CPI and HIES Statistics- Basic concepts, definitions and classifications

- Day 6:   7 November 2011
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What is Consumer Price Index?

- An indicator which measures average changes over time in prices of fixed basket of goods and services of constant quality and quantity that a reference population acquire, use or pay for consumption.
  - – average measure
  - – change over time
  - – goods and services for personal consumption, not for purpose of investment

Assigned a value of 100 in some selected index base period,

What is the CPI used for?

- Macro-economic indicator
  - - indicator of inflation
  - - internal purchasing power of the currency
  - - international comparison
  - - national accounts deflator
- Income adjustment
  - - indexation of wages and social security allowances
  - - indexation of pensions and benefits
- Price adjustment of private contracts
- Price analyses

What are the measurement issues?

- Reliability
- Representativeness
- Completness
- Accuracy
- Timeliness

International Standards

- provide guidelines which are generally accepted as good statistical practice to the countries when developing or revising their CPIs
- reduce non- comparability between countries
- **secure consistency with other statistical series**

- ICLS: 1925, 1947, 1957, 1962,1987, 2003
- 1989 Manual on CPI,
- 2004 Manual on CPI: Theory and Practice
- ILO Convention No. 160
- ILO Recommendation No. 170

Recent developments

- Ottawa city group on prices
- Boskin report
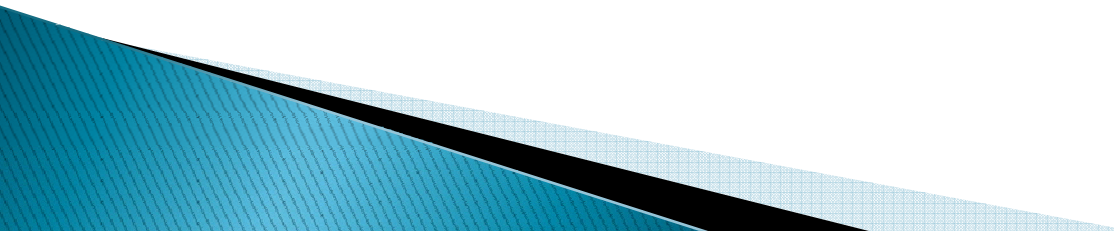- Other research projects
- Harmonised index of consumer prices

Measurement objectives

- An indicator which measures changes over time in the general level of prices of consumption goods and services that a reference population acquire, use or pay for.

- (i) to measure the change over time in the cost of purchasing a fixed basket of consumption goods and services of constant quality and characteristics – fixed-basket price index

- (ii) to measure the effect of price change on the cost of achieving a standard of living corresponding to that achieved during some period in the past –COLI

Is CPI a Cost of living index?

- COLI - How much does it cost now to have the same standard of living or level of untility as I had at some defined time in the past.
- **Fixed-basket price index** (Laspeyres') - How much does it cost now to buy the same basket of goods and services as I bought at some defined time in the past.

    - index of prices change only, other factors constant

    - it does not take into account the changes in consumption patterns that consumers make in response to relative price changes

    - only approximation to the « true »cost of living – upper bound

Fixed-basket index vs COLI

- In practice- no conflict between these two objectives. Calculated as weighted averages of price changes with weights reflecting consumption patters in some period.
- The difference is expected to increase with the age of the weights .
- If expenditure shares remain constant over time- fixed basket index coincides with COLI

Main Uses of CPI

- To adjust wages and social security benefits to compensate for changes in cost of living
- To measure the inflation experienced by households
- To deflate components of total household consumption expenditure in NA

⬇ Need to construct a family of CPIs for specific purposes (only one official). If only one index to be produced: the concept appropriate for its most important purpose should be chosen

Adjustment of wages and social security benefits

Various money payments may be linked to the CPI:

- wages
- social security benefits
- interest, rents, alimony, child support
- taxation

Type of index

- Fixed basket price index or cost of living index
- exclusion of certain item (cigarettes)

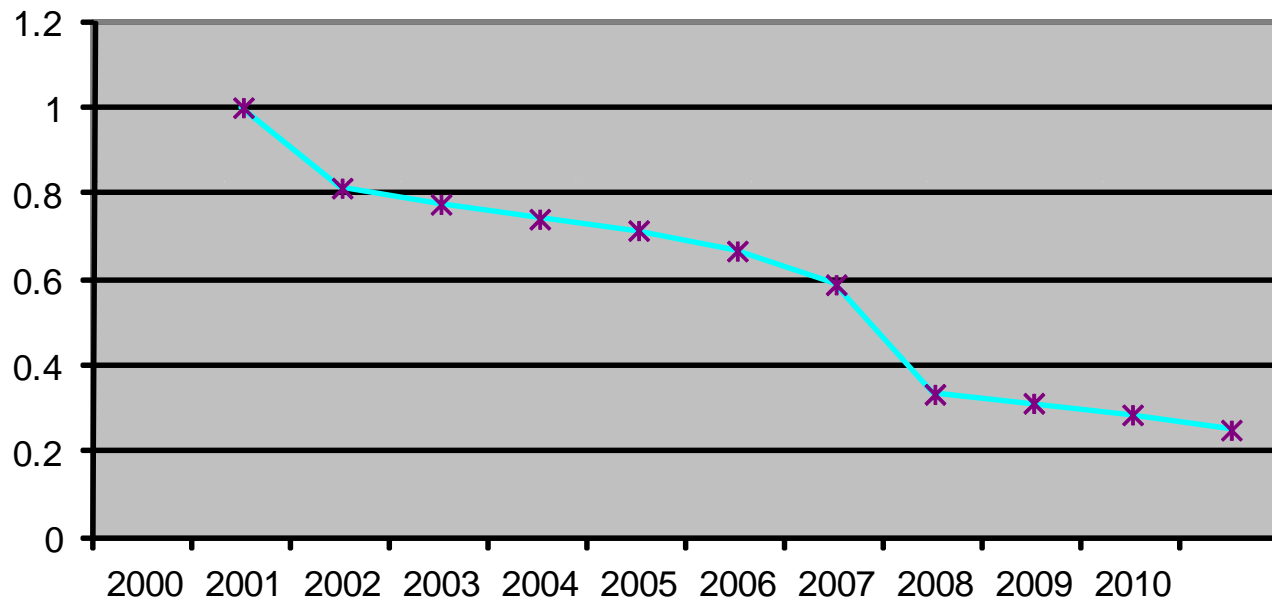# Using the CPI to adjust payments: cost of living adjustments

Adjusting government old age pensions

- a hypothetical pension is US$ 800 a month in 2009.
- the CPI increased by 5.0% between 2009 and 20010
- The pension to be paid in 2010 should be increased by US$40.

Purchasing value of income
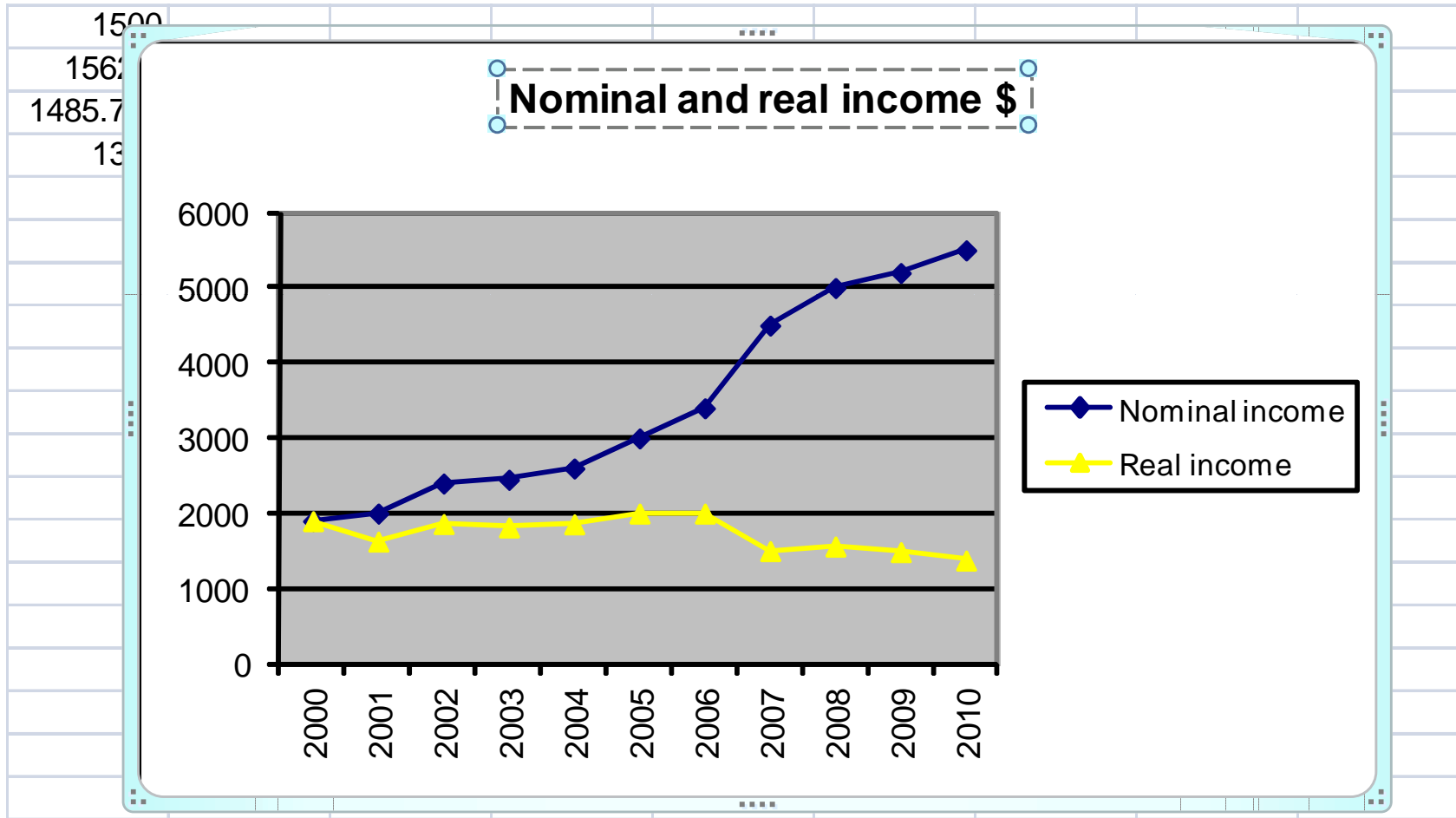
Purchasing value of the currency

Deflating economic series

▶

	Average annual household income, in current $	CPI (2000=100)	Average annual household income, in constant 2000 $
1995	$35,000	95.5	$36,649
2000	$40,000	100	$40,000
2005	$45,000	116.5	$38,627
2010	$50,000	121.7	$41,085

Nominal income between 2000 and 2010 increased 25%.

At the same time prices increased for 21.7%.

Real Increase was 2.7%

Uses

▸ National accounts deflation
- ◦ CPI coverage often different from household consumption expenditure in national accounts
- ◦ should be done at a disaggregated level

▸ Purchasing Power Parities
- ◦ PPPs and CPI cover similar consumer goods and services
- ◦ but non-representative commodities also need to be priced

Limitations

- Does not match current individual consumption
- Wide individual variations around "average"
- Does not reflect budget reallocations
- Reflects price changes, not absolute levels
- Not "cost of living"
- Measures time-to-time, not place-to-place changes
- It is not complete measure of all price changes in an economy

Is CPI an Inflation Index?

- **Inflation** index covers all transactions carried out in the economy, not only consumer goods and services

- **CPI** applies to the prices in the final stage in the chain of consumption (restricted to private household, only refer to household consumption)

Scope of the Index

- Population, geographical, outlet, item coverage

  Depends on the specific purpose

 (i) inflation index - domestic concept, all households

 (ii) compensation index - national concept, particular group of households

(iii) NA deflator - all households (including institutional)

Consumption expenditures

- Consumption : all goods and services that are acquired, used or paid for by households but not for business purposes and not for the acquisition of wealth
- Three distinct meanings: each may lead to a different CPI

  (i) total set of goods and services acquired by households

  (ii) the actual physical process of consuming goods and services

  (iii) the subset which households pay
- Distinction important for owner-occupied housing, own-account consumption, credit purchases, social transfers in kind

Classification

- Classification – COICOP (an integral part of the 1993 SNA)

  – Individual consumption expenditure

  12 division, 47 groups, 114 classes

  – For CPI purpose it is desirable to disaggregate basic classes into more homogenious commodity groups

CPI Construction

▸ Important Elements:
- Consumption basket
- Expenditure weights
- Price observation
- Method of calculation

Consumption Basket and Weights

- Weights: proportion of the expenditure relating to the items at the lowest level of classification system
- Remain fixed from one re-weighting exercise to the next
- If remain fixed for several years – weights should be representative of the behaviour of household consumers over a longer period

Sources of weights

- HIES
- National accounts
- data from the retail trade statistics
- industry surveys
- export/import statistics
- expert estimates

- scanner data

Weights reference period

- **long enough** to cover a seasonal cycle;
- reasonable **stable**
- **not too distant** from the price reference period

Periodic review of basket and weights

- Significant changes in consumption pattern
  - demographic composition of the population,
  - technological development,
  - changes in the level and distribution of households' income and preferences.
- Periodic review of the basket and weights- at least once every 5 years

Sampling methods

- Sample of zones within regions, outlets, items, prices

(i) Probability sampling – preferred method
   – permits estimation of sampling error and
   – optimisation of the sample size
(ii) Non-probability sampling methods – if sampling frames are lacking and it is too costly to obtain them

- Approach dependent on availability of data, cost and expertize

Sampling methods

(i) Probaility sampling:

▸ simple random (or equal probability) sampling (SI);

▸ stratified sampling with SI sampling in each stratum

▸ sampling with probability proportional to size

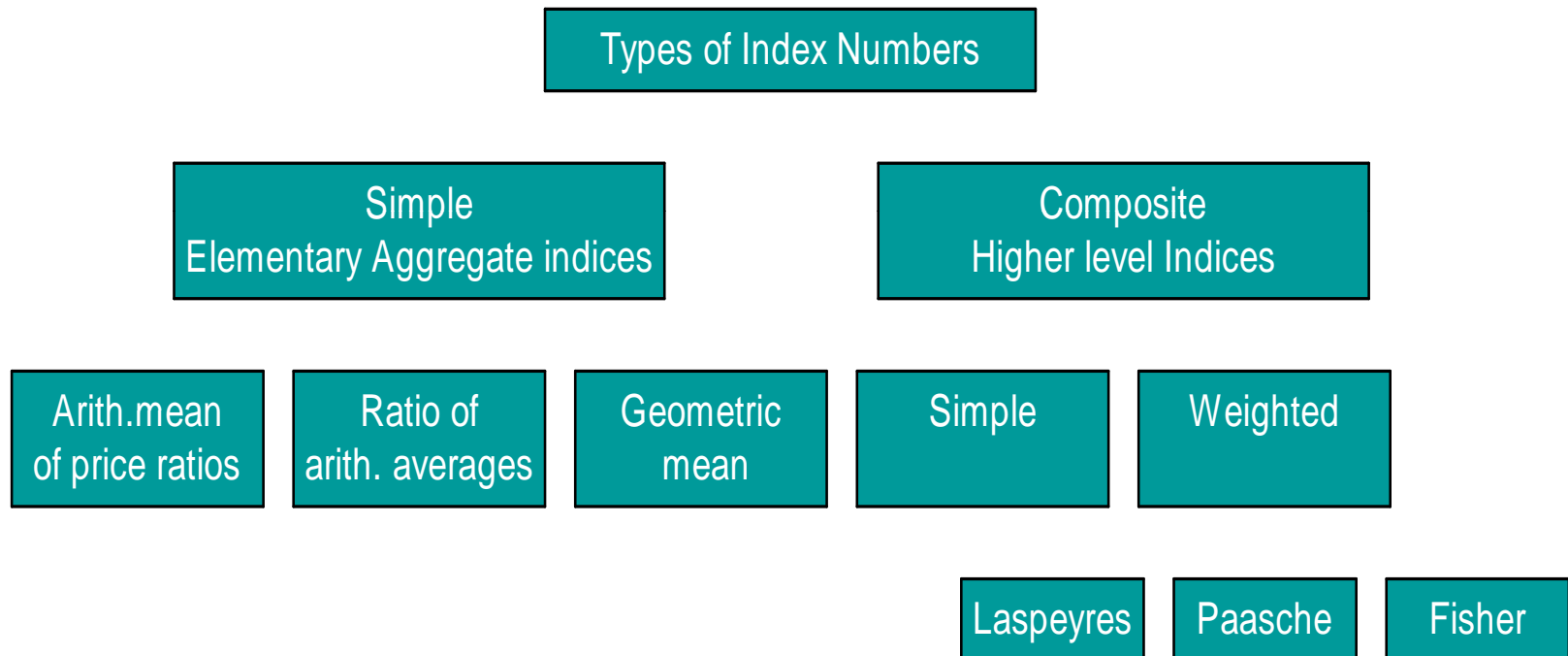▸ stratified sampling with PPS sampling in each stratum

(ii) Non-probability sampling:

• Judgmental sampling

• Cut-off sampling (the elements with the highest sales or value of other auxiliary variable are included into the sample);

• Quota sampling (a priori fixation of the number of elements;

Sample Design

▸ **Probability sampling methods– preferred,** ensure that each element (region, outlet, item) has a known chance of being selected

  – enables us to use population variance to determine and optimize sample size

  – permits estimation of sampling error and

  – *costly*

  – *may result in the selection of items that are difficult to price*

▸ Non–probability sampling methods (cut–off)– if sampling frames are lacking and it is too costly to obtain them, but also if sample size small.

Index calculation

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                        │  Types of Index Numbers │
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Simple Elementary Aggregate indices	Composite Higher level Indices

Arith.mean of price ratios	Ratio of arith. averages	Geometric mean	Simple	Weighted

Laspeyres	Paasche	Fisher

Elementary Aggregate

- Elementary aggregate: expenditure on an item or group of items stratified by type of outlet and region, by type of outlet only, by region only, or nothing.

- Elementary aggregate index – index number for a smallest set of products which are close substitutes for each others and for which reliable expenditure weights can be estimated

Elementary Aggregate Indices

- Ratio of arithmetic mean prices
- Arithmetic mean of price relatives
- Ratio of geometric mean prices
- Geometric mean of price relatives

Different formulae for different elementary aggregates
- – homogeneity within the elementary aggregate
- – elasticity of demand
- – variation in prices

Ratio of arithmetic mean prices

$$I_{t/0} = \frac{\frac{1}{n}\sum_{i=1}^{n} p_t^i}{\frac{1}{n}\sum_{i=1}^{n} p_0^i} * 100$$

▸ satisfies permutation and circular (generates the same result whether calculated as a direct or chained index)

▸ fails unit test

▸ assumes fixed quantities, elasticity of demand=0

▸ Gives more importance to higher prices

▸ Suitable for homogeneous items

Arithmetic mean of price relatives

$$I_{t/0} = \frac{1}{n}\sum_{i=1}^{n}\frac{p_t^i}{p_0^i}*100$$

▸ does not satisfy permutation and circular test

▸ not recommended in a chained form, generates bias

▸ satisfies unit test, can be used for heterogenous items

▸ does not satisfy time reversal test, $p_{2/1} \neq 1/p_{2/1}$

Geometric mean

$$I_{t/0} = \frac{\sqrt[n]{\prod_{i=1}^{n} p_t^i}}{\sqrt[n]{\prod_{i=1}^{n} p_0^i}} * 100 \qquad I_{t/0} = \sqrt[n]{\frac{\prod_{i=1}^{n} p_t^i}{\prod_{i=1}^{n} p_0^i}} * 100 = \sqrt[n]{\prod_{i=1}^{n} p_{t/0}^i} * 100$$

- passes two transitivity tests and change of unit test
- equal weight to each item
- assumes fixed expenditures, elasticity of demand=1
- undefined when one price = 0
- same result in a direct and chained form

Elementary Aggregate Indices

▸ Hypothetical example

Variety	Price	
	Period 1	Period 2
X	10	15
Y	20	22
Z	15	17

▸ ratio of arithmetic mean prices =120.0
▸ arithmetic mean of price relatives =124.4
▸ ratio of geometric mean prices =123.209
▸ geometric mean of price relatives= 123.209

Example: Elementary indices for an elementary aggregate containing three varieties

Variety	Price in the period			
	0	**1**	**2**	**3**
x	5	5	4	5
y	4	8	6	4
z	8	4	10	8
Arithmetic mean	5.7	5.7	6.7	5.7
Geometric mean	5.4	5.4	6.2	5.4

(a) Arithmetic average of price ratios

Index direct	100.0	116.7	118.3	100.0
Index chained	100.0	116.7	157.5	142.6

(b) Ratio of arithmetic mean prices

Index direct	100.0	100.0	117.6	100.0
Index chained	100.0	100.0	117.6	100.0

(c) Ratio of geometric mean prices and geometric average of price

Index direct	100.0	100.0	114.5	100.0
Index chained	100.0	100.0	114.5	100.0

Recommendations

- Select items/products with the objective of achieving homogeneous groups. This has the advantage of reducing the discrepancies between the compilation methods used at the elementary aggregate level.
- The choice of formula depends:
  - degree of homogeneity within the elementary aggregate
  - dispersion of prices and price movements
  - need to reflect substitution within the elementary aggregate
- It is possible to use different formulae for different elementary aggregates within the same CPI.
- Use GM formula particularly where there is a need to reflect substitution within the EA or where the dispersion in prices or price changes within the EA is large.
- The RAP may be used for EA that are homogeneous and where consumers have only limited opportunity to substitute or where substitution is not to be reflected in the index.
- The APR formula should be avoided in its chained form, as it is known to result in biased estimates of the elementary indices.
- Where possible, EA indices to be calculated as weighted averages.

Upper Level Indices

Many different formulae – weighted indices

- Laspeyres' Index – the only practical option for a timely product
- Paasche's Index
- Marshall's Index
- Fisher's Ideal Index- to be calculated retrospectively for analitical purposes
- Sidgwick and Drobisch Index

Laspeyres' Index

$$I_{2/1}(L) = \frac{\sum_{i=1}^{n} p_2^i q_1^i}{\sum_{i=1}^{n} p_1^i q_1^i} * 100$$

- fixed basket, base year quantities as weights
- weight reference period corresponds to price reference period
- measures pure price change
- assumes no quantity changes in response to price changes
- upward bias, upper bound of the « true » COLI

Paashe's Index

$$I_{2/1}(P) = \frac{\sum_{i=1}^{n} p_2^i q_2^i}{\sum_{i=1}^{n} p_1^i q_2^i} * 100$$

- fixed basket, current year quantities as weights
- a new set of weights required each year
- although each period is directly comparable with the base year, the comparison of the different years among themselves is not valid, for the reason that the aggregate of goods differs each year.
- downward bias, lower bound of the « true » COLI

Superlative Indices

- ▸ **Törnqvist Index**

- ▸ **Edgeworth Index**

- ▸ **Walsh Index**

- ▸ **Fisher Index**

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$$I_{2/1}(T) = \prod \left(I_{2/1}^{i} \right)^{\left(W_1^i + W_2^i \right)/2}$$

$$I_{2/1}(EM) = \frac{\sum\limits_{i=1}^{n} p_2^i (q_1^i + q_2^i)}{\sum\limits_{i=1}^{n} p_1^i (q_1^i + q_2^i)}$$

$$I_{2/1}(W) = \frac{\sum\limits_{i=1}^{n} p_2^i \sqrt{q_1^i * q_2^i}}{\sum\limits_{i=1}^{n} p_1^i \sqrt{q_1^i * q_2^i}}$$

$$I_{2/1}(F) = \sqrt{I_{2/1}(L) * I_{2/1}(P)}$$

Compromise solution, no bias in any known direction

Upper Level Indices

▸ Hypothetical example

Item	Period 1		Period 2		Price Relatives	
	Price	Quantity	Price	Quantity	P2/P1	P1/P2
Beef	1	1	1.6	0.8	1.6	0.625
Chicken	1	1	0.8	2	0.8	1.25

▸ Laspeyres' Index =120.0
▸ Paasche's Index = 102.9
▸ Edgeworths Index = 110.0
▸ Fisher's Ideal Index =111.1
▸ Törnqvist Index = 111.0
▸ Walsh Index=111.0

Special problem areas

- Old products disappear
- New or improved products appear with large value sales
- Imposed quality change
- Seasonal unavailability

Quality changes

- *By quality change (difference) is understood* a.change in characteristics of a good or service that changes the utility that the consumer derives from it

- Purpose – pricing producsts of constant quality
- If quality difference is detected, but not removed, it will be reflected as a price change
- ⬇ price change will be overstated (understated)
- ⬇ any adjustments to payments will be affected

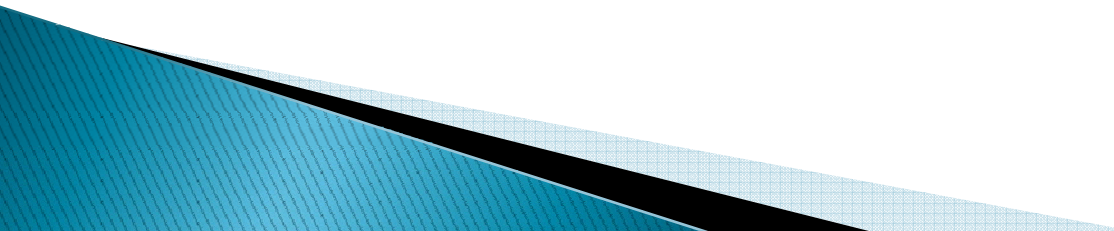# Methods for Estimating the Value of the Quality Difference

- Methods used to adjust for quality change can have considerable impact on a CPI

- (i) Implicit adjustment procedures
  - less reliable,
  - based on assumptions
- (ii) Explicit adjustment procedures
  - complex and costly- to be directed to items with large weights
  - try to make a direct estimate of change in value due to change in characteristics

Implicit quality adjustment methods

The pure price component is estimated first; the remaining part is considered as change due to quality difference

➢ Overlap: assumes that the entire price difference in an overlapping point in time is due to a difference in quality

➢ Overall mean imputation: assumes that the pure price change is equal to the average price change for non-missing items

➢ Class mean imputation: assumes that the pure price change is equal to the average price change for items judged as essentially equivalent or directly quality adjusted

Explicit/Direct QA methods:

- Adjusting by changes in some quantitative characteristic
- adjusting by estimated production costs
- adjusting by costs of additional options
- hedonic methods: estimate the relationship between the prices and technical characteristics of a set of different models

Seasonal variation

Seasonal unavailability
- Impute prices
    * Carry forward last price
    * Mean of last season's prices
    * Extrapolate using price trends of available items
- Omit item and re-allocate weight
- 12-month centred moving average
- Seasonally varying weights

Dissemination

- Quick public release to all users simultaneously.
- Sub-indices for major groups according to COICOP.
- An index excluding rents in addition to an all-items index.
- Average prices for important and homogeneous items
- List of items and outlets kept confidential.
- Public acceptance of CPI
- Retrospective corrections – only when necessary
- Description of methodology and data sources
- Documentation ensures accuracy, relevance and transparency of the index. It is useful tool for the training and introduction of staff.

Accuracy of the Index

- CPI – subject to variance and potential bias
- Bias – any systematic deviation with respect to some ideal index

  Occurs when the CPI produces results which are systematically higher or lower than the true price changes; this may happen at different aggregation levels

Potential sources of bias in price indices

- Spending pattern changes
- Quality changes
- Appearance of new goods and services
  - non-inclusion
  - delayed inclusion
- Estimation tehniques

Procedures to Minimise the Bias

- ▸ Regular updates of the weights and basket
- ▸ Use of unbiased elementary aggregate formulae
- ▸ Proper treatment of quality changes
- ▸ Allows for inclusion of new goods and services (when a new item should be included)