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A rental-equivalence index
for owner-occupied housing
in West Germany 1985 to 1998

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Abstract

In this paper, we review the German practice of imputing the costs of owner-occupied housing by increasing the relative weight of actual rents in the CPI. As the structure of owner-occupied housing differs substantially from that of rental housing, this variant of the imputation method may cause a bias in the German CPI. For assessing the appropriateness of the German imputation method, we estimate alternative rental equivalent indices based on the GSOEP. We find some evidence of an understatement of the "true" rate of price increase, which is, however, not directly related to the imputation method.

Key Words: Consumer Price Index, hedonics, housing, matched models.

JEL Classifications: C21, C43, D12, E31, R21, R31

Non-technical summary

The appropriate treatment of owner-occupied housing is one of the most difficult problems in the field of price measurement. For owner-occupied housing, the traditional acquisition approach, which neglects the difference between the period of purchase and the period of usage, does not result in a fully satisfactory estimate of the cost-of-living since residential structures are extremely long-lived. In the German Consumer Price Index (CPI) - as in the US CPI - a rather simple proxy measure is employed for capturing the price developments in the owner-occupied segment of the housing market. Actual rents are used for the imputation of the costs of owner-occupied housing, which is achieved by increasing the expenditure weight of the rent subindices. Approximating the costs of owner-occupied housing by means of the rent index seems to be a valid method for Germany as the German housing market is only relatively lightly regulated, the tax system not severely distorting and the share of rental housing quite substantial. However, the structure of owner-occupied housing differs substantially from that of rental housing. Rental housing typically takes the form of flats in apartment houses, whereas single-family houses and terraced houses predominate in the owner-occupied segment. Furthermore, only rents for a restricted sample of dwellings are recorded for the purpose of consumer price statistics. As price trends might differ between various segments of the housing market, there is a potential for bias in the German CPI. For assessing the appropriateness of the German imputation method we estimate alternative indices of the costs of owner-occupied housing based on rental equivalents as reported in the GSOEP. The GSOEP is a yearly household panel, which among other things reports on housing conditions in Germany including actual rents and equivalent rents as estimated by owners. In the first stage of our study we investigate whether the owners' estimates are reasonable. For this purpose we estimate hedonic functions for rents and equivalents rents. In most cases we find that the sign and the size of the estimated coefficients do not differ significantly between rental and owner-occupied housing. This is probably the consequence of the partial overlap of markets for rental and owner-occupied housing, but also indicates that the owners' estimates of equivalent rents are reasonable on average. In the second stage we compile several quality-adjusted rental-equivalence indices for owner-occupied housing and compare these indices with the official data. Furthermore we estimate indices for total housing based on actual rents and rental equivalents as reported in the GSOEP. We find some evidence of an understatement of the "true" rate of price increase in the official CPI housing subindex, which is, however, not directly related to the imputation method.

Nichttechnische Zusammenfassung

Die angemessene Behandlung selbstgenutzten Wohneigentums ist eines der schwierigsten Probleme der Preismessung. Der traditionelle „acquisition approach", der den Unterschied zwischen dem Kaufakt und der Nutzung vernachlässigt, führt in diesem Bereich nicht zu einer wirklich zufriedenstellenden Schätzung der Lebenshaltungskosten. Dies liegt vor allem an der extremen Langlebigkeit von Gebäuden. Im deutschen Verbraucherpreisindex (VPI) wie auch im US-amerikanischen CPI wird eine einfache Ersatzmethode für die Abbildung der Preisbewegungen selbstgenutzten Wohneigentums verwendet. Dabei werden anstelle der Kosten der Nutzung des Wohneigentums tatsächliche Mieten für Mietwohnungen angesetzt. Technisch geschieht dies durch die Anhebung des Gewichts des Mietenindex. Die Approximation der Kosten der Nutzung des Wohneigentums durch den Mietenindex könnte für Deutschland eine angemessene Methode sein, da der deutsche Wohnungsmarkt nur relativ leicht reguliert ist, das Steuersystem nicht sehr verzerrend wirkt und der Anteil der Mietwohnungsverhältnisse beträchtlich ist. Allerdings unterscheidet sich die Struktur der Eigentümerwohnungen deutlich von derjenigen der Mietwohnungen. Gemieteter Wohnraum findet sich vor allem in mehrstöckigen Gebäuden, während selbstgenutztes Wohneigentum häufiger bei freistehenden Einfamilienhäusern und bei Reihenhäusern vorkommt. Hinzu kommt, dass für die Verbraucherpreisstatistik nur Mieten für eine beschränkte Auswahl von Wohnungstypen erhoben werden. Da sich die Preistrends zwischen den verschiedenen Segmenten des Wohnungsmarkts unterscheiden können, könnte der deutsche VPI verzerrt sein. Um die Angemessenheit der deutschen Imputationsmethode zu beurteilen, schätzen wir alternative Indizes für eigengenutztes Wohneigentum basierend auf Mietäquivalenten, wie sie im GSOEP berichtet werden. Das GSOEP ist ein jährliches Haushalts-Panel, das unter anderem ausführlich über die Wohnverhältnisse in Deutschland informiert, einschließlich der gezahlten Mieten und der Mietäquivalente, wie sie von den Eigentümern geschätzt werden. Im ersten Schritt unserer Untersuchung prüfen wir, ob die Einschätzungen der Eigentümer vernünftig erscheinen. Zu diesem Zweck schätzen wir für Mieten und Mietäquivalente hedonische Gleichungen. In den meisten Fällen finden wir, dass sich Vorzeichen und Größe der geschätzten Koeffizienten zwischen Mietwohnungen und selbstgenutzten Eigentümerwohnungen nicht signifikant unterschieden. Dies ist vermutlich eine Folge der partiellen Überlappung der Märkte für gemietetes und selbstgenutztes Wohnen, deutet aber auch an, dass die Einschätzungen der Eigentümer im Durchschnitt vernünftig sind. Im zweiten Schritt berechnen wir verschiedene qualitätsbereinigte Indizes für selbstgenutztes Wohneigentum, basierend auf den Mietäquivalenten, und vergleichen die Ergebnisse mit den amtlichen Angaben. Des weiteren berechnen wir Indizes für das Wohnen insgesamt. Wir finden Hinweise auf eine gewisse Unterzeichnung des „wahren" Preisanstiegs durch den offiziellen VPI, die allerdings nicht direkt von der gewählten Imputationsmethode herrührt.

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1 Introduction

The appropriate treatment of owner-occupied housing is perhaps one of the most complex problem of price measurement. Besides the extreme heterogeneity of residential structures and the outstanding importance of location, the fact that houses are very long-lived causes exceptional difficulties.[1] The extreme longevity of residential structures implies that the period of usage extends greatly beyond the period of purchase. Therefore, at least 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 promise very satisfactory results.[2] Instead, a distribution of the initial cost of purchase over the life of the residential structure is called for. Basically, this demands the postulation of an appropriate depreciation profile. The inclusion of capital gains and losses resulting from property price changes and of interest rate effects then leads to a user cost estimate. The change in this figure is considered to be the appropriate measure in changes of the cost of living for housing purposes.

The exact estimation of user costs for owner-occupied housing is a very demanding task. Especially the determination of the appropriate depreciation rate and the measurement of the change in residential property prices pose numerous difficult theoretical and practical problems. Furthermore, the inclusion of interest rate effects and capital gains and losses tends to give a rather volatile measure of user costs.[3] Therefore, the user cost approach is not very popular with price statisticians. As an alternative some experts have propagated the rental equivalence approach.[4] If there is a well-developed rental market which is not distorted by taxes, actual rents represent the opportunity costs for owners. Hence, there

[1] For an authoritative discussion of the problems at hand and alternative approaches, see Diewert (2003).

[2] However, if the purpose of the CPI is more a restricted one as it is the case with the HICP, an acquisition approach may be considered to be fully appropriate. On this issue, see, for example, Leifer (2001).

[3] On this issue, see Blinder (1980) and Blackley/Follain (1995). Ayuso/Restoy (2003) report substantial but temporary deviations of property prices from rents and vice versa with the dynamics of the rental prices generally been smoother than that of asset prices. Schulz/Werwatz (2001) also find that rents in the German capital Berlin reacted more slowly to changing market conditions than house prices, but that residential property prices were driven by overconfidence following German unification.

[4] See, among others, Gillingham (1983). On the other hand, Darrough (1983) thinks that rents and user costs are inherently different (because of the distortions caused by taxes).

should be a close relationship between actual rents and user costs. If this were true, the observation of actual rents for dwellings that closely match owner-occupied dwellings in terms of characteristics would be a suitable alternative to calculating user cost measures.

In practice, it is, however, often difficult to find rented dwellings, which closely match owner-occupied dwellings, as there is at most only a partial overlap of the markets for owner-occupied and rental housing. Rental housing typically takes the form of flats in apartment houses, whereas single-family houses and terraced houses predominate in the owner-occupied segment. The main reasons for this phenomenon are likely to be the principal-agent problems arising from leasing property (as the level of care for a rented asset tends to be suboptimal, see Henderson/Ionannides 1983) and the high costs of multi-party ownership of assets which arise from free rider behaviour of some owners and high costs of co-ordination between owners (Gervais 2002). Therefore in the absence of distorting taxes the allocation "one building - one owner" seems to be optimal (Glaeser/Shapiro 2002). This implies, however, that the tenure choice is not separable from the decision about structure, and the probability of finding rental dwellings which closely match owner-occupied dwellings might not be very high.

In the German Consumer Price Index (CPI) - as in the US CPI - a rather simple proxy measure is employed for capturing the price developments in the owner-segment of the housing market. Actual rents are used for the imputation of the costs 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 seems to be a valid method for Germany as the German housing market is relatively lightly regulated, the tax system not severely distorting and, as a consequence, the share of rental housing quite substantial (European Central Bank 2003). However, the structure of owner-occupied housing differs substantially from that of rental housing and for the purpose of consumer price statistics only rents for a restricted sample of dwellings are recorded. As price trends might differ between various segments of the housing market, there is a potential for bias in the housing component of the German CPI. Furthermore, given the substantial weight of housing in the German CPI, any bias in the housing component will impact on the accuracy of the total CPI.

For assessing the appropriateness of the German imputation method we estimate alternative indices of the costs of owner-occupied housing based on rental equivalents as reported in the German Socio Economic Panel (GSOEP). The GSOEP is a yearly household panel, which among other things reports on housing conditions in Germany including actual rents and rental equivalents as estimated by owners. The owners are asked to estimate the monthly rent which would have to be paid for renting their own dwelling.

This seems to be a promising strategy to obtaining rental equivalents if owners have a good knowledge of markets.

We assess the quality of the owners' estimates of rental equivalents by estimating hedonic functions for rents and rental equivalents and comparing the estimated coefficients. This is a feasible approach for Germany as, despite the differences in average characteristics, the markets for owner-occupied and rental housing overlap to some extent. The econometric estimation strategy follows closely that of our companion paper on housing rents (Hoffmann/Kurz 2002). In most cases we learn that the sign and the size of the estimated coefficients do not differ significantly between rental and owner-occupied housing. This finding suggests that there is no substantial variation in the marginal valuation of characteristics across markets and between actual rents and estimated rental equivalents, which is probably the consequence of the partial overlap of rental and owner-occupied housing. It also suggests that the owners' estimates of equivalent rents are reasonable on average.

As the estimates of the rental equivalents mostly seem to be well educated, they can provide a basis for the compilation of price indices for owner-occupied housing. This is done in a similar way to that for actual rents in our earlier paper. Since the hedonic functions from which the quality-adjusted price indices are derived are estimated for each period separately, we allow for changing relative prices of characteristics. Furthermore, we calculate both fixed-based traditional Laspeyres indices as well as superlative indices.

The paper is organised as follows: In section 2 below we briefly describe the peculiarities of the subindex for rental and owner-occupied housing in the German CPI. In section 3 the GSOEP is introduced. In section 4 a hedonic analysis of rental equivalents and actual rents on basis of the GSOEP is performed. In section 5 we present and discuss alternative indices for owner-occupied housing based on rental equivalents. Section 6 merges the new findings with those of our previous paper on the developments of actual rents. Finally, section 7 provides some conclusions.

2 The housing subindex of the German Consumer Price Index

The German CPI sub-index for housing covers rental and owner-occupied housing.[5] It is based on a panel of rental dwellings for which rents are collected with a quarterly frequency.[6] 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 change in quality that stems from wear and tear. As no adjustments are made for simple reconditioning measures either, we may assume that on average no distortions result from this practice. In regions with substantial construction activity the matched-model sample is supplemented with data on new dwellings for which a rudimentary quality adjustment for differences in size is performed.

Rents are collected for a restricted selection of dwelling types only. Three narrowly defined types of apartments were selected from the privately financed segment of the market, three other types from the subsidised segment. There are no separate price representatives for owner-occupied housing. While the importance of owner-occupied housing in Germany is much smaller than in other industrialised economies, still more than 40% of the households live in their own residential property.[7] Therefore, for a meaningful measure of the cost-of-living an adequate estimate of the cost of owner-occupied housing is required. For the German CPI (as for the US CPI), the price component for owner-occupied dwellings is taken from the subindices for actual rents. The relative weight of owner-occupied housing - which is not published separately - is derived from the share of rental equivalents in the household consumption expenditures as estimated in the national accounts. This results in more than doubling the weight of the subindex for rented flats in the German CPI.[8] The disproportionate expenditure share of rental equivalents in relation to the share of owner-occupiers reflects the fact that owner-occupied dwellings are typically of a higher-priced type than rental dwellings. As the subsidised apartments have no direct equivalent in the owner-occupied segment and most owner-occupied dwellings have more than three rooms, the biggest share of the imputation falls on the expenditure weight of the privately financed four room apartments.

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[5] For details, see Hoffmann/Kurz (2002).

[6] As the German CPI rent index is derived from a dwelling sample and not a renter sample, and as 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/Nakamura/Voith (2001).

[7] See European Central Bank (2003).

[8] In 1985, actual rents in West Germany amounted to 37.03 billion euro, rental equivalents to 41.87 billion euro. In 1991 the corresponding figures were 49.61 and 58.78 billion euro.

Table 1: Dwelling types in the German CPI

Dwelling type	Expenditure weights including imputed rent for owner-occupied as a ‰-age		
	1985	1991	1995
Overall	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

The German imputation practice implicitly assumes that the housing cost dynamics are exactly identical for rented and owner-occupied dwellings. This might be quite misleading.[9] Firstly, the structure of owner-occupied dwellings may differ substantially from that of rental dwellings. Therefore housing costs may vary across segments of the housing market. While such level effects themselves do not distort price indices, changes in the relative valuation of housing characteristics may lead to differences in the dynamics of the housing costs. In this case the flats chosen to capture the price dynamics in the rental market may not provide a fully appropriate basis for imputing the developments of the costs of owner-occupied housing. This is even more probable in the German case as the sub-index for rents in the CPI is based on a rather restricted sample of dwelling types (Table 1). Only three and four room apartments are covered, whereas single-room flats and single-family and terraced houses are missing. This limitation proved not to be of great importance for the measurement of the development of actual rents (Hoffmann/Kurz 2002), but might cause distortions for imputed rents. Furthermore, the regulation of the rental market and the differences in taxation might distort the correspondence between user costs and rental equivalents derived from actual rents. However, the regulation of the German rental market is not very tight, and - after a change in the 1980s - the tax system tended to be not as favourable to owner-occupied housing as in other industrialised countries.[10] Therefore, we may hope that regulation and taxes do not substantially distort the connection between user costs and rental equivalents in Germany.

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[9] For a discussion of these topics in the context of the US CPI, see Crone/Nakamura/Voith (2000).

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

3 Owner-occupied housing in the German Socio-Economic Panel

The German Socio-Economic Panel (GSOEP) is an annual household panel that assembles information about living and working conditions in Germany.[11] Among other data, the GSOEP reports major physical and locational characteristics of dwellings, rents actually paid by households and rental equivalents as estimated by owners. The GSOEP started in 1984 with nearly 6,000 households, 65% of which were tenants and 35% owners.[12] In 1990 the data set was enlarged to include eastern Germany. The GSOEP surveys the same households every year. New persons enter the GSOEP sample for western Germany by birth or by marriage, or - since 1992 - by moving from the eastern part to the western part of the country. Split households, for example owing to divorce or children leaving the parental home, are followed up. Still, panel mortality is quite pronounced. Therefore, in 1998 the GSOEP was refreshed by about 1,000 households. By then, slightly over 5,500 households in the sample were living in western Germany.[13]

In the GSOEP owners are asked to estimate an equivalent rent for their property. The corresponding question reads: "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, mainly on water supply and refuse collection. Up to 1998 the same was true of the rents collected for the compilation of the CPI; since then, however, the CPI has related to rents excluding any additional expenses. As we want to compare the development of rental equivalents in the GSOEP to the rent measure in the CPI, we restrict our study to the period 1985 to 1998.

Although we focus on apartments rather than households, we cannot generate a true dwelling panel from the GSOEP. In the case of a move, the GSOEP follows the household into the new flat. The old flat is lost. In the period under review, we observe a total of 10,000 different households but 14,000 different dwellings. The greater number of dwellings reflects moves within the sample.

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[11] For a detailed description of the GSOEP, see SOEP Group (2001).

[12] The GSOEP is a disproportionate sample since foreigners are deliberately oversampled. However, sampling weights are delivered together with the GSOEP, which can be used to expand the sample to the whole population, as depicted by the German Mikrozensus (an annual 1% representative sample of the German population). Hence, estimates based on weighted GSOEP data can be regarded as approximately representative of Germany. All figures and results reported in this study stem from the weighted sample.

[13] After reunification, rental housing markets were still highly regulated in eastern Germany, and most dwellings were state-owned and rents were only adjusted towards the market value 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. Therefore, we restrict our analysis to western Germany and exclude dwellings located in eastern Germany.

Table 2: Housing in the GSOEP
(Share in overall expenditure on housing including imputed rent for owner-occupied housing as a %-age, weighted sample)

Dwelling type	1985	1991	1998
Owner-occupied dwellings	50.0	55.0	50.0
of which			
Dwellings according to CPI specification	11.0	13.1	12.0
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	0.0
4-room apartment (including kitchen), with bathroom, central heating, built after 1948	10.1	12.9	12.0
Other dwellings	89.0	86.9	88.0
Rented dwellings	50.0	45.0	50.0
of which			
Privately financed dwellings	74.9	78.9	85.1
Dwellings according to CPI specification	24.0	25.9	29.8
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	5.9
4-room apartment (including kitchen), with bathroom, central heating, built after 1948	18.8	20.1	23.9
Other dwellings	51.0	53.0	55.3
Subsidised dwellings, built after 1948	25.1	21.1	14.8
Apartments according to CPI specification	15.3	13.9	9.1
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	3.6
4-room apartment (including kitchen), with bathroom, central heating	9.2	7.9	5.2
Other apartments	9.9	7.2	5.7

When extracting the housing sample from the GSOEP, we found evidence of misreporting. For some dwellings, for example, the reported occupancy duration is not consistent with the vintage. Also some rents and rental equivalents seem to be excessively volatile. As there is no chance of distinguishing ex post accurately and badly reported data, we used the panel structure of the data and developed standardised procedures for deciding whether to keep or drop an observation and for adjusting inconsistent data.[14] However, as only about 1 % of the observations in every year was adjusted, the corrections are rather marginal.

A comparison of the structure of the housing expenditure shares in the GSOEP with that of the CPI basket of consumption reveals that while nearly 40% of rents refer to dwellings that correspond to the CPI specifications, this is the case for less than 15% of the estimated equivalent rents for owner-occupied housing (Table 2). This finding raises some doubts about the suitability of the CPI sample for the imputation of housing costs for owner-occupied housing.

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[14] For a more detailed description of the adjustments made, see Hoffmann and Kurz (2002).

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
Landlord-tenant relationship				
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	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	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-Westfalia	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 1998 GSOEP

	Rented		Owner- occupied	
Variable	Mean	Std. dev.	Mean	Std. dev.
Rent (DM)	793.3	352.1	1361.5	557.5
Landlord-tenant relationship				
Occupancy duration (years)	11.0	12.1	19.9	17.2
Subsidised apartment	0.18	0.30		
Physical characteristics				
Vintage				
Built 1918 or earlier	0.12	0.21	0.13	0.23
Built between 1918 and 1948	0.17	0.28	0.10	0.18
Built between 1949 and 1971	0.42	0.49	0.31	0.43
Built 1972 or later	0.29	0.41	0.46	0.50
Built between 1972 and 1980	0.13	0.23	0.21	0.33
Built between 1981 and 1990	0.07	0.13	0.13	0.23
Built 1991 or later	0.09	0.16	0.12	0.21
Size (square meters)	70.6	26.6	116.2	42.3
Furnishing				
Kitchen	0.99	0.02	1.00	0.00
Bathroom	0.99	0.02	0.99	0.02
Toilet	0.99	0.02	0.99	0.02
Central heating	0.92	0.15	0.97	0.06
Cellar	0.93	0.13	0.97	0.06
Gallery	0.67	0.44	0.89	0.20
Garden	0.28	0.40	0.88	0.21
Property type				
Farm house or other	0.02	0.04	0.03	0.06
Single-family houses	0.11	0.20	0.46	0.50
Terraced house	0.08	0.15	0.30	0.42
Apartment house (3-8 flats)	0.56	0.49	0.15	0.26
Apartment house (more than 8 flats)	0.22	0.34	0.05	0.10
Multi-storey building	0.02	0.04	0.01	0.02
Locational characteristics				
Type of quarter				
Residential area	0.68	0.44	0.80	0.32
Downtown district	0.01	0.02	0.00	0.00
Industrial area	0.01	0.02	0.00	0.00
Mixed area	0.29	0.41	0.18	0.30
Other	0.01	0.02	0.01	0.02
Conurbation type (inhabitants)				
500,000 and more (central area)	0.49	0.50	0.19	0.31
500,000 and more	0.08	0.15	0.15	0.26
100,000 - 500,000 (central area)	0.13	0.23	0.08	0.15
100,000 - 500,000	0.05	0.10	0.08	0.15
50,000 - 100,000	0.03	0.06	0.04	0.08
20,000 - 50,000	0.07	0.13	0.11	0.20
5,000 - 20,000	0.10	0.18	0.18	0.30
2,000 - 5,000	0.04	0.08	0.09	0.16
Less than 2,000	0.02	0.04	0.07	0.13
State				
West Berlin	0.08	0.15	0.01	0.02
Baden-Württemberg	0.12	0.21	0.18	0.30
Bavaria	0.15	0.26	0.21	0.33
Bremen	0.02	0.04	0.01	0.02
Hamburg	0.05	0.10	0.00	0.00
Hesse	0.08	0.15	0.07	0.13
Lower Saxony	0.10	0.18	0.14	0.24
North Rhine-Westfalia	0.31	0.43	0.24	0.36
Rhineland-Palatinate / Saarland	0.07	0.13	0.07	0.13
Schleswig-Holstein	0.03	0.06	0.07	0.13

A closer look at the structure of rental and owner-occupied housing in the GSOEP (Tables 3a and 3b) reveals that renters predominately live in apartment houses, whereas single-family and terraced houses are the most common dwelling types among owners. Thus the German pattern of tenure choice is close to the "one asset - one owner" allocation which seems to be optimal from the view of economic theory.[15] This finding indirectly backs the judgement that the German housing is not severely distorted by regulations and taxes. 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.[16] This may be explained by the fact that owners live more often in dwellings built after 1971. In addition, rental housing is predominately located in big cities, whereas ownership is more evenly spread across the conurbation types.

Moreover, there are striking differences in the mobility of renters and owners. Between 6% and 11% of the renters move inside the sample each year, but less than 1% of the owners. These figures do not include those households which enter the sample after having moved recently or those households which were not contacted successfully by the GSOEP in the year immediately following the move. Hence, the average occupancy duration in owner-occupied housing is almost twice as high as that of rented dwellings.

However, even as the structure of rental housing clearly differs from that of owner-occupied housing, there are some important overlaps which may connect markets and price levels and price trends. About one-fifth of renters live in single-family or terraced houses, and about one-fifth of owners live in flats. Furthermore, the quite substantial standard deviation of the size of rented and owner-occupied dwellings also implies that there is no strict delineation of owner-occupied and rental housing in terms of size. And finally, we find both forms of tenure in all types of conurbation, which means that there is no strict regional separation.

Apart from some remarkable exceptions, the average dwelling did not change very much in the period under review. Both rented and owner-occupied dwellings became somewhat larger, slightly better equipped and more modern from 1985 to 1998. The average size of rented dwellings increased by about 6%, while with 11% the gain in size was even more

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[15] However, there are cases of separate ownership of rental flats in apartment houses since the tax system favours separate ownership over joint ownership and the principal-agent problems tend to be even worse with residential property investment funds.

[16] The list of amenities reported in the GSOEP is little 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 in 1985. This means that there is not much variation in four out of seven furnishing variables. Substantial differences can be found only for central heating, galleries and gardens.

Figure 1: Rents and rental equivalents in the GSOEP
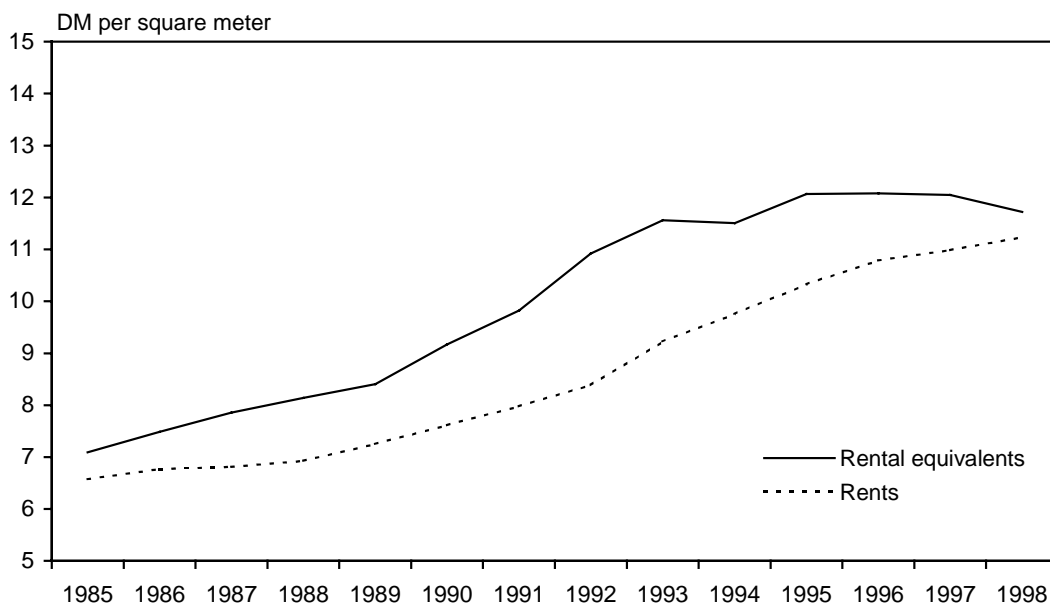
pronounced for owner-occupied dwellings. The importance of central heating increased by 13 (owner-occupied dwellings) and 14 (rental dwellings) percentage points. The share of dwellings built after 1971 rose from 16% to 29% in the case of rented dwellings and from 24% to 46% in the case of owner-occupied dwellings. This implies that the relative age structure of owner-occupied dwellings improved further. Throughout the period under review, the locational distribution of dwellings did not change much.

A preliminary visual inspection of the level and the development of actual rents and rental equivalents - not adjusted for differences and changes in quality - suggests that the markets for rental and owner-occupied housing may indeed be interconnected (Figure 1). It is true that in each year of the period under review estimated equivalent rents were higher than actual rents both in absolute terms and per square meter, and, that, up to 1992, the equivalent rents increased substantially faster than actual rents. However, in the years following 1992 the increase in actual rents was rather strong, whereas the estimated equivalent rents nearly stagnated, albeit at a high level. Over the full period, these differences cancelled out and both the mean of the actual rents and the mean of the estimated equivalent rents went up by about 80% or 4¾% per year. Rents per square meter increased by about 70% (from DM6.60 on average to DM11.20). The increase in estimated equivalent rents per square meter was a little bit more subdued: the average level of rental equivalents rose from DM7.10 to DM11.70 (+65%). In the following section 4 we will analyse more carefully the differences in the level of actual rents and estimated equivalent rents. Section 5 tries to shed some more light on the dynamics of actual rents and rental equivalents, and link it to changes in characteristics.

4 Hedonic analysis of estimated equivalent rents

The purpose of this chapter is the assessment of the GSOEP rental equivalents' quality. In particular, we would like to know whether the owners' estimates by and large are reasonable and whether the markets for rental and owner-occupied housing are interconnected. The analysis in section 3 revealed that, on the one hand, estimated equivalent rents are higher than actual rents, and, on the other hand, owner-occupied dwellings on average are of higher quality than rented dwellings. Hence, there is a correspondence of quality and price differences at the macro level. Here we ask whether the higher level of the rental equivalents found in the GSOEP is systematically related to differences in quality at the micro level. Furthermore, we would like to know whether the marginal valuation of characteristics differs between rental and owner-occupied housing. And finally we try to assess the reasonableness of owners' estimates. The exploration of these topics is feasible with the GSOEP data as we have seen in section 3 that there is some overlap of rental and owner-occupied housing in terms of characteristics.

The technique on which our analysis is based is the hedonic regression approach. The key idea of the hedonic technique is that prices of goods are closely related to characteristics. In its most general form, the hedonic relationship can be given as:

(1) $\quad p = f(X) + u$,

which explains the price p by different traits $X = (x_1, x_2, \ldots x_i, \ldots x_n)$ and an error term u. The exact form of the hedonic function f(.) is widely discussed throughout the literature, and a great variety of functional forms have been proposed. Our previous analysis in Hoffmann/Kurz (2002), which explores these issues in more depth, has shown that for rental housing the log-log form works quite well. After some testing we decided to apply the same functional form to the estimated equivalent rents for owner-occupied housing:

(2) $\quad \ln p = c_0 + \sum_i c_i x_i + u$.

The only continuous right-hand variable entering the regression, the size of the dwellings, is log-transformed. The other variables x_i, which include the characteristics in Table 3, are transformed into dummies.[17] The main advantages of the log-log model are computational efficiency and the straightforward interpretation of the coefficients c_i as elasticities, which measure percentage changes of the rent in response to a 1% increase in the level of the (continuous) traits.

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[17] 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/Kurz (2002).

At the first stage, hedonic models were estimated separately for rental and owner-occupied housing. The constant term gives the 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 an apartment house with up to eight flats and was built before 1949. The baseline dwelling is equipped with a bathroom, toilet, central heating and a gallery or a garden. It was privately financed, and the current household has been living there for more than ten years. The hedonic regressions were estimated by ordinary least squares separately for each year from 1985 to 1998. As the Cook-Weisberg-Test indicated heteroscedastistic residuals in most periods, heteroscedasticity-consistent robust standard errors were computed. All regressions were weighted with the sample weights provided by the SOEP group. Hence, the estimates may be regarded as approximately representative for western Germany.

Table 4 reports the regression results for the first and the last year in our sample.[18] Overall, the hedonic regressions for owner-occupied housing broadly seem to be as well behaved as that for rental housing. It is true that the adjusted R-squared for owner-occupied housing with 0.43 to 0.56 is somewhat lower than that for rented housing, which ranges from 0.53 to 0.65.[19] The difference, however, is not very large. Moreover, most of the estimated coefficients are statistically significant and have the expected sign. These findings can be interpreted as indicating that the owners' estimates of equivalent rents are by and large reasonable. Otherwise we would have expected to find a much lower R-squared and statistically insignificant parameter estimates or parameter estimates with implausible signs. Finally, the parameter estimates are in an order of size similar to that for rented flats. We interpret this finding as indicating that the markets are indeed interrelated.

There are, however, some differences. Most importantly, the occupancy duration which proved to be so vital in the Hoffmann/Kurz (2002) hedonic explanation of actual rents, turned out to be insignificant in the case of owner-occupied housing. Owners do not take into account the occupancy duration when assessing the rental value of their dwelling. This means that the length-of-stay discounts found for rental housing either stem from an unmeasured quality deterioration related to the previous 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. Hence, we drop the length-of-occupancy variable from the model for rental equivalents. Further noticeable differences can be found in the valuation of property types and of the location in different states.

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[18] For a broader exposition and discussion of the regression set-up and results including the issues of flexibility of the functional form, interaction between variables, heteroscedasticity, multicolliniarity, misspecification and missing variables, see our earlier paper Hoffmann/Kurz (2002).

[19] The R-squared are, however, substantially larger than those reported by Crone/Nakamura/Voith (2000).

For testing statistically the differences between the coefficients of rental and owner-occupied housing, we run the hedonic regression model for a pooled sample simultaneously covering both segments of the housing market. The explanatory variables are interacted with a dummy variable taking the value of one for owner-occupied dwellings and zero for rented housing. Statistically significant coefficients of the interaction terms would indicate that the influence of the variables is not the same on rents and rental equivalents. Most interaction terms turn out not to be statistically significant in most periods, thus confirming the visual impression of no substantial differences in the coefficient estimates. Statistically significant differences are found in some years for the size variable, the property type and the location at the level of states. Typically, the elasticity of estimated equivalent rents with respect to size is somewhat lower than that of actual rents. On average, a 1% increase in size implies an increase in equivalent rents of about 0.65%, but of 0.75% in actual rents. Furthermore, in the opinion of owners, single and terraced houses are more valuable than flats in apartment houses, whereas in the case of rental dwellings sometimes the opposite seems to be true. This finding might be related to the fact that the tenure choice is not fully separable from the decision about structure. There are also some differences between actual rents and estimated equivalent rents with respect to locational variables.

Whereas differences in marginal valuations tend to be quite small and restricted to few characteristics, the overall dummy for owner-occupied housing in almost all periods was statistically significant above zero,[20] indicating a higher valuation of owner-occupied housing even after controlling for differences in quality and the length of stay for renters. It is true that the adjustment for differences by our hedonic regression model is incomplete as the GSOEP reports only a restricted number of characteristics. If owner-occupied dwellings were on average better equipped with unreported amenities, this might explain some of the differences. Linneman/Voith (1991) argue that there is an intrinsic preference for homeownership, which may bias the estimates upwards. The estimated difference is, however, neither invariant nor trended, but displays a cyclical pattern, which seems to be at variance with purely quality or preference-related explanations.

An alternative explanation starts from our earlier finding that rents for sitting tenants reflect a kind of tenancy discounts meaning that quality adjusted rents are on average lower in existing contracts than in new contracts (Hoffmann/Kurz 2002). Furthermore, we found that these discounts display a cyclical pattern. These phenomena are probably the result of the peculiarities of contracting on the rental market (Francois 1989), which may

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

Table 4: Cross-section hedonic regressions

Variable	1985 Rented		1985 Owner-occupied		1998 Rented		1998 Owner-occupied	
Constant	2.733	***	2.983	***	3.137	***	3.783	***
Physical characteristics								
Vintage								
Between 1949 and 1971	0.139	***	0.096	***	0.103	***	0.065	**
1972 or later	0.315	***	0.258	***				
Between 1972 and 1980					0.184	***	0.149	***
Between 1981 and 1990					0.227	***	0.174	***
1991 or later					0.292	***	0.209	***
ln Size (square meters)	0.772	***	0.776	***	0.799	***	0.725	***
Furnishing								
Without bathroom/toilet	-0.126	***	-0.071		-0.160	*	-0.274	***
Without central heating	-0.226	***	-0.151	***	-0.178	***	-0.116	**
Without garden/gallery	-0.064	***	-0.087		-0.038	**	-0.114	
Property type								
Farm house or other	-0.097		-0.046		-0.045		-0.104	
Single-family house	-0.162	***	0.148	***	-0.038		0.063	**
Terraced house	-0.043		0.158	***	-0.047		0.058	*
Apartment house (more than eight flats)	0.054	***	0.156	***	0.016		-0.006	
Multi-storey building	0.109	***	0.167	***	0.037		0.018	
Locational characteristics								
Type of quarter								
Downtown district	0.221	***	0.277		0.057		-0.070	
Industrial area	-0.238		0.052		-0.145	***	0.135	***
Mixed area	0.017		-0.061	**	0.012		-0.047	*
Other	0.101		0.075		-0.083		-0.003	
Conurbation								
500,000 and more	-0.069	**	-0.136	***	-0.073	**	-0.101	***
100,000 to 500,000 (central area)	-0.140	***	-0.187	***	-0.163	***	-0.141	***
100,000 to 500,000	-0.224	***	-0.338	***	-0.194	***	-0.186	***
50,000 to 100,000	-0.058		-0.176	***	-0.256	***	-0.242	***
20,000 to 50,000	-0.210	***	-0.300	***	-0.175	***	-0.294	***
5,000 to 20,000	-0.290	***	-0.392	***	-0.213	***	-0.279	***
2,000 to 5,000	-0.256	***	-0.413	***	-0.324	***	-0.319	***
Less than 2,000	-0.289	***	-0.501	***	-0.336	***	-0.288	***
State								
West Berlin	-0.095	***	0.001		-0.001		0.238	***
Baden-Württemberg	0.032		0.012		0.094	***	0.012	
Bavaria	0.030		0.012		0.095	***	-0.055	*
Hamburg/Bremen/ Lower Saxony/ Schleswig-Holstein	0.068	***	0.047		0.111	***	-0.002	
Hesse	0.046		-0.031		0.101	***	0.010	
Rhineland-Palatinate/ Saarland	-0.036		-0.005		0.094	**	-0.115	***
Adjusted R-squared	0.58		0.55		0.65		0.55	
Number of observations	2752		1552		2542		1633	

Without variables describing the landlord-tenant relationship for rented dwellings. * indicates that, statistically, the coefficient is significant different from zero at the 90%-level (** at the 95% level, *** at the 99% level); heteroscedasticity-robust standard errors are used for the calculation of the t-statistics.

be reinforced by the German housing market regulation.[21] However, Genesove (2003) reports substantial evidence of nominal rent rigidity especially for sitting tenants in the US also. Therefore, the difference between estimated rental equivalents and actual rents may result from an pervasive orientation of owners at rents negotiated for new rental contracts (Francois 1989, Frick/Grabka 2001). If the hypothesis that owners derive their estimates from new rental contracts were true, then the (quality-adjusted) estimated equivalent rents should mirror actual rents for new contracts closely. Francois (1989) in a study for the U.S. indeed found that while estimated equivalent rents were typically above the average level of actual rents, they were close to rents in 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 and display a much more pronounced cyclical pattern with a strong acceleration at the beginning of the 1990s and a downward correction in the second half of the decade (Figure 2). Furthermore, the level and the cyclical pattern of the new contract rents resembles that of the estimated equivalent rents in the GSOEP.

A formal test of this proposition on the line proposed by Francois (1989) is not feasible with the GSOEP data 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, indicating that the orientation of the owners' estimates at rents for new contracts explains only a part of the "mark-up". Hence our results resemble that of Goodman/Ittner (1992) who found that owners in the U.S. overestimate the value of their property.

Regarding the development over time, the coefficients proved to be quite stable both for actual rents and for estimated equivalent rents. For a formal test on stability we employ the Wald test. We pool the sample over adjacent periods and interact each regressor with a time dummy. Since the Wald test rejects the null hypothesis that the interactive terms are jointly significantly different from zero, the parameter estimates can be regarded as stable over adjacent periods. For longer time-spans, parameter stability is definitely rejected, and we find slow-moving trends in some parameters.

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[21] 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 from rents for new contracts and for contracts for which rents have been adjusted recently (within four years). This regulation implies that rents for sitting tenants adjust to changing market conditions with some delay only. For details, see Hoffmann/Kurz (2002) and European Central Bank (2003).

Figure 2: Rental equivalents and rents in new contracts

DM per square meter
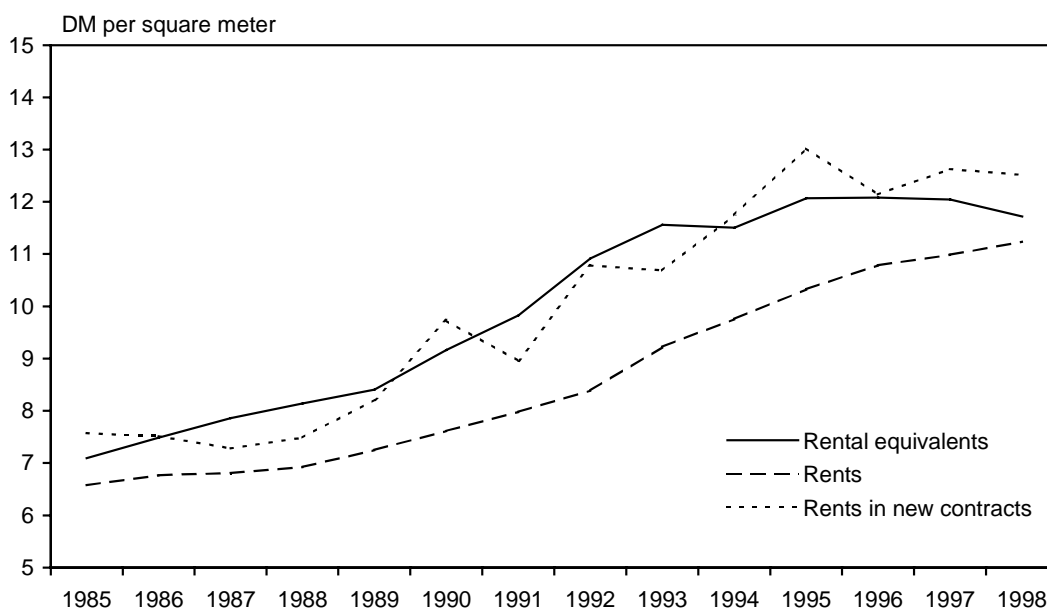
By and large, our hedonic modelling of equivalent rents as estimated by owners can be considered fairly successful. For the most part, the estimated parameters are statistically significant and reasonable and appear to be moving only slowly over time, thus reflecting the peculiarities of the housing market. The adjusted R-squared is not much lower than that found in hedonic equations for actual rents. Furthermore, for most characteristics the differences in the marginal valuations between owner-occupied and rented housing tend to be rather small. It is true that even after quality adjustments there is on average a sizeable difference between estimated rental equivalence and actual rents owners which can be only partly explained by reference to the rents in new contracts, which tend to be higher than rents for sitting tenants. Still, in our view, these findings indicate that the owners' estimates of equivalent rents are by and large reasonable and that the markets for rental and owner-occupied housing are interrelated in Germany.

5 Alternative rental equivalence indices for owner-occupied housing

In this section, we compile various rental equivalence indices for owner-occupied housing from the GSOEP data. In the first stage, we compute indices without hedonics, both simple statistical measures and matched-models indices. In the second stage, we estimate indices quality-adjusted by means of hedonic techniques. In doing this, we replicate the programme of our earlier paper on actual rents (Hoffmann/Kurz 2002). Since all measures have been calculated using GSOEP weights, they can be regarded as being approximately representative of western Germany.

Table 5: Statistical measures of the change in equivalent rents

(1985=100)	1989	1992	1995	1998
Without quality adjustment				
Ratio of arithmetic means	117.4	156.3	182.5	183.2
Ratio of geometric means	120.0	158.1	187.4	191.1
Per square meter				
Ratio of arithmetic means	118.4	153.9	170.1	165.3
Ratio of geometric means	117.7	151.1	170.9	169.9

As measured by the geometric mean, non-adjusted rental equivalents increased by 91% or 5.1% a year in the period under review (Table 5). Equivalent rents per square meter, which give a rough quality-adjusted measure of price increase, increased at a substantially slower pace (70% or 4.2% a year), reflecting the growing size of the average dwelling. However, given the results of the hedonic regressions, the measure of rents per square meters probably overadjusts for the benefits from increasing the size of dwellings, because it assumes a strictly proportional relationship between size and rents. The estimated regression coefficients suggest that the elasticity of equivalent rents (as of actual rents) is substantially smaller than one (see Table 4, page 14).

A superior method of calculating quality-adjusted price indexes is the matched-model technique which restricts the intertemporal comparison to prices of goods which are observed in both periods. Fixed-base matched-models indices refer to a invariant base period. As the GSOEP is a household panel, a fixed-base dwelling sample degenerates from period to period as households move to different locations, implying that such an index becomes less and less representative. Hence, we also calculate chained matched-models indices, using three popular aggregation methods.

The matched-models indices (Table 6) 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 deviating trends, thus confirming the poor reputation of this index type.

Table 6: Matched-models indices

(1985=100)	1989	1992	1995	1998
Fixed-base matched models				
Ratio of arithmetic means (Dutot)	111.4	137.1	158.1	158.0
Ratio of geometric means (Jevons)	113.3	138.4	159.8	161.0
Arithmetic mean of changes (Carli)	119.2	145.8	168.6	168.9
(Number of observations)	(849)	(474)	(258)	(121)
Chained matched models				
Ratio of arithmetic means (Dutot)	112.4	141.9	157.8	155.4
Ratio of geometric means (Jevons)	115.1	144.3	162.5	161.2
Arithmetic mean of changes (Carli)	134.7	182.9	224.8	242.9
(Number of observations)	(1265)	(1047)	(1032)	(936)

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. At 61% or 3.7% per year it is slightly lower than the estimate derived from the simple rent-per-square-meter measure. However, in the medium term there are sizeable differences between the fixed-base and the chained measures.

Turning to quality-adjusted indices based on hedonic regression techniques, we start with the time-dummy method.[22] As Wald-Tests revealed that the estimated coefficients of the hedonic equations are stable over two periods at least, we pool samples over two adjacent years and calculate a biannual price index by exponentiating the coefficient of the time dummy. The resulting annual indices are multiplied into a time series.

Table 7: Hedonic indices based on adjacent-year regressions

(1985=100)	1989	1992	1995	1998
Owner-occupied housing	115.6	144.1	163.1	160.8

According to the adjacent-year index, rental equivalents for owner-occupied housing increased by 60.8% or 3.7% per year (Table 7). 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 geometric means matched-models index in the chained variant indicating that for the data set under review matched-models indices deliver reasonable results.

Table 8: Explicit hedonic indices

(1985=100)	1989	1992	1995	1998
Laspeyres 1985	113,9	142.3	166.4	165.4
Laspeyres, chained	115.7	143,0	162.7	162.0
Paasche 1985	113,2	139,5	160.8	161.0
Paasche, chained	115.6	144.8	165.0	166.6
Fisher 1985	113,6	140,9	163.6	163.2
Fisher, chained	115.6	143.7	163.8	164.3

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[22] For a detailed description of the calculation of the different indices, see Hoffmann and Kurz (2002).

The explicit hedonic indices calculated from the parameter estimates of the cross-section hedonic models and the average level of attributes over the full period give slightly higher estimates of price change (Table 8). According to the chained Fisher index, equivalent rents increased by 64% or 3.9% per year. These differences to the time-dummy index, however, emerge at the end of the period under review only. Up to 1995, the explicit hedonic index is close to the adjacent-year and the matched-models indices. Overall, the differences between the various indices appear to be quite small.

Table 9: CPI measures of rent inflation
(1985=100)

	1989	1992	1995	1998
Total	108.8	123.7	142.3	153.0
4-room apartments (privately financed)	107.9	123.0	141.1	151.0

In the period from 1985 to 1998, the CPI subindex for housing increased by only 53% or 3.3% per year. For privately financed four-room apartments, which are mainly used for the imputation of rental equivalents in the CPI, the recorded rate of change is even lower (51% or 3.2% per year). This finding suggests that the official CPI housing subindex may be biased downwards. As the CPI measure of housing cost inflation is derived from a restricted sample of dwellings only, the difference may originate from the lack of representativity of the CPI sample for owner-occupied housing.

Our earlier research on the measurement of housing rents (Hoffmann/Kurz 2002) revealed firstly that actual rents as measured by a chained hedonic Fisher index increased by 64.1% in the period under review, giving nearly exactly the same estimate of long-run price change as the index based on rental equivalents developed in this paper. Hence, we might tentatively conclude that the quite pronounced differences in the composition of rental and owner-occupied housing do not matter for inflation measurement if rental housing is broadly covered (and not restricted to a small sample of typical rental flats). Secondly, we found that for rental housing the differences in price trends between a sample restricted to flats matching the CPI specifications and a sample covering other dwellings are trivial. Hence, it seems that even the restriction of the sample to few dwelling types is not the cause of the differences either. Hence, the German imputation method per se does not seem to distort inflation measurement.

Furthermore, our findings suggest that in the period under review no substantial changes in relative prices between owner-occupied and rental housing in terms of rents and rental equivalents occurred. It is, however, not entirely clear whether this conclusion can be transferred to true user costs. The slowly rising share of owner-occupied housing in Germany might be interpreted as indicating a change in relative costs in favour of owner-

Figure 3: Fisher indices for owner-occupied and rental housing
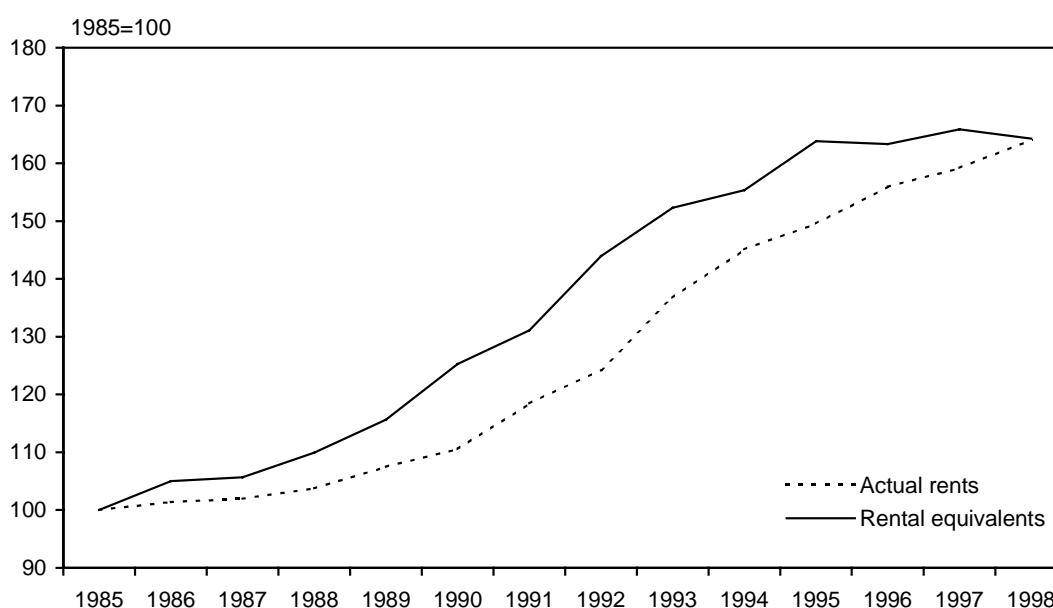
occupied housing.[23] However, even with unchanged relative prices we would expect to see a rising importance of ownership resulting from the growth of real disposable income. Hence, the rather small gain in the weight of owner-occupied housing seems not to be at variance with the finding of largely invariant long-term relative prices.

A closer look at the data reveals that while, in the long run, quality-adjusted estimated rental equivalents display exactly the same trend as quality-adjusted actual rents, there are important differences in the short to medium term (Figure 3). Whereas rental equivalents increased more sharply in the period up to 1992, opening a gap to actual rents, actual rents afterwards made up the differences by increasing substantially faster. These divergences at least partly reflect the orientation of the owners' assessment of the rental value of their residential property at rents for new contracts, which increased steeply in this period, responding to the inflow of population from eastern Germany and other countries in Eastern Europe and the unification boom in Germany.[24] Hence, the equivalent rents mirror the present state of the housing market more closely, whereas the actual rents echo developments in the (recent) past.

In this context a problem with the interpretation of the rental equivalence concept arises. If the purpose of the rental equivalent concept is to produce an index for a fictional population of renters, then it seems not to be entirely appropriate to derive the rental

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[23] According to housing surveys, the share of owner-occupied housing increased in western Germany from 1985 to 1998 by about 2pp.

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

equivalents from rents in new contracts only. Given the peculiarities of the rental market, owners cannot expect to achieve in long-term contracts market clearing rents in each period. Hence it seems reasonably to adjust estimated rental equivalents by applying the length-of-stay discounts estimated in our hedonic rent equation. For the most part this modification should impact on the estimated level of rentals equivalents only. With time-varying tenancy discounts, however, the estimate of the change in rental equivalents will be affected also. We discuss this problem in more detail in the following chapter, in which indices for total housing are calculated and compared with the official price data.

6 Price indices for overall housing

Based on the findings in the previous chapters and in our earlier paper, we have now reached a state where we are able to calculate an index for total housing and investigate the differences to the official CPI index. In principle, there are two ways of calculating indices for total housing from our earlier findings. Firstly, using adequate weights, we may calculate a weighted average of the indices for rental and owner-occupied housing. Secondly, as the results of the tests on equality of the parameter estimates in the hedonic regressions do not indicate substantial divergences, we may pool the renter and the owner sample and then proceed as for the separate samples.

We choose the latter method and start with a regression model including a full set of interaction terms between rental and owner-occupied housing. From this model all insignificant interaction terms are dropped, 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 traits, we calculate fixed base and chained Laspeyres, Paasche and Fisher indices 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 tenancy discounts.

For this purpose we need to stipulate a distribution of the length-of-stay for owners which would be relevant in a fictional universe of renters. As mentioned before, there are substantial differences in the actual 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 decision of households. Therefore, we would expect households with potential mobility needs to rent and households without mobility needs to own. Compromising on these two arguments, we take the average of the owners and the

renters occupancy durations for the stipulation of the length-of-stay in the fictional world exclusively populated by renters.

Table 10: Explicit hedonic indices for total housing
(1985=100)

	1989	1992	1995	1998
Non-adjusted				
Laspeyres 1985	111.1	132.6	155.8	165.2
Laspeyres, chained	111.4	132.3	155.9	164.1
Paasche 1985	110.9	131.3	154.6	163.6
Paasche, chained	111.5	133.7	158.1	166.8
Fisher 1985	111.0	131.9	155.2	164.4
Fisher, chained	111.5	133.0	157.0	165.5
Adjusted for length of occupation				
Laspeyres 1985	109.9	130.4	154.6	164.2
Laspeyres, chained	110.0	129.7	153.1	161.1
Paasche 1985	109.9	129.2	153.1	162.3
Paasche, chained	110.1	131.3	156.6	165.4
Fisher 1985	109.9	129.8	153.9	163.2
Fisher, chained	110.1	130.5	154.8	163.3

According to our calculations, in the period under review total housing costs increased by 66% or 4.0% per year. Adjusting the owner-occupied segment for the effect of the occupancy duration on actual rents reduces the estimated rate of price increase only slightly to 63% or 3.8% per year. Over the full period, the length-of-stay adjusted index for total housing rises exactly as strongly as the estimated indices for rents and rental equivalents, with the increase in rents being more subdued at the beginning and more vigorous at the end of the period (Figure 4).

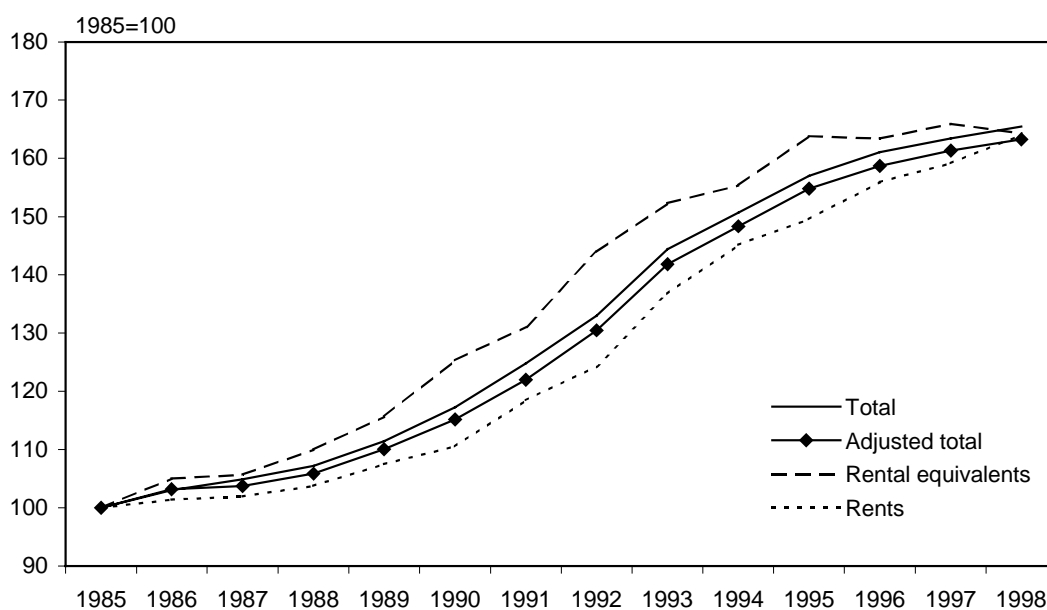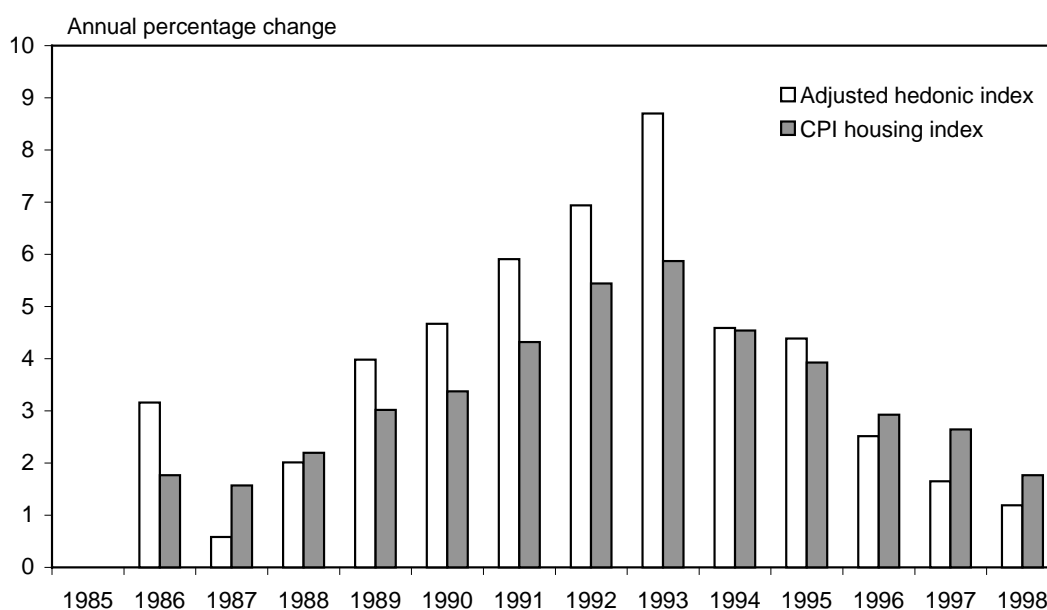**Figure 4: Fisher indices for housing**

Figure 5: Changes in housing costs

Annual percentage change

Whereas the differences between the length-of-stay-adjusted and the non-adjusted Fisher indices are rather small, there is a substantial discrepancy with the official CPI housing cost inflation measures. Over the full period of 13 years, the difference to the adjusted Fisher index amounts to 10 percentage points or 0.5pp per year.

A closer inspection of the dynamics of the various indices reveals that until 1988 the CPI measures were rather close to the hedonic indices. Starting in 1989, the rates of increase of the hedonic index turned out to be substantially higher than for the CPI rent subindex. From 1994 on the CPI and the hedonic measures by and large displayed the same rate of change. These findings may be interpreted as evidence of a time-variant bias in the German CPI housing cost measure.

It is quite difficult to give a plausible explanation for this finding which resembles that of our earlier paper on rents. 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.[25] In our earlier paper we discuss a list of potential causes but conclude that neither of those is fully convincing. Probably the divergence stems from hidden differences in the CPI and GSOEP dwelling samples unrelated to the types of dwellings. Such differences can, however, not be explored without a detailed examination of the CPI sample.

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

7 Conclusion

This paper has two main results. Firstly, the German imputation method for owner-occupied housing basically seems to be sound. Imputing rental equivalents from actual rents recorded from a restricted sample of rented flats does not seem to cause severe distortions. Secondly, we find some evidence of a downward bias in the German housing cost measure which seems to stem from unidentified problems in the German rent measure. In this aspect our results resemble that of some recent studies for the US CPI which also hint at biases in housing inflation measures. Crone/Nakamura/Voith (2000) report that in the period 1985 to 1993 the US CPI overstated the increase in the cost of owner-occupied housing services, but underestimated the increase in rents somewhat. A more sizeable understatement of rent inflation was found for the period 1940 to 1977 (Crone/Nakamura/ Voith, 2001). Gordon/VanGoethem (2003) also report evidence of a substantial downward bias in the US CPI rent component. Hence there seems to be various empirical evidence that some understatement of inflation for some "old" products may counterbalance somewhat the overstatement of inflation for "new" products reported in the literature.

At a more technical level, our results 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 which can be only partly explained by the orientation of owners at market rents for new contracts. Probably this "mark-up" for owner-occupied housing is partly related to characteristics not reported in the GSOEP. If this were true, the "mark-up" would not indicate a "true" overestimation of rental values. As the range of characteristics reported in the GSOEP is rather limited, the hedonic adjustment for quality differences is clearly incomplete. We could feel, however, confident that our estimates gave the "true" rate of price if the unreported characteristics were strongly correlated with the reported traits. Most likely this is not the case, and the true rate of price change probably has been smaller. This qualification of our results does not, however, help to explain the differences between our hedonic measure and the CPI measure, since the quality adjustment in the CPI housing component is even more rudimentary.

A further caveat applies to the econometric techniques employed in this paper. Ekeland/Heckman/Nesheim (2003) and Heckman/Matzkin/Nesheim (2003) have reminded us that for welfare considerations and for the compilation of true cost-of-living indices the structural parameters actually underlying the hedonic market are needed, and they propose semiparametric and instrumental-variables methods for recovering these parameters. It is true that we allow for some non-linearities in our estimation. However, by and large our estimation procedure remains in the realm of traditional parametric hedonic techniques,

which choose the best fitting functional form from a restricted range of alternatives. In this respect our paper is rather conventional. Some readers might prefer to see more refined econometric techniques, but this is beyond the scope of our paper.

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