Quality Adjustment in the Producer Price Index

Overview
The Producer Price Index (PPI) is a constant quality fixed-input output price index. It measures monthly price change in the economy by following the prices of a representative sample of items each month. A detailed description of each item and the way it is sold is considered its price basis. To ensure the PPI measures only 'pure' price change based on market factors, it must exclude any change in price of the sampled items that is due to a change in the price basis such as physical changes to the item or changes in the way the item is sold. BLS employs quality adjustment procedures to adjust for changes in the price basis. In normal monthly production of the PPI, the staff of Industry Analysts reviews every item that has any change to its description or terms of transaction to determine if the price basis has changed and what action should be taken.

Describing the Price Basis
The PPI samples and collects its items by industry. Before a sample of items is collected, a BLS Industry Analyst studies the industry, including the range of production and the economics of the industry. Because it is important to identify changes in the price basis, collection materials are designed to ensure the PPI captures every price determining variable associated with an item. During initial collection, item information is collected on a checklist describing the physical characteristics of a product or an exact description of the service provided and any terms of transaction, such as the type of buyer, the quantity sold, and any contract terms.

Monitoring the Price Basis
Each month subsequent to initial collection, respondents provide prices for their items. They are also asked to confirm all of the details of the product specification and terms of transaction. If any of these have changed, an Industry Analyst contacts the respondent to discuss the change and gather additional information. The Industry Analyst reviews this information to determine if there has been a change to the price basis.

Changes to the Price Basis
While we try to price the exact same item during the life of a sample, some changes to the price basis are inevitable. Common examples of changes include:
- An item is discontinued and replaced with another; for example, a certain airline flight between two cities has been discontinued but the airline replaces it with a different route between other cities.
- A product is physically changed; for example, a piece of luggage has its vinyl trim replaced with leather.
- The terms of transaction are changed, with or without a change to the product; for example, a manufacturer had been reporting a price for sale of 100 desks as part of a long term contract but the contract expired and she now is reporting a price for the spot sale of a single desk.

It is important to note that not all changes to an item result in changes to the price basis. For example, a change to an item's name or model number with no corresponding change to the physical product would not be considered a change to the price basis.

If the Industry Analyst determines there has been a change to the Price Basis, the Analyst decides the best approach to ensure the PPI reflects only pure price change based on market factors.

Methods of Quality Adjusting

When a change to the price basis does occur, the Industry Analyst has a range of quality adjustment methods available to isolate any pure price change from price change due to the change in price basis. The most appropriate method depends on the type of change and the information available from the respondent. At the most basic level, PPI indexes are calculated using the following ratio:

$$\frac{\text{Net Price (N) / Base Price (N)}}{\text{Net Price (N - 1) / Base Price (N - 1)}}$$

An item's initial base price is the price that was in effect in the first month a price was collected. Note that if an item's product specifications and terms of transactions are unchanged from that first month, the base price for N and N-1 are the same. All of the quality adjustment methods modify the current month's base price so the net price and base price used for each month represent the same price basis even if there is a change between months.

The standard methods of quality adjustment available are:

Explicit quality adjustment

In most cases, *explicit quality adjustment* is the preferred method of quality adjustment. It is used when there is a known change to an item and the respondent can provide the production cost differences (marked up to selling price) of the change. By modifying the current month base price to account for the production cost differences, the current and previous month ratios can be compared and only price change that is market–related and not due to the change in the item will be reflected in the index.

For example, assume a respondent had been reporting a price for a table made from pine wood. The table top was changed to use oak wood and the price was raised from $175 to $200. Also assume that the base price for the pine topped table was $150 before the top was changed to oak wood. The respondent noted the change to the table raised production costs $20 dollars. Consequently, the entire price change was not pure price change. The PPI will adjust the base price and not show the proportion of the change due to product change (change in inputs) as a price increase.

The formula for an explicit quality adjustment is:

New Base Price = (Old Base Price (N-1) * New Price (N))/(New Price (N) – VQA))

New Base Price = ($150*($200/($200-$20)) = $166.67

Where:

Old Base Price (N-1) = Previous month's base price for the item before the change, ($150)

New Price (N) = Current month's net price for the item after the change, ($200)

VQA = The value of the quality adjustment, the production cost change due to the change in the item, ($20)

In this example, if the Base Price were not adjusted, this item would have shown a 14% price increase, but with the adjustment the item shows a 3% price increase.

Overlap

Unfortunately, it is not always possible to obtain the production cost differences associated with a change to an item. In some cases, the respondent is unable or unwilling to provide that information. If the item with the new price basis had previously been available, we can use the *overlap method*. This would be the case if an item was discontinued and replaced with a previously available item. Using this method, prices for the new price basis in the previous month are compared to prices for the old price basis in the previous month. Price change reported on the old price basis is tracked through the overlap month and price change reported on the new price basis is followed beginning in the overlap month.

For example assume a respondent discontinued the $3,200.00 hot tub we had been pricing. He agreed to price a different hot tub with more features that sold for $4,600.00. The new hot tub had been available for several months but he could not provide the production cost differences between the two hot tubs. In this case, we would use the overlap method and compare the price of the old hot tub with that of the new hot tub in the last month they were both available. Assume the Base price was $2,800.00 prior to the change in hot tubs.

The formula for the Overlap Method is:

New Base Price = ((Old Base Price (N-1) * New Price (N-1)) / Old Price (N-1))

New Base Price = (($2,800 * $4,600) / $3,200) = $4,025.00

Where:

Old Base price (N-1) = Previous month's base price for the item, ($2,800)

New Price (N-1) = Previous month's net price for the new item, ($4,600)

Old Price (N-1) = Previous month's net price for old item, ($3,200)

In this example, if the Base Price were not adjusted, this item would have shown a 44% price increase but with the adjustment the item shows no price increase.

Ratio method
The ratio method is a simple method to account for changes in the quantity of an item included in the price basis. The current month base price is modified by the ratio of the new size to the old size. It is best used when economies of scale are not present.

For example, assume a respondent changed the size of a jar of spaghetti sauce from 22 ounces to 20 ounces but did not change the price of $2.11. In this case, we would adjust the base price by the ratio of the new and old sizes. Assume the Base Price had been $1.89 prior to the change in jar size.

The formula for the Ratio Method is:

New Base Price = (Old Base Price (N-1) * New size (N) / Old size (N-1))
New Base Price = ($1.89 * 20 / 22) = $1.7182

Where:

Old Base price (N-1) = Previous month's base price for the item, ($1.89)
New Size (N) = Current month's size, ($20)
Old Size (N-1) = Previous month's size, ($22)

In this example, if the Base Price were not adjusted, this item would have shown no change in price, but with the adjustment the item shows a 10% price increase.

Link to the cell relative
When no other information is available, the Industry Analyst can perform a link to the cell relative. This would be done if no explicit quality adjustment information is available and the item was never available at the same time with both the old and new price basis. This method adjusts the base price so the item shows a price change in the month of the price basis change that is equal to the average price change for similar items (those in the homogeneous index 'cell') with good reported prices.

For example, a respondent discontinues the clock radio with a cassette player that she had priced for the PPI and shifts all of her production to IPod docking stations. She agrees to price an IPod docking station but there is no overlap period and she cannot provide the production cost differences. Assume the clock radio sold for $42.00 and had a Base Price of $39.00. The IPod docking station sells for $64.00.

The formula for a link to the cell relative is:

New Base Price (N) = ((Old Base Price (N-1) * New Price (N)) / Cell Relative Price (N))
New Base Price (N) = (($39.00 * $64.00) / $42.84) = $58.2633

Where:

Old Base Price (N-1) = Base price for the old item in N-1, ($39)
New Price (N) = Net price for the new item in N-1, ($64)
Cell Relative Price (N) = is a price calculated by adjusting the Old Price by the price movement of the item's cell. In this example assume the IPod docking station cell showed a 2% increase, ($42 * 1.02 = $42.84).

In this example, if the Base Price were not adjusted, this item would have shown a 52% price increase, but with the adjustment the item shows a 2% price increase.

Special cases

Specialized techniques that use hedonic regressions and external data have been incorporated into the PPI. This section provides information on these special cases.

Hedonic regressions estimate the relationship between the characteristics of an item and its price. These regressions yield estimates of "implicit prices" for specified item characteristics which may be used to value the quality improvement resulting from changes to the item. The value of the quality improvement can then be removed from the reported price change to obtain a measure of the pure price change. Hedonic regressions work well in industries with rapid technological change where quality changes are not directly related to production costs such as computers. Since hedonic regressions require complex modeling, they are not attempted on a case by case basis but are established as a procedure for certain product areas. For detailed information on the PPI program's use of hedonic modeling, please refer to the following article, Hedonic Models in the Producer Price Index.

Additionally, for several service industries that lack sufficient quality adjustment data at the company level, data can be obtained from an external source to determine the VQA for explicit quality adjustment. These industries include the following:
- Private passenger auto insurance
- General medical and surgical hospitals
- Nursing care facilities

Private passenger auto insurance[1]

For insurance, the output measured is the assumption of risk and financial intermediation. The challenge in pricing this output over time is identifying and adjusting for changes in risk. For changes in explicitly endogenous risk factors such as changes in coverage, insurance companies have suitable cost data to allow for meaningful cost-based quality adjustment. However, for changes in exogenous risk factors that go beyond the scope of policy negotiations, such as an increased incidence of theft, company-specific data would not be sufficient to definitively quantify risk.

For pricing private passenger auto insurance, the age of the insured auto must remain constant to assure that its value remains at a constant real level for the duration of the pricing period. Risk changes occur even though the age of the insured auto remains the same. To keep the age constant, the model year of the auto is updated once a year to the next model year. For example, a 1996 Honda Accord is changed to a 1997 model in the subsequent year. However, changing the model year can also move the auto into a different risk category known as a symbol group. Insurance companies are unable to assess this risk change on their own, but a valuation can be obtained from the Insurance Services Office (ISO). This organization pools risk information industry-wide, producing data which are broader in scope than any one company could gather on its own. The ISO assigns autos to symbol groups based on their risk characteristics. For the PPI program's purposes, the ISO provides the value of risk change for every auto included in the index. The ISO monitors the symbol group that is assigned to an auto and the particular risk associated with that symbol group. When an auto moves into a different symbol group, ISO assigns a value to the risk change that occurs. This value is then used to explicitly quality adjust the premium used in the PPI. Therefore, the risk changes are not reflected in the index as pure price changes.

General medical and surgical hospitals[2]

The PPI for General medical and surgical hospitals measures the monthly change in prices received by hospitals for the provision of medical care to patients. The provision of care is delivered through various inputs including, but not limited to, many types of surgery, pharmaceutical treatments (aspirin, antibiotics, etc.), assessments of bodily functions, and rehabilitation and counseling from professional health care staff.

A concern in pricing hospitals is the change in treatments over time. Improvements in medical technology, new procedures, or new drugs can impact treatments in terms of the length of hospital stay, the types or amount of drugs administered, or treatment outcome. It is difficult to determine when such a change is a change in quality or a pure price change. A price change associated with a change in treatment that results in the same outcome would be treated as a pure price change. However, if a new treatment is developed with substantial differences in outcome, a quality adjustment may be warranted. An example is replacing a surgical treatment with a drug treatment that produces a different outcome.

The Department of Health and Human Services' Hospital Compare (HC) database captures changes in inputs that either indicate or serve as proxies for changes in health quality measures. From September 2008 to September 2017, the PPI program used these measures to estimate an explicit value of quality adjustment for items priced in the General medical and surgical hospitals index. For more information on PPI hospital quality adjustment during this period, refer to Proposal for Adjusting the General Hospital Producer Price Index for Quality Change.

The Hospital Compare database no longer captures the specific input measures used for PPI quality adjustment. Therefore, PPI now uses traditional quality adjustment methods as necessary.

Nursing care facilities[3]

The primary output of nursing care facilities is the care and services provided to residents, largely through inputs represented by the nursing staff. Any changes in staff intensity per resident per day may indicate a change in output quality. To measure this change in quality, PPI staff adjusts items based on one of the quality indicators published by the Department of Health and Human Services for that industry. The quality indicator measures changes in nurse staffing levels for each nursing home. A positive correlation between nurse staffing levels and the quality of services provided by nursing homes was demonstrated before any steps were taken to quality adjust the nursing care facilities index . While nurse staffing is only one of many complex factors that impact the quality of nursing care facilities services, analyses by the Institute of Medicine (IOM), the Centers for Medicare and Medicaid Services (CMS), and the General Accounting Office (GAO) point to nurse staffing as a key factor in determining the quality of nursing care facilities care. A dollar value is assigned to changes in nurse staffing levels using mean wages calculated by the BLS Occupational Employment Statistics program.

More Information

For detailed information on PPI methodology in general, including quality adjustment and index calculation formulas, please see the Chapter 14 of the BLS Handbook of Methods that covers Producer Prices.

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[1] Bathgate, Deanna, "United States Producer Price Indexes for Non-Life Insurance" (Paper presented at the 26th Voorburg Group Meeting on Services Statistics, September 19 – 23, 2011), http://www.voorburggroup.org/Documents/2011%20Newport/Papers/2011%20-%2036.pdf

[2] Hospital Quality Valuation Team. U.S. Bureau of Labor Statistics, "Proposal for Adjusting the General Hospital Producer Price Index for Quality Change," (Paper presented at the National Bureau of Economic Research Summer Institute Conference on Research in Income and Wealth, July 14, 2008), http://conference.nber.org/confer/2008/si2008/PRCR/murphy2.pdf

[3] Agliata, Michael and John Lucier. "Appendix: The Effect of the New Quality Adjustment Methodology for Nursing Home Price Indexes." (Paper presented at the 19th Voorburg Group Meeting on Services Statistics, September 15, 2004), http://stds.statcan.ca/english/voorburg/documents/2004%20ottawa/papers/2004-051.pdf