

House price index, market prices and flow of services methods.

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Abstract

This paper describes changes made in March 2006 in the calculation of the Icelandic house price index to better address quality adjustment. The sample for the capital area was split into two strata, the weights used for calculation of the total house price index now reflect the value of all dwellings sold in the last three years, the geometric replaced the arithmetic mean when averaging house prices and the house price index is now calculated as a superlative index (Fischer). The paper also surveys the framework for owner occupied housing in connection with different market price approaches to measure user cost and problems connected with their use.

Key words:

Consumer price index, cost of living index, household expenditure surveys, owner occupied housing, user cost.

JEL: C43, C81, D11, E31.

1. Methods used for the calculation of house price indices and the Icelandic house price index.

Houses differ widely in quality, they are not homogenous goods and are often produced as one of a kind, are unique durables (Diewert (2003b) p. 24) so any comparison of their price changes is difficult and lead to some kind or other of quality adjustment. When a house is sold it does not appear on the market in exactly the same condition as when it was purchased so the matched model methodology is not usable. Therefore the quality adjustment of a house price index is necessary. Every sale of a house is random and does not necessary reflect the stock of houses but one requirement of such indices is that they should either reflect the stock of houses or the transaction of houses. Usually the indices suitable for use in the CPI are of the transaction kind. The methods used when the stock is valued are value estimates, but the aim of CPI's is to measure price changes and therefore the transactions indices are usually used for CPI price measurement.

Two kind of methods are broadly used in the calculation of house price indices and for quality adjustment which can be either direct or indirect or in both forms. Firstly there are hedonic methods, either the repeated sales method or other hedonic methods. The repeated sales method uses houses that are sold more than once (Baily, Muth and Nourks (1963)) and with a subsequent development in a weighted form (Palmquist (1980)). The problem with this method is the risk for bias, e.g. when major renovation or other changes have been made on the house which increase the quality or if the wear of the house has been high causing a decrease in the quality. Such changes are not captured by this method. In Iceland this method can not be used because the number of housing transaction are too few and thus not enough repeated sales to be able to calculate the repeated sales index. The other hedonic methods measure the prices of characteristics and the correct functional form is crucial. There is considerable amount of studies available and the most frequently characteristics used is age and square footage (Sirmans, Macpherson, Ziets (2005) p. 9).

The other form of indices measure the average or median sales prices. Often the characteristics of sales are kept fixed as a quality adjustment issue in a similar way as in the hedonic case.

The planning of the house price indices also take into account their use. The most common use are in the field of urban economics, e.g in evaluation of effects of location or communications. Realtors also use house price indices in their work to evaluate properties.

The house price index used in the Icelandic CPI is based on market prices for houses that are obtained from sales contracts that the Land Registry has collected for many years. They are suitable for this purpose because they are standardized throughout the country. Every sales contract contains information on the property and its owners and the sales price, along with precise details on payment terms. Every property has a special, distinctive number which is used in the register of the Land Registry. These detailed data form a basis for the aggregate real estate value and form the grounds for measuring the market price of real estate in the consumer price index. Since the contracts are gathered through the offices of the District Commissioners upon being registered, almost every concluded real estate agreement is obtained.¹ About 8,000-10,000 real estate sales contracts are closed annually, so that each year some 8-10% of all the housing in the country is bought and sold. The price concept is the same as for other price measurements in the index, in that the price taken for computations is the one the consumer actually pays for goods and services, the price of the goods in cash. A sales contract details how payments are arranged; in fact, that information enters into figuring its present value. The basic reason for applying the present value is the fact that the value of money paid today is different from the value of money paid in the future.

The price concept used in the CPI is cash price. There are different forms of payments when a house is bought. As money received today is not the same as money received at a future point of time it is needed to calculate the present value of each contract. According to the market information the discount rates varies depending on the type of payment. The discount rate is measured monthly and if the change exceed a certain minimum it is changed. When the discount rate is lowered, the present value of the property increases and vice versa. Changes in the market prices and the discount rate influence the price measurement. 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 in other parts of the CPI and the prices taken into account are those that the consumer pays in reality. In the long run the nominal and cash house price follow each other but within shorter interval they can divert temporarily.

The housing price index is computed from changes in the present value of real estate as declared in sales contracts. The greater part of the sales contracts serve in producing the

¹ It is not only in the interest of buyers that a contract is being registered but also a condition for credit services from the Housing Financing Fund and the commercial banks.

imputed rent and the weighted national average.² The calculation of price changes for real estate is a three-month moving average, with a one-month delay.³ April includes contracts from the period January to March, May contracts from the period February to April, and so on. Price information is gathered and the price change for imputed housing rent is estimated on the basis of all the sales contracts. In both these cases the value of housing is used. In the case of the CPI the use is for the measurement of price changes and the aim to measure price change of properties sold.

The house price index used in the calculation of the simple user cost in the Icelandic CPI is by a house price index that until now has been calculated by using average prices but keeping fixty on following details:

- The category sizes.
- Types of properties, single family houses, multi family housing.
- Location in the country, capital area, outside the capital area

2. Methodological changes in the Icelandic house price index.

The aim of the changes made to this property index in March was to improve the calculation in respect of quality changes. The changes made are based on reasearch of their influence on the house price index results over the period January 2000 to April 2006. In that period there were 56.700 properties sold, nearly 6,500 single-family houses, approximately 35,000 multi-family housing in the capital city area and 8,000 single-family houses and 7,700 multi-family housing outside the capital city area.

Following methods were implemented:

The capital area has been split into two strata, an inner/older and an outer/newer where nearly 30% of the single-family houses sold belonging to the inner/older area. There are 8 categories for property size, giving after these changes altogether 18 sub-indices for housing in the capital city area and 8 indices by size category for property outside the capital city area. From both of these sets of indices, 4 overall indices are calculated for multi-family housing and single-family houses, inside and outside the capital city area. Hence 30 sub-indices are used when calculating the aggregate index for real estate prices and increases the number of

² This has been the case since March 2000. The index for the entire country was then recalculated back to March 1997.

³ Contracts from places outside the capital area, however, arrive with a two-month delay.

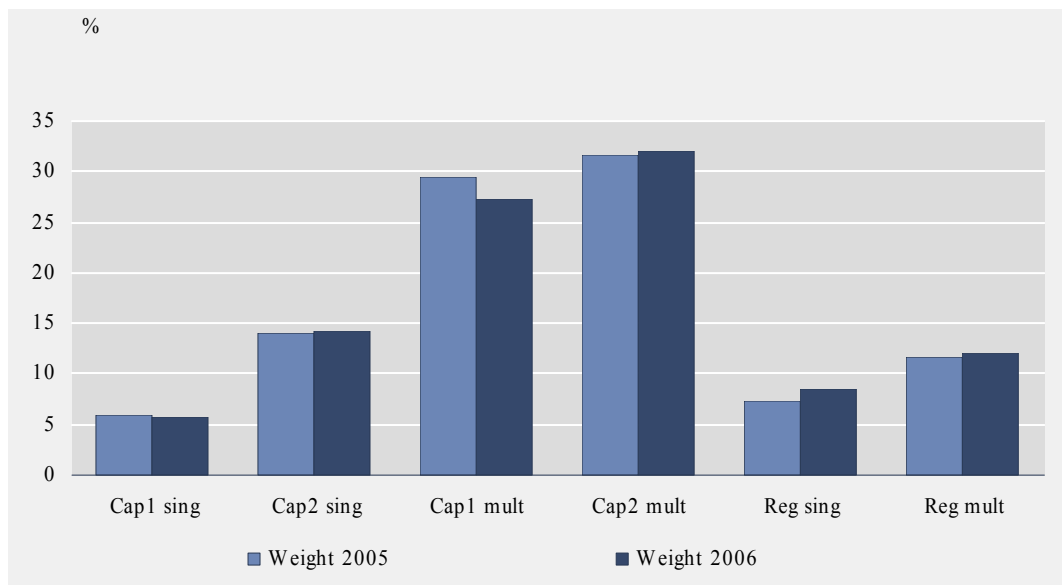
subindices calculated from 20. Emphasis is placed on comparing price developments within housing categories, not among types of property or among the different regions of Iceland.

The weights used for calculation of the total house price index now reflect the value of all dwellings sold in the last three years instead of being based on the number of dwellings sold. The reason for this is an increased divergence between value weight and quantity weights in the last years because of great price chances of houses.

The geometric mean replaces the arithmetic mean when averaging house prices within each stratum at the elementary level. This is in line with the calculation method used at the elementary aggregate level in the Icelandic CPI. The geometric mean is also used in hedonic calculations and the geometric mean is a typical matched model estimator (Diewert 2003b p. 32, Diewert 2003c p. 334, Haan 2005 p. 431).

The house price index is calculated as a superlative index (Fischer) using the values for 2002–2005 as the weight for the Laspeyres index and the values for 2003–2006 to calculate the Paasche index. The weights are changed monthly and are shown in the following figure

Figure 1. Weights in the house price index in March 2006



Note: Weight 2005 refers to March 2002-2005, weight 2006 to March 2003-2006. Cap1 is the inner part of the capital city area, Cap2 is the outer part, Reg is housing outside the capital area. Sing are single- flat houses, mult are multi-flat houses.

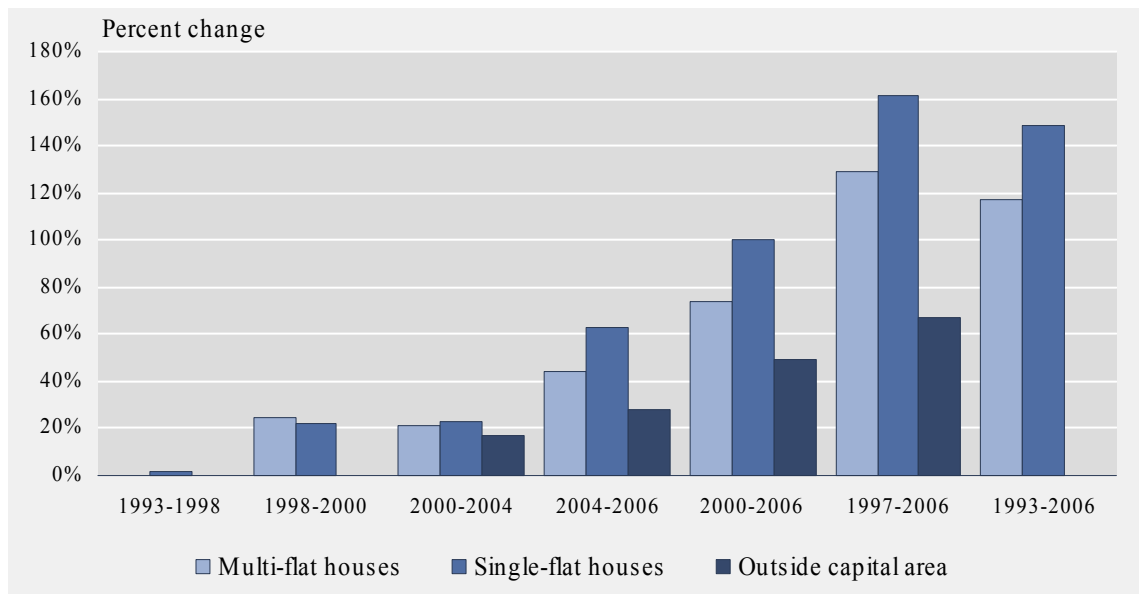
The Land registry is now making a new housing sales database, bringing together all register based information about the property with the sales contracts. This database will be excellent tool for research in the future, paving the way for a hedonic house price index.

3. Housing prices and rentals

There has been a considerable house price inflation in Iceland in recent years as is shown in figures 1 and 2. In real terms, house prices (deflated by the CPI less housing cost) in the period 1997 to April 2006 have increased by 129% for multi-flat houses and 161% for single-flat houses in the capital area. For houses outside the capital area, the average price change in the same period was 67%. The average price change for the whole country was about 116%.

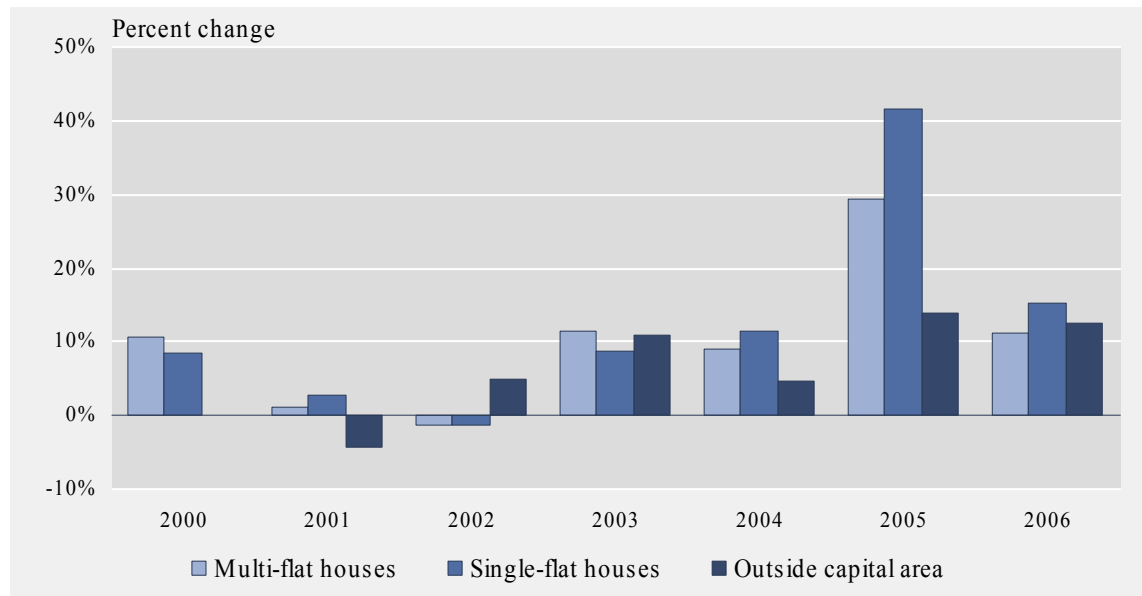
In the period 1993-1998 house prices were stagnant or fell slightly. In the period 1998 to 2000 there was 24% increase in house prices in the capital area in real terms and 17% outside the capital area in the same period. In the period 2000-2004 the average prices in the whole country rose by 20%.

Figure 2. Changes in real housing prices, deflated by the consumer price index less housing cost, changes over periods of years



Note: Prices outside the capital area were included in the index in March 2000. For 2006 prices in April.

Figure 3. Changes in real housing prices, 2000–2006, deflated by the consumer price index less housing cost.



Note: Prices outside the capital area were included in the index in March 2000. For 2006 prices in April.

Following the lowering of real interest rates in the period July- December 2004 and increased supply of loans the real house prices rose on the average from 2004 to April 2006 by nearly 43%.

Rental and housing markets are in theory both sides on the same coin and should therefore move in similar fashion. But that is not necessary the case. The durable stock can be different and there are costs in the rental market that do not face those living in own housing and should not should be included in the owners cost (Diewert (2003b), p. 47-50).

Until 2004 rental markets and house prices in Iceland moved in similar fashion. But changes in the loan market and lowering of the real interest rates led to a considerable price increase. Table 1 shows the price changes in the markets.

Rent increased more than imputed rent in the years 2001 to 2003. From 2003 this has changed and in the period 2004 to June 2005 housing prices rose more than 29%. When the effect of lower real interest rate through the user cost measurement is taken into account the imputed rent increase in the same period by just over 21%.

Table 1. Rent, imputed rent and market prices in the Icelandic CPI 2000-2006

Year	Rent	Imputed rent	Market prices	imputed/rent	market/rent
2001	9,0%	6,4%	6,4%	1,007	0,991
2002	8,7%	4,8%	4,8%	0,971	0,956
2003	9,9%	11,0%	11,7%	0,981	0,972
2004	7,9%	9,1%	10,5%	0,991	0,995
2005	6,2%	21,9%	28,5%	1,138	1,204
2006	6,2%	13,8%	15,5%	1,219	1,308

In April 2006 the share of imputed rent over rent is 21.9% but market prices are 30.8% higher the rent and real interest rates play important role in the price setting mechanism in the rental and owners occupiers markets. In the twelve month prior to June 2005 the effect of price changes of owner occupied housing in the CPI was 2.1%. If the effect of real interest rates on the CPI had not been taken into account, the increase in housing prices would have led to a 3.2% increase on the CPI but the effect of changes in real interest rates have reduced the price change by 1.1% or nearly one fourth. The average real rates used in the model were 4.0% in July 2004 and are 3.7% in June 2005. This differs from the market price approach used in the case of net acquisition because changes in real interest rates are not taken into consideration leading to overestimation of price changes when interest rates fall and vice versa when they rise

4. Approaches in calculating owner occupied housing

Measuring the share of owner-occupied housing in an index has two facets, as housing is used not only for residence but also as an investment, which adheres to its own particular set of rules. For this reason, value measurement of the use of owner-occupied housing has long been a problem when calculating consumer price indices, especially in small rental markets, such as the Icelandic one.

Two main approaches can be considered for computing the use of owner-occupied housing. One takes into consideration the service flow from residence in owner-occupied housing and includes *rental equivalence* and *user cost*, while the other includes *net*

acquisition. What is common to both approaches is that market price is used to measure price changes; however, the approaches to calculating expenditure weights differ.

In countries where rental equivalence is used, information is taken from national accounts, based on rent surveys or housing owners asked what rent they feel would be paid for their apartment if it was rented, and the results obtained are used to derive weights. In cases where user cost is calculated, the annuity for the property base is used to determine the expenditure weight. In the net acquisition approach, on the other hand, the full price of the housing is capitalized in a single expense entry, creating the weight for that approach.

In all these instances, developments in the prices for owner-occupied housing are calculated according to changes in market price. In the case of rental equivalence, the reference is to changes in the rent paid for comparable housing, while in the case of user cost the reference is to the changes in market prices for bought housing, used as well as new. The net acquisition approach should theoretically be based on new housing. Real estate prices for new and used properties could easily change in a parallel manner, and then the same real estate index could be applied, in both the user cost and net acquisition approaches.

5. Market price methods to calculate owner occupied housing

The three market price methods used for these two approaches are rental equivalence, user cost and net acquisition

Rental equivalence is computed in many places where rental markets are strong and rental changes can be used for properties in the general market that correspond to owner-occupied housing. The rental equivalent then changes in accordance with the rent for those apartments. A necessary condition for this is i) that the rental market be large enough for there to be types and sizes of properties in the rental market which are comparable to those in owner-occupied housing, and that the market rent rate be used as an equivalent of rent changes for owner-occupied housing. ii) that the rental market not be controlled and that rent not be subsidized by the authorities or market prices governed in some other way. iii) that cost borne by landlords but not by tenants or those living in owner-occupied housing not be included in price measurements. The rental equivalence approach cannot be used in Iceland because of how small the rental market is and also

because of the Icelandic market's difference in composition from what generally applies to owner-occupied housing. The majority of Icelanders, or about 80%, live in owner-occupied housing according to the household expenditures survey.

In instances where the rental market is small, the service flow from owner-occupied housing is often measured in terms of *simple user cost* (Diewert (2002), p. 621 and (2003) p. 28 and 53) in similar way as in the Icelandic consumer price index. The annuity (imputed rent) is computed from the property's market price, and the imputed housing rent is measured on the basis of certain real interest rates and depreciation. Real interest is the required return on (or opportunity cost of) capital tied up in the property or taken on credit. Property wear is taken into account by basing depreciation on an estimate of the lifetime of the property. Consideration is shown for use of the housing, or residence in it, but the return on the investment is calculated with the real long-term interest rate. Price changes are determined mostly by changes in the market price of all properties sold and to some extent by changes in real interest. The consumer price index measures short-term price changes, providing that there is no substitution between living in owner-occupied housing and renting, in other words that due to the tiny size of the rental market, it is not possible in the short-term to sell the housing and rent other housing instead. Although several countries calculate the housing in the index as a user cost, none of them use real interest rates for calculating user cost except Iceland. In Iceland longer mortgages are usually indexed with the CPI. In some countries mortgage profiles are used but they only reflect the life time of the mortgage not the house and it is often very difficult to separate financing used for housing from other financing. Some countries use market prices of houses to evaluate depreciation or the mortgage rate.

The CPI measures price changes in household expenditures but does not take into account changes in households income. Two kind of income are connected to owner occupied housing. One is the imputed rent that is assumed that the owner pays himself for using the housing durable and the other one is the capital gain/loss the income from the price increase of the durable. In the full user cost approach this income from the use of the durable the capital gain is subtracted. This is natural in the case of firms as a part of measuring the profit of the firm but when it comes to households the same is not the case. Income is not subtracted from expenditures in the context of the CPI when the aim is to measure the changes in expenditures. The amount of money needed or available to cover

the expenses is not measured so capital gains are not taken into account in that way.⁴ There are also substitution argument for not doing so as there are considerable hindrances moving over from own housing into tenancy. This is very important for Iceland were the privat rental market is very small and considerable difficulties in finding suitable apartments to rent. There are also very high cost connected with selling and buying, such as transaction cost. In the case of the simple user cost the long-term real interest used in the calculation shows the return on the investment during the lifetime of the durable in real terms. With house price inflation also taken into consideration, the real interest rate reflects in this way the capital gain.⁵

Research into the use of the full user cost also shows that the results will also be very volatile (Gillingham (1980 and 1983), Johannessen (2004) and Verbrugge). One part of that is that in all cases nominal interest rates not real interest rates are used and the interest rates are therefore not quality adjusted and as such the measured capital gain includes the effect of inflation on the user cost and in that way increases the volatile short term movements.

Housing cost can be valued in reference to *net acquisition*. The net item represents the housing that is built in excess of the housing that is depreciated. When calculating the consumer price index, housing is capitalized at the time of purchase, in the same way as other durables in consumer price index calculations. Price changes are measured based on the price of new houses, including housing the resident built and housing purchased directly from a builder or real estate broker. Furthermore, apartments bought from the business sector or public parties must be accounted for. This index is to some extent similar to a producer price index for buildings. The amount of new apartment housing built each year varies, depending among other things on the economic situation. The net changes might turn out negative in some years and thereby also the weights for new housing. If this approach is to be used, weights must be calculated as means over several years. Weight fluctuations are greater and relate more closely to economic cycles when the net acquisition approach is used instead of the user cost or rental equivalence approaches; moreover, the weight for owner-occupied housing normally comes out lower. (Diewert 2002a, p. 62). The change in house prices used with this method overestimates

⁴ The same can be said about capital gain/loss from trading in shares.

⁵ The capital gain can in certain periods be higher or lower than the required rate of return. The long-term real interest rate is an approximation of capital gain over the lifetime of a durable good.

the house price change when real interest rates falls as their influence on house prices are not taken into account.

A payment method is sometimes used, especially if information is lacking on the market price of housing or on the housing market. By this method, the flow of payments for the purchase of housing is measured without normally giving attention to the funding of consumption when calculating the consumer price index. Attention is however given to payments for housing purchases, instalments, interest, maintenance and housing improvements. This approach is similar to the one used for the Icelandic consumer price index during the period of 1988 to 1992. Nominal interest, which in fact partly reflects inflation, is included, but no consideration shown to the distribution of housing use over a longer period.

In some countries housing is considered chiefly an investment, with the resulting argument that it should not be included in the consumer price index, so that owner-occupied housing is left out of it. In some instances the countries do not have sufficient information on price changes in the property market to be able to apply any of the approaches described above. Owner-occupied housing has still not been included in the harmonized consumer price index calculated for the EEA countries, but there are plans to do so, probably by the net acquisition approach and with a price index for all properties sold.⁶

The methods used for the calculation of owner occupied housing differs as the share of households living in own housing. Following table shows the methods used in different countries and the share of owner occupiers (Hansen (2000), Housing Statistics (2004) and Christensen, Dupont, Schreyer (2005)).

User cost: Iceland (80), Ireland (78), United Kingdom (69), Canada (66). Finland (64) and Sweden (46).

Rental equivalence: Norway (77), United States (68), Japan (60), Denmark (51), Netherlands (54), Germany (45), Switzerland (31).

Net acquisition: United States until 1983, Australia (70), New Zealand (65), HICP from 2007.

⁶ Eurostat's current suggestion includes among other things the following: "A price index for all dwellings purchased by households as a self-standing index." Eurostat (2004), p. 6.

Excluded: Italy (78), Spain (81), Greece (74), Luxembourg (67), Portugal (66), Belgium (68), France (56) and Austria (57).

6. Simple user cost

Owner occupied housing has two aspects. A house is a place to live in and at the same time an investment. To separate the measurement of the use from that of investment is a difficult problem in CPI calculation, especially where rental market is thin. The flow of service of living in own house is calculated as imputed rent in the Icelandic consumer price index, but the buying of the house is an investment and therefore not taken into account directly in the calculation.

The user cost method converts a part of the expenditure on a durable (such as a house) into flow of services by taking into consideration use of capital, long term financial (opportunity) cost (interest) and the use of the durable (depreciation).

In Iceland, the approach of calculating housing cost as a simple user cost was adopted in November 1992.⁷ To begin with price measurements for housing covered only the capital city area; since April 2000, however, they apply to the whole country.⁸ The main source when determining a base weight for housing is the official real estate assessment of housing, information on that being available from household expenditure surveys. The Land Registry of Iceland calculates real estate value for all the property in the country. In the middle of the year 2001 the Land Registry revised the estimation method after extensive research, using hedonic regression. The base for the analysis was the capital area and the estimates for other parts of the country were calculated with regional coefficients (Fasteignamat (2002). P. 9 and p. 17-22) (Ingvarsson (2002), p. 31 and p. 259-270). The value of all properties in the country are measured in a harmonised way based on information about properties sold. This is done with reference to the law as “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 first paragraph. of the law no. 6/2001 the estimated value shall be the discounted market value as estimated last November” (Ingvarsson (2002), p. 260). The Land Registry of Iceland has collected the sales contracts

⁷ A similar user cost approach was adapted by the National Economic Institute just after 1980, when inflation was high in Iceland, to measure the profitability of domestic fishing and fish processing.

⁸ In April 2000, an adjustment was made for having over-measured housing price changes on account of this; this adjustment lowered the index by about 0.35%. At the same time, an adjustment was made for having undervalued housing rents in the index, with the correction for this raising the index by around 0.34%.

over a long period of time and the information on market prices of properties received from them is used by the Land Registry as the base for their evaluation of all houses' real estate value. It is also used in the calculation of the simple user cost in the CPI. This basic information is the same as the one used for the price measurement of housing in the CPI and therefore the real estate value is very suitable for the user cost calculation.

The simple user cost is calculated in two steps. One is the calculation of the weight by using a real interest rate to measure the long term financial cost and the use of the durable. The other part is the price adjustment of the user cost weight (expenditure) by a house price index. Technically it is done by calculating this cost as an annuity.⁹ An annuity is a “sequence of equal payments made at equal intervals of time” (Ayres, p.80). In the index calculation the property value is calculated as an annuity and includes both the real interest rate and depreciation. The annuity formula has the general form:

$$(1) P_H = A_{HV} * \left[\frac{(1+r)^N - 1}{r * (1+r)^N} \right]$$

where P_H is the present value of the house, A_{HV} , the annuity of the house value, where r is the real interest rate and N the life time of the durable (depreciation is given by an assumed lifetime of 80 years, and no scrap value in the end i.e. 1.25 per cent). The annuity formula (1) is derived from a geometric series and the interest is calculated over the lifetime of the durable and added to the durables value and then converted into equal payments (annuity). By using annuity both the interest rate and the depreciation are calculated from the same base and changes in the same direction when the property value changes. In addition the rent amount is also calculated over the lifetime of the durable. Lower lifetime of the durable (higher depreciation) leads to lower total interest rate.

7. Real interest rate

If only nominal interest rates are known, they have to be adjusted for quality according to changes in inflation in order to determine the real interest rate. The subsequent changes in

⁹ This user cost method is in some ways similar as Steiner [29] suggested in the Stiegler report 1961. He uses in his user cost model the annuity method to measure depreciation and interest rates but does not use real interest rates.

the consumer price index being subtracted to figure the real interest. In Iceland, real interest is preset, with the subsequent changes in the consumer price index being added to figure the nominal interest.¹⁰ Nominal interest rates reflect inflation, as well as risk and expectations, the higher the inflation, the higher the interest rates get. The fact, that a part of the price of using the capital is due to factors other than the service price for the use of money, makes the use of interest rates a quality adjustment issue. The quality issue in this case is that inflation is embedded in the interest rates and distorts the real interest value, making a quality adjustment necessary. The real interest rate from this point of view is the quality adjusted nominal interest rate. The quality adjustment is necessary as in the case of every good and service that has a better or worse quality reflected in its price.

The relationship between nominal and real interest is often expressed according to Fisher's equation (1896) (Diewert, 2003a, p. 21). The nominal interest rate is designed r_t , the real interest rate as r^* and the general inflation rate as p_t . The expression is:

$$(2) r_t = (1+r^*)(1+p_t) - 1$$

It means that the real interest rate, when not known, is the difference between the change in the nominal interest rate and the change in consumer inflation and the quality adjustment is expressed by calculating as follows:

$$(3) r^* = (1+r_t)/(1+p_t) - 1$$

There could be a problem in the case of short-term movements. There are indications that the Fisher effect is not very strong in the short term even if it is so in the longer run (Mishkin 1992). If this is right the use of this method should probably be extended to some kind of average over a longer period of time.

When consumers buy real estate they finance it partly through their equity and partly with credit. The long-term real interest rate unites two leading factors in financing: the share which the buyer needs to finance by borrowing money and the required return on the buyer's equity. In the model for user cost, the share of each factor is based on information from the sales contracts used in price measurements the long-term real interest rate used in

¹⁰ Indexation is allowed only for financial obligations that are for five years or longer.

the simple user cost model shows the return on investment over the lifetime of the durable. In this way the real rate measures the capital gain. It can be lower or higher at periods than the rate of return used but it is approximated by the average long-term real interest rate.

The real interest rates used in the calculation of the simplified user cost are sticky over the lifetime of the durable but are partly kept variable to reflect short term trends in interest rates. When consumers buy property they finance it with equity and mortgages and the average long-term real interest rate in the model takes into account these two main types of financing. In the simple user cost model the division between these two forms of finance is mainly based on information from the sales contracts used for the house price measurement. As a result the opportunity financial cost covering the lifetime of the durable is estimated by keeping the equity rate fixed but allowing the mortgage real interest share to vary.

The required return on equity, which is constant over the lifetime of the durables, was determined in accordance with the long-term rate of return that pension funds require. When this approach was adopted this rate of return amounted to 3% and been left unchanged for these calculations.¹¹

Long-term loans from the Housing Financing Fund were revamped in July 2004 through the introduction of cash loans, so-called ÍLS securities offering a lower real interest rate than before and soon after that commercial and savings banks increased greatly their housing loans at competitive interest rates. The initial fall in mortgage rates was included in the Icelandic CPI in July but as of August 2004¹² it was decided that the variable real mortgage rates, used in the calculation of the simple user cost of housing, should be calculated as a 60 month's moving average.

This decision was made in anticipation of frequent mortgage rate changes which might give rise to month-to-month volatility in the CPI. The feared volatility of real interest rates on housing credit has not materialized and the rates have over the recent months been stabilized at a substantially lower level than before. Statistics Iceland decided to change the method of averaging real interest rates in the model for owner occupied housing in the

¹¹ The long-term rate of return of pension funds now lies between 2% and 3.5%. The assessment of long-term claims due to the Damage Compensation Act is 3.5%.

¹² This corresponds with what has been done before in similar circumstances, such as at the end of 1993 when the interest rate on real estate securities fell from 6% to 5% and when, in the first half of 1995, the rate rose from 5% to 5.1%.

CPI as of May 2005. A twelve month moving average will be applied instead of the five year one introduced in August 2004. This change leads to a lowering of the Icelandic CPI by 0.45% in May 2005. The new method will be applied until the CPI is rebased in March 2006 when it will be reconsidered (Statistics Iceland (2005b)).

There are three parts that influence the results of the calculation of the annuity. House prices, interest rates and depreciation. The formula for the annuity is:

$$(4) \quad A_{HV} = P_H * \left[\frac{r * (1+r)^N}{(1+r)^N - 1} \right]$$

Dividing through it by $(1+r)^N$ gives the equation in the form:

$$(4a) \quad A_{HV} = P_H * \left[\frac{r}{1 - (1+r)^{-N}} \right]$$

The average real interest rate, measured monthly, has hovered around 4% since 1992. When changes in real interest occur, however, they have a direct effect on the annual payment. where A_{FM} is the base for the annuity and P_H the present value of the base (the discounted cash value in sales contracts), r the real interest and N the lifetime (in years). Increases in the average real interest rate, in the instance of a long lifetime, increase the annuity (the imputed rent) by just about the same ratio.

The real interest rate also influence the value of the property used as the base for calculating the annuity as lower interest rates normally lead to a higher house prices. In calculating the present value of the sale contracts the loans with fixed interest rates are discounted by rate of return reflecting the change in the real interest rate. A rise in the real interest rate lowers the present value of the property. This fact is in accordance with the economic reality that a higher real interest rate leads to less demand and lower price of housing.

8. Depreciation

It is difficult to find a depreciation rate that accurately reflects property wear, and this issue is always subject to considerable uncertainty. Generally speaking, three methods are common in deciding what the depreciation rate should be. The first way to approach this is to find out the property's age and by approximation estimate its lifetime, "*assuming* a depreciation model that seems most appropriate." (Diewert, 2003b, 23). The second method bases on cross-sectional information to determine the depreciation rate, and the third method regards information on rental rates or the hire purchase of durables. The first method was chosen when the depreciation was decided that entered into computations of the simple user cost. "The first and simplest method is to impose a particular depreciation pattern on the average observed life of structures to derive a depreciation rate." (Malpezzi, Ozanne, Thibodeau, 1987, p. 373)

The depreciation rate used in the user cost calculation was obtained mainly by considering the age of the housing stock. According to the Real Estate Registry the stock at the end of the year 2001 has the following age structure: 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 age structure.

The depreciation rate was determined chiefly by reference to the construction year of the property base. According to the national registry of real estate from the end of 2001 (Ingvarsson, 2002, p. 261), the division of residential housing by the year of construction shows that about 90% of all properties were built after 1940, more than a third in the period of 1960-1980 and a little less than one-third after that. The premises regarding depreciation therefore seem to accord with the age groupings in the base according to the time of construction. The user cost covers both buildings and the land on which they are built. The depreciation is in fact 1.5% for real estate, which corresponds to a lifetime of about 67 years. Sites are not depreciated, as they do not wear out as time passes, and depreciation should only be calculated on the value of the building; however, the value of the site and the building are never separated in the price information upon which the housing index is founded. For practical reasons, a mean depreciation is calculated for the whole base, both building and site. The depreciation in the index is 1.25% of the real estate value. The value of land is separated in the real estate value calculated by the Land Registry and is approximately 15% of the total value of the house. In the future Statistics

Iceland will consider separation of the value of land from the house value in the calculation of the user cost.

There are three most common depreciation methods: i) straight line depreciation when the depreciation is divided into equal shares, ii) one hoss shay or light bulb depreciation when the durable is depreciated when it falls apart and iii) geometric depreciation when the durables value declines by constant percentage rate. The depreciation is usually in the form $(1 - \delta)^N$, where δ is the depreciation rate and N the lifetime of the durable (number of payments). It means that the depreciation is largest in the beginning. According to the geometric method the durable is never fully depreciated.

The form of the annuity formula is an inverted geometric depreciation of the type $(1 - \delta)^{-N}$ and it differs from the usual geometric depreciation in that it is small in the beginning but increases as the years go on.

The depreciation measured as the amortization of the principal (sinking fund), where $N = 80$, reaches the 50 per cent level in the 64th year. In the year 73 it covers two third of the total depreciation. The interest payment equals the depreciation amount in the 64th year and after that the depreciation amount is larger than the interest. The yearly depreciation measured this way is nearly 0.2 per cent in the beginning and around 4 per cent at the end.

It should be added that unlike the usual geometric depreciation the durable is fully depreciated. It is similar to the one hoss shay method as the depreciation is largest at the end of the durables lifetime and that the durable is fully depreciated but contrary to the one hoss shay method it depreciates over whole the lifetime of the durable.

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