)			
		Stage 1			Stage 2			Stage 3			Stage 4						
Commodity type	Detailed commodity	Ind. 1	Ind. 3	Ind. 8	Ind. 2	Ind. 4	Ind. 10	Ind. 5	Ind. 9	Ind. 11	Ind. 6	Ind. 7	Ind. 12	PC	CI	Gov	Exp
Unprocessed goods	1		a														
	2																
	3																
Processed goods	4																
	5					b											
	6																
Construction	7																
Traditional services	8																
	9																
Transportation services	10																
Trade services	11																
	12																
	Imports																

NOTE: PC = personal consumption, CI = capital investment, Gov = government purchase, and Exp = export.

Stage 1 ID Stage 2 ID Stage 3 ID Stage 4 ID

The intermediate demand by production flow portion of the system includes four main indexes: intermediate demand stage 1, intermediate demand stage 2, intermediate demand stage 3, and intermediate demand stage 4. These indexes track prices for inputs consumed by industries classified in each of the four stages of production, excluding inputs both produced and consumed within the same stage of production. The intermediate demand stage 1 index measures price change for transactions represented by the yellow boxes in exhibit C, the intermediate demand stage 2 index measures price change for transactions represented by the red area, the intermediate demand stage 3 index does the same for transactions indicated by the peach-colored area, and the intermediate demand stage 4 index does the same for transactions shown in the light-gray portion. As shown earlier, the intermediate demand indexes were constructed with the goal of being able to analyze forward price transmission through the stages of production and eventually to final demand.

With the release of data for January 2011, the PPI program introduced a new, experimental aggregation system. This system expands upon the current SOP system by including price indexes for services and construction as well as goods. The system covers both the final-demand and intermediate-demand portions of the economy. Indexes for the final-demand portion of the economy track price change for specific types of commodities sold for personal consumption, capital investment, government purchase, or export. Indexes in the intermediate-demand portion of the system track price change for commodities purchased by businesses as inputs to production. To meet differing needs of data users, the alternative aggregation system includes two separate treatments of intermediate demand. The first aggregates price indexes for intermediate-demand commodities on the basis of the type of commodity, where major commodity types include processed goods, unprocessed goods, traditional services, transportation services, and trade services. The second treatment aggregates intermediate-demand commodities into four stages with an emphasis on maximizing forward flow of commodities.

The PPI program is currently soliciting feedback from data users with respect to the experimental aggregation indexes presented in this article. To provide feedback, please contact Jonathan Weinhagen at weinhagen.jonathan@bls.gov.

Notes

[1] The PPI program continues to publish the all commodities index in spite of multiple counting problems because the index is referenced in many price escalation contracts. Despite this use of the all commodities index, the PPI program does not recommend using this index for contract escalation or data-analysis purposes.

[2] For a list of all areas that the PPI does not cover, see **www.bls.gov/ppi/ppinoncoverage.htm** (visited Feb. 14, 2011).

[3] In contrast to the PPI for overall final demand, which is composed of prices for commodities sold for personal consumption, capital investment, government purchase, and export, the BEA definition of gross domestic product (GDP) and of the GDP implicit price deflator comprise personal consumption, capital investment, government purchases, and net exports (exports minus imports).

[4] The BEA "Make of Commodities by Industries" table is located on the Web at **www.bea.gov/industry/io_benchmark.htm#2002data** (visited Jan. 25, 2011).

[5] For a detailed explanation of how the PPI program developed the intermediate demand by production flow indexes, see the paper "PPI Data Analysis of IO Data for Experimental Aggregation System" at **www.bls.gov/ppi/expaggbeadata.pdf** (visited Feb. 14, 2011).

Producer Price Index
U. S. Bureau of Labor Statistics
February 2011