Measuring Inflation: What It Measures and How It Is Measured

Comparing Price Measures— The CPI and the PCE Price Index

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July 18, 2022

Overview of the Consumer Price Index (CPI) Program

- Goal of the CPI
- Scope / Coverage
- Classification Systems
- Weighting
- Sampling
- Data Collection
- Estimation
- Publication and CPI products
- Limitations of the CPI

Goal of the CPI

- The goal of the CPI is to approximate a cost of living index.

- Cost of living is a theoretical concept. The CPI seeks to measure the change in the cost of living by measuring the change in prices that consumers pay for a market basket of goods and services.

Scope / Coverage

- The CPI reflects prices paid by consumers in urban areas of the U.S. for a market basket of goods and services.
  - "Urban" in this context is broadly defined and encompasses over 90 percent of the population.
  - Any item purchased for consumption, goods or services, is eligible for pricing.

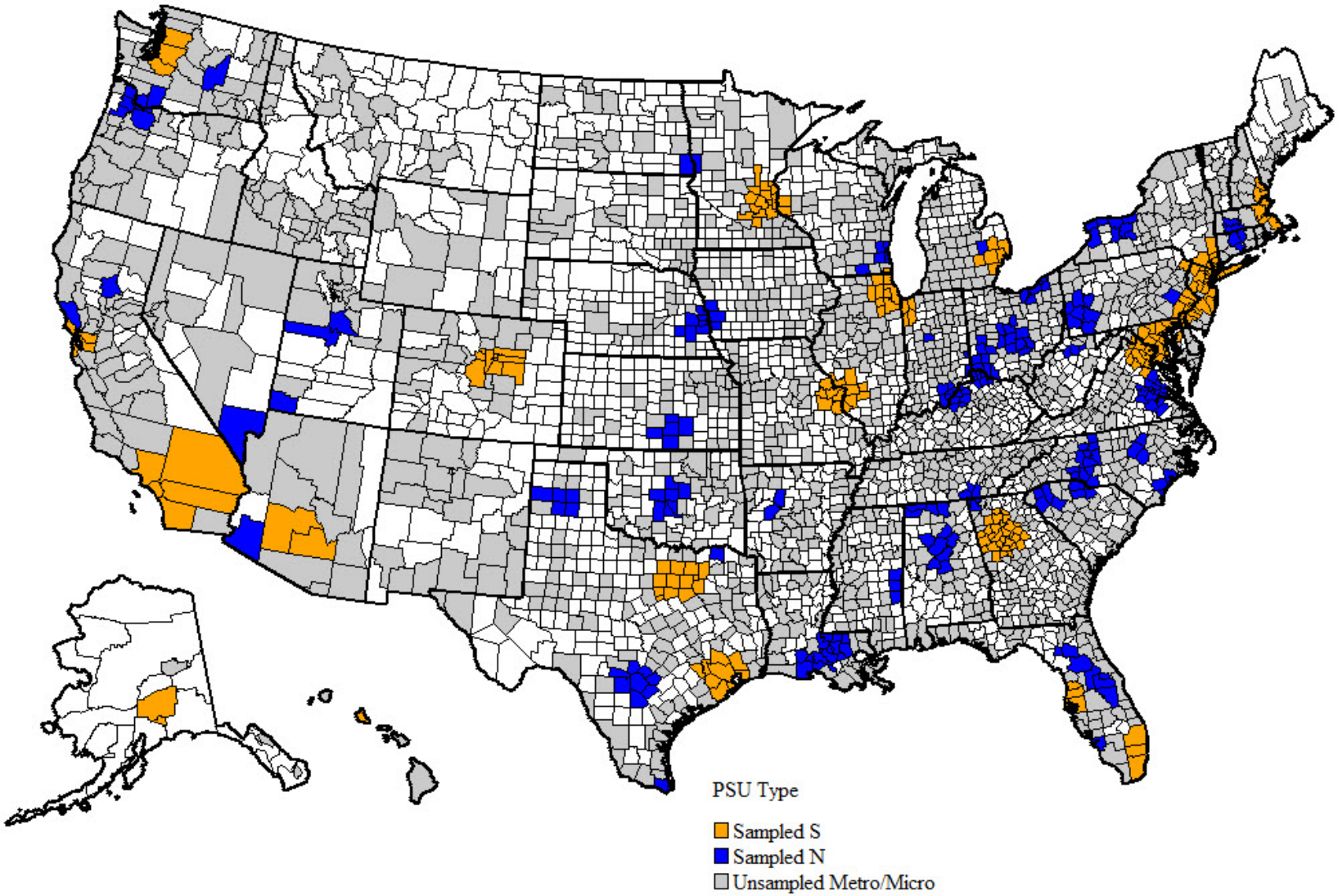
Data sources in the CPI

- The CPI is a product of a series of interrelated samples. The CPI requires:
  - A geographic sample, a set of areas where prices will be collected
  - A survey of consumers expenditures of to create and appropriately weight a market basket of goods and services to be priced
  - A survey of where consumers shop, to create a sample of outlets in which prices are collected.
  - Samples of prices. In the CPI there are separate price samples for commodities and services and for housing.

Sampling / Geography

- The CPI reflects prices paid by consumers in urban (broadly defined) areas of the U.S.
- Based on Census and OMB definitions, 75 geographic areas are selected to represent the urban population.
- These 75 areas are referred to as Primary Sampling Units (PSUs); these are grouped into 32 geographic areas

2018 Area Sample



Data collection / Outlets

- The geographic sample and market basket form a matrix of component cells from which to build a CPI.
- Item categories x Geography Units = Cells
  - 243 item categories x 32 geography units = 7776 cells
  - Basic indexes calculated for each cell

Creating a sample of items

- The Telephone Point-of-Purchase Survey of households (TPOPS) has been used to create the frame of outlets in each PSU; this survey is being phased out and going forward this will be done using the survey of consumer expenditures.
- BLS Field Representatives visit outlets and use Computer Assisted Data Collection (CADC) to select and price items using probability sampling.
- Items are described completely in terms of price determining characteristics using CPI Checklists.

Pricing the sample

- The exact items are chosen using statistical methods that give individual items a chance to be selected proportional to their sales for that particular product or service line at the selected outlet.
- CPI price data are collected throughout the entire month. The month is divided into three pricing periods, with field representatives required to collect data during each period.
- In most cities, prices on many items are collected bimonthly rather than monthly

Sample rotation

- Sample rotation allows the sample of specific items in the CPI to stay up-to-date.
  - This allows, for example, the specific cell phones or automobiles in the CPI sample to be representative of what consumers are buying
- The outlet/item sample are replaced every four years, 1/8th of the sample every 6 months

Getting the prices

- The price sought in the CPI is the retail, transaction price paid by the consumer, including sales and excise taxes.
- Each month a field staff of around 400 part-time economic assistants and 100 full-time economists collect prices for over 83,000 individual items per month (around a million prices per year) based on personal visits to more than 23,000 outlets in 75 cities.

Data Collection / Housing

- One of the most important measures in the CPI is tracking the rate of inflation in housing services through a survey that collects data from around 5,900 housing rental units per month, about 71,000 annually
- The rent sample serves two purposes:
  - First, it provides the data for measuring changes in shelter for consumers who rent (about one third of all consumers).
  - Second, the CPI rent sample provides the data for measuring changes in shelter costs for consumers who own their own homes (about two thirds of all consumers).

Rental equivalence

- This latter index is estimated based on the concept of rental equivalence or the market rent that would be charged for these owner occupied dwellings if they were rented.
- In the CPI, increases (or decreases) in the market value of a home are not viewed as the proper measure of housing inflation.
- Rather, we strive to measure the payments made by consumers in a given month to obtain the services of a home (aka shelter). We call this concept Owners' Equivalent Rent (OER).

Weighting

- Conceptually, the CPI seeks a market basket that is representative of what is actually purchased by consumers. We know bananas should be in the market basket, but how much weight should they have?
- The source of weighting for the CPI is the Consumer Expenditure Survey (CE).

The CE survey

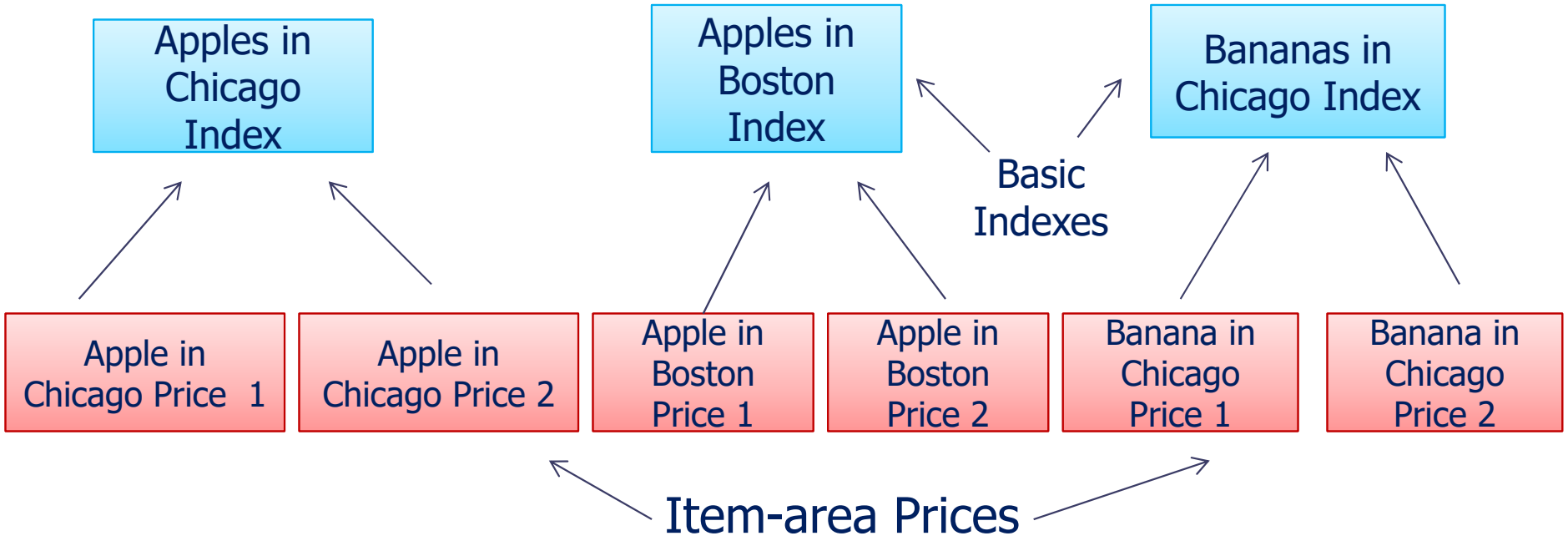
- The CE consists of two separate surveys –a quarterly interview and a diary:
  - The quarterly interview surveys (over 5 consecutive quarters) are used to ask consumers about their major purchases.
  - Additionally, a sample of consumers keep diaries of their purchases over two single two-week period.

Expenditure weights

- These surveys are used to create the expenditure weights that are used in constructing the CPI market basket.
- The expenditure weights have been updated every two years. Annual updates are planned going forward.
- The weights used in the CPI in 2022 are based on consumer expenditures in 2019-2020.

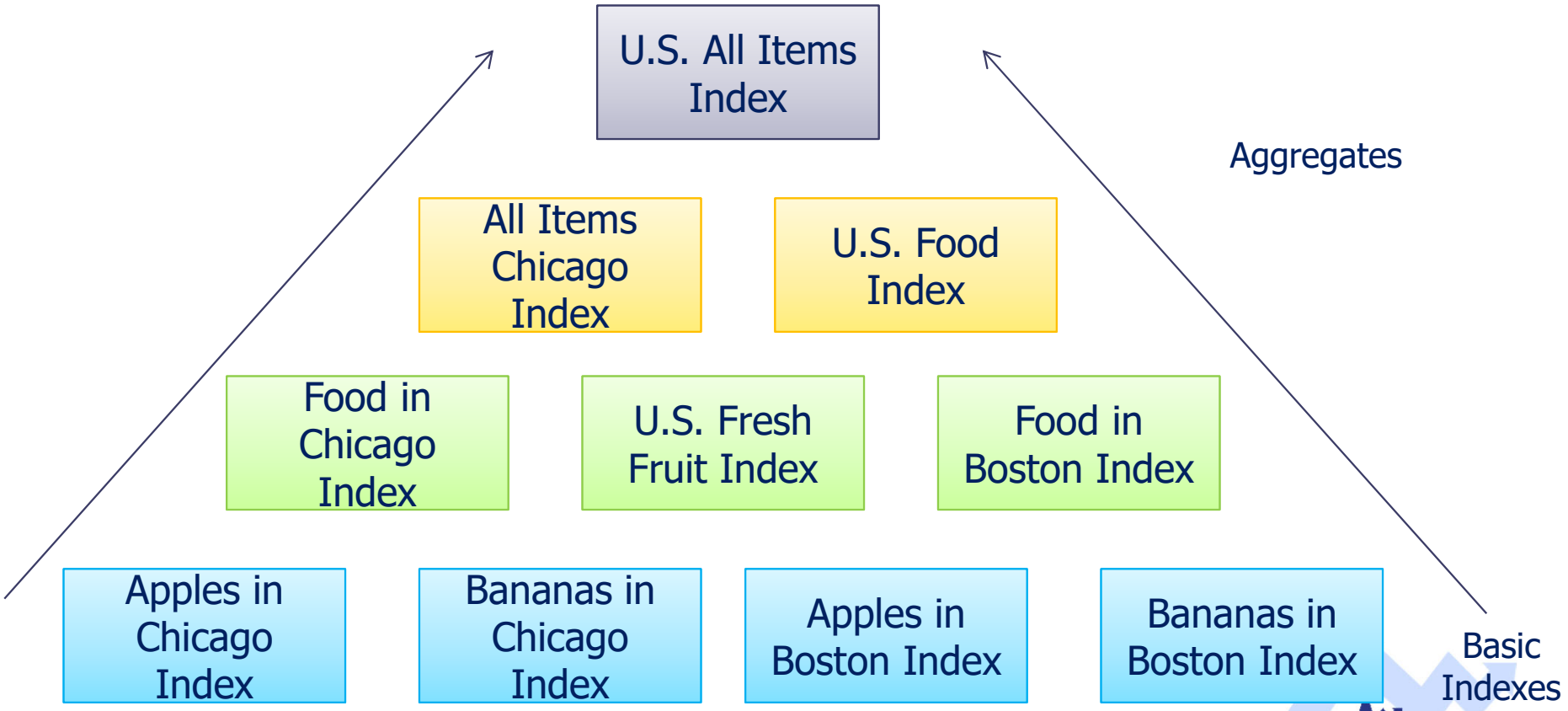
CPI Aggregation Example: Lower level

- The CPI is calculated in a two-stage process. At the first stage, the price changes within each item-area are averaged to form the item-area or "basic" indexes



CPI Aggregation Example: Upper level

- At the second stage, these basic item-area indexes can be averaged together to form aggregate indexes for different areas and item categories, including the overall U.S. City Average All Items Index



Classification systems: Major groups

- In the CPI, the consumer market basket is a categorization of goods and services with corresponding weights. In the U.S. there are 243 categories of items (goods and services) that are aggregated into eight major groups:
  - Food And Beverages
  - Housing
  - Apparel
  - Transportation
  - Medical Care
  - Recreation
  - Education and Communication
  - Other Goods and Services

Classification systems: Analytical

- Additionally, the CPI can be divided into food, energy, and all items less food and energy:
- All Items
  - Food
    - Food at home
    - Food away from home
  - Energy
    - Energy commodities
    - Energy Services
  - All items less food and energy

Estimation

- The geometric mean formula is used for basic indexes at the lower level for items where some substitution is realistic. It implicitly assumes a degree of substitution among the items used in calculating a price index.
- The Laspeyres formula is used at the lower level in categories where substitution would be difficult or unlikely, such as medical care services
- The Laspeyres formula is used at the upper level in the aggregation of basic indexes (except in the C-CPI-U); thus there is an assumption of no substitution between fruits and vegetables or gasoline and airline fares

Seasonal Adjustment

- Seasonal adjustment is used to eliminate price change that occurs at about the same time and of the same magnitude every year.
- Seasonal factors are created for many different CPI series and are revised annually for the prior five years of data.
- Only U.S. level data is seasonally adjusted
- Seasonally adjusted data are typically used for analysis of month-to-month price change. Because it is subject to revision, it is not typically used for official purposes

Treatment of missing price data

- Virtually all price index programs must deal with missing price data
  - If a price is temporarily or seasonally unavailable, the price is typically imputed and a price will be collected in a future period.
  - If the item is no longer sold or traded, each price program has procedures for:
    - How to replace the item in the sample
    - What price change to use between the old and new sample items

Item substitution in the CPI sample

- When the field makes a substitution, the CPI commodity analyst (CA) can:
  - (1) Deem the substitution "comparable"
  - (2) Estimate directly the quality change between the two versions ("quality adjustment")
  - (3) Deem the substitution non-comparable

Comparable substitution

- (1) Comparable substitution: If the CA determines there is little or no change between the two versions, she codes the substitution as “comparable.” This means the entire price change between the discontinued and new versions are shown in the index as price change
  - Implicitly, this also means the quality change between the two versions is zero

Direct quality adjustment

- (2) Direct quality adjustment: If the CA determines there is a change in quality between the discontinued and new versions—and the CA can estimate the value of that quality change—the CA will use a quality adjustment for that item
  - In direct quality adjustment, the value of the quality change must be quantified in some way

Methods of direct quality adjustment

- Methods of direct quality adjustment
  - If the difference in product is easily measurable, adjustment might be straightforward, such as when the new product is a different size or weight
    - For example, a 2.0 ounce candy bar might be replaced by a 1.8 ounce candy bar. If they were the same nominal price, the quote would be computed as about an 11 percent price increase
  - Regression models ("hedonics") or estimates of production costs may be used to estimate the value of a quality change
    - For example, a regression model might be used to estimate the dollar value of a larger television screen
  - In other cases, cost data might be used to estimate a value
    - For example, if the new car is $100 more expensive than the older model, but has a stronger bumper that cost the automaker an additional $10 to install, the CA may only show a $90 price increase

Imputation

- (3) Non-comparable substitution: If the CA determines the quality change between the two versions is significant—and cannot be reasonably quantified—the CA will code that substitution "non-comparable"
  - When a quote is coded non-comparable, the price change for that items is effectively imputed by similar items in the same geographic area

CPI Products: CPI-U and CPI-W

- CPI-U: Broadest, most commonly used and cited CPI.
  - All items U.S. city average and all items less food and energy get most attention, but breakdowns by geographic area and by category are also published
- CPI-W: Based on spending patterns of wage earners and clerical workers
  - About 28 percent of the population
  - Used to adjust Social Security payments and other federal payments

Chained CPI-U

- Chained Consumer Price Index for All Urban Consumers (C-CPI-U).
  - First produced in 2002, data back to January 2000 (December 1999=100).
  - The final C-CPI-U is designed to be a closer approximation to a cost-of-living index in that it reflects changes in consumer spending patterns across CPI item categories every month.
  - Differs from the CPI-U in both **weighting** and **formula**.
  - It is released monthly with the CPI-U and CPI-W, but is subject to multiple revisions before becoming final 10-12 months after the initial release

R-CPI-E

- R-CPI-E: The research CPI for the Elderly, R-CPI-E, representing Americans ages 62 and older, was developed in 1987 at the request of Congress. The series was reconstructed back to December 1982.
  - For the experimental CPI-E, we calculate weights for a subset of households where the reference person or their spouse is age 62 or older.
  - Important limitations to consider

R-CPI-U-RS

- R-CPI-U-RS: (Retroactive series) Historical research index that estimates what the CPI would have been had current methods always (back to 1978) been in place
  - R-CPI-U-RS shows slightly lower historical inflation than the CPI-U
  - All items and All items less food and energy available online; detailed indexes available upon request
- Average price data: The CPI publishes average price data for a limited set of food items, as well as gasoline, fuel oil, and electricity

Limitations of the CPI: Sampling error

- Sampling error: CPI is based on a series of samples, so the price change of the sample may not be the price change of the entire universe of prices
- Standard error for all items one month change in all items index is 0.04 percent.
- The standard error for many narrower CPI categories and geographic regions is much higher

Limitations of the CPI: Substitution bias

- Consumer substitution: Consumers change spending behavior over time in response to price change and other reasons
  - Use of geometric means formula assume unitary elasticity of substitution at lower level, probably little or no bias in first stage
  - CPI-U and CPI-W assume no upper level substitution and still have bias at second stage
  - Final C-CPI-U should be nearly free of substitution bias

Limitations of the CPI: Quality change and new goods

- Quality change bias
  - Goal of the CPI is constant quality price change
  - Many methods of quality adjustment are used but they are imperfect and subject to error
- New goods bias
  - New goods and new models entering the economy constantly
  - Biennial weight updates and more frequent sample rotation have improved the timeliness of the CPI market basket, but there is still some time lag

Limitations of the CPI: Other possible biases

- Other sources of bias
  - CPI subject to the biases of survey that feed into it, such as the CE
    - Example: Under reporting of tobacco purchases
  - Outlet bias: Consumers may substitute to new outlets that offer lower prices
  - CPI is based on inflation experience of urban consumers rather than entire population

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