ORGANISATION DE COOPÉRATION ET DE DÉVELOPPEMENT ÉCONOMIQUES

OECD OCDE

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

OECD-IMF WORKSHOP

Real Estate Price Indexes
Paris, 6-7 November 2006

Paper 20

House price index, market prices and flow of services methods

Rosmundur Gudnason and Gudrun Jonsdottir
(Statistics Iceland)

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

Rósmundur Guðnason

Statistics Iceland

Borgartúni 21a

IS - Reykjavík 150, Iceland

Tel: +354 528 1201

Fax: +354 528 1099

rosmundur.gudnason@statice.is

Guðrún R. Jónsdóttir

Statistics Iceland

Borgartúni 21a

IS - Reykjavík 150, Iceland

Tel: +354 528 1202

Fax: +354 528 1099

gudrun.jonsdottir@statice.is

Version, 5 December 2006[1]

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 reflects the value of all dwellings sold in the last three years, the geometric mean replaced the arithmetic mean when averaging house prices and the house price index is now calculated as a superlative index (Fisher). 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:

Assessment methods, consumer price index, cost of living index, household expenditure surveys, house price indices, owner occupied housing, real estate price indices, repeated sales methods, stratification method, user cost.

JEL: C43, C81, D11, E31.

[1] The authors like to thank Erwin Diewert, Heiðrún Guðmundsdóttir, Örn Ingvarsson, Mark Proud'homme, Mick Silver and the participants at the OECD-IMF, Workshop on real estate price indexes 6th-7th November 2006 and at the Ottawa group meeting in London, 14th-16th May 2006 for helpful comments.

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

Houses differ widely in quality, they are not homogeneous goods and are often produced as one of a kind, i.e. they are unique durables (Diewert (2003b) p. 24). Under the matched model method the price changes of the same good is measured between periods. Maintenance and depreciation of houses varies over time so matching is difficult and quality adjustment of some sort is necessary. Houses do not appear on the market in exactly the same condition as they were when last purchased or produced so the matched model methodology fails and a quality adjustment of the house price index is needed.

Every sale of a house is random and does not necessarily reflect the value or the quantity of the housing stock. Often it is required that they either reflect the stock (value or quantity) of houses or the transactions. 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 CPIs is to measure price changes and therefore the transaction indices are often used in CPI price measurement.

There are four main methods suggested in constructing constant quality adjusted real estate price indexes (Diewert (2006), p. 6-18).

The *repeated sales* method uses houses that are sold more than once (Baily, Muth and Nourks (1963)) and has been developed in a weighted form (Palmquist (1980)). That method can be interpreted as a hedonic method where the characteristic is the house sold. 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 cannot 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 *assessments* method is based on a comparison between valuation of a house, often official, and its salesprice. In that case information on housing characteristics is not needed. Its quality is also dependant upon the methods used in the house valuation. It is an unweighted transaction index using the arithmetic mean as an estimator and compared to the repeated sales method all housing transactions are used in the calculations. Example of such indices are found in New Zealand, Denmark, Sweden and the Netherlands (Wal et al. (2006)). If detailed information about the characteristics of the properties is available a stratification can be used and geometric estimator and superlative weighting could also be applied improving the method.

The *stratifications* method uses information available about housing characteristics to split them into cells that are kept fixed and within each strata the average (Duot) or median sales prices are calculated but the estimator can just as well be geometric (Jevon). These indices can be either weighted or unweighted. The method is used in the Icelandic house price index for the calculation of the simple user cost model in the Icelandic CPI. The estimator is the geometric mean but keeping fixity on following details:

- Category sizes.
- Types of properties; multi-family housing, single-family housing.
- Location in the country; capital area, outside the capital area.
- Inside the capital area by age of the houses; older/inner and younger/outer[2].

The index is transaction index weighted superlatively (Fisher). Subindices are produced by this method.

The *hedonic* method measure the prices of characteristics of houses and in that case the correct functional form is crucial. There are considerable amount of studies available in this field, (Diewert (2003c), (2003d), (2004), (2005a), (2005b)), (Gouriéroux and Laferrère (2006)), (Haan (2004)), (Li, Prud'homme and Yu (2006)).

The house price index used in the Icelandic CPI is based on market prices for houses 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, 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 by the Land Registry, almost every concluded real estate agreement is obtained.[3] 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.

---

[2] Properties are separated in that way by age/depreciation.

[3] 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.

The price concept is the same as for other price measurements in the CPI, in that the price taken for computation 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 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 imputed rent and the weighted national average.[4] The price changes for real estate is calculated as a three-month moving average, with a one-month delay.[5] April includes contracts from the period January to March, May contracts from the period February to April, and so on.[6]

2. Methodological changes in the Icelandic house price index.

The changes made to the Icelandic property index in March 2006 aimed at improving the calculation in respect of measuring quality change. They are based on research of housing sales data over the period January 2000 to April 2006. In that period there were 57.200 properties sold, approximately 35.000 multi-family housing nearly 6.500 single-family houses, in the capital city area and 7.700 multi-family housing and 8.000 single-family houses 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 belong to the inner/older area. There are 8 categories for properties 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 subindices calculated from 20. Emphasis is placed

[4] This has been the case since March 2000. The index for the entire country was then recalculated back to March 1997.
[5] Contracts from places outside the capital area, however, arrive with a two-month delay. This will be changed in March 2007 and the contracts will arrive with the same delay as is the case for the capital area.
[6] This method gives sufficient price material in each month to allow for the detailed stratification used in the calculation. The results are revised as more complete sales information becomes available.

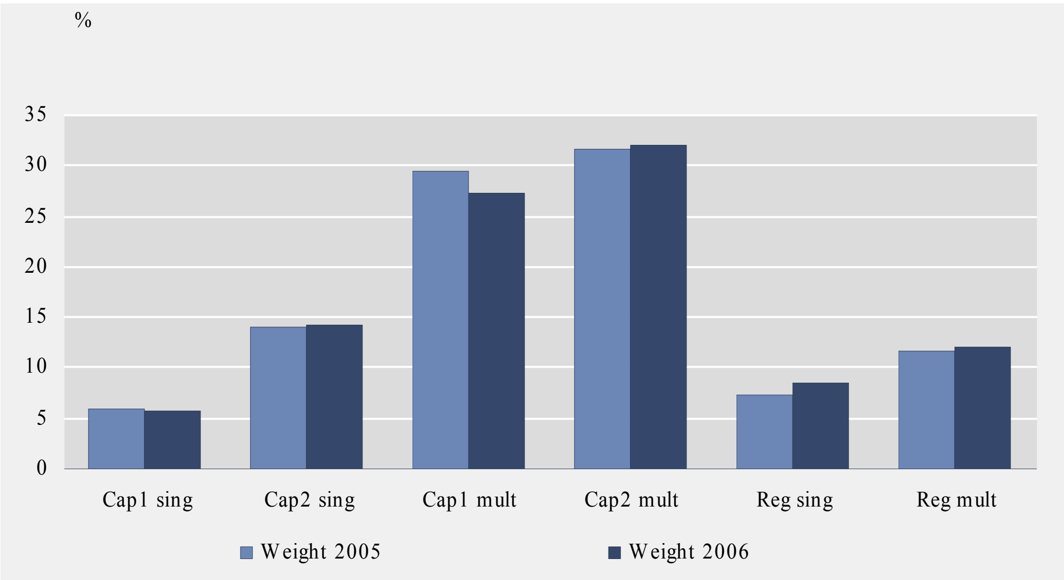
on comparing price developments within housing categories, not among types of property or among the different regions of Iceland.

Transactions effect the average value of the housing stock which might lead to an increased divergence between quantity and value weights especially in periods of high house price inflation. Value weight are therefore used in the house price index as they better reflect market changes then the number of dwellings sold.

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 and (2003c) p. 334), (Haan (2005) p. 431).

The house price index is calculated as a superlative index (Fisher) using the values for 2002–2005 as the weight for the Laspeyres index and the values for 2003–2006 to calculate the Paasche index[7]. 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.

[7] Consideration is now given to change the weighting period to a year for the Fisher calculation. This change will probably be implemented in March 2007.

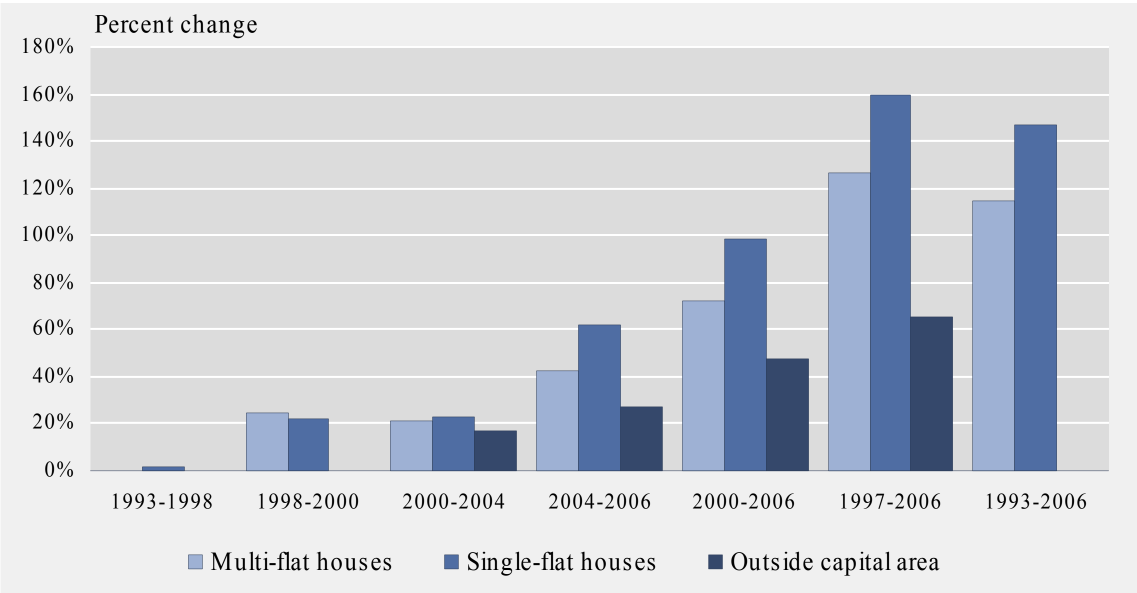
The Land registry is now creating a new housing sales database, bringing together all register based information about the property with the sales contracts. This database will be an excellent tool for research in the future, paving the way for a hedonic house price index.

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 October 2006 have increased by 126% for multi-flat houses and 160% for single-flat houses in the capital area. For houses outside the capital area, the average price change in the same period was 65%. The average price change for the whole country was about 114%.

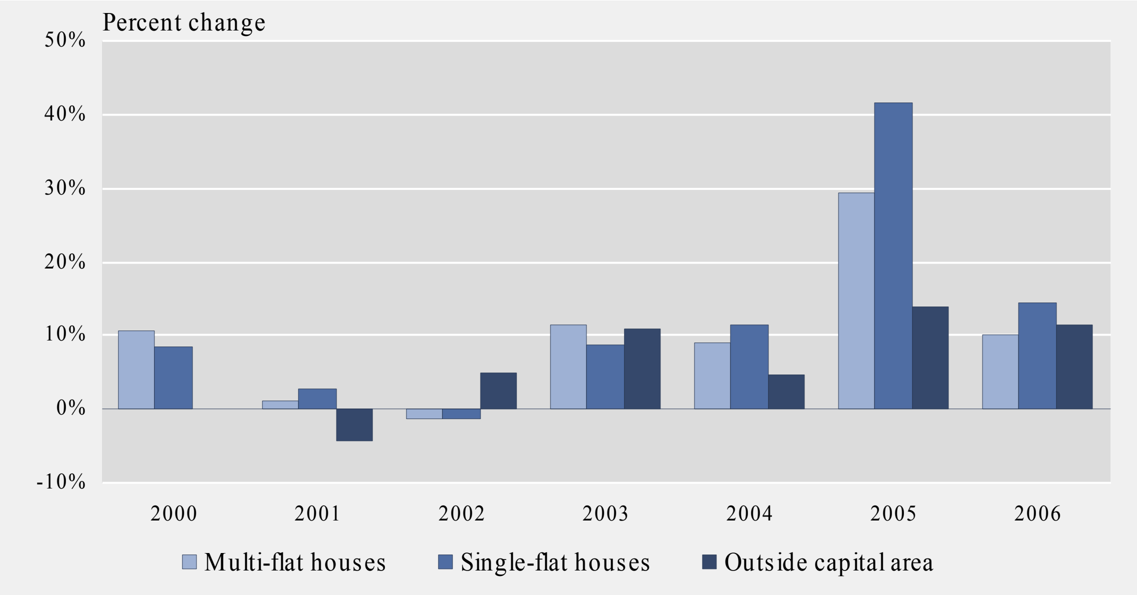
In the period 1993-1998 house prices were stagnant or fell slightly. In the period 1998 to 2000 there was 24% increase in house prices in the capital area in real terms and 17% outside the capital area in the same period. In the period 2000-2004 the average prices in the whole country rose by 20%.

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 October.

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. Prices 2006 refer to October, changes from the average 2005.

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 October 2006 by nearly 41%.

Rental and housing markets are in theory two sides on the same coin and should therefore move in a similar fashion. But that is not necessarily the case. The composition of the durable stock can differ and there are costs in the rental market that those living in own housing do not face and should therefore not 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 2001-2006.

Rent increased more than imputed rent in the years 2001 to 2003. From 2003 this has changed and in the period 2004 to 2005 housing prices rose by nearly 29%. When the effect of lower real interest rate through the user cost measurement is taken into account the increase in the imputed rent in the same period was nearly 22% and in the period October 2005-2006 housing prices rose by 10% and imputed rent by 7.7%. In October 2006 the share of imputed rent over rent is 16.6% but market prices are 28.8% higher.

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	9,0%	7,7%	10,0%	1,166	1,288

Note:. March 1997 = 100. Price changes 2006 refer to twelve Month's change October 2005-2006.

In the twelve months 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%, nearly one quarter. The average real rates used in the model were 4.0% in July 2004 and are 3.8% in October 2006.

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 simple 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 prices for 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 can be measured in terms of *simple user cost* (Diewert (2002), p. 621 and (2003a) 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 granted in real terms and 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 (durable) 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 where it is assumed that the owner pays himself for using the housing durable and the other 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 their profit but not for households. In the CPI where the aim is to measure the price changes of expenditures income is not taken into consideration. The amount of money needed or available to pay for the expenses is not measured nor is capital gains therefore taken into account.[8]

[8] The same can be said about capital gain/loss from trading in stocks.

There is also a substitution argument for not doing so as there are considerable hindrances moving over from own housing into tenancy. This is very important in the case of Iceland where the private rental market is very small and considerable difficulties are in finding suitable apartments to rent. There is also very high transaction cost connected with selling and buying. 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.[9]

Research into the use of the full user cost also shows that the results can be very volatile (Gillingham (1980 and 1983)), (Johannessen (2004)), (Verbrugge (2006)). In all these cases the interest rates used are nominal, not real, and therefore not quality adjusted. Inflation effects the user cost increasing the volatility of the short term price 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 the house price change when real interest rates falls as their influence on house prices are not taken into account.

[9] 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.

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.[10]

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.

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

[10] 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.

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 directly into account 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.[11] To begin with price measurements for housing covered only the capital city area; since April 2000, however, they apply to the whole country.[12] 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 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 over a long period of time and the information on market prices of properties is used by them as the base for evaluation of all houses' real estate value. It is also used in the calculation of the simple

[11] 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.

[12] 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 under-valued housing rents in the index, with the correction for this raising the index by around 0.34%.

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 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.[13] 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:

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

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

The fact, that a part of the price of using capital is due to factors other than the service price for 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

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

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.

In order to determine the real interest rate nominal interest rates have to be adjusted for quality according to changes in inflation. The subsequent changes in 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.[14] Nominal interest rates reflect inflation, as well as risk and expectations, the higher the inflation, the higher the interest rates get.

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 the simple user cost model shows the return on investment over the

[14] Indexation is allowed only for financial obligations that are granted for five years or longer.

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 mortages 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.[15]

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 2004[16] 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 did not materialized and the rates have 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 CPI as of May 2005. A twelve month moving average was applied instead of the five year one

[15] 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%.

[16] 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%.

introduced in August 2004. This change lead to a lowering of the Icelandic CPI by 0.45% in May 2005. The new method has not been changed even if the real interest rates have increased. It is reconsidered yearly when the CPI is rebased in March each year.

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), (Diewert et al. (2006)). 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 is 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 the whole lifetime of the durable.

References

Ayres, Frank, JR., (1963), Mathematics of Finance, *Schaum's Outline Series, McGraw Hill Book Company*, May 1963.

Bailey, M.J., Muth, R.F., Nourse, H.O., (1963), A Regression method For Real Estate Price Index construction, *Journal Of The American Statistical Association*, Volume 58, Number 304, December 1963, 933-942.

Barker, K., (2003), Review of Housing Supply. Securing our Future Housing. Interim Report – Analysis., HMSO 2003.

Barker, K., (2005), The Housing Market and the Wider Economy, *State of the Economy Conference, Instituite for Economic Affairs*, 24 January 2005.

Case, K.E., Shiller, R.J., (1987), Prices of Single-Family Homes since 1970: New Indexes for Four Cities. *New England Economic Review*, September/October 1987, 45-56.

Case, K.E., Shiller, R.J., (1989), The Efficiency Of The Market For Single-Family Homes. *American Economic Review*, March 1989, Vol. 79 No. 1, 125-137.

Central Statistical Office, (1994), Treatment of owner occupiers housing index in the retail price index, *Retail Price Index Advisory Commitee,* December 1994.

Clapp, J.M., Giacotto, C., Tirtiroglu, D., (1991), Housing Price Indices Based on All Transactions Compared to repeat Subsamples. *AREUA Journal* , Vol. 19 No.3. 1991, 270-285.

Christensen, A.K., Dupont, J., Schreyer, P (2005), International Comparability of the Consumer Price Index: Owner Occupied Housing, paper presented at the OECD seminar; Inflation measure: too high – too low – internationally comparable?, Paris, 21-22 June 2005.

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

Diewert, W. E., (1999), The Consumer Price Index and Index Number Purpose, *Journal of Economic and Social Measurement, 27 (2001) 167-248.*

Diewert, W. E., (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. E., (2002), Harmonized Index of Consumer Prices: Their Conceptual Foundations, *Swiss Journal of Economics and Statistics 138:4, 547-637.*

Diewert, W. E., (2003a), Measuring Capital, *NBER Working Paper w9526*, Cambridge MA:NBER.

Diewert, W. E., (2003b), The Treatment of Owner Occupied Housing and Other Durables in a Cost of Living Index, *Discussion Paper 03-08*, Department of Economics, University of British Columbia, Vancouver, Canada, V6T 1Z1.

Diewert, W. E., (2003c), Hedonic Regression A Consumer Theory Approach. *Studies in income and wealth Volumer 64 Scanner Data and Price Indexes.* The University of Chicago Press 2003.

Diewert, W.E., (2003d), Hedonic Regressions: A Review of Some Unresolved Issues. *International Working Group on Price Indices (Ottawa Group). Proceedings of the Seventh Meeting*, Paris, 27-29 May 2003. Thierry Lacroix editor, 71-110, INSEE, Paris, France, November 2003.

Diewert, W.E., (2004), On the Stochastic Approach to Linking the Regions in the ICP. Discussion Paper 04-16, Department of Economics, University of British Columbia, November.

Diewert, W.E., (2005a), Weighted Country Product Dummy Variable Regressions and Index Number Formulae, *The Review of Income and Wealth* 51:4, 561-571.

Diewert, W.E., (2005b), Adjacent Period Dummy Variable Hedonic Regressions and Bilateral Index Number Theory. Discussion Paper 05-11, Department of Economics, University of British Columbia.

Diewert, W. E., (2006), The Paris OECD-IMF Workshop on Real Estate Price Indexes: Conclusions and future Directions. Paper presented at the OECD-IMF Workshop on Real Estate Price Indexes held in Paris, 6-7 November 2006.

Diewert, W.E., Wykoff, F.C., (2006), Depreciation, Deterioration and Obsolescence when there is Embodied or Disembodied Technical Change, forthcoming in *Price and Productivity Measurement*, W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (eds.), Canada: Trafford Press.

Eurostat, (2003), Price Index of newly built dwellings Draft Technical Manual, ver. 0.90, December 2003.

Fasteignamat ríkisins, (2002), *Árbók 2002*, Fasteignamat ríkisins 2002 (Land Registry of Iceland, Yearbook 2002, in Icelandic).

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

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

Gouriéroux, C., Laferrère, A., (2006), Managing hedonic housing price indexes: the French experience. Paper presented at the OECD-IMF Workshop on Real Estate Price Indexes, Paris, 6-7 November 2006.

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

Guðnason, R., (2003a), How do we measure inflation? Some measurement problems, *International Working Group on Price Indices (Ottawa Group). Proceedings of the Seventh Meeting*, Paris, 27-29 May 2003. Thierry Lacroix editor, 289-320, INSEE, Paris, France, November 2001.

Guðnason, R., (2003b), Owner Occupied Housing: Market Price Approach To User Cost, Invited paper at the Joint ECE/ILO Meeting on Consumer Price Indices, Geneva, 4-5 December 2003.

Guðnason, R., (2004a), Simple User Cost and Rentals, paper presented at the Eight meeting of the International Working Group on Price Indices (The Ottawa Group), Helsinki, Finland, 23-25 August 2004.

Guðnason, R., (2004b), How do we measure inflation? English translation of an article, Hvernig mælum við verðbólgu? *Fjármálatíðindi (the economic journal of the Icelandic Centralbank),* 1, 2004, 33-54.

Guðnason, R., (2004c), Market price approach to simple user cost. *Statistical Journal of the United Nations ECE 21 (2004), 147-155.*

Guðnason, R., (2005), Market prices and user cost. Paper presented at the OECD seminar: Inflation Measures: Too High–Too Low–Internationally Comparable? Paris, 21-22 June 2005.

Haan, Jan de., (2004), Direct and indirect time dummy approaches to hedonic price measurement. *Journal of Economic and and Social Measurement (29) 2004, 427-443*

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

Hill P., (1999), Capital Stocks, Capital Services and Depreciation, paper presented at the third meeting of the Canberra Group on Capital Stock Statistics, Washington, D.C..

Housing Statistics in the European Union, 2003, (2004), National Agency for Enterprise and Housing, Cophenhagen July 2004.

Hulten, C. R., (1990), the Measurement of Capital, *Fifthy Years of Economic Measurement,* E. R. Berndt and J.E. Triplett (eds.), Chicago: the University of Chicago Press.

Hulten, C. R., F.C. Wykoff F.C., (1996), Issues in the Measurement of Economic Depreciation: Introductory Remarks, *Economic Inquiry 34,* 10-23.

Ingvarsson, Ö, (2002), Endurmat Fasteigna í júní 2001, Matsaðferðir við fasteignamat, gerð reiknilíkana og niðurstöður úr þeim, *Árbók VFÍ TFÍ 2002 (in Icelandic),* 259-270, Reykjavík.(2002). (Revaluation of real estate in June, methods of evaluation for real estate, models and conclusions, *Yearbook VFÍ TFÍ 2002 (Association of Chartered Engineers in Iceland and Association of Chartered Technicians in Iceland)*, 259-270, Reykjavík.)

Johannessen, R., (2004), Owner-occupied housing in Norway: Why the rental equivalence approach is preferred, paper presented at the Eight meeting of the International Working Group on Price Indices (The Ottawa Group), Helsinki, Finland, 23-25 August 2004

Jörgenson, D. W., (1996), Empirical Studies of Depreciation, *Economic Inquiry 34,* 24-42.

Jörgenson, D. W., (1967), The Theory of Investment Behaviour, *in Determinants of Investment Behaviour,* edited by Robert Ferber, National Bureau Of Economic Reasearch, New York.

Koev, E., (2003), Combining Classification and Hedonic Quality Adjustment in Constructing a House Price Index. Licentiate Thesis, Department of Economics, University of Helsinki, January 2003.

Li, W., Prud'homme, M., Yu, K., (2006), Studies in Hedonic Resale Housing Price Indexes. Paper presented at the OECD-IMF Workshop on Real Estate Price Indexes held in Paris, 6-7 November 2006.

Malpezzi, S., Ozanne, L., Thibodeau, T.G., (1987), Microeconomic Estimates of Housing Depreciation, *Land Economics: Nov 1987; 63,372-385.*

Malpezzi S., Chun, G.H., Green, R.K., (1996), New Place-to-Place Houisng Price Index for U.S. Metropolitan Areas, and Their Determinants, *Real Estate Economics, V26 2:,* 235-274.

McCharty, J., Peach R.W., (2004), Are home Prices The Next "Bubble"?. *FBNY Economic Policy Review*, December 2004, 1-17.

Muth, R. F., (1972), On the Measurement of Shelter Cost for Homeowners in the Consumer Price Index, *Bureau of Labour Statistics, mimeograph, 1972.*

Muth, R. F., (1975), The User Cost of Owner-Occupied Housing, *Bureau of Labour Statistics, mimeograph, 1975.*

Palmquist, R.B., (1980), Alternative Techniques For Developing Real Estate Price Indexes. *Revview of Economics and Statistics* , Vol. 62. 1980, 442-448.

DiPasquale, D., Sommerville C.T., (1995), Do House Price Indices Based on Transacting Units Represent the Entire Stock? Evidence from the American Housing Survey. *Journal of Housing Economics 4*, 1995, 195-229.

DiPasquale, D., Wheaton W.C., (1996), Urban Economics and real Estate Market. Prentice Hall, 1996.

Mishkin, F, S., (1992), Is the Fisher effect for real? A reexamination of the relationsship between inflation and interst rates., *Journal of Monetary Economics*, volume 30, Issue 2, November 1992, 192-215.

Ribe, M., (2004*),* Swedish reconsideration of user cost approaches to owner occupied housing. *Statistical Journal of the United Nations ECE 21 (2004),* 139-146.

Sirmans, G.S., Macpherson, D.A., Ziets, E.N., (2005), The Composition of Hedonic Pricing Models. *Journal of Real Estate Literature* , volume 13, Number 1, 2005, 3-43.

Smith, D. A., (1975), The Flow of Services Approach to Estimating the Homownership Component of the CPI, *Bureau of Labour Statistics, mimeograph, 1975*

Statistics Iceland, (2004), Changes in the calculation of owner occupied housing in the CPI in August 2004, Statistics Iceland press release, August 2004.

Statistics Iceland, (2005a), Consumer price index April 2004-2005, *Statistical Series, Hagtíðindi, 2005:2,* 3 May 2005.

Statistics Iceland, (2005b), Changes of the Consumer Price Index in May 2005, Statistics Iceland press release, 3 May 2005.

Statistics Iceland, (2006), Changes of the Consumer Price Index in May 2006, Statistics Iceland press release, 3 May 2006.

Steiner, P., (1961), Consumer Durables in an Index of Consumer Prices, *Staff Paper no. 6 in The Price Statistics of the Federal Government,.* New York: National Bureau of Economic Reasearch, General series no. 73.

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

Verbrugge, R., (2006), The puzzling divergence of rents and user costs, 1980-2004. Paper presented at the OECD-IMF Workshop on Real Estate Price Indexes held in Paris, 6-7 November 2006.

Wal, Erna van der., Steege Dick ter., and Kroese, Bert. (2006), Two ways to construct a house price index for the Netherlands: the repeat sale and the sale price appraisal ratio. Paper presented at the OECD-IMF Workshop on Real Estate Price Indexes held in Paris, 6-7 November 2006.

Weeken, O., (2004), Asset pricing and the housing market. *Bank of England Quarterly Bulletin:* spring 2004, 32-41.