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Owner occupied housing in the Icelandic Consumer Price Index

Abstract
Simple user cost has been used in the compilation of occupied housing (OOH) in the Icelandic Consumer Price Index for nearly thirty years, i.e. since 1992. During this time the Icelandic economy has experienced volatile cycles including the global financial crisis in 2008-2009 resulting in the bank crash which was an extreme case. The simple user cost method is sensitive to the economic cycle and as a result questions arise on the suitability of the method.

This paper describes methods used in the compilation of OOH in Iceland from 1914 and onwards and evaluates the results. Simple user cost method is described and the results during the application period described. Results for a full user cost method are simulated and related issues of estimated real assets rates explored. User cost methods are used by two other countries for compilation of OOH in their CPI and they are compared to the simple user cost method. The rental market in Iceland is described and the CPI simulated where OOH is compiled using actual rentals only. The results over 22 years for actual rent and imputed rent are compared with different domestic economic indicators. At last the Swedish user cost method is applied to Icelandic data and the results analysed.

Key words:
Consumer price index, cost of living index, owner occupied housing, user cost.
JEL: C43, C81, D11, E31

1. Introduction

The expenditure weights for housing in the Icelandic CPI (Consumer Price Index) have been estimated in three different ways over the years. In the period 1922-1968 the weights were estimated from payed rent for a house, between 1968 and 1992 the expenditure weights were based on the estimated cost of owning a house using Household Expenditure Survey (HES) data where the weights included financial cost and reflected a payment method and from 1992 the weights were calculated as user cost based on the real estate value of a house with the aim to measure flow of services.

The main use of the CPI in the period 1922-1984 was for indexation of wages. In the period 1922-1992, two different input price indexes were used for price updating of housing. Rent index that was input price index including wages (45 per cent) and material (55 per cent) or BCI (building cost index). In the years 1939-1968 only part of the price change measured by the rent index was used (15 per cent) in the compilation of OOH. Even if the weights were decided by estimated rent payed, the price change of rents

was not used in the CPI compilation. These measurement methods underestimated systematically the CPI price change.

From 1992 user cost method was applied for measuring owner occupied housing and the price change measured by a house price index (HPI) and real interest rates. The index was to measure the flow of services as imputed rent. CPI was no longer mainly a wage compensation index but general price indicator and the CPI measured more price change than for CPI less housing. According to the 1995 CPI act the scope for the CPI was to measure prices for private consumption and a flow of services method chosen for OOH in line with national accounts.

In 1997, actual rents and imputed rents for OOH were separated in the compilation of the CPI with own weight and price measurement of actual rent. Rent is the payment for using a property over given time period. In Iceland the rental market is small as only 20 per cent of properties are rented and only half of tenants pay market rent as the other half pays subsidized rent. Market rent and imputed rent should in theory move in similar fashion.

During 1992-2019 these two series measured approximately the same price change. Over this period there have been different phases of price movements. In the years 2005-2008, imputed rent increased more than market rent and in the years 2009-2016 market rent changed more than imputed rent. The latter was a volatile economic period which is often considered to begin with the banks entering the property mortgage market in 2004, to peak with the bank crises in 2008 and to conclude with the economic recovery that followed.

Even if imputed rent both rose and fell during the period 2004-2016 the CPI did not change steeply. Imputed rent is counter-cyclical to the CPI less housing and stabilised the CPI total results. The exchange rate has strongly affected the changes in the CPI less housing as approximately one third of expenditures were imported goods. Owner occupied housing is not directly influenced by the exchange rate but is decided by the prices of properties through actual rent and imputed rent. The fact that these factors balance each other out stabilises the CPI and is a very important characteristic of the Icelandic CPI.

Three countries calculate their OOH as a user cost. Iceland aims at calculating general price indicator where all prices used in the CPI price measurement reflect the current price level. Sweden and Canada use payment methods and the aim of the calculation is compensation. The prices of the capital stock is always on average 12-15 years old and the price level reflects prices from earlier time periods.

Simulation of the Swedish user cost method with Icelandic data show that over the period 2007-2019 the overall price change of the CPI is similar by both methods. The Swedish method is though much more volatile using Icelandic data, partly reflecting higher rate of price change in Iceland compared to Sweden.

2. The calculation of housing in the Icelandic CPI from 1914 to present[1].

In 1915 Statistics Iceland started collecting prices of daily necessities at a quarterly interval in 40 outlets for 61 items. These items were not weighted by their importance for consumption as there was no household expenditure survey available to map consumption.

2.1 Housing; Estimation of weights and calculation of price change

In 1922 there was a demand for an indicator of cost of living for the purpose of wage indexing and the then director of Statistics Iceland estimated a base for such an index partly derived from the expenditures of his own family. The weighted version of the Icelandic CPI was calculated for the first time in that year based on these weights with reference to a household with an annual income of 1.800 *krónur* before The First World War. The index was calculated back to 1914 at the price level in October each year. Prices for food collected quarterly were also available.

The main problem was the calculation of housing and as most people lived in rented housing the problem was described as follows:

> "The housing has been the most difficult subject. Admittedly, there are reports available that were collected with the census on 1st December 1920.… Under normal circumstances, it can be assumed that the building cost of houses is the dominating factor in deciding the rent." (Þorsteinsson, Þ. (1923), page 17 and 18)

The weight for housing was assessed from estimated rental costs. However, it was assumed that rent would not be entirely based on construction costs and that the price increase was "based on more guesswork than on the other items" (Þorsteinsson, Þ. (1923), page 19). The base of the index was therefore an evaluation of estimated rent and price updated with estimation of construction costs.

In 1930 the result from 1923-1928 was recalculated based on information from the 1930 census which showed higher increase in rent prices than the published results (by almost 60 per cent). The index was therefore adjusted backwards from 1923 to 1928 and the effect of the price increase was 2.6 per cent on the total CPI

From 1922 until 1968 the CPI index weights for housing were estimated according to estimated rent payed by households although changes in the prices of market rent were not used in the CPI compilation. According to HES results there were always some participants that lived in own housing. In the 1939 approximately one third of the participants lived in own housing and the rent share for them was estimated.

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In 1950 the index weight for rent was adjusted upwards without effecting price measurements.

In 1968 the weight was estimated by the Wage Level Board (WLB) as estimated cost facing the households. The price updating was partly based on maintenance as measured by the Building cost index (BCI) and change in nominal interest rates. These estimates were repeated annually until the method collapsed completely because of rising inflation towards the end of this period in the eighties.

Table 1. Weights, shares and price updating of housing 1922-2019

Year	Origin of weights for rents	Share (%)	Price updating	Interval
1924	Estimated rent	18.4	BCI	Yearly
1939	Rent from tax returns	20.4	Rent index, wages (45%) and material (55%), 15% of the price change used	Monthly
1959	Rent from HES	17.3	Rent index, wages (45%) and material (55%), 15% of the price change used	Monthly
1968	Rent cost estimated by the Wage level board	16.1	Housing cost, BCI and nominal interest rates	Yearly
1984	Rent cost estimated by the wage level board, including financial cost	11	Building cost index	Monthly
1988	Actual expenditures on houses including financial cost	12.8	Cost including nominal interest	Monthly
1992	User cost	15.5	HPI, real interest rates, depreciation	Monthly
1997-2019	User cost	from 10.5 to 21.8	Imputed rent: HPI, real interest rates, depreciation. Actual rent: rental contracts	Monthly

In the period 1922-1939 price change of housing followed changes in the BCI. From 1939-1968 price change of housing was calculated by a rent index that was an input price index. Rent control was established in 1941 stipulating that price changes included in the CPI were limited to maintenance and the price change should be measured as 15 per cent of the total change of the rent index which was an input price index based on wages (45 per cent) and material (55 per cent).

The price change of housing was calculated in line with this until 1959 even though the law on rent control expired in 1951. The rent index rose from 1939-1960 by 1363 per cent whereas the part of it used for CPI compilation increased by 205 per cent. This method for compiling rent prices was also used in the period 1959-1968.

The weight for housing was estimated as housing cost in 1968 and price updated by BCI and nominal interest rates. In 1984 the weight for housing was measured as housing cost including change in interest

rates but the weight was price updated by the building cost index. In 1988 similar cost approach was utilised, but based on HES expenditures. The HES results showed more people living in their own dwelling and weights were estimated including housing cost and payments. In the compilation the BCI was used and nominal interest rates including the effects of indexation.

In 1992 user cost, including real interest rates and depreciation, was applied and a price update of properties by house price index (HPI). This was a flow of services method aiming at measuring rental equivalence.

In the period 1922-1968 the CPI weight was estimated as rent. In the period 1968-1992 the weight was estimated by housing cost including financial cost. After 1992 a user cost approach has been used and the weight calculated as an annuity of the average house value. In 1997 OOH in the CPI was split into separate sub-indexes for actual rent and imputed rent.

The price estimate has however been cost oriented by either input price indexes (of wages and material), by the BCI or as in the later periods by a payment method. After 1992 the price change of the HPI is used along with the real interest rates.

The weight share of housing was estimated 17.2 per cent of expenditures in 1914. In 1939 it was estimated as 20.4 per cent and rose to 24.3 with the revaluation of the weight in 1950. In 1959 the estimated share was 17.3 per cent and in 1968 it was valued as 16.1 per cent. In 1984 the weight of housing was estimated to be 11 per cent and in 1988 as 12.8.

In 1992 the share rose to 15.5 per cent and in 1997 it was 10.5 per cent. The expenditure share of housing in the CPI was 20.8 per cent in 2019.

2.2 Housing in the CPI after 1992

Since November 1992 owner occupied housing has been calculated as user cost for estimating rental equivalence. The aim was to use a flow of services method in line with national accounts standards. The user cost method included both the rental market as well as owner occupied housing in a combined index. The change was described in the following way

> "As the majority of the Icelandic people live in their own housing and the rental market is very small, it was decided to calculate the housing component of the index as rental equivalence in accordance with national accounts methods when it comes to own housing." (Statistical Series (1992), p. 486)

Improved information on the rental market paved the way for a split housing component into actual rent index and imputed rent for OOH in March 1997

To begin with the HPI only covered the capital area. In April 2000 the house prices in the whole country were included based on the first quarter of 1997. This was possible because more comprehensive data on

house prices outside the capital area became available. An outcome of a rent survey in 1999 showed that property prices had been valued too high by 0.35% while actual rent had been valued too low by 0.34%. The CPI and the housing components were adjusted accordingly.

From November 1992-August 2004 the estimated monthly real interest rate was used in the calculation of the simple user cost. Long term loans from the Housing Financing Fund were revamped in July 2004 and mortgage interest rates were lowered. Soon after that, commercial and savings banks greatly increased their housing loans at competitive interest rates. The initial fall in mortgage rates was included in the Icelandic CPI in July 2004.

However, as of August 2004 it was decided to calculate the real mortgage rates as 60 months moving average. The feared volatility of real interest rates in 2004 on housing credit did not materialize and the rates stabilized at a substantially lower level than before. In May 2005 it was decided to move over to 12 months moving average of the real interest rates and that method has been used since.

In April 2006 the calculation of the Icelandic house price index was changed 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 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).

In October 2019 Statistics Iceland reviewed the composition of average real interest rates for OOH. The supply of mortgage plans for Icelandic homebuyers had changed and the share of mortgages from Icelandic pension funds increased.

2.3 Development of prices in the Icelandic CPI

In the period 1914-1924 the CPI rose by nearly 221 per cent and the housing component rose by 231 per cent. During 1924-1939, which was a period of deflation, the level of the CPI fell by nearly 16 per cent, yet the housing component rose by 51 per cent in the same period.

In the period 1939-1959 the housing component rose by 114 per cent, the CPI less housing rose by 852 per cent and building cost index rose by 1189 per cent. In the period 1959-1968 CPI less housing increased the most, 150 per cent, while housing prices only increased by 50 per cent.

From 1968-1984 inflation was very high measured by all indicators. In 1979 indexation of financial obligations was introduced by law as to secure savings and to restore the loan market. In 1983 indexing wages was abolished and the role of the Wage Level Board became emblematic and advisory.

Table 2. The Icelandic CPI, CPI less housing, Housing and BCI, 1914-2019

Period	Number of years	CPI	CPI less housing	Housing	BCI
		Change (%) in period			
1914-1924	10	221	219	231	226
1924-1939	15	-16	-29	51	-6
1939-1959	20	650	852	114	1,189
1959-1968	9	116	150	51	124
1968-1984	16	12,777	14,617	6,085	15,210
1984-1988	4	145	148	124	129
1988-1992	4	61	64	44	71
1992-1997	5	11	11	-4	16
1997-2019	22	165	121	421	236

The aim of the index also changed, instead of indexing wages to a more general price indicator. In this period the price changes of housing were considerably lower than other indicators suggesting that the methods used led to lower price change in the CPI.

In 1988-1992 there was a similar pattern as housing prices declined less than the CPI less housing or the BCI.

In 1992 user cost was implemented and in the period 1992-1997 the price change of housing was lower than prices in other parts of the CPI. This changed in the period 1997-2019 as prices change of housing was higher than changes in the CPI.

In the period from 1914-1992 the price change for housing was always lower than other price indicators, with the exception of the deflation in the years 1924-1939. CPI less housing and building cost index were always measuring higher price changes than the CPI. This underestimation of the housing price change influenced the overall CPI.

This changed after 1992 when the flow of services approach was adapted and housing prices changed generally faster than other prices in the CPI.

Main indices and their annual price changes in the period 1992-2019 are shown in annexes 1a and 1b.

3. Icelandic CPI, expenditure surveys, legislation and use.

3.1 Household expenditures surveys

It was stipulated by law in 1939 that a household expenditure survey should be conducted under the supervision of the Wage Level Board. The WLB approved the results but Statistics Iceland gathered the data and compiled the index. The members of the board where appointed by the Confederation of labour unions, the Confederation of employers and the government. At this time wages were indexed by price changes in CPI.

In 1939 the first household expenditure survey was conducted and applied as of the first quarter that year. It was based on expenditures of 40 workers' families.

> "After this, government and parliament intervention of the index became more common as its use for indexing wages and benefits increased." (Þorsteinsson, Þ. (1964), pp. 42)

The household expenditure surveys from 1939-1984 were mostly based on families of workers and public servants, all of whom had children. The first survey to consider all households was the 1978/79 survey that was used for compilation of the 1984 base in the CPI. The sample was drawn from the National Registry. One drawback of using the National Registry is that bigger families have higher probability of being selected than smaller families with respect to their numbers in the country. The first adjustment to correct for the oversampling of bigger families was made in the 1995 HES where a weight was applied to family types with respect to size. As of the year 2001 the HES survey was conducted yearly, using a small sample each year.

> "Each year, 1,222 households are randomly selected for the survey sample. The response rate in the survey has been around 40% in recent years. The results are aggregated for three consecutive years at a time to increase the reliability of the results and reduce temporary fluctuations. The reasons for this are the small size of the annual sample and also the low response rate. The survey has been conducted continuously since 2000. Results for the years 2000 and 2001 were first used in 2002, mainly to review the weights for food and beverages. The results of surveys for three years were first utilized in the 2004 rebasing of the index and were mainly based on the expenditure surveys of 2000-2002. The primary source for the elementary aggregate is Statistics Iceland's Household Expenditure Survey. Its data is used directly in the calculation of items that comprise about 45% of expenditures in the elementary aggregate. When more detailed data is available, or the consumption study does not provide a sufficient breakdown, more accurate data is gathered, covering about 55% of the expenditure weights. This is done, among other things, to reduce the bias in the CPI due to base data." (Guðnason, (2019b), p. 3)

3.2 The CPI legislation

In the period 1939-1995[1] there were laws passed for each index base compiled. In these laws it was stipulated that HES should be conducted and used as base for the CPI. There were not any further directives about the CPI scope or calculation. This changed in 1995 when the frame of the CPI was defined by law (Act no. 12/1995) on the consumer price index. The law in 1995 was set in parallel with the decision to index financial obligations, i.e. mortgages, by the consumer price index.

In the CPI act the role of the index is defined as to show changes in private consumption and the frame of the index is set in line with the national accounts. The index should be based on HES conducted at least every fifth year. The name of the index was changed to Consumer price index after having been called Cost-of-living index from 1922. Statistics Iceland decides and publishes the index instead of the WLB which was replaced by advisory board. From 1995 until 2008 all prices were measured on the first two working days of a month but after that the price collection occurs in the middle of a month. 3.3

3.3 Use of the CPI

The CPI was from 1939 to 1984 mostly used for wage indexation. The aim and measurement of the index was to a large extent influenced by the government and representatives from labour unions and employers' organisations, e.g. through the WLB.

This changed in the middle of the nineties and wage indexation was abolished. The aim of the CPI changed gradually until 1995 when the role of the CPI was established as a general price indicator in line with NACC standards with the Act on the Consumer Price Index.

The use of the CPI for indexation from 1979 has been outside the field covered by Statistics Iceland with the CPI as is also the case for other uses such as for monetary policy. The use of the CPI for indexation has always been decided by the government and the parliament.[2] Indexation has been commonly used in Iceland since 1979 and the combination of indexes used has changed much. In the period 1979 to January 1989 the credit terms index was a composite index of the consumer price index (2/3) and the building cost index (1/3). In the period February 1989 to March 1995 it was composed equally of the consumer price index, building cost index and wage index. Since 1995 indexation is by the CPI.

[1] The acts are: 10/1939, 22/1950, 1/1959, 70/1967, 87/1980, 5/1984 and 12/1995.

[2] The acts are: 13/1979, 13/1995 and 38/2001.

4. Full user cost methods for owner occupied housing and volatility

There are mainly two factors used in the simple user cost model; interest rates and depreciation. The user cost method converts the expenditure on a durable (such as a house) into flow of services by considering the use of capital, long term financial (opportunity) cost (interest) and the use of the durable (depreciation).

The CPI is confined to the expenditures of households and household income is not included in the calculation of the index. Hence, capital gain/loss are excluded. Conceptually, the Icelandic CPI measures price changes in household expenditures exclusive of changes in households' income and it is the stated aim to measure changes in the price level of expenditures without regard for the amount of money needed or available to pay for the expenditures.

4.1 Simulation of full user cost and assets real interest rate

In the full user cost approach the purchasing cost of the durable is calculated at the beginning of the period, the use of the durable (the services) during the period and subtracting from these costs the capital gain/loss realised when selling the durable at the end of the period and income added into the calculation. Capital gain is subtracted from expenditures and capital loss is added to expenditures.

In the full user cost model it is assumes that it is possible to sell the house and buy another at the same moment in time. This is not a realistic assumption as there is always some time lag. There is also in addition a considerable transaction cost when buying and selling that is omitted.

Research show that the results of full user cost are very volatile (Gillingham (1980) (1983), Johannessen, R. (2004), Verbugge, R. (2008).

The effect of full user cost on the Icelandic CPI was estimated and detailed CPI data on expenditures for the years 1992-2019 used. The average real estate value used in the monthly calculation of the simple user cost was utilised.

Figure 1. Effect of estimated full user cost on the Icelandic CPI 1992-2019

In the simulated full user cost it is anticipated the house is first bought in January 1992 and sold 12 month later. This exercise is then repeated for each month to 2019 and the capital gain/loss added/subtracted to the results.

The simulation of the full user cost method on the Icelandic data gives similar results of extreme volatility as the studies show, making full user cost not usable in the calculation of the CPI.

The full user cost method uses nominal interest rates and nominal property prices and thus reflects inflation, both general inflation and property price inflation. Real interest rates and real property prices can also be used in the full user cost method by adjusting for the effect of inflation. In that case the real interest rates can be defined as the difference between the nominal interest rate change and the rate of change in property prices (Diewert, 2003b and 2004, Diewert and Shimizu, 2019, Zhiesang, 2020).

In the simple user cost model real mortgage interest rates refers to the consumer side (household) and the way a property value is financed on purchase. The real interest rate is assumed to be the required return on (or opportunity cost of) capital tied up in the property or borrowed. Simple user cost reflects these two main types of financing in the opportunity financial cost covering the lifetime of the durable by keeping the equity rate fixed but allowing the mortgage real interest rate to vary.

The real interest market rates are available in Iceland. I is an advantage of the method that the variable real interest rate used in the simple user cost model is a market rate which has been relatively stable over the time. The average real interest rate in the period 1992-2019 has fallen by 21.2 per cent. The average logarithmic yearly rate of change in this period is -0.8 per cent (monthly -0.07 per cent).

All owners face this rate as well as landlords who account for it while deciding on rent charged for their property. When this opportunity cost or the required real rate of return deviates from the real property assets prices the difference in the full user cost model is the capital loss or gain or the income or loss of the owner as an investor.

The real assets rates are not market rates but are derived from nominal property prices. Real assets rates are estimated by deflating property prices with a chosen price index. The full volatility of house prices will be reflected in the assets real interest rates derived this way. The CPI is not well suited as it includes house prices.

There are generally three other price indices available that could be considered for deflation to derive at the real property price rate or the real assets rate.

CPI less housing is an alternative and is probably on methodological ground best suited as estimator for property assets real price change. Other possible indices for deflation are the wage index and the building cost index.

Table 3. Real property prices 1992-2019, average logarithmic changes

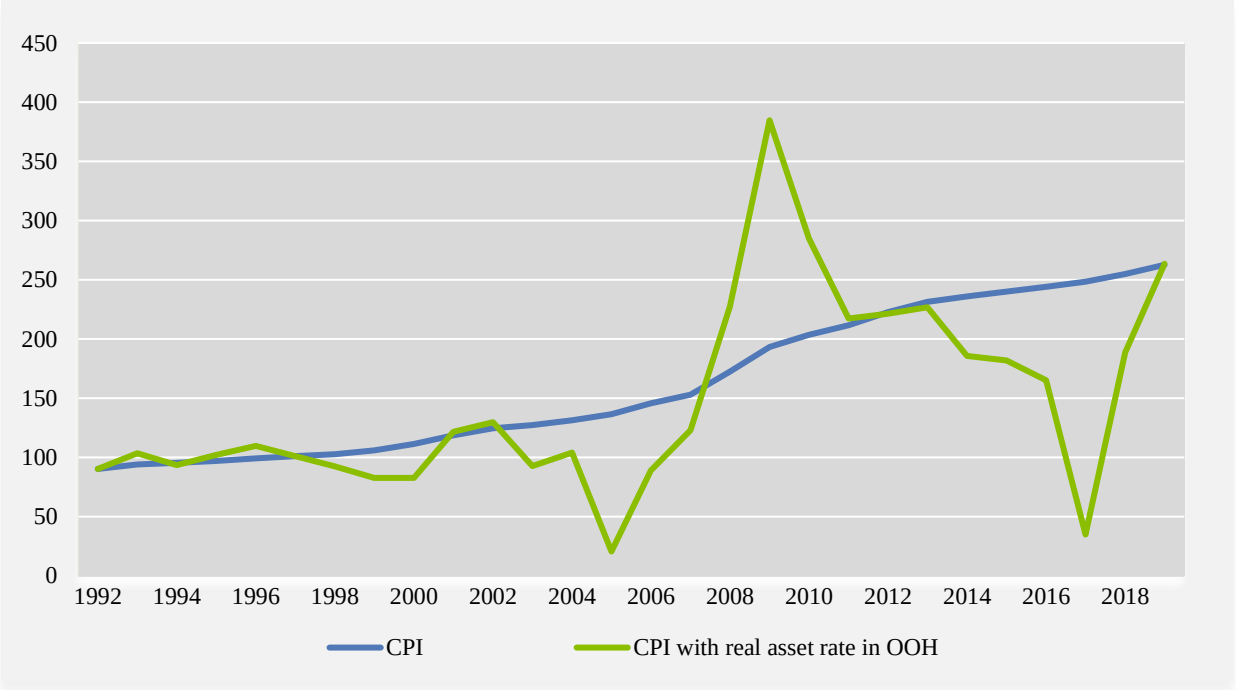
Changes	Property prices	Property prices deflated by		
%	Total Country	CPI less housing	Wage index	Building cost index
Annual				
1992-2019	6.9	3.4	0.5	1.7
1997-2019	8.4	4.6	1.3	2.7
2001-2019	8.1	4.3	1.2	2.1
2007-2019	5.6	1.4	-1.0	-0.2
Monthly				
1992-2019	0.56	0.28	0.04	0.14
1997-2019	0.67	0.38	0.11	0.22
2001-2019	0.65	0.35	0.10	0.17
2007-2019	0.45	0.12	-0.08	-0.01

Over the period 1992-2019 the real property prices in relation to CPI less housing changed by 146.2 per cent. In relation to the wage index the change was 13.4 per cent and deflated by the building cost the real change was 56.3 per cent. There is also considerable difference in the result on average change dependant on the time period chosen reflecting the volatility in the economic situation in Iceland.

Yearly real logarithmic property prices deflated by the CPI less housing rose on the average 3.4 per cent (0.28 per cent monthly). Average real price change for the wage index was 0.5 per cent (0.04) and deflated by the building cost index it rose by 1.7 per cent (0.14).

The real property prices in relation to the building cost index, an input price index show a little higher real price change than the wage index. The price change of the building cost index reflects building cost without land and could therefore be used but as an input price index it does not directly reflect market prices of houses. The real property prices in relation to wage index show very small average change but are dependent on income and therefore not suited for this exercise.

Figure 2. Effect of estimated real asset rate on the Icelandic CPI, 1992-2019



The effect of full user cost in real term was estimated using the detailed CPI data on expenditures available for the years 1992-2019. The rate used in this calculation is the difference between the real interest rate used in the imputed rent calculation and the real asset rate derived from a 12 month change in the real property price index. The real estate house value is that same as is used in the calculation of imputed rent in the CPI. In the simulated full user cost in real terms it is anticipated that the real assets rate is applied to the real estate property value as it was a year ago.

The first property value used is from January 1992 and the real asset rate used is covering the period January 1992 to January 1993. This exercise is then repeated for each month to 2019 and the capital gain/loss added/subtracted to the results.

The results are extremely volatile as was in the case of full user cost and obvious that this approach is not to be recommended for use in the CPI. The extreme points reflect the time when the real asset prices rose or fell much. It was in 2005 when they rose by 28.7 per cent, in 2009 when the fell by 22.2 per cent and in 2017 when they rose by 22.2 per cent. In the full real user cost approach these changes lead to extreme

changes as income is subtracted from expenditures when they rise steeply (as in 2005 and 2017) and the changes added to expenditures when prices fell (as in 2009).

In annex 3a and 3b the yearly real property price indexes deflated by CPI less housing, the wage index and that BCI and their price change in the period 1992-2019 are shown.

4.2 Volatility of full user cost and smoothing

Simulation of the full user cost method in nominal or real terms using Icelandic CPI data show that the results are extremely volatile. The volatility of the method is based on two facts, the interest rate used (nominal) and the price changes of the assets.

In studies of full user cost the remedy suggested is to smooth over longer time period but that does not solve the problem of volatility. Nominal interest rates include the effects of inflation. If inflation is high or low volatility increases.

House price volatility is also an established fact. The Icelandic house price index is a good example of this. In the period from 1992-2019 the price changes were in the interval of - 9.7 per cent to +28 per cent with considerable variations between years.

In annex 2a and 2b the yearly property price indices in Iceland and their price change in the period 1992-2019 are shown.

Short time smoothing is used in the housing component in the Icelandic CPI. The house price index is calculated as three months moving average and real interest rates are calculated as 12 months moving average.

Smoothing over longer time periods is more problematic and difficult to use due to the backward looking aspect which ages the price measurement. By using 30 years moving average of prices, the outcome is a price level on average of 15 years old prices. Using such a method raises the question of “What story does such an index tell?”

Smoothing effects:

- There is a close relation between a smoothed version of CPI housing component and a payment method as both relate to older time intervals that does not reflect current flow of services.
- The results of smoothing depend on the volatility in the underlying time series where extreme volatility lead to sudden price increase or decrease. This is probably also the reason why studies on house price volatility have not led to successful smoothing results.
- It is often difficult to understand the result of smoothing over time as it is not necessary in line with current price changes. The results of smoothed prices can be higher/lower than current price changes.

In an Icelandic study in 2018 the effect were estimated of "Swedish treatment of the capital stock"based on "30-year EMA[1] of the capital stock" using Icelandic data. This study used the capital area house price index for the period 1994-2018. The reference year was 1969 so the estimated time series had to reach back 30 years to 1939 prolonging time series backwards using the BCI as reference. The underlying period for the EMA was therefore nearly 80 years (24 years of available property price index and 55 years of estimated property price index). The results was:

> "Given the above information the Taskforce requested a study of the potential impact on CPI volatility if the current sub-index (042) for owner-occupied housing (OOH), i.e. the imputed rent index, was replaced by an index based on a 30-year EMA of the capital stock. This is thought of as an approximation of the Swedish treatment of the capital stock. The prior expectation was that employing the long term EMA would reduce the CPI volatility. However, this was not so. … Due to the negative correlation of the current owner-occupied housing cost sub-index (042) with other sub-indices the current method of encompassing owner-occupied housing costs into the CPI results in lower volatility (standard deviation) relative to the EMA approach." (Harðarson (2019), p.7)

The study presented in this paper uses 15 year moving average of the property price index for 27 years. In the period 2007-2019 the smoothed property price index rose 24.5 per cent more than the property price index. This reflects the fact that the property prices fell considerably in the time period after the banking crises having effect on the smoothed results.

The conclusion is that it is not likely that smoothing would give less volatile result than according to the present simplified user cost method using current prices.

[1] Exponential moving average

5. The Icelandic simplified user cost.

In Iceland, the approach of calculating housing cost as a simple user cost was adopted in November 1992. The method is relatively easy to implement and not resource demanding and therefore well suited for a small statistical office to implement.

5.1 Simple user cost

In the beginning the price measurements for housing covered only the capital area and since April 2000 the whole country. The main source when determining a base weight for housing is the official real estate assessment of housing, information available from household expenditure surveys. The entire real estate property of Iceland is valued in a harmonized way through information on the market price of properties sold using hedonic method.

Price measurement occurs monthly according to a price index for sold properties and changes in long-term real interest rates. A sales contract includes payment arrangement details; this information is used for computing the present value of the sales contract. 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 Icelandic housing price index is computed from changes in the present value of real estate sales and the price changes for real estate are calculated as a three-month moving average, with a one-month delay. For example, the index result in May is based on prices collected in the period of February through April compared to prices from January to March. A stratification method is used in the compilation. The classifications used for this stratification are size, property type and location. The estimator used in the calculation is geometric and the index is calculated superlatively (using the Fisher index, in this case). This form of the property price index was adopted in 2006.

The annuity formula is derived from a geometric series and the real interest is calculated over the lifetime of the durable and so is the depreciated durables value. The result is then converted into equal imputed payments (annuity). By using annuity both the interest rate and the depreciation is calculated from the same base and change in a harmonised way and calculated over the lifetime of the durable. The loan market in Iceland is characterised by indexation as most loans are indexed by the CPI and bear real index rates.

The principal of the mortgage is indexed to the CPI and then has a pre-set real rate of interest on the principal. The simple user cost method is developed in line with this fact as the most common form is annuity loan. The similarities are that under the simple user cost method the depreciation is calculated (similar to a down payment of a loan) as is the real interest over the lifetime of the durable (length of the loan) and divided into equal imputed rent payment (equal loan payments). There is however difference in how the asset and loan are treated from the point of view of indexation.

- The monthly real estate value (value of the property) is price updated with the house price index (asset price). Then the imputed annuity (user cost) is calculated by a given real interest rate and depreciation.

- Loan with monthly payments is price updated by the CPI. Then the annuity (loan payment) is calculated by using the real interest rate and length of the loan.

The methods differ as the house (durable) is price updated by the house price index but the loan by the CPI. The annuity for the house is the imputed rent (user cost) and the annuity of the loan is the payment of the loan.

Usually the expenditure weight using the annuity method is lower than the calculation of weight including interest rate and depreciation using other approaches. This is similar to loans when annuity is used that lead to lower original payment compared to other form of loan payment.

Given data for house prices, real interest rates and depreciation, the formula for the annuity is:

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

A_{HV} is the annuity based on the house value, P_H is the present value of the house, r is the real interest rate and N is the lifetime of the durable (years).

According to the formula the real interest rate has a direct influence on the annuity. The annuity (imputed rent) increases by almost the same amount as the real rate when the rate is not very small (in this case 3.3 per cent) and the lifetime long (80 years). The user cost is therefore vulnerable to real interest rate changes.

5.2 Real interest rate

Real interest rates in Iceland are pre-set but not derived from nominal interest rates. This is a direct consequence of indexation of mortgages which is the most generally used form of loan contracts for households in Iceland. Mortgages principal and savings are indexed according to law by the national CPI. All indexed loan contracts include real interest rates which are applied to calculate the next payment after the price update of the principal of the loan by the CPI.

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 part of the house price paid in cash is considered the buyer's equity. 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. During computation in order to estimate the opportunity cost of the capital for the lifetime of the asset the interest on equity is fixed, while interest on borrowed money varies.

When this approach was adopted this rate of return amounted to 3% and has been left unchanged for these calculations. Interest on borrowed money is changed monthly using twelve months moving average from one month to the next. On the other hand, it is certain that developments in the real interest rate are reflected in price measurements of housing over the long term.

From November 1992-August 2004 the estimated monthly real interest rate was used in the calculation of the simple user cost, as of August 2004 it was decided that the variable real mortgage rates should be calculated as a 60 month moving average. As of May 2005 the method of averaging real interest rates was changed to a 12 month moving average and that has been unchanged since.

5.3 Depreciation

The user cost covers both buildings and the land on which they are built. The depreciation rate was determined chiefly by reference to the construction year of the property base. 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, for practical reasons the depreciation is compiled on both building and site as the two are not separated in the source data. The depreciation in the index is 1.25% of the real estate value, reflecting the share of land with zero depreciation which corresponds to a lifetime of about 80 years.

The form of depreciation is an inverted geometric depreciation. It differs from the usual geometric depreciation in the sense that it is small in the beginning but increases as the years go on and the durable is fully depreciated. 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.

5.4 Price development of imputed and actual rent 1997-2019

Over the period 1997-2019 the price change for imputed rent was nearly 423 per cent and for actual rent nearly 416 per cent, imputed rent increased 1.4 per cent more than actual rent. The average yearly price change for imputed rent and actual rent are very similar. The yearly logarithmic change is 7.8 per cent (0.63 per cent monthly) for imputed rent and very similar for actual rent, 7.7 (0.62). In the time period 2007-2019 imputed rent rose on average yearly about 4.4 per cent (0.39) and actual rent 6.6 per cent (0.53).

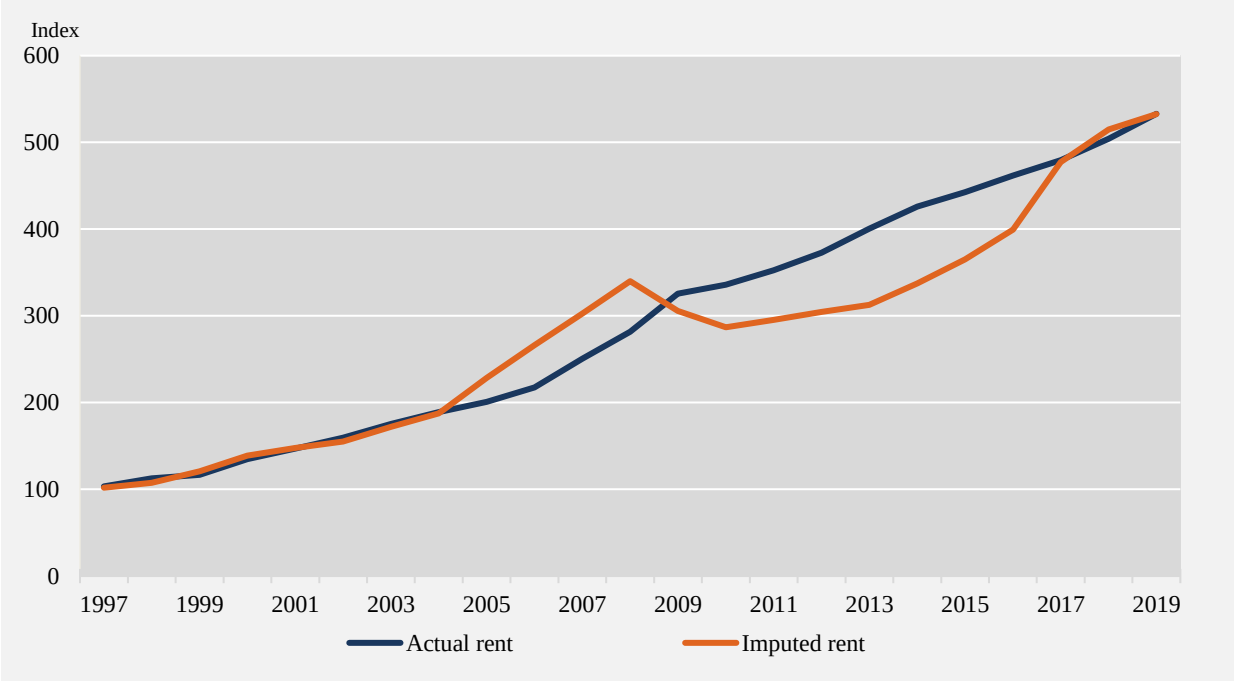
Table 4. Property prices, imputed and actual rent 1992-2019, average logarithmic change

Changes	Property prices	CPI prices	
%	Total country	Imputed rent	Market rent
Yearly			
1992-2019	6.9	6.2	
1997-2019	8.4	7.8	7.7
2001-2019	8.1	7.4	7.4
2007-2019	5.6	4.8	6.5
Monthly			
1992-2019	0.56	0.51	
1997-2019	0.67	0.63	0.62
2001-2019	0.65	0.60	0.60
2007-2019	0.45	0.39	0.53

Even if the price change of imputed and actual rent change similarly over the whole period there are two periods when imputed rent increased more than actual rent. This was after the banks entered the market for mortgage loans in 2004 and there was a significant increase in supply of mortgages in the period 2004-2008 and property prices rose.

Following the bank crash in 2008, when the Icelandic banking system collapsed, house prices fell but actual rent rose at the same time. This development changed in 2013 when house prices rose and imputed rent and actual rent started to align again which happened in 2016. This time was extremely critical in the Icelandic economic history and internationally.

Figure 3. Actual rent and imputed rent in Iceland 1997-2019. March 1997=100



In annex 4a and 4b the yearly property price index, imputed rent and actual rent in Iceland are shown and their price change for the period 1992-2019.

6. User cost methods in Sweden and Canada.

There are three countries that calculate their OOH with user cost; Iceland, Sweden and Canada. There are certain differences between their approaches because the aims with the calculation differs. Iceland targets flow of services method and rental equivalence in line with NACC standards but Sweden and Canada use different variants of payment methods. This chapter outlines the methods used in the three countries.

Iceland and Sweden use the COICOP classification of consumption in their CPI. The housing component includes actual rent, imputed rent and other expenditures, such as maintenance, electricity and heating. Canada uses a national consumption classification which differs in some aspects from the COICOP classification for housing. The treatment of other expenditures than OOH is similar and therefore not addressed specifically.

6.1 The Swedish user cost method[1]

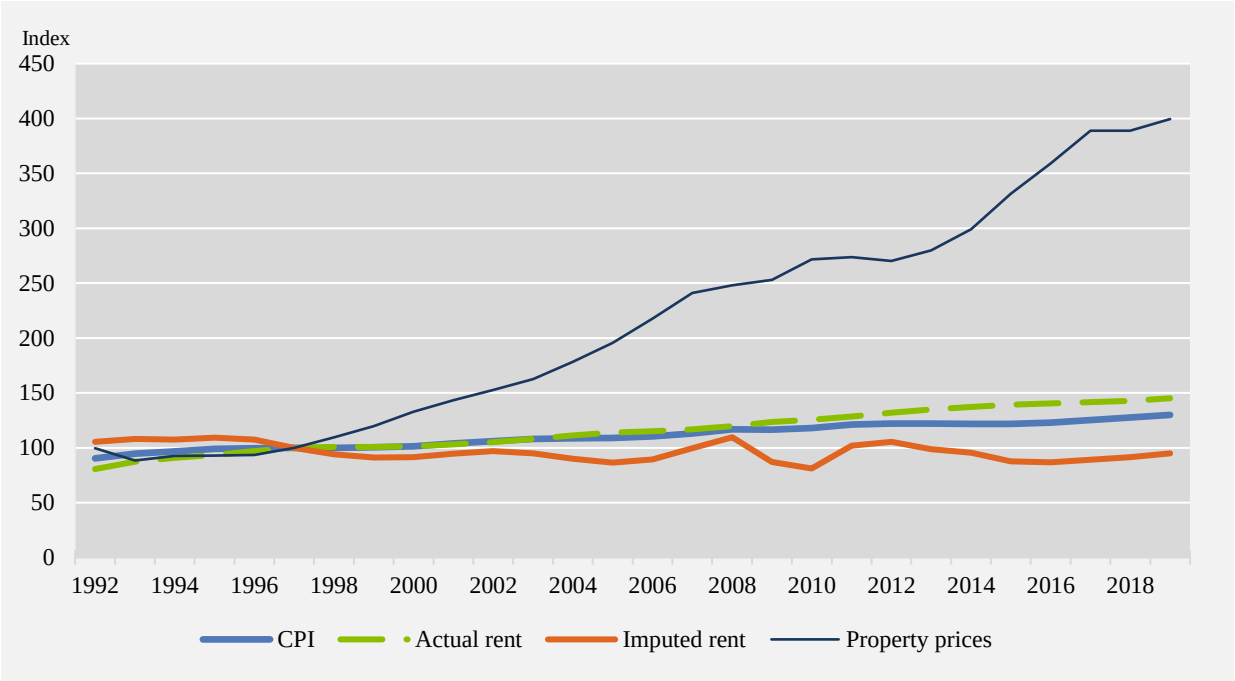
The imputed rent in the Swedish CPI includes both small houses and housing cooperatives and the user cost includes both types of housing. The base weight for small houses is the estimated original capital invested in each property calculated with historical prices in accordance with the length of ownership. Renovations are included but not new houses.

In the calculation a property price capital stock index of historical prices is used. The historical value of the property is based on the estimated present taxation value of the property. That value is back calculated to the estimated original capital value by this capital price index taken the length of the ownership by the same person into account. It measures the capital used at the price level when the property was purchased. The base for housing cooperative is historical average prices calculated by the length of the ownership in accordance with a property price index for all housing cooperatives sold.

The base expenditure share is in line with the historic buying prices and calculated by multiplying average estimated buying price for small houses by the total number of houses (now approximately 1.8 million). The method used for the housing cooperatives is multiplying the average buying price that is available with the total number of housing cooperatives (now approximately 1 million). In the calculation a 30% tax reduction available for most owners is subtracted. In each index link the stock available cover all historical buying prices with 2 years delay.

[1] The author would like to thank Emanuel Carlsson and Martin Ribe for thorough introduction to the Swedish user cost method at Statistics Sweden on June 18, 2018.

Figure 4. Indices in Sweden 1992-2019; CPI, actual rent, imputed rent and property prices for houses, 1997=100



Source: Statistics Sweden

The interest base weight for small houses is calculated by applying the average interest rate to the historical buying prices for the total housing stock in the base period. The interest rate used is the average current nominal interest rate on loans available for buying small houses In the calculation of the monthly interest rate, the base period interest weight is calculated by the product of the capital stock index and the interest rate index. The interest rate is calculated of the whole stock covering both mortgages and own equity.

Index for the monthly charges for the housing cooperative is calculated by three subindices. Index for the monthly cooperative charge (covering approximately 67 per cent of the expenditure weight), index for inner reparations (8 per cent) and the rent index (25 per cent). The average interest rate is applied to the historical buying prices for the total housing stock in the base period. In the calculation of the monthly interest rate the base period interest weight is calculated by the product of the hedonic capital stock index and the interest rate index.

The capital stock index consists of two parts, property price index and the stock stratified by the time of ownership for all houses and housing cooperatives as it was two years ago. The property price index for houses is published quarterly with 1-2 quarters time lag and for housing cooperatives monthly. Houses are price updated by a property price index monthly approximating 25-30 years moving average and for cooperatives by a monthly hedonic index.

Table 5. CPI, housing components in Sweden 1992-2019, 1997=100

Changes (%)	CPI	Market rent	Imputed rent	Property prices
Yearly				
1992-2019	1.4	2.2	-0.4	5.3
1997-2019	1.2	1.7	-0.2	6.5
2001-2019	1.3	1.9	0.0	5.9
2007-2019	1.2	1.8	-0.4	4.3
Monthly				
1992-2019	0.11	0.18	-0.03	0.43
1997-2019	0.10	0.14	-0.02	0.53
2001-2019	0.10	0.16	0.00	0.48
2007-2019	0.10	0.15	-0.03	0.35

Source: Statistics Sweden

In the calculation of the interest rate index a monthly interest rate is used that is collected from financial statistics compiled by Statistics Sweden reflecting outstanding debt and the most common interest rate being three months variable rates.

The base weight for depreciation of houses is based on tax value of the stock estimated by a property price index to prices in December each year and the depreciation calculated as 1.4% of this stock. In each month the weight share is price updated by a maintenance index that is a mix of material and labour components. Depreciation for housing cooperatives is calculated in a similar fashion.

The Swedish approach compiles user cost with interest (opportunity cost) and depreciation. The main aim is compensation and it is a variant of a payment method but not a flow of services approach.

There is a different underlying price change between the Swedish CPI and the actual and imputed rent of housing and housing property price indices. In the period 1992-2019 the Swedish CPI rose by nearly 44 per cent but actual rent rose by 80 per cent, whereas imputed rent fell by 10 per cent. Property prices of houses increased at the same time interval just over 300 per cent.

For the CPI the average yearly logarithmic price change is 1.4 per cent (0.11 per cent per month). There is also similar price change over the time and the CPI price change is similar over this period. The average monthly price change for market rent is 2.2 per cent (0.18). The average monthly price change for imputed rent is close to zero, -0.04 (-0.03).

There is a different price pattern for the house price index that has a 5.3 per cent (0.43) average yearly price change.

The Swedish user cost is defined as partial as capital gain/loss is not taken into account as is the case in the Icelandic user cost method. The difference is however apparent in the age of the underlying house pricing series and the Swedish choice of nominal interest rates.

In annex 5a and 5b the yearly CPI, market rent, imputed rent and property prices for houses in Sweden and their price change in the period 1992-2019 are shown.

6.2 The Canadian user cost method[1]

Statistics Canada's approach is to measure the impact of price changes on the costs incurred by homeowners while they own a home. These costs include mortgage interest and replacement cost (depreciation).

The basket weight for the mortgage interest cost is the total interest paid on mortgages by Canadian households. The mortgage interest cost is estimated using administrative data supplemented by Survey of Household Spending (SHS) data. To estimate its value, administrative data, namely banks' financial statements, collected and published by the Office of the Superintendent of Financial Institutions (OSFI) and data are used. Based on OSFI data, Statistics Canada estimates the effective interest rate paid on residential mortgages as the ratio of banks' residential mortgage income divided by the banks' total residential mortgage loans in the basket reference period. The mortgage balances, as reported by SHS, is then multiplied by this effective rate to derive the CPI mortgage interest weights.

The mortgage interest cost index is intended to measure price-induced changes in the amount of mortgage interest owed by the target population. Two price factors contribute to these changes through time. First, changes in dwelling prices affect the initial amount of debt; hence they also affect the amount of principal outstanding in subsequent periods. Second, given the amount of principal outstanding the amount of mortgage interest payments is determined by changes in the price of credit. Consequently, the mortgage interest cost is defined as a product of two indices; an index that estimates the change in dwelling prices and a rent index.

The New Housing Price Index (NHPI) is the source of data on dwelling price movements. The price index is estimated by comparing the average level of dwelling prices in the 25-year interval prior to the price observation period of the index with the average level of dwelling prices in the 25-year interval prior to the price reference period. The procedure is based on the assumption that the dwelling price at the time the debt was initially contracted affects the amount of principal outstanding at any given time. Hence, the total amount of principal currently outstanding for the population of homeowners depends on dwelling prices from all the past periods in which their mortgages were initiated.

[1] This description is mainly based on Statistics Canada, (2019) and Shoumere, (2017).

The mortgage index is derived using two administrative data sets. The first one is produced by the Bank of Canada and provides the amounts of new mortgage loans as well as the corresponding interest rates for the nine largest banks. This dataset allows for monthly update of the mortgage loans by term and covers a large spectrum of interest rates, including variable rates and over 5 years fixed rates. The second source of data is the banks' financial statements collected and published by OSFI. It is assumed that the amount of mortgage interest cost at any given time depends on interest rates at the time when the current mortgage agreement was contracted. Hence, it is only through new and renegotiated mortgage contracts that the current interest rates affect the amount of mortgage interest currently owed by the population of homeowners. A standardized mortgage interest cost function reflects this assumption by considering the initiation and renegotiation of mortgages.

The depreciation basket weight is partially derived from a household expenditure survey. The basket weight for equal to the annual depreciation of the stock of owner-occupied dwellings, is estimated to be 1.5% of the estimated market value of this stock at the end of basket reference year derived from HES. Respondents are asked how much they would expect to receive for their house if they were to sell it. This amount is multiplied by a "house/property" ratio to obtain an estimate of the value of the house, excluding the land. The value of land is not included in the base for depreciation.

The replacement cost index relates to that portion of owner-occupied dwellings that is assumed to be consumed. This is represented by the worn-out structural portion of housing (depreciation of housing) or the amount a homeowner must spend to maintain the home's market value. The price index for the replacement cost is derived by taking the total value of homes owned in Canada at the end of the basket reference year and adjusting the total each month by changes in house prices as reflected by the New Housing Price Index, exclusive of land.

The Canadian user cost is defined as partial as capital gain/loss is not taken into account.

7. Comparison between user cost methods in Iceland, Sweden and Canada.

These user cost methods used in the CPIs in Iceland, Sweden and Canada all take interest rates and depreciation into account. The methods differ regarding their aim and in the choice of interest rates.

The Icelandic user cost measures the flow of services method targeting rental equivalence as defined in the national accounts and all prices are current prices. The Icelandic method uses the whole capital stock and calculates a rate of return on own equity. The method uses real interest rates as defined in loan contracts.

The Swedish and Canadian user cost methods reflect that the main use of their CPI is for compensation. The prices used are from various time points which refer to 12-15 years on average in the past. Both countries use nominal interest rates available for properties mortgages**.**

Table 6. User cost in Iceland highlights

Field	Method
Coverage	Simple user cost
Theoretical	National accounts, rental equivalence
Aim	Flow of services, model
Price index	All properties sold, superlative, Fischer
Time period	3 months moving average
Stock	Total stock valued at current prices
Weight	The annuity (present value) of the housing stock
Own equity	Yes
Interest	Real, twelve months moving average
Depreciation	1.5% of property excluding land (1.25% of total)

Both the Swedish and the Canadian owner-occupied housing methods are payment related. The Canadian method is a full payment method using remaining debt of mortgages at the time of measurement as weight. The payment method covers only households that are in debt and excludes households which have none. In this respect the Swedish method differs considerably from the Canadian as all households living in their owned homes are included.

Table 7. User cost in Sweden highlights

Field	Method
Coverage	Partial user cost
Theoretical	Compensation
Aim	Payment model, stock at prices when the property was bought
Price index	All single flats, Laspeyres index. Housing cooperatives, hedonic index
Time period	25-30 year moving average
Stock	Total stock valued at original buying prices, valued in prices 12-15 years ago
Weight	The capital housing stock index multiplied by the average nominal interest rate
Own equity	Yes
Interest	Nominal, current rate
Depreciation	1.4% of total stock

The Swedish method however estimates the original buying price at the time when the homes were bought. The interest is calculated from the whole stock including in that way own equity. All three countries use present time interest rates. The choice of interest rates in Iceland is real interest rates, but in Sweden and Canada nominal interest rates are used.

Table 8. User cost in Canada highlights

Field	Method
Coverage	Partial user cost
Theoretical	Compensation
Aim	Payment, outstanding mortgages
Price index	New building, without land
Time period	25 years moving average
Stock	Outstanding mortgages valued in prices 12-13 years ago
Weight	Outstanding mortgages multiplied with average interest rate
Own equity	No
Interest	Nominal, current rate
Depreciation	1.5% of total stock

The treatment of depreciation is similar in all three countries. The depreciation is calculated at a similar rate from a stock that is price updated to current prices. The stock in Iceland and Sweden are register based but in Canada estimated by the statistical office. The stock is updated yearly in Iceland but every third year in Sweden.

In the property price indexes used in Iceland and Sweden land is included but the index used in Canada excludes land. Depreciation is calculated in Canada and Iceland from the property stock excluding land.

8. Actual rent and rental equivalence.

To measure owner occupied housing with a flow of services method the relevant approach is rental equivalence. Rental and housing markets should in theory move in a similar fashion. That is not necessarily the case as the composition of the durable stock can differ compared to the rentals stock and there are costs in the rental market that those living in own housing do not face and should therefore not be included.

Rental equivalence is computed where rental markets are strong and rental changes can be used for properties in the general market that correspond to the owner-occupied housing stock. The rental equivalent then changes in accordance with the price change of rent for those dwellings.

Table 9. Tenure status according to EU SILC, 2004-2016

%	Owners			Tenants			
	No mortgage	With mortgage	Total	Market rate	Reduced rate	Rent-free	Total
2004	18.2	67.2	85.3	6.7	6.6	1.4	14.7
2005	17	69.8	86.9	6	6.1	1.1	13.1
2006	18.9	67.3	86.2	6.7	6.3	0.7	13.8
2007	14.8	71.6	86.3	5.7	6.4	1.5	13.7
2008	14.2	71.6	85.8	6.8	6.1	1.4	14.2
2009	14.9	69.3	84.2	7.8	6.5	1.5	15.8
2010	13.8	67.6	81.3	10.4	6.9	1.4	18.7
2011	15.1	62.8	77.9	11	8.8	2.3	22.1
2012	14.6	62.7	77.3	13	7.8	2	22.7
2013	14.6	62.9	77.4	12.1	8.8	1.6	22.6
2014	16.1	62	78.2	12.4	8.3	1.1	21.8
2015	15	62.7	77.7	11.2	9.4	1.7	22.3
2016	14.8	63.9	78.7	10.5	9.2	1.6	21.3

A necessary condition for this is that the rental market needs to be sufficiently large to provide properties of comparable characteristics in the rental market to those in owner-occupied housing, and that market rent rate must be used as an equivalent price changes of rent for owner-occupied housing.

Another condition is that the rental market is not controlled or rental market prices governed in some other way.

Cost borne by landlords but not by tenants or those living in owner-occupied housing should not be included in price measurements. The rental equivalence approach has not been used or deemed feasible for use in Iceland because of how small the rental market has been and because of the Icelandic rental market's difference in composition from what generally applies to owner-occupied housing.

Table 10. Housing stock, number of rental contracts and transactions, 2005-2018

	Stock Total	Rented Number	Transacted Number	Rented %	Transacted %
2005	116,859	5,229	11,207	4.5	9.6
2006	120,797	5,045	8,627	4.2	7.1
2007	125,683	5,213	11,223	4.1	8.9
2008	129,366	7,307	4,112	5.6	3.2
2009	130,065	10,522	2,670	8.1	2.1
2010	130,855	10,413	3,570	8.0	2.7
2011	131,298	9,956	5,887	7.6	4.5
2012	131,717	9,149	6,690	6.9	5.1
2013	132,471	10,042	7,431	7.6	5.6
2014	133,585	10,165	8,314	7.6	6.2
2015	134,843	9,521	10,067	7.1	7.5
2016	136,423	8,575	11,074	6.3	8.1
2017	138,182	7,598	10,658	5.5	7.7
2018	140,600	7,570	10,974	5.4	7.8

Source: Registers Iceland

The most consistent source on the size of the rental market is the EU SILC survey (European Union statistics on income and living condition). It is a harmonised European survey and a part of concerns housing. The share of tenants in 2016 was 21.3 per cent. When the survey was first conducted in 2004 this share was 14.7 per cent. It declined to begin with and was 13.7 per cent in 2007 and rose to the highest point in 2012, 22.7 per cent.

Approximately half of tenants pay market rent and that share has risen from approximately 6 per cent in 2005 to 10.5 per cent in 2016. Tenants paying reduced rates are just above 9 per cent and in rent free around 1.6 per cent.

The share of tenants paying market rent in Iceland is low and most of them are living in multi flat buildings. Can the results of rental equivalence be based on so small share? To answer that the rate of new rental contracts added each year have to be observed. That information can be collected from the rental contract deeds that are formally registered as a precondition for rent benefits to be collected by tenants.

These contracts apply both to market rented properties as well as properties with reduced rent and are the source for the price measurement of actual rent in the CPI. Each month the average amount of contracts used in the monthly price measurement is between 15-16 thousand. All rental contract available are used for measuring the actual rent. When estimating rental equivalence new rental contracts added each month should be the source.

The total amount of rental contract registered each month vary but have been on average around 8 thousand each year and highest around 10 thousand. Compared to number of contracts used in the compilation of the

property price index they are on the average around the same figure and cover nearly 6 per cent of the housing stock.

The problem with this data is that most rented dwellings are in multi-flat buildings but few in detached housing. This causes problems to ensure continuous and reliable measures for calculation of imputed rent in for probably about 35-40 per cent of the OOH stock should the rental equivalence approach be applied.

The total number of rental contracts available are in line with the number of sales contracts used for the compilation of the property price index. That fact works in favour for using the contracts for measuring rental equivalence but the contracts referring to market rent are only a part of that total.

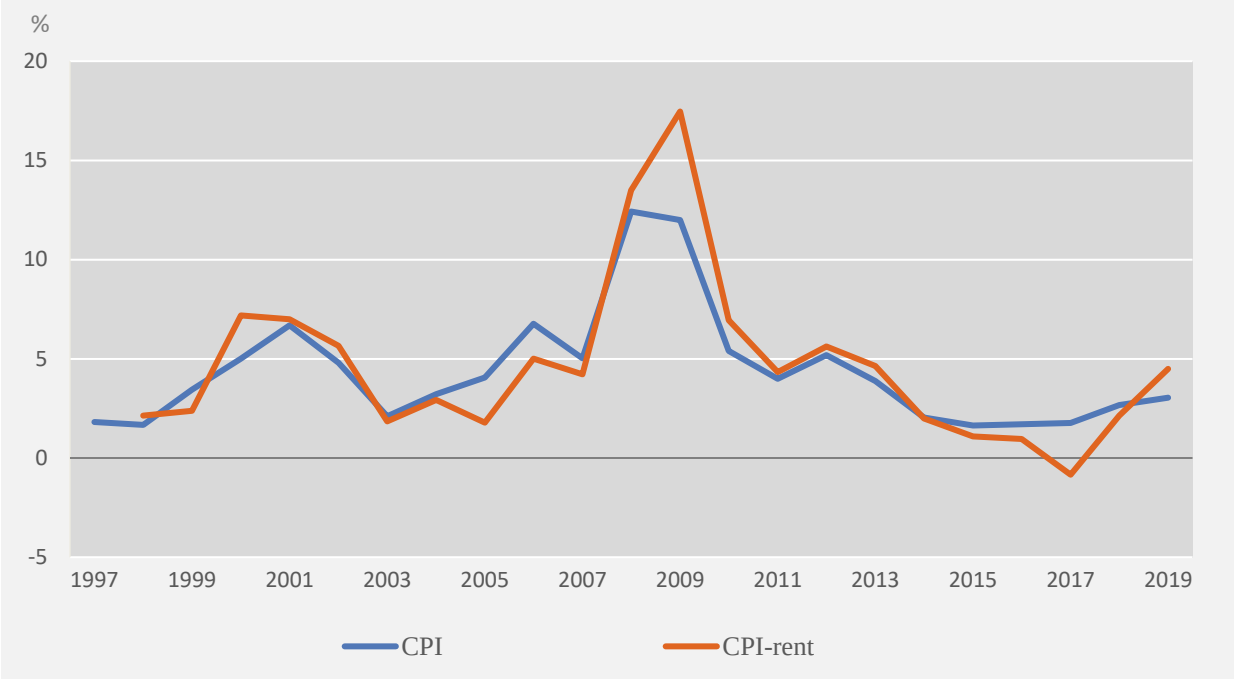
Rental contracts are different from sales contract as they cover longer time periods. The duration of such contract is often from 3 months to years and some are not time limited. That means that the results from these contracts change slowly compared to imputed rent calculated by simple user cost.

How would the CPI have changed if imputed rent would have been measured as rental equivalence? It was estimated by replacing imputed rent calculated as simple user cost with actual rent index. The base data reference was the annuity for imputed rent in March 1997 and the weight was then price updated by the market rent index monthly for the period January 1997 to December 2019.

The results show some difference in results between these series.

In the period 2000-2002 the CPI-rent measures 3.3 per cent higher price change and in addition in the period 2008-2010 8.1 per cent higher price change than the CPI.

Figure 5. CPI and estimated CPI rent yearly price changes 1997-2019



In the period 2004-2007 the CPI-rent measure 5.1 per cent lower price change and 2015-2018 4.6 per cent lower price change. The effect of implementing the CPI-rent by calculating imputed rent as rental equivalence instead of simple user cost would be considerable.

Following the bank crash there were lot of measurement problems that arose both for the HPI and the rental market. Trade of houses collapsed and those who lost their houses also re-rented them probably at lower rent than user cost would give. The effect of that was probably missed in the CPI calculation and the actual rent price change could have been overestimated just as the initial fall in the property price index. (Guðnason, Jónsdóttir, (2009) and Guðnason, Jónsdóttir and Jónasdóttir, (2009a and 2009b))

9. Imputed rent, actual rent and domestic price indicators 1997-2019.

As the aim of the user cost measurement is to estimate the flow of services an interesting question is how the actual rent price changes and imputed rent changes compare?

Table 11. Actual rent and imputed rent, 1997-2019, March 1997=100

	Market rent	Imputed rent	Actual rent %	Imputed rent %	Imp/rent %	Imp/rent Share
1997	103.39	101.85				
1998	112.68	107.38	9.0	5.4	-3.3	0.95
1999	116.84	120.93	3.7	12.6	8.6	1.04
2000	134.65	138.98	15.2	14.9	-0.3	1.03
2001	146.82	147.82	9.0	6.4	-2.5	1.01
2002	159.53	154.94	8.7	4.8	-3.5	0.97
2003	175.36	171.98	9.9	11.0	1.0	0.98
2004	189.23	187.60	7.9	9.1	1.1	0.99
2005	200.98	228.68	6.2	21.9	14.8	1.14
2006	217.63	266.15	8.3	16.4	7.5	1.22
2007	250.60	302.68	15.2	13.7	-1.2	1.21
2008	281.64	339.83	12.4	12.3	-0.1	1.21
2009	325.47	305.82	15.6	-10.0	-22.1	0.94
2010	336.03	287.02	3.2	-6.1	-9.1	0.85
2011	352.56	295.52	4.9	3.0	-1.9	0.84
2012	372.94	304.52	5.8	3.0	-2.6	0.82
2013	400.46	312.80	7.4	2.7	-4.3	0.78
2014	426.08	337.44	6.4	7.9	1.4	0.79
2015	442.76	365.09	3.9	8.2	4.1	0.82
2016	461.91	399.58	4.3	9.4	4.9	0.87
2017	479.63	477.13	3.8	19.4	15.0	0.99
2018	504.20	515.10	5.1	8.0	2.7	1.02
2019	532.98	532.64	5.7	3.4	-2.2	1.00

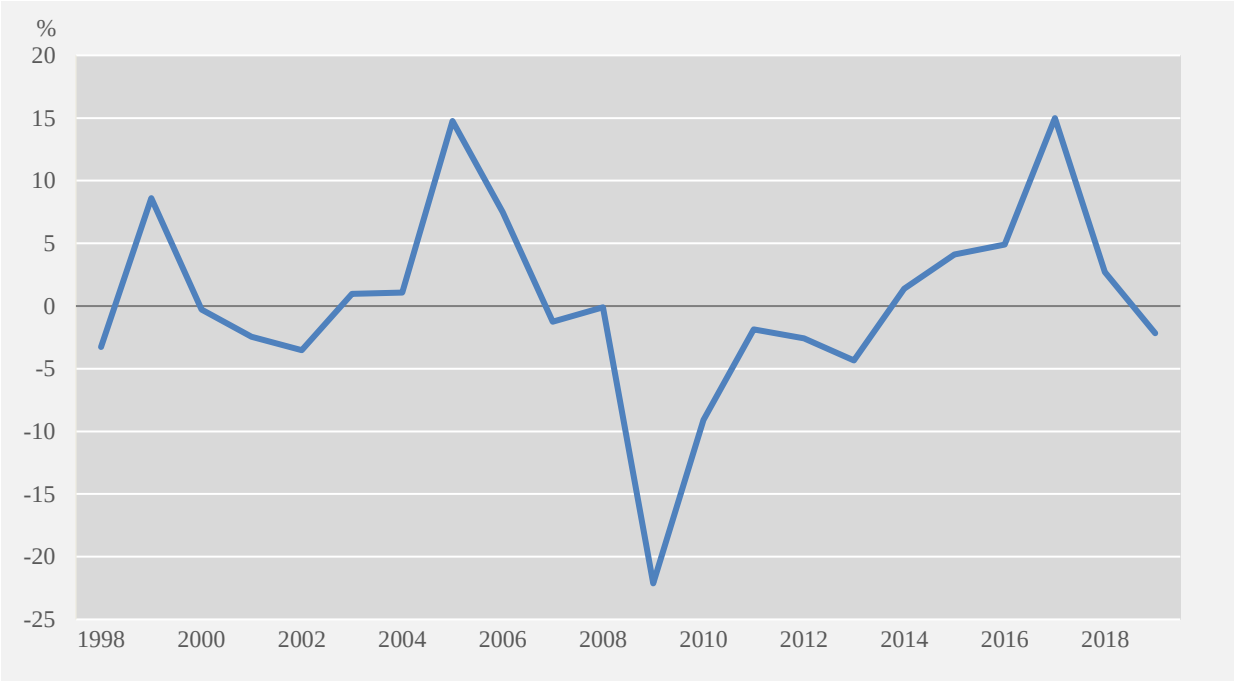
The efficiency of the simple user cost method can be tested by comparing the price changes of actual rent and imputed rent as they should move in similar fashion over time.

From March 1997 to 2019 market rent changed by 433 per cent and imputed rent by 432.6 per cent. Actual rent increased 0.06 per cent more than imputed rent. From 1997-2019 the average yearly logarithmic change for market rent was 7.7 per cent (monthly 0.62 per cent) and imputed rent 7.8 per cent (0.63).

Both series move in a similar fashion over the period 1997-2019 and even though temporary differences occur the long-term change is the same and the ratio of imputed rent to actual rent is around one. The series

move apart in the years 2005-2008, the ratio being around 1.20. In the year 2010-2014 the ratio was just over 0.8 and returning near unity in 2017-2019.

Figure 6. The ratio of imputed rent to market rent in Iceland 1997-2019

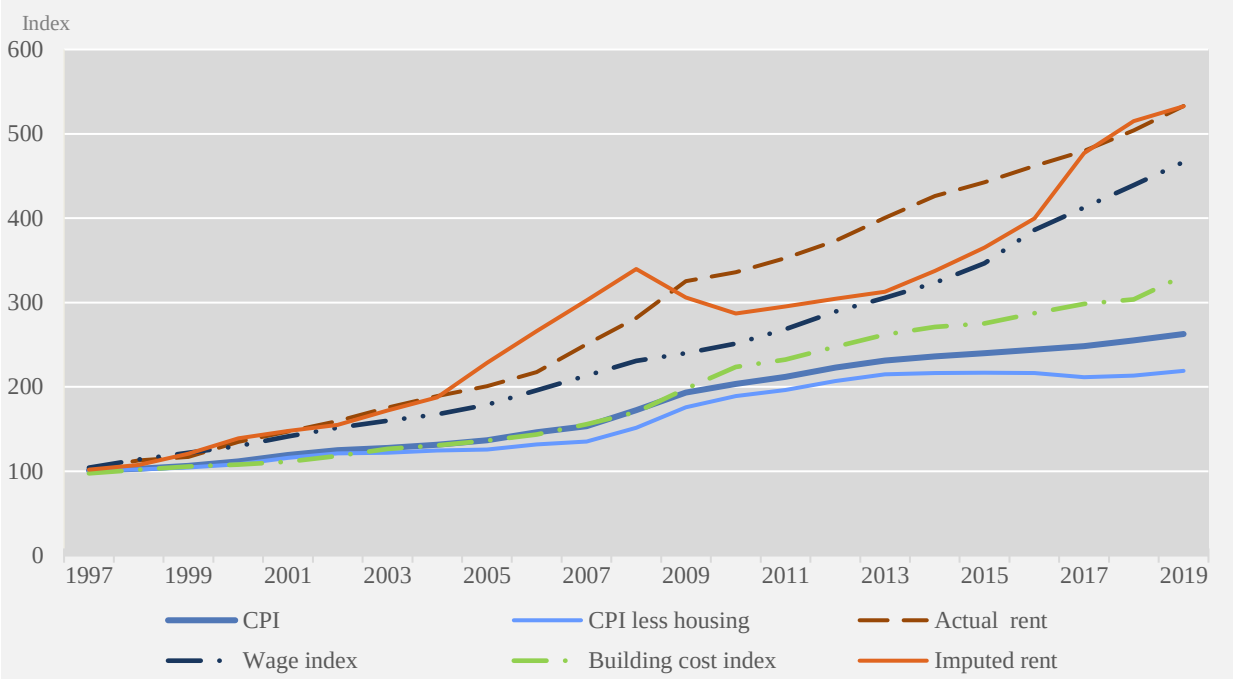


In 1999 imputed rent rose by 8.6 per cent above actual rent. Actual rent increased more than imputed rent in the years 2001 to 2003. From 2003 this changed and in the period 2004 to 2006 imputed rent increased over market rent by over 23 per cent.

It was when housing prices increased as the effect of lower real interest rate and better access to credit increased in the imputed rent above actual rent.

In 2007-2008 there were similar changes in both actual and imputed rent.

Figure 7. Price and housing indices in Iceland 1997-2019, March 1997=100



After the bank crash in 2008 imputed rent lowered by 22.1 per cent more than actual rent. This development continued until 2014. In 2017 there was again increase in imputed rent by 19.4 per cent, the difference in relation to actual rent being 15 per cent. The reason for this was increase in real wages, higher demand because of increase in tourism and immigration all leading to increased demand for properties.

The ratio of imputed rent to market rent can be seen an indicator of the magnitude of divergence between these series if the ratio are outside the interval 0.95-1.05[1].

In the years 2005-2008 the ratio is above these limits. This is the prelude to the bank crash as banks grew stronger, supply of property loans increased and real interest rates sunk. In the period 2009-2016 the ratio is below this limit. This is the time of the bank crash and the recovery period following it.

The domestic indicator following the imputed rent closely especially in periods 1997-2004 and 2010-2015 is the wage index. The real annual logarithmic property prices change in relation to the wage index change over this period is 1.3 per cent (monthly 0.11 per cent).

The bank crash in 2008 caused big measurement problems in the CPI. This influenced the price fall of the imputed rent and the rise in actual rent.

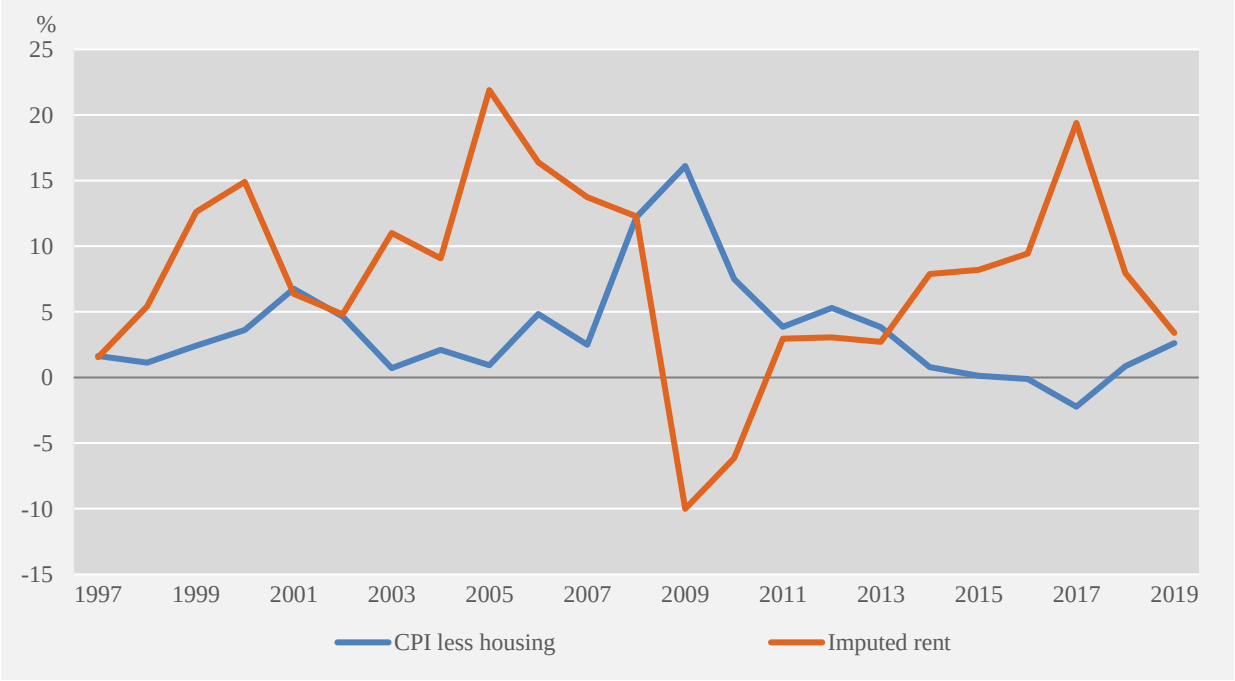
> "The first thing that could be affected was the eventual lack of prices (holes) following the downturn which still is not a big problem but influences the CPI price collection. The import of new cars stopped at once in October but had already declined considerably since March-April 2008 when the

[1] Having more than -0.1 or +0.1 per cent effect on the CPI.

exchange rate of the Icelandic Krona fell significantly. One immediate effect of the crises was that some of the outlets in the sample closed down. Housing market was affected by increase in non-monetary payments and changes in consumption influencing many parts of the CPI. Share of discount stores in the food market increased leading to a shopping substitution bias that had to be corrected." (Guðnason, Jónsdóttir, 2009, p. 2)

"Following the downturn of the housing market the price observations (number of contracts) used in the calculation of the house price index are fewer. Compared to the period 2000-2004 the observations have decreased by 65-85% influencing the calculation strongly. Still the stratification (by type, location and size) in the index is kept fixed in the calculation as earlier stated using a superlative approach. In housing trade, real estate or liquid assets may constitute a part of the payment for the purchase of a dwelling. Such non-monetary payments are found in approximately one third of the contracts and the present value of the contract is then calculated by a rate of return reflecting the risk of such trade. These contracts are a part of the price building in the market and have to be taken into account." (Guðnason, Jónsdóttir, Jónasdóttir (2009a), p. 9)

Figure 8. CPI less housing and imputed rent, yearly change 1997-2019



In the period 1997-2019 the CPI increased annually on the average by 4.4 per cent (0.36 per cent on average monthly). CPI less housing rose by 3.6 per cent (0.29).

Even if the imputed rent rose and fell under the period 2004-2016 the CPI did not change steeply. Imputed rent increases counter cyclical to CPI less housing stabilising the CPI results. The exchange rate affects the CPI less housing as approximately one third of expenditures are imported goods. Owner occupied housing

is not influenced by these factors in the short term but by prices of properties through actual rent and imputed rent. These changes balance each other out. This is an important characteristic of the Icelandic CPI.

Data on yearly property prices, imputed rent and actual rent, indices and change are found in Annex 4a and 4b.

10. Simulation of Swedish user cost with Icelandic data.

The aim of this exercise is to simulate the Swedish user cost method with Icelandic data. It is of interest to observe the results when different methods are applied using the same data set. Though this exercise only uses Icelandic data it could also be interesting to do similar calculations using Swedish data and applying the Icelandic simple user cost method but that is not done as this paper focuses on Iceland.

Comparing methods used to calculate consumer prices between countries is difficult, especially when user cost methods are applied. The aim with the user cost methods used in Sweden and in Iceland differs. The Icelandic method aims at rental equivalence reflecting current prices. The Swedish method is designed for using the CPI for compensation of wages and pensions. It does not reflect in the CPI rental equivalence or increase in current house prices and the prices used always refer to earlier time periods.

The core difference of the Icelandic and Swedish partial/simple user cost methods is the choice of interest rates and the valuation of the property stock. Sweden uses nominal interest rates while Iceland uses real interest rates. The main difference between the real and the nominal rates reflects inflation rates. The Swedes value the property stock in prices at the year of purchase of the dwellings whereas the Icelanders seek to evaluate the property stock in current prices.

10.1 Simulation methods and data

The basic data in the model is the same as is utilised in the compilation of the Icelandic CPI and cover 324 months, January 1992 to December 2019. These expenditures are used to calculate the monthly annuity and the capital stock index to simulate the Swedish approach.

The data is the monthly average estimated real estate value of own housing, the property price index or the estimated capital stock index based on the average turnover of properties over the years. The average real estate value in December 2006 is the base value of the simulated capital stock index based on fifteen years moving average.

The nominal interest rate data series is published regularly by the Central Bank of Iceland and cover the period 1992-2019. The average interest rates are applied to the real estate value of the house that is price

updated by the house price index in the case of the Icelandic method and the estimated capital stock index in the case of Sweden. Depreciation is based on the Icelandic property stock in current prices and the property index is applied using the relevant depreciation rates.

Table 12. Average properties sale as share of total housing stock 2001-2018

	Capital area	Outside capital	Total
Min	2.5	1.2	2.1
Average	8.4	3.8	6.6
Max	14.1	7.2	9.6

Source: Registers Iceland

The Swedish capital stock index is a weighted moving average of house prices where the weight each year is the average of the original purchasing price of the real estate. The Icelandic property price index is reweighted to simulate the capital stock index. In Sweden the sale of properties for small houses are around 3-4 per cent of the stock each year approximating a 30 years ownership of a house resulting in a capital stock that is on the average 15 years old. To derive at the original purchasing price of the capital stock in Iceland the average turnover in the housing market in Iceland is estimated using the transaction of properties in Iceland as per cent of the property stock in the period 2001-2018.

The average turnover is 6.6 per cent per year and the period of average ownership is 15 years and the average age of the stock is 7.5 years. This turnover ratio differs over time and the max ratio is 14.1 per cent and the min 1.2 per cent.

To estimate the capital stock index the property price index from January 1992 is used. The first period in this estimated capital stock index is January 1992 – January 2007 and the last interval is December 2003-December 2019.

10.2 Simulation results

The estimated average value of the capital stock in the beginning of the period using the capital stock index is 40.3 per cent lower than the domestic real estate value at that time and the value at the end of the period is 27.4 per cent lower.

There are two factors that are deciding the results of the Icelandic and Swedish user cost methods. It is the price development of the property price index and the capital stock index and the change in real and nominal interest rates.

Table 13. Swedish user cost method with Icelandic data

	Property price index Ice	Capital stock index 15 years MA SWE	Interest rates	
			Real Ice	Nominal Swe
2007	100.0	100.0	100.0	100.0
2008	106.2	110.0	106.8	110.6
2009	95.9	119.4	106.3	87.8
2010	93.0	127.7	102.2	48.5
2011	97.3	136.2	100.2	33.1
2012	104.0	145.7	95.7	36.9
2013	110.0	155.7	92.4	42.1
2014	119.3	166.6	91.8	41.9
2015	129.1	178.0	91.8	39.1
2016	141.7	190.2	91.6	43.2
2017	169.4	205.0	91.6	38.1
2018	183.3	222.3	91.1	35.8
2019	191.5	240.2	85.1	34.8

The property price index changed by 91.5 per cent 2007-2019. The estimated capital stock index increased by 140.2 per cent for the same period. The price increase of the capital stock index is 25.4 per cent higher in the period than for the property price index.

Interest rates fell in the above period. The fall in nominal rates was 65.2 per cent and the real interest rates deceased by 14.9 per cent. The average nominal interest rate was 16 per cent per year in 2007 and in 2019 it was down to 5.6 per cent. The average real interest rate was 3.9 per cent in 2007 and in 2018 it was down to 3.4 per cent.

The combined results for changes in property prices and the interest rates are reflected in the consumer price index. Over the period the CPI calculated by both methods show similar results. The Icelandic CPI measure 0.4 per cent higher price change. The results are more volatile for the capital stock method reflecting both higher capital stock index and lower nominal rate. The standard deviation for CPI calculated by the Swedish method is approximately six times as big as the standard deviation for the Icelandic CPI. The difference in the nominal rates compared to the real rate is mostly due to inflation and is a decisive factor in making the Swedish user cost more volatile in Iceland.

Table 14. Icelandic CPI and a simulated CPI with Icelandic data by the Swedish user cost method

Year	Icelandic CPI	Annual change (%)	OOH effect (%)	Simulated IS CPI with SWE method	Annual change (%)	OOH effect (%)
2007	100.0			100.0		
2008	112.7	12.7	0.31	113.4	13.4	1.98
2009	126.2	12.0	0.05	123.6	9.0	-1.47
2010	133.0	5.4	-0.18	131.9	6.8	-0.36
2011	138.3	4.0	-0.05	137.9	4.5	0.33
2012	145.5	5.2	0.07	145.7	5.7	0.70
2013	151.1	3.9	0.00	150.9	3.6	0.43
2014	154.2	2.0	0.09	153.8	1.9	0.07
2015	156.8	1.6	0.07	156.6	1.8	0.32
2016	159.4	1.7	0.11	158.7	1.4	-0.02
2017	162.2	1.8	0.20	161.3	1.6	-0.17
2018	166.6	2.7	0.23	166.5	3.2	0.49
2019	171.6	3.0	0.10	171.0	2.7	0.05

In Sweden the capital stock index for small houses shows very similar results as 25-30 years moving average of the property price index for small houses. The moving average change for the property index for smaller houses is also the same even for 20, 15 of 10 years moving averages for that index. The volatility of the index is low and the price change is similar over the years as is the trend of prices that are reflected in the capital stock index.

The economic situation differs between countries and in the case of Iceland the volatility in exchange rates and inflations are considerably higher compared to Sweden.

The average logarithmic yearly house prices in Sweden increased by 5.3 per cent (0.43 per cent per month) in the period 1992-2019. In Iceland the property price index rose on average by 6.9 per cent (0.56) in the same period.

The average yearly price change of imputed rent in Sweden was on average -0.4 per cent (-0.03). The average change in imputed rent in Iceland was 6.2 per cent (0.51).

The average yearly price change in the Swedish CPI 1992-2019 was 1.4 per cent (0.11) and in Iceland the CPI increased yearly 4.0 per cent (0.36).

The conclusion is therefore that the Swedish user cost method applied in Iceland measures the price change over time similarly but shows more volatility in different years because of more volatile economic situation in Iceland than Sweden confronts.

Appendix 1a. Main indices 1992-2019, March 1997=100

Year	CPI	CPI less housing	Wage index	Building cost index
1992	90.4	89.4	86.6	86.0
1993	94.1	93.8	87.8	87.9
1994	95.5	95.4	88.9	90.1
1995	97.1	96.8	92.9	93.0
1996	99.3	99.3	98.9	97.5
1997	101.1	101.0	104.2	101.8
1998	102.7	102.1	114.0	105.4
1999	106.3	104.6	121.7	107.8
2000	111.6	108.4	129.8	111.1
2001	119.1	115.7	141.3	118.0
2002	124.8	121.1	151.4	126.6
2003	127.4	121.9	159.9	130.7
2004	131.5	124.5	167.4	136.4
2005	136.8	125.7	178.7	143.6
2006	146.1	131.7	195.8	155.9
2007	153.4	135.0	213.4	170.1
2008	172.5	151.5	230.8	197.9
2009	193.2	175.9	239.9	223.5
2010	203.6	189.1	251.4	232.3
2011	211.7	196.4	268.4	247.4
2012	222.7	206.8	289.3	262.0
2013	231.3	214.7	305.7	271.2
2014	236.0	216.4	323.4	275.2
2015	239.9	216.7	346.6	287.5
2016	244.0	216.4	386.0	298.3
2017	248.3	211.6	412.4	303.7
2018	254.9	213.4	439.1	318.7
2019	262.7	219.0	460.5	331.7

Appendix 1b. Main indices per cent change, 1992-2019, March 1997=100

Annual change in % Year	CPI	CPI less housing	Wage index	Building cost index
1993	4.1	4.9	1.4	2.2
1994	1.5	1.7	1.2	2.5
1995	1.7	1.4	4.5	3.2
1996	2.3	2.7	6.4	4.8
1997	1.8	1.7	5.4	4.5
1998	1.7	1.1	9.4	3.5
1999	3.4	2.4	6.8	2.3
2000	5.0	3.6	6.6	3.1
2001	6.7	6.8	8.9	6.2
2002	4.8	4.6	7.1	7.3
2003	2.1	0.7	5.6	3.3
2004	3.2	2.1	4.7	4.3
2005	4.0	0.9	6.8	5.3
2006	6.8	4.8	9.5	8.6
2007	5.0	2.5	9.0	9.1
2008	12.4	12.2	8.1	16.4
2009	12.0	16.1	3.9	12.9
2010	5.4	7.5	4.8	3.9
2011	4.0	3.8	6.8	6.5
2012	5.2	5.3	7.8	5.9
2013	3.9	3.8	5.7	3.5
2014	2.0	0.8	5.8	1.5
2015	1.6	0.1	7.2	4.5
2016	1.7	-0.1	11.4	3.8
2017	1.8	-2.2	6.8	1.8
2018	2.7	0.9	6.5	4.9
2019	3.0	2.6	4.9	4.1

Appendix 2a. Property market prices in Iceland 1992-2019, 1st quarter 1997=100

	Reykjavík greater capital area				
Year	Multi-flat houses	Single-flat houses	Capital area total	Outside capital area total	Country total
1992	98.3	97.7	98.2	98.2	98.2
1993	99.2	98.3	99.1	99.1	99.1
1994	102.4	98.7	101.7	101.7	101.7
1995	101.1	100.8	101.1	101.1	101.1
1996	99.2	99.0	99.2	99.2	99.2
1997	100.4	101.7	100.6	100.5	100.6
1998	106.1	107.1	106.3	105.4	106.0
1999	119.5	122.1	120.0	114.4	118.4
2000	142.4	141.6	142.3	120.9	136.3
2001	153.7	155.3	154.0	123.7	145.6
2002	158.8	160.2	159.1	135.8	152.6
2003	178.1	175.4	177.6	151.6	170.4
2004	198.1	199.5	198.4	162.2	188.3
2005	258.6	285.1	263.4	186.5	241.9
2006	298.4	341.4	309.6	221.5	282.6
2007	324.6	370.6	337.5	249.9	309.2
2008	345.0	397.3	359.6	263.1	328.4
2009	310.0	364.7	325.3	237.6	296.5
2010	298.3	346.2	311.7	238.8	287.5
2011	310.6	351.2	322.0	257.6	300.8
2012	337.7	373.6	347.8	263.6	321.6
2013	363.3	385.6	369.6	271.0	340.2
2014	400.8	404.6	401.9	288.7	368.8
2015	437.3	432.3	435.9	308.6	399.2
2016	483.1	467.9	478.9	334.5	438.2
2017	576.3	563.6	572.7	398.8	523.7
2018	610.9	615.5	612.2	457.9	566.9
2019	633.1	641.1	635.3	490.8	592.0

Appendix 2b. Property market prices in Iceland, per cent change 1992-2019

Annual changes %	Reykjavík greater capital area			Outside capital area total	Country total
	Multi-flat houses	Single-flat houses	Capital area total		
1993	0.9	0.7	0.9	0.9	0.9
1994	3.2	0.3	2.7	2.7	2.7
1995	-1.2	2.1	-0.6	-0.6	-0.6
1996	-1.9	-1.7	-1.8	-1.8	-1.8
1997	1.2	2.7	1.4	1.3	1.4
1998	5.6	5.3	5.6	4.9	5.4
1999	12.7	14.0	12.9	8.5	11.7
2000	19.2	16.0	18.6	5.7	15.1
2001	7.9	9.6	8.2	2.3	6.8
2002	3.3	3.2	3.3	9.7	4.8
2003	12.1	9.5	11.7	11.7	11.7
2004	11.2	13.7	11.7	7.0	10.5
2005	30.5	42.9	32.8	15.0	28.5
2006	15.4	19.8	17.5	18.8	16.8
2007	8.8	8.5	9.0	12.8	9.4
2008	6.3	7.2	6.6	5.3	6.2
2009	-10.1	-8.2	-9.5	-9.7	-9.7
2010	-3.8	-5.1	-4.2	0.5	-3.0
2011	4.1	1.4	3.3	7.9	4.6
2012	8.7	6.4	8.0	2.3	6.9
2013	7.6	3.2	6.3	2.8	5.8
2014	10.3	4.9	8.7	6.5	8.4
2015	9.1	6.9	8.5	6.9	8.2
2016	10.5	8.2	9.9	8.4	9.8
2017	19.3	20.4	19.6	19.2	19.5
2018	6.0	9.2	6.9	14.8	8.2
2019	3.6	4.2	3.8	7.2	4.4

Appendix 3a. Real property market prices 1993-2019, March 1997=100

Year	Property prices country total	Property prices deflated by CPI less housing	Wage index	Building cost index
1992	98.2	109.8	113.3	114.1
1993	99.1	105.6	112.8	112.7
1994	101.7	106.6	114.4	112.9
1995	101.1	104.4	108.8	108.7
1996	99.2	99.9	100.3	101.8
1997	100.6	99.6	96.5	98.8
1998	106.0	103.8	93.0	100.6
1999	118.4	113.2	97.3	109.9
2000	136.3	125.8	105.0	122.7
2001	145.6	125.8	103.0	123.4
2002	152.6	126.0	100.7	120.5
2003	170.4	139.7	106.5	130.3
2004	188.3	151.2	112.5	138.1
2005	241.9	192.5	135.4	168.5
2006	282.6	214.5	144.4	181.3
2007	309.2	229.0	144.9	181.8
2008	328.4	216.7	142.3	165.9
2009	296.5	168.5	123.6	132.7
2010	287.5	152.0	114.4	123.8
2011	300.8	153.2	112.1	121.6
2012	321.6	155.5	111.2	122.7
2013	340.2	158.4	111.3	125.4
2014	368.8	170.4	114.0	134.0
2015	399.2	184.2	115.2	138.9
2016	438.2	202.5	113.5	146.9
2017	523.7	247.5	127.0	172.4
2018	566.9	265.6	129.1	177.9
2019	592.0	270.3	128.5	178.5

Appendix 3b. Real property market prices, per cent change, 1993-2019, March 1997=100

Annual changes %	Property prices country total	Property prices deflated by		
		CPI less housing	Wage index	Building cost index
1993	0.9	-3.8	-0.5	-1.3
1994	2.7	1.0	1.4	0.2
1995	-0.6	-2.1	-4.9	-3.7
1996	-1.8	-4.4	-7.7	-6.4
1997	1.4	-0.2	-3.8	-2.9
1998	5.4	4.2	-3.6	1.8
1999	11.7	9.1	4.6	9.2
2000	15.1	11.1	7.9	11.6
2001	6.8	0.0	-1.9	0.6
2002	4.8	0.2	-2.2	-2.3
2003	11.7	10.9	5.7	8.1
2004	10.5	8.2	5.6	6.0
2005	28.5	27.3	20.4	22.1
2006	16.8	11.4	6.6	7.6
2007	9.4	6.7	0.3	0.2
2008	6.2	-5.3	-1.8	-8.7
2009	-9.7	-22.2	-13.1	-20.0
2010	-3.0	-9.8	-7.5	-6.7
2011	4.6	0.8	-2.0	-1.8
2012	6.9	1.5	-0.8	0.9
2013	5.8	1.9	0.1	2.2
2014	8.4	7.6	2.5	6.8
2015	8.2	8.1	1.0	3.6
2016	9.8	9.9	-1.4	5.8
2017	19.5	22.2	11.9	17.4
2018	8.2	7.3	1.7	3.2
2019	4.4	1.8	-0.4	0.3

Appendix 4a. Property prices, imputed and actual rent 1992-2019, March 1997=100

	Property prices	CPI prices	
	Total country	Imputed rent	Market rent
1992	98.2	103.7	
1993	99.1	104.2	
1994	101.7	102.3	
1995	101.1	102.1	
1996	99.2	100.3	
1997	100.6	101.9	103.4
1998	106.0	107.4	112.7
1999	118.4	120.9	116.8
2000	136.3	139.0	134.7
2001	145.6	147.8	146.8
2002	152.6	154.9	159.5
2003	170.4	172.0	175.4
2004	188.3	187.6	189.2
2005	241.9	228.7	201.0
2006	282.6	266.2	217.6
2007	309.2	302.7	250.6
2008	328.4	339.8	281.6
2009	296.5	305.8	325.5
2010	287.5	287.0	336.0
2011	300.8	295.5	352.6
2012	321.6	304.5	372.9
2013	340.2	312.8	400.5
2014	368.8	337.4	426.1
2015	399.2	365.1	442.8
2016	438.2	399.6	461.9
2017	523.7	477.1	479.6
2018	566.9	515.1	504.2
2019	592.0	532.6	533.0

Appendix 4b. Property prices, imputed and actual rent, yearly per cent change 1992-2019, March 1997=100

	Property prices	CPI prices	
	Total country	Imputed rent	Market rent
1992			
1993	0.9	0.5	
1994	2.7	-1.9	
1995	-0.6	-0.1	
1996	-1.8	-1.8	
1997	1.4	1.5	
1998	5.4	5.4	9.0
1999	11.7	12.6	3.7
2000	15.1	14.9	15.2
2001	6.8	6.4	9.0
2002	4.8	4.8	8.7
2003	11.7	11.0	9.9
2004	10.5	9.1	7.9
2005	28.5	21.9	6.2
2006	16.8	16.4	8.3
2007	9.4	13.7	15.2
2008	6.2	12.3	12.4
2009	-9.7	-10.0	15.6
2010	-3.0	-6.1	3.2
2011	4.6	3.0	4.9
2012	6.9	3.0	5.8
2013	5.8	2.7	7.4
2014	8.4	7.9	6.4
2015	8.2	8.2	3.9
2016	9.8	9.4	4.3
2017	19.5	19.4	3.8
2018	8.2	8.0	5.1
2019	4.4	3.4	5.7

Appendix 5a. CPI, actual rent, imputed rent and property prices for houses in Sweden 1992-2019, 1997=100

	CPI	Market rent	Imputed rent	Property prices
1992	90.3	80.6	105.5	99.5
1993	94.5	87.3	108.1	88.4
1994	96.6	90.7	107.5	92.4
1995	99.0	93.5	109.2	92.9
1996	99.5	96.9	107.5	93.4
1997	100.0	100.0	100.0	100.0
1998	99.9	100.8	94.1	109.6
1999	100.3	100.7	91.1	119.7
2000	101.3	101.2	91.5	132.8
2001	103.8	102.9	94.5	143.4
2002	106.0	105.1	96.9	152.5
2003	108.1	107.9	94.9	162.6
2004	108.5	111.3	89.9	178.3
2005	109.0	114.0	86.5	195.5
2006	110.5	115.0	89.5	217.7
2007	112.9	116.8	99.6	240.9
2008	116.8	119.8	109.6	248.0
2009	116.5	123.6	87.1	253.0
2010	117.9	125.6	81.1	271.7
2011	121.0	128.5	102.0	273.7
2012	122.1	131.9	105.4	270.2
2013	122.1	134.8	98.7	279.8
2014	121.8	137.2	95.3	299.0
2015	121.8	139.2	87.5	331.3
2016	123.0	140.4	86.8	359.1
2017	125.2	141.5	89.1	388.9
2018	127.6	142.9	91.3	388.9
2019	129.9	145.1	95.0	399.5

Source: Statistics Sweden

Appendix 5b. CPI, actual rent, imputed rent and property prices for houses in Sweden, yearly per cent change 1992-2019, 1997=100

Annual changes %	CPI	Market rent	Imputed rent	Property prices
1993	4.6	8.4	2.4	-11.2
1994	2.2	3.9	-0.5	4.6
1995	2.5	3.1	1.5	0.5
1996	0.5	3.6	-1.5	0.5
1997	0.5	3.2	-7.0	7.0
1998	-0.1	0.8	-5.9	9.6
1999	0.4	0.0	-3.1	9.2
2000	1.0	0.5	0.4	11.0
2001	2.5	1.7	3.3	8.0
2002	2.1	2.1	2.5	6.3
2003	1.9	2.6	-2.0	6.6
2004	0.4	3.1	-5.3	9.6
2005	0.4	2.4	-3.8	9.6
2006	1.4	0.9	3.5	11.4
2007	2.2	1.6	11.3	10.7
2008	3.5	2.5	10.0	2.9
2009	-0.3	3.2	-20.5	2.0
2010	1.3	1.6	-6.9	7.4
2011	2.6	2.3	25.7	0.7
2012	0.9	2.6	3.4	-1.3
2013	0.0	2.3	-6.3	3.6
2014	-0.2	1.7	-3.4	6.9
2015	0.0	1.5	-8.2	10.8
2016	1.0	0.9	-0.9	8.4
2017	1.8	0.8	2.7	8.3
2018	2.0	0.9	2.5	0.0
2019	1.8	1.6	4.0	2.7

Source: Statistics Sweden

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