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# Using house prices to compute the price of housing in the CPI

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**Abstract:** Rental-equivalence is often used in computing price changes of owner-occupied housing in the CPI. We employ an alternative approach, employing interest-adjusted house prices. For Norway 2000-2008 our method yielded a 30% CPI-increase, compared to the official 17%.

**JEL classification:** E3, E5.

**Keywords:** consumer price index, inflation measurement, owner-occupied housing.

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## Introduction

Consumer price indices (CPI) capture price changes in non-durables accurately but measure changes in prices of durables and services less precisely. Considerable effort has gone into constructing an apparatus that incorporates housing into the CPI in a meaningful way as the price of housing services for owner-occupiers is important in economic planning and policy, especially during house price booms and busts. Including some measure of the price of owner-occupied housing seems desirable under inflation-targeting monetary policies. It appears plausible that consumers anchor their inflation expectations in a way that incorporates the cost of housing. If the CPI is constructed in a way that does not mirror consumers' cost of living experiences, policymakers may be surprised when they observe consumer behavior (see Beatty and Røed Larsen (2005) and Røed Larsen (2007)).

A house is both a consumption good, delivering a service stream, and an investment object, delivering returns and capital gains (or losses). Disentangling consumption and investment is difficult, so whether or how to include asset prices in monetary policy is a contentious topic (Goodhart (2001)). In measuring inflation, analysts prefer to focus solely on consumption prices and leave out investment returns. The rental-equivalence approach was designed to separate consumption and investment in housing expenditure. Put simply, the change in the price of the consumption stream an owner faces is equal to the change in the implicit rental value of the house. However, in practice rental-equivalence faces several challenges. We propose an alternative, simple and theoretically valid method: the consumption cost approach. Measured in this way, consumer prices in Norway increased by 30 percent during the period 2000-2008, whereas the official CPI, using the rental-equivalence principle, increased by 17 percent. The difference is economically important. If the consumption cost approach had been used in place of the rental equivalence approach, the Norwegian central bank may not have felt obliged to lower interest rates, as they did, in response to low inflation.

## Computing the price of owner-occupied housing

There have been several approaches to including owner-occupied housing in the CPI. The *acquisition* approach says the price of a house should be treated like any other price. The *payments* approach is based on observed interest payments for households with a mortgage. Analysts object that the former ignores the role played by interest rates while the latter ignores the role played by households with equity. The *user cost* approach adds interest payments, maintenance costs, and the difference between purchase and sales price. However, this measure confuses consumption prices with investment returns; it may even be negative when house prices rise rapidly. Negative prices of consumption have an uncertain theoretical basis since they imply infinite demand when expected ex ante (Deaton and Muellbauer (1980)). When the user cost of housing is negative, it could lead to a decline in the overall CPI; agents might find this peculiar in an economy where every price is increasing.

*The rental-equivalence approach* addresses these shortcomings by tracking the changes in the implicit, or imputed, rental value of owned houses (Arévalo and Ruiz-Castillo (2006)). Imputed rents for owners are based on surveys of rented dwellings. But in many countries the rental market is small and concentrated so to impute rent a challenging out-of-sample prediction must be performed. Moreover, rental contracts often include clauses with inflation adjustments, which may create endogeneity when rental prices depend on the CPI and the CPI depends on rental prices.

We combine elements of earlier approaches<sup>1</sup>. First, we compute what a buyer of a home would have to pay for the consumption of owner-occupied housing services, over a given holding period, leaving investment returns aside. Then we compare this estimate of the price of housing consumption with the same estimate in the previous period, and calculate the change. In order to compute the estimate of the price of housing consumption, we leave out payments on the principal, since such payments should be classified as saving, not consumption. We also leave out capital gains that arise from sales prices being higher than purchase prices and thus correct the user cost concept. We include only interest payments, maintenance costs, and transactions costs. To avoid endogeneity between the CPI and short-term interest rates, we use smoothed long-term market interest rates of fixed-rate mortgages and expected short-term rates for variable-rate mortgages.

In the consumption cost approach, we write the cost of the consumption stream of owner-occupied housing,  $C$ , for a household at a given point in time as the sum total of interest payments, maintenance costs, and transaction costs over the entire holding period. Thus,  $C$  equals  $\gamma i A (1 - \tau) + t c A + \gamma m A$ , where  $\gamma$  is the holding period,  $i$  the interest rate,  $A$  the average house price,  $\tau$  the tax deductibility rate,  $t c$  are transaction costs and government fees (rate), and  $m$  is maintenance cost (rate).

### **Implementation: The case of Norway**

An empirical computation of the consumption cost can be implemented by utilizing equation (1):

$$(1) \quad C_t = A_t [(1/3) \sum_{i=t-2}^t t c_i + \gamma (1/3) \sum_{i=t-2}^t m_i + \Phi_t (1 - \tau) \gamma \{i_{L,t} - (1/5) \sum_{i=t-4}^t (i_{L,t} - i_{S,t})\} + \Psi_t (1 - \tau) \gamma i_{L,t}],$$

where the subscript  $t$  denotes period. We incorporate the proportion of variable rate mortgages,  $\Phi$ , the proportion of fixed-rate mortgages,  $\Psi$ , time variant transaction costs and

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<sup>1</sup> See Beatty, Røed Larsen, and Sommervoll (2005) for a detailed description of the theory.

maintenance costs  $tc_t$  and an estimator for expected variable short-term rate,  $i_{s,t}$ , at a given point in time. Note transaction costs are estimated using three years of data to remain consistent with the official 3-year moving average of past consumption patterns in the computation of CPI-weights. Also note, the expected variable short-term rate,  $i_{s,t}$ , is computed as the long-term rate,  $i_{l,t}$ , less a moving average of fixed-rate premium (for tractability we choose 5 years). We estimate an average holding period of 12 years using data from several Norwegian cross-sectional surveys of household standard of living. Notice that the resulting index  $I_t = C_t/C_{t-1}$  will be dominated by the term  $A_t/A_{t-1}$  when the holding period becomes long, and thus tend towards a pure house price index. Finally, the weight of this sub-price index is the ratio of housing consumption to total consumption,  $w_C = C/(O+C)$ , where O is all other consumption.

### **Empirical Results**

Table 1 summarizes the relevant housing statistics. Notice that the imputed rental index for owner-occupied housing increased by 25 percent over the period 2000-2008, while the official house price index rose by 61 percent. Using the consumption cost approach, we find that the price of owner-occupied housing service streams rose 63 percent from 2000 to 2008, far more than rental values. This result emerges from combining both changes in house prices with changes in mortgage interest rates, transaction costs, and maintenance costs.

[Table 1 in here]

In Table 2, we show the impact of the re-calculation of the housing component on the housing sub-price index and the weight of housing in the CPI.

[Table 2 in here]

Observe that the re-calibrated weights are substantially higher than the official weights. This, combined with larger estimated price increases in the housing sub-price index, leads to an inflation measure that indicates overall prices rose 30 percent between 2000 and 2008, whereas the official figure is 17 percent.

### **Conclusion and Policy Implications**

The CPI aims to capture changes in the price of a basket of goods and services. It is sensitive to the means of incorporating the price of housing consumption for homeowners. The rental-equivalence principle equates the price change of such consumption to the change in implicit rent. Above, we examine another method that tracks expenditures associated with consuming housing services and omits capital gains. The upshot is that while the official inflation in Norway over the period 2000-2008 was measured at 17 percent, the consumption cost approach measures it at 30 percent.

The two methods will often yield comparable estimates, except when house prices change rapidly. Since the consumption cost method involves computations based on house prices and (fixed, long-term) market interest rates, it offers a potentially useful tool for monetary policymakers under inflation-targeting (Huang and Liu (2005) and Mankiw and Reis (2003)).

### **Appendix: Computational Notes**

Statistics are from the fourth quarter or from December if the series is monthly. The variable interest rate is the average rate over all banks and all asset-backed loan types to all household

types. NIBOR (Norwegian Inter-Bank Offer Rate) is the December average over daily one-month rates. The fixed rate is the average 10-year rate over all banks and over all households for 60% financing of NOK 1 million. The proportion of variable rate mortgages is unity minus the proportion of fixed rate loans of all types for all banks issued that year. For early years, where some information is not available, we impute backwards. We employ a proportion of mortgage-to-own-equity financing such that 80% of house purchases are mortgage financed and 20% own-equity financed with opportunity cost measured using the Norwegian Inter-Bank Offer Rate (NIBOR), again using 5-year moving averages to compute an expected variable rate at given points in time. Transaction costs are 3-year moving averages and backward imputed prior to 2003 (source: Norges Eiendomsmeidlerforbund). Maintenance cost is a 3-year moving average, estimated from Consumer Expenditure Surveys and backward imputed from 2000 to 1998.

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**Table 1. The Cost of Housing for Tenants and Owners. Norway. 2000-2008**

<b>Period</b>	<b>Official Rental Index, Tenants</b>	<b>Official Rental Index, Imputed Owner-occupied</b>	<b>Official House Price Index</b>	<b>Int. Rate, 10-year Fixed-rate</b>	<b>Var. Int. Rate, All Banks</b>	<b>NIBOR</b>	<b>Share, Var. Rate</b>	<b>CC Housing Index</b>
<b>2000</b>	1	1	1	7.98	8.5	7.49	0.85	1
<b>2001</b>	1.04	1.05	1.08	7.65	8.41	6.86	0.85	1.10
<b>2002</b>	1.08	1.09	1.11	7.75	8.45	6.95	0.85	1.24
<b>2003</b>	1.12	1.13	1.15	6.25	4.36	2.77	0.85	1.00
<b>2004</b>	1.14	1.15	1.27	5.34	3.68	1.99	0.85	0.97
<b>2005</b>	1.17	1.17	1.38	5.48	3.77	2.48	0.87	1.07
<b>2006</b>	1.19	1.19	1.60	5.59	4.4	3.79	0.92	1.18
<b>2007</b>	1.22	1.22	1.73	6.42	6.35	5.86	0.92	1.50
<b>2008</b>	1.26	1.25	1.61	6.2	7.12	4.43	0.93	1.63
<b>Total Increase</b>	26%	25%	61%					63%

**Table 2. Consumer Price Index, Official and Consumption Cost (CC). Norway. 2000 - 2008**

<b>Period</b>	<b>Weights, Owner-occupied, official</b>	<b>Weights, Owner-occupied, CC</b>	<b>CPI, Official</b>	<b>CPI, CC</b>
<b>2000</b>	0.123	0.260	1	1
<b>2001</b>	0.114	0.272	1.02	1.04
<b>2002</b>	0.117	0.290	1.05	1.10
<b>2003</b>	0.116	0.244	1.06	1.03
<b>2004</b>	0.117	0.236	1.07	1.04
<b>2005</b>	0.111	0.246	1.09	1.07
<b>2006</b>	0.117	0.256	1.11	1.12
<b>2007</b>	0.132	0.296	1.14	1.24
<b>2008</b>	0.150	0.306	1.17	1.30
<b>Total Increase</b>			17%	30%