Technical Notes

New methodology reduces importance of used cars in the revised CPI

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The Consumer Price Index measures the average change in the prices paid by urban consumers for a fixed market basket of goods and services. The used car index, a subcomponent of the CPI, measures the average price change of used cars. The methodology used by the Bureau of Labor Statistics to produce the index has been improved since the introduction of used cars into the Consumer Price Index in December 1952. This study summarizes the methodology used to produce the index since the revision of the CPI in January 1987 and identifies the improvements made at that time.

The procedures utilized in the production of the used car index differ from those used in most other indexes which compose the Consumer Price Index in four significant areas: (1) derivation of expenditure weights, (2) the sampling frame, (3) the price data source, and (4) the need for a depreciated price. These differences occur because eligible vehicles enter the consumer market as used vehicles and depreciate in value over time.

Expenditure weight for used cars

The weight assigned to used cars in the CPI reflects their significance in total consumer expenditures. Before January 1987, the CPI used car weight was based on data from the 1972–73 Consumer Expenditure Survey, which indicated a relative importance for used cars of 2.507 percent.

The 1987 revision of the CPI is based on the expenditure patterns from the 1982–84 Consumer Expenditure Survey. In this revision, a new methodology is used for computing the weight for used cars. The weight is computed from reported purchases of used cars less trade-ins on used cars, trade-ins on new cars, and all other sales of consumer-owned cars. This procedure treats all consumers as a single group for expenditure determinations. Consequently, the purchase of a used car by a consumer from another consumer, even if a dealer acts as an intermediary, is considered a transfer of wealth within the

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consumer group and does not affect the weight for the used cars index in the CPI. The procedure used in the past " . . . utilizing gross purchases less trade-ins assigned too high a weight to used cars . . . ".[1] In the current procedure, only the portion of a used car purchase attributed to dealer's profit margin is counted as an expenditure by consumers. This new methodology results in a relative importance for used cars of 1.249 percent as of December 1986.

In the new method, the used car weight is a residual which represents (1) consumer purchases of used cars sold by business and government entities, (2) dealer profit and related costs on used cars that had originally been owned by consumers, and (3) consumer purchases of cars that enter the U.S. market from abroad as used cars. The BLS conducted research to determine the relative magnitude of these components and found that about four-fifths of the weight is from used cars originally bought by business and government entities but later sold to consumers. Gross dealer profits on sales of used cars originally owned by consumers account for most of the remaining weight, while sales of used cars from abroad account for the balance. The used car sample is taken on cars previously owned by business and government entities because these cars represent most of the weight in the index. To account for the portion of the weight not covered in the sample, it is assumed that dealer profit margins do not change drastically and that the price movements of used cars from abroad are similar to those from business and government sales.[2]

The used car sample

Prior to January 1987, the used car sample consisted of 21 cars. Each car was priced for models 2 through 6 years old, for a total of 105 vehicles tracked. The sample was selected using production totals for the 1970–74 model years and 1976 used car prices for those cars.

Currently, the sample consists of approximately 350 cars and is more reflective of the new definition of expenditures on used cars. From the universe of fleet cars (cars bought by business and government entities) in 1983 and 1985, a sample is selected using probability proportionate to size of the following characteristics: size class, body style, front or rear wheel drive, number of cylinders, make, and several options for which data are available on business and government purchases. All cars in the used car sample are domestic vehicles. Imports are eligible for

selection but are rarely chosen in the sampling process because they have an insignificant share of the fleet market. All cars are assigned the options of power steering, automatic transmission, power brakes, and air conditioning because almost all fleet cars are sold with these options. Data on sales of the various new car models and on the percentage of each model equipped with the options for which fleet data are not available are also used to select models and options. This treatment of options differs from previous methodology by allowing a probability selection of options.

In addition, the age of cars is determined by a probability selection from the ages at which fleet cars are replaced. One-year-old cars are not used because no data are available to adjust them for depreciation, while cars older than 6 years are not priced because continuous pricing data are not available. Approximately 90 percent of fleet cars are sold within the above age limitations. Two- and 3-year-old cars dominate the sample.

Used car price data

For most CPI items, price data are obtained directly from outlets where a Bureau of Labor Statistics field representative can usually find the same item available for purchase that was available during the previous pricing period. This methodology is not practical for used cars, however, because each car purchased has been driven a varying number of miles, has a differing group of options, is in extremely variable condition, and has a negotiated price. In addition, repeatedly obtaining prices for comparable cars at a given outlet is not likely to be possible.

These problems have been overcome through the development of a unique pricing procedure for used cars. The prices used are national average auction prices. There are approximately 170 wholesale used car auctions held in the United States, most of which are held once a week. The prices paid at the auctions serve as the data source for the prices reported in the *Official Used Car Trade-In Guide*, published by the National Automobile Dealers Association. This guide provides an average price each month for cars in "clean" condition and is the data source used for the CPI.

Each car priced represents a specific model, from 2 to 6 years old, with a selected group of options. To maintain the tracking of a car of a specific age, the model year priced is updated every year; that is, each car priced is replaced by a car that is 1 year newer.

The depreciated price. Because the value of a car declines with age, it is necessary to adjust for the estimated amount of depreciation that occurs each month to maintain a vehicle of constant quality. This is done using the prices of the tracked car and that of a comparable car 1 year newer. The price difference between the cars represents, in large part, the depreciation that occurs over a year. The value of the depreciation that occurs every month is estimated by taking the 12th root of the depreciation relative (the price of the newer car divided by the price of older car).

In addition, the depreciation relative is adjusted to remove the differences in quality between the two model years of the cars. This is done by using the estimate of the percentage difference in quality between the two model year cars that is used in producing the new car index of the CPI.[3] A simplifying assumption is that the relative value of the quality differences remains constant as the cars grow older. When no comparable car of newer vintage is available, a depreciation relative is calculated using the prices of other similar vehicles that are available for the given vintages. However, using the quality adjustments from the new car index is advantageous because it increases the methodological consistency between the new car and used car indexes. The quality adjustment procedures are necessary because each new model year is generally considered to be slightly better than the preceding model year. Without the adjustments, small successive errors of approximation occur whose effects are cumulative.

Procedurally, the calculation of the depreciation relative of a given car begins with the national average auction price of the car in the current period, the national average auction price of the car of 1 year newer vintage in the current period, and the estimate of percent quality change between the newer and older vintage cars from the new car index. The depreciation relative is then calculated as follows:

$$DR_t^{m,v} = \frac{P_t^{m,v+1}}{P_t^{m,v}\left(1 + \frac{Y_{m,v+1}}{100}\right)}$$

where:

$DR_t^{m,v}$ is defined as the depreciation relative for make and model m of vintage v (model year) in month t;

$P_t^{m,v+1}$ is defined as the price in period t for make and model m of vintage $v+1$ (the newer car);

$P_t^{m,v}$ is defined as the price in period t for make and model m of vintage v (the tracked car); and

$Y_{m,v+1}$ is defined as the percentage quality change between vintage v and vintage $v+1$ for make and model m.

Prior to the 1987 revision, a 3-month average of the depreciation relatives was used to smooth the index. To evaluate this procedure, a simulation of the monthly indexes was conducted with and without the averaging of the depreciation relatives. It was found that the index without the averaging was the smoother of the two series, and thus averaging was discontinued.

Next, to obtain the monthly depreciation factor, BLS takes the 12th root of the monthly depreciation relative and raises it to the Nth power as follows:

$$DF_t^{m,v} = (DR_t^{m,v})^{N/12}$$

where:

DF$_t^{m,v}$ equals the depreciation factor in time *t* for model *m* of vintage *v*, and *N* is the number of months since the first month the model was introduced.

Before 1987, an arithmetic calculation was used instead of a geometric calculation when producing the depreciation factors. However, a geometric estimate is theoretically more correct because cars depreciate in value at a constant rate. The geometric estimate was therefore included as part of the revision of the index.

Finally, to compute the depreciated price for the month, the Bureau multiplies the average auction price for the car by the depreciation factor as follows:

$$DP_t^{m,v} = (P_t^{m,v})(DF_t^{m,v})$$

where:

DP$_t^{m,v}$ is the depreciated price in month *t* for model *m* of vintage *v*.

To produce the prices used in the index, BLS uses a 3-month moving average of the depreciated prices. This average is used to smooth the index and to adjust for the lag caused by the use of auction prices, which do not immediately reach the consumer market.

Quality adjustments

With the CPI revision, the prices of used cars are adjusted beginning each September for quality differences between model years. This adjustment for quality between the newer vintage cars and the older vintage cars that are being replaced is the same percentage adjustment that was used during the original new car model changeover. Because the index uses a 3-month moving average depreciated price, the adjustment is made over the 3 months that the model year shift occurs. Whenever there is a percentage difference in quality between cars of adjacent vintages, one-third of this adjustment is made in each month of the 3-month period by entering a quality adjustment for each specific quoted car.

Conclusion

The used car index has been improved in four areas: definition of expenditure weight, sampling, methodology of index computation, and introduction of explicit quality adjustments. The relative importance of used cars in the CPI now more accurately reflects their importance in consumer expenditures. In addition, the sample is larger and the cars and options priced are selected using probability proportionate to size sampling techniques. Furthermore, the index computation now uses a theoretically correct geometric formula for computing depreciated prices and explicit adjustments are made for the quality differences between cars of different vintages. As a result of these

enhancements, the used car index, since the revision, is a better measure of price changes in the eligible portion of the consumer market. ☐

——FOOTNOTES——

[1] *Price Statistics of the Federal Government*, General Series 73 (New York, National Bureau of Economic Research, Price Statistics Review Committee, 1961), p. 47.

[2] Dealers' profit margins were estimated using the NADA *Official Used Car Guide* and the *Official Used Car Trade-In Guide* (McLean, VA, National Automobile Dealers Association), along with other industry sources.

[3] To learn more about new car quality adjustments, see BLS *Handbook of Methods*, Bulletin 2285 (Bureau of Labor Statistics, April 1988), pp. 168-69.

BLS to produce monthly indexes of export and import prices

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Twenty years ago the Bureau of Labor Statistics, which is responsible for the Consumer Price Index (CPI) and the Producer Price Index (PPI), began a third price program, designed to track prices of goods in U.S. international trade. The International Price Program (IPP), produces the U.S. Export Price Index and the U.S. Import Price Index. These indexes are intended to reflect price trends of foreign-produced goods entering the United States or domestic products leaving this country or its territories.

The program completed coverage of merchandise trade in the early 1980's with price indexes for all product categories. The indexes are constructed using 23,000 items, approximately 9,000 for the export index and 14,000 for the import series. Originally, data for the indexes were only collected and published annually. However, beginning in 1974, collection was switched to a quarterly basis. (Products are priced in the third month of each quarter: March, June, September, and December.) The Bureau has also recently begun publishing price indexes for selected international services (such as international airline fares).

Uses of data

The export and import price indexes have a variety of uses in economic analysis. Their original purpose centered on their use as deflators for the foreign trade sector of the national accounts. In general, deflating the gross national product values for inflation provides a more useful measure of economic growth because nearly all analyses of the

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