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IMPROVED PRICE INDEXES FOR DURABLE GOODS: MEASURING THE COURSE OF SWEDISH HOUSING PRICES

By

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IMPROVED PRICE INDEXES FOR DURABLE GOODS: MEASURING THE COURSE OF SWEDISH HOUSING PRICES

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ABSTRACT

This paper presents an improved methodology for estimating asset prices for durables such as residential housing. The method combines cross sectional and panel data; utilizing all available transactions information; distinguishing among the effects of observable and unobservable aspects of quality; distinguishing between the effects of depreciation and vintage; and modeling the dynamics of the error structure explicitly.

The expanded model is used to analyze price dynamics by exploiting an unusually rich and detailed body of data -- extensive descriptive and financial information on every house sale in Sweden during a twelve year period.

The results confirm the importance of many aspects of quality in affecting the course of housing prices, as well as the role of individual-specific and idiosyncratic aspects of housing. The results are compared with the price trends produced by more primitive methods and published by official sources.

JEL Codes: C43, R31

I. INTRODUCTION

Unstandardized assets with long lives which are infrequently sold present difficult problems in the imputation of price series. Housing, which represents almost half of the U.S. private capital stock and thirty percent of household expenditures, is a conspicuous example.

The accurate measurement of housing and real estate price trends is itself crucial to understanding market behavior. For example, recent conclusions about the "efficiency" of the housing market depend crucially upon specific techniques which generate the price indexes used to measure the returns to arbitrage (Case and Shiller, 1989). Similarly, models which investigate the determinants of speculative bubbles in real estate (Abraham and Hendershott, 1996) rely upon index number techniques for the measurement of prices.

Finally, accuracy in measurement of housing prices is of enormous practical importance. Applications range from the estimation of regional variation in the cost of living to the computation of transfer payments under housing subsidy programs. As primary housing markets have become more integrated with secondary markets, the computation of housing prices has become of great practical importance to investors who confront choices among portfolios composed of real estate securities and other assets (Shiller, 1993).

This paper presents an improved methodology for estimating asset prices for durables such as residential housing. The method extends and synthesizes several techniques recently suggested in this journal (Case and Quigley, 1991, and Hill et al, forthcoming) for combining so called hedonic and repeat sales methods.

The improved model is used to compute price indexes for owner-occupied homes in Sweden, relying upon the most detailed and complete body of housing market information ever assembled. The data consist of essentially all used owner-occupied dwellings sold at arms length in Sweden during the period 1981-1993. Individual house sales are recorded nationally by the Central Bureau of Statistics, together with extensive information on the characteristics of dwellings, structures, and parcels. Our analysis makes use of the master file of sales information, containing observations on almost 500,000 owner-occupied property sales between January 1, 1981 and June 30, 1993.

Section II below describes the statistical model, a synthesis of several "hybrid models" proposed in the literature. Section III describes the data on housing prices and the salient features of the Swedish housing market. Section IV presents and interprets our results, and section V offers some concluding comments comparing our index with that published by the Central Bureau of Statistics.

II. THE STATISTICAL MODEL

By now, the general properties of hedonic and repeat sales models of housing price indexes are well known, and the advantages of "hybrid" techniques combining the two approaches are well established (see Case and Quigley, 1991; Case, Pollakowski, and Wachter, 1991; Quigley, 1995; and Hill et al, forthcoming). In this section, we introduce an estimation technique combining the desirable features of several estimators currently used.

Assume that the sale price of a housing unit is an amalgam, PQ, of an index representing the price, P, of a housing unit and another representing the level of services, Q, emitted by that unit. To represent this, suppose

$$(1) \quad V_{it} = Q_{it} + P_t + \omega_{it} \quad ,$$

where V_{it} is the logarithm of the observed selling price of house i at time t, Q_{it} is the log of the quality of house i sold at time t, and P_t is the log of the constant quality housing price index at time t. ω_{it} is a random error, reflecting idiosyncratic aspects of particular transactions, e.g., a "distressed" sale.

According to equation (1), each house emits a quality of service Q_{it} which is priced at P_t at a particular point in time. Q_{it} is unobserved, but

$$(2) \quad Q_{it} = \beta X_{it} + \xi_i + \eta_{it} \quad .$$

According to equation (2), housing quality is a function of a vector of observable characteristics of dwellings at time t,

X_{it}, a dwelling-unit-specific factor, ξ_i, and a random error, η_{it}. The vector X_{it} may include the vintage (production year) of the dwelling, Y_i, as well as the accumulated physical depreciation of that dwelling at year t, $[t - Y_i]$. The term ξ_i represents the unmeasured characteristics of house i. Combining (1) and (2) yields

(3) $V_{it} = \beta X_{it} + P_t + \delta_{it}$,

where δ_{it} is a composite error term,

(4) $\delta_{it} = \xi_i + \eta_{it} + \omega_{it} = \xi_i + \varepsilon_{it}$.

Assume

(5) $E(\xi_i) = 0$

$E(\xi_i)^2 = \sigma_\xi^2$.

If all dwellings in a given sample were repeat sales, all the parameters of the model could be estimated by making further assumptions about the structure of the errors, ε_{it}.

Multiple observations on dwellings, i.e. repeat sales, provide three sources of information in estimating the model:

First, they permit the systematic components of housing quality to be distinguished from the unmeasured idiosyncratic components, ξ_i, that vary among individual dwelling units.

Second, they permit the depreciation of dwellings to be distinguished from the vintage of dwellings. Presumably, newer dwellings embody technical progress which makes them more valuable. However, for a given construction vintage, sales observed later in time should be at lower prices, ceteris paribus, reflecting physical depreciation of the asset.

Third, multiple sales permit an explicit analysis of the error generating process, which potentially improves the efficiency of estimation of the price index P_t, as well as the parameters β.

A sample of single sales permits equation (3) to be estimated, but it does not permit the measured characteristics of houses to be distinguished from the unmeasured, individual specific, characteristics of those dwelling units. Presumably, many characteristics of individual houses that are difficult to measure quantitatively, particularly in a large sample, are important in affecting house values. Similarly, in a single cross section, depreciation cannot be distinguished from the effects of vintage and the course of pure price change over real time. In a linear model, the variables are simply colinear. Finally, single sales do not permit any investigation of the autocorrelated structure of errors.

To combine samples of single and multiple sales in the same analysis, combine equations (3) and (4), recognizing the distinction between vintage and depreciation:

$$(6) \quad V_{it} = \beta X_{it} + P_t + \beta_y Y_i + \xi_i + \varepsilon_{it} = \beta X_{it} + P_t + \gamma_{it} \quad .$$

In this formulation, we include vintage in the regression as a component of the vector of observable characteristics, X_{it}, of dwellings. In any cross section, we can measure X_{it}; year of construction, Y_i; age, $(t-Y_i)$; and time, parameterized by P_{it}. But they are not independent. When the year of construction is included among the regressors, its estimated coefficient includes the accumulated depreciation of dwellings.

Now estimate the parameters of (6) using the subsample of repeat sales. That is, regress the log sale price on the log of housing characteristics, a set of dummy variables for time period (or perhaps some other parameterization of time), and a set of dummy variables for individual dwellings. The residuals from this regression are sufficient to provide an estimate of the depreciation parameter β_d and the error structure:

$$(7) \quad \gamma_{it} - \gamma_{i\tau} = \beta_d(t-\tau) + \varepsilon_{it} - \varepsilon_{i\tau} \quad ,$$

$$(8) \quad \varepsilon_{it} = \rho^{(t-\tau)}\varepsilon_{i\tau} + \upsilon_{it} \quad ,$$

assuming that υ_{it} is white noise.

The error variances, σ_ξ^2, σ_υ^2 and σ_ε^2, are estimated from (6) and (8), and the effect of vintage β_v is merely $(\beta_y - \beta_d)$.

Together, these parameters identify completely the variance-covariance matrix of disturbances in equation (6).

$$(9) \quad E(\gamma_{it}, \gamma_{i\tau}) = \begin{cases} 0 & \text{for } i \neq j, \\ \sigma_\xi^2 + \sigma_\upsilon^2 \{\rho^{(t-\tau)} / (1 - \rho^2)\} + \beta_d^2 t\tau & \text{for } i = j. \end{cases}$$

Now, using the entire sample of single sales and repeat sales, estimate equation (3) by generalized least squares, where the GLS matrix is the inverse of the right hand side of equation (9).

This approach, which uses all sales observations, not just repeat sales, in a common framework, is an extension of the hybrid techniques proposed by Quigley (1995) and by Hill, Knight, and Sirmans (HKS, forthcoming). Each of these previous models relies upon an explicit error structure to combine single sales and multiple sales in a common regression framework. In common with the HKS model, the estimator proposed here distinguishes between vintage and depreciation in their effects upon housing prices. In contrast to the HKS model, the estimator proposed here distinguishes between the individual-specific components of house values and random errors. This proposed technique is also simple to implement -- relying upon generalized least squares models rather than maximum likelihood methods. In contrast to the model proposed by Quigley, the estimator proposed here incorporates a conventional autoregressive structure rather than the more cumbersome assumption of a random walk in housing prices.[1]

In contrast to repeat sales methods, which have been routinely applied to the art market as well as the housing market, the estimator proposed here is based upon all market information, not just that provided by multiple sales of the same property.

III. THE DATA

Housing transactions data are recorded routinely in Sweden and are maintained historically by the Central Bureau of Statistics in Stockholm. The raw data utilized in this study consist of all residential (non farm) housing sales recorded during the 1981:I-1993:II period divided into eight geographical regions.[2] Sales prices are taken directly from the sales

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1 The recent empirical analysis reported by Hill, Knight, and Sirmans provides convincing evidence that the simple model of serial correlation "fits the data" as well as the random walk model, at least in one empirical application.

2 The raw data are maintained on two separate files: one (370,860 observations) containing all multiple house sales (the "repeat-sales" file) during the period; and another (692,456 observations) containing all arms-length housing sales in the country during the same period (the "all-sales" file). The former file includes a unique identification number for each different property; the latter file does not include any identifying information at all. Both files have the same format and contain a large number of variables measuring property characteristics. In the first step of the analysis, the two files were merged. Then, those observations in the "all-sales"

contract that is submitted to court in order to obtain legal confirmation of ownership. Information about characteristics derive from form submitted by the homeowner to the tax authorities, information that is use to assess values for property tax purposes.

Figure 1 shows the regional breakdown of the data. The eight regions vary in geographical size between the capital region of Stockholm (Region I) and the rural north (Region VIII). Table 1 reports the distribution of dwellings by the number of sales during the twelve year period in each region. About three quarters of the dwellings in the sample were sold once, but the distribution of sales has a long tail within each region. The analysis sample consists of 487,804 transactions[3] on 374,008 houses.

Table 2 summarizes the average characteristics of houses sold in the eight regions during this period.

The average selling price of houses in Stockholm, 788,613 SEK (or roughly $120,000 US) was more than sixty percent larger than the average in the other regions. The average interior

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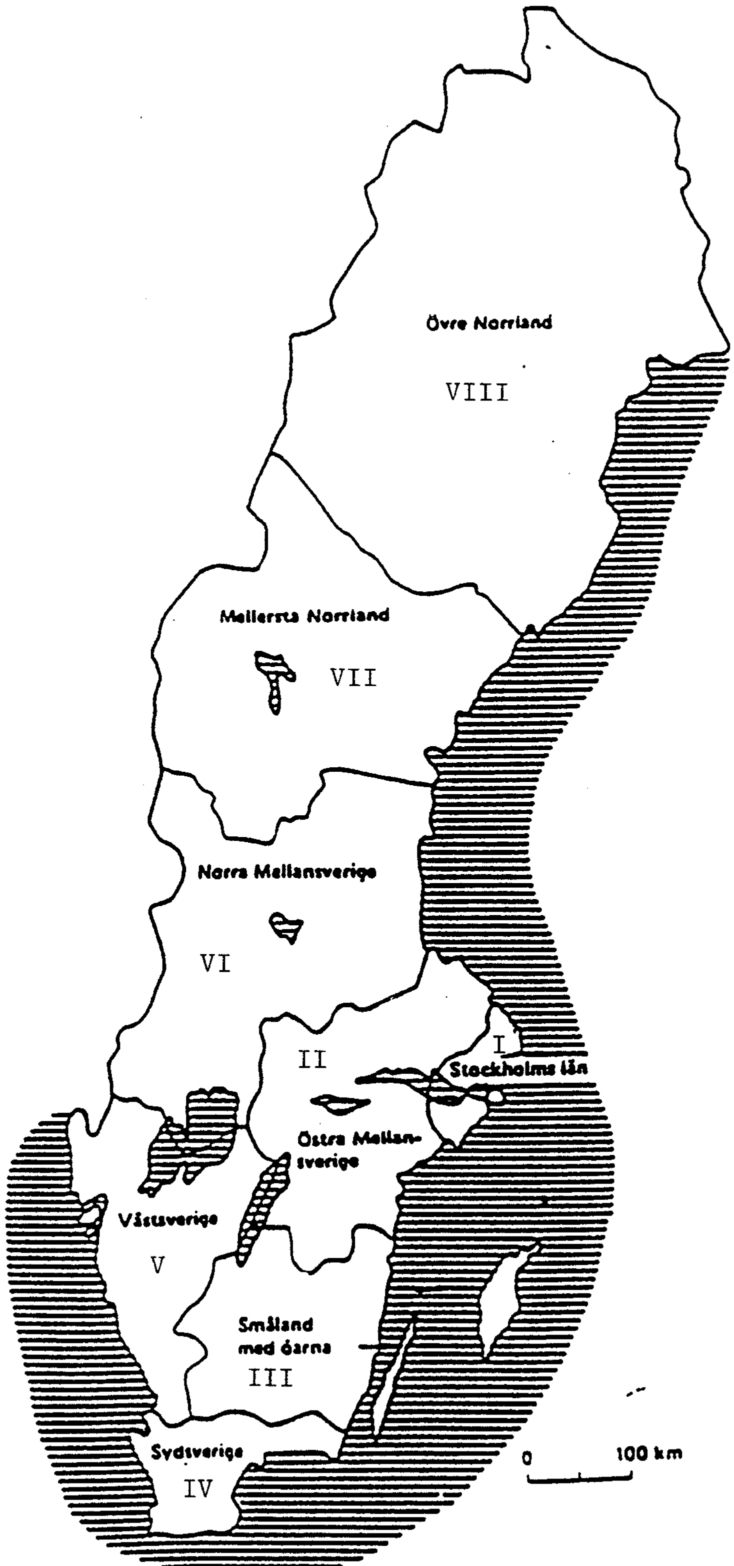
file whose characteristics matched exactly those of an observation in the "repeat-sales" file were eliminated (an exact match was sought on sale date and minor civil division as well as a variety of physical characteristics of the properties). We also eliminated duplicate records, again using exact matches. We also deleted multiple sales within a half year of each other. In this way redundant records were eliminated from the merged file.

[3] From the original all-sales file we have deleted all transactions involving institutions as buyer or seller, and a number of cases with missing observations on one or more of the housing characteristics. We have also excluded properties with very large lot sizes (above 10,000 square meters).

Figure 1
Boundaries of Major Economic Regions in Sweden



Source: Central Bureau of Statisitcs

Table 1
Number of Dwellings and Sales, 1981:I - 1993:II

Number of sales	Region I	II	III	IV	V	VI	VII	VIII	Total Number of Dwellings	Total Number of Transactions
1	44,228	48,779	30,310	46,995	60,407	30,551	11,535	14,657	287,462	287,462
2	9,536	11,728	6,355	10,983	14,055	7,018	2,786	3,879	66,340	132,680
3	1,859	3,073	1,371	2,510	3,089	1,776	698	829	15,205	45,615
4	388	855	262	520	698	443	175	214	3,555	14,220
5	116	281	44	155	157	127	56	67	1,003	5,015
6	47	105	11	48	34	45	20	17	327	1,962
7	10	35	1	9	4	15	4	6	84	588
8	3	10	1	5	2	3	1	1	26	208
9	1	2	0	0	1	1	0	1	6	54
10+	0	1	0	0	0	0	0	0	1	10
Total	56,188	64,868	38,355	61,225	78,447	39,979	15,275	19,671	374,008	487,804

Table 2
Average Characteristics of House Sales by Region, 1981:I - 1993:II
(Standard Deviations in Parentheses)

	Region							
	I	II	III	IV	V	VI	VII	VIII
Sale Price	788.613	481.351	388.089	449.301	506.615	385.231	377.985	408.758
(000 Crowns, SEK)	(479.36)	(250.09)	(211.16)	(296.30)	(308.76)	(199.02)	(212.90)	(217.92)
Size:								
interior size	122.242	119.592	122.767	120.224	118.283	116.176	116.166	117.760
(sq. meters)	(36.39)	(36.94)	(39.88)	(40.34)	(37.92)	(38.06)	(37.81)	(36.09)
parcel size	887.326	1292.980	1420.150	1212.810	1295.840	1542.490	1553.130	1390.530
(sq. meters)	(1690.68)	(2141.76)	(2053.47)	(1775.67)	(2883.84)	(2248.92)	(2103.96)	(2687.63)
one car garage	0.703	0.705	0.660	0.581	0.619	0.639	0.642	0.734
(1 = yes)	(0.46)	(0.46)	(0.47)	(0.49)	(0.49)	(0.48)	(0.48)	(0.44)
two car garage	0.047	0.077	0.068	0.044	0.060	0.072	0.055	0.099
(1 = yes)	(0.21)	(0.27)	(0.25)	(0.20)	(0.24)	(0.26)	(0.23)	(0.30)
Amenity:								
tile bath	0.123	0.091	0.098	0.144	0.113	0.081	0.075	0.070
(1 = yes)	(0.33)	(0.29)	(0.30)	(0.35)	(0.32)	(0.27)	(0.26)	(0.26)
sewer connection	0.988	0.983	0.979	0.973	0.976	0.983	0.989	0.993
(1 = yes)	(0.11)	(0.13)	(0.14)	(0.16)	(0.15)	(0.13)	(0.10)	(0.08)
sauna	0.218	0.218	0.181	0.122	0.176	0.185	0.207	0.395
(1 = yes)	(0.41)	(0.41)	(0.39)	(0.33)	(0.38)	(0.39)	(0.41)	(0.49)
stone/brick	0.232	0.349	0.350	0.552	0.286	0.239	0.167	0.190
(1 = yes)	(0.42)	(0.48)	(0.48)	(0.50)	(0.45)	(0.43)	(0.37)	(0.39)
single detached	0.669	0.815	0.878	0.867	0.787	0.882	0.855	0.865
(1 = yes)	(0.47)	(0.39)	(0.33)	(0.34)	(0.41)	(0.32)	(0.35)	(0.34)
finished basement	0.161	0.184	0.201	0.134	0.170	0.157	0.173	0.161
(1 = yes)	(0.37)	(0.39)	(0.40)	(0.34)	(0.38)	(0.36)	(0.38)	(0.37)
fireplace	0.373	0.345	0.469	0.261	0.344	0.382	0.347	0.285
(1 = yes)	(0.48)	(0.48)	(0.50)	(0.44)	(0.47)	(0.49)	(0.48)	(0.45)
laundry room	0.832	0.787	0.788	0.775	0.800	0.737	0.746	0.815
(1 = yes)	(0.37)	(0.41)	(0.41)	(0.42)	(0.40)	(0.44)	(0.44)	(0.39)
waterfront location	0.008	0.006	0.007	0.005	0.005	0.013	0.016	0.013
(1 = yes)	(0.09)	(0.08)	(0.08)	(0.07)	(0.07)	(0.11)	(0.13)	(0.12)

Quality:								
age at time of sale	26.073	29.109	32.538	35.903	29.959	33.385	31.921	26.114
(years)	(19.61)	(22.79)	(23.82)	(25.94)	(22.60)	(24.12)	(22.46)	(19.72)
year built	60.554	57.486	54.345	50.965	56.785	53.330	54.763	60.775
(19xx)	(19.46)	(22.54)	(23.65)	(25.77)	(22.41)	(23.92)	(22.26)	(19.37)
insulation;								
walls only	0.834	0.802	0.808	0.798	0.792	0.805	0.783	0.699
(1 = yes)	(0.37)	(0.40)	(0.39)	(0.40)	(0.41)	(0.40)	(0.41)	(0.46)
walls and windows	0.160	0.191	0.174	0.183	0.194	0.187	0.210	0.298
(1 = yes)	(0.37)	(0.39)	(0.38)	(0.39)	(0.40)	(0.39)	(0.41)	(0.46)
kitchen;								
good	0.209	0.230	0.270	0.298	0.263	0.309	0.281	0.219
(1 = yes)	(0.41)	(0.42)	(0.44)	(0.46)	(0.44)	(0.46)	(0.45)	(0.41)
excellent	0.785	0.754	0.703	0.684	0.720	0.665	0.692	0.772
(1 = yes)	(0.41)	(0.43)	(0.46)	(0.46)	(0.45)	(0.47)	(0.46)	(0.42)
heating system;								
electric radiator	0.401	0.330	0.316	0.331	0.361	0.304	0.370	0.389
(1 = yes)	(0.49)	(0.47)	(0.47)	(0.47)	(0.48)	(0.46)	(0.48)	(0.49)
electric furnace	0.114	0.088	0.076	0.093	0.108	0.098	0.104	0.173
(1 = yes)	(0.32)	(0.28)	(0.27)	(0.29)	(0.31)	(0.30)	(0.31)	(0.38)
solar/other	0.344	0.367	0.496	0.466	0.421	0.486	0.442	0.351
(1 = yes)	(0.47)	(0.48)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.48)
exterior steam	0.080	0.167	0.050	0.068	0.036	0.055	0.024	0.052
(1 = yes)	(0.27)	(0.37)	(0.22)	(0.25)	(0.19)	(0.23)	(0.15)	(0.22)
other central heat	0.050	0.020	0.022	0.020	0.050	0.020	0.025	0.008
(1 = yes)	(0.22)	(0.14)	(0.15)	(0.14)	(0.22)	(0.14)	(0.15)	(0.09)
wood burning stove	0.009	0.021	0.027	0.010	0.019	0.026	0.024	0.024
(1 = yes)	(0.09)	(0.14)	(0.16)	(0.10)	(0.13)	(0.16)	(0.15)	(0.15)
roof;								
cement/steel	0.668	0.773	0.805	0.663	0.768	0.764	0.590	0.448
(1 = yes)	(0.47)	(0.42)	(0.40)	(0.47)	(0.42)	(0.42)	(0.49)	(0.50)
slate/copper	0.010	0.009	0.012	0.016	0.013	0.011	0.008	0.008
(1 = yes)	(0.10)	(0.10)	(0.11)	(0.12)	(0.12)	(0.10)	(0.09)	(0.09)

Other:								
distance to center	4.796	5.803	7.965	5.495	5.928	5.706	11.369	6.586
(kilometers)	(6.29)	(6.93)	(9.61)	(5.37)	(5.87)	(9.02)	(14.23)	(13.31)
urban area	0.900	0.777	0.771	0.742	0.736	0.773	0.724	0.760
(1 = yes)	(0.30)	(0.42)	(0.42)	(0.44)	(0.44)	(0.42)	(0.45)	(0.43)
capital subsidy	3.418	3.124	2.873	2.921	3.251	2.787	2.852	3.273
(000 SEK)	(15.10)	(13.11)	(12.95)	(13.82)	(14.07)	(11.85)	(12.90)	(15.10)
conditional subsidy	29.162	24.410	24.721	27.889	26.802	22.507	24.403	23.948
(000 SEK)	(34.55)	(28.70)	(30.05)	(33.57)	(31.63)	(26.27)	(29.98)	(34.27)
number of transactions	71,394	87,262	48,482	79,737	101,618	52,730	20,337	26,254
number of dwellings	56,188	64,868	38,355	61,225	78,447	39,979	15,275	19,671

size, about 120 square meters, was quite similar across regions, while the average lot size was much smaller in Stockholm, 887 square meters, than in the other seven regions, which averaged 1200 - 1500 square meters.

The raw data includes a wide variety of indicators of the quality and amenity of dwellings. On the basis of preliminary analyses, we have included a number of these in the determination of price. Included are: two size variables and dummy variables for the number of garages; nine dummy variables recording various amenities, including for example the existence of an open fire place, a sauna, a laundry room; and twelve dummy variables measuring the quality of insulation, heating systems, kitchens, and roofs. In addition, we record the vintage (year of construction) of each dwelling and its age at sale.

Each dwelling is located in one of 111 well-defined labor market areas. Region I is a single labor market area (Stockholm); other regions are composed of several labor market areas (up to 24 areas for Region VI). For each dwelling, we measure the straight line distance to the economic center of its labor market area.[4]

In addition to these qualitative and quantitative aspects of the dwellings, we measure and hold constant one potentially

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4 More precisely, we measure the straight line distance of the parish containing each dwelling to the center of its economic area. Parishes are roughly the size of U.S. census tracts, and are subject to the same ambiguities in measuring distances from their centroids, i.e., urban parishes are usually smaller in geographical area than rural parishes.

important financial aspect of these house sales, namely the existence of transferable capital subsidies. Beginning in 1975, the Swedish government provided loans with guaranteed interest rates to the purchasers of newly constructed dwellings. The rules governing these subsidies varied over time ,i.e., with year of construction, They also varied with the size of dwellings, since they were tied to the construction cost of the dwelling. These subsidies are specific to the vintage, year of sale, and size of houses and are potentially capitalized into selling prices for used houses. We include an estimate of the present value of the remaining subsidy at the time of sale as a variable in the analysis.[5]

As indicated in Table 2, the present value of the average subsidy for all transactions in this sample is small, about 3,000 SEK or $500 US. However, for those transactions which include a subsidized house, the average value of the remaining capital subsidy is as high as 30,000 SEK or $5,000 US. The average conditional subsidy is thus between 3 and 6 percent of the average sale price. The average conditional subsidy for a new house built during the 1980s was about twenty percent of the initial selling price.

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5 The present value of these capital subsidies depends upon the current interest rate and interest rate expectations as well as the subsidy rules in effect at time of construction. In addition, because these subsidies interact with the tax code, their value also depends upon the marginal tax rate of the owner. These issues are discussed in Englund, Hendershott, and Turner (1995). The assumptions underlying the computation of the particular present value estimates we use are discussed in Berger, Englund, Hendershott, and Turner (1996).

Appendix Table A1 presents estimates of equation (6) based upon the sample of multiple sales. This regression, of the logarithm of selling price upon housing characteristics, is estimated by ordinary least squares. With one exception, the specification of the regression equation is identical for all eight regions.[6]

Table 3 presents the GLS estimates of the parameters of equation (6) as well as the estimates of equations (7) and (8). Panel A reports the GLS coefficients using the weights derived from equations (7) and (8).

The coefficient of almost every variable reported in Panel A is precisely estimated and plausible in magnitude. The elasticity of housing value with respect to interior size is about 0.5; with respect to parcel area, it is 0.02 to 0.04 (for one region parcel area is negative and insignificant). Of the 72 dummy variables indicating amenities, only one has an unanticipated sign. 71 of these measures of amenity are significant by conventional criteria. Saunas and fireplaces increase housing values, as do waterfront locations (especially in Stockholm! but less so in the cold north!).

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6 The only difference in specification is in the lot size variable. For the rural north (Region VIII), there are a fair number of large properties with low selling prices. For this region, we include the square of parcel size as well as a dummy variable for parcels between 2500 and 5000 square meters. For the other seven regions, we use the more parsimonious specification, including only parcel area. The latter representation fits the data almost as well. Using this specification, the elasticity of selling price with respect to parcel area is 0.03 at the means for Regions VIII, quite similar to estimates for the other regions.

Table 3
Parameters Affecting Housing Prices:
Estimates of Equations (6), (7), and (8)

A. Generalized Least Squares Estimates of Equation (6) Based on All Sales

	Region							
	I	II	III	IV	V	VI	VII	VIII
Size:								
interior size *	0.525	0.516	0.520	0.588	0.503	0.501	0.523	0.547
(sq. meters)	(140.83)	(150.24)	(100.89)	(134.31)	(144.42)	(109.34)	(62.84)	(63.20)
parcel size *	0.022	0.032	0.030	0.033	-0.001	0.042	0.022	0.059
(sq. meters)	(11.37)	(17.66)	(1.15)	(14.52)	(0.45)	(16.65)	(5.21)	(1.56)
one car garage	0.001	0.028	0.036	0.006	0.018	0.058	0.084	0.102
(1 = yes)	(0.54)	(11.03)	(10.06)	(2.34)	(7.98)	(17.90)	(14.51)	(15.09)
two car garage	0.070	0.077	0.082	0.045	0.078	0.105	0.118	0.143
(1 = yes)	(13.74)	(18.89)	(13.09)	(7.19)	(17.54)	(18.62)	(10.62)	(14.93)
Amenity:								
tile bath	0.059	0.029	0.038	0.066	0.063	0.033	0.016	0.022
(1 = yes)	(18.99)	(8.73)	(7.87)	(18.47)	(20.36)	(6.83)	(1.81)	(2.52)
sewer connection	0.172	0.172	0.213	0.247	0.142	0.199	0.249	0.171
(1 = yes)	(17.60)	(21.22)	(18.06)	(27.56)	(20.17)	(17.12)	(10.51)	(6.05)
sauna	0.053	0.070	0.097	0.107	0.077	0.085	0.088	0.088
(1 = yes)	(20.53)	(28.33)	(24.00)	(26.80)	(27.70)	(23.04)	(13.79)	(16.68)
stone/brick	0.009	0.031	0.050	0.050	0.043	0.051	0.049	0.067
(1 = yes)	(3.59)	(14.42)	(15.04)	(18.10)	(17.95)	(15.09)	(7.25)	(10.95)
single detached	0.087	0.047	0.069	-0.025	0.047	0.054	0.026	0.039
(1 = yes)	(27.35)	(15.44)	(14.09)	(5.92)	(14.78)	(11.33)	(3.14)	(4.48)
finished basement	0.061	0.123	0.125	0.073	0.084	0.105	0.101	0.095
(1 = yes)	(21.67)	(45.04)	(30.37)	(18.31)	(29.80)	(25.97)	(14.72)	(14.13)
fireplace	0.106	0.065	0.060	0.127	0.089	0.075	0.064	0.082
(1 = yes)	(44.31)	(30.37)	(19.74)	(42.45)	(40.40)	(26.31)	(12.20)	(15.69)
laundry room	0.009	0.065	0.092	0.080	0.071	0.081	0.126	0.105
(1 = yes)	(3.21)	(23.12)	(21.62)	(22.61)	(24.77)	(22.99)	(19.13)	(15.27)
waterfront location	0.358	0.287	0.304	0.310	0.239	0.214	0.094	0.031
(1 = yes)	(32.83)	(24.38)	(17.85)	(17.48)	(16.89)	(18.51)	(5.06)	(1.62)

Quality:								
year built	-0.001	0.003	0.003	0.003	0.003	0.003	0.005	0.004
(19xx)	(15.65)	(44.85)	(34.44)	(44.02)	(41.32)	(37.76)	(29.58)	(25.07)
insulation;								
walls only	0.050	0.068	0.094	0.070	0.016	0.039	0.059	0.059
(1 = yes)	(3.65)	(5.99)	(8.41)	(7.60)	(1.91)	(2.63)	(2.03)	(1.53)
walls and windows	0.105	0.104	0.172	0.130	0.075	0.097	0.138	0.125
(1 = yes)	(7.51)	(8.86)	(14.13)	(13.01)	(8.61)	(6.25)	(4.60)	(3.22)
kitchen;								
good	0.175	0.188	0.163	0.121	0.157	0.183	0.187	0.270
(1 = yes)	(13.22)	(21.87)	(15.23)	(10.82)	(18.10)	(18.76)	(11.22)	(10.59)
excellent	0.212	0.277	0.285	0.237	0.249	0.293	0.324	0.409
(1 = yes)	(15.85)	(31.54)	(25.91)	(20.74)	(28.04)	(29.29)	(18.82)	(15.82)
heating system;								
electric radiator	0.181	0.159	0.195	0.157	0.242	0.215	0.164	0.259
(1 = yes)	(9.21)	(12.65)	(13.43)	(11.75)	(17.28)	(14.76)	(6.63)	(5.34)
electric furnace	0.224	0.209	0.257	0.240	0.307	0.235	0.226	0.330
(1 = yes)	(11.30)	(16.11)	(16.62)	(17.23)	(21.42)	(15.45)	(8.79)	(6.76)
solar/other	0.206	0.139	0.190	0.153	0.235	0.203	0.166	0.235
(1 = yes)	(10.49)	(10.96)	(12.97)	(11.44)	(16.69)	(13.81)	(6.66)	(4.83)
exterior steam	0.156	0.335	0.230	0.366	0.278	0.211	0.226	0.292
(1 = yes)	(7.81)	(25.89)	(14.17)	(25.63)	(18.55)	(13.31)	(7.59)	(5.86)
other central hea	0.225	0.206	0.284	0.217	0.238	0.252	0.242	0.265
(1 = yes)	(11.19)	(14.60)	(16.40)	(13.63)	(16.18)	(14.65)	(8.35)	(4.90)
wood burning stov	0.207	0.080	0.112	0.053	0.147	0.169	0.093	0.093
(1 = yes)	(9.54)	(5.89)	(6.91)	(3.02)	(9.72)	(10.53)	(3.34)	(1.86)
roof;								
cement/steel	0.044	0.013	0.000	0.030	0.031	0.026	0.040	0.027
(1 = yes)	(18.66)	(5.32)	(0.00)	(10.69)	(12.32)	(8.13)	(7.79)	(5.06)
slate/copper	0.113	0.003	-0.059	0.014	0.035	0.027	0.017	0.012
(1 = yes)	(11.14)	(0.35)	(4.31)	(1.39)	(4.13)	(2.07)	(0.67)	(0.46)
Other: **								
distance to center	-0.009							
(kilometers)	(54.74)							
urban area	0.168	0.058	0.071	0.127	0.091	0.072	0.120	0.165
(1 = yes)	(44.44)	(21.01)	(16.92)	(38.70)	(33.44)	(19.24)	(19.60)	(27.43)

capital subsidy	1.065	2.135	1.938	1.842	1.601	1.545	1.866	0.257
(millions of SEK)	(7.76)	(14.82)	(9.19)	(9.86)	(11.35)	(7.76)	(4.93)	(1.09)
intercept	9.782	9.086	9.082	8.326	9.264	8.697	8.429	8.115
	(329.09)	(374.44)	(90.88)	(277.31)	(177.74)	(248.97)	(135.88)	(57.97)
R^2	0.756	0.740	0.725	0.728	0.755	0.723	0.759	0.694
number of transaction	71,394	87,262	48,482	79,737	101,618	52,730	20,337	26,254
number of dwellings	56,188	64,868	38,355	61,225	78,447	39,979	15,275	19,671
B. Estimates of Equations (7) and (8) Based on Residuals from Regression on All Multiple Sales								
β_d	0.0041	0.0030	0.0060	0.0063	0.0034	0.0051	0.0060	0.0065
(annual rate)	(11.38)	(8.73)	(11.40)	(14.35)	(9.03)	(10.41)	(7.60)	(9.87)
ρ	-0.538	-0.585	-0.664	-0.601	-0.579	-0.526	-0.543	-0.561
(quarterly rate)	(12.23)	(24.38)	(28.87)	(25.04)	(28.95)	(12.23)	(8.62)	(11.69)
C. Other								
σ_ξ^2	0.039	0.045	0.059	0.084	0.057	0.054	0.062	0.077
σ_ε^2	0.015	0.016	0.018	0.023	0.017	0.019	0.020	0.019
σ_v^2	0.015	0.015	0.017	0.023	0.017	0.019	0.020	0.018
β_v (annual rate)	0.0061	0.0000	0.0027	0.0032	0.0005	0.0019	0.0012	0.0022
capitalization rate	0.866	0.681	0.920	0.633	0.571	0.708	0.380	0.207

t-ratios are in parentheses. Model also includes 50 dummy variables, Pt, (not reported) representing quarter of sale.

* - variable measured in logarithms.

** - model also includes separate intercepts and distance variables for each of 111 labor market areas (not reported). Region I, Stockholm, is considered a single labor market area.

*** - model also includes dummy variables for used dwellings sold at ages less than ten years.

Almost all of the 96 dummy variables indicating quality -- insulation, heating systems, etc. -- are significant and economically important. In particular, houses with high quality kitchens and heating systems are much more valuable than others.

As expected, the distance to the employment center is highly significant. The price gradient for the monocentric region, Stockholm, indicates a relative price reduction of 0.8 percent per kilometer from the city center.[7]

All of the price gradients for the 110 other labor market areas (not shown) are negative, significant, and of the same order of magnitude as the gradient for Stockholm. Because the labor market areas are smaller, the intercepts and gradients are smaller than in the Stockholm region.

The coefficient on the subsidy variable is highly significant, with coefficients varying between 0.3 and 2.1. These coefficients imply that a substantial fraction of the benefits afforded during this period to purchasers of new homes was capitalized and "sold" to subsequent buyers of houses. At the means, capitalization of the average subsidy ranged from 21 percent in the far north (where population has been declining) to around 90 percent in Stockholm and Småland in the South, Region III, (where population has been increasing). Despite the large sample and the precisely estimated coefficients, we have little

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7 This form of the distance-price relationship, an exponential decline, is a standard result in urban location theory. See Muth (1969).

confidence in the precision of the estimated capitalization rates.[8]

Panel B of the table reports the estimate of depreciation and the autocorrelation coefficient, based upon analysis of the residuals from the OLS model. The estimate of the depreciation rate is small. Ten year old houses depreciate by about 0.3 to 0.7 percent per year during the rest of their lives. Of course, these statistical models hold at constant quality a host of economically important amenities and features -- many of which typically vary substantially with the age of dwellings. The unmeasured factors, however, include the effects of wear and tear and landscaping, presumably age-related.

The coefficient of autocorrelation is negative and is precisely estimated in each of the eight regions. The magnitude, -0.5 or -0.6, suggests that autocorrelation is important for

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8 Our lack of confidence in capitalization estimates arises from several sources. First, these subsidies were provided only to houses built after 1975. They are thus concentrated in new houses where depreciation is decidedly non linear. In the models reported in Table 3, we have included dummy variables for dwellings less than ten years old. If these dummy variables are excluded (or if other plausible variants are adopted, say 5 or 15 dummy variables), there are minor differences in the estimated depreciation rate but larger changes in the estimated capitalization rate. We experimented by confining the sample to houses built after 1975. The estimate of capitalization is still sensitive to the specification of depreciation (age at sale). Beyond the correlation of capital subsidies with age, however, is the calculation of subsidy levels. This calculation is based on strong assumptions about discount rates and about expected future market interest rates. We conclude that capital subsidies are capitalized into the sale of values of used houses and that the specification employed is sufficient to hold constant these effects in the estimation of price indexes. We cannot say with confidence that the capitalization rate is 90 percent rather than 40 percent.

houses that are sold within two or three quarters after they were purchased, but it is not important at all for houses sold after intervals of, say, two years.[9] $(.6^8 \cong .02)$

Given the high transactions costs in the housing market, a short interval between acquisition and disposition of a house reflects an unusual transaction. On the one hand, a rapid disposition may represent a "distressed sale" arising from divorce or job loss. Individuals forced to sell on short notice often take large losses. On the other hand, a rapid disposition may represent an unusual profit opportunity arising from an underpriced house by an uninformed seller. Either of these explanations is consistent with a large negative autocorrelation in prices for individual sales after short holding periods and essentially no autocorrelation in prices for individual sales after moderate or long holding periods.

Panel C reports the variance components and other parameters. The overall regression for each of the eight regions explains roughly three-fourths of the variation in housing prices. As indicated in Panel C, about three-quarters of this residual variation represents unmeasured dwelling-specific effects. Only about six percent of the variation in housing prices is unrelated to housing attributes or the timing of sales. Also reported in Panel C are the estimated capitalization rates (discussed above) and the estimated effect of vintage. According

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9 For dwellings sold more than once, the average elapsed time between sales is about 5 years.

to the estimates, there is a small positive vintage effect -- ceteris paribus new houses are more valuable. Again, many of the conventional aspects of vintage are measured explicitly in the data. The unmeasured vintage-related aspects of dwellings in this sample are probably quite subtle -- the layout of rooms and stairways, for example.

V. DISCUSSION

Figures 2 and 3 summarize the price indexes derived from this analysis. They present the estimated selling price of a typical urban house (one with the average characteristics of houses sold in Stockholm) in each of the eight regions during the 1981 - 1993 period. The course of housing prices throughout the country was roughly similar in different regions during the period -- prices were flat in nominal terms through 1986, rose sharply through 1991, and were in free fall throughout the rest of the sample period. The figures reveal substantial regional deviations from this general trend. In particular, prices in the Stockholm region have been more volatile than prices in other regions. In 1981 the Stockholm price level was twice the price level in Region III; at the peak in the first quarter of 1991 that ratio was 2.8, and in the second quarter of 1993 it was down at 2.3.

Explanations for the price development may be sought in fundamentals such as household disposable income and the tax and subsidy system (Jaffee, 1994, Englund, Hendershott, and Turner,

Figure 2
House Price Indexes for Sweden
Regions I - IV

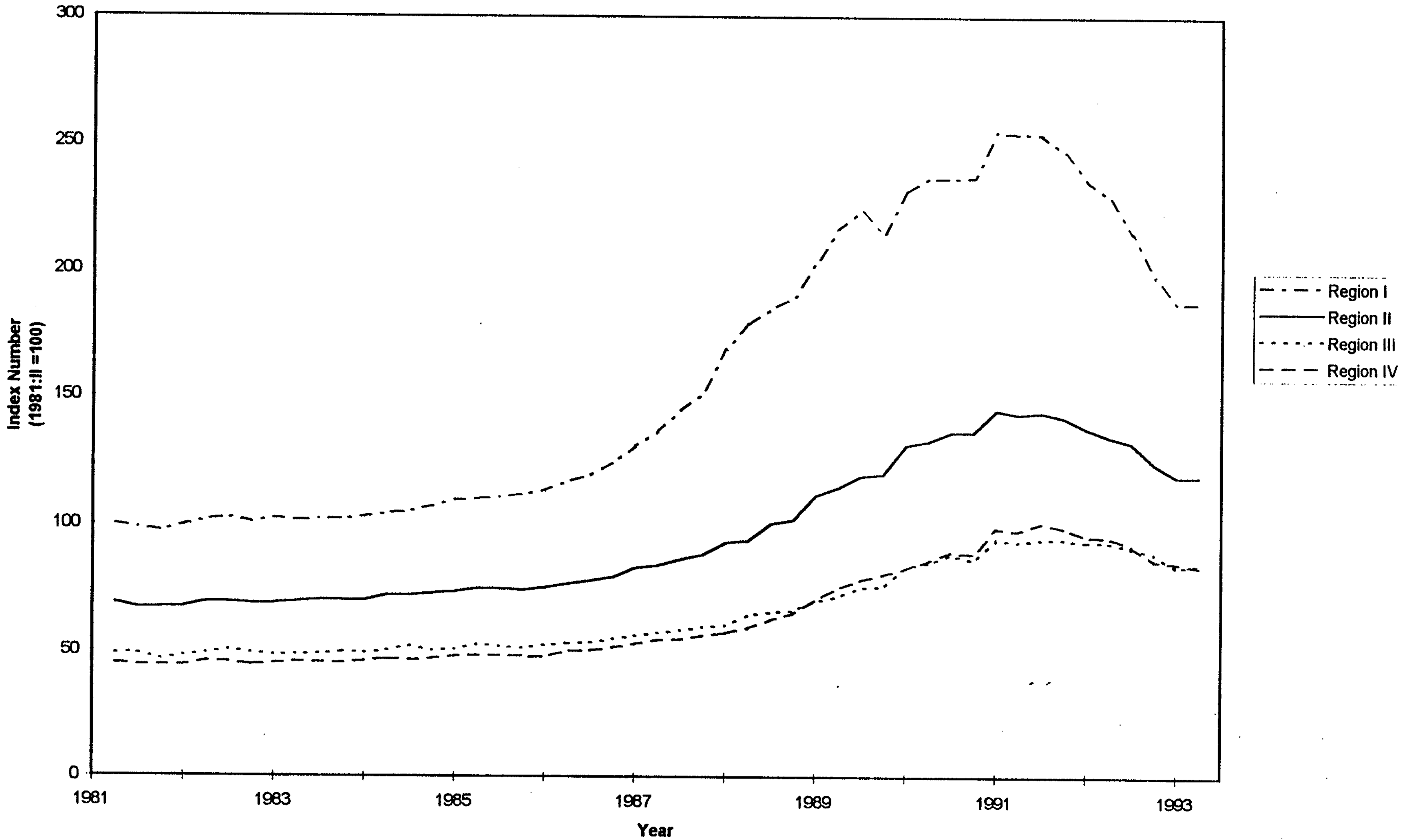
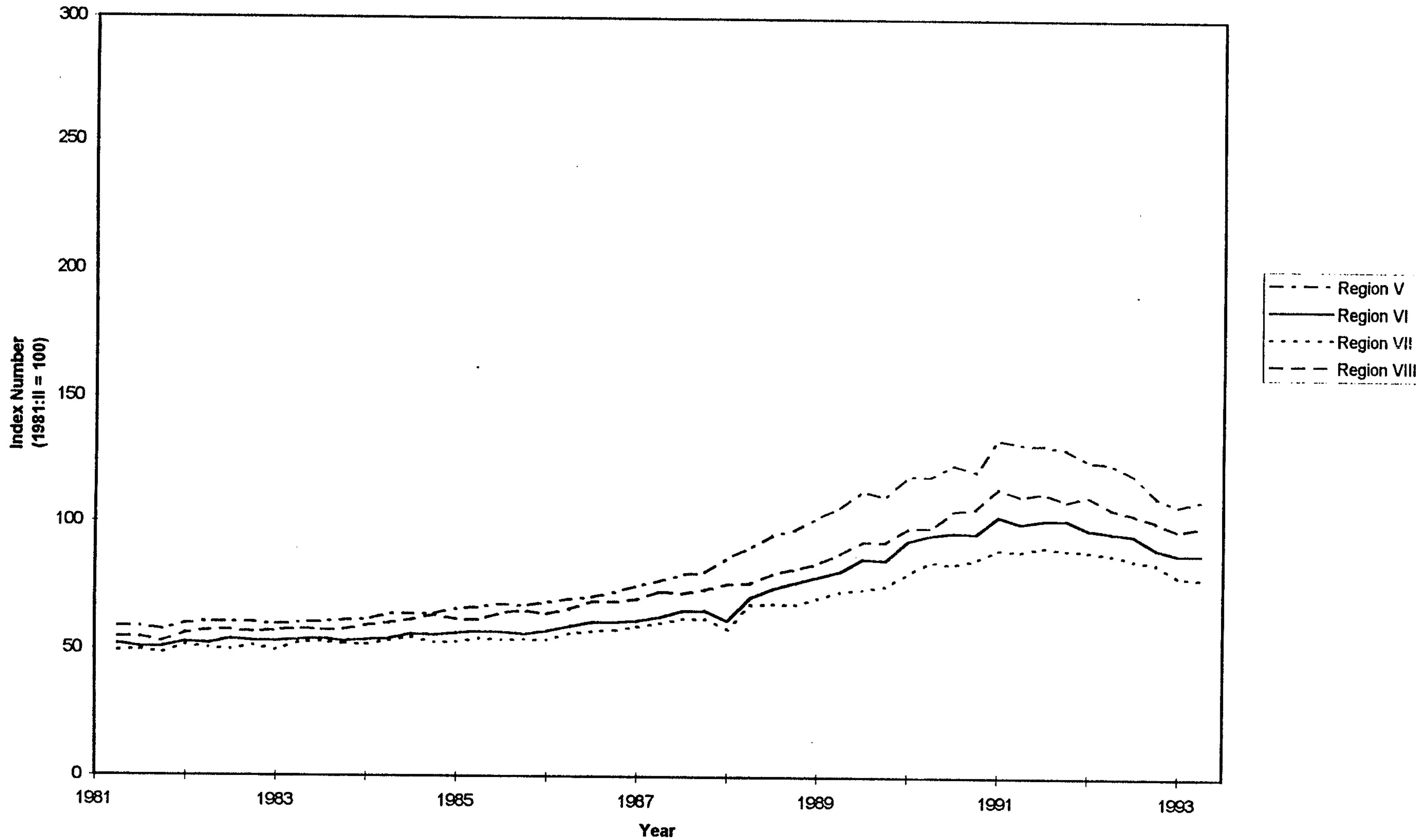


Figure 3
House Price Indexes for Sweden
Regions V - VIII



1995a and Hort, 1995). Sweden entered the 1980's with towering budget deficits and switched to a more restrictive fiscal and monetary policy in 1981. Simultaneously, a tax reform, implemented gradually between 1982 and 1985, reduced the tax subsidies provided to owner-occupiers. After 1985, house prices started to rise again, partly driven by a more lax fiscal policy. A further stimulus to housing demand was the deregulation of the credit market beginning in 1985. Finally, a major tax reform cutting the marginal tax rate on interest deductions from 50 to 30 percent was announced in 1989 and implemented in 1991. Beginning in that year, prices fell in nominal terms (for the first time since World War II). Again several factors coincide: the tax reform, a major depression with a five percent decline in real GDP from 1990 to 1993, and sharply increasing real interest rates resulting from a disinflationary monetary policy.

It is possible to compare the price indexes developed here with the official index published by Statistics Sweden (SCB).[10] Before 1986, the SCB index is only available annually, and the differences between SCB indexes and our indexes are small. There is some tendency in each of the regions for our index series to be leading relative to that of SCB. In Table 4 we summarize some

[10] The SCB index is constructed using the assessed value of properties (presumably a hedonic relation based on expertise and judgment). Within each region, SCB divides all dwellings into twelve classes according to assessed value for tax purposes. The price index is constructed as a weighted average of the mean sales prices in the different assessed-value classes. The weights are given by the fraction of all properties (not just those transacted) within a particular size class.

Table 4

Comparisons of Quarterly Percentage Changes in Housing Prices for EQR and SCB Indexes

1986:I-1993:II

	Mean		Variance		Serial correlation coefficient	
	EQR	SCB	EQR	SCB	EQR	SCB
Region						
I	0.0187	0.0163	0.0023	0.0023	0.6313**	0.7013**
II	0.0165	0.0157	0.0013	0.0012	0.4033*	0.5483**
III	0.0171	0.0164	0.0012	0.0010	0.1740	0.4353*
IV	0.0201	0.0192	0.0014	0.0013	0.4840**	0.6363**
V	0.0174	0.0163	0.0016	0.0015	0.2758	0.5032**
VI	0.0158	0.0150	0.0018	0.0012	0.1306	0.1868
VII	0.0140	0.0117	0.0017	0.0008	0.0380	0.4680*
VIII	0.0158	0.0151	0.0011	0.0012	0.1601	0.2289

Notes:

* significant at the 5 percent level

** significant at the 10 percent level

key statistics of the two series for the eight regions. Over the whole period we find prices increasing somewhat faster in each region according to our methodology ("the EQR index") than according to the SCB index. The variances are very similar for the two series, with the exception of two of the smaller regions (VI and VII).

An important use of housing price indices has been to analyze the predictability of investment returns. Case and Shiller (1989) and others find strong evidence of positive serial correlation for U.S. metropolitan areas, and Englund and Ioannides (1996) document the same pattern in nationwide price data (of varying quality) for a number of OECD-countries. Here we find less evidence of (first order) serial correlation according to our index than according to official statistics. While the SCB index exhibits significant positive serial correlation (at the ten percent level) in six of the eight regions, ours is significant in only three regions. The average point estimate of the serial correlation coefficient using the techniques developed in this paper is 0.29 compared with an average of 0.46 for the official SCB index. These differences suggest that the way we estimate price indexes may be crucial for any conclusions about the efficiency of housing markets.

VI. CONCLUSION

This paper introduces an improved methodology, combining cross sectional and panel data, for estimating asset prices for durables such as residential housing. The method distinguishes between the effects of observable and unobservable aspects of quality and between the effects of depreciation and vintage upon asset prices. The method also investigates price dynamics at the level of individual house sales.

The model is used to analyze the structure of housing prices in Sweden by investigating a rich body of data on all house sales in the country during a twelve year period. The empirical estimates confirm the importance of a host of quality and amenity measures in determining housing prices, the independent effects of depreciation and construction vintage, and the capitalization of interest rate subsidies. The results also suggest that unusually short turnover periods between sales of any house are associated with atypical price movements -- reflecting distressed sales or uninformed initial offer prices.

Observable housing characteristics explain roughly three quarters of the variation in housing prices in this rich sample of transactions. Another 19 percent of the variation in prices arises from unmeasured individual-specific variation, leaving only about six percent unaccounted for.

Price indexes for housing assets computed from these regressions reveal a similar pattern of price development across regions during the sample period -- generally stable prices through 1987, followed by a roller coaster ride -- with a peak in 1991 and free fall thereafter.

A comparison of these indexes with those published officially reveal some differences. The indexes produced by the methods outlined in this paper show slightly higher average changes in quarterly prices and substantially lower serial correlation in quarterly prices. They also suggest that returns are less predictable -- and the market is more efficient -- than is revealed in official statistics.

Appendix Table A1
Estimates of Equation (6) based on all Multiple Sales
Dependent Variable: Logarithm of Selling Price

	Region							
	I	II	III	IV	V	VI	VII	VIII
Size:								
interior size *	0.503	0.516	0.537	0.577	0.491	0.508	0.506	0.527
(sq. meters)	(87.76)	(105.42)	(68.31)	(86.31)	(95.52)	(75.49)	(42.08)	(43.70)
parcel size *	0.026	0.025	0.419	0.021	0.327	0.037	0.023	0.243
(sq. meters)	(8.79)	(8.93)	(7.04)	(5.81)	(11.09)	(9.33)	(3.61)	(3.22)
one car garage	0.004	0.028	0.027	0.003	0.013	0.063	0.087	0.100
(1 = yes)	(1.23)	(8.06)	(5.00)	(0.81)	(4.03)	(13.77)	(10.78)	(10.61)
two car garage	0.090	0.077	0.085	0.048	0.085	0.106	0.132	0.135
(1 = yes)	(11.89)	(13.11)	(8.74)	(5.03)	(12.61)	(13.08)	(8.21)	(10.07)
Amenity:								
tile bath	0.061	0.028	0.040	0.077	0.061	0.050	0.019	0.029
(1 = yes)	(12.87)	(5.97)	(5.44)	(14.33)	(13.20)	(7.48)	(1.58)	(2.41)
sewer connection	0.177	0.168	0.254	0.242	0.105	0.102	0.246	0.131
(1 = yes)	(10.96)	(13.51)	(12.83)	(16.84)	(9.57)	(5.38)	(6.32)	(2.85)
sauna	0.043	0.064	0.101	0.112	0.075	0.076	0.084	0.081
(1 = yes)	(11.20)	(18.42)	(16.90)	(18.51)	(18.44)	(14.87)	(9.72)	(11.51)
stone/brick	0.009	0.036	0.046	0.053	0.044	0.048	0.048	0.065
(1 = yes)	(2.53)	(11.99)	(9.15)	(12.79)	(12.57)	(10.15)	(5.29)	(7.82)
single detached	0.080	0.060	0.073	-0.031	0.053	0.066	0.044	0.033
(1 = yes)	(17.18)	(13.91)	(9.23)	(4.71)	(10.61)	(9.99)	(4.02)	(2.92)
finished basement	0.063	0.122	0.118	0.073	0.090	0.111	0.109	0.101
(1 = yes)	(14.66)	(31.41)	(19.39)	(12.06)	(21.68)	(19.87)	(11.81)	(11.19)
fireplace	0.102	0.069	0.052	0.113	0.093	0.068	0.055	0.083
(1 = yes)	(28.07)	(22.55)	(11.10)	(24.97)	(28.05)	(16.69)	(7.49)	(11.46)
laundry room	0.010	0.057	0.083	0.075	0.061	0.062	0.097	0.080
(1 = yes)	(2.35)	(14.41)	(12.69)	(13.93)	(14.38)	(12.17)	(10.39)	(8.48)
waterfront location	0.362	0.184	0.224	0.304	0.169	0.217	0.013	0.060
(1 = yes)	(16.20)	(9.36)	(7.40)	(9.62)	(6.42)	(11.45)	(0.46)	(1.99)

Quality:								
year built	-0.002	0.003	0.003	0.003	0.003	0.003	0.005	0.004
(19xx)	(16.21)	(31.58)	(22.79)	(28.82)	(28.63)	(26.13)	(20.63)	(17.47)
insulation;								
walls only	0.071	0.083	0.075	0.086	0.030	0.023	-0.076	0.080
(1 = yes)	(2.81)	(4.79)	(4.24)	(5.85)	(2.30)	(0.98)	(1.61)	(1.46)
walls and windows	0.125	0.113	0.138	0.149	0.081	0.071	-0.010	0.124
(1 = yes)	(4.91)	(6.40)	(7.28)	(9.42)	(5.91)	(2.88)	(0.21)	(2.23)
kitchen;								
good	0.250	0.155	0.147	0.104	0.165	0.138	0.107	0.315
(1 = yes)	(11.23)	(11.76)	(8.42)	(5.68)	(11.94)	(8.50)	(3.91)	(8.04)
excellent	0.278	0.234	0.255	0.214	0.243	0.236	0.232	0.447
(1 = yes)	(12.40)	(17.41)	(14.28)	(11.46)	(17.26)	(14.27)	(8.35)	(11.31)
heating system;								
electric radiator	0.048	0.153	0.183	0.161	0.267	0.242	0.333	0.141
(1 = yes)	(1.14)	(7.31)	(7.07)	(7.01)	(11.31)	(9.29)	(6.79)	(1.63)
electric furnace	0.083	0.212	0.238	0.261	0.340	0.246	0.398	0.207
(1 = yes)	(1.98)	(9.94)	(8.69)	(10.96)	(14.14)	(9.22)	(7.93)	(2.39)
solar/other	0.066	0.140	0.184	0.169	0.273	0.229	0.337	0.127
(1 = yes)	(1.57)	(6.68)	(7.02)	(7.33)	(11.52)	(8.76)	(6.84)	(1.46)
exterior steam	0.029	0.332	0.207	0.370	0.293	0.218	0.401	0.168
(1 = yes)	(0.69)	(15.58)	(7.44)	(15.26)	(11.87)	(7.99)	(7.54)	(1.91)
other central heat	0.076	0.187	0.278	0.215	0.255	0.257	0.412	0.119
(1 = yes)	(1.80)	(8.28)	(9.34)	(8.07)	(10.45)	(8.89)	(7.83)	(1.28)
wood burning stove	0.058	0.077	0.107	0.039	0.180	0.209	0.261	-0.018
(1 = yes)	(1.30)	(3.43)	(3.71)	(1.33)	(7.08)	(7.49)	(4.87)	(0.20)
roof;								
cement/steel	0.048	0.013	0.011	0.032	0.030	0.017	0.039	0.018
(1 = yes)	(14.11)	(3.87)	(1.96)	(7.80)	(8.41)	(3.75)	(5.48)	(2.55)
slate/copper	0.103	0.024	-0.108	0.023	0.063	-0.014	0.038	-0.038
(1 = yes)	(6.78)	(1.80)	(5.20)	(1.53)	(4.98)	(0.77)	(1.13)	(1.18)

Other: **								
distance to center	-0.008	---	---	---	---	---	---	---
(kilometers)	(34.56)							
urban area	0.158	0.054	0.055	0.118	0.069	0.055	0.104	0.126
(1 = yes)	(28.59)	(13.69)	(8.24)	(23.79)	(16.99)	(9.98)	(12.11)	(14.95)
capital subsidy	1.297	1.667	2.756	1.775	1.398	2.078	1.129	0.582
(millions of SEK)	(5.96)	(7.52)	(7.24)	(5.47)	(6.02)	(6.48)	(2.25)	(1.16)
intercept	9.943	9.119	7.532	8.419	8.415	8.889	8.614	7.699
	(180.60)	(250.13)	(38.65)	(178.97)	(87.25)	(163.88)	(85.65)	(30.04)
R^2	0.766	0.753	0.740	0.732	0.754	0.738	0.763	0.696
number of transactions	27166	38483	18172	32742	41212	22179	8802	11597
number of dwellings	11960	16090	8045	14230	18040	9428	3740	5014

Notes:

t-ratios are in parentheses. Model also includes 50 dummy variables, P_t, representing quarter of sale (not reported).

* - variable measured in logarithms.
** - model also includes separate intercepts and distance variable for each of 111 labor market areas (not reported). Region I, Stockholm, is considered a single labor market area.
*** - model also includes dummy variables for used dwellings sold at ages less than ten years.

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