Chapter 5

A RENTAL EQUIVALENCE INDEX FOR OWNER OCCUPIED HOUSING IN WEST GERMANY

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1. Introduction

Determining the appropriate treatment in official economic statistics of owner occupied housing (OOH) services is a complex problem.[2] Besides the heterogeneity of residential structures and the importance of location, their long lived nature causes difficulties.[3] In the context of a cost-of-living index, the traditional acquisitions approach, which does not differentiate between the period of purchase and the period of consumption, does not seem to be satisfactory.[4] Instead, a distribution of the initial cost of purchase over the life of the residential structure or the expected period of ownership seems called for. Period specific user costs are the theoretically implied solution to this inter-temporal distribution problem. However, user costs have proved problematical to compute. If there is a well developed rental market that is not distorted by taxes, rents can be viewed as representing the opportunity costs for owners of living in the homes they own.[5] This line of reasoning suggests that the use of data on actual rents for

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[2] On this issue, see Blinder (1980) and Blackley and Follain (1995). See also Gillingham (1983).

[3] For an authoritative discussion of the problems at hand and alternative approaches, see Triplett (2001), Diewert (2003) and ILO et al. (2004, chapter 23). See also Diewert and Nakamura (2009) in this volume.

[4] However, if the purpose of the CPI is more restricted as for the European Harmonised Index of Consumer Prices (HICP), an acquisitions approach may be considered to be appropriate. See, for example, Leifer (2001).

[5] Darrough (1983), however, argues that rents and user costs are inherently different because of the distortions caused by taxes. Ayuso and Restoy (2003) report substantial but temporary deviations of property prices from rents and vice versa with the dynamics of the rental prices generally found to be smoother. Schulz and Werwatz (2004) find that rents in the German capital of Berlin reacted more slowly to changing market conditions than house prices. Verbrugge (2008) and Garner and Verbrugge (2009) also observe that user costs are more volatile than rents, and furthermore that for the period of 1978 to 2001, U.S. rents and user costs do not appear to share a common trend.

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W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009),
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dwellings that closely match owner occupied dwellings in terms of characteristics is a suitable alternative to directly calculating user cost measures.

The importance of owner occupied housing in Germany is less than in most other industrialised economies.[6] Nevertheless, more than 40% of households live in their own residential properties. In the German consumer price index (CPI), as in the U.S. CPI, actual rents are used for the imputation of the cost of owner occupied housing, which is done by increasing the relative weight of the rent subindex. Approximating the costs of owner occupied housing by means of the rent index is said to be a valid method for Germany because the German housing market is lightly regulated, the tax system is not severely distorting and the share of rental housing is quite substantial.[7] However, the distribution of types of owner occupied housing differs substantially from that for rental housing. In Germany, rental housing typically takes the form of flats in apartment buildings, whereas single family houses and terraced houses predominate in the owner occupied segment. Only a restricted sample of dwelling types are used for the rent sample for the official German CPI. Price trends might differ between various segments of the housing market, creating a potential for bias. Given the substantial weight of housing, any bias in the housing component raises concerns about the accuracy of the total CPI.

For assessing the appropriateness of the German rental equivalence imputation method, we estimate alternative indexes of the costs of owner occupied housing using the German Socio Economic Panel (GSOEP). The GSOEP is a yearly household panel that reports on housing conditions in Germany including actual rents for renters. Each owner is asked to estimate the monthly rent they would need to pay to rent their own dwelling. This is a promising strategy for obtaining rental equivalents provided that owners have a good knowledge of market conditions.

We assess the quality of owner estimates of rental equivalents by estimating separate hedonic functions for rents and for rental equivalents and then comparing the estimated coefficients for the functions. The estimation strategy follows our companion paper on dwelling rents (Hoffmann and Kurz 2002). We find, in general, that the estimated coefficients do not differ significantly between rental and owner occupied housing. This finding implies that the variation in the marginal valuation of characteristics across markets, and between actual rents and reported rental equivalents, is not significant. This, in turn, implies that it is reasonable to use the estimated hedonic functions as a basis for the compilation of price indexes for OOH.

In section 2, we describe the peculiarities of the subindex for housing in the German CPI. In section 3, the German Socio Economic Panel (GSOEP) is introduced. In section 4, a hedonic analysis is performed of rental equivalents and actual rents as reported in the GSOEP. The hedonic functions from which the quality adjusted price indexes are derived are estimated for each period separately to allow for changing relative prices of characteristics. We calculate fixed based traditional Laspeyres and superlative indexes. In section 5, we discuss alternative indexes for owner occupied housing based on rental equivalents. Section 6 merges our new findings with those of our previous paper on the developments of actual rents. Section 7 concludes.[8]

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[6] See the European Central Bank (2003).

[7] For a comparative analysis of European housing markets, see European Central Bank (2003).

[8] In some respects, our paper resembles Arévalo and Ruiz-Castillo (2006). They discuss the feasibility of the rental equivalence approach in the context of the Spanish housing market that is dominated by owner occupied housing. However, the Arévalo and Ruiz-Castillo study uses cross sectional data whereas we have panel data. Also, they use a procedure due to Heckman (1979) to allow for the interdependence of tenure mode and housing characteristics.

2. The Housing Subindex of the Official German CPI

The official German CPI subindex for housing covers rental and owner occupied housing.[9] For the German CPI (as for the U.S. CPI), the price component for owner occupied dwellings is currently produced using the index for rents.[10] The rent index itself is calculated as a matched models index. Quality adjustments are performed only when major renovations take place. No adjustments are made for the creeping changes in quality that stem from wear and tear. As no adjustments are made for ongoing maintenance investments either, the hope is that, on average, these omissions cancel out. In regions with substantial construction activity, the matched models sample is supplemented with data on new dwellings, for which rudimentary quality adjustments for differences in size are performed.

For the German CPI, rent data are collected for a restricted selection of dwelling types: three narrowly defined types of apartments from the privately financed segment of the market, and three from the subsidised segment. Only three and four room apartments are covered, so single and two room flats and also single family and terraced houses are missing.

The relative weight of owner occupied housing, which is not published separately, is derived from the share of rental equivalents in household consumption expenditures as estimated for the national accounts. This practice results in more than doubling the weight of the subindex for rented flats in the German CPI to take account of owner occupied housing. This reflects the fact that larger proportions of the owner occupied dwellings are of higher priced types.[11]

The German imputation practice implicitly assumes that the housing cost dynamics are similar for rented and owner occupied dwellings. This could be misleading.[12] Firstly, the distribution of owner occupied dwellings by type differs substantially from that of rental dwellings. This is especially a worry in the German case as the subindex for rents in the CPI is based on a very restricted list of dwelling types (given at the left in table 1). Furthermore, the regulation of the rental market and the differences in taxation could introduce biases.[13]

[9] For details, see Hoffmann and Kurz (2002).

[10] However, the German CPI rent index is derived from a dwelling sample and not a renter sample, and since prices at the lower level are aggregated by means of a Dutot index, it is not prone to the non-response-bias described by Crone, L.I. Nakamura and Voith (2001).

[11] In 1985, in the national accounts, West German actual rents amounted to 37 billion euro and estimated rental equivalents to 42 billion euro. In 1991, the corresponding figures were 50 and 59 billion euro.

[12] For further discussion in the context of the U.S. CPI, see Crone, L.I. Nakamura and Voith (2000, 2008, 2009).

[13] On these issues, see Hoffmann and Kurz (2002) and the European Central Bank (2003).

Table 1. Dwelling Types in the German CPI

Dwelling type	CPI expenditure weights (including imputed rent for owner occupied dwellings) as a % in the base year: 1985	1991	1995
All dwelling types	177.77	191.93	185.02
Privately financed apartments	143.99	163.45	166.33
3 room apartment (including kitchen), with bathroom, furnace heating, built by 1948	3.91	2.96	3.89
3 room apartment (including kitchen), with bathroom, furnace heating, built by 1948	16.71	12.15	35.53
4 room apartment (including kitchen), with bathroom, central heating, built after 1948	123.37	148.34	126.91
Subsidised apartments, built after 1948	33.78	28.48	18.69
3 room apartment (including kitchen), with bathroom, furnace heating	5.51	5.03	1.30
3 room apartment (including kitchen), with bathroom, central heating	28.27	18.91	13.13
4 room apartment (including kitchen), with bathroom, central heating	---	4.54	4.26

3. Owner Occupied Housing in the German Socio-Economic Panel (GSOEP)

The GSOEP is an annual household panel that assembles information about living and working conditions in Germany.[14] Among other information, the GSOEP reports major physical and locational characteristics of dwellings, rents actually paid by households, and rental equivalents as estimated by owners. The panel started in 1984 with nearly 6,000 households, 65% of which were tenants and 35% owners.

In the GSOEP, owners are asked: “And if you lived in this flat or house as a tenant: what do you estimate would be the monthly rent without heating costs?” The wording implies that the equivalent rents reported in the GSOEP include some housing related expenses such as water supply and refuse collection. Up until 1998, the same was true of the rents collected for the compilation of the German CPI. Since 1998, however, rent data for the CPI excludes any additional expenses. As we want to compare the development of rental equivalents in the GSOEP to the rent measure in the CPI, this analysis is restricted to rented and owner-occupied dwellings in West Germany for 1985 to 1997.[15]

[14] For a detailed description of the GSOEP, see the SOEP Group (2001). Foreigners are deliberately oversampled.

[15] In 1990, the coverage of the GSOEP was extended to East Germany. However, most dwellings in East Germany were still state-owned. Rents were adjusted towards market values in phases. Owner occupied housing was marginal, and even at the end of the 1990s, the share of owner occupied housing was substantially below western levels. Also, in estimating the hedonic equations, an enlargement of the sample in 1998 was found to cause difficulties.

Sampling weights are provided together with the GSOEP. Estimates based on weighted GSOEP data can be regarded as approximately representative of Germany. All figures and results reported in this study are derived from the weighted sample.[16]

Although the focus in this paper is on dwellings rather than households, we cannot generate a true dwellings panel from the GSOEP. In the case of a move, the GSOEP follows the household. For the period under review, we observe a total of 10,000 different households, but 14,000 different dwellings. The greater number of dwellings reflects household moves.

A comparison of the structure of the housing expenditure shares in the GSOEP with that of the German CPI basket reveals that while nearly 40% of the rental expenditures reported in the GSOEP are for types of dwellings that correspond to CPI specifications, this is the case for less than 15% of the estimated rent expenditures for owner occupied housing, as can be seen from the second row of figures in table 2. This finding raises some doubts about the suitability of the CPI sample for the imputation of housing costs for owner occupied housing.

A closer look at the structure of rental and owner occupied housing (tables 3a and 3b) reveals that renters predominately live in apartment buildings whereas single family and terraced houses are the most common dwelling types for owners. There are further differences in the structure of rental and owner occupied housing. Owner occupied dwellings are on average larger and (slightly) better equipped than rented ones.[17] Owners also live more often in dwellings built after 1971. Rental housing is predominately located in big cities, whereas ownership is more evenly spread across various types of places of residence.

There are striking differences in the mobility of renters and owners. Between 6% and 11% of the renters move into the sample each year, whereas the corresponding figure for owners is less than 1%.[18] The average occupancy duration in owner occupied housing is almost twice as high as for rented dwellings.

However, even though the distribution of types of rental housing clearly differs from that of owner occupied housing, there are some important overlaps. About one fifth of renters live in single family or terraced houses, and about one fifth of owners live in flats. The quite substantial standard deviations for size for rented and owner occupied dwellings imply that there is no strict delineation of owner occupied and rental housing in terms of size. Also, we find both forms of tenure in all locations.

[16] When extracting the housing sample from the GSOEP, we found evidence of misreporting. For some dwellings, the reported occupancy duration is not consistent with the vintage. Also, some rents and rental equivalents seem to be excessively volatile. We used the panel structure of the data and developed procedures for deciding whether to keep observations and for adjusting inconsistent data. For a more detailed description of the adjustments made, see Hoffmann and Kurz (2002). About 1% of the observations each year were adjusted.

[17] The list of amenities reported in the GSOEP is a bit outdated since, as long ago as the 1980s, nearly all dwellings had a kitchen, a bathroom and a toilet. A cellar was available in more than nine out of ten dwellings. Substantial differences can be found only for central heating, galleries and gardens.

[18] These figures do not include those households that enter the sample after having moved recently or those households that were not contacted successfully by the GSOEP in the year immediately following the move.

Table 2. Housing as a Percentage of Household Expenditures

Dwelling type	1985	1991	1997
Owner occupied dwellings: all	**50.0**	**55.0**	**52.0**
Owner occupied dwellings, by type:			
Dwellings included in the CPI specifications	**11.0**	**13.1**	**12.9**
3 room apartment (including kitchen), without bathroom, furnace heating, built by 1948	0.1	0.0	0.0
3 room apartment (including kitchen), with bathroom, central heating, built by 1948	0.8	0.2	0.1
4 room apartment (including kitchen), with bathroom, central heating, built after 1948	10.1	12.9	12.8
Other dwellings	89.0	86.9	87.1
Rented dwellings: all	**50.0**	**45.0**	**48.0**
Rented dwellings, by type:			
Privately financed dwellings	**74.9**	**78.9**	**82.9**
Dwellings included in the CPI specification	**24.0**	**25.9**	**26.3**
3 room apartment (including kitchen), without bathroom, furnace heating, built by 1948	0.6	0.1	0.0
3 room apartment (including kitchen), with bathroom, central heating, built by 1948	4.6	5.7	4.3
4 room apartment (including kitchen), with bathroom, central heating, built after 1948	18.8	20.1	22,0
Other dwellings	51.0	53.0	56.6
Subsidised dwellings, built after 1948	**25.1**	**21.1**	**17.1**
Dwellings including in the CPI specification	**15.3**	**13.9**	**11.8**
3 room apartment (including kitchen), with bathroom, furnace heating	0.8	0.9	0.3
3 room apartment (including kitchen), with bathroom, central heating	5.3	5.1	4.4
4 room apartment (including kitchen), with bathroom, central heating	9.2	7.9	7,1
Other apartments	9.9	7.2	5.3

Note: Housing expenditure includes imputed rent for owners. All calculations use weighted GSOEP data.

Over the period covered, both rented and owner occupied dwellings became somewhat larger, slightly better equipped and more modern. The average size of dwellings increased by about 8% for rental units and by 13% for owner occupied dwellings. Throughout the period under review, the locational distribution of dwellings did not change much.

In each year, estimated equivalent rents were higher than actual rents, both in absolute terms and per square meter. Up to 1992, the equivalent rents also increased substantially faster than actual rents. In the years following 1992, the increase in actual rents was strong whereas the estimated equivalent rents nearly stagnated, albeit at a high level. Over the full period, these differences nearly cancel out and both the mean of the actual rents and the mean of the estimated equivalent rents (per square meter) go up by about 70%, or 4½% per year.

Table 3a. Characteristics of Dwellings in the 1985 GSOEP

	Rented		Owner occupied	
Variable	**Mean**	**Std dev**	**Mean**	**Std dev**
Rent (DM)	438.2	206.8	743.1	376.8
Occupancy duration (years)	10.9	11.3	22.4	17.6
Subsidised apartment	0.27	0.44		
Physical characteristics				
Vintage				
Built 1918 or earlier	0.14	0.35	0.20	0.40
Built between 1918 and 1948	0.21	0.41	0.16	0.37
Built between 1949 and 1971	0.49	0.50	0.40	0.49
Built 1972 or later	0.16	0.37	0.24	0.43
Built between 1972 and 1980				
Built between 1981 and 1990				
Built 1991 or later				
Size (square meters)	66.7	24.8	104.8	37.8
Furnishing				
Kitchen	0.98	0.14	1.00	0.00
Bathroom	0.95	0.22	0.98	0.14
Toilet	0.97	0.17	0.98	0.14
Central heating	0.78	0.41	0.84	0.37
Cellar	0.93	0.26	0.97	0.17
Gallery	0.60	0.49	0.76	0.43
Garden	0.26	0.44	0.88	0.32
Property type				
Farm house or other	0.01	0.10	0.07	0.26
Single family houses	0.09	0.29	0.45	0.50
Terraced house	0.08	0.27	0.30	0.46
Apartment house (3-8 flats)	0.57	0.50	0.13	0.34
Apartment house (more than 8 flats)	0.22	0.41	0.04	0.20
Multi storey building	0.03	0.17	0.00	0.00
Locational characteristics				
Type of quarter				
Residential area	0.65	0.48	0.75	0.43
Downtown district	0.01	0.10	0.00	0.00
Industrial area	0.00	0.00	0.00	0.00
Mixed area	0.32	0.47	0.21	0.41
Other	0.02	0.14	0.03	0.17
Conurbation type (inhabitants)				
500,000 and more (central area)	0.48	0.50	0.15	0.36
500,000 and more (other area)	0.13	0.34	0.19	0.39
100,000 - 500,000 (central area)	0.11	0.31	0.08	0.27
100,000 - 500,000 (other area)	0.04	0.20	0.08	0.27
50,000 - 100,000	0.03	0.17	0.02	0.14
20,000 - 50,000	0.06	0.24	0.09	0.29
5,000 - 20,000	0.10	0.30	0.21	0.41
2,000 - 5,000	0.03	0.17	0.10	0.30
Less than 2,000	0.01	0.10	0.08	0.27
State				
West Berlin	0.08	0.27	0.01	0.10
Baden-Württemberg	0.12	0.32	0.18	0.38
Bavaria	0.15	0.36	0.20	0.40
Bremen	0.02	0.14	0.01	0.10
Hamburg	0.05	0.22	0.01	0.10
Hesse	0.09	0.29	0.10	0.30
Lower Saxony	0.10	0.30	0.13	0.34
North Rhine-Westphalia	0.30	0.46	0.20	0.40
Rhineland-Palatinate / Saarland	0.05	0.22	0.10	0.30
Schleswig-Holstein	0.03	0.17	0.06	0.24

Table 3b. Characteristics of Dwellings in the 1997 GSOEP

	Rented		Owner occupied	
Variable	Mean	Std dev	Mean	Std dev
Rent (DM)	776.8	375.6	1365.9	591.9
Occupancy duration (years)	10.8	11.6	19.0	17.6
Subsidised apartment	0.20	0.40		
Physical characteristics				
Vintage				
Built 1918 or earlier	0.09	0.29	0.16	0.37
Built between 1918 and 1948	0.17	0.38	0.09	0.29
Built between 1949 and 1971	0.45	0.50	0.31	0.46
Built 1972 or later	0.29	0.45	0.45	0.50
Built between 1972 and 1980	0.15	0.36	0.22	0.41
Built between 1981 and 1990	0.06	0.24	0.12	0.32
Built 1991 or later	0.08	0.27	0.11	0.31
Size (square meters)	71.9	26.1	117.9	40.1
Furnishing				
Kitchen	0.99	0.10	1.00	0.00
Bathroom	0.99	0.10	0.99	0.10
Toilet	0.99	0.10	0.99	0.10
Central heating	0.90	0.30	0.96	0.20
Cellar	0.95	0.22	0.98	0.14
Gallery	0.66	0.47	0.89	0.31
Garden	0.31	0.46	0.89	0.31
Property type				
Farm house or other	0.02	0.14	0.07	0.26
Single family houses	0.12	0.32	0.42	0.49
Terraced house	0.08	0.27	0.29	0.45
Apartment house (3-8 flats)	0.54	0.50	0.15	0.36
Apartment house (more than 8 flats)	0.22	0.41	0.06	0.24
Multi-storey building	0.02	0.14	0.01	0.10
Locational characteristics				
Type of quarter				
Residential area	0.64	0.48	0.79	0.41
Downtown district	0.01	0.10	0.00	0.00
Industrial area	0.01	0.10	0.00	0.00
Mixed area	0.34	0.47	0.19	0.39
Other	0.01	0.10	0.01	0.10
Conurbation type (inhabitants)				
500,000 and more (central area)	0.50	0.50	0.20	0.40
500,000 and more (other area)	0.08	0.27	0.14	0.35
100,000 - 500,000 (central area)	0.11	0.31	0.09	0.29
100,000 - 500,000 (other area)	0.06	0.24	0.07	0.26
50,000 - 100,000	0.02	0.14	0.03	0.17
20,000 - 50,000	0.08	0.27	0.11	0.31
5,000 - 20,000	0.10	0.30	0.19	0.39
2,000 - 5,000	0.03	0.17	0.11	0.31
Less than 2,000	0.02	0.14	0.06	0.24
State				
West Berlin	0.07	0.26	0.01	0.10
Baden-Württemberg	0.13	0.34	0.19	0.39
Bavaria	0.16	0.37	0.19	0.39
Bremen	0.02	0.14	0.00	0.00
Hamburg	0.04	0.20	0.01	0.10
Hesse	0.08	0.27	0.06	0.24
Lower Saxony	0.10	0.30	0.14	0.35
North Rhine-Westphalia	0.32	0.47	0.26	0.44
Rhineland-Palatinate / Saarland	0.06	0.24	0.08	0.27
Schleswig-Holstein	0.03	0.17	0.06	0.24

4. Hedonic Analysis of Estimated Equivalent Rents

The analysis in section 3 reveals that estimated equivalent rents are higher than actual rents, and moreover that owner occupied dwellings on average are of higher quality than rented dwellings. Here we ask whether the higher level of the rental equivalents found in the GSOEP is related to micro level differences in quality. Furthermore, we investigate whether the valuation of characteristics differs between rental and owner occupied housing. The technique on which our analysis is based is the hedonic regression approach. In Hoffmann and Kurz (2002) we show that for rental housing, taking the logs of the dependent variable, rent, and the one continuous explanatory variable, size of the dwelling, and adding dummy variables for other characteristics, works well.[19] Here we use the same functional form for owner reported equivalent rent:

$$(3\text{-}1) \quad \ln \text{rent} = c_0 + c_1 \ln \text{size} + \sum_{i=2}^{n} c_i x_i + u,$$

where the dwelling traits are given by $X = (x_1, x_2, \ldots, x_i, \ldots, x_n)$ and u denotes an error term.

Using ordinary least squares, equation (3-1) was estimated separately for each year for renters (with actual rent), for owners (with equivalent rent), and for pooled renter-owner samples. The constant term gives the estimated rent for the baseline dwelling (without size effects). It is located in a residential area in the central district of a city of more than 500,000 inhabitants in North Rhine-Westphalia. The property is in an apartment house with up to eight flats, built before 1949. It is equipped with a bathroom/toilet, central heating, and a gallery or garden. It was privately financed, and the current household has been there for more than ten years. For most of the regressions, the Cook-Weisberg test showed evidence of heteroscedasticity. Thus, heteroscedasticity consistent robust standard errors were computed.

The occupancy duration that proved important in the Hoffmann and Kurz (2002) hedonic study of actual rents for rental dwellings is insignificant in the case of owner occupied housing. This means that the length-of-stay discounts found for rental housing either stem from unmeasured quality deterioration related to the length of occupancy, which does not take place in owner occupied housing, or the discounts are a consequence of the peculiarities of the landlord-tenant relationship. Here we drop the length-of-occupancy variable from the model.

Table 4 reports the regression results for the first and the last year in our sample.[20] The adjusted R squared values for owner occupied housing range from 0.43 to 0.56, and those for rented housing range from 0.53 to 0.65.[21] Most of the estimated coefficients are statistically significant and have the expected signs. Most parameter estimates are similar for rental and owner occupied dwellings. However, differences are evident in the valuation of different property types and for location.

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[19] The occupancy duration is split into several dummy variables to allow for non-linearity in tenancy discounts. Furthermore, the occupancy duration variables have been interacted with the dummy variable for social housing. For details, see Hoffmann and Kurz (2002).

[20] For a fuller exposition and discussion of the regression set-up and the results including the issues of flexibility of the functional form, interaction between variables, heteroscedasticity, multicollinearity, misspecification and missing variables, see Hoffmann and Kurz (2002).

[21] The R-squared values are, however, still larger than those reported by Crone, L.I. Nakamura and Voith (2000).

To test the statistical significance of the differences between the coefficients of rental and owner occupied housing, for a pooled sample covering both segments of the housing market, the explanatory variables were interacted with dummy variables for owner occupied dwellings and for rented housing.[22] We used Wald tests to determine the significance of differences in the influence of the characteristics on rents versus the rental equivalents. Statistically significant differences were found in some years for the size variable, the property type, and the location. For example, typically, the estimated elasticity of equivalent rents with respect to dwelling size is somewhat lower than that of actual rents. Also, for owners, we find that single and terraced houses are more valuable than flats in apartment buildings, whereas the opposite is found sometimes for rental dwellings. Perhaps the tenure choice is not fully separable from the decision about dwelling type. However, the differences in the estimated impacts of the characteristics for rents versus rental equivalents are mostly found to be insignificant. Whereas differences in marginal valuations tend to be quite small and restricted to a few characteristics, the overall dummy for owner occupied housing, in almost all periods, is statistically significant and greater than zero,[23] indicating a higher valuation of owner occupied housing even after controlling for differences in quality and the length of stay for renters. Heston and Nakamura (2009) suggest two reasons for this discrepancy that is also observed in U.S. data. The first is what they term the pride factor: owners may value distinctive features of their dwellings more than the market does.[24] Secondly, there might be unmeasured characteristics. As the GSOEP reports only a restricted number of characteristics, this could explain some of the observed differences.

In line with our earlier finding for rental units (Hoffmann and Kurz 2002), we find here too that quality adjusted rents are on average lower for existing contracts than for new ones. However, looking at our results for each of the nine years, we find that these discounts display a cyclical pattern. These phenomena are believed to be the result of the peculiarities of contracting on the rental market (Francois 1989).[25] Genesove (2003) reports U.S. evidence of nominal rent rigidity for sitting tenants. The difference between estimated rental equivalents and actual rents might result from a tendency of owners to form their ideas about what their homes would rent for on the basis of new rental contracts (Francois 1989).

Of course, if the hypothesis is true that owners tend to base their rental equivalent estimates on new rental contracts, then the (quality adjusted) estimated equivalent rents should mirror actual rents for new contracts closely. Francois (1989), in a study for the United States, found that while estimated equivalent rents were typically above the average level of actual rents, they were close to rents for new contracts. Figures on rents in new contracts derived from the GSOEP also give some support to this hypothesis. Rents in new contracts tend to be higher than those for sitting tenants, display a more cyclical pattern, and more nearly resemble the pattern for the estimated equivalent rents for owners.

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[22] Alternatively, a SUR estimator could be applied to take account of cross correlations in the regressions.

[23] It is only in 1985 and 1986 that the coefficient is not significantly different from zero.

[24] Linneman and Voith (1991) argue that many owners have a preference for homeownership. See also Goodman and Ittner (1992).

[25] In Germany, rents for sitting tenants generally can only be increased up to the level of rents for comparable dwellings in the vicinity. The level of rents for comparable dwellings is typically assessed by reference to a rent survey published by local authorities. The representative list of rents has to be compiled for new contracts and for contracts for which rents have been adjusted within four years. This means that rents for sitting tenants adjust to changing market conditions with a delay. See Hoffmann and Kurz (2002) and the European Central Bank (2003).

Table 4. Cross Section Hedonic Regressions

	1985		1997	
Variable	**Rented**	**Owner occupied**	**Rented**	**Owner occupied**
Constant	2.733[a]	2.983[a]	3.066[a]	4.031[a]
Physical characteristics				
Vintage				
Between 1949 and 1971	0.139[a]	0.072[a]	0.072[a]	0.062[c]
1972 or later	0.315[a]	---	---	---
Between 1972 and 1980		0.136[a]	0.136[a]	0.153[a]
Between 1981 and 1990		0.257	0.257[a]	0.176[a]
1991 or later		0.333	0.333[a]	0.248[a]
ln size (square meters)	0.772	0.776	0.809[a]	0.658[a]
Furnishing				
Without bathroom/toilet	-0.126[a]	-0.212	-0.212[a]	-0.352[a]
Without central heating	-0.226[a]	-0.156[a]	-0.156[a]	-0.116[b]
Without garden/gallery	-0.064[a]	-0.030	-0.030	-0.114
Property type				
Farm house or other	-0.097	-0.174	-0.174[a]	-0.094
Single-family house	-0.162[a]	-0.047[a]	-0.047	0.097[b]
Terraced house	-0.043	-0.061[a]	-0.061	0.127[a]
Apartment house (more than eight flats)	0.054[a]	0.009[a]	0.009	0.028
Multi-storey building	0.109[a]	0.083[a]	0.083[c]	0.105
Locational characteristics				
Type of quarter				
Downtown district	0.221[a]	0.013	0.013	0.093
Industrial area	-0.238	0.109	0.109	0.155
Mixed area	0.017	0.014[b]	0.014	-0.053c
Other	0.101	-0.052	-0.052	-0.081
Conurbation				
500,000 and more (other area)	-0.069[b]	-0.072[a]	-0.072[b]	-0.153[a]
100,000 to 500,000 (central area)	-0.140[a]	-0.171[a]	-0.171[a]	-0.135[a]
100,000 to 500,000 (other area)	-0.224[a]	-0.276[a]	-0.276[a]	-0.190[a]
50,000 to 100,000	-0.058	-0.206[a]	-0.206[a]	-0.205[a]
20,000 to 50,000	-0.210[a]	-0.130[a]	-0.130[a]	-0.249[a]
5,000 to 20,000	-0.290[a]	-0.280[a]	-0.280[a]	-0.263[a]
2,000 to 5,000	-0.256[a]	-0.293[a]	-0.293[a]	-0.297[a]
Less than 2,000	-0.289[a]	-0.553[a]	-0.553	-0.303[a]
State				
West Berlin	-0.095[a]	-0.040	-0.040	0.408[a]
Baden-Württemberg	0.032	0.125	0.125[a]	0.092[b]
Bavaria	0.030	0.095	0.095[a]	0.002
Hamburg/Bremen/ Lower Saxony/ Schleswig-Holstein	0.068[a]	0.116	0.116[a]	0.002
Hesse	0.046	0.109	0.109[a]	0.126[b]
Rhineland-Palatinate/ Saarland	-0.036	0.098	0.098[b]	-0.122[a]
Adjusted R-squared	0.58	0.55	0.62	0.62
Number of observations	2752	1552	2237	2237

Note: A superscript a, b or c indicates that, statistically, the coefficient is significantly different from zero at the 99, 95 or 90% level of confidence, respectively. Heteroscedasticity robust standard errors were used.

With our data, a formal test of the hypothesis proposed by Francois (1989) is not feasible since the number of new rental contracts in the GSOEP is too small. As an alternative, we define the baseline dwelling differently. Instead of referring to households with a length of stay of more than ten years, we re-estimate the hedonic model for a baseline household with an occupancy duration of up to two years. It turns out that the size of the estimated dummy for owner occupied housing shrinks. However, it stays statistically different from zero in nearly all years. Even after quality adjustments, there is, on average, a difference between the predicted rental equivalence and actual rents that can be only partly explained by the hypothesis that owners base the rental equivalence values they provide on the rents in new contracts. Still, in our view, these findings indicate that the owners' estimates of equivalent rents are, by and large, consistent with actual rents and that the markets for rental and owner occupied housing are interrelated in Germany.

Regarding the development over time, the estimated coefficients are quite stable, both for actual and equivalent rents. To test for stability, we pool the sample over adjacent periods and interact each regressor with a time dummy. A Wald test rejects the null hypothesis that the interactive terms are jointly significantly different from zero, implying that the parameter estimates can be regarded as stable over adjacent periods. For longer time spans, parameter stability is rejected; instead we find evidence of slow moving trends for some parameters.

5. Alternative Rental Equivalence Indexes for Owner Occupied Housing

In this section, we present various rental equivalence indexes for owner occupied housing. We start with non-hedonic indexes: both simple statistical measures and matched models indexes. We then compare the results to indexes that are quality adjusted using hedonic techniques. In this part of our study, we replicate the research approach of our study of actual rents (Hoffmann and Kurz 2002). All measures have been calculated using GSOEP weights, so they can be regarded as being approximately representative for West Germany.

As measured by the geometric mean, non-adjusted rental equivalents increased by 90%, or 5.5% per year, over the period under review (table 5). Equivalent rent per square meter increased at a substantially slower pace: 72% over the review period, or 4.6% a year.

Table 5. Average Measures of the Change in Equivalent Rents (1985=100)

	1988	1991	1994	1997
Without quality adjustment				
Ratio of arithmetic means	112.8	139.9	172.0	183.8
Ratio of geometric means	114.9	142.5	175.2	189.9
Per square meter				
Ratio of arithmetic means	114.8	138.5	162.2	169.8
Ratio of geometric means	113.0	136.4	162.4	172.2

As the GSOEP is a household panel, household moves cause a fixed base index to become less and less representative over time. Hence, we also calculate chained matched model indexes (table 6).[26] The matched models indexes indicate that the true quality adjusted increase in estimated equivalent rents is perhaps even smaller than suggested by the rent-per-square-meter measure. Only the linked Carli index exhibits a strongly deviating trend, thus confirming the poor reputation of this type of index.

Over the full period, the fixed base geometric mean matched models index gives nearly the same estimate of price change as the chained geometric mean index (though in the medium term there are greater differences between the fixed base and chained measures). It shows a lower rate of increase than the table 5 estimate for the simple rent-per-square-meter measure.

Table 6. Matched Models Indexes (1985=100)

	1988	1991	1994	1997
Fixed base matched models				
Ratio of arithmetic means (Dutot)	107.5	124.1	149.8	159.0
Ratio of geometric means (Jevons)	108.6	126.0	151.6	161.6
Arithmetic mean of changes (Carli)	115.6	133.3	158.5	169.0
(Number of observations)	(992)	(634)	(309)	(168)
Chained matched models				
Ratio of arithmetic means (Dutot)	109.0	129.1	153.5	156.5
Ratio of geometric means (Jevons)	**111.0**	**131.8**	**157.5**	**160.8**
Arithmetic mean of changes (Carli)	126.0	162.5	210.0	237.6
(Number of observations)	(1314)	(1213)	(1034)	(1028)

Turning to quality adjusted indexes based on hedonic regression techniques, we start with the time dummy method.[27] A Wald test reveals that the estimated coefficients of the hedonic equations are stable over adjacent periods. Hence we pool the samples for adjacent years and calculate a biannual price index by exponentiating the coefficient of the time dummy. The resulting annual indexes are multiplied to form chain time series.[28]

From table 7, it can be seen that over the period of 1988 through 1997, according to the adjacent year index, rental equivalents for owner occupied housing increased by 63.1% for the review period, or 4.2% per year. This is less than indicated by the measures based on average rental equivalents or rental equivalents per square meter, reflecting the improvement in the quality of owner occupied housing. The estimate is, however, close to that of the chained variant of the geometric means matched models index suggesting that, for the data under review, matched models indexes deliver reasonable results.

[26] For the various elementary index number formulae, we refer the reader to ILO et al. (2004, chapters 9 and 20).

[27] On hedonic indices see ILO et al. (2004, chapter 21) and Diewert and Nakamura (2009).

[28] We made extensive checks to explore whether the type of bias analysed by van Dalen and Bode (2007), which results from the fact that least-squares estimates of x are biased estimates of e^x, is of empirical relevance in our calculations. We find that our time dummy estimates are not affected at the level of precision reported in the tables.

Table 7. Hedonic Indexes Based on Adjacent Year Regressions (1985=100)

	1988	1991	1994	1997
Owner occupied housing	111.1	131.7	154.7	163.1

Table 8 shows the results for three alternative index number formulae evaluated with and without chaining and making use of the parameter estimates from the cross section hedonic equations. According to the fixed base Fisher formula (Fisher 1985=100), equivalent rents increased by 63.6% for the review period, or 4.2% per year. This is slightly above the estimated rate of increase for the time dummy method that was also used (table 7). The chained Fisher index yields a slightly higher estimated increase of 65.9% for the review period, or 4.3% per year. Overall, the differences among the various indexes appear to be quite small.[29]

Table 8. Explicit Hedonic Indexes (1985=100)

	1988	1991	1994	1997
Laspeyres (1985=100)	109.2	128.2	154.2	164.7
Laspeyres, chained	110.0	130.3	154.4	164.2
Paasche (1985=100)	108.5	127.4	150.7	162.5
Paasche, chained	109.9	131.8	156.4	167.6
Fisher (1985=100)	108.9	127.8	152.4	163.6
Fisher, chained	110.0	131.1	155.4	165.9

Over the same period, the official CPI subindex for housing increased by just 48% or 3.3% per year (table 9). For privately financed four room apartments, which are mainly employed for the imputation of rental equivalents in the CPI, the recorded rate of change is only marginally higher (48.4%). This finding suggests that the official CPI housing subindex might be biased downwards.

Table 9. CPI Measures of Rent Inflation (1985=100)

	1988	1991	1994	1997
Total	105.0	117.0	136.0	148.0
4 room apartments (privately financed)	105.1	116.7	135.8	148.4

One might suspect that this downward bias originates from the lack of representativity of the CPI sample for owner occupied housing, since the official CPI measure of housing cost

[29] The explicit indexes suffer a bit more strongly from the bias mentioned in the previous footnote than the time-dummy indexes. However, up to 1997, the cumulated bias amounts to just 0.8%. In most years, the bias is significantly smaller than 1%.

inflation is derived from a restricted sample of dwellings. Our earlier research on the measurement of housing rents (Hoffmann and Kurz 2002) revealed, however, that actual rents, as measured by a chained hedonic Fisher index, increased by 59.2%, or 4.0% per year over the period under review giving only a slightly lower estimate of long run price change compared with the corresponding index based on rental equivalents that is developed in this paper. Also, we found for rental housing that the differences in price trends between a sample restricted to flats matching the CPI specifications and a sample covering other dwellings are trivial.

Our new findings also suggest that, for the period under review, no substantial changes occurred in relative prices between owner occupied and rental housing.

A closer look at the data reveals that while, in the long run, quality adjusted estimated rental equivalents for owners display exactly the same trend as quality adjusted actual rents for renters, nevertheless, important differences exist in the short to medium term. Whereas rental equivalents increased more sharply in the period up to 1992, opening a gap versus actual rents, afterwards actual rents increased substantially faster and nearly made up the gap. The rents for new contracts increased steeply in this period, responding to the inflow of population from East Germany and other countries in Eastern Europe and the unification boom in Germany.[30] Hence, the equivalent rents mirror the present state of the housing market more closely, whereas the actual rents echo developments in the (recent) past.

6. Price Indexes for Overall Housing

The findings in the earlier sections of this paper, and in our earlier paper, show how we can calculate an index for total housing and examine its effects versus the official CPI index for Germany. In principle, there are two ways of calculating indexes for total housing from our earlier findings. Using appropriate weights, we may calculate a weighted average of the indexes for rental and owner occupied housing. Alternatively we can pool the renter and the owner samples and then proceed as for the separate samples.

We start with a regression model including a full set of interaction terms between rental and owner occupied housing. Statistically insignificant interaction terms have been dropped from this model, with the result that only interaction terms for the length of stay, the size of the dwelling, the location in states and for single and terraced houses are kept. Taking the estimated marginal valuations and the average levels of the traits, we calculate fixed base and chained Laspeyres, Paasche and Fisher indexes in two variants. In the first variant we stay with our original specification for owners, whereas in the second variant we adjust for the length of stay and the time varying tenancy discounts.

For this purpose, we need to stipulate a distribution of the length-of-stay for owners that would be relevant in a fictional universe of renters. As mentioned before, there are substantial differences in the average occupancy duration between renters and owners, the latter being much longer than the former. The longer occupancy duration of owners is probably related to the relatively high transaction costs for owner occupied housing. On the other hand, there is clearly a kind of sorting effect as the transaction costs are also an important argument in the tenure

[30] On these issues, see Deutsche Bundesbank (2002, 2003).

decision of households. Therefore, we expect households with potential needs for mobility to be more likely to rent and households without mobility to be more likely to own. Based on these arguments, we take the average of the owner and the renter durations as the length-of-stay in a fictional world exclusively populated by renters.

According to our calculations for the period under review, total housing costs increased by 63.4%, or 4.2% per year. Adjusting the owner occupied segment for the effect of the occupancy duration on actual rents over the period of years covered by this analysis reduces the estimated rate of price increase only slightly, to 61.3%, or 4.1% per year (see table 10). Whereas the differences between the length-of-stay-adjusted and the non-adjusted Fisher indexes are rather small, there is a substantial discrepancy versus the official CPI housing cost inflation measures (table 9). Over the full period of 12 years, the difference versus the adjusted Fisher index amounts to about 13 percentage points, or 0.7 percentage points per year.

A closer inspection of the dynamics of the various indexes reveals that until 1988, the CPI measures are rather close to the hedonic indexes. Starting in 1989, the rates of increase for the hedonic indexes are substantially higher than for the CPI rent subindex. But from 1994 on, the CPI and the hedonic measures by and large again display the same rate of change. These findings, which resemble those of our earlier paper on rents,[31] may be interpreted as evidence of a time related bias in the German CPI housing cost measure. Probably it is no coincidence that major divergences appear for the first time in the year in which immigration started to put pressure on the German housing market.[32] In our earlier paper we discuss a list of potential causes, but conclude that none of these is fully convincing. Probably the divergence stems from hidden differences in the CPI and GSOEP dwelling samples that are unrelated to the types of dwellings. Such differences can, however, not be explored without a detailed examination of the CPI sample which is beyond the scope of this paper.

7. Conclusions

We find that the official German imputation method for owner occupied housing basically seems to be sound on the whole. However, we find some evidence of a downward bias in the German housing cost measure, though the causes remain unclear.

Our results seem to indicate that the equivalent rents reported in the GSOEP, as estimated by owners, are by and large reasonable. It is true that we find evidence of an overestimation of the level of estimated rental equivalents that can be only partly explained by a presumed tendency of owners to be aware primarily of rents for new contracts, and for this to affect their estimates of what their homes would rent for. In addition, probably the relatively higher expected rental values reported by owners for their homes reflect characteristics not reported in the GSOEP. To the extent that the latter is true, the higher values reported by owners could be an indication that the range of characteristics reported in the GSOEP, which is obviously limited, is not fully adequate to support the use of hedonic methods for making adjustments for quality differences.

[31] See Hoffmann and Kurz (2002).

[32] See Deutsche Bundesbank (2002) and Deutsche Bundesbank (2003).

Table 10. Explicit Hedonic Indexes for Total Housing (1985=100)

	1988	1991	1994	1997
Non-adjusted				
Laspeyres 1985	107.1	123.7	149.9	162.8
Laspeyres, chained	107.2	124.3	149.9	162.1
Paasche 1985	106.8	124.0	148.1	161.4
Paasche, chained	107.2	125.3	151.4	164.8
Fisher 1985	106.9	123.8	149.0	162.1
Fisher, chained	107.2	124.8	150.7	163.4
Adjusted for length of occupation				
Laspeyres 1985	105.9	121.5	148.4	161.6
Laspeyres, chained	105.8	121.5	147.1	159.2
Paasche 1985	105.7	121.6	146.7	159.8
Paasche, chained	105.9	122.5	149.5	163.5
Fisher 1985	105.8	121.5	147.5	160.7
Fisher, chained	105.8	122.0	148.3	161.3

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