How do we measure inflation? Some measurement problems

Seventh meeting of the International Working Group on Price Indices
(The Ottawa Group),
Paris, France, 27-29 May 2003

Rósmundur Guðnason
Statistics Iceland
Borgartúni 21a
IS - Reykjavík 150, Iceland
rosmundur.gudnason@statice.is
Preconference version, May 2003[1]

Abstract

The paper describes methods used in the calculation of the Icelandic CPI and resembles a conditional COLI. Substitution is counted for by using the geometric mean and by allowing substitution between stores. Methods used for correction of shopping substitution bias (outlet substitution bias) are described. This bias increased when inflation rose suddenly in the year 2001 and was corrected by quality adjustment, mainly based on evaluation of different selection of goods. Store weights were adopted in April 2002 which make such corrections easier. The main sources are cash receipts collected in the household budget survey. Additional sources include information gathered from the main retail groups. Corrections of the CPI were made in December 2001, March 2002 and May 2003, leading to 0.55 per cent lowering of the index. Owner occupied housing is calculated as user cost using depreciation and real interest rate. Using the real interest rate is specific for the Icelandic method.

JEL: C43, C81, D11, E31.

Keywords: Consumer price index, cost of living index, household budget surveys, shopping substitution bias, outlet substitution bias, quality adjustment, owner occupied housing, user cost.

---

1. Introduction

It is difficult to define inflation and no unique definition available. It is often said that it is "permanent general rise in prices"[2] or as "continusly rising prices or equivalently of a continuously falling value of money"[3]. The first definition refers to general conditions the other refers mostly to monetary aspects of rising prices. The question then rises how to measure this permanent increase or change in prices. The tool for such measurement are price indices that measure price changes in distinct periods. It is most common to use consumer price indices for that task but they cover households consumption expenditures. They are based on well known practices recognised both domestically and internationally, the dataset is based on regular extensive price collection, often bound by law. The consumer price index measure the price change of private consumption. If the aim is to measure the total price changes in the society there is a need to measure, in addition to private consumption, both public consumption and investment. The problem with such a total measurement is that the indices needed are often either not available or published timely enough to be of use. It is for that reason that the consumer price index is used as the reference for inflation. The tasks in the measurement of inflation is to find the changes in prices that reflect the inflation development in best way possible. Most of the theoretical literature on indices is about witch prices should be measured and what methods are most reliable for that task. To measure prices is a complex and difficult exercise. Arnljótur Ólafsson describes the problem in the following way in the year 1880 as follows and that description is still valid. "The word price is not a long word but it has not brought any luck to economists or other scholars. The right meaning is truly difficult to find, it is difficult to find the way to the origins of prices and their causes, their increase or decrease. No thing is as volatile and changeable as prices"[4]. The extent and the immense quantity of transactions means that the oversight and total information is not available without intensive effort. Estimates are therefore necessary and here indices enter the stage. The basic task in the calculation of indices is how to compile this extensive information so it reflects changes in prices in the right way. If a complete information on both prices and quantities would be available for all goods and services the index problem would be easily solved. The main problem with price

---

[2] Jón Sigurðsson (1974) 30
[3] D. Laidler og M. Parkin (1975) 741, Verðbólguvandinn (1978) 41.
[4] Arnljótur Ólafsson (1880) 106.

indices is how to calculate them in the most sensible way taking into consideration best available information at each time.

In the last ten years there have been a considerable development in the methodology of consumer price indices especially in the field of elementary indices. That work has mainly been conducted in an international working group, the Ottawa group. The working group was originally started in Ottawa in Canada in the year 1994 with the aim to be a forum for research and discussion about price measurement. The group has held seven meetings (2003) and discussed the theoretical side of this issue but has mainly dwelled with practical research in the field of consumer price indices. This work has to a great extent been used in the drafting of two international manuals on indicies. One of them is about consumer price indices and is written under the auspices of ILO. The other one is about producer price indices worked under IMF direction.

In the last years there has also been a discussion internationally about bias in consumer price indices especially after the publication of the Boskin report in 1996 that discussed the subject. The discussion that followed and the fact that there has been a considerable lowering of inflation internationally have further pointed to the issues of price measurement, especially if inflation is upward biased.

ILO has sponsored the drafting of resolutions standards about consumer price indices since 1925. Their latest resolution on the issue is from 1987. The main objective of the resolutions is to make it easier for states to build good consumer price indices. Preparations are ongoing for the ICLS (International Conference of Labour Statisticians) that will be held at the end of the year 2003 where a new resolution will be adopted. The resolution will take into account changes in methodology and priorities in the production of consumer price indices

When preparing for the Euro as a common currency in Europe high priority was put on inflation targets and in the Maastrict treaty there were clause about them. This clause led to the intensive work on harmonisation that has been conducted in Europe in last years under the leadership of Eurostat. Since the beginning of 1997 the harmonised index of consumer prices has been calculated monthly. It is based on common methods that are stipulated by law[5].

---

[5] Eurostat (2001)

This paper deals with the sources of and methods used in the calculation of the Icelandic CPI and how it resembles a conditional cost of living index. In chapters 2 and 3 there is discussion about methods of calculations used in the index and new data sources deriving from the continuous household budget survey conducted by Statistics Iceland. Chapters 4, 5 and 6 discuss the fields where the calculation of the consumer price index resembles conditional cost of living index. Chapter 4 describes the calculation of the index, chapter 5 correction of a shopping bias and chapter 6 describe the calculation of housing in the index.

2. Methods for calculations

2.1 Fixed base indices and Cost of living indices

Theoretically there are two main methods used in the calculation of indices. On one hand the expenditures are kept fixed and fixed base indices calculated. Fixed base indices are called pure price indices if they measure only price change when the quantities are kept fixed. If the weights refer to older times the indices calculated are called Laspeyres and if the reference is to present time they are referred to as Paasche indices.

(2.1) Laspeyres: $$P_L = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$$

(2.2) Paasche: $$P_P = \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t}$$

Where i = goods, 1, ... n, P_i = price of good i, Q_i = quantity of good i.

Fixed base indices show changes in expenditures between two periods when fixed quantity of goods and services are bought. They can be of different nature and the prices or weights used in their making are diverse. When they are calculated it is not supposed that consumers change their selection of goods when the price relatives change, i.e. there is no substitution. Usually fixed base indices used are of Laspeyres type as information about old weights is usually available and it is sufficient then to collect prices for the index calculation. In the case of Paasche indices there is in addition to the price collection need to continously gather information about new

weights which is both complicated and cumbersome. Theoretically though there are no arguments to select one rather than the other.

The other main method, cost of living (COLI)[6], measures changes in welfare in a wide meaning. It has been defined as "the ratio of the minimum expenditures required to attain particular indifference curve under two price regimes"[7] All parts of welfare can not be measured with price indices, such as influence of climate, nature catastrophes, terrorism and plagues. Conditional cost of living indices cover domain where price indices can be used. It is assumed that consumers keep their quality of life fixed and the cost of living index measure changes in cost connected with that. Economically it is connected to theories about true cost of living[8] meaning that consumers maximise their utility at lowest cost. According to this individuals maximise their utility by changing their consumption if prices go up to buy cheaper goods or goods with less rise in prices.

2.2 Superlative indices

Methods for measuring utilities for individuals are not available and that makes the measurement of cost of living indices difficult. It was therefore a great discovery that symmetric indices, so called superlative indices[9], reflect in an adequate manner a true cost of living with given assumptions about the functional form of the utility function[10]. It is therefore possible to calculate a cost of living index without directly measuring other assumptions such as indifference curves.

Cost of living index and pure price index can be defined as the ratio of expenditures in two periods. In the fixed base index the quantity is kept fixed but it can change in an cost of living index. The calculation of cost of living indices is connected to consumption theories. In reality the method of calculations is not so different as it might seem at first sight. "In practice, the real problem for all price indexes, whether they are intended to be measure of inflation or changes in the cost of living, is to get the most appropriate or relevant weights. It should be noted that even when the objective is to measure the changes in the cost of living, the indexes actually calculated in practice are always pure price indexes of one kind or another. When the

---

[6]The concept of cost of living is an economic concept. In Iceland the concept is very often mixed with the question about the level of living cost for different types of households. The COLI does not answear that question and it is not found in the calculation of the CPI.
[7] Pollak (1989) 6
[8] Konus (1924).
[9] The concept was first used to classify indicies Fisher (1922) 247.
[10] Diewert (1976)

weights are 'right', it matters little whether the index is intended to be an inflation or a cost of living index."[11]. Superlative indices are symmetric and two periods always taken into consideration, old and new. The problem is that information about new weights are rearly available until after some time and it is therefore difficult to calculate them in timely fashion. They differs from fixed base indices in that they either use old weights (Laspeyres) or new weights (Paasche). Bias in the consumer price index is measured as the difference between the index results compared to the result from the calculation of a superlative index. Laspeyres index is biased upwards and the Paashce index downwards. The best known of the superlative indices is the ideal index most often related to the American economist Irving Fisher[12] but that index is the geometric mean of Laspeyres and Paasche indices (2.9). Its popularity can be traced to the axiomatic (test) method that originates from Fisher[13], but according it the ideal index performs best. The only superlative index that reconciles with pure price indices is named after Walsh[14] (2.10), where the weights are the geomean of the quantities and the two periods.

2.3 The axiomatic method

Different methods for calculations of indices show different results. The problem with the selection of a method that is best suited for the calculation is connected with that fact. Therefore it is important to have a tool to scrutinise the different technical properties of the index and to observe which mathematical criterias they fulfil. A method for this is the axiomatic or test method, most often connected with Fisher. The conditions or criteria that indices have to pass to be considered as good indices are put forward. Different indices are tested by these criteria and the results indicate which conditions hold. The results can be used for the selection of method for calculations i.e. if you only look at the technical properties of indices. Examples of such tests are[15]:

1. Positivity, indices (quantity- and price vectors) must show positive results.
2. Identity test, if prices of all goods in two periods are like the index should be unchanged.

---

[11] Hill (1999b) 10

[12] Fisher 1922.

[13] It was Walsh that was the first to reasearch the test method systematically. Diewert (1993) 39.

[14] Walsh (1901) 398 and (1921) 97

[15] Extensive summation is to be found for example in Diewert (2002b), chapter 16, where he dicusses 20 index tests.

3. Proportionality in current prices, if all prices in one period are multiplied by the same constant the new index should be the old index multiplied with the new constant.

4. Invariance to changes in the units of measurement, the index does not change even if the units change.

5. Time reversal test, if data from two periods are crossed then the result should be the inverse of the original index.

6. Quantity reversal test, if quantities between two periods are crossed then the index should be unchanged.

7. Mean value test for prices, the index result falls in between the highest and lowest price relatives.

8. Paasche and Laspeyres bounding test, the index result fall within Laspeyres and the Paasche indices.

9. Monotonicity in current prices, if prices change then the index changes.

10. Test of permutation or price bouncing, if shops cross prices between months and the price in the later month are connected to the prices in the former month then the index should not change. (For example if the price of a good rises from 20kr. to 25 kr. or by 25 per cent and prices than go down from 25kr. to 20kr. or lowers by 20 per cent then the index should be unchanged and show no change).

11. Test of transitivity, indices calculated directly between two periods should show the same results if they are chained.

The test are not equally important and no definitive rules are available to tell which of them are the most important. The results are therefore always dependant on judgement. The time reversal test, for example, says that the same result should be reached in the calculation whether the index is calculated forward or backward which can be of significance and therefore it is important that indices pass that test.

2.4 Elementary indices

Difference is made between calculation methods used for the elementary aggregates (the lowest level where weights are available) and methods used in the calculation of the total index. At the basic heading level weights are not itemised and the results calculated only with prices. At the elementary level the price changes can be viewed

either as the average of price relatives (indices) or the relative of average prices. The main elementary indices calculated are:

P_1 = prices in period 1, P_0 = prices in period 0 and n = number of price observations.

Average of price relatives (indicies) named after Carli.

(2.3) $$P_{CAR} = \frac{1}{n} \Sigma \left(\frac{P_1}{P_0} \right)$$

Relative of average prices named after Dutot.

(2.4) $$P_{DRA} = \frac{\frac{1}{n} \Sigma P_1}{\frac{1}{n} \Sigma P_0}$$

Geomean of price relatives (indicies) named after Jevons.

(2.5) $$G_{JAR} = \Pi \left(\frac{P_1}{P_0} \right)^{1/n}$$

Relative of geomean prices named after Jevons.

(2.6) $$G_{JRA} = \frac{\Pi P_1^{1/n}}{\Pi P_0^{1/n}}$$

Harmonic mean of price relatives.

(2.7) $$H_{AR} = \frac{1}{\frac{1}{n} \Sigma \left(\frac{P_0}{P_1} \right)}$$

Relative of harmonic means.

(2.8) $$H_{RA} = \frac{\Sigma n / P_0}{\Sigma n / P_t}$$

The connection between these methods is that the geomean is always lower then the simple averages and higher then the harmonic means.

Carli index (2.3) which is the average of price relatives, is used in some countries but its use has declined considerably in later years. The index has many undesirable properties. "But we shall see that the simple arithmetic average produces one of the very worst of index number. And if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number, it will have served a

useful purpose"[16]. It does not pass the time reversal test (5), transitivity test (11) or the permutation test (10) and is therefore not appropriate in chain indices and considerable biased upward. Its use in the harmonised index of consumer prices is prohibited[17].

The Dutot index (2.4) the relative of average prices passes most tests except the invariance to changes in the units of measurement (4). Different package sizes influence the results and the index also has indirect weights where more expensive goods have greater influence on the average than cheaper goods[18]. The Dutot index is appropriate when the goods are homogeneous and was alone used in the Icelandic CPI until March 1997.

The Jevons index (2.5 and 2.6) has been in use in the Icelandic CPI since March 1997. The geometric mean can be calculated as relative of prices or as the relative of average prices and these two methods are indifferent[19]. The Jevons index is superior in that way as it passes all major tests. Different package sizes do not influence the results and that characteristic is used in the calculation of the Icelandic CPI. The harmonic mean (2.6 and 2.7) can both be calculated as price relative and average of relative prices. The harmonic mean is the inverse of Carli (2.3). The harmonic mean does not pass tests (10) and (11) and is used on very small scale in CPI calculations and is always biased downward[20].

2. 5 Indicies for calculation of the total index

When the price changes for the elementary goods have been calculated they are used to calculate the total index. The use of a fixed base index is the most common method. Superlative indices are a better choice because they are symmetric and work against the bias inherited in the Laspeyres and Paasche indices by neither favouring the old or the new weight information. The main reason why they are not used commonly is the lack of information about the present weights. The main superlativ indicies are.

---

[16] Fisher (1922) 29-30.

[17] Eurostat (2001) 217.

[18] It is very commom to use it in price surveys in Iceland but it is ill suited for that purpose. Expensive items have more weights in the results and different package sizes change the results.

[19] $G_J = \prod \left(\frac{P_1}{P_0} \right)^{1/n} = \frac{\prod P_1^{1/n}}{\prod P_0^{1/n}}$

[20] If a geomean of the harmonic mean of price ratios (2.7) and Carli (2.3) is calculated the result lead to elementary indices with very similar properties as the Jevons index. First pointed out by Fisher (formula 101). Fisher (1922) 472, Carruters, Sellwood and Ward (1980) 25, Dalén (1992) 140.

Fisher price indicies is defined as the geometric mean of Laspeyres and Paasche indicies

(2.9) $$P_F = \sqrt{P_L * P_P}$$

It is the only superlativ index that passes all the major tests and is in that way similar to the geometric mean in the elementary indicies, Walsh index which is a pure price index with the quantity weights as the geometric mean of the quantities of two periods.

(2.10) $$P_W = \frac{\sum_{i=1}^{n} p_i^t \sqrt{q_i^t q_i^0}}{\sum_{i=1}^{n} p_i^0 \sqrt{q_i^t q_i^0}}$$

Törnquist priceindex is defined as a geometric mean of price relatives weighted by the average expenditures in both periods.

(2.11) $$P_T = \prod_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right)^{s_i}$$ where $s_i = \frac{w_i^t + w_i^0}{2}$ and w_i is the expenditure

weight for a good i as share of total expenditures $w_i^0 = \dfrac{p_i^0 * q_i^0}{\sum_{i=1}^{n} p_i^0 * q_i^0}$

2.6 Substitution in indices

"The problem of how to construct an index number is as much one of economic theory as of statistical technique"[21]. Assumptions that there is an economic connection between indices move the task of measuring inflation into economics. Indices can be looked at economically, i.e. how they show changes in substitution. When demand elasticities are observed the elasticity for the geomen is 1 and Dutot equal to 0. Geomean corrects for substitution in accordance with these assumptions simple averages not. The consumer keeps his total expenditure unchanged by exchanging goods that are increasing in price for those goods that are sold at lower prices. Elasticities are very changeable but indices can be corrected with formulas which take

---

[21] Frisch (1936) 1

into consideration the fact that goods have different elasticities. Theoretically this has been solved by using formulas that use CES functions (constant elasticity of substitution). In a simple version of the Loyd-Moulton[22] formula different elasticities are taken into consideration, σ and weights, q:

$$(2.12) \qquad P_{LM} = \left\{ \sum_{i=1}^{n} q_i^0 \left(\frac{p_i^t}{p_i^0} \right)^{1-\sigma} \right\}^{\frac{1}{1-\sigma}} \quad for \ \sigma \neq 1$$

The elasticity coefficient reflects substitution and corrects the index for it. If Laspeyres weight is used substitution can be corrected without changing weights. Elasticity coefficients are probably unsteady and this method demands heavy data collection and effort and it is unlikely that it will be a workable solution to correct substitution bias[23].

3. New methods in the household budget survey

3.1 Detailed data from shopping receipts

Retail stores and other shops give their consumers detailed receipts and Statistic Iceland has used them in the household budget survey. The method was first used in 1995[24] and after that in the continuous HBS that started in year 2000[25]. In the survey participants return the receipts instead of copying detailed information from it into the diaries. The total amount bought is written into the diary and the receipt put into a pocket in the diariebook. The main idea in the beginning was to make the participation easier for the households by allowing them to return the receipts. In addition it turned out to be a new source of information, used to improve the weights for the consumer price index[26]. "This method allows much more accurate estimates of the composition and quantity of household goods than otherwise would be the

---

[22] Loyd (1975) og Moulton (1996).

[23] Balk (1999), Haan (2001) og Opperdoes (2001).

[24] This method was first described in the year 1995 when it was pointed out that with the receiptes there would be a possibility to measure the expenditures on debet- and credit cards as that information was available on the receipts. Guðnason (1995) 173.

[25] In the continous HBS the sample for a three years period is similar in size as it was in the 1995 survey. The number of households in the sample each year is about one third of the number in 1995. Participating households were in the year 1995 1375, in the year 2000 657 and 611 2001.

[26] Ireland is the only country that has used this method systematically in a similar way in their 1999 HBS. However they did not use the detailed information that can be gathered in the way described here. Some other countries allow the use of the receipts without using them systematically as is done here. This is the case for Australia and New Zeeland.

case". " The utilisation of this method also enables precise information to be gathered about consumer activities at much lower effort and cost than previous methods and shows a link between the goods purchased and the buyer"[27].

3.2 Overview of data from receipts

More shops use bar code cash registers now than in the year 1995. This is partly due to the increased concentration in the retail market as there are today three dominating groups in the market. View over the amount of data that come from the receipts can be shown by summing up transactions from the receipts and the diaries[28]. This can be viewed in two ways, either as the number of transactions or amount of expenditures. In the 1995 survey 41 per cent of all transactions came from receipts. This number was in the year 2000 about 69 per cent and 2001 it was at 74 per cent. For food and beverages 53 per cent of the records came in this way 1995, 84 per cent in the year 2000 and 2001 the records were about 89 per cent. Receipts covered more than 12 per cent of the total expenditure of households in the 1995 survey, 26 per cent in the year 2000 and about 31 per cent in the year 2001.

Considerable increase has been in the coverage of receipts from the year 1995 as they now cover nearly one third of the expenditures and approximately 75 per cent of the transactions.

3.3 Detail of the receipts

Usually the following information can be found on every receipt:

1. Detailed amount of the total of transactions and the number of items. This opens up the possibility of balancing the data and in that way increase the data security. It also makes the estimate of the total amount of transactions easier and it can even be used before the survey is finalised.

2. Name of the shop, it is therefore clear where the item is bought and the expenditure share for each household in each shop can be measured. That information is the base for the processing of the data and its use in the CPI, especially for creating the store weights.

3. Timing and the date of the transaction which opens the possibility to map in a exact way consumers consumption behaviour, when and at which time of day they shop.

---

[27] Rósmundur Guðnason (1997) 129.
[28] Large and rare expenditures are collected in the quarterly questionnaire, but these records are not counted here. They are not taken into consideration in the final results.

4. Description of the item, quantity, price, and total amount. The information includes package size and brands and in some cases the quantities. Fruits and vegetables are often weighted at the cash register and in those cases the quantities are reported. This opens the possibility for making exact quantity weights.

5. Form of payment, showing if the items are paid by cash, debet- or credit cards (e.g. Visa, master Card) or with check.

This information shows for example how much the costumer buys in each shop, how often and when. The place where the household lives is known so this information shows where the participants shop regionally. This detailed information have been of significant use in the making of the CPI base. In some cases the amount on the receipt is not detailed and in the 1995 survey this was the case of about 1,5% of the transactions which is less than it the former HBS. When the information from the receipts has been registered they have been balanced and the results can be used for shopping research. They are as of now only used for groceries in retail stores to make very detailed weights but could probably be used for other basic headings as well.

3.4 Data from receipts and shops compared

The first scanning of goods was done more than a quarter of a century ago[29]. The development since than has been at a very fast speed and now the biggest part of shops sales takes place in this form. When goods are bought in retail shops they are scanned at the point of sale, the buyer gets detailed receipt for the transaction and the scanner data from each sale is captured in the outlets database. The receipt the consumer get is a mirror of the information available in the stores database. If all the receipts were kept together they would show the same result as the retailer sales information. If this information is compiled from the consumer it can be seen who the buyer is and what is bought which gives this data a special value exceeding the data that can be collected from the shop. In the databases there are also transactions from other sectors than the households and they cover therefore wider range of transactions. The receipt is a bill from the shop and shows always the total amount to be paid by the costumer. When the data is finalised that is a very handy characteristic as this data can always be balanced[30]. That is done by comparing the results that have

---

[29] It was in the year 1974, Hawkes og Smith (1999) 284.
[30] One third of the expenditures is balanced in this way but this is the first HBS that is known to take advantage of this possibility.

been registered in the database of the survey with the total on the receipt. The information about the place of buying is available immediately when it has been registered in the database and the weights of shops are therefore always at hand.

3.5 The use of data from receipts

Research in the 1995 receipts data showed that it was feasible for use in getting more detailed weights than was possible before. Comparison of result from the receipts and scanner data from the biggest stores for the year 1995 showed similar results. In addition to that the results showed that the biggest stores had in the year 1995 considerable market share among households outside the capital area although their activity was mostly concentrated in the capital area[31]. Today the CPI for groceries is calculated with very detailed store weights.

When the stores weights for groceries were revised in December 2001 the data from the receipts collected in the continues HBS for the period January 2000 to November 2001 were compared with very detailed monthly sales information for the same period from the biggest group and these data set showed very similar results. Based on these data sets a correction of the weight shares for stores were done in December 2001. It is possible to use the total result because they are balanced as soon as they have been registered even if the survey is still ongoing and the final results not available, as was the case in the year 2001. Considerable development is possible with the use of this new very detailed information and the next step in its use could be as described in the following. "Further, shopping habits of households as mapped in the HBS could be used as a source for weights. This would be done by utilising information on detailed expenditure of typical costumers in each type of outlet. Calculation of the average price change would then be based on the expenditure of different households in the outlets. So for each outlet there would be different indices calculated for all types of households"[32]. There are five types of households in the HBS which would mean that the elementary aggregates for the households buying of groceries in the stores would probably be around 20000. The price collection as it is now would be used to calculate more elementary aggregates than is now possible without any increase of the price collection. This shows in a nutshell the real coverage of the information gathered from the receipts and how they can be further used.

3.6 Other new uses in the processing- communication expenditures

---

[31] Rósmundur Guðnason (1998) 209.
[32] Hallgrímur Snorrason og Rósmundur Guðnason (1999) 337.

The part of private consumption which has increased at greatest speed in last years is telecommunications, especially mobile phone services. Telephone companies give consumers often detailed bills that can be utilised in the HBS. The bills are rather complicated and it is time consuming to register them in the survey as the interviewers do that in the quarterly questionnaire. To make the participation and the interviewers work easier participants were asked for permission to let the bills be electronically collected from the telephone company. This method has been successful and now most of the bills are gathered that way. This change led to increased safety in the data collection and more reliable results. The information gathered in this way was compared with the detailed data from the telephone company about amount of time units sold and both sources showed similar results[33]. These results were first incorporated into CPI in the year 2001. Information was gathered about new services that had increased in coverage such as SMS messages. The uses of prepaid telephone cards have also increased considerably but as the service is prepaid there are no bills issued and information about the use can not be collected through the HBS but has to be gathered directly from the telephone companies. The number and amount spent on prepaid telephone cards is collected in the HBS. The method of collecting detailed bills has given good results and increased the safety in the measurement of the weight share and price changes in telecommunications in the CPI.

---

[33] Rósmundur Guðnason (2001) 634.

4. the calculation of the Icelandic consumer price index

What kind of index is the Icelandic consumer price index and how is it calculated? The consumer price index is a modified Laspeyres fixed base chain index with yearly links. The index resembles strongly conditional cost of living index. It allows for substitution by using the geometric mean and owner occupied housing is calculated as user cost.

4.1 The calculation of the consumer price index, overview

Elementary aggregate is the smallest unit in the index where only prices are available. It is split into approximately 6000 shop- and expenditure weights. Elementary indices (696) are calculated at the level of basic heading. Five different methods are used in the calculation of elementary aggregates in the consumer price index.

1. Relative of geometric mean prices (2.6) used in the calculation of nearly 39% of the base expenditures.
2. Weighted relative of geometric mean prices (see appendix) for groceries[34], covers nearly 18% of total expenditures.
3. Laspeyres (2.1) or relative mean prices (Dutot) (2.4), covers nearly 38% of the index.
4. Superlative index (Fisher) (2.9), covers more than 2% of the expenditures.
5. Indices that cover nearly 3% of the index.

The calculation and price collection in the Icelandic
consumer price index in January 2003

	Elementary aggregate				
	Basic heading	Weights	Items	Prices	Expenditure shares
Method of calculation	number	number	number	number	per cent
Relative of geometric mean prices	221	323	2,083	5,436	39
Weighted relative of geometric mean prices	364	4,000	800	10,000	18
Laspeyres or relative of mean prices	99	1,509	1,185	2,891	38
Superlative index	7	203	75	203	2
Indexes	5	13	27	27	3
CPI total	696	6,048	4,170	18,557	100

---

[34] Perishable items sold in food stores.

The number of subindices in the index is 696. Geometric mean is used in the calculation of 585 subindices, covering 57 per cent of the base expenditures[35], thereof groceries 364 and other 221. Number of subindices calculated as simple averages are 99 and other methods used for 12.

4.2 Sources for the base of the consumer price index

It is important how the elementary aggregates are organised and what sources are used when they are compiled. The main source in that work is the HBS. Data from that survey is directly used in the compilation of aggregates covering about 64% of the base expenditures in the CPI. When the data from the HBS is not adequately detailed more detailed information is gathered from other sources covers approximately 29 per cent of the base expenditures in the CPI. These expenditures are, alcohol and tobacco, medicine, medical services, petrol, local bus traffic, domestic flight, communication, entering fees for swimming pool and TV subscriptions.

Net weights are calculated for expenditure covering about 7 per cent of the index. It is used for expenditure on new cars, insurances and lotteries. Expenditure weights for new cars are calculated as the difference between cars bought and sold a method used in the calculation of the HICP and the national accounts. Insurances are calculated using net weights based on the revenue from the insurances when the claims have been subtracted and the income from financial activities added[36]. The lottery weight is calculated in a comparable way, i.e. the winnings are subtracted from the income of the lotteries[37].

4.3 the calculation of the consumer price index

The calculation of the consumer price index is complicated and many methods used. Circumstances and available data govern the way of solution. Each year approximately 220 thousand prices are collected for the CPI on the average more than 18 thousand per month[38].

---

[35] Similar amount of expenditures is calculated with the geometric mean both in the Norwegian and the US CPI. Dalton, Greenless and Stewart (1998) 3 and Johannessen (2001) 15.
[36] The weight shares are calculated as a three years averages as is done in the HICP.
[37] The price collection covers both the price of the ticket as the ratio of winnings.
[38] In addition on the average 1000 more prices are collected that are not taken into the calculation. This can for example be new items which are incorporated into the calculation gradually. Those items have been added after reference from the price collectors, information from the continous HBS or from scanner data from stores.

4.3.1 The relative of the geometric mean prices (2.6).

The method is used in the calculation of nearly 39 per cent of the index expenditure. The geometric mean corrects for substitution that arises when consumers change their consumption because of changes in prices. It differs how many prices are collected for each basic heading but the price change is calculated for all items available in both periods. The last price available is used if the item is not available at the time of price collection[39]. It depends upon the nature of the basic headings how many prices are collected. When the items are heterogeneous, the basic heading not detailed and the prices vary the calculation will be more reliable collecting many prices within this method of calculation. Such is the case for car spares, toys, and books. When the items are homogeneous few prices can be sufficient for reliable price measurement. The results in the calculation of the geometric mean is independent of the package size and thus allows for different package sizes in the same basic heading. The substitution is only measured within the basic heading not between them according to this method of calculation.

4.3.2 Weighted relative of the geometric mean prices for groceries, perishable items (see appendix).

The method covers nearly 18 per cent of the base expenditures. Retailers are divided into for groups, Baug, Kaupás, Samkaup and Other. Each group is divided into stores that now totals eleven[40]. Stores are the base unit in the calculation of the index for groceries and their activity reaches all regions in the country. Regional weights are not any longer in use[41]. Store weights make the calculation of the index simpler and make it easier to treat changes in shopping habits, especially when one store replaces another[42]. One reason is the concentration in the retail sector. Three groups now dominate the biggest part of the retail market for groceries. The fact is that the prices within a store are very similar, independent of localisation in the country.

In each store the geomean of prices for all items within a basic heading is calculated. The items can be of different size and make and items only available in one store can be included. The total is weighted in accordance with the share of each store in the

---

[39] If item is not available for three months the HICP rule is used and a new item is chosen.

[40] They were 13 in April 2002 in the link month. Since then Nýkaup has been merged with Hagkaup and KÁ merged with Nóatún. In the HBS a total of 155 retail stores is registered.

[41] From March 1997 to March 2002 regional indicies for groceries were calculated in the CPI. The total was weighted by using regional weights.

[42] Store weights have also changed in the year 2002 and 2003. For example two clock stores 10-11 (in Borgarnesi and Egilsstöðum) and one Hagkaup store have been changed into Bónus stores.

total sale within each of the 364 basic headings for the groceries. The total number of price quotation is between 9-10 thousand each month. The prices are collected for more than 800 items and the store weights are nearly 4000. In the stores about 5500 average prices are calculated and when they have been aggregated within each basic heading they amount to 3500. For further explanation the subindex for rice can be observed (COICOP group 01111). Seven rice items are priced, in packages of different sizes, types and brands. The average prices in the 11 stores for these 7 items are 49 and they are all used when the average prices are calculated for the basic heading. The weight is based upon the amount for rice sold in each store. If an item is not available within a store the substitution effect is supposed to be as follows. The consumer first searches for another item within the same basic heading in the store. If no item is available he goes to another store and buys the item at the average price of all the other stores where the good is available. Substitution between stores is in that way allowed. In the calculation of the groceries subindices the average is calculated for all items available and then compared to the average price of the same items in the base period of the index[43]. The number of prices collected differs therefore from month to month and the average prices used each time also differs. One of the major advantages of this calculation method is the fact that all the prices collected each time are used in the price measurement. The basic assumption for use of this method is that many prices are underlying each average price calculated. To increase the probabilities that this condition is fulfilled the prices are collected from more than one shop within the biggest stores.

4.3.3 Laspeyres (2.1) or relative of mean prices (2.4)

Laspeyres or relative of mean prices is used for subindices that cover nearly 38 per cent of the CPI expenditures. The method is mainly used when there are detailed weights and exact additional information available. In many cases no substitution effect occur as is the case with the geometric mean. When the weights are at the item level it does not matter if the geomean is used or the relative of averages. These basic headings are alcohol and tobacco[44], housing, cars[45], petrol, driving lessons, communications, lotteries, package holidays and insurances[46].

---

[43] This differs from the calculation of the relative of geomean prices when the item is not available. In that case it is incorporated in the calculation at the last known price.
[44] There is a substitution effect at hand but the weigth is very detailed down to a bottle of alcohol and a packet of tobacco. The base is changed once a year and the price comparision within the year is paired.

4.3.4 Superlative indicies (2.9, 2.10 and 2.11)

This method is used for basic headings covering nearly 2 per cent of base expenditure. To be able to utilise this method detailed information about the expenditure structure has to be at hand. Fixed base indicies do not measure such changes but superlative indices do. If a new weight is available (Paasche) then it is used along with the older weight (Laspeyres) and the result calculated as Fisher, Walsh or Törnquist indices. New tariffs for services often include readjustment of the tariff structure and price changes which can lead to considerable changes in consumptions patterns. The price changes are calculated according to the consumption pattern last available and also with estimated new weights and in that way the substitution effect which can be considerable, is taken into account[47]. The expenditure are: TV tariffs, local buses, domestic flight, swimming and kindegarten.

4.3.5 Subindices calculated with indicies

Approximately 3 per cent of the CPI expenditure is calculated in this way. The indices are mostly used by convenience and their calculation in independent of the CPI calculation. The biggest item calculated in this way is housing maintenance where subindices from the building cost index are used. Other subindices change in accordance with the wage index such as child minding, au pair and home care services. Subindices for food, electricity and heat are used for calculating school accommodation. The CPI is used for calculating expenditure calculated as ratios such as stamp charges, title deeds and loan cost.

It is not appropriate to use the CPI for measurement in the CPI calculation it can have circular effect on the price change and the use of it is therefore an exception. It is difficult to know exactly about its coverage but rent is probably the basic heading mostly affected as about half of all rent contract in the rent sample are indexed by the CPI.

4.3.6 The calculation of the total CPI

The total index is calculated as modified Laspeyres index. The modification is such that the base from year 2002, mainly originating from the year 2000 HBS is price updated from year 2000 to March 2002. The price changes in the CPI are then calculated from the base in March 2002 to the month of calculation.

---

[45] Substitution effect is at hand but the weight is revised yearly according to a very detailed information about import.

[46] Price changes are estimated after a extensive model of the Icelandic insurance market.

[47] Usually these subindices do not change frequently.

When the total index is calculated the average price changes are first calculated for each subindices. The subindices are aggregated and presented at different level of aggregation. The index is chain linked in March each year and the results for March on the old and new base used as link.

The risk is always at hand that the index over- or underestimates the price changes in chain indicies[48]. Drift in indices can occur if there are big price changes in the link month. It can be seasonal price changes or other kind of changes and it is of special importance that they are not overestimated. The clothing sales are not over in all shops in March so there is need for special care when replacements are made to avoid drift (in this case under estimation of price change).

---

[48] Frish (1936) 8-9, Szhulc (1983) 555-556.

5. Changes in shopping habits and households shopping (outlet) substitution bias

The prices of the same or similar goods are often very different in shops and the consumers always need to take that fact into consideration. Consumer price indices measure the price change of private consumption and in reality the prices should be measured in the households. That is not done mainly because sufficient information about the shopping habits of households is not available. In the price collection for the index the prices are measured in the shops and the average prices are weighted by division of stores sales. When the households change their shopping habits the average prices of the goods bought change without anything happening in the shops, the prices there could be unchanged. To take such effect into consideration there is a need to change the weights of the shops and take that effect into consideration in the price measurement[49].

It is important that the sample of shops reflect households trade correctly. Shopping is steadily changing and consumers alter their shopping habits. Shops closes and new ones open or they close without any replacement. New shops are also opened but they do not necessary replace another directly.

Consumers organise their buying in accordance with this development. If a shop closes down consumers are forced to change but can by goods at the same place if the shop is replaced by another or in a new store. However if consumers buy the same goods in some other place at a lower price, it need to be taken into account in the index calculation, otherwise an households shopping substitution bias (often called outlet substitution bias) will occur[50].

Until now it has not been possible to follow such changes because of lack of information. Not accounting for the shopping substitution in the CPI equals to the assumption that all the price difference between stores is because their service level is different. In that case no price change is measured in the CPI when consumers change their shopping habits. "When pure price difference exists, a change in market condition make it possible for some households to switch from purchasing at higher to lower prices, for example by changing outlets from which they purchase. The

---

[49] If the price change would be measured with households weights their share of shopping in different stores would be changed when shopping habits changed.

[50] In reality the price policy of a shop does not matter in connection with that but the consumption behaviour of the households does. Therefore it seems more appropriate to talk about households shopping substitution bias instead of outlet substitution bias.

resulting fall in the average price paid by households counts as price fall for CPI purposes, even though the prices charged by the outlet may not change."[51]. The discussion about this kind of bias has not been on a big scale internationally and correction of indices are exceptional[52].

5.1 Inflation, changes in the organisation of shops and shopping habits

In April 2001 the inflation in Iceland increased considerable and from April to the end of the year the CPI rose by 7.3 per cent and the twelve month change at that time was 9.4 per cent. In the year 2002 the price changes diminished and from the beginning to the end of the year the CPI rose by 1.4 per cent.

When the inflation rose there were considerable changes in the organisation of shops and shopping habits in the country, especially in groceries as consumers moved their trade to shops where prices were lower. The share of self service petrol stations increased also remarkably in a few months time. Considerable increase in the share of discount stores occurred mainly within the Baugurgroup as the Bónusstores increased their market shares by approximately 40 per cent in the year 2001. Now they have the countries biggest share in the groceries market.

In addition to inflation few other factors were important. In October 2000 the Bónus stores allowed the use of credit cards in their stores, but before that there was only possible to pay by cash. The number of Bónus stores increased. They were 9 in the first quarter of the year 1999 but in the middle of the year the first shop outside the capital area opened, in Ísafjörður and a Hagkaup store in Kjörgarði was changed into Bónus store. The last months of the year 2000 till the end of 2001 6 new Bónusstores were opened, thereof two outside the capital area, in Akureyri and Selfoss. New stores were also opened in or near the shopping centres of Kringlan and Smárinn at the end of the year 2001. Last part of the year 2002 two clockshops (10-11) were turned into Bónus stores, in Borgarnes and Egilsstaðir. In April 2003 Hagkaup store in Keflavík was turned into Bónus store and the number of shops was then 20. Similar development but on a smaller scale happened with the second largest group, the Kaupás group, as they opened the Krónastores. These great changes in the organisation of shops and shopping habits especially in the year 2001 were so fast and massive that they had to be taken into account in the CPI price measurement.

---

[51] ILO (2002b), chapter 1, 38.
[52] Reinsdorf (1993), Boskin (1996) 28-29 og 67, BLS (1997) 5.

In the Bónusstores the prices are often lower than in other type of stores and that price difference has remained even if the quality difference between them and other stores have diminishes. In that connection some changes may be pointed out that have incurred at the Bónusstores mainly in the year 2001.

In the beginning the shops were placed in simple housing, away from the main shopping centres, few commodities were available and they had do be paid with cash, few cash registers were available in each store and the opening hours limited. The newest stores are placed in more spacious housing, in or near shopping centres like Kringlan, Mosfellsbær or Smáralind[53]. The costumers who in the beginning paid for their commodities with cash can now use credit cards. The item selection has increased[54], there are more cash registers in each shop and they are now open every day of the week.

These shops are now widespread around the country, in Ísafjörður, Akureyri, Selfoss, Borgarnes and in Egilsstaðir. The selection of goods is still more limited than in other stores so consumers have to go to other shops if they wish to have more diverse selection of commodities and the items are often different, especially regarding sizes of packages. Of the basic heading for groceries in the index only 15 are not available in these stores[55]. It is easier for consumers to shop at the Bónusstores as they have grown in number and are therefore easier to reach.

The trademark of the stores has become the best known within the retail trade in the country. That decreases consumers search cost and has certainly actuated these large changes[56].

Consumers can choose between different level of service when buying petrol. The service stations now offer the costumer the choice between full- or self service. Self service stations have rapidly grown in number. In the year 2001 approximately 10 per cent of costumers moved from full service to self service when buying petrol.

Petrol is a homogeneous good and the difference between the forms of service is less than before. Since the self service stations became more accessible the queues have

---

[53] The drift cost in lowprice shops is not necessary higher in shopping centres than elsewhere. Low price stores attract costumers which can effect the amount the rent that they pay.
[54] In the year 1999 grocerie items were 1100 but had reached 1400 in the year 2000. Kaupþing (1999) 9, Íslandsbanki (2000) 19.
[55] For example Bónus stores do not sell tobacco and some types of meat do not have any subindices in Bónus.
[56] It can be measured by regression coefficients. Such research has been conducted and shows that prices have the biggest attraction. (Personal communication with Jón Scheving Thorsteinsson, managing director, Baugur ID).

vanished but they were common before. Thus the consumer now spends the same time at the station whether he uses the full service or not and often the self service is quicker. The quality difference between self service and full service at petrol stations is therefore very small or none at all.

5.2 Quality adjustment and the changes in the outlet sample

5.2.1 Quality adjustment for groceries

In price measurement under estimation of quality change of goods or services leads to over estimation of inflation. The danger is biggest when inflation increases suddenly and the buying pattern of households changes on a large scale. The service level of the shop influences consumers shopping and it includes all factors that influence quality and features that decide the outlet type. Such factors are commodity selection and availability of items, number of stores and their localisation, number of cash registers, opening hours and the method of payment. All these elements have to be reflected correctly in the price measurement. Quality is both subjective and individual and therefore a considerable difficulty is faced in measuring the level of service, except for the selections of goods. The difference between dicount stores and stores of other type is less than before regarding the components that were listed above.

There is a possibility to measure quality difference in the level of service by comparing the selection of items available or the goods that are joint in the stores as they reflect the part of service level that can be price measured. Some of the commodities that were available in the old store are not available in the new one, there are other types of packages and brands. The consumer shops in the same place but in a new type of store. The method used in that case is to compare the items available in the shop which closes down with the items in the replacement shop. The difference in price level between the stores for goods available in both stores are used to measure the price change. Difference in weights of the shops does not influence to a great extent the result of the calculations of the CPI if the price change within the shops are similar. Simulations tests in December 2001 by changing stores weights and recalculating the index gave approximately the same results as the published CPI. When consumers move between stores and buy the same goods but at a lower price a part of that is a pure price change and it is not until that price change is taken into account that the CPI is lowered.

5.2.2 Changes in the outlet sample

From the year 1997 - 2001 six stores that were in the CPI sample closed down and in all these cases new store was taken into the CPI instead. The price changes were measured by comparing prices of joint goods[57] and the difference in the level of service quality adjusted in that way.

The changes in the shopping patterns in 2001 were treated in a similar way. The result was that nearly half of the increase in the market share of the low price stores was taken into account as a price reduction and the other half as a quality adjustment due to difference in assortment. The result was incorporated into the CPI in December 2001 and in April 2002, but then store weight were adopted which make it easier to incorporate new stores into the sample instead of shops that drop out. In three cases have there been changes in the year 2002. First Nýkaup in the Kringla shopping centre were changed into Hagkaup store in May 2002[58] and the weight for Nýkaup was moved over to the Hagkaup stores. KÁ in Selfossi was turned into Nóatún store in the middle of the year and the weight for that store moved over Nóatún. In December 2002 two new Bónus stores were incorporated instead of two clock stores (10-11) and their weight moved to Bónusstores. The difference in assortment was some, even if the number of basic heading is similar, especially regarding difference in package sizes and brands[59]. One of these shops was in the CPI sample so that change would have been measured with older methods. The changes have continued and in May 2003 more than 1% of the total groceries weight were moved between stores[60].

Store weights have proved their relevancy and they make treatment of sudden changes in shopping habits much easier.

5.3 Correction of stores weights for groceries

When the inflation escalated in the year 2001 consumers directed their shopping to shops with lower price level. On the whole nearly 10 per cent of consumers changed their shopping habits in a very short time period, buying goods in shops with lower

---

[57] Examples of such changes that influenced the CPI was when Nettó store opened in Reykjavík in August 1998, replacing store that was in the CPI sample and the change was measured immidiately. Indirect influence was also at hand as other stores lowered their prices when this happened.

[58] Hagkaup in Kringlan shopping center had been changed into Nýkaup in June 1998.

[59] Approximately half of the goods available in the clock store (10-11) was available in the Bónus store

[60] Hagkaup in Njarðvík was closed replaced by a Bónus store in April 2003. In April 2003 a clock shop (11-11) in Mosfellbæ was replaced by Krónustore. The director for the Kaupásgrup have announced that more such changes will occur in the year 2003.

prices. Consumers think that there are advantages in such an exchange. It is not known that such sudden changes in shopping habits have happened in such short time interval in other places[61].

Because of this development it was necessary to change the weights effecting the CPI measurement. The CPI base is revised each year but when the changes in the retail market were so big it was necessary to take it into account in the calculation of the CPI as soon as the information was available. An exact information about the groceries sale was at hand so mapping the changes was possible. This information about market share came from cash receipts in the continuous HBS and in addition exact information was collected from the biggest group about monthly sales of stores. Information from both these sources was compared showing similar results. Again the correction was made by measuring the level of service reflected in common goods. The correction of the store weights for groceries in December 2001 led to a price cut of the food component in the index by 1.3 per cent, bringing down the CPI by 0.27 per cent. These effects were estimated again in April 2002 leading up to a further lowering of the index, by 0.10 per cent[62]. At the same time the effect of changes in the shopping habit for petrol led to the lowering of the CPI by 0.08 per cent. In April and May 2003 additional changes in the shopping structure were estimate leading up to a 0.07 per cent's lowering of the CPI.

The total effect on the CPI, by correcting for changes in household's shopping substitution on groceries and petrol in December 2001, April 2002 and 2003, was a decrease by nearly 0.55 per cent.

---

[61] "I think that this has never happend in the world before. Although it is possible that WaalMaart growth in some regions in the USA may have been similar."(Personal communication with Jón Scheving Thorsteinsson, managing director, Baugur ID).

[62] In April 2002 a third source of information, namely VAT-reports from the Internal revenue directorate, were used. They supported and strengthened the result form other source's.

6. Housing in the Consumer price index

In the years 2000-2002 about 82 per cent of Icelanders lived in own housing according to the HBS. To buy an own house is the aim of most people in Iceland and is usually the biggest investment of individuals in their lifetime. House is a place to live in and at the same time an investment and to price measure the use has been a problem in CPI calculation. The use of own house is calculated as imputed rent in the consumer price index, but the buying of the house is an investment and therefore not taken into account in the calculation.

6.1 Methods in the calculation of owner occupied housing

Four main methods are used in the calculation of owner occupied housing. Rental equivalence, user cost, net approach and the method of payments[63]. The most convenient method is to calculate rental equivalence where the result for rented housing in the rent market is used. The rental equivalence is like a rent for comparable apartment or houses. The primary assumtion is that the rent market has an adequate coverage so market rent can be measured for comparable types and sizes of properties and that the results can be used as equivalence to changes in rent for own housing. Secondly that the rent market is not controlled, rent is not subventioned by governments or the market prices controlled in other ways. This method can not be used in Iceland because of the small rent market that also has different composition than the stock of own housing. The method is used in Denmark, Germany, Netherland, Norway, USA, Switzerland and Japan[64].

Another method measures user cost, it is used in the Icelandic CPI. The service of living in own house is measured as the cost. Annuity is calculated of the market price of the house and the imputed rent measured according to a certain real interest rate and depreciation rate. The real interest rate is based on the required rate of return (the opportunity cost) on the capital bound in the property, independent on whether it is owned capital or a loan. The wear of the property is taken into account, it is depreciated in accordance with the expected lifetime of the house. In addition minor repairs are taken into consideration and public tariffs connected to the house such as sewer, garbage and water[65]. It is only the use of the house that is accounted for not

---

[63] The fifth possibilty is to leave owner occupied housing out of the CPI.
[64] This information is based on Boldsen Hansen (2000).
[65] Additional user cost model is based on cash flow. In that method the nominal interest rates and depreciation are measured.

the capital gain of the investment. The price change is measured by all properties sold in the country. The consumer price index is a short time measurement tool for estimating price change and assumed that no substitution between living in own housing and renting is possible. Some countries calculate their housing as a user cost but none of them uses real interest rates in that calculation except Iceland. They are Finland, Sweden, Iceland, Ireland United Kingdom and Canada.

The third method is to measure the housing with a net method. The net housing cost is the value of new houses in excess of depreciation of the stock. The housing is taken as any other expenditure in the index when it is bought or built and treated equally as other durabel goods in the CPI. This method is for example used for cars, electrical equipment; they are capitalized and taken into consideration in the CPI at the point of purchase. The price change is, using only price changes of new buildings. Included are houses constructed by the consumer and properties bought directly from a construction company or real estate agents. In addition it's necessary to take into account properties that are bought directly from other sectors in the economy. This index has many similar properties as a producer price index for buildings[66]. Each year there is a different amount built of new houses. The net change in housing can therefore be negative in some years and the net weight for housing too if calculated by the this method. It will therefore probably be necessary to calculate the weight as a average over few years. The weights will be more volatile when the net method is used than is the case for rental equivalence or user cost and the net weight will usually be lower[67]. The method is used in Australia and New Zeeland.

The fourth method is the payment method. The payments when buying the house are counted for, payment on loans, interests, reparations and renovations. This method is similar to the method used in the Icelandic CPI in the years 1988 to 1992. It's main failure is the use of the nominal interest rate, as it in reality partly reflect the inflation, and the ignorance of the fact that the use is spread over a longer period of time. Some countries consider housing mainly as investment and argue that it should therefore, similar to other investment, not be taken into the CPI . The reason might also be that price information about the property market is not available, making the above mentioned methods impossible to apply. The owner occupied housing is left

---

[66] The method has been under study for inclusion in the HICP.
[67] Even half of it (Diewert 2002a) 62.

out of the CPI[68] in Greece, Italy, Spain, Portugal, Belgium, Austria, Luxembourg and France.

6.2 Owner occupied housing in the Icelandic consumer price index

The method to calculate housing as user cost and price update it with price changes of all properties sold was adopted in November 1992 and has been mostly unchanged since then. In the beginning the prices were only measured in the capital area but since April year 2000 they cover the whole country[69]. The base for the calculation is the real estate value of the house and that information is collected in the HBS. The user cost is calculated with real interest rate that is now 4 per cent and depreciation rate of 1.25 per cent of the house's real estate value. The price measurement is monthly updated by price index for properties sold. Owner occupied housing covers imputed rent, minor repairs and other cost, such as tariffs for sewer, garbage and water. The weight for housing cost comes from the HBS as an imputed figure and the monthly weight is calculated as an user cost of the real estate value. There are three factors taken into consideration when the user cost is measured. First the base for the annuity, second the real interest rate and third the depreciation.

6.2.1 Weight as the annuity base

The base is the estate value of the property. "the law about the measurement of the real estate value says that it should be based on the market price of the property. According the 1 paragr. of the law nr. 6/2001 shall the estimated value be the discounted market value as estimated last November"[70]. In the middle of the year 2001 the real estate value was revised by the Land registry of Iceland after extensive research by regression analysis. The base for the analysis was the capital area and the estimate for other parts of the country was calculated with regional coefficients[71]. The value of all properties in the country are measured in a harmonised way based on information about sold properties. This basic information is the same as used in the price measurement of housing in the CPI and the real estate value is therefore well suited as a base for the user cost calculation.

---

[68] Share of owner occupied housing in these countries is: Greece (75), Italy (78), Japan (78), Portugal (66), Belgium (65), Austria (50), Luxembourg (72), France (54). Boldsen Hansen (2000) 12.
[69] Correction was made for over measurment of price changes of houses in April 2000 lowering the CPI by 0.35 per cent. At the same time under estimation of rent was corrected leading to a 0.34 per cent increase in the CPI..
[70] Örn Ingvarsson (2002) 260.
[71] Fasteignamat Ríkisins (2002) 17-22 og Örn Ingvarsson (2002) 259-270.

6.2.2 Real interest rate

Usually when consumers buy properties they finance it partly which own equity and the rest with loans. The user cost model is based on the financing as measured in the sales contract that are the base for the price measurement. This division of financing is used to calculate the real interest rate used in the calculation. The payment according to the sales contracts is taken as the buyers own equity[72]. The real interest rates used for the own equity reflect the long time rate of return of housing investments. In the calculation of the imputed rent it is supposed that own equity is approximately the half of the house price. When deciding the real interest rate for own equity and because the rate of return has a long term character it was set as the estimated rate of return for the pension funds in the country. When these methods of calculation were adopted the long time interest rate of the pension funds was 3 per cent and it has been kept unchanged since then[73]. Other forms of payment according to the contracts are usually new loans or loans that are taken over and the real interest rate used in the calculation is according to the credit terms[74]. These are most often loans from the Housing financing fond or loans that are taken over by the buyer from the old State housing board. Other financing is mainly originating from the pensions funds. The average real interest rate measured in this way has been around 4 per cent in the last years[75].

6.2.3 Depreciation

Depreciation should reflect the tear and wear of property and is always very uncertain. The maintenance differs and therefore also the obsolescence. The depreciation rate used in the index is 1.25 per cent of the real estate value. Land is not depreciated as it does not wear over the time. The depreciation should therefore only be calculated of the value of the building. By convenience the depreciation is calculated of the whole value of the housing stock. The depreciation is therefore in reality 1.5 per cent of the house setting the life time of the property to approximately 67 years. The housing stock divided after the building year published in the real estate registry at the end of

---

[72]This share could of course partly be financed with loans, not with properties.

[73] The long time rate of return for the pensions funds is now in the range of 2.0-3.5 per cent. Long time rate of return according to the liability law is 3.5 per cent.

[74] Real interest rates for these payments lie in the range of 5.0 to nearly 9.0 per cent.

[75] The capital gain of the investment is not taken into account here. It is added to the rate of return of the investment taken into account in this method. Investments are not taken into the calculation of the CPI. The capital gains are in reality connected to investment decision of firms where the captial gains can be decisive in deciding the viability of the investment. It is therefore more connected to a PPI aspect than to the CPI.

the year 2001[76] shows that 90 per cent of all property is constructed after the year 1940, more than one third in the period 1960-1980 and one third is constructed later. The depreciation rate seems therefore to be in accordance with the property stock after building year. The depreciation prerequisite depends on the maintainance of the stock but in the CPI only minor reparations are taken into account[77].

6.3 Price measurement of properties

6.3.1 Real estate prices and price indices for housing

The market prices are gathered from the sales contracts which the Land registry of Iceland has collected for many years. These data are the base for their evaluation of house's real estate value and is also used for the measurement of market prices used in the CPI. The sales information is collected through the District Commissioners and the change in the ownership of the property can not be registered unless the sales contract is at hand. Between 8-10 thousand sales contracts are collected each year covering 8-10% of all properties in the country[78]. In the sales contracts the form of payment is shown and that information is the base for the calculation of the present value of the contract. The rate of return in the contract after type of payment is based on market information. The rate of return is measured every month and if the change exceed a minimum the rate of return is changed[79].

Changes in the market price and the rate of return influence the price measurement. When the rate of return goes down the, the present value goes up and increase in the rate of return lowers the present value. The present value of the contract is used for the price updating of properties in the CPI. The price measurement concept is the same as is used in other parts of the CPI and the prices taken into account are those the consumer pay in reality for goods and services.

The prices are the average prices in the country[80]. The total price information from all the sales contracts are used in the calculation of the imputed rent. In the calculation the combination of the house's size is kept fixed, based on the sale's volume in each category for the last three years. The price change is measured for houses (13 per cent

---

[76] Örn Ingvarsson (2002) 261

[77] It is a question if major reparation should be added to the value of the housing stock before the weight is calculated.

[78] It does not matter whether the numer or sales value are used.

[79] The rate of return has been changed four times in the year 2002.

[80] This has been in this way since March 2000. The index for the whole country was then calculated backwards to March 1997.

share) and appartments (59) for the capital area (72) and houses (15) and apartments (13) outside the capital area (28).

The emphasis is on the of price change comparison within three groups of properties not between types of properties or between regions. The size groups are eight. In total nine subindices for housing are calculated in the capital area and eight for housing outside it. The main indices are four, for houses and apartments in and outside the capital area. In total the calculation is based in all on 21 subindices, used in the calculation for the total index for property prices. The calculation is based on three month's average with one month's time lag[81]. The sales contracts in april refer to the period January to March and in May for the period February to April e.t.c.

6.3.2 Property prices in the consumer price index

The user cost is calculated with assumptions about the rate of return and depreciation. These change very seldom, are approximately. The imputed rent reflects therefore the market prices changes in properties. Asset prices are incorporated into the CPI in that way. It does not matter in reality if the net weight[82] would be used. It reflected the market prices of houses in the same way. The methods will therefore show similar market price change given that the price change of new housing and all properties sold (where the new houses are also taken into the measurement) are similar.

This method of measuring price changes in the property market in the consumer price index has been successful[83]. Research done by the Icelandic Centralbank showed housing as an important part in measurement of future inflation. "On the other hand lot of information is lost if the housing post is taken out of the CPI"[84]. The connection between housing prices and inflation was pointed out. "The significant correlation between housing prices and the CPI for more than two years ahead might indicate that there is unused information about future inflation in the development of housing prices"[85].

A strong connection can be observed between price changes in the rent market and the changes in the market prices of housing, i.e. both indices seem to develop in similar way in the longer run even though they in shorter time periods can move in dissimilar

---

[81] Contracts from places outside the capital area arrive with two months timelag.
[82] Except that the weight would be lower.
[83] One of the main uses of the CPI is for indexation of long term loans for housing. It is therefore proper that property prices are reflected in that index.
[84] Þórarinn G. Pétursson (2002) 60.
[85] Þórarinn G. Pétursson (2002) 59.

cycles. Imputed and paid rent showed similar changes from March 1997 until the middle of the year 2002 but that has changed in the last month of 2002.

High rent prices give an incentive for buying own houses. Contraction or resistance in the housing market sales has emerged in grown tendency to let properties go as payment into the sale[86] entailing an increased supply of apartments for renting which again entails to lowering of the rent.

---

[86] Share of properties and other capital goods in the contracts were nearly 20 per cent of the value in the year 1995 and about 4 per cent in 2001. Fasteignamat Ríkisins (2002) 31

Appendix

Calculation of elementary indicies for groceries in the Icelandic consumer price index.

Jevonsindex is used for the calculation of elementary indicies for groceries in the CPI. The stages in the calculations are:

1) For each price observation, i, in store j, within basic heading k, an unweighted geomean is calculated:

$$(1) \qquad P^t_{jk} = \prod_{i=1}^{n} \left(p^t_{ijk} \right)^{1/n}, for \ p_{ijk} > 0$$

Where:

price observations, i= 1,..,n

stores, j= 1,..,m

basic heading, k= 1,..,h.

To make the calculations technically easier the logarithms are taken on both sides:

$$(1a) \quad \ln\left(P^t_{jk} \right) = 1/n \sum_{i=1}^{n} \ln\left(p^t_{ijk} \right)$$

Operations (1) and (1a) are carried out in the same way for all basic headings in March (basemonth) each year and in the month of calculation.

The following price tables are available after the first step in the calculations:

P^t_{jk} : Average price for basic heading k, in store j, in the month of calculation.

P^0_{jk} : Average price for basic heading k, in store j, in the base period.

2) Weights are for the first time taken into consideration in the calculation at this step. Stores have a weight share in each of the basic headings, where

$\sum_{j=1}^{m} w_{jk} = q_k$ [87]. The weight share is as based on:

---

[87] Special case : If $P_{jk} = 0$ in store that has $w_{jk} > 0$: then a scaling of the weight is made moving it over to the other stores.

w_{jk} : Households expenditure shares in a store for basic heading k, and q_k is

the base expenditure share in the index for basic heading k and $\sum_{k=1}^{h} q_k$ is the

total expenditure for groceries.

Weighted geomeans P_{jk}^{t} and P_{jk}^{0} are calculated

(2) $\overline{P}_{k}^{t} = \prod_{j=1}^{m} \left(p_{jk}^{t} \right)^{w_{jk} / \sum w_{jk}}$, for $P_{jk}^{t} > 0$.

$\overline{P}_{k}^{0}$ is calculated in the same way.

The logarithm of the ratio of the averages is taken and the equation adjusted to a convenient form.

$$\mathrm{Ln}\left(\frac{\overline{P}_{k}^{t}}{\overline{P}_{k}^{0}} \right) = \sum_{j=1}^{m} w_{jk} \left(\ln \overline{P}_{jk}^{t} - \ln \overline{P}_{jk}^{0} \right)$$

The result $\dfrac{\overline{P}_{k}^{t}}{\overline{P}_{k}^{0}}$, is the price change for basic heading k , from the base period

of the index to the month of calculation. It is used in the calculation for each

elementary index, v_k .

The index for groceries is calculated as $\dfrac{\sum_{k=1}^{h} q_{k}^{0} * \overline{P}_{k}^{t}}{\sum_{k=1}^{h} q_{k}^{0} * \overline{P}_{k}^{0}}$, i.e. an Laspeyresindex

References

Allen R.C.D. (1975), Index Numbers in Theory and Practice, Macmillan.

Arnljótur Ólafsson (1880), Auðfræði, Hið Íslenska Bókmenntafélag, Kaupmannahöfn

At What Price? Conceptualizing and Measuring Cost-Of-Living and Price Indexes, Panel on Conceptual, Measurement and other Statistical Issues in Developing Cost of Living Indexes (2001), Schultze, Charles, Mackie, Christopher ritstjórar, Commitee on National Statistics Division of Behavioral and Social Sciences and Education National Reasearch Council, National Academy Press, Whasingon DC.

Balk, M. Bert (1995), Axiomatic Price Index Theory: A Survey, *International Statistical Review* 63, 69-93.

Balk, M. Bert, (1997), On the use of unit value indicies as consumer price subindicies, *Proceedings of the Fourth Meeting of the International Working Group on Price Indices* Walther Lane, editor, 112-120. Bureau of Labour Statistics, Washington, DC, January 1999.

Balk, M. Bert, (1999), On curing the CPI's sustitution and new goods bias, Statistics Netherlands *Reasearch paper nr. xxxx*

BLS, (1997), Measurement Issues In The Consumer Price Index, Bureau of Labour Statistics U.S Department of Labour, June 1997.

Boskin, M.J., Dulberger, E. R., Gordon R. J., Griliches, Z, Jörgensen, D., (1996), Final Report to the Senate Finance Commitee from the Advisory Comission to study the Consumer Price Index, December 4,1996.

Boldsen Hansen, Carsten (2000), The treatment of owner occupied housing in the CPI, final Report by Task Force XII, January 2000, Eurostat.

Carruthers, A.G., Sellwood D.J. og Ward P.W. (1980), Recent Developments in the Retail Prices Index, *The Statistician* 29, 1-32.

Dalén, Jörgen (1992), Computing Elementary Aggregates in the Swedish Consumer Price Index, *Journal of Official Statistics* 8, 129-147

Dalén, Jörgen (2001a), The Swedish Consumer Price Index. A Handbook of Methods, SSB 2001.

Dalén, Jörgen (2001b), Statistical targets for price indexes in dynamic universes, *Paper and Proceedings of the Sixth Meeting of the International Working Group on Price Indicies* Keith Woolford editor, 437-467, Australian Bureau of Statistics, Canberra, Australia, November 2001.

Diewert, W. Erwin, (1976), Exact and Superlative Index Numbers, *Journal of Econometrics* 4, 115-145.

Diewert, W. Erwin, (1978), Superlative Index Number and Consistency in Aggregation, *Econometrica* 46/4, 883-900.

Diewert, W. Erwin,. (1987), Index Numbers, 767-780, *The New Palgrave: A Dictionary of Economics*, Volume 2, J. Eatwell, M. Milgate and P. Newman, editors, Macmillan, London.

Diewert, W. Erwin, (1993), The Early History of Price Index Research, pp. 33-65, *Essays in Index Number Theory*, Volume 1, W.E. Diewert and A.O. Nakamura ritstjórar, Amsterdam: North-Holland.

Diewert, W. Ervin, (1995). Axiomatic and Economic Approaches To Elementary Price Indexes. Department of Economics University of British Columbia, *Discussion paper No.: 95-01*, Vancouver Canada, January 1995.

Diewert W. Ervin (1996), Sources of Bias in the Consumer Price Index*, The University of New South Wales Discussion Paper* 96/4.

Diewert, W. Ervins (1998), Index Number Issues in the Consumer Price Index,47-58, *Journal of Economic Perspectives* 12/1,

Diewert, W. Ervin, (1999), The Consumer Price Index and Index Number Purpose, *Proceedings of the Ottawa Group Fifth Meeting*, Reykjavík, Iceland, August 25-27, 1999, Rósmundur Guðnason and Þóra Gylfadóttir editors, Statistics Iceland, Reykjavík, September 2000. Available at the website:

http://www.statice.is/ottawa/papers.html

Diewert, W. Ervin, (2001), The Consumer Price Index and Index Number Theory: A Survey, *Discussion Paper 01-02*, Department of Economics, University of British Columbia, Vancouver, Canada, V6T 1Z1.

Diewert, W. Ervin (2002a), Harmonized Index of Consumer Prices: Their Conceptual Foundations, *European Central Bank Working Paper paper* NO. 130 March 2002, ECB.

Diewert W. Ervin (2002b), Chapters 13-15 in the ILO CPI manual, 10 December 2002, ILO Geneva. Available at the website

http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm

Eurostat (2001), Compendium of HICP reference documents (2/2001/B/5), Eurostat 2001

Fasteignamat Ríkisins (2002), *Árbók 2002*, Fateignamat Ríkisins 2002.

Fisher, Irving (1922), The Making of Index Numbers, Houghton-Mifflin, Boston.

Frisch, Ragnar (1936), "Annual Survey of General Economic Theory: The Problem of Index Numbers", *Econometrica* 4, 1-38.

Gillingham, Robert (1980), Estimating the user cost of owner occupied housing. *Monthly Labour Review* 1980/February.

Gillingham, Robert (1983), Measuring The Cost Of Shelter For Homeowners: Theoretical And Empirical Considerations. *Review of Economics and Statistics* XLV (2) 1983.

Goodhart, Charles (2001), What Weight Should Be Given To Asset Prices In The Measurement Of Inflation , *The Economic Journal* 111 (June), F335-F356.

Hagstofa Íslands (1999), Húsaleigukönnun Hagstofu Íslands í mars 1999, að finns á vef: http://www.hagstofa.is/frettir/husa.pdf

Hallgrímur Snorrason og Rósmundur Guðnason, (1999), The Use of cash register data, *Proceedings from the 52nd session of the International Statistical Institute*, book 1, 335-338. Bulletin of the International Statistical Institute, Helsinki 1999.

Haan, Jan de, Opperdoses Eddy, Schut, Cecile, (1997). Item Sampling in the Consumer Price Index: A Case Study Using Scanner Data. Statistics Netherlands, 1997.

Haan, Jan de (2001), Generalized Fischer Price Indexes and the Use of Scanner data in the CPI, *Paper and Proceedings of the Sixth Meeting of the International Working Group on Price Indicies* Keith Woolford editor, 286-310, Australian Bureau of Statistics, Canberra, Australia, November 2001.

Hawkes, William, Smith, Roger (1999), Improving consumer price measurement through the use of scanner data and market segmentation, *Proceeding of the Measurement of Inflation Conference, Cardiff University, Cardiff, UK, August 31-September 1, 1999*, 283-397, Mick Silver og David Fenwick editors, Eurostat, Cardiff University, ONS.

Hill, T. Peter (1988), Recent Developments in Index Number Theory and Practice, 124-146, *OECD Economic Studies No 10/1988*, OECD.

Hill, T. Peter (1993), Price and Volume Measures", 379-406, í *System of National Accounts 1993*, Eurostat, IMF, OECD, UN og World Bank, Luxembourg, Washington, D.C., Paris, New York, and Washington, D.C.

Hill, T. Peter (1997), The Measurement of Inflation and Changes in the Cost of Living, Joint ECE/ILO meeting on Consumer Price Indicies, Geneva, 24-27 November 1997.

Hill, T. Peter (1999a), COL Indexes and Inflation Indexes, *Proceedings of the Ottawa Group Fifth Meeting*, Reykjavík, Iceland, August 25-27, 1999, Rósmundur Guðnason and Þóra Gylfadóttir editors, Statistics Iceland, Reykjavík, September 2000. Available at the website: http://www.statice.is/ottawa/papers.html

Hill, T. Peter (1999b), Inflation, the Cost of Living and the Domain of a Consumer Price Index, Joint ECE/ILO Meeting on Consumer Price Indicies, Geneva, 3-5 November 1999.

Hofsten, Erland v. (1952), Prices, Indexes and Quality Changes, London, George Allen & Unwin Ltd.

ILO (2001), Consumer Price Indices, Report II, Meeting of Experts on Labour Statistics, Geneva, 22-31 October 2001, ILO.

ILO (2002a), Report of the Meeting of Experts on Labour Statistics, Geneva 22-31 October, ILO.

ILO (2002b), Chapters 1, 3 and in the ILO CPI manual, 10 December 2002, ILO Geneva. Available at the website
http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm.

Íslandsbanki FBA (2000), Baugur Útboðs og skráningarlýsing Desember 2000, Íslandsbanki FBA.

Johannessen, Randi (2001), Mikroindexformel i konsumentprisindex, *Notater 2001/64*, SSB.

Jón Sigurðsson (1974), Verðbólga á Íslandi 1914-1974, *Fjármálatíðindi,* janúar-júlí 1974, 29-43.

Kaupþing FBA (1999), Baugur apríl 1999, Kaupþing FBA.

Konsumentprisindexnämnden (1999), Konsumentprisindex betänkande från utredningen om översyn av konsumentprisindex, Justitiedepartementet, Stocholm, SOU:1999:24.

Konüs, A.A. (1924), The Problem of the True Index of the Cost of Living, þýtt í *Econometrica* 7, (1939), 10-29.

Laidler, P., Parkin M. (1975), Inflation a Survey, *Economic Journal*, 85, December 1975.

Lloyd, P.J. (1975), Substitution Effects and Biases in Nontrue Price Indices, *American Economic Review* 65, 301-313.

Moulton, B.R. (1996), Constant Elasticity Cost-of-Living Index in Share Relative Form, Bureau of Labor Statistics, Washington D.C., December.

Opperdoes, Eddy (2001), Some empirical experiments whith CES functions, *Paper and Proceedings of the Sixth Meeting of the International Working Group on Price Indicies* Keith Woolford editor, 631-647, Australian Bureau of Statistics, Canberra, Australia, November 2001.

Pollak, R.A. (1983), "The Theory of the Cost-of-Living Index", pp. 87-161, *Price Level Measurement*, editors W.E. Diewert and C. Montmarquette, Ottawa: Statistics Canada.

Reinsdorf, Marshall, B. (1993). The effect of outlet price differential in the U.S. consumer price index, 227-254, *Price Measurement and Their Uses*, M.E: Manscher and A.H.Young editors, NBER Studies in income and wealth 57, University of Chicago Press, Chicago.

Reinsdorf, Marshall B., (1996). Constructing Basic Component Indexes for the U.S. CPI from Scanner Data: A Test Using Data on Coffee. Bureau of Labour Statistics, Working Paper 277, Washington, DC, April 1996.

Rósmundur Guðnason, (1995), Note on the practices in the field of insurance, financial services and public price policies in the Icelandic CPI. *Proceedings of the Second Meeting of the International Working Group on Price Indicies, Stockholm, Sweden November 1995*, 171-175, Statistics Sweden.

Rósmundur Guðnason, (1997), Improved methods for the evaluation of the composition and quantity of household goods. *Proceedings of the Third Meeting of the International Working Group on Price Indices*, B.M. Balk ritstjóri, 129–131, Research paper no. 9806, Statistics Netherlands, Febuary, 1998.

Rósmundur Guðnason, (1998), Comparison of different sources for weights of selected groups in the Icelandic CPI: Consumers bar-code receipts vs scanner data from supermarkets. *Proceedings of the Fourth Meeting of the International Working Group on Price Indices*, W. Lane editor, 205–209, Bureau of Labour Statistics, Washington, DC, January 1999.

Rósmundur Guðnason, (2001), Telecommunication services in the CPI – a quantity approach, *Paper and Proceedings of the Sixth Meeting of the International Working*

Group on Price Indicies, Keith Woolford editor, 631-647, Australian Bureau of Statistics, Canberra, Australia, November 2001.

Silver, Mick (1995). Elementary Aggregates, Micro Indices and Scanner Data: Some Issues In The Compilation Of Consumer Price Indices. *Review of Income and Wealth*, series 41, Number 4, 427-438. December 1995.

Silver, Mick (2002), Chapter 7 in the ILO CPI manual, 10 December 2002, ILO Geneva. Available at the website

http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm

Szulc, B.J. (1983), Linking Price Index Numbers, 537-566, *Price Level Measurement*, W.E. Diewert and C. Montmarquette editors, Ottawa, Statistics Canada.

Szulc, Bohdan, J. (1989), Price Indicies below the basic aggregation level, Turvey, R: Consumer Price Indicies. An ILO Manual,167-177.

Szulc, Bohdan, J. (1994), Choice of the price index formula at the micro aggregation level empirical evidence, paper from the first meeting of the Ottawa group, 31 October-2 November 1994.

Szulc, Bohdan J. (2001), User Cost Approach to the Estimation og Price Change for Private Transportation. Experimental Study in the Spirit of Cost of Living Index, *Paper and Proceedings of the Sixth Meeting of the International Working Group on Price Indicies*, Keith Woolford editor, 480-493, Australian Bureau of Statistics, Canberra, Australia, November 2001.

Triplett, Jack. E. (2001), Should the Cost-of-Living Index Provide the Conceptual Framework for a Consumer Price Index?, *The Economic Journal* 111 (June), F311-F334.

Turvey, Ralph (1989), Consumer Price Index. An ILO Manual, ILO Geneva.

Turvey, Ralph (2000), True Cost of Living Indexes, *Proceedings of the Ottawa Group Fifth Meeting*, Reykjavík, Iceland, August 25-27, 1999, Rósmundur Guðnason and Þóra Gylfadóttir editors, Statistics Iceland, Reykjavík, September 2000. Available at the website: http://www.statice.is/ottawa/papers.html

Verðbólguvandinn, (1978), Álit nefndar sem ríkisstjórnin skipaði hinn 21. október 1976 til að kanna horfur í verðlagsmálum og gera tillögur um ráðstafanir til að draga úr verðbólgu, Verðbólgunefnd, Reykjavík.

Walsh, C.M. (1901), The Measurement of General Exchange Value, New York: Macmillan and Co.

Walsh, C.M. (1921), The Problem of Estimation, London: P.S. King & Son.

White, Alan G. (1999), Measurement bisases in consumer price indexes, *International Statistical Review*, 67(3): 301-325, December 1999.

Þórarinn G. Pétursson (2002), Mat á kjarnaverðbólgu og notkun við mótun peningastefnunnar, *Peningamál 2002/4*, 52-61, Seðlabanki íslands.

Örn Ingvarsson (2002), Endurmat Fasteigna í júní 2001, Matsaðferðir við fasteignamat, gerð reiknilíkana og niðurstöður úr þeim, *Árbók VFÍ TFÍ 2002*, 259-270, Reykjavík.