How the CPI measures price change of *Owners' equivalent rent of primary residence (OER)* and *Rent of primary residence (Rent)*

Shelter, the service that housing units provide their occupants, is a major part of the CPI *market basket*—the goods and services that people need for day-to-day living. Two CPI indexes, *Owners' equivalent rent of primary residence (OER)* and *Rent of primary residence (Rent)*, measure the change in the shelter cost consumers receive from their primary residences.

Housing units are not in the CPI market basket. Like most other economic series, the CPI views housing units as capital (or investment) goods and not as consumption items. Spending to purchase and improve houses and other housing units is investment and not consumption. *Shelter*, the service the housing units provide, is the relevant consumption item for the CPI. The cost of shelter for renter-occupied housing is rent. For an owner-occupied unit, the cost of shelter is the implicit rent that owner occupants would have to pay if they were renting their homes.

Weights for *OER* and *Rent*

The expenditure weight in the CPI market basket for *Owners' equivalent rent of primary residence (OER)* is based on the following question that the Consumer Expenditure Survey asks of consumers who <u>own</u> their primary residence:

> "If someone were to rent your home today, how much do you think it would rent for monthly, unfurnished and without utilities?"

The following questions, asked of consumers who <u>rent</u> their primary residence, are the basis of the weight for *Rent*:

> "What is the rental charge to your [household] for this unit including any extra charges for garage and parking facilities? Do not include direct payments by local, state or federal agencies. What period of time does this cover?"

From the responses to these questions, the CPI estimates the total shelter cost to all consumers living in each index area of the urban United States. (The weights of CPI item categories are consumers' spending on them during the weighting period, 2005-06 as of January 2008.) The *OER* and *Rent* indexes have the largest weights of

the 211 item categories (*item strata*) that comprise the CPI market basket. As of December 2008 their shares of the total weight (their *relative importances*) in the CPI for All Urban Consumers (CPI-U), were 24.433 percent and 5.957 percent, respectively.

The CPI Housing Survey

Because rents change rather infrequently, the CPI program collects rent data from each sampled unit every six months. (Price collection is monthly or bimonthly for most other CPI items.) Collecting rent data less frequently allows a much larger sample. The CPI divides each area's rent sample into six sub-samples called *panels*. The rents for panel 1 are collected in January and July; panel 2, in February and August, etc.

The sample design of the Housing Survey is fairly complex, but the underlying principle is that the units are selected in proportion to their share of total spending on rent. Total spending on rent includes the total spending on rent of primary residence plus the implicit spending on owners' equivalent rent. Using data from the 1990 Decennial Census of Population and Housing, the CPI defined small geographic areas, called *segments,* within each of the 87 CPI pricing areas. Segments are one or more Census blocks. The Census provided the numbers of renter and owner housing units in each segment and the average rent of the renter units in each segment; BLS estimated the average implicit rent of the owner units in the segment, enabling the CPI to calculate the total spending (rent plus implicit rent) for each segment. The CPI selected a sample of segments in each pricing area using stratified sampling in proportion to total shelter value. CPI agents visited the segments and selected a small number (usually 5) of renter-occupied housing units in each one to represent the segment. For segments that contain largely owner-occupied housing units, rental units from segments close to the selected segment to help represent the segment.

The Housing sample design generates a weight for each housing unit in the sample. The unit weights are denoted $U_{a,i}$, (not to be confused with the biennial weights for the item strata in the index areas). A unit's weight is its segment's share of the renter and owner spending divided equally among the segment's sample units, so a unit's weight is relative to all housing—owner and renter. Part of each unit weight represents renter housing and the rest represents owner housing. Owner-occupied units are not priced in the CPI Housing Survey. To make the unit weights specific to the renter universe a factor, denoted $\alpha_{i,a}$, which is equal to the renter share of total (owner and renter) in the unit's segment, is applied to the sampling weight of each unit. To make the weights specific to the owner universe, $(1-\alpha_{i,a})$, the complement

of the rent factor, is applied to $U_{a,i}$. Thus each unit's weight is allocated between renter housing and owner housing.

Price Change for *OER* and for *Rent*

Using the sample of rental units, the CPI calculates a measure of price change for each CPI index area for the *Rent* index and for the *OER* index. The first step is standardizing the collected (market) rents, putting them on a monthly basis, and adjusting them for a number of circumstances that should not affect the CPI. These include adjusting for any changes to the structure, such as changes in the number of rooms or bathrooms or in the type of heating and cooling equipment, or changes in the number of pets. These standardized rents are called normalized rents.

In addition the CPI adjusts the rent for the effect of aging of the rental units over time. The Housing sample collects the rents from the same housing units every six months. Consequently, each time the CPI observes the rent of a sample unit it is six months older. To account for this aging, an age-bias factor[1] is applied to the current rent; this raises the rent slightly because the older unit is slightly less desirable. For example, a unit with a rent of $900 might have the rent adjusted to $901.

The CPI assumes that sample units reported to be vacant are transitioning to new tenants. Experience with rent data has shown that units tend to experience rent change when the tenant changes. To avoid missing this rent change for vacant units, the CPI performs a *class-mean imputation* to estimate their rents. The estimated current rent of a vacant unit is its previous rent times the average rent change of newly-occupied units. For example, if the average rent increase for new tenants in an area was 5 percent, a currently-vacant unit that rented six months earlier for $1000 would have a current estimated rent of $1050.

To calculate the relatives of change for the *Owners' equivalent rent* index, the CPI calculates what it calls the *pure rent* from the normalized rent, removing the value of any utilities included in the rent. Owner-occupants pay for their own utilities and the CPI accounts for them outside of *Shelter*.

The CPI uses the following formula to calculate the monthly relative of price change for the *OER* index for area ***a*:**

1 Ptacek and Baskin, "Revision of the CPI Housing Sample and Estimators," Monthly Labor Review, December 1996, pp.38-39, available at: http://stats.bls.gov/opub/mlr/1996/12/art5full.pdf.

$$\Delta_{a,OER}^{t-1\to t} = \sqrt[6]{\frac{\sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\times pure\,rent_{i,a}^{t}\right] \Big/ \sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\right]}{\sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\times pure\ rent_{i,a}^{t-6}\right] \Big/ \sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\right]}}$$

$$= \sqrt[6]{\frac{\sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\times pure\ rent_{i,a}^{t}\right]}{\sum_i \left[\left(U_{i,a}\times(1-\alpha_{i.a})\right)\times pure\ rent_{i,a}^{t-6}\right]}}$$

The numerator and the denominator in the formula are weighted averages of the pure rents in period t and $t-6$. The weights are the sample weights $U_{i,a}$ adjusted by ($1-\alpha_{i,a}$), which is the complement of rent factor. Dividing the average pure rent for the current month (month t) by the average pure rent from six months earlier (month $t-6$) yields the six-month relative of price change. The sixth root of this relative is the one-month change in owners' equivalent rents for index area a.

For the *Rent* index the CPI computes what it calls the *economic rent* that further adjusts for any changes in what the rent covers between collections. For example, if the rent no longer includes electricity, an estimate of the value of the electricity is added to the current period's rent. If other services (such as a swimming pool or off-street parking) are included, the CPI records these and makes adjustments to the economic rent if they change.

The CPI uses the following formula to calculate the monthly relative of price change[2] for the *Rent* index for area a:

[2] A relative of change is a ratio of prices in one period to prices in a previous period. When on average prices do not change, the relative of change is equal to 1.0; it is greater than one when they rise on average and less than one when they fall. To convert a relative of change into a percent change, subtract 1 and then multiply by 100.

$$\Delta_{a,\mathrm{Re}nt}^{t-1\to t} = \sqrt[6]{\frac{\sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\times econ\,rent_{i,a}^{t}\right] \Big/ \sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\right]}{\sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\times econ\,rent_{i,a}^{t-6}\right] \Big/ \sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\right]}}$$

$$= \sqrt[6]{\frac{\sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\times econ\,rent_{i,a}^{t}\right]}{\sum_i \left[\left(U_{i,a}\times\alpha_{i.a}\right)\times econ\,rent_{i,a}^{t-6}\right]}}$$

The numerator and the denominator in the formula are weighted averages of the economic rents in period ***t*** and ***t-6***. The weights are the sample weights $U_{i,a}$ adjusted by the rent factor $\alpha_{i,a}$. Dividing the average economic rent for the current month (month ***t***) by the average economic rent from six months earlier (month ***t-6***) yields the six-month relative of price change. The sixth root of this relative is the one-month change in rents for index area ***a***.

Occasionally the CPI fails to collect data for a sample unit. When this occurs, the CPI omits non-response units from the price change calculation in the period that they were missing and distributes their weights among the collected units. After calculating the current month indexes, the CPI calculates an economic rent and a pure rent for them for use in the future. These imputed values are the previous (six month earlier) values multiplied by the relative of price change ($\left(\Delta_a^{t-1\to t}\right)^6$). This has the effect of assuming that the missing observations had the same movement as the non-missing ones during the period they were missing; the CPI will reflect any additional price movement for them when data collection for them resumes.

Elementary Indexes for *OER* and *Rent*

Construction of the elementary indexes from the monthly relatives of price change is a straight–forward chaining:

$$IX_{a,OER}^{t} = IX_{a,OER}^{t-1} \times \Delta_{a,OER}^{t-1\to t}$$

$$IX_{a,\mathrm{Re}nt}^{t} = IX_{a,\mathrm{Re}nt}^{t-1} \times \Delta_{a,\mathrm{Re}nt}^{t-1\to t}$$

The index for period ***t*** is computed by multiplying the index for period ***t*-1** by the relative of price change from ***t*-1** to ***t***.

Aggregate Indexes for *Rent* and *OER*

The final step is to combine the elementary indexes into indexes for aggregates, such as the U.S. *OER* index and U.S. *Rent* index, using the weights as described above. The CPI uses the same method for all its aggregate indexes, as described in the CPI chapter of the BLS Handbook of Methods[3].

In December 2008 the *OER* index was 254.875, indicating that Owners' equivalent rents had risen 154.9 percent since December 1982 and the *Rent* index was 247.278, indicating that rents had risen 147.3 percent since its 1982-84=100 reference base. The indexes are on different bases because the *OER* series was introduced into the CPI in January 1983 so it is on its original base. The *Rent* index has been part of the CPI since its beginning[4]; in 1988, the CPI reset the bases of all indexes that existed in January 1982 putting them on a 1982-84 basis.

Frequently Asked Questions on the *Rent* and *OER* Indexes

1. Why doesn't the CPI include the cost of buying and financing houses as well as property taxes and home maintenance and improvement?

Houses and other residential structures are not consumption items and, therefore, should not be CPI items. All buildings and structures are capital goods, which are items that provide a service. In the case of houses and other residential structures, that service is shelter.

Buildings and structures are also investment items, things that are bought and resold in organized markets with a potential for gain. House prices frequently appreciate; in this respect they differ from consumer durables such as vehicles.

[3] Available at https://www.bls.gov/opub/hom/pdf/homch17.pdf

[4] The BLS actually has data on rents back to 1913, preceding the first publication of the CPI in 1921. The rent index for 1913 is 21.0 on a 1982-84=100 basis, indicating that rents in 1982-84 were 376 percent higher than in 1913 and in December 2007 they were 1078 percent higher (more than 11 times higher) than in 1913.

Although there are well-organized markets for consumer durables, they typically depreciate.

Interest costs (such as mortgage interest), property taxes and real estate fees, along with most maintenance and all improvement costs, are part of the cost of the capital good and are not consumption items either. The CPI adjusts the expenditures for home maintenance downward before using it in the CPI weight.

2. Why does the CPI use Owners' equivalent rent for owner-occupied shelter?

The consumption item that residences provide is the shelter service that their occupants receive. For renter-occupied dwellings the cost of this service is the rent the occupants pay for its use for a period of time.

The most efficient way to measure the price of the shelter service owner occupants receive from their homes is to estimate the rent that the residence would command.

3. How did the Housing Survey select rental units?

CPI samples are selected in stages. The sample of 87 CPI pricing areas was selected first for use by all components of the CPI. The pricing areas are metropolitan areas and smaller urban places selected to represent 38 CPI areas of the urban United States.

The Housing Survey samples small areas called segments in the 87 pricing areas. The primary sample of segments is based on the 1990 Decennial Census and represents housing units constructed before 1990 in their pricing areas. The CPI began using the current primary housing sample in January 1999. Secondary housing samples add newly constructed units to represent housing units constructed since 1990.

Finally, within each selected segment, the survey chooses a small number of renter-occupied housing units. These represent both the owner and renter units in those segments and thus in their pricing area and ultimately in the urban United States.

4. How are the rental units in the sample related to the owner and renter units in the universe of housing units in the United States?

Each selected renter unit represents both renter-occupied and owner-occupied housing in its CPI area. Since the areas comprise the urban United States, the

sample of rental units represents all housing units in the urban United States. More specifically each selected unit represents a known amount of the total of explicit expenditure for rent plus implicit expenditure for owners' equivalent rent.

5. How big is the sample of rental units compared to the number of owner and renter units in the universe of housing units in the urban United States?

The CPI Housing survey has about 32,000 renter-occupied housing units. In the 1990 Census, which was the sampling frame for the primary CPI Housing survey, there were about 28.6 million renter-occupied units and 41.3 million owner-occupied housing units in the urban United States.

6. Does every rental unit in the sample represent both the owner and renter units in the universe of housing?

No, some units represent only renter units; for these units, $\alpha_{i,a} = 1$. Others only represent owners, so their $\alpha_{i,a} = 0$. For example, rental units under rent control do not represent any owner-occupied housing units. In some areas the sample yielded relatively few rental units suitable for measuring owners' equivalent rent; in these areas the sample has supplemental rental units that represent owners exclusively. In addition, sample rental units in largely owner-occupied neighborhoods mainly represent owner housing, so their $\alpha_{i,a}$ can be near 0.

7. How does the CPI collect data from the selected rental units?

CPI agents identify respondents for each sampled housing unit. The respondent could be its occupant (the renter), its owner (the landlord), a property manager or an authorized representative of the occupant.

The agents contact the respondents on a regular schedule to obtain their most recent rents and other information about the rental units. Note: The CPI contacts owner-occupied units only during the Consumer Expenditure Survey, in order to derive item-area expenditure weights. Owner-occupied units are not visited in the pricing survey of rents.

8. Why doesn't the CPI Housing Survey collect rents every month from each sampled housing unit?

Rents tend to change much less often than the prices of most consumption items, so collecting rents less frequently than other items is very efficient. The CPI can have a larger sample for rents by collecting them less frequently.

9. What does the CPI Housing Survey collect from each sampled housing unit?

When a unit is on cycle, CPI agents obtain the current rent, what additional services (for example, utilities) are included and information on any changes to the unit or the rental agreement.

10. Can changes in utilities and other services included in the reported rent affect the index for *Rent of primary residence*?

Yes. The *Rent of primary residence* index, following longstanding CPI practice for rents, is a measure of "contract rent," which includes utilities and most services a particular landlord provides with the rental unit. (The CPI removes unusual inclusions such as food or nursing care.) The CPI computes economic rent from the collected rent for each sample rental unit. Economic rent includes utilities if the landlord has provided them in both the current period and the previous period.

When there has been a change in what the landlord provides, the CPI adjusts the economic rent. If, for example, the landlord no longer provides electricity, an estimate of the cost of electricity is added to the current economic rent to make it comparable to what was previously provided.

11. Can changes in utilities and other services included in the reported rent affect the index for *Owners' equivalent rent*?

Yes. The *Owners' equivalent rent of primary residence* index, to be consistent with the concept in the weight for Owners' equivalent rent, i.e., rent without utilities or furniture, uses "pure rent." Pure rent is the sample unit's collected rent less the estimated value of landlord-provided utilities and services. If a landlord provided electricity in the earlier period but not in the current period, the pure rent in the earlier period is adjusted to remove the estimated cost of electricity and the pure rent of the current period is not adjusted. Consequently, the pure rent will rise unless the landlord adjusted the rent to compensate for no longer providing electricity.

12. How does the CPI adjust for landlord-provided utilities?

When collecting rents the survey also collects information on whether the landlord provides electricity, water service and sewer service, and on what type of fuel is used for heating and for hot water and who pays for these.

The estimated cost of all landlord-provided utilities is subtracted from the rent in the calculation of pure rents for the *Owners' equivalent rent* index.

For the Residential rent index, if a landlord stops providing a utility, the estimated cost of that utility is added to the current month's economic rent, making the current month consistent with the situation six months earlier. (While very rare, if a landlord were to start providing a utility, the cost would be subtracted from current month's rent.)

13. How does the CPI estimate the cost of utilities?

For each sample unit the CPI estimates the cost of five types of utilities and makes appropriate adjustments to both economic and pure rents. The types include three energy utilities, Electricity, Natural Gas, and Fuel Oil, plus Water service and Sewer service. For Water and Sewer service, the CPI has estimates of their average cost in each of the 87 CPI pricing areas, which it updates monthly using the movement of CPI index for *Water and sewerage maintenance*.

For the three energy utilities, the CPI estimates the quantity (in BTUs) of electricity, natural gas and fuel oil that each rental unit in the CPI Housing survey uses. The CPI then values these quantities using CPI average price data.

To estimate the quantities, a BLS statistician used data from the Department of Energy's Residential Energy Consumption Survey (RECS) to estimate formulas for each of the three energy types. The formulas predict a housing unit's energy consumption from the following characteristics and variables:

- The number of bedrooms and other rooms
- The fuel used for heating
- The fuel used for heating hot water
- The Heating/Cooling Degree Day Zone for the CPI pricing area
- The type of structure
- The decade when the structure was built
- The type of air conditioning
- The Census Region of the urban area

Inserting each housing unit's characteristics into the regression equation for a type of energy yields a predicted quantity of energy consumed. The CPI for January 2006 began using formulas derived from the 2001 RECS.

To value these estimated quantities, the CPI uses average prices. The CPI average price program produces average prices for the following series:

- 100 therms of natural gas
- 500 KWH of electricity
- 1 gallon of fuel oil #2

The Housing survey converts these to price per BTU to make them consistent with the predicted quantities. Each housing unit's cost for each of the three utilities is its estimated consumption amount times an estimate of its index area's average utility price. The Housing survey uses average prices from preceding months because those for current month are not available in time.

14. Why do the indexes for *Rent of primary residence* and *Owners' equivalent rent* often differ from each other?

Although the two indexes use the same basic data, rents on the same sample of rental units, the indexes can, and often do, move differently from each other.

The indexes use the sampled rental units to represent different universes -- sample units that represent many owner units represent few renter units and vice versa. The fact that rent-controlled housing units are not part of the owner index can make a significant difference in areas such as New York, San Francisco and Los Angeles.

In addition, the two indexes handle utilities included in the rent differently. The owner index removes them completely. The renter index adds or removes the estimated cost of utilities only in the relatively rare case when there is a change in their inclusion in a particular sample unit.