Use of Consumer Expenditure Survey Data in the Consumer Price Index

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Agenda

- ■ CPI Overview
  - ▶ Estimation methods
  - ▶ Data sources

- ■ Current CPI requirements of CE
  - ▶ Expenditure weights for index estimation
  - ▶ Expenditure weights for item sample selection
  - ▶ Adjustments made to CE data to meet CPI needs

- ■ Possible future CPI information needs

CPI Overview

CPI = measure of average change over time in the prices paid by consumers

$$_i IX^C_{[0;t]} = \frac{\min \sum_i {}_i P_t \times {}_i Q_t \Big|_{U=U_0}}{\sum_i {}_i P_0 \times {}_i Q_0}$$

The minimum expenditure ($P_t Q_t$) on a set of consumption items (i) required in comparison period (t) to attain the same level of satisfaction or utility (U_0) achieved in base period (0), divided by the actual expenditure ($P_0 Q_0$) on those items (i) in base period (0)

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CPI Overview

$$_i IX_{[0;t]}^{C} = \frac{\min \sum_i {}_i P_t \times {}_i Q_t \Big|_{U=U_0}}{\sum_i {}_i P_0 \times {}_i Q_0}$$

CPI Overview - Formulas

Geometric Mean Index:

$$_i IX^{G}_{[t-1,t]} = e^{\left(\dfrac{\sum_i {}_i \left| PQ \right|_b \times \ln \left(\dfrac{P_t}{P_{t-1}} \right)_i}{\sum_i {}_i \left| PQ \right|_b} \right)}$$

$$_i IX^{C}_{[0;t]} = \dfrac{\min \sum_i {}_i P_t \times {}_i Q_t \Big|_{U=U_0}}{\sum_i {}_i P_0 \times {}_i Q_0}$$

Laspeyres Index:

$$_i IX^{L}_{[t-1,t]} = \dfrac{\sum_i {}_i \left(P_t Q_b \right)}{\sum_i {}_i \left(P_{t-1} Q_b \right)}$$

Tornqvist Index:

$$_i IX^{T}_{[t-1,t]} = e^{\left(\dfrac{\sum_i {}_i \dfrac{\left| PQ \right|_{t-1}}{2} \times \ln \left(\dfrac{P_t}{P_{t-1}} \right)_i}{\sum_i {}_i \left| PQ \right|_{t-1}} + \dfrac{\sum_i {}_i \dfrac{\left| PQ \right|_t}{2} \times \ln \left(\dfrac{P_t}{P_{t-1}} \right)_i}{\sum_i {}_i \left| PQ \right|_t} \right)}$$

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CPI Overview - Formulas

$$_i IX_{[0;t]}^{C} = \frac{\min \sum_i {}_i P_t \times {}_i Q_t \Big|_{U=U_0}}{\sum_i {}_i P_0 \times {}_i Q_0}$$

Geometric Mean Index:

$$_i IX_{[t-1,t]}^{G} = \prod_i \left(\frac{P_t}{P_{t-1}} \right)_i^{{}_i s_b}$$

Laspeyres Index:

$$_i IX_{[t-1,t]}^{L} = \frac{\sum_i \left(\frac{P_t}{P_b} \right) \times {}_i s_b}{\sum_i \left(\frac{P_{t-1}}{P_b} \right) \times {}_i s_b}$$
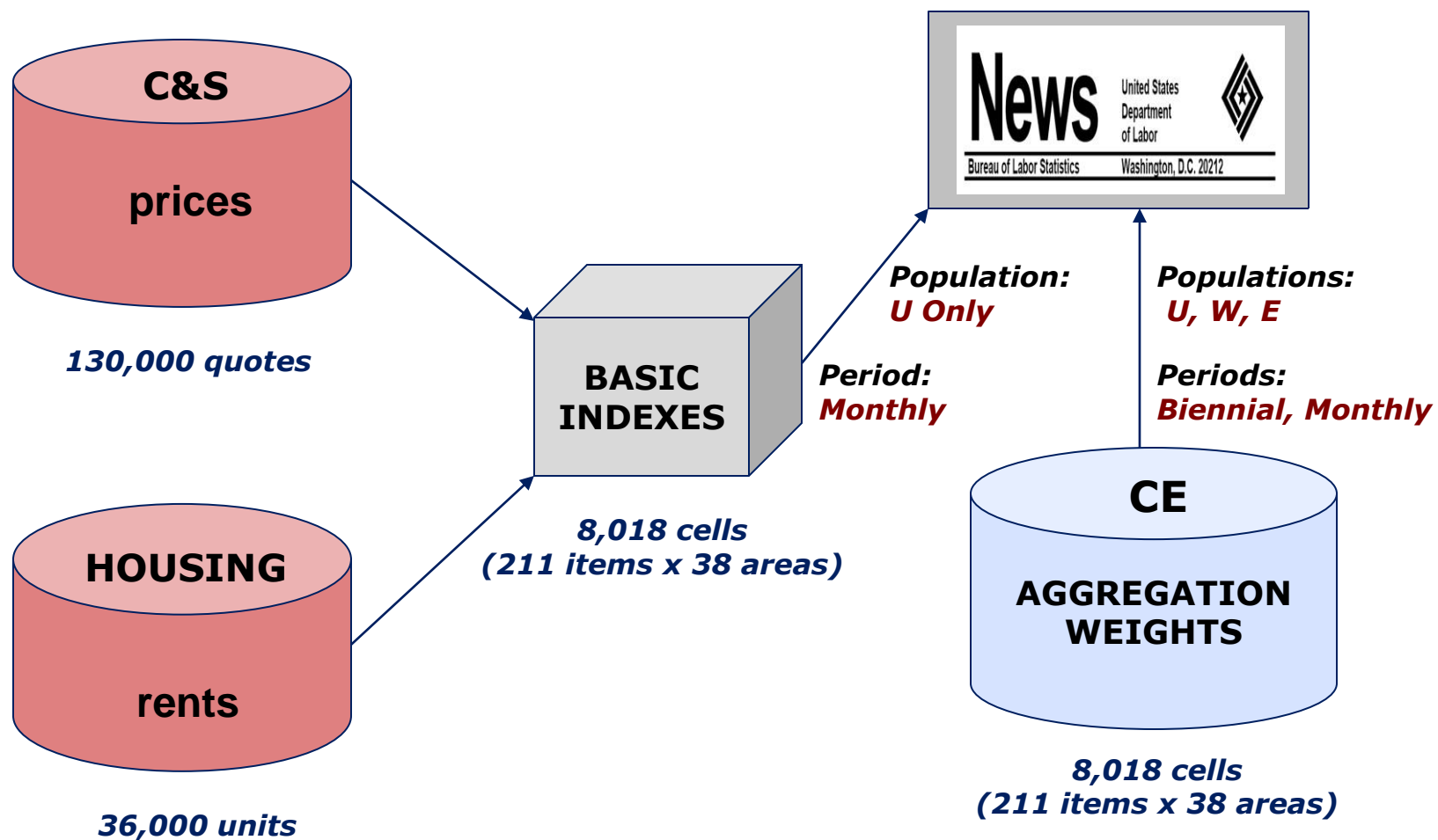
Tornqvist Index:

$$_i IX_{[t-1,t]}^{T} = \prod_i \left(\frac{P_t}{P_{t-1}} \right)_i^{\left(\frac{{}_i s_{t-1} + {}_i s_t}{2} \right)}$$

Weights

Prices

b= calendar period of expenditure weight; t = month

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CPI Overview - Surveys

1. Point-of-Purchase Survey (TPOPS)

   ▪ Outlet sampling frame for **C&S** Pricing Survey

   ▪ Primary source of **weights** at the basic level of index estimation

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2. Pricing Survey (C&S)

   ▪ Source of **prices** for goods and services

3. Housing Survey (HOUSING)

   ▪ Source of **prices** for rent and owner's equivalent rent

Household surveys administered by Census

4. Consumer Expenditure Surveys (CE)

   ▪ Exclusive source of **weights** at aggregate level of estimation

   ▪ Also used to select the categories of items to price in **C&S**

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CPI Overview – Estimation Steps

C&S

prices

130,000 quotes

HOUSING

rents

36,000 units

News United States Department of Labor

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BASIC INDEXES

8,018 cells
(211 items x 38 areas)

Population:
U Only

Period:
Monthly

Populations:
U, W, E

Periods:
Biennial, Monthly

CE

AGGREGATION WEIGHTS

8,018 cells
(211 items x 38 areas)

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CPI Data Requirements

- Demographics
  - ▶ Urban non-institutional population for the CPI-U
    - – 88% of total U.S. population

  - ▶ Consumer units living in urban areas for which a majority of income is earned in wage-earning or clerical occupations for the CPI-W
    - – 29% of total U.S. population

  - ▶ Consumer units where the reference person or spouse is 62 years of age or older for the CPI-E
    - – 16% of total U.S. population
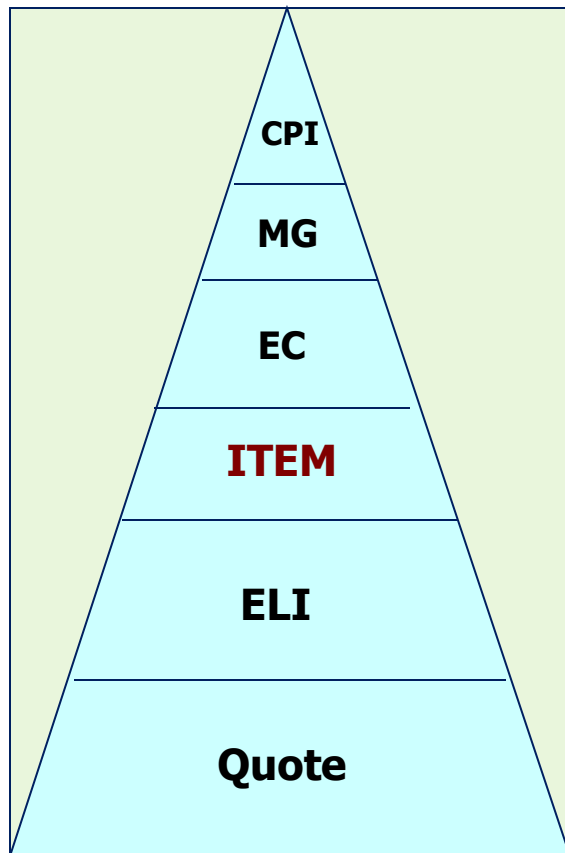
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CPI Data Requirements

- Expenditures
  - ▶ Net out-of-pocket expenses for all consumer **products and services within CPI's scope, at the** appropriate level of:
    - – Consumption detail
    - – Geography
    - – Periodicity
  - ▶ **Acquisition approach to 'expenditure' definition**
    - – **Exception: Owner's Equivalent Rent**
  - ▶ Timeliness
    - – September 1 deadline for all expenditure data for the previous calendar year (for calculation of January indexes of the following year, published in February)
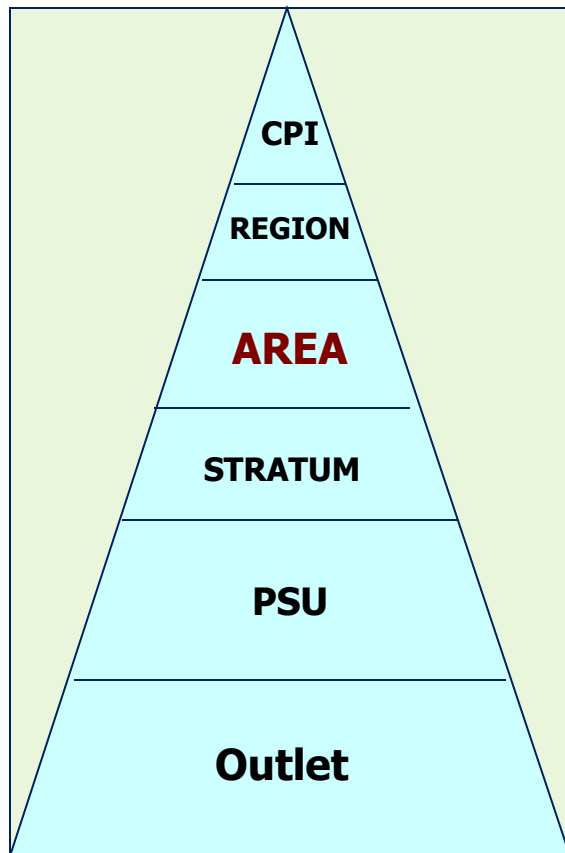
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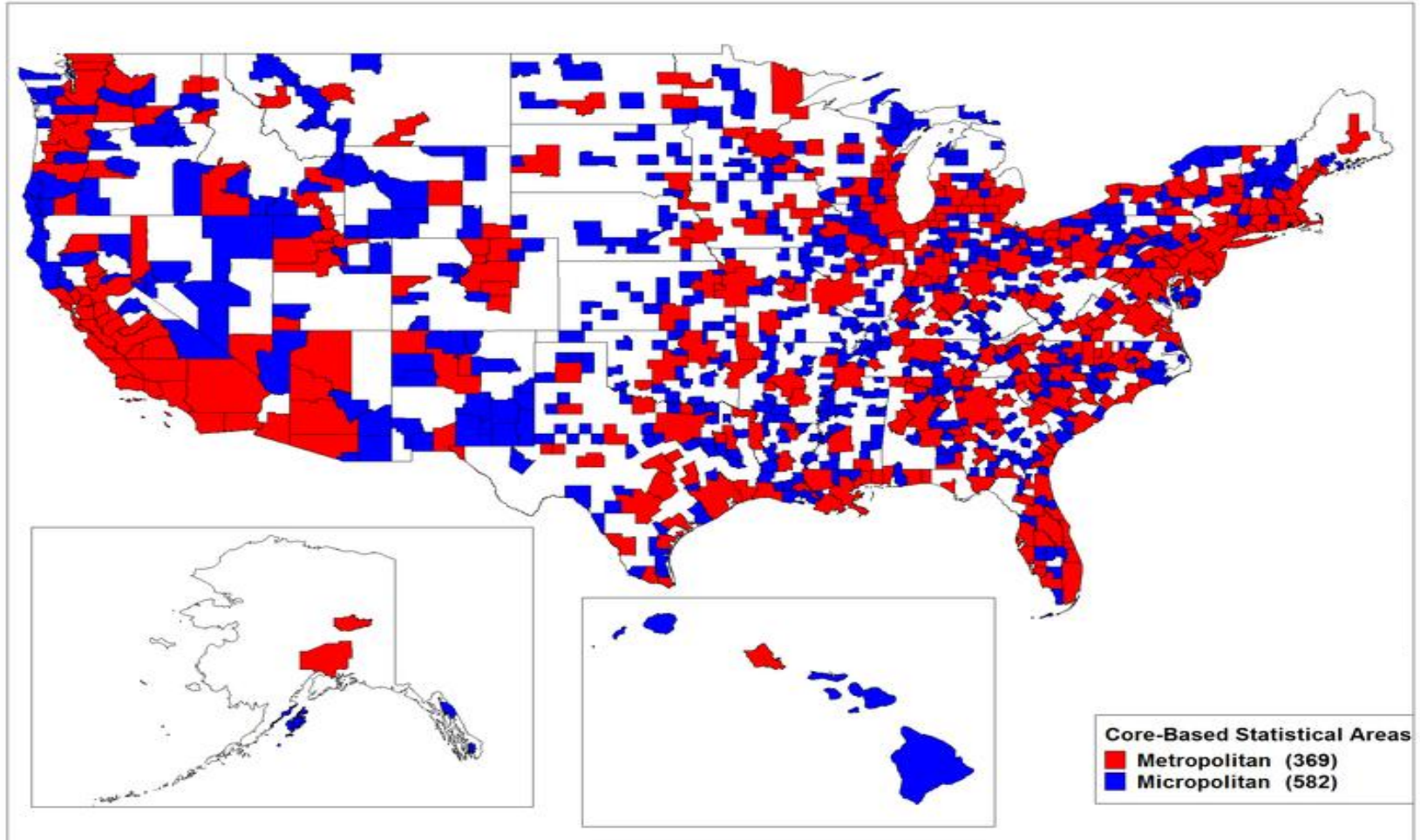# CPI Data Requirements: Consumption Item Detail

Set of all consumer expenses

LEVEL	n	CODE	DESCRIPTION
Universe	∞		All consumer expenses
Market Basket Items	∞		Eligible goods and services
All CPI Items	1	SA0	All-items
Major Group	8	SAH	Housing
Expenditure Class	70	SEHK	Appliances
Item Stratum	211	SEHK01	Major Appliances
Entry Level Item	303	SEHK011	Refrigerators and freezers
		SEHK012	Washers and Dryers
		SEHK013	Stoves and cooktops
		SEHK014	Microwave ovens
Sampled quote	130,000		LG front-loading, energy-star washer

Pyramid (top to bottom): CPI, MG, EC, **ITEM**, ELI, Quote

CPI Data Requirements: Geographic Detail

LEVEL	n	CODE	DESCRIPTION
Universe	3,143		All counties in the United States
Urban counties	1,863		Eligible counties w\ urban population
All CPI Areas	1	0000	U.S. City Average
Region	4	0300	South
Index Area	38	X300	South X-size cities
Stratum	87	B344	Norfolk, VA
and selected			Fayetteville, NC
Primary Sampling Unit			Greenville, NC
PSU	950	B344	Norfolk, VA
Sampled Outlet	40,000		General Store, Main St., Norfolk VA

CPI Data Requirements: Geography

Core-Based Statistical Areas
- Metropolitan (369)
- Micropolitan (582)

CPI Data Requirements: Periodicity

- Periodicity
  - ▶ CPI-U (Urban population)
    - – Base-period expenditures required for Laspeyres index (CPI-U)
      - • Ideal: previous-**month for 'true' Laspeyres**
      - • Current: annualized expenditures from 2-year lagged biennial period
    - – Monthly expenditures required for Tornqvist index (C-CPI-U)
      - • Ideal: publish 2-3 weeks after end of calendar month
      - • Current: publish 14-25 months after end of calendar month; annualized CPI-U expenditures used in Geometric Mean index for preliminary versions of C-CPI-U, until final monthly weights become available
  - ▶ CPI-W and CPI-E
    - – Same periodicity requirements as CPI-U

CPI Data Requirements:
Item Sample Selection

- Four-year sample life:
  - ▶ Each ITEM-**PSU 'cell' has a new sample selected once every** 4 years; once initiated into the Pricing Survey, each sampled quote is priced monthly or bimonthly for 4 years

- Multi-step sample selection process:
  - ▶ Select a sample of outlets to represent each PSU (TPOPS)
  - ▶ **Select ELI's to represent each ITEM STRATA**
    - – 70% of ITEMs are single-ELI
    - – 30% require ELI selection based upon expenditures (CE)
  - ▶ Combine selected ELIs with selected outlets
  - ▶ Select a unique, well-specified good or service (quote)

CPI Data Requirements:
Item Sample Selection - Example

- ITEM = Major Appliances (HK01)
- PSU = Washington, DC (A312)
- SAMPLE ROTATED = August 2011
- OUTLET HITS = 2
- ITEM HITS = 4
- TOTAL SAMPLE SIZE = 8

CE data from years 2007 and 2008 used to calculate selection probabilities

	ELI	TITLE	# Reports (A312)	# Reports (South Region)	Share of Total Expenditures	Selected ELIs
1	HK011	Refrigerators & Freezers	19	401	14.8%	1
2	HK012	Washers & Dryers	34	661	65.9%	2
3	HK013	Ranges & Cooktops	11	215	4.6%	0
4	HK014	Microwave Ovens	14	328	14.7%	1

CPI Data Requirements:
Item Sample Selection - Example

- ELI = Washers and Dryers (HK012)

- CLUSTERS
  - 01b Washers
  - 02b Dryers

- SPECS (for Washers)
  - Type
    - Top-loading or front-loading
  - Brand
  - Capacity in cubic-feet
  - Control interface
  - Screen type
  - Control types
  - Manufacturer warranty
  - Number of wash cycles
  - Special wash cycles
  - Max spin speed
  - Number of water levels
  - Automatic dispensers
  - Washtub material
  - Color
  - Country of origin

CPI Data Requirements: Adjustments

■ **Insufficient expenditures collected at required consumption item detail**

▶ Motor Fuels
  – CPI requires expenditures for 5 ELIs:
    • 3 Gasoline ELIs: Regular Unleaded, Mid-grade, Premium
    • 2 Alternative Fuel ELIs: Diesel, Other Motor Fuels
  – Sales data from C&S Survey used to allocate CE total into the 5 required ELIs

▶ Food at home items
  – Diary is exclusive source for 61 ITEM STRATA, but excludes trip expenses
  – Global food questions from Interview used to adjust Diary reports

▶ Medical Care
  – CPI requires net out-of-pocket expense, but outlays and reimbursements collected separately and unmatched in CE
  – Aggregate totals for calendar year used to estimate net expense for each CU

CPI Data Requirements: Adjustments

- **Insufficient Sample Size**
  - ▶ Base-period Expenditures for CPI-U, CPI-W, and CPI-E
    - Annual estimates required, for each elementary ITEM in each elementary AREA
    - Currently, a two-year period is used to produce annualized CPI-U, CPI-W, and CPI-E expenditure weights
    - Each ITEM-AREA expenditure estimate is also composite-estimated with the corresponding ITEM-REGION-SIZE expenditure estimate, to lower variance

  - ▶ Monthly Expenditures for C-CPI-U
    - Required for each elementary ITEM in each elementary AREA
    - For each ITEM, data are summed to the U.S. level each month, then allocated into the 38 areas using rolling 12-month period allocation factors

  - ▶ ELI Selection Probabilities for Item Sample Selection
    - Required at the ELI-PSU level, annually
    - Currently, annualized probabilities are derived at the ELI-REGION level, using two-years of CE data

CPI Data Requirements: Sample Size

CE sample size per year, 2007-2008

	INTERVIEW		DIARY	
	Interviews	Unique Consumer Units	Diaries	Unique Consumer Units
CPI-U	25,520	13,111	12,758	6,890
CPI-W	7,343	3,836	4,882	2,057
CPI-E	6,655	3,283	3,517	1,752

Per Elementary Area:

	INTERVIEW		DIARY	
	Interviews	Unique Consumer Units	Diaries	Unique Consumer Units
CPI-U	672	345	336	181
CPI-W	193	101	128	54
CPI-E	175	86	93	46

CPI Data Requirements: Sample Size

Number of CE expenditure records per elementary CPI cell, 2007-2008

	Item-Area-Biennial	Item-Area-Monthly
Minimum	0	0
10%	11	0
25%	34	1
Median 50%	99	5
75%	318	16
90%	1,221	60
Maximum	24,354	1,266
% of cells with 0 reports	1.5%	15%
% of cells < 30 reports	22%	83%

CPI Data Requirements: Summary

- **Weights for Index Estimation:**
  - ▶ Annual expenditure detail for matrix of elementary item-area cells:
    - 211 ITEMs x 38 AREAs = 8,018 cells
    - Urban (CPI-U), Wage-earner (CPI-W), and Elderly (CPI-E) populations
  - ▶ Monthly expenditure detail for same elementary matrix
    - Urban population only (C-CPI-U)

- **Weights for Item Sample Selection:**
  - ▶ Annual expenditure detail for matrix of 303 ELIs x 87 PSUs
    - Urban population only

Possible Future CPI Information Needs

- Use of CE to identify the frame or a portion of the frame of retail outlets for collection of prices in the C&S Pricing Survey

  ▶ Need to improve or replace the Telephone Point of Purchase Survey (TPOPS)

  ▶ Possible use of the Census of Retail Trade, Centers for Medicare and Medicaid Services data, and other administrative sources for a portion of TPOPS.

  ▶ Use of CE or some other survey to collect the balance of retail outlet information.

Possible Future CPI Information Needs

■ Use of CE to collect key price-determining characteristics (SPECS) of exactly what is purchased

- ▶ Process of collecting information on sales from store managers is difficult and burdensome

- ▶ CE data at the CLUSTER or SPEC level could absorb some of the burden now on the C&S respondent

- ▶ Would allow separate item sample selection for the CPI-W and CPI-E

- ▶ If performed in conjunction with collecting the point-of-purchase, could permit separate outlet sample selection for CPI-W and CPI-E

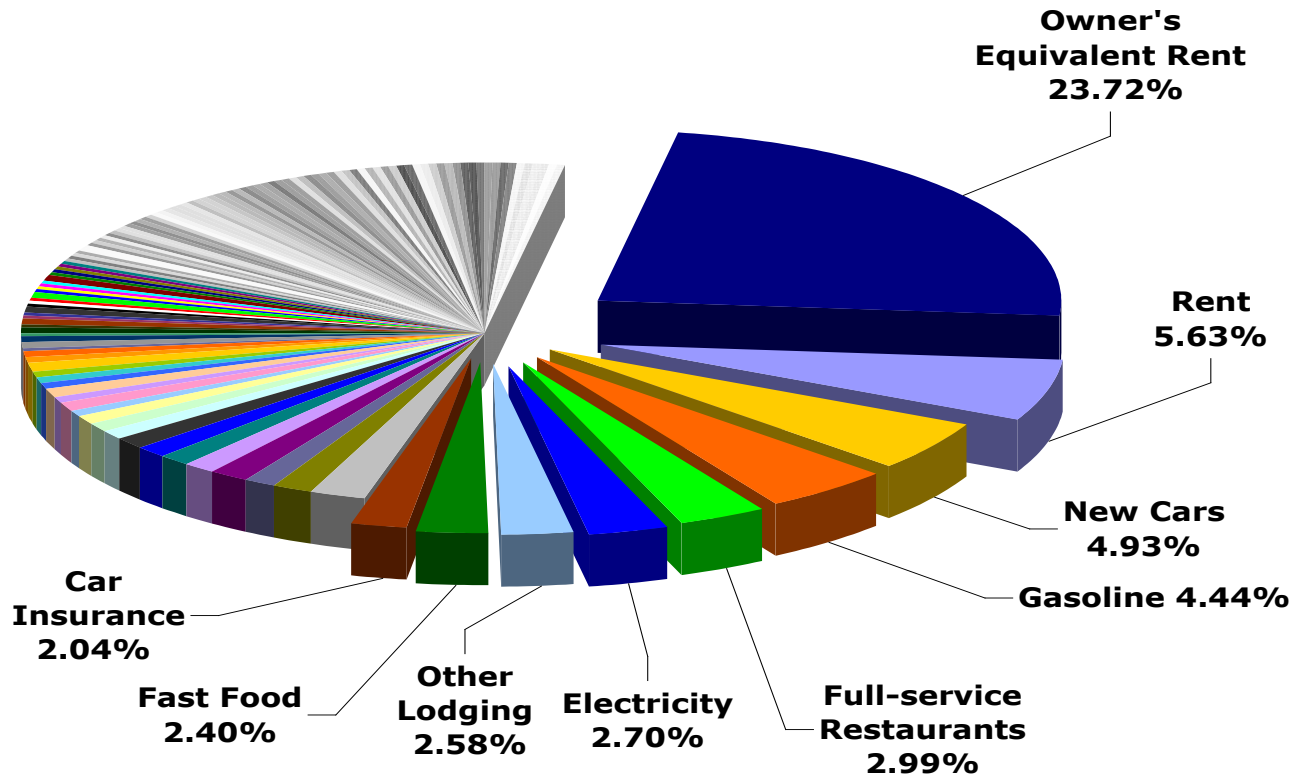# Possible Future CPI Information Needs

- **Sample size**
  - ▶ Adequate to support annual ELI-PSU expenditure detail, for the urban population
  - ▶ Adequate to support monthly ITEM-AREA expenditure detail, for the urban population
  - ▶ Adequate to support various demographic indexes
- **Timeliness**
  - ▶ Ideal goal: receipt of data for calendar month (t) by the end of the first week of following month

CPI Item Weights

Relative importance of CPI Item Strata, 2005-2006 Biennial Period

Importance of Weights

Relative Importance of Gasoline in Washington, DC
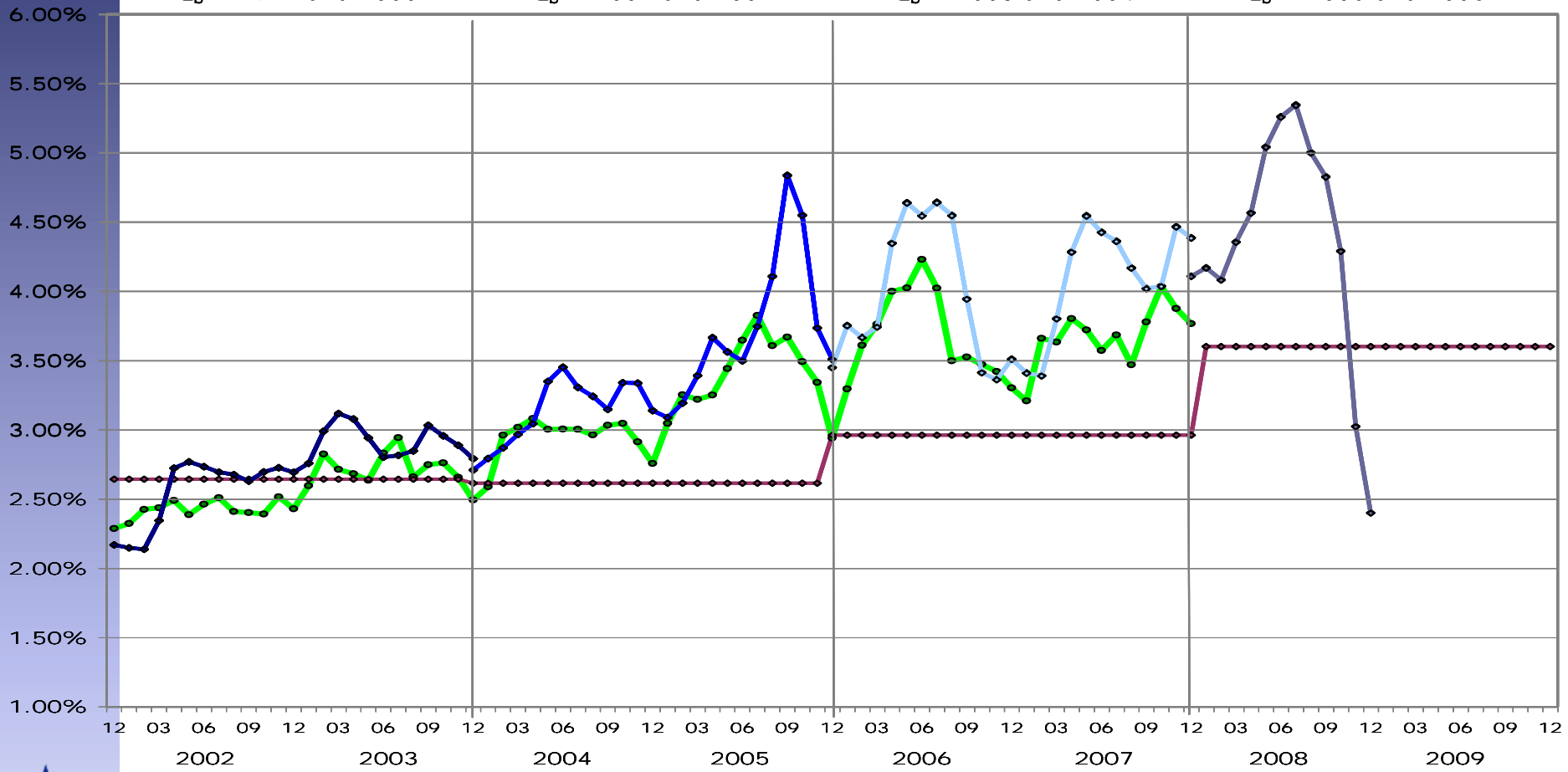
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