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ABSTRACT

We analyze by far the most extensive data base yet employed in estimating capitalization of below-market interest rates into asset prices: nearly 300,000 sales of owner-occupied homes in Sweden from 1981 to 1993 with 40,000 including government subsidized interest rates. Our estimates indicate very clearly that interest subsidies are capitalized into house prices. The below-market financing parameter is consistently significantly negative in all model specifications, irrespective of assumptions about the degree of foresight, representation of the age structure and interest rate measure for all ten regions that we have studied. In our favored model specification the estimated capitalization coefficients center on minus unity, indicating full capitalization.

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1. Introduction

Owing to the widespread usage of assumable mortgages and the sharp rise in mortgage rates during the second half of the 1970s and early 1980s, numerous U.S. house sales in the early 1980s were accompanied by below-market financing. This triggered a barrage of empirical studies estimating the extent to which the value of the below-market financing was capitalized into house prices or, put more grandly, testing whether the housing market was efficient.[1] The studies used widely varying methodologies (e.g., some capitalized the value of pre-tax interest saving and others after-tax) and obtained a similarly wide range of capitalization effects, from only a third capitalization of after-tax interest savings to over full capitalization of the larger pre-tax interest saving. In fact, the most consistent attribute of these studies was their small sample size. Only one of the seven studies had over 162 observations, and that had but 319.

In Europe below-market financing has been widely available through various government programs (see Turner et al. (1996) and Boelhouwer (1997) for surveys of these programs). In the 1990s there has been a trend towards reducing these subsidies as a contribution towards an overall reduction of government transfer programs. Sweden is a prime example. Loans at subsidized interest rates have been available to owners of most housing constructed after 1974, both owner-occupied homes and rental apartment buildings. In the late 1980s the present value of these interest-rate subsidies amounted to close to a fifth of construction costs. Since the early 1990s the subsidies have gradually been reduced, and the system is due to be phased out in the 2000s.

In order to understand the impact of these subsidy programs on the housing market -- both as they were introduced and as they are now abandoned -- it is important to know to what extent the interest subsidies have been capitalized into house prices. Thus, in this paper we revisit the capitalization issue, but using an ample data sample consisting of all arms length sales of one-family houses in Sweden during the period 1981-1993, nearly

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[1] Five of these studies appeared in a 1984 special issue of *Housing Finance Review* (see Jaffee (1984) for a summary) and two more appeared in that journal shortly thereafter (Malatesta and Hess (1986) and Haurin and Hendershott (1986)).

300,000 transactions 40,000 of which had subsidies accompanying them. We focus on owner-occupied single-family houses, whereas a companion paper (Hendershott and Turner (1997)) addresses similar issues for apartment buildings.

Swedish interest subsidies only apply to special loans collateralized by the building in question. When a property changes hands, the subsidized loan is routinely transferred to the new owner, subject to standard credit evaluation. Because the subsidy is tied to the building rather than the owner, one would expect the subsidy value to be fully capitalized in the purchase price in an efficient housing market. The home buyer effectively purchases a package of house *cum* subsidy, and, provided that equivalent housing services are available without subsidies, transaction prices of houses of identical quality should differ by exactly the value of the subsidy. Consequently, testing for full capitalization can be interpreted as testing for efficiency and rationality in the housing market.

Like other efficiency tests, however, testing for full capitalization is really a joint test of efficiency and a particular expectations assumption. The present value of subsidies -- the difference between after-tax cash outlays with and without the subsidy -- depends on the future course of subsidy and tax rules and market interest rates, so any subsidy measure embodies expected values of these components. Given that tax rates, subsidy rules, and monetary policy have been changed a number of times during the sample period, it is not clear how these expectations should be modelled. Purely static and perfect foresight are two possible forecasting rules that we employ.

A second group of problems relate to the difficulty of measuring the subsidy even with known expectations of tax rates, subsidy rules, and interest rates. The subsidy includes two option values that should be reflected in the market interest rate used in the subsidy calculations. First, the subsidy applies to loan-to-value ratios up to 95%. Unfortunately, for most of the period studied, market interest rates are only available on 70% loans. Uncertainty in house prices implies that households will, on occasion, be able to increase their well being by giving up their house and defaulting on their loan. While the value of the default option on a 70% loan is likely trivial, that on a 95% loan can be substantial.[2] Thus using available market rates on 70% loans, rather than rates including the extra value of the default option on 95% loans, loans will understate the correct subsidy measure. Second, an increase in market interest rates after the subsidy is obtained will increase the value of the subsidy more than an equal decrease in market rates will lower it because the rate increase will lengthen the period the subsidy will be earned, while a rate decrease will shorten the period. Thus interest rate uncertainty, too, causes the subsidy value based on 70 percent market interest rates to understate the full subsidy value.

A further problem is that the value of subsidies is likely to differ across households. One reason is that marginal tax rates on interest deductions were a function of income over part of the studied period. A possibly more important reason is that some households were rationed in the credit market via minimum downpayment requirements or maximum payment-to-income ratios. They would not be indifferent to having "fairly priced" subsidized loans. For such households the value of subsidies should be based on a comparison with a shadow interest rate containing a premium reflecting the intensity of the downpayment and mortgage payment constraints (Haurin and Hendershott, 1986).[3]

The paper is organised in the following way. In section 2 we give some details about the subsidy system and present our calculations of the present value of the subsidies. The hedonic model to be estimated is set up in section 3. Section 4 contains a presentation of data sources and how we deal with various measurement problems. In section 5 results are presented for different assumptions about expectations formation and the unobserved market interest rate on 95% loans. It turns out that the results are not very sensitive to either assumption. Clearly the higher the assumed mark-up on 95% loans over 70% loans

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[2]In Sweden mortgage lenders have recourse not only to the collateral but also to other assets and future income, hence decreasing the value of the default option (Hendershott and Turner, 1994). Nevertheless 95% loans currently command an interest premium of 50-100 basis points.

[3] Many younger households are wealth constrained (have difficulty making the downpayment on their desired house), cash flow constrained (have difficulty making mortgage payments on this house owing to a high LTV), or both. Wealth constrained households do not want subsidized credit because at least some of the subsidy value is built into the price upon which the downpayment is based. Cash flow constrained households want subsidized credit because the reduction in initial interest rate outweighs the higher house price, lowering their initial mortgage payments.

the larger is our measure of the subsidy and, hence, the lower the estimated degree of capitalization. Our main assumption, a mark-up of 50 basis points, yields estimates that are very close to full capitalization of after-tax subsidies under either expectations assumption.

2. The interest subsidy system, taxes and subsidy values

Starting in 1975 most purchasers of single-family houses of less than 185 square meters constructed after 1975 have been entitled to loans at guaranteed interest rates. In order to be eligible for subsidies the house has had to meet certain criteria. In particular there has been a production-cost ceiling, i.e. houses with production costs above the ceiling received no subsidies at all. Those eligible could receive subsidized loans covering a certain proportion of approved building costs, corresponding to the production costs of a house of a maximum area (typically 120 square meters). The rules for calculating these costs have changed over time, however. Subsidized loans have come in two forms. Primary loans, corresponding to 70 per cent of approved building costs, have been provided by various private mortgage institutions at market conditions with the government covering the difference between the market interest rate and the guaranteed rate. This loan has been subject to standard screening of the borrower by the mortgage institution. On top of this a government agency has offered secondary mortgage loans, corresponding to 25 per cent of costs, at the same guaranteed interest rate and without any extra screening of borrowers. Effectively the government has taken all the credit risk.

These loans have had very long maturities, typically 30 - 50 years. Most of them have had interest rates fixed for five years. Especially during the first part of the studied period this form of loan contract was very dominant. Following the deregulation of the financial system in the mid 80s there has been much more diversity in loan terms than in earlier years.

Guaranteed interest rates have followed a pre-announced pattern with yearly increases as the loan ages until the guaranteed rate reaches the same level as the market rate minus one per cent, at which time the subsidy disappears. Usually this happened after around a decade. In the early 1980s the first-year rate was 5.5 per cent with yearly increases of 0.5 percent. Subsequently rules were changed several times both for new and pre-existing loans. In 1986, guaranteed rates were cut across the board followed by sharp increases for older houses in 1987. After that rules were rather stable until the early 1990s, when guaranteed rates on pre-existing loans were again increased. The full matrix of guaranteed interest rates for all construction years and purchase years contained in our sample is given in *table A1* in the appendix.

We calculate the value of the interest subsidies as the present value of below-market after-tax cash flows over the life-length of the loan. Denoting the market interest rate by i_t, the guaranteed rate by i_t^*, the loan value by L_t and the marginal tax rate by τ_t, we compute the subsidy value at time t_0 as

$$(1) \qquad SUB_{t_0} = \sum_{t=t_0}^{T} \frac{(1-\tau)(i-i_t^*)L_t}{\left[(1+(1-\tau)i\right]^{t-t_0+1}}.$$

Nonsubscripted variables refer to time t_0, and L evolves according to standard amortization schedules for housing loans.[4] T is defined as the first date when i^* reaches i. At this date the house drops out of the subsidy system and is not eligible to future subsidies even if i were to exceed i^*. This expression assumes *static expectations*, i.e. future tax rates, market interest rates, and subsidy rules are taken to be those existing at time t_0.

Of course, household expectations about future market interest rates, tax rates and subsidy rules need not be static. As an alternative, we compute the subsidy value assuming perfect foresight. With *perfect foresight* households correctly forecast the course of tax rates, interest rates and subsidy rules through 1995 and thereafter make static forecasts. That is, the market interest rate in equation (1) is altered every fifth year based on the evolution of market rates, the tax rate is altered annually, and the entire structure of subsidy rates is changed whenever the rules changes (see *table A1*).

[4] Around 10 per cent of the initial loan is amortized in the 10th year after origination.

The relevant tax rate is the marginal rate applicable to interest deductions. Prior to 1985 this rate depended on household income. Because we do not have information about the owners of particular houses, we impute the marginal tax rates of representative owners using data from the *Housing and Rent Surveys*. The tax rates of different types of houses for the years 1981-1984 are obtained by regressing the marginal tax rates of recent movers during these years on a set of dummy variables corresponding to different assessed values. The resulting tax rates vary from between 47 and 50 per cent for the cheapest houses up to 79 per cent in 1981 and 61 per cent in 1984 for the most expensive houses. After 1984 the tax rate applicable to interest deductions was the same for all households: 50 per cent from 1985 to 1988, 47 per cent in 1989, 40 per cent in 1990, and 30 per cent in 1991 and after. The general decline in tax rates over time raises the value of the subsidy.

Initially, we measure i as the rate on 70 per cent LTV, five-year fixed-rate primary loans, but subsidy values based on this rate underestimate the true subsidy in two ways. First, the market interest rate for primary loans is applied to the secondary loan (up to 95 per cent), which has greater default risk. Unfortunately we have no observations for most of the period on market interest rates on above 70 per cent LTV loans. Such loans were simply not available to most homebuyers before the latter part of the 1980s. In the United States, where the lender has recourse to the underlying housing collateral only, the default option alone would add roughly a half percentage point premium to the market borrowing rate. In Sweden, however, lenders have recourse to other assets and future labor income. Thus the occurrence of default is far less and the required default premium should be considerably lower (Hendershott and Turner, 1994).

Second, the fact that interest rate uncertainty adds to the expected value of the subsidy is ignored; if future interest rates were to be higher not only would the yearly subsidy rate increase, it would also apply for a longer period. As a crude way of accounting for both the default option and interest rate uncertainty, we have also calculated subsidy rates adding first one-half percentage point and then a full point to the market interest rate on 70 percent loans.[5] As we shall see, this adds considerably to the subsidy rates.

The average subsidy rates for new construction, expressed as a per cent of construction costs, are presented in *table 1* for both static and perfect foresight expectations based on the 70 percent LTV loan rate and 0.5 and one per cent mark-ups. We view the estimates based on the one-half point markup as our best estimates, with estimates based on zero and one point mark-ups giving lower and upper bounds. In the right-most column of *table 1* we have indicated the rate on the 70 per cent LTV loans.

Table 1: Subsidy rates on new construction in per cent of construction costs

	No Mark-up		Mark-up=0.5		Mark-up=1		
	Perfect foresight	Static expectations	Perfect foresight	Static expectations	Perfect foresight	Static expectations	Market interest
1981	12.3	12.6	16.4	16.8	20.5	20.8	15.9
1982	14.2	12.9	18.1	17.0	22.2	21.0	15.3
1983	11.7	9.6	15.4	13.6	18.8	17.8	14.4
1984	11.6	8.9	15.6	13.0	19.2	17.6	13.5
1985	16.7	11.3	20.2	15.2	23.3	19.6	13.2
1986	12.4	11.9	16.3	16.2	19.8	20.5	12.1
1987	13.6	13.7	17.4	17.7	20.7	21.4	13.1
1988	11.9	14.3	15.9	18.7	20.3	22.7	12.6
1989	12.9	14.7	17.4	19.0	21.8	22.9	12.7
1990	18.5	24.5	22.6	28.4	27.1	31.9	15.3
1991	14.2	19.1	17.1	23.7	21.2	27.8	13.0
1992	12.9	16.8	15.7	20.8	18.4	24.5	13.0
1993	6.6	7.1	9.7	11.2	12.6	14.9	10.0
Average	13.0	13.7	16.8	17.8	20.5	21.8	

[5] See Haurin and Hendershott (1986) for a discussion of the correct market interest rates to use in calculating subsidy values.

The patterns over time are similar. The impact of the declines in market interest rates during the 1980s is roughly offset by the decline in the marginal tax rate and the 1986 cut in the guaranteed rate. The upward blip in market interest rates in 1990 temporarily raised the subsidy, and then the sharp decline in 1993 substantially lowered it.

We see that the mark-up is important. With no mark-up, subsidies are in the 10 to 20 per cent range. With a half point mark-up, subsidies rise to 15 to 25 per cent, and with a full point mark-up they are as high as 20 to 30 per cent.

Assuming static expectations yields subsidy rates that are one percentage point higher on average than assuming perfect foresight. While the average difference is not large, there is a timing difference. Perfect foresight gives consistently higher subsidy rates than static expectations between 1982 and 1985, whereas the opposite holds between 1987 and 1993. In the former period there was a sharp reduction of tax rates and the guaranteed interest rate was lowered in 1986. Both of these changes, if anticipated, contribute to increasing subsidy rates. In the latter period guaranteed interest rates on older stock were increased in 1992 and 1993, and market interest rates fell in 1991 and 1993. These changes contribute to decreasing perfect foresight subsidy rates.

The full matrix of subsidy rates, based on the one-half percent interest rate mark-up, is given for static expectations and for perfect foresight, respectively, in *tables 2* and *3*. These rates are expressed as fractions of current value replacement cost, historical cost adjusted by house price inflation (less one per cent per year for depreciation) since construction. The subsidies generally decrease over the life of a house, reflecting guarantee rates and nominal house prices. This pattern is altered in 1992-93 owing to the decline in nominal house prices. In the right most column of *table 2* we have indicated the number of new single-family houses constructed in each year. The total stock in 1990 was 1.9 million houses. In that year subsidies covered houses built since 1980, i.e. close to ten per cent of the total stock of houses.

Table 2 Post-tax present values of interest subsidies, in per cent of construction costs. Static expectations and mark-up of 0.5 per cent.

	Year of purchase													
Year of production	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	# New houses
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	45484
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	37827
1977	2.7	2.4	1.2	0.4	0	0.5	0	0	0	0.2	0	0	0	37330
1978	10.4	9.4	7.6	6.0	4.2	3.6	1.6	0	0	1.5	0	0	0	35730
1979	12.8	11.2	10.0	8.0	6.7	7.4	4.8	2.3	0.9	3.5	0.8	0.5	0	34807
1980	12.7	11.7	9.6	6.6	5.1	7.6	6.0	3.4	2.2	4.4	1.4	1.0	0	31665
1981	16.8	15.1	13.7	10.2	8.1	8.5	7.6	4.6	3.3	6.1	1.9	1.5	0	28039
1982	0	17.0	14.8	13.0	11.0	11.5	8.9	5.7	4.3	7.5	3.1	1.9	0	20903
1983	0	0	13.6	11.8	11.9	12.7	10.9	6.9	5.4	8.9	4.4	3.3	0	16978
1984	0	0	0	13.0	12.0	14.7	12.8	8.8	6.6	10.4	5.7	4.7	0.3	13325
1985	0	0	0	0	15.2	16.4	15.5	10.7	8.0	11.0	6.3	5.4	0.7	11106
1986	0	0	0	0	0	16.2	14.6	11.7	9.2	12.0	7.3	6.5	1.2	9074
1987	0	0	0	0	0	0	17.7	13.7	12.1	14.1	9.7	8.1	1.8	10147
1988	0	0	0	0	0	0	0	18.7	15.2	17.0	12.8	11.4	2.8	10829
1989	0	0	0	0	0	0	0	0	19.0	20.3	16.3	15.0	6.9	12557
1990	0	0	0	0	0	0	0	0	0	28.4	24.4	22.8	15.1	13463
1991	0	0	0	0	0	0	0	0	0	0	23.7	23.8	18.0	16710
1992	0	0	0	0	0	0	0	0	0	0	0	20.8	17.2	10283
1993	0	0	0	0	0	0	0	0	0	0	0	0	11.2	4421

In attempting to estimate the degree of capitalization of subsidies we will face the problem of disentangling the impact of declining subsidy value as the guaranteed rate rises over time from the effect of depreciation as the house ages. With pooled cross-section data it is not possible to identify age, time and vintage effects except conditional on assumptions about functional form. Hence, if all houses were subsidized, capitalization effects could only be identified conditional on prior beliefs in a particular functional form for depreciation. Using a panel of houses with different years of purchase is helpful, however, because the age structure of subsidies varies considerably from year to year. In some years, like 1992 and 1993, the subsidy rate is at least as high for two-year old houses as for new house whereas in other years, like 1990, the difference is as large as 11-13 percentage points between a new and a two-year-old house. Assuming depreciation patterns to be constant over time, we can have some confidence in the potential for identifying capitalization and age effects.

Table 3 Post-tax present values of interest subsidies, in per cent of construction costs. Perfect foresight and mark-up of 0.5 per cent.

	Year of purchase												
Year of production	1981	1982	1983	1984	1984	1986	1987	1988	1989	1990	1991	1992	1993
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	1.4	1.0	0.7	0.4	0.4	0.3	0	0	0	0	0	0	0
1978	9.1	8.1	7.7	6.2	6.2	3.3	1.4	0	0	0	0	0	0
1979	12.7	11.3	11.3	9.8	9.8	6.6	4.3	2.4	0.9	0.7	0.5	0.3	0
1980	13.1	12.4	12.7	11.2	11.2	8.7	6.9	5.4	4.2	3.4	2.5	1.8	0
1981	16.4	14.9	15.3	13.0	13.0	7.5	5.7	4.0	2.7	1.8	0.9	0.5	0
1982	0	18.1	17.4	16.9	16.9	11.7	8.1	5.9	4.2	3.0	1.8	0.6	0
1983	0	0	15.4	14.4	14.4	12.2	9.1	6.2	4.6	3.4	2.3	1.3	0
1984	0	0	0	15.6	15.6	14.1	11.0	8.1	5.8	4.5	3.3	2.4	1.3
1985	0	0	0	0	20.2	19.1	17.6	13.7	10.7	8.5	6.8	5.7	4.4
1986	0	0	0	0	0	16.3	13.9	11.9	9.1	7.1	5.4	4.7	3.9
1987	0	0	0	0	0	0	17.4	14.2	12.3	9.8	7.6	6.2	5.6
1988	0	0	0	0	0	0	0	15.9	12.1	9.3	6.9	4.8	2.2
1989	0	0	0	0	0	0	0	0	17.4	14.1	11.3	9.7	7.6
1990	0	0	0	0	0	0	0	0	0	22.6	18.8	16.9	14.3
1991	0	0	0	0	0	0	0	0	0	0	17.1	15.8	13.9
1992	0	0	0	0	0	0	0	0	0	0	0	15.7	14.8
1993	0	0	0	0	0	0	0	0	0	0	0	0	9.7

In principle identification should also be aided by the fact that some houses are not entitled to subsidies at all. But this fact is of limited use for two reasons. First, whether a house has a subsidy or not is a function of house characteristics like size and quality (reflected in production costs). But these characteristics also affect the price of the house directly, i.e., identification of capitalization of subsidies based only on this type of information would be conditional on the functional form of the relation between these characteristics and house value. Second, our database does not contain observations on the actual subsidies of individual houses, but subsidy values have to be imputed given our knowledge of the rules.

As we discuss in *section 4*, we probably do a far from perfect job at identifying unsubsidized houses.

3. A model for estimating the value of housing subsidies

Application of the hedonic pricing model to housing is based on the notion that consumers value the characteristics of a house such as lot size, structural characteristics, and neighbourhood amenities (Rosen, 1974, Wigren, 1986). Total value is determined by the quantities of these components and the manner in which they are bundled into a "housing package." The basic hedonic model is

(2) $$P^* = F(X),$$

where P* is the value of the house and X is a vector of characteristics. The hedonic function F reflects a mixture of demand and supply factors and theory gives little if any guidance about functional form.

When the house is subsidised, the value P of the package of housing characteristics *cum* subsidy is

(3) $$P = F(X) + \gamma SUB,$$

where SUB is the value of the subsidies and γ represents the extent to which the subsidies are capitalized into house prices, with $\gamma=1$ indicating full capitalization. This can be transformed into

(4) $$P = F(X)/(1-\gamma\lambda),$$

where λ is the ratio between the subsidy and the purchasing price. Assuming a multiplicative form of the hedonic function and taking logs yields

(5) $$lnP = ln\ \alpha + \beta ln\ X - ln(1-\gamma\lambda) \cong ln\ \alpha + \beta ln\ X - \gamma ln(1-\lambda),$$

where α is the constant term implicit in F, and β is a vector of hedonic parameters. The approximation involved in the second step presumes that γ is near unity (between 0.5 and

2). The hypothesis of complete capitalization is tested by estimating (5) with this approximation and checking whether the estimate of γ differs significantly from minus one.

4. Data

We use data from several sources. The main body is transactions data from the Statistics Sweden (SCB) sales register for the period 1981 to 1993. These include all arms' length purchases of single-family houses during the period, over 700,000 transactions. From this source we obtain the sales price and an identification number for each dwelling. This makes it possible to link to the real-estate register with a multitude of hedonic characteristics of the house, the most important being living area, age and house type. We also know location down at the parish level (roughly equivalent to a U.S. census tract). All parishes are represented by dummy variables in the hedonic regressions.

The transactions data do not contain a direct measure of subsidies. We impute subsidies as a function of observable characteristics of each house in two steps. First, we identify which houses have a subsidy. This is done using knowledge about the rules in operation in any particular year. Unfortunately, the rules have been subject to interpretation by local authorities, making such identification inexact. Given the nature of our data the best we can do is to impute eligibility from living area. From *table A2* of the appendix, based on the *Housing and Rent Surveys,* we see that between 80 and 95 per cent of houses of "normal size" (95 to 175 square meters) have subsidies, whereas the fractions are lower for larger and smaller houses. This suggests that one may identify subsidized units mainly based on living area. We have improved on this by estimating separate logit models for three categories of houses based on square meters: less than 89, 90-185, and over 185. The models express whether a house has a subsidy or not as a function of characteristics like size, region and assessed value. We estimated the logit models on data from the *Housing and Rent Surveys* for 1982, 1985, 1987, 1989, 1991, and 1993, containing nearly 7,000 observations regarding houses constructed after 1975.

We excluded houses old enough that the guaranteed rate exceeds the market rate, i.e., corresponding to the zeros in the lower left segment of *tables 2* and *3*. Further, because access to subsidized loans was rationed in the 1970s, we included dummy variables for houses built during this period. The estimated models are presented in the appendix, *table A3*. In the middle-size class the model predicts that essentially all houses have subsidies, i.e., the ten per cent observed without subsidies appear almost completely unsystematic. Among small and large houses, where the observed frequencies of having subsidies is around 50 per cent, the models have 71 per cent correct predictions (predicted probability of the observed alternative over 50 per cent). As expected, there is a pronounced negative size effect for large houses, and a positive effect for small houses. The year dummies for houses built up until 1981 are generally positive for small houses, but have mixed signs for large houses.

The next step is to compute a measure of the amount of subsidy for each house, conditional on receiving a subsidy at all, corresponding to the numbers in *tables 2* and *3*. This is done based on information from the *Housing and Rent Survey* for various years on the amount of subsidized loans as well as living area (in square meters), construction year and other characteristics of the house that matter for subsidies and applying this on the transactions data base. Important parameters in the calculation of the value of subsidies, according to equation (1), are the rules themselves, the marginal tax rate, τ, and the market interest rate, i.

Equation (5) is estimated separately for a number of local labor-market regions, following Wigren (1986). We confine ourselves to the ten largest so called LL-regions out of a total of 111 such regions in Sweden, defined by Statistics Sweden on the basis of commuting patterns. Key sample statistics for each of these regions are listed in *table 4*.

As can be seen, house prices vary with population, being about twice as high in the capital of Stockholm as in some of the smaller regions. On average, 9.4 per cent of all sales have subsidies, and the average subsidy is between 4.5 and 7.2 per cent of the sales price. Houses with subsidies are on average between 19 and 44 per cent more expensive than houses in general.

Table 4: Sample statistics; mean subsidies and sales prices in different regions

Region	Total population (1996)	# sales	Percent with subsidy	Average subsidy (SEK)	Average price, all sales	Average price, sales with subsidy
Stockholm	1,704,000	82,495	9.54	41,964	789,000	942,000
Göteborg	832,000	54,820	8.92	43,072	616,000	830,000
Malmö	596,000	44,210	8.13	45,549	498,000	685,000
Helsingborg	285,000	25,471	9.83	39,121	438,000	625,000
Uppsala	267,000	15,772	12.39	40,471	521,000	666,000
Linköping	238,000	17,862	11.22	40,039	439,000	583,000
Örebro	182,000	12,194	6.91	35,401	381,000	538,000
Västerås	170,000	12,233	11.04	41,845	499,000	655,000
Norrköping	167,000	10,942	10.69	41,118	502,000	638,000
Borås	159,000	11,966	8.47	40,687	392,000	566,000

5. Capitalization estimates

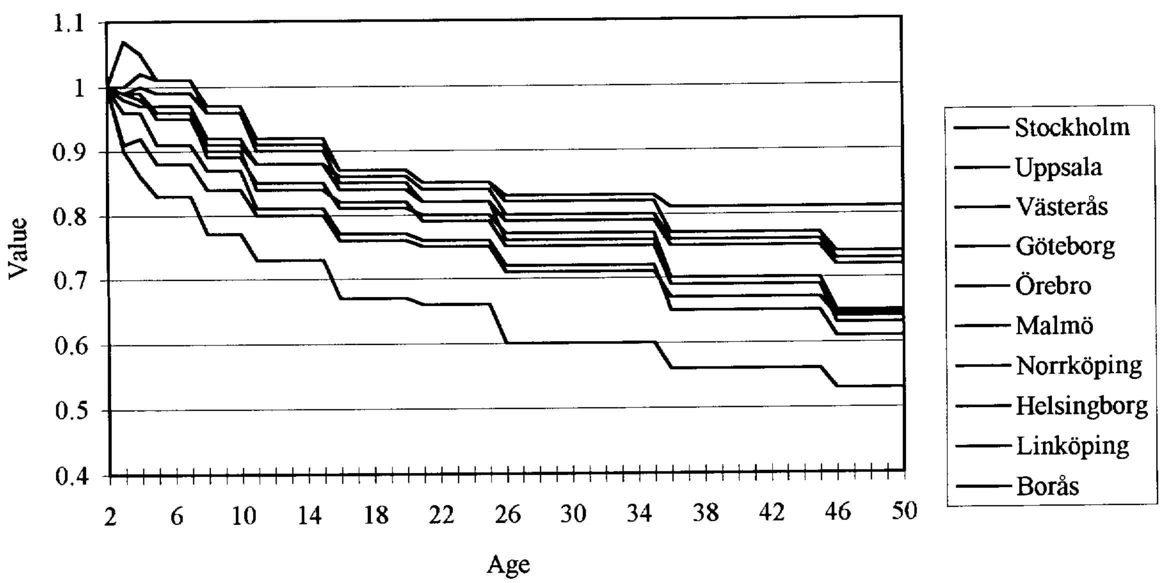
We have estimated equation (5) including essentially the full set of hedonic variables present in the data base and a set of dummy variables representing the different parishes. Year dummies represent calendar time. We estimate these regressions by OLS.[6] The subsidy variable is expressed as a fraction of the predicted sales price of the house, λ. If the actual sales price were used in calculating λ this would create an obvious endogeneity problem because the sales price would appear on both sides of the equation. We handle this by estimating a hedonic price equation not including the subsidy variable among the regressors in a first step. In a second step we compute our measure of λ based on the predicted value from this first-stage regression.

We have estimated the model using a dummy structure to represent the age of the dwelling. Given the potential collinearity between age and the subsidy rate this seems

[6] Results on the same set of data, reported in Englund, Quigley and Redfearn (1997), indicate that the differences in parameter estimates between OLS and GLS using information on repeat sales is rather small.

more appropriate than assuming a particular functional form.[7] In a majority of regions, the age structure rises at year one and two and then assumes the expected declining pattern. This suggests that a majority of the price quotations for age zero and one houses are not true market prices (controls on builder profit mean that the first buyer reaps a windfall upon sale). Thus we have deleted houses sold at age zero and one.[8] Conditional on the price at age two, the age pattern (i.e. the coefficients of the age dummies) is fairly similar across regions, as is shown in *figure 1*, although there is still some evidence of price increases in the early years. In particular, the seven per cent increase in value in Helsingborg in year 3 is significantly greater than zero.

Figure 1: Age structure, different regions.



Note: The regions are listed from top to bottom ordered according to the age coefficient at age 45 and above.

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[7] In preliminary work we also estimated the model assuming log-linear depreciation. This gave a slightly worse fit, but not significantly different capitalization estimates.

[8] Doing so reduces our samples by less than one percent; it does not significantly alter the capitalization estimate.

In *table A6* of the appendix we present results of the basic model for the Stockholm region based upon perfect foresight and the one-half percent markup. The $\overline{R}^2$ value is 0.83 and most coefficients are quite well determined with the expected signs. The elasticity with respect to living area is 0.45 and the elasticity with respect to lot size is 0.11. Beachfront raises the value by 38 per cent. The time dummies indicate the well-known pattern of rapidly rising prices in the late 1980s with a peak in 1991 and a steep decline thereafter. Generally these results are similar to those reported in Englund, Quigley and Redfearn (1997) based on hybrid hedonic and repeat-sales methods and using the same data base.

Table 5 summarizes the estimates of γ, the elasticity of price with respect to one plus the subsidy rate, or rather - since it is computed on a subsidy inclusive basis - with respect to one over one minus the subsidy rate. In the table we only report estimates based on a 0.5 per cent mark up over the market interest rate for primary loans. The estimates based upon static expectations center around minus unity (average -1.01). Only for three cities is the estimate significantly different from minus one, indicating one case of overcapitalization and two cases of undercapitalization. In almost all cases estimates based on perfect foresight give somewhat larger values of γ than estimates based on static expectations, as would be expected given that the subsidy rates are mostly lower when based on perfect foresight. The average capitalization rate now is 1.20. For only two cities the coefficients are (insignificantly) smaller than unity and in five cases they are over 1.2; moreover, four of these estimates are significantly greater than unity in absolute value, suggesting overcapitalization.

To give a feeling for the sensitivity of our results to the interest measure we have also estimated the model based on the unadjusted market rate for 70% loans and based on a one per cent mark-up over this rate. These estimates should give upper and lower bounds to the degree of capitalization. Estimates based on the unadjusted rate indicate overcapitalization with average γ values of 1.51 under perfect foresight and 1.22 under static expectations, whereas adding a full percentage results in undercapitalization with average γ values of 0.86 under perfect foresight and 0.76 under static expectations. Given that we regard these values as upper and lower bounds, we conclude that there is little evidence of large deviations from full capitalization.

Table 5: Estimates of the capitalization parameter γ with interest mark-up of 0.5 per cent.

Region	Perfect foresight	Static expectations
Stockholm	-1.136 (0.074)	-0.949 (0.068)
Göteborg	-1.231 (0.084)	-1.108 (0.088)
Malmö	-1.001 (0.109)	-0.785 (0.101)
Helsingborg	-1.106 (0.144)	-0.889 (0.133)
Uppsala	-1.688 (0.165)	-1.483 (0.156)
Linköping	-0.947 (0.141)	-0.758 (0.122)
Örebro	-1.426 (0.183)	-1.242 (0.183)
Västerås	-1.378 (0.168)	-1.058 (0.151)
Norrköping	-0.778 (0.190)	-0.902 (0.167)
Borås	-1.266 (0.184)	-0.963 (0.162)

Standard errors in parenthesis

6. Concluding Comments

In this paper we have analyzed by far the most extensive data base yet employed in estimating capitalization of below-market interest rates into asset prices: nearly 300,000 sales with 40,000 including below-market interest rates. The estimates indicate very clearly that below-market financing is capitalized into house prices. The below-market financing parameter is consistently significantly different from zero in all model specifications we have tried. This holds irrespective of assumptions about the degree of foresight, representation of the age structure and interest rate measure for all ten regions that we have studied. In our favored model specification based on a 0.5 per cent interest mark-up the hypothesis of zero capitalization is rejected with t-ratios varying between 5 and 15. Further, the estimated γ coefficients center on full capitalization. With a 0.5 per cent mark-up the average coefficient is almost exactly minus one under static expectations and a bit larger (in absolute value) under perfect foresight.

While we find the results appealing, we note two caveats. First, our estimate of the value of below market financing may be measured with significant error. The estimate relies on uncertain measures of both the current market interest rate (the default and interest rate options) and expectations of future interest rates, tax rates, and subsidy rules. Second, in markets where households are wealth (downpayment) or income (mortgage payment) constrained, the expected coefficient on the below-market financing variable could differ from unity. The extent of the deviation would depend on which of these constraints is more prevalent. It would also depend on the nature of the housing market equilibrium. One would expect the market to be segmented with rationed households in subsidized housing and non-rationed households in unsubsidzed dwellings. In such case it is in fact the value of the subsidy to the unconstrained households that should be capitalized. This would explain why we get estimates of the capitalization parameter close to unity despite the fact that rationing is likely to have been important for many households. Further work will investigate the possible impact of these constraints.

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Appendix

Table A1. Guaranteed interest rates, Single-family houses.

Year of production	Purchase year												
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
1975	10.50	10.55	12.45	13.60	14.75	13.65	14.85	15.35	15.85	16.35	16.85	17.60	18.10
1976	9.35	9.85	11.25	12.35	13.45	12.35	13.55	14.05	14.55	15.05	15.55	16.30	16.80
1977	8.65	9.15	10.25	11.30	12.35	11.75	12.95	13.45	13.95	14.45	14.95	15.70	16.20
1978	7.45	7.95	8.80	9.70	10.60	10.00	11.20	11.70	12.20	12.70	13.20	13.95	14.45
1979	6.75	7.25	7.90	8.65	9.15	8.65	9.85	10.35	10.85	11.35	11.85	12.60	13.10
1980	6.00	6.50	7.00	7.50	8.00	7.50	8.70	9.20	9.70	10.20	10.70	11.45	13.55
1981	5.50	6.00	6.50	7.00	7.50	7.20	8.15	8.65	9.15	9.65	10.15	10.90	12.65
1982		5.50	6.00	6.50	7.00	6.70	7.65	8.15	8.65	9.15	9.65	10.40	12.00
1983			5.50	6.00	6.50	6.30	7.05	7.55	8.05	8.55	9.05	9.80	11.20
1984				5.50	6.00	5.80	6.55	7.05	7.55	8.05	8.55	9.30	10.40
1985					5.50	5.30	6.00	6.50	7.00	7.50	8.00	8.75	9.55
1986						4.80	5.50	6.00	6.50	7.00	7.50	8.25	9.00
1987							4.90	5.40	5.90	6.40	6.90	7.65	8.40
1988								4.90	5.40	5.90	6.40	7.15	7.85
1989									4.90	5.40	5.90	6.65	7.25
1990										4.90	5.40	6.15	6.65
1991											4.90	5.40	5.90
1992												4.90	5.40
1993													4.90
Market rate	15.85	15.30	14.36	13.52	13.16	12.11	13.07	12.64	12.66	15.25	12.95	12.95	10.01

Table A2 Share of houses with subsidies, different sizes and construction years

Size (square meters)	1982	1985	1987	1989	1991	1993	All
- 60	0.00	.	0.00	0.00	0.00	0.00	0.00
60 – 74	0.00	0.00	0.28	0.17	0.20	0.09	0.15
75 – 84	0.58	0.68	0.46	0.33	0.40	0.37	0.46
85 – 94	0.70	0.95	0.82	0.82	0.70	0.37	0.74
95 – 114	0.95	0.95	0.81	0.89	0.91	0.91	0.89
115 – 174	0.85	0.97	0.81	0.82	0.93	0.96	0.87
175 – 184	0.84	0.91	0.81	0.51	0.90	0.96	0.81
185 – 244	0.80	0.72	0.54	0.68	0.93	0.82	0.67
245 – 264	0.00	0.41	0.06	0.00	0.48	.	0.19
265 -	0.00	0.00	0.00	0.00	.	0.57	0.04
All	0.85	0.95	0.79	0.81	0.90	0.89	0.85

Source: *Housing and Rent Survey*, different years.

Table A3: Logit equation of having subsidies. Parameter estimates (standard errors in parenthesis)

	Size class (sq. meters)		
	-89	90-185	186-
Intercept	-11.65 (11.54)	-6.010 (2.018)	19.36 (3.49)
Area	0.069 (0.314)	0.139 (0.029)	-0.100 (0.022)
Area squared	0.00046 (0.00215)	-0.00051 (0.00010)	0.00012 (0.00004)
Assessed value	1.279 (0.589)	0.059 (0.225)	-1.453 (0.609)
Assessed value squared	-0.1058 (0.0578)	-0.0062 (0.0219)	0.1466 (0.0662)
Stockholm	-0.202 (0.560)	-0.624 (0.227)	-0.008 (0.535)
Gothenburg	-0.417 (0.557)	-0.484 (0.228)	-0.835 (0.593)
Medium-sized cities	-0.819 (0.511)	-0.429 (0.160)	-1.081 (0.439)
1976	-	-2.237 (0.244)	-1.729 (0.911)
1977	1.764 (1.239)	-1.896 (0.258)	-0.730 (0.750)
1978	1.233 (1.331)	-1.223 (0.337)	-1.464 (0.977)
1979	-	-1.521 (0.227)	-0.159 (0.560)
1980	0.316 (0.872)	-1.012 (0.289)	2.024 (0.958)
1981	1.553 (0.699)	-0.530 (0.181)	0.394 (0.398)
Chi square	75.82	189.35	84.61
# observed with subs	104	3884	126
# correctly predicted [Pr(Subs)>0.5]	77	3882	96
# observed without subs	103	307	116
# correctly predicted [Pr(Subs)<0.5]	69	1	76

Table A4: Parameter estimates for Stockholm, dependent variable log house price. Perfect foresight and mark-up of 0.5 per cent.

Variable	Parameter estimate (standard error)
Living area (log sq. meters)	0.4511 (0.0031)
Additional area (log sq. meters)	0.0150 (0.0006)
Lot size (log sq. meters)	0.1053 (0.0014)
Waterfront location (1=yes)	0.3237 (0.0064)
Two-story building (1=yes)	-0.0206 (0.0020)
Basement (1=yes)	-0.0063 (0.0023)
No garage (1=yes)	-0.0135 (0.0019)
Two car garage (1=yes)	0.0427 (0.0037)
No sewer connection (1=yes)	-0.1271 (0.0090)
No heating (1=yes)	-0.0958 (0.0108)
Thermopane (1=yes)	0.0222 (0.0029)
No insulation (1=yes)	-0.0381 (0.0082)
Brick walls (1=yes)	0.0414 (0.0021)
Tile or copper roof (1=yes)	0.0114 (0.0020)
Copper roof (1=yes)	0.0431 (0.0077)
No electricity (1=yes)	-0.0014 (0.0178)
No toilet (1=yes)	-0.0867 (0.0086)
No bathroom (1=yes)	-0.0588 (0.0034)
Tiled bathroom (1=yes)	0.0317 (0.0025)
Laundry room (1=yes)	-0.0289 (0.0021)
Wooden or clinker floor (1=yes)	0.0222 (0.0021)
Recreation room (1=yes)	0.0437 (0.0025)
Fireplace (1=yes)	0.0491 (0.0020)
Sauna (1=yes)	0.0507 (0.0021)
Rural area (1=yes)	-0.0530 (0.0035)

Table A4, continued

Building age = 2-3 years	-0.0142 (0.0129)
3-4 years	0.0022 (0.0131)
4-5 years	-0.0057 (0.0132)
5-8 years	-0.0394 (0.0142)
8-11 years	-0.0916 (0.0144)
11-16 years	-0.1386 (0.0145)
16-21 years	-0.1593 (0.0145)
21-26 years	-0.1860 (0.0145)
26-36 years	-0.2094 (0.0146)
36-46 years	-0.2139 (0.0146)
Subsidy (log 1-lamma)	-1.1356 (0.0739)
Purchase year 1982 (1=yes)	0.0245 (0.0042)
1983	0.0462 (0.0040)
1984	0.0739 (0.0040)
1985	0.1304 (0.0040)
1986	0.2167 (0.0040)
1987	0.3967 (0.0042)
1988	0.6416 (0.0042)
1989	0.8068 (0.0042)
1990	0.9322 (0.0046)
1991	0.9775 (0.0042)
1992	0.8232 (0.0049)
1993	0.6661 (0.0057)
$\overline{R}^2$	0.8272
Number of observations	82494