Rent indices for housing in West Germany 1985 to 1998

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Abstract

In several studies, hedonic methods have been used successfully for the ex post assessment of the accuracy of inflation measurement. Most of those studies relate to high-tech products, with respect to which traditional methods of compiling price indices often fail. We apply hedonic methods to rental housing services, which display less quality progress. However, as German households devote about 10 % of their total expenditure to rented housing services, even a small bias in this field might induce a substantial distortion in overall inflation measurement. On the basis of data from the German Socio-Economic Panel, we perform a hedonic analysis of housing rents and compile different price indices. Overall, we conclude that there is some evidence of an understatement of rent inflation in the official rent index for West Germany at the beginning of the 1990s.

Keywords: Consumer Price Index, hedonics, housing, matched models.

JEL Classifications: C21, D43, D12, E31

Zusammenfassung

Hedonische Methoden wurden in einer Reihe von Studien erfolgreich für die ex post Analyse der Genauigkeit der Inflationsmessung verwendet. Die meisten dieser Studien beziehen sich auf High-tech Produkte, bei denen traditionelle Methoden zur Berechnung von Preisindizes oftmals versagen. Wir wenden hedonische Methoden auf Mieten für Wohnungen an. Dort ist der Qualitätsfortschritt weniger stark. Da aber die privaten Haushalte in Deutschland rund 10 % ihres Budgets für Mieten ausgeben, könnte selbst eine kleine Verzerrung in diesem Bereich die Genauigkeit der Inflationsmessung insgesamt empfindlich stören. Auf Grundlage von Daten des Sozioökonomischen Panels schätzen wir hedonische Gleichungen für Wohnungsmieten und berechnen verschiedene Indizes. Insgesamt kommen wir zu dem Ergebnis, dass es in Westdeutschland Anfang der neunziger Jahre Hinweise auf eine Unterschätzung des Mietenanstiegs durch den offiziellen Mietenindex gab.

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1 Introduction

German households spend about 10 % of their income on rental housing services, but less than 1 % on information technology (IT). Still, potential mismeasurement of price movements for IT has attracted much more attention than potential mismeasurement of housing costs in the recent debate on the accuracy of inflation measurement. On the one hand, this is understandable, as rapid technological progress in IT is conducive to the prejudice that mismeasured IT prices cause a major bias in overall consumer-inflation measurement. To the experts in the field, the difficulty of adjusting prices for improving product quality when prices are declining is well known.

Looking at housing services, at first glance it might seem that price measurement poses no comparable problems. As the stock of dwellings does not change substantially from month to month, and even from year to year, forced item replacements occur less often than in the case of other products, thus reducing the need for quality adjustments. But housing services differ from other products in many respects. Dwellings are extremely heterogeneous products. The rental value of a dwelling is determined not only by its physical characteristics but also by its location. Depreciation, on the one hand, and maintenance and improvements, on the other hand, change the quality of dwellings over time. Tenants may either buy or rent a flat. Rent contracts between landlords and tenants are often regulated. All these factors may render the analysis of housing costs more difficult than the analysis of the prices of many other products, and provide a potential for measurement bias.

And indeed, in a recent study on U.S. data, Crone/Nakamura/Voith (2000) found evidence that, in the period 1985 to 1993, the Bureau of Labor Statistics (BLS) measure of housing costs understated inflation for rental units and overstated inflation for owner-occupied houses. According to their estimates, overall the BLS measure overstated the increase in the cost of housing by about 6.6 percentage points, which implies a bias of 0.6 percentage point a year for the housing component and of about 0.15 percentage point for the total CPI. Gordon/Mandelkern (2001) report some evidence indicating an understatement of in-

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flation by the BLS rent index. These findings underline the need to look not only at products with high rates of quality change but also at more normal products.

Given the limited importance of expenditure on IT products in households' budgets, and the much more important role of outlays on housing services, a much smaller measurement bias for rents might imply a bias of a similar order of magnitude for the overall Consumer Price Index (CPI). An estimate of the typical bias for IT prices might amount to 10 percentage points a year. With an expenditure share of 1 %, this would imply an overall bias for the CPI of 0.1 percentage point a year. A downward bias in inflation measurement for rents of just 1 percentage point a year, with an expenditure share of 10 %, would fully cancel out the above-mentioned upward bias resulting from the mismeasurement of IT prices.

The basic idea of this paper is to use an independent data set to construct several benchmark measures of housing-service inflation for the purpose of cross-checking the rent index in the German CPI. In this paper, we will only look at price movements for rental housing. In a companion paper, we also present measures of price movements for owner-occupied housing (Kurz/Hoffmann 2002). Here we will consider three reasons why the German price index for rental housing services may fail us:

- Sampling: Are the flats sampled for price observations representative of the whole universe of flats? If not, does disproportionate sampling distort the accuracy of inflation measurement?
- Aggregation: What is the adequate index formula? Is an adequate index formula employed? Does the choice of the index formula matter to the accuracy of inflation measurement?
- Quality adjustment: Can the methods of adjusting rents for changing characteristics of dwellings be considered appropriate in the Consumer Price Index? If not, do the inadequacies of quality adjustment induce a substantial bias?

We take the data for our analysis from the German Socio-Economic Panel (GSOEP), which is a yearly household panel that reports extensively about housing conditions. As the GSOEP reports rents inclusive of additional expenses on refuse collection and similar housing-related services, and as, after 1998, the CPI series on rents does not cover additional expenses any longer, we confine our analysis to the period 1985 to 1998. Furthermore, since the GSOEP for East Germany starts in 1990 only and rents in East Germany were strictly regulated in the first half of the 1990s, the analysis is restricted to dwellings in West Germany.

The paper is organised as follows: In section 2 below we briefly describe the German market for rental housing. Section 3 continues by discussing the peculiarities of the price index for rental housing in the German CPI. In section 4, the GSOEP is introduced, and in section 5 the results of an hedonic analysis of housing rents in Germany are presented. In section 6 we look at the development of rents as described by different types of indices and discuss the results. Finally, section 7 concludes.

2 The German market for rental housing services

The German market for rental housing is - by international standards - extremely well developed. Nearly 60 % of households live in rented dwellings. In most other European countries, rental housing has much lower importance. As a consequence, German consumers spend about 10 % of their income on rents for housing services, and the weight of apartment rents in the German Harmonised Index of Consumer Prices (HICP) is much higher than that in most other euro-area countries (see Table 1).

After the abolition of post-war controls, the German market for rental housing was basically a free market until, at the beginning of the 1970s, a new set of regulations was introduced. Since then, several restrictions on evicting tenants and on increasing the rents for sitting tenants have applied.[1] However, compared with many other European countries, rental housing in Germany is still loosely regulated, which may partly explain the low share of owner-occupied housing.[2]

There are two major segments of the German market for rental housing, which differ with respect to the intensity of regulation: firstly, there is the relatively loosely-regulated market for privately financed dwellings, and secondly, the more strictly-regulated market for dwellings with public co-financing. In the following, we term the first segment privately financed dwellings, the second segment subsidised dwellings. This labelling is to some extent misleading, as, for a long time, housing has mostly been subsidised in Germany, but the degree of subsidisation is much higher in the second sector than in the first.

1 On the regulation of the German markets for rental housing, see Eekhoff (1981), Hubert (1993), Sonnenschein (1994) and Kofner (1996). For recent developments - the regulation of rental housing was changed in 2001 - see Grundmann (2001).

2 Moreover, the regulation of housing markets generally, taxes and subsidies, and the regulation and structure of financial markets influence the modal split between owner-occupied housing and rental housing. Thus, relatively unfavourable conditions for owner-occupied housing might also explain the large share of rental housing in Germany.

Table 1: The weight of rental housing in euro-area HICPs in 2001

Country	HICP weight of actual rents in ‰
Austria	36.4
Belgium	64.3
Finland	51.8
France	63.8
Germany	86.6
Greece	36.7
Ireland	21.3
Italy	28.2
Luxembourg	45.6
Netherlands	97.8
Spain	20.7

As already mentioned, the regulation of publicly co-financed housing is comparatively strict. For a certain time-span, these dwellings may be let only to persons who meet certain conditions (relating to income, family size etc.), and rents are kept under control. For some dwellings, public authorities even retain the right to nominate tenants. If the occupants no longer meet the conditions for claiming a subsidised flat, they do not have to leave the apartment, but they may have to pay a higher rent. After a certain period, the special restrictions on the selection of tenants and on the setting of rent are lifted. Afterwards, the standard regulations apply.

In the submarket for privately financed dwellings, in principle freedom of contract applies. For vacant dwellings, rents can largely be negotiated freely between landlords and potential tenants. However, there are some restrictions on evicting tenants and on increasing rents for sitting tenants. In the period under review, tenants could be evicted only by landlords citing several limited and well-defined reasons. For sitting tenants, rents could only be increased up to the level of rents for comparable dwellings in the vicinity. Furthermore, there was a general ceiling on rent increases (up to 30 % in a three-year period). Most of the time, and in most regions, however, this stipulation was not binding as, in the German low-inflation environment, rent increases were typically well below 10 % a year. Moreover, as rent-escalation clauses, indexed rents and additional rent increases for improvements, as well as limited-period rent contracts were likewise admissible, the regulation of the rental housing market cannot be classified as extremely strict.

There were some restrictions on the absolute level of rents as well. If rents were more than 20 % above the level of comparable rents customary in the vicinity, then they were regarded as being excessive by the courts, which constituted an administrative offence; if rents exceeded the level of comparable rents by more than 50 %, they were considered as being usurious, which constituted a criminal offence. That regulation may sound stricter than it was, as rents up to 50 % above the level of comparable rents could be justified by the landlord’s own costs, especially by mortgage burdens.

Today, the level of rents for comparable dwellings in the vicinity is typically assessed by reference to a rent survey published by local authorities (Börstinghaus/Clar 1997). 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). Rents from the subsidised sector may not be included. These stipulations further weaken the restrictions on rent increases and on the level of rents. In the early years of our sample, rent surveys were not yet available in most municipalities, and tenants could reject requests for rent increases more easily. Thus, the regulation of rent increases has become less binding during the period under review.

This kind of relatively light regulation of rental housing, which couples restrictions on the eviction of tenants with restrictions on rent increases for sitting tenants but leaves new contracts unregulated, has been termed second-generation rent control (Arnott 1995) or tenancy rent control (Basu/Emerson 2000). A likely consequence of such regulation is that tenants pay higher rents sooner and lower rents later, because landlords anticipate that they might not be able fully to adjust rents for sitting tenants to market trends (Eekhoff 1981, Börsch-Supan 1986, Nagy 1997, Basu/Emerson 2000). In a cross-section, the level of rent would then vary inversely with the length of tenancy. This phenomenon has been termed tenancy or residency discount in the literature.

However, such tenancy discounts may also be found in unregulated markets. As Guasch/ Marshall (1987) have argued, several factors may contribute to this outcome. Firstly, as landlords prefer tenants who do not cause extra costs by such bad behaviour as making excessive noise, running down the apartment, or paying the rent only irregularly, but cannot distinguish between low-cost and high-cost tenants ex ante, they tend to grant discounts to those tenants who have revealed that they are of the low-cost type. Hubert (1995) gives a formal proof of this hypothesis. Secondly, transaction costs may contribute to tenancy discounts, but this depends on the relative weight of moving costs for tenants and vacancy costs for landlords (Shear 1983). Moreover, quality-related price differences between dwellings may be falsely identified as tenancy discounts. As the quality of flats typically deteriorates slowly during a tenancy, either the rent has to be lowered relative to the market level, or the dwelling has to be reconditioned regularly to keep the tenant in residence. And finally, a tenancy discount may be suggested by the data simply because tenants stay longer in dwellings with low quality-adjusted prices.

Guasch and Marshall propose breaking down global tenancy discounts into sit discounts and true length-of-stay discounts. By and large, asymmetric information about the future behaviour of a new tenant can only explain a discount, which increases with inflation only in absolute terms, but not in relative terms. This type of discount is termed sit discount. A true length-of-stay discount, which increases in relative terms with the length of the tenancy, might be rationalised by an argument put forward by Schlicht (1983): as the economic and social conditions of a tenant change, the dwelling chosen under earlier conditions becomes less optimal. If the landlord is interested in keeping this specific tenant, he will lower the rent with the decreasing willingness to pay. More often length-of-stay discounts are, however, a consequence of legal restrictions on rent increases.

Thus, both the peculiarities of housing markets and the regulations may result in tenancy discounts, which may cause a kind of lock-in effect with local non-substitution, since old contracts are not available to potential new tenants, and new contracts may not be attractive to sitting tenants, even if the old flat does not suit their needs any more.

Whether tenants on average benefit from the regulation of rental housing in Germany is an interesting question in itself, but the answer to this question is not crucial for the purposes of this paper. However, the related question as to whether the regulation is strictly binding has some relevance to inflation measurement. If the answer is in the affirmative, then true length-of-tenancy discounts will emerge, which implies that the regulation separates markets. This might have consequences for the optimal design of the index formulae.

Furthermore, true length-of-stay discounts imply that a substantial proportion of rent increases occur when tenants move, that is, when a change of tenants takes place. This is quite similar to a phenomenon found in many goods markets: price changes often coincide with a change of models (Moulton/Moses 1997). Thus, in the short and in the medium term, the measured rate of rent increase may depend on the rate of tenant turnover in the set of dwellings sampled for price-observation purposes.[3] If the rate of turnover is not representative of the true universe of dwellings, this might result in a distorted measure of rent increases.

The same phenomenon occurs if rents for sitting tenants adapt less rapidly to changing market conditions than rents for new contracts, which implies that tenancy discounts vary with the state of the market. In Germany, the regulation of rent increases for sitting tenants may add to the relative inflexibility of rents for sitting tenants. Therefore we may expect that in periods experiencing an unexpected increase in demand for housing, primarily the rents for new contracts will rise. The rents in existing contracts may follow only with a substantial delay, which implies that the tenancy discounts will increase temporarily. In that case, the estimate of rent inflation will be biased downwards in the short run, if the rate of tenant turnover in the price-index sample is below the true rate of turnover.

3 Only in a true steady state with a stable pattern of tenant turnover and tenancy discounts the rate of tenant turnover does not matter for the measured rate of inflation.

3 The German Consumer Price Index for apartment rents

Basically, the German CPI sub-index for housing services is a matched-model index.[4] As a rule, the same flats are sampled each period, which implies that the rent component of the CPI is based on a dwelling sample, not on a household sample. Typically, the statisticians stay with a dwelling if the tenant changes.

The matched-model method is very popular with statisticians, as "like" is compared with "like", which lessens the burden of quality adjustments stemming from the comparison of prices for heterogeneous products. However, this technique may yield distorted measures of price change. A matched-model index for washing machines, for example, may fail because price movements may differ between models in the matched sample and models not inside the sample, that is, between models sold in both periods and old and new models (Silver/Heravi 2001b). In the case of dwellings, a further problem emerges: the quality of dwellings may change from one period to the next. On the one hand, there is wear and tear, which reduces the quality of housing services; on the other hand, renovation or reconstruction measures may take place. Furthermore, the characteristics of the neighbourhood of a dwelling may change.

In the U.S. CPI, adjustments are made for the creeping change in quality that stems from wear and tear (Randolph 1988). Nothing similar to this is done in the German CPI. Thus, the index for rental housing services in the German CPI may understate true housing-service inflation. However, in Germany no adjustments are made for simple reconditioning measures, either. Only if the landlord gives specific improvement measures as an explicit reason for his request for higher rents, then this part of the rent increase (which is termed "Modernisierungsumlage" in German) is accounted for as being quality-related, and is neutralised for the calculation of the rate of inflation. Hence we tentatively might conclude that no major bias results from quality changes related to wear and tear and renovation measures in the German CPI.

As mentioned above, a pure matched-model index may fail to give an accurate estimate of true price movements because the prices of models outside the sample might differ from prices inside. In the case of housing services, this is relevant to new dwellings. In Germany, the statistical offices widen the sample of flats if the stock of dwellings increases. For the new flats added to the sample, a rudimentary quality adjustment is performed: if the size of the new apartment is s^{new} and the average size of apartments already in the sample s^{old}, then the quality-adjusted rent for the new apartment r^{new}_{ad} is calculated as:

4 For details on the rent component in the German CPI, see Rostin (1966), Rostin (1967), Guckes (1975) and Angermann (1985). On the German CPI in general, see Hoffmann (1998).

(1) $$r_{ad}^{new} = r^{new} \frac{s^{old}}{s^{new}}.$$

As new dwellings are typically of better quality in many dimensions than older flats, this procedure quite likely biases the rent index upwards. On the other hand, this kind of quality adjustment relies on the assumption that rents increase proportionally with size. If, however, rents increase less than proportionally with size, this procedure overadjusts for the increase in size.

The sampling of dwellings for the German CPI is of the non-probability type. Dwellings are selectively sampled for six types of flats (for three types of flats in the privately financed segment and for three types of flats in the subsidised segment of the market; see Table 2). Only 3- and 4-room apartments (including kitchen) are considered, that is, apartments with one or two bedrooms; smaller apartments and bigger dwellings, such as single-family houses, are not taken into account. If price trends for those types of dwellings outside the sample differ from those in the sample, the estimate of the rent increase will be distorted. Each month rents are collected for one-third of the sample. This lower-than-usual frequency of price collection is considered appropriate as rents are typically changed only once a year. The turnover of tenants in the CPI sample varies between 5 and 10 % a year.

As for other products in the German CPI, at the lowest level - that is, for the six types of flats - rents are aggregated by a Dutot index (the ratio of an arithmetical average of rents). With $r_{ij}{}^{t}$ representing the rent of flat j in group i in period t and n^t the number of flats in period t, the Dutot index gives:

(2) $$I_i^{0,t} = \frac{\frac{1}{n^t}\sum_{j=1}^{n^t} r_{ij}^t}{\frac{1}{n^0}\sum_{j=1}^{n^0} r_{ij}^0}.$$

For a matched sample, which implies $n^t = n^0$, a Dutot index can be described as a Laspeyres-type index, where the weights of each item are proportional to its relative price in the base period:

(3) $$\frac{\sum_j r_{ij}^t}{\sum_j r_{ij}^0} = \frac{\sum_j r_{ij}^0 \frac{r_{ij}^t}{r_{ij}^0}}{\sum_j r_{ij}^0} = \sum_j g_{ij}^0 \frac{r_{ij}^t}{r_{ij}^0} \qquad \text{with} \qquad g_{ij}^0 = \frac{r_{ij}^o}{\sum_j r_{ij}^0}.$$

Table 2: Apartment rents in the German Consumer Price Index

Basket	1985		1991
Starting in In inflation measurement since Up to	01/1985 09/1989 08/1995		01/1991 08/1995 12/1998
Apartment type	CPI weight in ‰[1]	CPI weight at 1991 prices in ‰[1]	CPI weight in ‰[1]
Overall	177.77	188.41	191.93
Privately-financed apartments	143.99	152.65	163.45
3-room apartment (including kitchen), without bathroom, furnace heating, built by 1948	3.91	4.29	2.96
3-room apartment (including kitchen), with bathroom, furnace heating, built by 1948	16.71	18.30	12.15
4-room apartment (including kitchen), with bathroom, central heating, built after 1948	123.37	130.06	148.34
Subsidised apartments, built after 1948	33.78	35.70	28.48
3-room apartment (including kitchen), with bathroom, furnace heating	5.51	5.97	5.03
3-room apartment (including kitchen), with bathroom, central heating	28.27	29.82	18.91
4-room apartment (including kitchen), with bathroom, central heating	.	.	4.54

[1] Including imputed rent of owner-occupied housing.

If the CPI sample of dwellings were representative of the whole population of occupied dwellings, then the weights would correspond perfectly to fully representative base-period expenditure shares, and the CPI rent sub-indices would correspond to true Laspeyres indices.

In a second stage, state ("Land") rent indices are calculated using a Laspeyres index with expenditure shares a_i^0 taken from the fixed base period (see Table 2):

(4) $$I_L^{0,t} = \sum_i a_i^0 I_i^{0,t} .$$

Finally, the Federal rent index is calculated as an arithmetical mean of state rent indices, using population shares of the base period b_k^0 as weights:

(5) $$I_F^{0,t} = \sum_k b_k^0 I_k^{0,t} .$$

The weights of the different types of flats changed substantially between the base year 1985 and the base year 1991 (see Table 2). Privately-financed apartments generally increased in importance, especially the 4-room type. On the other hand, the share of subsidised apartments declined, reflecting the ongoing lapsing of the special restrictions on rents for dwellings and the declining share of public co-financing in housing construction.

Table 3: Apartment rent developments according to the German CPI

Percentage change per annum

Apartment type	1985-1998
Overall	3.3
Privately financed apartments	3.3
3-room apartment (including kitchen), with bathroom, furnace heating, built by 1948	4.0
4-room apartment (including kitchen), with bathroom, central heating, built after 1948	3.2
Subsidised apartments, built after 1948	3.4
3-room apartment (including kitchen), with bathroom, furnace heating	4.0
3-room apartment (including kitchen), with bathroom, central heating	3.3

The use of the Laspeyres formula for the compilation of price indices has been criticised from the angle of the theory of the cost-of-living index because a Laspeyres index is exact only for Leontieff preferences, which imply no substitution. For most products, the assumption of no substitution will result in a distorted estimate of the change in the cost of living if relative prices change. In the field of rental housing services, things may differ. If the regulations described above were binding in the sense that they effectively separated housing markets, then a Laspeyres index might be the adequate index formula because households could not substitute. For instance, if there are true regulation-induced tenancy discounts, rents are lower for sitting tenants, but new tenants cannot rent an equivalent flat on the conditions applying to the sitting tenant. Hence a Laspeyres index might be appropriate for this market.

However, tenants do move. We may therefore understand the regulations as adding to the already substantial transaction costs in housing markets. Applying a revealed-preference argument, we still may prefer more flexible index formulae, such as the Fisher formula, to the Laspeyres formula: if households do not adapt to changing conditions, the Fisher formula will give the same results as the Laspeyres formula. However, if households do adapt, than the estimates will differ, and from a cost-of-living perspective we would prefer a measure which reflects the adjustment of housing choices.

According to the German CPI, in the period from 1985 to 1998 rents increased by 3.3 % a year on average (see Table 3). The rate of change differed substantially among the various types of dwellings. Rent increases were above the average for 3-room apartments in the private segment of the market and for flats with furnace heating. This indicates that sampling might matter for the accuracy of housing service inflation measurement. However, there was no substantial difference in price increases between privately financed and subsidised apartments.

4 Apartment rents in the German Socio-Economic Panel

The German Socio-Economic Panel (GSOEP), which is described in detail in SOEP (2001), is a yearly household panel that assembles information about living conditions in Germany. Among other data, the GSOEP reports rents actually paid by households and major characteristics of dwellings. Moreover, additional locational information is available in an extended version of the GSOEP.

The GSOEP started in 1984 with nearly 6,000 households, 65 % of which were tenants and 35 % lived in owner-occupied housing. In 1990 it was enlarged to include eastern Germany. The GSOEP continues questioning the same persons every year. New persons enter the West German sample of the GSOEP by birth or by marriage, or - since 1992 - by moving from eastern Germany to western Germany. Split households, for example owing to divorce or grown-up children, are followed up. Still, the problem of panel mortality is quite severe in the GSOEP, as many households sooner or later choose not to answer the questionnaire any more. Therefore, the number of households which have continuously replied to the questionnaire since the first wave of the GSOEP is rather small. In 1998, the last year covered by our study, the GSOEP was refreshed by about 1,000 households. By then, slightly over 5,500 households of the sample were living in West Germany, about 60 % of them in rented flats.

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, which is a yearly 1 % representative sample of the whole population. Hence estimates based on weighted GSOEP data can be regarded as representative of Germany. All figures and results reported below stem from the weighted sample. We exclude from our analysis only households living in residential homes, student halls and other hostels, as rents paid by such households are likely to be biased either by housing subsidies or by the inclusion of services like catering. The rents reported in the GSOEP include some housing-related expenses on electricity, water supply and waste disposal. The same was true of the rents collected for the compilation of the CPI up to 1998; since then, however, the CPI has related to rents excluding any additional expenses. Hence, we restrict our study to the period 1985 to 1998.

Although we focus on apartments, rather than households, we cannot generate a true dwelling sample from the GSOEP. In the case of a move, we follow the household into the new flat and lose the old apartment. In the period under review, we observe in all about

Table 4: Rental housing in the GSOEP (weighted sample)
(Share in overall expenditure on rents in %)

Apartment type	1985	1991
Privately financed apartments	75.0	78.9
Apartments according to CPI specifications	24.0	25.9
3-room apartment (including kitchen), without bathroom, furnace heating, built by 1948	0.6	0.1
3-room apartment (including kitchen), with bathroom, furnace heating, built by 1948	4.6	5.7
4-room apartment (including kitchen), with bathroom, central heating, built after 1948	18.8	20.1
Other apartments	51.0	53.0
Subsidised apartments, built after 1948	25.2	21.1
Apartments according to CPI specifications	15.3	13.9
3-room apartment (including kitchen), with bathroom, furnace heating	0.8	0.9
3-room apartment (including kitchen), with bathroom, central heating	5.3	5.1
4-room apartment (including kitchen), with bathroom, central heating	9.2	7.9
Other apartments	9.9	7.2

6.000 different households and 10,000 different dwellings. The greater number of apartments reflects moves within the sample. Between 6 % and 11 % of households move inside the sample each year, which is nearly as high as in the dwelling sample of the official CPI. However, this figure does not include those households which enter the sample after having moved recently, or those households which were not contacted successfully by the GSOEP team in the year immediately following the move. Hence the true rate of turnover seems to be higher in the GSOEP than in the dwelling sample of the CPI.

For the purpose of comparing rent developments in the GSOEP with the German CPI, we split the data set into two subsamples: in the "CPI sample", we include apartments that correspond to the specification of the apartments in the consumer price statistics; the "Non-CPI sample" consists of other dwellings. Table 4 reports the expenditure shares of the various apartment types. According to the GSOEP, households spend only about 40 % of their total expenditure on rental housing on the CPI types of apartments. The remaining 60 % is spent on dwellings which do not correspond to CPI definitions. If the price trend of flats not covered in the CPI differs substantially from the price trend of CPI-type apartments, then the low coverage of the CPI will lead to a severe sampling bias.

Table 5 reports sample means and standard deviations of GSOEP variables relating to housing conditions. Besides data on rents, the GSOEP contains a lot of information about physical and locational characteristics of dwellings, and on other factors which may influence rents. Firstly, the GSOEP differentiates between subsidised and non-subsidised dwellings. Secondly, the GSOEP provides information on the previous length of the ten-

Table 5: Summary statistics of dwelling characteristics in the GSOEP (weighted sample)

	1985		1998	
Variable	Mean	Std. dev.	Mean	Std. dev.
Rent (DM)	438.2	206.8	793.3	352.1
Landlord-tenant relationship				
Occupancy duration (years)	10.9	11.3	11.0	12.1
Subsidised apartments	0.27		0.18	
Physical characteristics				
Vintage				
Built 1918 or earlier	0.14		0.12	
Built between 1918 and 1948	0.21		0.17	
Built between 1949 and 1971	0.49		0.42	
Built 1972 or later	0.16		0.29	
Built between 1972 and 1980			0.13	
Built between 1981 and 1990			0.07	
Built 1991 or later			0.09	
Size (square metres)	68.7	24.8	72.3	26.6
Furnishing				
Kitchen	0.98		0.99	
Bathroom	0.95		0.99	
Toilet	0.97		0.99	
Central heating	0.78		0.92	
Cellar	0.93		0.93	
Gallery	0.60		0.67	
Garden	0.26		0.28	
Property type				
Farm house or other	0.01		0.02	
Single-family houses	0.09		0.11	
Terraced house	0.08		0.08	
Apartment house (3-8 flats)	0.57		0.56	
Apartment house (more than 8 flats)	0.22		0.22	
Multi-storey building	0.03		0.02	
Locational characteristics				
Type of quarter				
Residential area	0.65		0.68	
Downtown district	0.01		0.01	
Industrial area	0.00		0.01	
Mixed area	0.32		0.29	
Other	0.02		0.01	
Conurbation type (inhabitants)				
500,000 and more (central area)	0.48		0.49	
500,000 and more	0.13		0.08	
100,000 - 500,000 (central area)	0.11		0.13	
100,000 - 500,000	0.04		0.05	
50,000 - 100,000	0.03		0.03	
20,000 - 50,000	0.06		0.07	
5,000 - 20,000	0.10		0.10	
2,000 - 5,000	0.03		0.04	
Less than 2,000	0.01		0.02	
State				
West Berlin	0.08		0.08	
Baden-Württemberg	0.12		0.12	
Bavaria	0.15		0.15	
Bremen	0.02		0.02	
Hamburg	0.05		0.05	
Hesse	0.09		0.08	
Lower Saxony	0.10		0.10	
North Rhine-Westphalia	0.30		0.31	
Rhineland-Palatinate / Saarland	0.05		0.07	
Schleswig-Holstein	0.03		0.03	

ancy.[5] We subsume these two variables under the heading "landlord-tenant relationship". Physical characteristics include the period of construction, the property type and the furnishing. The location of a flat is described by the type of quarter, the type of conurbation - classified by the number of inhabitants and discriminating between city-centre and suburbs - and the state ("Land"). The latter two characteristics are supposed to capture factors having an effect on rents, such as differences in job opportunities, infrastructure, cultural life or leisure facilities. The type of quarter serves as a proxy for the close surroundings of a dwelling, which, however, the GSOEP cannot monitor perfectly. It is not reported, for example, whether a flat is located in a quiet street or on a noisy crossroads.

Apart from some remarkable exceptions, the average dwelling did not change very much during the period under review. The share of subsidised apartments declined by about a third. Apartments became somewhat larger, slightly better equipped and more modern. The size of the average dwelling increased by about 5 %, the share of dwellings fitted with central heating increased from 78 % to 92 %, and the share of dwellings built after 1972 grew from 16 % to 29 %. Throughout the period under review, the reported average previous length of tenancy did not change. Almost all dwellings were equipped with a kitchen, a bathroom and a toilet. About half of the dwellings were located in the central area of a big city, and most of the apartments were part of a multi-unit property.

In addition to the variables listed in Table 5, the GSOEP asks tenants about the need for renovation, and whether modernisation measures (like the installation of new heating systems or bathrooms) have taken place. Unfortunately, up to 1991 only modernisation measures paid for by the tenant are reported. These measures never coincide with a reported change in rent. After 1991, modernisation measures paid for both by tenants and by landlords are reported, and measures paid for by landlords often coincide with an increase in rents. The reported share of freshly-modernised flats increases from 2 - 3 % a year in the period up to 1991 to about 8 % in the period afterwards.

When extracting the housing sample from the GSOEP, we found substantial evidence of misreporting of rents and other variables. For example, some households report highly volatile rents while staying in the same dwelling. For other flats, the reported length of occupancy duration is not consistent with the reported vintage of the dwelling. As there is no chance of distinguishing ex post between accurately and badly reported data, we developed standardised procedures for deciding whether to keep or drop an observation and for ad-

[5] As the GSOEP is an annual panel, the length of tenure cannot be measured entirely consistently for all households. The calculation of the length of tenure as the difference between the current year and the reported year of the move results in some overlap. Even if the true occupancy duration of two households is the same, a different timing of the interviews might lead to different measures of the length of tenure. Similar problems arise with the assignment of rent increases to specific years.

justing inconsistent data. For this purpose we made use of the panel structure of the data set. If inconsistencies over years were detected, we compared the data given for adjacent periods. For example, when a reported rent declines just for one period and returns to its previous level in the following year, we replaced the reported rent by the value given in the adjacent years. Furthermore, some of the data were adjusted with the help of additional information from other variables. The reported age of the dwelling was cross-checked with the year the household stated it had moved in. In similar fashion, we dealt with inconsistencies between apartment size and the number of rooms. When an adjustment neither by comparison with adjacent years nor by cross-checking with other variables was possible, the observations were skipped.

The questions concerning the furnishing of a dwelling are only asked in the first interview of new and recently moved households. For the following periods, the information is simply copied from the first interview. However, in the years 1991 and 1999, households were asked to answer the full questionnaire. In both years, a substantial number of households reported furnishing which had not been reported in the first interview, indicating that an improvement in the dwelling had taken place. Whenever possible, we dated the change and adjusted the corresponding variables. However, one has to bear in mind that up to 1991 not all of the modernisation measures are registered, and that adjustments are therefore likely to be incomplete. The summary statistics reported in Table 5 and all results of the statistical and econometric analyses given below refer to a sample modified as described.

5 Hedonic analysis of apartment rents

The basic idea of the hedonic technique stems from the hypothesis that there is an identifiable relationship between the prices and characteristics of heterogeneous products (Triplett 1987). In its most general form, the hedonic relationship can be given as:

(6) $$p = f(X) + u,$$

which explains the price p by different traits X 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. Ideally, the hedonic function would be derived from a fully specified model with maximising agents, as has been done for fully competitive markets, among others, by Rosen (1974), Arguea/Hsiao (1993) and Diewert (2001), and, for markets with monopolistic competition, by Feenstra (1995). Empirical hedonic specifications, which are not derived from models, and which do not take account of the peculiarities of the market under review, may give distorted estimates.

In most applications, however, an empirical attitude to functional forms prevails: typically, the functional form which gives the best statistical fit, and which does not violate some basic requirements that seem to be sensible for hedonic equations, is chosen. As the regulation of the German market for rental housing services is very complex, but not very strict, we too pursue an empirical approach, which, however, is guided by a priori knowledge about the peculiarities of the housing market. A functional form which is often employed, since it has proved to be quite robust in empirical studies, is the log-log model:

(7) $$\ln p = c_0 + \sum_i c_i x_i + u \,.$$

When x_i is continuous, it is log-transformed. The other x_i are dummy variables. 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 trait. The main disadvantage of the log-log model is lack of flexibility. The log-log model can be described as a restricted version of the more general Box-Cox model, which is very popular in the hedonic analysis of housing markets (Goodman 1978, Linnemann 1980, Quigley 1982). However, applying the Box-Cox transformation to our set of variables did not improve the fit of the hedonic regression substantially. Furthermore, it resulted in less stable coefficient estimates. We therefore refrained from applying the general Box-Cox specification and simply tested the log-log functional form against the log-linear model using J-tests as proposed by Davidson/MacKinnon (1981). Following this test, the log-log specification is chosen.[6]

Recently, the issue of flexibility has attracted additional attention (Curry/Morgan/ Silver 2001). From the perspective of flexible functional forms, Diewert (2001) proposes the application of translog functions or generalised dummy-variable techniques. Models of these types contain a full set of interaction terms between variables, and therefore adapt very flexibly to the data. Interaction between variables might be of special importance for analysing housing markets, which differ from other markets mainly with respect to location. It is true that the prices of most products vary with the location where they are sold, as retailing costs differ regionally, but for most products the regional price differences are not very great. In the case of housing, things are different; as dwellings cannot be moved, housing needs to be understood as a tied-up sale or lease of physical and locational characteristics. Therefore, the adequate specification of locational variables is of the utmost importance in the hedonic analysis of housing prices. Otherwise, a lot of econometric

6 For the J-test, both the log-log and the log-linear model may be chosen as null hypothesis. Unfortunately, the power of J-tests is rather low. Often both hypotheses are rejected, and no definitive answer is obtained. This is also the case for our data. However, the t-values rejecting the log-linear form are always greater than the corresponding t-values rejecting the log-log equation. Following Bode/van Dalen (2001), we therefore choose the log-log model.

problems are the consequence, and the estimates may be seriously distorted (Sheppard 1999). Often-mentioned phenomena demanding specification are: spatially varying attribute prices (Can/Megbolugbe 1997, Pace/Gilley 1997, Bell/Bockstael 2000); and age-related heteroscedasticity (Goodman/Thibodeau 1997), to which both wear and tear and maintenance and renovation measures contribute. Interaction between variables has also been an important topic in the German debate on the appropriate functional form of hedonic regressions for the compilation of tables of comparable rents (Krämer 1992, Ronning 1995, Schlittgen/Uhlig 1997). The major disadvantage of models with a full set of interaction terms is the loss of degrees of freedom. We therefore refrain from applying these techniques. However, we do test for interaction terms, and, from the generalised dummy-variable approach, we adapt the idea of splitting up continuous variables.

We estimate regressions for the full data set, the CPI and the Non-CPI sample. All estimates are weighted by the GSOEP weights. The final specification of the regression equations is the result of an eclectic approach based on a priori knowledge of the peculiarities in the German housing market, and trial and error. The log-log specification results in well-behaved estimates of rents per square metre, which decrease with size, but at a diminishing rate.[7]

Except for the size variable, our preferred regression model contains only dummy variables on the right-hand side. The constant term gives the rent for the baseline dwelling (without size effects). The dwelling 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, which is an apartment house with fewer than nine flats, was built before 1949. The baseline apartment is equipped with a bathroom, toilet, central heating and a gallery or a garden. It was privately financed, and the current tenant has been living there for more than ten years.

By splitting the originally continuous tenancy variable into dummy variables, we allow for non-linearity in tenancy discounts. For newly-leased flats, the discount may vary with the length of the tenancy, whereas rents for longer spells of tenancy may become more similar. Concerning the age of the house, we put all vintages before 1949 into one group because we find no statistically significant rent difference for earlier vintages. As almost all apartments have bathroom and toilet, following Frick/Grabka (2001), we summarise both variables by a dummy variable, which is zero when the flat lacks either toilet or bathroom or both. Similarly, we combine garden and gallery, so that the resulting variable measures the

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[7] Putting the number of rooms, too, into the regression does not give satisfactory results because rooms are highly correlated with size. To avoid multicollinearity, we followed Behring et al. (1988) and alternatively estimated a specification using the average size per room, and dummy variables for different numbers of rooms as regressors. As we did not find substantial differences in the results, but a slightly lower adjusted R-squared, we decided to skip the room variable altogether, and stayed with just size and size-squared.

discount for apartments with neither. We omit the information about a kitchen as almost all flats are equipped with one. The cellar variable is statistically insignificant, so it is left out as well. Because of their small size, the German city states Hamburg and Bremen are poorly represented in the sample. We therefore put them together with Lower Saxony and Schleswig-Holstein, which border the city states. The coefficients of the dummy variables for the need for renovation and for recent modernisation measures vary in sign, and are not significant in most years. This may be because the modernisation variable is not consistently reported over the period under review, and therefore more or less useless. We dropped both variables from the regression.

We tested interaction terms for those variables where a priori reasoning indicates that it might be sensible. Most of the terms did not prove to be statistically different from zero. However, we find that the rent differential between subsidised and privately-financed dwellings - that is, the discount for subsidised housing - decreases with the length of occupation. Two factors may contribute to this outcome. Firstly, tenancy discounts may mostly occur in the private segment of the market. Secondly, with rising tenure, households living in a subsidised flat may pass the income threshold, which qualifies them for living in a subsidised dwelling. In this case, they do not have to leave the flat, but they may have to pay a higher rent. We therefore allow the discount for subsidised housing to vary over tenancy, and include corresponding interaction terms.

Splitting the overall quality of a dwelling into different traits may lead to high correlation among variables. For example, all apartments in newly-built houses are likely to have central heating and bathrooms. Although we modify and omit some of the variables in the regression model, multicollinearity may still be a problem, with the unfortunate consequence that estimates may lack precision. A Belsley/Kuh/Welsch (1980) condition number higher than 30 indicates that multicollinearity may be a severe problem for the precision of the estimates. For all samples and periods, we get condition numbers around 20 or below, so that multicollinearity does not seem to be a major problem in our data set.

Overall, our specification seems to fit the data reasonably well. To economise on space, and on the patience of the reader, we report in Tables 6a to 6c the results of the first and the last pair of adjacent years of our sample only. Further results are available on request. The adjusted R-squared ranges from 0.53 to 0.65. On average, our specification explains about 60 % of the variation in logarithmic rents. The Cook-Weisberg (1983) test of homoscedastic residuals is rejected in most periods. A closer inspection of the data indicates that the heteroscedasticity mainly seems to stem from the occupancy duration. We do not, however, find age-related heteroscedasticity. Both age and tenancy are potential sources of het-

Table 6a: Cross-section log-log hedonic regressions: full sample

Dependent variable: ln rent

Explanatory variables	1985		1986		1997		1998	
Constant	2.733	***	3.012	***	3.066	***	3.137	***
Landlord-tenant relationship								
Occupancy duration								
up to two years	0.191	***	0.178	***	0.159	***	0.161	***
two to three years	0.164	***	0.152	***	0.165	***	0.076	***
three to four years	0.151	***	0.110	***	0.189	***	0.146	***
four to five years	0.151	***	0.090	***	0.084	**	0.123	***
five to six years	0.092	**	0.130	***	0.131	***	0.083	**
six to seven years	0.112	***	0.051	*	0.154	***	0.052	
seven to eight years	0.057		0.062		-0.059		0.090	**
eight to nine years	0.076		0.134	**	0.026		0.048	
nine to ten years	0.080		0.135	***	0.013		-0.084	
ten to eleven years	0.048		0.124	***	-0.022		0.003	
Subsidised apartments	-0.040		-0.068	***	-0.071	***	-0.081	***
Subsidised apartments, occupancy duration								
up to two years	-0.179	***	-0.228	***	-0.025		-0.119	**
two to three years	-0.136	**	-0.115	**	-0.162	***	-0.054	
three to four years	-0.158	***	-0.062		-0.228	***	-0.180	***
four to five years	-0.147	***	-0.053		-0.123	*	-0.116	**
five to six years	-0.071		-0.060		-0.121	*	-0.142	*
six to seven years	-0.141	**	-0.059		-0.142		0.001	
seven to eight years	-0.162	*	-0.087		0.110		-0.096	
eight to nine years	-0.131	**	-0.172	*	0.030		0.039	
nine to ten years	-0.009		-0.172	***	0.014		0.011	
ten to eleven years	-0.027		-0.118	**	0.122		-0.045	
Physical characteristics								
Vintage								
Between 1949 and 1971	0.139	***	0.109	***	0.072	***	0.103	***
1972 or later	0.315	***	0.258	***				
Between 1972 and 1980					0.136	***	0.184	***
Between 1981 and 1990					0.257	***	0.227	***
1991 or later					0.333	***	0.292	***
ln Size (square metres)	0.772	***	0.715	***	0.809	***	0.799	***
Furnishing								
Without bathroom/toilet	-0.126	***	-0.178	***	-0.282	***	-0.160	*
Without central heating	-0.226	***	-0.182	***	-0.156	***	-0.178	***
Without garden/gallery	-0.064	***	-0.093	***	-0.030		-0.038	**
Property type								
Farm house or other	-0.097		-0.216	***	-0.174	***	-0.045	
Single-family house	-0.162	***	-0.123	***	-0.047		-0.038	
Terraced house	-0.043		-0.054	*	-0.061		-0.047	
Apartment house (more than 8 flats)	0.054	***	0.033	*	0.009		0.016	
Multi-storey building	0.109	***	0.134	***	0.083	*	0.037	
Locational characteristics								
Type of quarter								
Downtown district	0.221	***	0.192	***	0.013		0.057	
Industrial area	-0.238		-0.129	**	0.109		-0.145	***
Mixed area	0.017		0.019		0.014		0.012	
Other	0.101		0.110	*	-0.052		-0.083	
Conurbation								
500,000 and more	-0.069	**	-0.002		-0.072	**	-0.073	**
100,000 to 500,000 (central area)	-0.140	***	-0.132	***	-0.171	***	-0.163	***
100,000 to 500,000	-0.224	***	-0.204	***	-0.276	***	-0.194	***
50,000 to 100,000	-0.058		-0.158	***	-0.206	***	-0.256	***
20,000 to 50,000	-0.210	***	-0.193	***	-0.130	***	-0.175	***
5,000 to 20,000	-0.290	***	-0.300	***	-0.280	***	-0.213	***
2,000 to 5,000	-0.256	***	-0.272	***	-0.293	***	-0.324	***
less than 2,000	-0.289	***	-0.296	***	-0.553	***	-0.336	***
State								
West Berlin	-0.095	***	-0.068	**	0.040		-0.001	
Baden-Württemberg	0.032		0.033		0.125	***	0.094	***
Bavaria	0.030		0.055	**	0.095	***	0.095	***
Hamburg/Bremen/Lower Saxony/Schleswig-Holstein	0.068	***	0.066	***	0.116	***	0.111	***
Hesse	0.046		0.069	***	0.109	***	0.101	***
Rhineland-Palatinate/ Saarland	-0.036		0.019		0.098	**	0.094	**
Adjusted R-squared	0.58		0.62		0.61		0.65	
Number of observations	2752		2502		2237		2542	

* indicates that, statistically, the coefficient is significantly 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.

Table 6b: Cross-section log-log hedonic regressions: CPI sample

Dependent variable: ln rent

Explanatory variables	1985		1986		1997		1998	
Constant	2.664	***	2.732	***	2.708	***	2.686	***
Landlord-tenant relationship								
Occupancy duration								
up to two years	0.195	***	0.216	***	0.070		0.195	***
two to three years	0.141	**	0.174	***	0.047		0.041	
three to four years	0.159	**	0.036		0.153	***	0.191	***
four to five years	0.178	***	0.128	*	0.095		0.101	*
five to six years	0.070		0.185	***	0.014		0.099	
six to seven years	0.115	*	0.072		0.136	**	0.005	
seven to eight years	0.116		0.022		-0.106		0.078	
eight to nine years	0.024		0.104		-0.017		0.033	
nine to ten years	0.128	*	0.045		-0.104		-0.141	*
ten to eleven years	-0.039		0.094		0.049		0.041	
Subsidised apartments, occupancy duration	-0.080		-0.066		-0.123	***	-0.047	
up to two years	-0.165	**	-0.267	***	0.112		-0.130	*
two to three years	-0.114		-0.145	**	-0.016		0.010	
three to four years	-0.155		0.032		-0.249	***	-0.152	*
four to five years	-0.181	**	-0.088		-0.150	*	-0.140	*
five to six years	-0.128		-0.124		0.026		-0.266	***
six to seven years	-0.107		-0.182	**	-0.088		0.012	
seven to eight years	-0.171		0.012		0.178	*	-0.114	
eight to nine years	-0.056		-0.073		0.078		0.117	
nine to ten years	-0.136		-0.027		0.200	**	0.072	
ten to eleven years	0.174		-0.112		0.098		-0.019	
Physical characteristics								
Vintage								
between 1949 and 1971	0.153	**	0.090	*	0.096	**	0.096	***
1972 or later	0.351	***	0.254	***				
between 1972 and 1980					0.156	***	0.178	***
between 1981 and 1990					0.320	***	0.246	***
1991 or later					0.376	***	0.308	***
ln Size (square metres)	0.794	***	0.788	***	0.891	***	0.898	***
Furnishing								
Without bathroom/toilet	-0.030		-0.211	***	-0.245	*	-0.337	***
Without central heating	-0.326	***	-0.227	***	-0.331	***	-0.152	***
Without garden/gallery	-0.066		-0.080	**	0.025		0.012	
Property type								
Farm house or other	-0.050		-0.007		-0.188	**	-0.040	
Single-family house	-0.369	***	-0.230	***	0.010		-0.032	
Terraced house	-0.110	**	-0.103	**	-0.047		-0.077	
Apartment house (more than 8 flats)	0.026		-0.010		0.031		-0.005	
Multi-storey building	0.147	***	0.140	***	0.176	***	0.054	
Locational characteristics								
Type of quarter								
Downtown district	0.102		0.096		0.259		0.053	
Industrial area	-0.101		-0.107		-0.170	*	-0.248	**
Mixed area	-0.015		-0.020		0.018		0.011	
Other	0.234	***	0.231	***	0.073		0.116	**
Conurbation								
500,000 and more	-0.064		-0.002		-0.049		-0.088	*
100,000 to 500,000 (central area)	-0.106	***	-0.114	***	-0.130	***	-0.090	***
100,000 to 500,000	-0.192	***	-0.176	***	-0.249	***	-0.179	***
50,000 to 100,000	0.016		-0.057		-0.217	***	-0.147	***
20,000 to 50,000	-0.170	***	-0.189	***	-0.051		-0.177	***
5,000 to 20,000	-0.335	***	-0.292	***	-0.270	***	-0.179	***
2,000 to 5,000	-0.144		-0.285	***	-0.193	***	-0.210	***
less than 2,000	-0.385	***	-0.244		-0.561	**	-0.577	***
State								
West Berlin	-0.129	***	-0.077		0.064		0.067	*
Baden-Württemberg	-0.065		0.016		0.064	*	0.055	*
Bavaria	0.032		0.064	*	0.083	**	0.119	***
Hamburg/Bremen/Lower Saxony/Schleswig-Holstein	0.023		0.030		0.095	***	0.120	***
Hesse	0.036		0.086	**	0.060	*	0.112	***
Rhineland-Palatinate/ Saarland	-0.086		0.029		0.099		0.107	*
Adjusted R-squared	0.58		0.62		0.61		0.65	
Number of observations	930		890		837		990	

* indicates that, statistically, the coefficient is significantly 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.

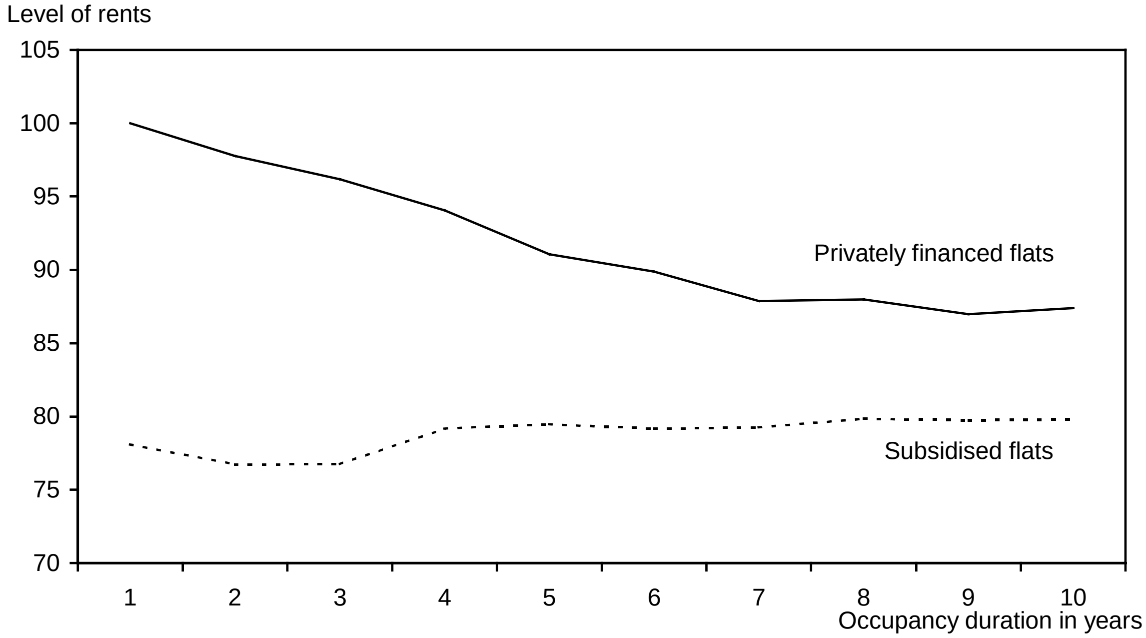
Table 6c: Cross-section log-log hedonic regressions: Non-CPI sample

Dependent variable: ln rent

Explanatory variables	1985		1986		1997		1998	
Constant	2.769	***	3.076	***	3.182	***	3.281	***
Landlord-tenant relationship								
Occupancy duration								
up to two years	0.176	***	0.163	***	0.197	***	0.130	***
two to three years	0.173	***	0.134	***	0.207	***	0.089	***
three to four years	0.145	***	0.143	***	0.207	***	0.115	***
four to five years	0.118	***	0.074	**	0.085	**	0.111	***
five to six years	0.099	**	0.077		0.177	***	0.066	*
six to seven years	0.113	**	0.049		0.158	***	0.072	
seven to eight years	0.025		0.090	**	-0.033		0.085	*
eight to nine years	0.092	*	0.140	**	0.076		0.056	
nine to ten years	0.042		0.171	***	0.091	**	-0.037	
ten to eleven years	0.078		0.137	***	-0.036		-0.019	
Subsidised apartments,	0,028		-0,023		-0,007		-0,109	***
occupancy duration								
up to two years	-0.225	**	-0.215	**	-0.114		-0.082	
two to three years	-0.167		-0.085		-0.277	***	-0.078	
three to four years	-0.164	**	-0.166	*	-0.148		-0.217	***
four to five years	-0.108	*	-0.068		-0.063		-0.076	
five to six years	-0.036		-0.005		-0.224	***	0.135	
six to seven years	-0.207	**	0.030		-0.236		-0.006	
seven to eight years	-0.201	*	-0.247	***	0.053		-0.019	
eight to nine years	-0.228	***	-0.390	***	0.076		0.045	
nine to ten years	0.107		-0.295	***	-0.139	*	-0.009	
ten to eleven years	-0.167		-0.108		-0.055		-0.032	
Physical characteristics								
Vintage								
between 1949 and 1971	0.153	***	0.125	***	0.058	**	0.094	***
1972 or later	0.317	***	0.245	***				
between 1972 and 1980					0.122	***	0.172	***
between 1981 and 1990					0.225	***	0.196	***
1991 or later					0.308	***	0.280	***
ln Size (square metres)	0,760	***	0,697	***	0,782	***	0,772	***
Furnishing								
Without bathroom/toilet	-0.136	***	-0.168	***	-0.267	***	-0.121	
Without central heating	-0.232	***	-0.176	***	-0.146	***	-0.182	***
Without garden/gallery	-0.061	***	-0.096	***	-0.055	**	-0.065	***
Property type								
Farm house or other	-0.101		-0.246	***	-0.173	***	-0.048	
Single-family house	-0.080	**	-0.059		-0.103	***	-0.035	
Terraced house	-0.004		-0.015		-0.062		-0.025	
Apartment house (more than 8 flats)	0.058	**	0.051	**	-0.001		0.031	
Multi-storey building	0.085		0.140		0.012		0.028	
Locational characteristics								
Type of quarter								
Downtown district	0.220	***	0.216	***	0.035		0.035	
Industrial area	-0.576	*	-0.181	***	0.222	**	-0.120	**
Mixed area	0.042	**	0.039	*	0.004		0.009	
Other	0.042		0.057		-0.152		-0.138	
Conurbation								
500,000 and more	-0.081	**	-0.004		-0.073	*	-0.054	
100,000 to 500,000 (central area)	-0.170	***	-0.155	***	-0.205	***	-0.205	***
100,000 to 500,000	-0.264	***	-0.235	***	-0.257	***	-0.183	***
50,000 to 100,000	-0.105	**	-0.213	***	-0.210	***	-0.301	***
20,000 to 50,000	-0.248	***	-0.209	***	-0.217	***	-0.171	***
5,000 to 20,000	-0.303	***	-0.331	***	-0.293	***	-0.243	***
2,000 to 5,000	-0.322	***	-0.288	***	-0.321	***	-0.371	***
less than 2,000	-0.297	***	-0.330	***	-0.521	***	-0.180	*
State								
West Berlin	-0.089	*	-0.071	*	0.032		-0.049	
Baden-Württemberg	0.079	**	0.038		0.172	***	0.112	***
Bavaria	0.027		0.058	*	0.119	***	0.091	***
Hamburg/Bremen/Lower Saxony/Schleswig-Holstein	0.107	***	0.106	***	0.125	***	0.105	***
Hesse	0.045		0.065	*	0.156	***	0.106	***
Rhineland-Palatinate/ Saarland	-0.034		0.014		0.100		0.078	**
Adjusted R-squared	0.60		0.62		0.63		0.67	
Number of observations	1822		1612		1400		1552	

* indicates that, statistically, the coefficient is significantly 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.

Figure 1: The level of rents by tenancy duration



The level of rents is calculated from the average parameter estimates for the full sample. Rents for privately financed flats in the first year of occupancy=100.

eroscedasticity, as, with increasing age or tenancy, the distribution of unmeasured quality may widen and the extent to which discounts are granted may differ. In the tables 6a to 6c, robust standard errors are reported.

To test for functional misspecification and missing variables, we employ Ramsey's (1969) RESET procedure. The RESET test indicates that the functional form may not be appropriate or that important variables are missing. We tested several non-linear specifications, but they led to very similar results. We may therefore tentatively conclude that missing variables are a problem in our regressions. However, there is no straightforward solution to this problem, as no additional variables are available.[8]

The estimated coefficients are in most cases significant, and show the expected sign. In a cross-section, rents vary inversely with the length of occupancy duration (see Figure 1). There is strong evidence of a sit discount, but also some evidence of length-of-stay discounts, as the relative level of rents for sitting tenants decreases until the seventh year of

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8 At first glance, making use of the panel structure of the GSOEP seems to be a promising strategy for overcoming the shortage of right-hand-side variables. The fixed-effects approach adjusts estimates for unobserved heterogeneity by including a separate intercept for each dwelling. This approach results in a kind of matched-model index for dwellings which stay in the sample for more than one period. It does not help us, however, with the quality adjustment between old and new dwellings. The application of a random-effects model is rejected by the Hausman test, and results in substantially distorted estimates of quality-adjusted rent change, because the unobserved characteristics seem to be highly correlated with the characteristics reported by the GSOEP.

tenancy. This may be due to decreasing quality, tenancy discounts offered by the landlord or market distortions caused by legal regulations. For longer occupancy durations, however, rents for sitting tenants increase on average in line with rents for new contracts. Rents for subsidised flats are significantly lower than rents for privately financed flats, and we find no evidence of tenancy discounts. Apartments in older houses are significantly cheaper than those in new buildings.[9] Extra features, like a gallery or central heating, have to be paid for, whereas the coefficients of property type and quarters are only weakly significant. Conurbation matters: rents are higher in big cities and centres than in smaller towns and non-central areas. Driven by the high rent level in Hamburg, we observe throughout the sampling period significant rent mark-ups in the combined area Hamburg, Bremen, Lower Saxony and Schleswig-Holstein.

Regarding the development over time, the coefficients proved to be quite stable. To test formally for stability, we use the Wald test rather than the Chow test, because the latter relies on the F statistic, which requires homoscedastic residuals. 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 time, with the exception of the years 1988/89, 1990/91 and 1997/98 in the CPI sample.

For longer time-spans, parameter stability is definitely rejected, and we find slow-moving trends in some parameters. For example, before unification, rents were significantly lower in Berlin than in North Rhine-Westphalia; after 1990, the difference becomes insignificant. The rent difference between Bavaria and North Rhine-Westphalia increased until 1993 and afterwards remained at a high level. Similarly, the coefficients of Baden-Württemberg and Hesse show a growing tendency over the sample period. These developments are plausible, given the favourable economic developments in the three states. The mark-up for newly rented flats follows a cyclical pattern, and reaches its highest level at the beginning of the nineties, when the housing market was very tight, and declines afterwards, with the easing of the market as a result of a high level of construction activity and a slowdown in income growth in the first half of the nineties. The rent differential between tenancy durations of two and three years displays the same pattern with some lag. Hence we may conclude that tenancy discounts in Germany vary with the state of the housing market.

9 The vintage coefficient can be interpreted in two ways (Hoven 1984, Randolph 1988). Firstly, quality may differ between construction periods. For example, we might expect that the average quality of dwellings of a more recent vintage is higher than the average quality of older dwellings. Secondly, the quality of a dwelling may deteriorate as it grows older. Without identifying assumptions, it is not possible to separate these effects.

Comparing the CPI with the Non-CPI sample, we find only small differences between the parameter estimates. For example, the discount on dwellings without gallery and garden is highly significant in the Non-CPI sample, whereas the effect is lower and often not significant among CPI flats. Moreover, the mark-up for dwellings in conurbations seems to be higher for the Non-CPI sample. To test formally for the equality of coefficients, we run regressions on the full sample, interacting each regressor with a dummy variable for flats that belong to the CPI sample. We apply a Wald test on the null hypothesis that the coefficients of the interaction terms are zero, i.e. that there is no difference between the sub-samples. In all years, the test indicates that the parameter estimates are indeed different. However, looking at single interaction coefficients, we find no stable pattern over time. The rent differentials arising from differences in occupancy duration appear to be smaller in the CPI sample; the same seems to be true of the state variables. For example, the coefficient of the northern region Hamburg, Bremen, Lower-Saxony and Schleswig-Holstein is not always significant in the CPI sample. In the southern states, the mark-up compared with North-Rhine Westphalia is smaller in the CPI sample than in the Non-CPI sample. Overall, rents in the CPI sample seem to adapt more slowly to changes in the tightness of the housing market.

By and large, our hedonic estimates of housing rents in the GSOEP can be considered fairly successful, as they result in reasonable parameter estimates, which mostly appear to move only slowly over time, thus reflecting the peculiarities of the housing market. In the following section, we will use the results of the hedonic regressions to compile quality-adjusted rent indices. Given the robustness of our cross-section regressions, that should not pose major problems. Two caveats, which are related, apply. Firstly, specification tests indicate that our hedonic regressions may be misspecified. As we tested extensively for functional forms and interaction terms, missing variables probably are at the core of the problem. This relates to the second caveat: even with more than nine explaining variables, we can describe the quality of dwellings only broadly. Many more characteristics, which are not reported by the GSOEP, may be considered price-relevant. If any of these unreported traits are trended and not perfectly correlated with the reported traits, then our estimates of quality-adjusted price change will be biased.[10]

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[10] There is another issue which has not been fully explored. Our regressions are based on the idea that, by moving, households adapt to changing needs, and that therefore parameter estimates do not vary with tenancy in a cross-section. Because of the lock-in effects resulting from tenancy discounts, tenants may choose to stay in a flat, even though it does not suit them any more. Therefore the valuations of characteristics may depend on the year of moving in, so that, within one period, parameter estimates may differ according to the length of occupancy. To test this assumption, we reorganised the panel and compiled separate regressions for the year of moving in. Indeed, the R-squared is higher than in the cross-section regressions. However, the estimated rent developments for different years of moving in rely in part on very few observations, resulting in implausible rent growth in some of the subsamples.

6 Alternative indices of apartment rents

In this section, we report alternative indices of apartment rents compiled from GSOEP data. It is our hope that these indices will contribute to a better understanding of rent dynamics in West Germany. Furthermore, as we want to assess the accuracy of inflation measurement, we present our preferred estimate of rent increase, and compare it with the relevant sub-index in the CPI. In a first stage, we compile rent indices without hedonics, both simple statistical measures and matched-model indices, and in a second stage, quality-adjusted indices, based on hedonics. All measures have been computed for the CPI sample, the Non-CPI sample and the full sample, and, since they are weighted with GSOEP weights, can be regarded as being representative of West Germany.

According to the GSOEP, average rents increased by 81 %, or 4.7 % a year, in the period under review (Table 7). Rents per square metres, which give a crude quality-adjusted measure of price increase, rose by 71 %, or 4.2 % a year.[11] Rent increases in the CPI sample are below the figures for the full sample, rent increases in the Non-CPI sample are above, indicating a potential sampling bias. The ratio of the arithmetic means of rents typically gives lower estimates of price change than the geometric means.

In the next stage, we compute two types of matched-model indices: fixed-base and chained indices. As the GSOEP is a household sample, rather than a true dwelling sample, a matched-model index derived from the GSOEP gives an estimate of rent increase for sitting tenants.[12] Since most households move at least once in the period under review, the GSOEP fixed-base matched sample degenerates from period to period. Panel attrition also contributes to the shrinking of the sample. Thus the fixed-base matched sample might become less and less representative of the whole universe of dwellings. For the full sample, our matched-model index starts with 2971 households; in 1998, only 166 are left (see Table 8). The CPI sample matched over the years 1985 and 1998 contains only 52 households, the Non-CPI sample 114 households.

The annually chained matched models are compiled by calculating adjacent-year matched-model indices, which are multiplied into a time series. The number of dwellings in the chained matched sample decreases as well. As households principally return to the sample

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[11] Given the results of the hedonic regressions, the measure of rents per square metres overadjusts for the benefits from increasing the size of dwellings, because it assumes a strictly proportional relationship between size and rents. The empirical analysis of the data indicates that the marginal valuation of size decreases with size.

[12] A matched-model index derived from a true dwelling sample would also include rent increases taking place with the turnover of tenants.

Table 7: Statistical measures of rent inflation
(1985=100)

	1989	1992	1995	1998
Full sample				
Without quality adjustment				
Ratio of arithmetic means	112.6	131.8	162.7	181.0
Ratio of geometric means	113.3	132.4	162.9	184.8
With crude quality adjustment (rents per square metres)				
Ratio of arithmetic means	110.3	127.6	157.1	170.9
Ratio of geometric means	111.0	129.0	157.7	175.8
CPI sample				
Without quality adjustment				
Ratio of arithmetic means	108.2	127.1	156.8	174.8
Ratio of geometric means	109.1	127.8	157.7	178.3
With crude quality adjustment (rents per square metres)				
Ratio of arithmetic means	106.6	123.8	150.8	166.0
Ratio of geometric means	107.6	124.9	151.3	169.0
Non-CPI sample				
Without quality adjustment				
Ratio of arithmetic means	115.3	134.6	166.2	184.8
Ratio of geometric means	115.7	135.2	165.9	188.6
With crude quality adjustment (rents per square metres)				
Ratio of arithmetic means	112.6	129.9	161.0	173.9
Ratio of geometric means	113.0	131.3	161.4	179.8

after moving, and as the turnover of tenants does not change over time, this is the result of panel attrition.

Both for the fixed-base and for the chained matched-model indices, three different formulae are applied. The ratio of the arithmetic mean of rents, which has been termed the Dutot index:

(8) $$I^{Dutot} = \frac{\frac{1}{n}\sum_{i=1}^{n} r_i^t}{\frac{1}{n}\sum_{i=1}^{n} r_i^0},$$

the ratio of the geometric mean of rents, which is termed the Jevons index:

(9) $$I^{Jevons} = \frac{\prod_i^n (r_i^t)^{\frac{1}{n}}}{\prod_i^n (r_i^0)^{\frac{1}{n}}},$$

Table 8: Matched-model indices
(1985=100)

	1989	1992	1995	1998
Full sample				
Fixed-base matched models				
Ratio of arithmetic means (Dutot)	107.7	122.5	141.0	156.9
Ratio of geometric means (Jevons)	109.3	124.0	143.7	159.5
Arithmetic mean of changes (Carli)	120.0	140.5	148.3	164.7
(Number of observations)	(1217)	(765)	(404)	(166)
Chained matched models				
Ratio of arithmetic means (Dutot)	107.4	119.9	137.8	148.0
Ratio of geometric means (Jevons)	108.5	120.8	140.0	152.0
Arithmetic mean of changes (Carli)	120.3	143.4	176.5	201.9
(Observations)	(2084)	(1859)	(1495)	(1197)
CPI sample				
Fixed-base matched models				
Ratio of arithmetic means (Dutot)	107.7	122.5	143.3	158.0
Ratio of geometric means (Jevons)	109.7	124.1	144.3	161.8
Arithmetic mean of changes (Carli)	132.3	157.0	149.4	167.2
(Observations)	(430)	(297)	(154)	(52)
Chained matched models				
Ratio of arithmetic means (Dutot)	106.2	119.3	138.1	147.1
Ratio of geometric means (Jevons)	107.9	121.4	142.0	153.0
Arithmetic mean of changes (Carli)	125.7	150.8	182.5	204.7
(Observations)	(739)	(662)	(515)	(422)
Non-CPI sample				
Fixed-base matched models				
Ratio of arithmetic means (Dutot)	107.7	122.5	139.7	156.3
Ratio of geometric means (Jevons)	109.0	123.8	143.4	158.3
Arithmetic mean of changes (Carli)	111.5	127.6	147.4	163.5
(Observations)	(787)	(468)	(250)	(114)
Chained matched models				
Ratio of arithmetic means (Dutot)	108.1	120.2	137.7	148.4
Ratio of geometric means (Jevons)	108.8	120.5	138.8	151.2
Arithmetic mean of changes (Carli)	116.7	138.7	172.4	199.6
(Observations)	(1345)	(1197)	(980)	(775)

and finally, the arithmetical mean of price changes (Carli or Sauerbeck indices):

(10) $$I^{Carli} = \sum_{i=1}^{n} \frac{1}{n} \frac{r_i^t}{r_i^0} .$$

In spite of the dramatically contracting sample, most of the matched-model indices are well-behaved (Table 8). For the fixed-base matched samples, the Dutot indices generally are close to the geometric mean, but are 2.0 to 3.8 percentage points lower in 1998. The Carli indices give higher estimates of price change, the difference from the Jevons index amounting to 5.2 to 5.4 percentage points after 13 years.

Basically the same pattern emerges from chained matched-model indices, with the major exception that the chained Carli indices differ much more strongly from the geometric-mean indices than the fixed-base Carli does. This can be explained by occasional misreporting of rents. The resulting bouncing of rents is a potential cause of serious index drift for Carli-type indices (Szulc 1983). When we calculated the chained indices for a panel which was cleared up more rigorously, the Carli indices were much closer to the geometric mean. However, we refrain from using this panel for our study, as the bouncing of rents may not be solely due to misreporting. The distance between the Dutot indices and the geometric means increased for the chained matched samples as well (to 2.8 to 5.9 percentage points), but remained within reasonable bounds.

Even with the differences being relatively small, it is remarkable that, without exception, the Dutot index gives lower estimates of price change than the Jevons index. This indicates that the rate of price increase is lower for expensive dwellings than for cheap dwellings, because the Dutot index can be described as a weighted arithmetical mean of price changes, with the weights being proportional to the relative level of rents (see section 3). As the sample of flats in the GSOEP can be regarded as representative, the Dutot index corresponds to an exact Laspeyres index. A geometric-mean index, weighted in a comparable manner, would result in an even lower estimate of price change. The dwelling sample of the official CPI, however, cannot be regarded as representative, as has been explained in section 4. Hence, in this context the Dutot index lacks any clear interpretation.

According to our computations, the rent increase is much lower in the matched indices than the increase in average rents. The fixed-base Dutot index yields an estimate of price change of 3.5 % a year; the Jevons index is slightly higher. This figure is 1.2 percentage point lower than the average rent measure for the full unbalanced sample. Two factors contribute to this outcome. Firstly, the matched-model indices capture rent increases for sitting tenants only. Changes in rent resulting from the turnover of tenants are not covered. Secondly, only dwellings without major changes in characteristics are included in the matched samples. Dwellings with major modernisation measures are treated like new dwellings, and enter a matched sample only in the period after the measure.

Furthermore, the rent increase according to the chained matched-model indices is substantially lower than that for the fixed-base matched-model indices. The chained Dutot index increases by 3.1 % a year, compared with 3.5 % for the fixed-base variant. Comparable figures for the Jevons index are 3.3 % and 3.7 %. The major difference between the fixed-base matched samples and the annually-chained matched samples is that, in the latter, there are more flats with a short duration of previous occupancy than in the former. In our hedonic estimates, we found strong evidence of sit discounts, generating low rates of rent increase in the early periods of a tenancy. The evidence of length-of-stay discounts is significantly weaker, implying that, in the medium term, rents for sitting tenants adjust in line with changing market conditions. In a fixed-base matched sample, rent increases will therefore be higher than in the chained matched sample, and this pattern emerges from the matched-model indices, thus substantiating the results of our hedonic regressions.

Differences between rent increases for the CPI sample and those for the Non-CPI sample are small, both for the fixed-base and the chained matched-model indices. This indicates that there is a common price trend in the market, affecting different types of dwellings similarly.

In the next stage, we compute indices based on hedonic regressions. There are basically three ways of generating quality-adjusted price indices using hedonic techniques (Musgrave 1969, Triplett 1989, Berndt/Griliches/Rappaport 1995): firstly, the explicit calculation of indices, also termed characteristics-price method; secondly, the imputation of "missing" prices; and thirdly, the time-dummy method. For computational convenience, we apply the first and the third method only.[13] For the first method, parameter estimates are taken from the hedonic cross-section regressions. Price indices can be calculated, either of the simple Laspeyres and Paasche types or of the more refined superlative indices, with data on average levels of characteristics from different periods. If the parameter estimates for adjacent periods are close, the third method is computationally more efficient. Stable coefficients allow data to be pooled over time and regressions to be run over several periods, saving degrees of freedom. The change in quality-adjusted rents can then be estimated directly from a time dummy added to the specification.

As stability of parameter estimates is confirmed in the short run for our regressions, we compile additional regressions by pooling two adjacent years and including a time dummy. The annual quality-adjusted rent index is estimated directly by exponentiating the coefficient of the time dummy $\hat{\gamma}$:[14]

(11) $$I^{adjacent \cdot years} = e^{\hat{\gamma}} .$$

The annual quality-adjusted rent indices are then multiplied into a time series.

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[13] The second method may be considered superior, since it fully uses the information from matched models and estimates only the quality-adjusted price difference between old and new models (Silver/Heravi 2001a). However, with misreporting in the data, averaging over rents and characteristics, as is implied by the first and third method, may give more robust results.

[14] As the expected value of a nonlinear function is not equal to a nonlinear function of expected values, the exponentiated coefficient gives a distorted estimate of rent. See, for example, Linnemann (1987) and Triplett (1989). Adding a one-half squared standard error corrects for the bias. On this issue, see Goldberger (1968). As the scale of the correction is small with statistically significant time dummies, we omit this correction.

Table 9: Indices based on adjacent-year regressions

	1989	1992	1995	1998
Full sample	107.7	124.2	150.1	163.6
CPI sample	107.5	124.0	150.3	163.7
Non-CPI sample	109.1	125.5	151.4	164.6

The adjacent-year regressions yield results which are very similar to the cross-section estimates. However, heteroscedasticity seems to be somewhat more severe in the pooled regressions, especially in the CPI and Non-CPI samples. Owing to the pooling process, the adjusted R-squared is typically slightly lower than in the cross-sections. By and large, the parameter estimates are close to the single-year regressions.

According to the indices based on adjacent-year regressions, quality-adjusted rents increased by 3.9 % a year (see Table 9).[15] The results do not differ much between the CPI and the Non-CPI sample, thus confirming the result of our matched-model indices, which indicates that there seems to be a common price trend in the market affecting similar types of dwellings similarly. The above-average increase in average prices found for the Non-CPI sample therefore largely seems to be related to bigger changes in quality. As our estimates of quality-adjusted price change do not differ much, there is no evidence of a potential for a severe sampling bias in the German CPI rent index. Even with sampling only a small number of well-defined apartment types, the Federal Statistical Office might succeed in capturing the general trend in rents.

The measure of quality-adjusted rent increase based on adjacent-year regressions implies that the quality of dwellings increased by 13 % or 0.9 % a year in the period under review.[16] The rate of quality advance proved to be substantially higher in the Non-CPI sample (1.1 % a year) than in the CPI sample (0.7 % a year).

For further analysing the dynamics of rent increase, we also compute explicit indices based on the parameter estimates of hedonic cross-section regressions and the average level of attributes.[17]

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15 Hedonic indices compiled from log-linear adjacent-year regressions yield broadly the same results. Once again, this demonstrates that the functional form does not matter very much for the measurement of quality-adjusted price change from adjacent-year regressions.

16 The quality index is computed by dividing the ratio of geometric means of rents by the measure of quality-adjusted price change. The ratio of geometric means is chosen because this measure corresponds more closely to the indices based on log-log adjacent-year regressions than the ratio of arithmetic means.

17 Regarding the size of the dwelling, which is the only continuous left-hand-side variable, a problem arises in the compilation of the average level of this trait. The regression relates to the average of log-transformed size, which is not identical to the log of the average size of the dwellings in the sample. Fortunately, both measures result in estimates of rent increase which do not differ much. Furthermore, there is

For a Laspeyres-type index, we take the average traits from the base period:

$$I^{Laspeyres} = \frac{P(C^t, X^0)}{P(C^0, X^0)}, \tag{12}$$

for a Paasche-type index, those from the reporting period:

$$I^{Paasche} = \frac{P(C^t, X^t)}{P(C^0, X^t)}, \tag{13}$$

and the Fisher-type index corresponds to the geometric mean of Laspeyres and Paasche:

$$I^{Fisher} = \left(\frac{P(C^t, X^0)}{P(C^0, X^0)} \frac{P(C^t, X^t)}{P(C^0, X^t)} \right)^{1/2}. \tag{14}$$

The explicit indices (see Table 10) yield results which are close to each other and to the results of the adjacent-year regressions. Differences between the chained Laspeyres and Paasche are bigger than between the direct Laspeyres and Paasche, indicating some problems with chaining for the explicit Laspeyres indices. Once again, there are no significant differences between rent-inflation measures for the CPI and the Non-CPI sample. Furthermore, the formula used for the compilation of the indices does not seem to matter very much. For the full sample, after 13 years, the fixed-base Laspeyres is only 0.4 percentage point higher than the Fisher index. This remarkable result can be rationalised with a reference to Table 5: as most of the reported traits change only marginally in the period under review, even diverging trends in marginal valuations of characteristics will not induce mismeasurement in a fixed-base Laspeyres index.

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a problem with the adequate utilization of the vintage variable. Hoven (1984) and Randolph (1988) show that there might be an ageing bias in fixed-base indices if a vintage variable is used for quality adjustment in a way similar to other characteristics. It is true that ageing is partly reflected in the estimated vintage coefficient, but we cannot isolate it from other influences. Therefore, a direct quality adjustment is not feasible without additional identifying assumptions. However, it is only the Laspeyres index over characteristics which understates inflation with respect to the vintage variable; the Paasche index overstates inflation, and the effect cancels out in the Fisher index. Furthermore, in our specification, it is quite likely that the tenancy variable reflects part of the depreciation of quality over time. As the dummy variables for the length of tenure are defined relative to the period under observation, there is no bias in the fixed-base indices.

Table 10: Explicit indices

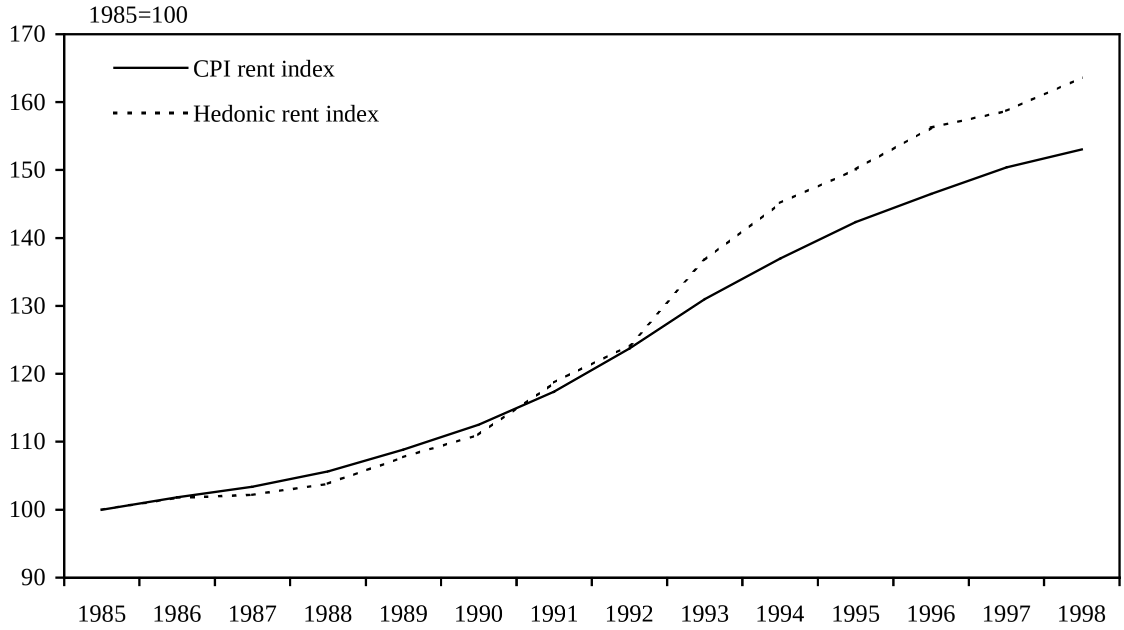
	1989	1992	1995	1998
Full sample				
Laspeyres 1985	107.1	124.5	149.0	166.5
Laspeyres, chained	107.3	123.3	147.9	161.9
Paasche 1985	107.4	123.6	149.2	165.7
Paasche, chained	107.7	125.3	151.3	166.2
Fisher 1985	107.3	124.1	149.1	166.1
Fisher, chained	107.5	124.3	149.6	164.1
CPI sample				
Laspeyres 1985	107.5	121.5	148.7	165.2
Laspeyres, chained	106.7	121.7	148.1	161.2
Paasche 1985	107.7	125.0	150.2	168.2
Paasche, chained	108.4	127.0	153.4	167.7
Fisher 1985	107.6	123.3	149.4	166.7
Fisher, chained	107.6	124.4	150.7	164.4
Non-CPI sample				
Laspeyres 1985	107.9	126.1	149.1	167.1
Laspeyres, chained	108.7	125.9	150.6	165.6
Paasche 1985	108.1	123.9	149.1	165.5
Paasche, chained	108.4	125.2	150.8	164.8
Fisher 1985	108.0	125.0	149.1	166.3
Fisher, chained	108.6	125.5	150.7	165.2

Compared with the official CPI rent-inflation sub-index, our measure reports higher rates of quality-adjusted rent change (see Figure 2), although we found no substantial differences in rent inflation between the CPI and the Non-CPI sample in the GSOEP. In the period under review, according to the official CPI measure, rents increased by 53.0 % or 3.3 % a year, whereas our approach results in an estimate of rent increase of 63.6 % or 3.9 % a year, implying a difference of about 0.5 percentage point a year. The bulk of the divergence occurs in the years 1991 to 1994; for the years before and after this period, the CPI and our hedonic measure give comparable estimates of rent change.

In the remainder of this section, we discuss potential causes of the divergent trends in quality-adjusted rents as reported by the official CPI index and our measure based on a hedonic analysis of GSOEP data. In section 1 and section 3, three potential sources of bias in the official measure were discussed: sampling, aggregation or index formula, and quality adjustment. None of these factors, however, accounts for a major fraction of the divergence of the two measures.

As hedonic measures of quality-adjusted rent increase for a sub-sample of the GSOEP corresponding to CPI specifications are only marginally higher than the equivalent figure for the full sample, the restricted sampling over types of flats in the CPI cannot explain major divergences between our measure of rent inflation and the CPI sub-index. Weighting and the choice of the index formula do not seem to be at the source of the divergences either. Applying GSOEP weights to the CPI price series results in an estimate of rent increase of

Figure 2: The CPI rent index and the hedonic rent index



53.9 %, which is less than 1 percentage point higher than the official figure (Table 11). The difference between the fixed-base Laspeyres and the chained Fisher index for the full GSOEP sample is below 2.5 percentage points, with the Laspeyres index giving a higher, rather than a lower, estimate of price change (Table 10).[18]

The quality-adjustment procedures both in the CPI and in our experiment are far from perfect, but they differ in certain respects: on the one hand, as the CPI adjusts rents of new flats just for size, our procedure is superior, since it takes account of all the reported traits. On the other hand, the CPI eliminates rent increases associated with specific quality improvements (the "Modernisierungsumlage") for old dwellings, which we cannot do, as improvements are not reported consistently in the GSOEP. However, when feasible, we adjust for improvements like the addition of central heating. Furthermore, we adjust for the vintage of the dwellings. Hence we might conclude that, on balance, it is unlikely that the quite substantial difference between the CPI measure and the GSOEP measure originates from different quality-adjustment procedures.

Furthermore, all explanations based on time-invariant features, like sampling, aggregation or quality-adjustment procedures, seem to be at variance with the fact that, until the begin-

18 For fully ruling out the possibility of the higher rate of rent increase in the hedonic measure being an unfortunate result of linking, we also pooled the years 1985 and 1998 in a single regression. Even with the violation of the underlying assumption of parameter stability, the estimated rate of price change is close to the chained adjacent-year estimate.

Table 11: The CPI rent index reweighted

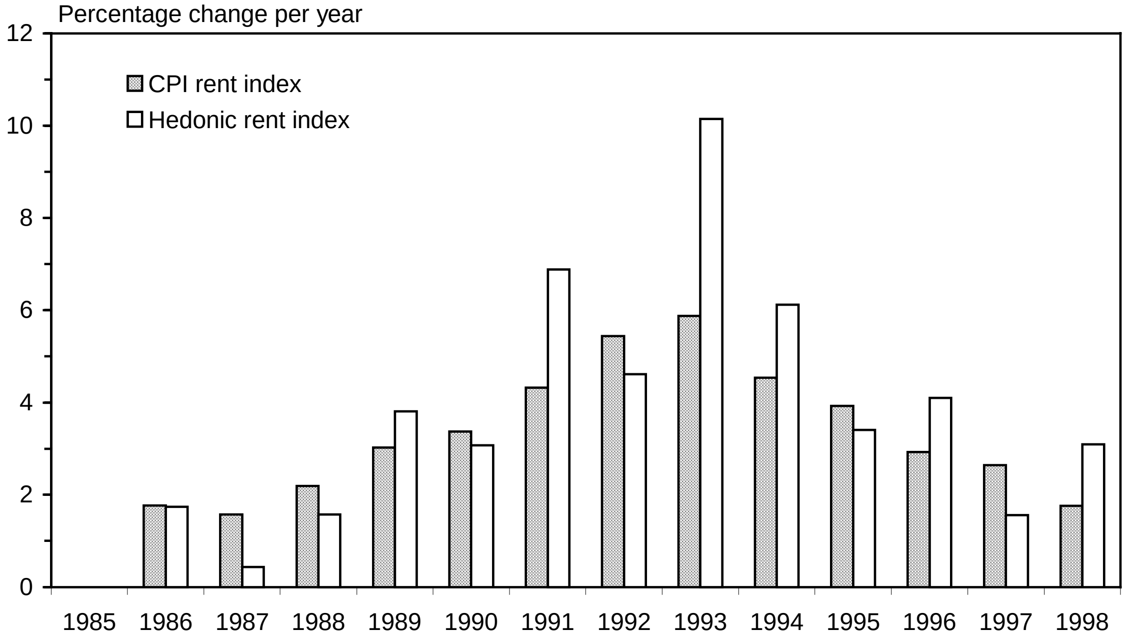
	1989	1992	1995	1998
Official CPI rent index	108.8	123.7	142.3	153.0
CPI GSOEP 1985 weights, Laspeyres	109.2	123.7	142.5	153.9
CPI GSOEP weights, Laspeyres chained	109.2	123.8	142.4	153.7
CPI GSOEP weights, Paasche	109.2	123.8	142.3	153.6
CPI GSOEP weights, Paasche chained	109.2	123.8	142.4	153.7
CPI GSOEP weights, Fisher	109.2	123.8	142.4	153.8
CPI GSOEP weights, Fisher chained	109.2	123.8	142.4	153.7

ning of the nineties, both measures of rent inflation were close together. As can be seen from Figure 2, a major divergence of our rent measure from the CPI sub-index emerges only after 1992. In terms of rates of change, the years 1991 and 1994 evidently separate a period with much higher rent increases in the hedonic measure than in the CPI sub-index (Figures 2 and 3). For these years, the cumulative rate of rent change amounts to 30.7 % in the GSOEP and only 21.7 % in the CPI. In the years before and after this extraordinary period, no major differences can be detected, if rates of rent increase are averaged over three or more years.[19]

The first half of the 1990s, when the GSOEP rents started to move away from the CPI, was characterised by above-average rent increases, induced by a demand shock resulting from immigration and favourable economic conditions at the turn of the decade. From the analysis of the peculiarities of the German rental housing market, we learned that the measured rate of rent increase may depend on the turnover of tenants in the short and medium term. In the hedonic analysis of the housing market and in the matched-model indices, we found strong evidence of sit discounts, but also some evidence of (variable) length-of-stay discounts. Only in the long run, did the rents of sitting tenants change in line with the market in Germany. In the medium term, therefore, the measured rate of rent increase in Germany may depend on tenant turnover. We cannot, however, fully explore this potential source of difference between the CPI index and our measure, as we have no exact data on the turnover of tenants in the dwelling sample of the statistical offices. There are indications, however, that the rate of tenant turnover in the official sample is lower than that in the GSOEP (see section 4). Furthermore, cross-checking the GSOEP with data from the 1993 housing survey seems to indicate that the turnover in the GSOEP is not excessive. To assess the potential size of a bias resulting from different rates of turnover, we made several simula-

19 Looking at individual years, rent increases seem to be much more volatile in the GSOEP than in the CPI. The most likely explanation of this phenomenon is the higher frequency of rent recording in the CPI, which is four times a year. Since rents are recorded for the GSOEP only once a year, an exact attachment of rent increases to individual years is not possible. Furthermore, the timing of interviews may vary from year to year. Therefore, even if we expect that, in the long run, our measure captures rent growth adequately, the estimate of rent growth for individual years might be substantially distorted by variations in the timing of the interviews.

Figure 3: Rent inflation according to the CPI and the hedonic index



tions, calibrated according to the results of our hedonic regressions. While the simulations qualitatively yielded the expected results, the magnitude of the bias is too small to explain a major part of the divergence between our measure and the CPI measure of rent inflation in the first half of the 1990s.

Overall, in the first half of the nineties, rents generally increased much faster in the GSOEP than in the CPI, and not just the rents in new contracts. Without additional information about the structure of the dwelling sample it is, however, impossible to explore the divergences further.

7 Conclusion

The main results of our study may be briefly summarised as follows: the GSOEP has proved to be a valuable source of data on rents and housing characteristics, which can be employed effectively for analysing changes in the cost of rental housing. It is true that there is some misreporting of rents and characteristics in the GSOEP, but it can either be eliminated or does not substantially distort the results. Furthermore, the sampling weights delivered with the GSOEP permit the estimation of representative results for West Germany.

Hedonic regressions of rents on housing characteristics, as reported in the GSOEP data, proved to be very robust. A simple log-log regression model with few interaction terms performed very satisfactorily; the results for more complex specifications did not differ much. Price indices compiled from matched samples and from hedonic regressions were mostly well-behaved and yielded sensible results. The explicit quality-adjusted indices calculated from parameter estimates and the average level of traits are close to each other, implying that the choice of the index formula does not matter very much for the accuracy of inflation measurement for housing services. However, chained Laspeyres indices occasionally yield different estimates of price change.

The hedonic analysis of housing rents suggests that tenancy discounts are of considerable importance in Germany. Rents for sitting tenants are typically lower than those in new contracts. Asymmetrical information, transaction costs and the regulation of the housing market may contribute to this outcome. Global tenancy discounts can be broken down into sit discounts and true length-of-stay discounts. We find strong empirical evidence of sit discounts. The evidence of true length-of-stay discounts, which imply that the rents of sitting tenants decline throughout the occupancy spell relative to the level of rents on the market, is less strong. Still we may conclude that in Germany a substantial part of rent increases takes place when tenants move. Furthermore, tenancy discounts seem to vary with the state of the housing market, being higher in periods of excess demand. Only in the long run do rents for sitting tenants adapt to changing market conditions. In the short run, therefore, the measured rate of rent increase may depend on the rate of tenant turnover.

We have found no evidence of a permanent and substantial bias in the German CPI subindex for rented housing services. Our study results in an estimate of quality-adjusted rent increase of about 64 % for the period 1985 to 1998, which is 10 percentage points higher than that in the CPI. This difference might be interpreted as evidence of a small downward bias (0.5 percentage point a year) in the CPI index for rents. However, nearly all the divergence of our measure from the CPI took place between 1990 to 1994. In that period, the difference between the two measures of rent inflation amounts to 1.8 percentage points a year. In the adjacent periods, the differences are close to zero.

Neither different aggregation nor sampling (with respect to the characteristics reported in the CPI specifications) procedures can explain these substantial differences in the period 1990 to 1994. Different rates of turnover may have contributed to this outcome, but they can explain only a small part of the difference. We cannot altogether rule out the possibility that the CPI quality-adjustment procedures monitor changing quality better than we do, given the limitations of our data. But neither the CPI nor our hedonic measure can adjust fully satisfactorily for the changing quality of flats, as, on the one hand, in the CPI adjustments are performed only for specific improvements, and, on the other hand, in the GSOEP many characteristics are not reported. Hence we cannot estimate a perfect quality-adjusted measure of rent increase. But it is extremely unlikely that the different quality-adjustment procedures could explain the differences in measured rent inflation in the period 1990 to 1994. Rents generally seem to have increased in this period much faster in the GSOEP than in the CPI sample. As no additional information about the official dwelling sample is available, we cannot explore the differences between the two measures any further.

Overall, we might conclude that, most of the time, the Federal Statistical Office succeeds in tracking rent inflation even with a significantly reduced sample of dwellings. In the first half of the 1990s, however, when the rental housing market in West Germany came under pressure, and rents increased substantially, the official measure seems to have understated rent inflation.

Appendix: Earlier hedonic studies on housing rents in Germany

Several hedonic studies on housing rents in Germany have been published in recent years. None of these studies, however, reports intertemporal rent indices. Either the hedonic regressions were performed for forecasting purposes, for the modelling of the tenure choice or for analysing the impact of imputed rent on the distribution of income, or they were prepared for the compilation of tables of comparable rents, which may be used as a reference for rent adjustments for sitting tenants (see Section 3). This appendix briefly reviews these earlier studies.

Behring/Börsch-Supan/Goldrian (1988) conduct a hedonic study based on the 1 % housing survey (1 % Wohnungsstichprobe) of 1978. They employ a standard log-linear specification of the hedonic function, which is estimated separately for six types of regions. Explanatory variables are physical and locational characteristics of the dwellings and several variables describing the landlord-tenant relationship. One of these variables is the previous length of the rent contract, which enters the regression equation in linear and squared form. As the coefficient of the linear term is negative, and the coefficient of the squared term positive, the tenancy discount rises less than proportionally to the occupancy duration. Furthermore, the tenancy discount differs between regions. The cross-section regressions explain between 60 % and 70 % of the variation in rents.

Bellgardt (2000) estimates a hedonic function for a sample of 20,000 households taken from the Sample Survey of Income and Expenditure (Einkommens- und Verbrauchsstichprobe) 1993. His linear regression model explains the variance in rents per square metre mainly by reference to locational characteristics, the building type and the vintage of the building. The characteristics of the flat play a minor role, with the exception of the inverse of the size of the flat, and a dummy for central heating. The length of occupation is not included in the list of regressors. The rather low R-squared of 0.42 reported in this study can be explained by the choice of the dependent variable.

Frick/Grabka (2001) present hedonic regressions on GSOEP data for the years 1988 (West Germany) and 1998 (West Germany and East Germany). The specification is log-linear; the dependent variable is rent per square metre. Size also enters the list of explanatory variables. Other explanatory variables are the physical and locational characteristics and the previous length of tenancy. Furthermore, they also include information on the income position of the tenant, which serves as a proxy for hidden quality. The R-squared is between 0.29 for 1998 in western Germany and 0.44 for 1998 in eastern Germany.

Increasingly, the tables for the estimation of comparable rents are compiled by hedonic methods, but most local authorities do not report detailed econometric specifications. Local authorities are not entirely free in the choice of the specification of the hedonic function, because legal stipulations entail the inclusion of some variables and the exclusion of others (Börstinghaus/Clar 1997). For example, the length of tenancy may not be included in the list of regressors, and only rents which have been adjusted in the previous four years may enter the sample. Furthermore, local authorities prefer simple specifications because they are more easily communicated to landlords and tenants. Therefore, the specifications employed for rent surveys differ substantially from our model.

Early attempts at employing regression models for the compilation of rent surveys were criticised heavily because they typically relied on simple linear cross-section models without any interaction terms (Krämer 1992, Ronning 1995, Schlittgen/Uhlig 1997). Given the rent *r* and other physical and locational characteristics x_i, a typical linear specification of the hedonic function would be:

(1) $$r = c_1 + c_2 size + \sum_i c_i x_i \ .$$

This simple linear specification rests on several assumptions which are not fully convincing. Firstly, the rent is linear in size. Secondly, other physical and locational characteristics, which typically are captured by dummy variables, add a fixed amount to the rent, regardless of size. And finally, the premium for a trait is unrelated to other characteristics of the flat.

To correct for some of the alleged shortcomings, Aigner/Oberhofer/Schmidt (1993) propose the following non-linear regression model:

(2) $$r = (c_1 + c_2 size)(1 + \sum_i c_i x_i) \ .$$

To ease the task of the local authorities, they suggest estimating the model in two stages. In the first stage, the rent is regressed on a constant and on the size of the flat:

(3) $$r = c_1 + c_2 size \ .$$

In the second stage, the ratio of the actual rent to the fitted rent is regressed on further characteristics:

(4) $$\frac{r}{c_1 + c_2 size} = \sum_i c_i x_i \, .$$

This model implies that traits other than size demand a percentage surcharge on rents.

A related regression model has been put forward by Blinkert/Höfflin (1994). For the first-stage regression, they stipulate a non-linear relationship between rent and size:

(5) $$r = c_1 + c_2 \frac{1}{size} \, .$$

Blinkert and Höfflin also tested whether interaction terms between characteristics other than size were statistically significant; however, they did not find any. The basic ideas behind this model resemble our specification; and indeed, this model gives, for the GSOEP, results which are close to our model.[20]

[20] The results are not reported here, but are available on request.

References

Aigner, Konrad, Walter Oberhofer, and Bernhard Schmidt (1993) Eine neue Methode zur Erstellung eines Mietspiegels am Beispiel der Stadt Regensburg. *Wohnungswirtschaft und Mietrecht* 46, pp. 16-21.

Angermann, Oswald (1985) Weiterentwicklung des Mietenindex in der Verbraucherpreisstatistik mit Hilfe von Ergebnissen der Wohnungszählung. *Wirtschaft und Statistik*, pp. 505-508.

Anglin, Paul M., and Ramazan Gençay (1996) Semiparametric Estimation of a Hedonic Price Function. *Journal of Applied Econometrics* 11, pp. 633-648.

Arguea, Nestor M., and Cheng Hsiao (1993) Econometric Issues of Estimating Hedonic Price Functions. With an Application to the U.S. Market for Automobiles. *Journal of Econometrics* 56, pp. 243-267.

Arnott, Richard (1995) Time for Revisionism on Rent Control? *Journal of Economic Perspectives* 9, pp. 99-120.

Arnott, Richard, and Masahiro Igarashi (2000) Rent Control, Mismatch Costs and Search Efficiency. *Regional Science and Urban Economics* 30, pp. 249-288.

Basu, Kaushik, and Patrick M. Emerson (2000) The Economics of Rent Control. *Economic Journal* 110, pp. 939-962.

Behring, Karin, Axel Börsch-Supan, and Georg Goldrian (1988) *Wohnungsnachfrageprognose 1995. Analyse und Prognose der Nachfrage nach Miet- und Eigentümerwohnungen*. Berlin und München: Duncker & Humblot.

Bell, Kathleen P., and Nancy E. Bockstael (2000) Applying the Generalized-Moments Estimation Approach to Spatial Problems Involving Microlevel Data. *Review of Economics and Statistics* 82, pp. 72-82.

Bellgardt, Egon (2000) Wohnkosten und Besitzformwahl: Empirische Ergebnisse der Einkommens- und Verbrauchsstichprobe. *Jahrbücher fur Nationalökonomie und Statistik* 220, pp. 653-668.

Belsley, David A., Edwin Kuh, and Roy E. Welsch (1980) *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York et al.: John Wiley & Sons.

Berndt, Ernst R., Zvi Griliches, and Neal J. Rappaport (1995) Econometric Estimates of Price Indexes for Personal Computers in the 1990´s. *Journal of Econometrics* 68, S. 243-268.

Blinkert, Baldo, and Peter Höfflin (1994) Die Qualität von Mietspiegeln als Modelle des Wohnungsmarktes - Tabelle oder Regression? Ein empirischer Beitrag zur Methodendebatte. *Wohnungswirtschaft und Mietrecht*, Heft 11, pp. 589-595.

Bode, Ben, and Jan van Dalen (2001) *Quality-corrected Price Indexes of New Passenger Cars in the Netherlands, 1990-1999*. Erasmus Universität Rotterdam Working Paper.

Börsch-Supan, Axel (1986) On the West German Tenants' Protection Legislation. *Journal of Institutional and Theoretical Economics* 142, pp. 380-404.

Börstinghaus, Ulf P., and Michael Clar (1997) *Mietspiegel. Probleme der Erstellung und Anwendung von Mietspiegeln aus juristischer und statistischer Sicht*. München: Beck'sche Verlagsbuchhandlung.

Can, Ayşe, and Isaac Megbolugbe (1997) Spatial Dependence and House Price Index Construction. *Journal of Real Estate Finance and Economics* 14, pp. 203-222.

Cook, R. Dennis, and Sanford Weisberg (1983) Diagnostics for Heteroscedasticity in Regression. *Biometrika* 70, pp. 1-10.

Crone, Theodore M., Leonard I. Nakamura, and Richard Voith (2000) Measuring Housing Services Inflation. *Journal of Economic and Social Measurement* 26, pp. 153-171.

Curry, Bruce, Peter Morgan, and Mick Silver (2001) Hedonic Regressions: Mis-Specification and Neural Networks. *Applied Economics* 33, pp. 659-671.

Davidson, Russell, and James G. MacKinnon (1981) Several Tests for Model Specification in the Presence of Alternative Hypothesis. *Econometrica* 49, pp. 781-793.

Diewert, W. Erwin (2001) *Hedonic Regresssions: A Consumer Theory Approach.* University of British Columbia, Department of Economics, Discussion Paper 01-12.

Eekhoff, Johann (1981) Zur Kontroverse um die ökonomischen Auswirkungen des Zweiten Wohnraumkündigungsschutzgesetzes. *Zeitschrift für die gesamte Staatswissenschaft* 137, pp. 62-77.

Feenstra, Robert C. (1995) Exact Hedonic Price Indexes. *Review of Economics and Statistics* 77, pp. 634-653.

Frick, Joachim R., and Markus Grabka (2001) Der Einfluß von Imputed Rent auf die personelle Einkommensverteilung. *Jahrbücher für Nationalökonomie und Statistik* 221, pp. 285-308.

Goldberger, Arthur S. (1968) The Interpretation and Estimation of Cobb-Douglas Functions. *Econometrica* 36, S. 464-472.

Goodman, Allen C. (1978) Hedonic Prices, Price Indices and Housing Markets. *Journal of Urban Economics* 5, pp. 471-484.

Goodman, Allen C., and Thomas G. Thibodeau (1997) Dwelling-Age-Related Heteroskedasticity in Hedonic House Price Equations: An Extension. *Journal of Housing Research* 8, pp. 299-317.

Gordon, Robert J., and Gail Mandelkern (2001) *Local Indexes of Apartment Rent and House Sale Prices*. URL: http://faculty-web.at.northwestern.edu/economics/gordon/EVhouse2.pdf.

Grundmann, Birgit (2001) Die Mietrechtsreform. *Neue Juristische Wochenschrift* 54, pp. 2498-2505.

Guasch, J. Luis, and Robert C. Marshall (1987) A Theoretical and Empirical Analysis of the Length of Residency Discount in the Rental Housing Market. *Journal of Urban Economics* 22, pp. 291-311.

Guckes, Siegfried (1975) Die Wohnungsmieten im Preisindex für die Lebenshaltung - Aufgabe und Grenzen der laufenden Mietenstatistik. *Bundesbaublatt*, pp. 444-448.

Hoffmann, Johannes (1998) *Problems of Inflation Measurement in Germany*. Economic Research Group of the Deutsche Bundesbank Discussion Paper 1/98.

Hoven, Leendert (1984) Het Prijsindexcijfer van de Huren en Kwaliteitsveranderingen. *Mndstat prijzen*, no. 8, pp. 9-20.

Hubert, Franz (1993) *German Housing Policy at the Crossroads*. FU Berlin, Institut für Wirtschaftspolitik und Wirtschaftsgeschichte Discussion Paper.

Hubert, Franz (1995) Contracting with Costly Tenants. *Regional Science and Urban Economics* 25, pp. 631-654.

Kofner, Stefan (1996) Vergleichsmietensystem und Kündigungsrecht: Reform der Regulierungen des Wohnungsmarktes? *Zeitschrift für Wirtschaftspolitik* 45, pp. 397-424.

Krämer, Walter (1992) Pro und Contra die Erstellung von Mietspiegeln mittels Regressionsanalyse. *Wohnungswirtschaft und Mietrecht* 42, pp. 172-175.

Kurz, Claudia, and Johannes Hoffmann (2002) *A rental-equivalence index for owner-occupied housing in West Germany*. Forthcoming.

Linnemann, Peter (1980) Some Empirical Results on the Nature of the Hedonic Price Function for the Urban Housing Market. *Journal of Urban Economics* 8, pp. 47-68.

Linnemann, Peter (1987) The Effect of Rent Control on the Distribution of Income among New York City Renters. *Journal of Urban Economics* 22, pp. 14-34.

Moulton, Brent E., and Karin E. Moses (1997) Addressing the Quality Change Issue in the Consumer Price Index. *Brookings Papers on Economic Activity*, No. 1, S. 305-349.

Musgrave, John C. (1969) The Measurement of Price Changes in Construction. *Journal of the American Statistical Association* 64, pp. 771-786.

Nagy, John (1997) Do Vacancy Decontrol Provisions Undo Rent Control? *Journal of Urban Economics* 42, pp. 64-78.

Pace, R. Kelly, and Otis W. Gilley (1997) Using the Spatial Configuration of the Data to Improve Estimation. *Journal of Real Estate Finance and Economics* 14, pp. 333-340.

Quigley, John M. (1982) Nonlinear Budget Constraints and Consumer Demand: An Application to Public Programs for Residential Housing. *Journal of Urban Econometrics* 12, pp. 177-201.

Ramsey, J. B. (1969) Tests for Specification Errors in Classical Linear Least Squares Regression Analysis. *Journal of the Royal Statistical Society, Series B,* 31, pp. 350-371.

Randolph, William C. (1988) Housing Depreciation and Aging Bias in the Consumer Price Index. *Journal of Business and Economic Statistics* 6, pp. 359-371.

Ronning, Gerd (1995) Ökonometrie für jedermann: Der Mietspiegel als Regressionsmodell. *Mitteilungen des Instituts für Angewandte Wirtschaftsforschung*, Heft 3, pp. S. 4-10.

Rosen, Sherwin (1974) Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy* 82, pp. 24-55.

Rostin, Werner (1966) Statistik über die Entwicklung der Wohnungsmieten auf breiterer Grundlage. *Wirtschaft und Statistik*, pp. 717-720.

Rostin, Werner (1967) Zur Änderung des Erhebungsrhythmus in der laufenden Mietenstatistik. *Wirtschaft und Statistik*, pp. 374-376.

Schlicht, Ekkehart (1983) The Tenant´s Decreasing Willingness to Pay and the Rent Abatement Phenomenon. *Journal of Institutional and Theoretical Economics* 139, pp. 155-159.

Schlittgen, Rainer, and Steffen Uhlig (1997) Zur Kombination von Tabellen- und Regressionsmethode bei dem Berliner Mietspiegel 1992. *Allgemeines Statistisches Archiv* 81, pp. 401 - 405.

Shear, William B. (1983) A Note on Occupancy Turnover in Rental Housing Units. *Journal of the American Real Estate and Urban Economics Association* 11, pp. 525-538.

Sheppard, Stephen (1999) Hedonic Analysis of Housing Markets. In: Ed S. Mills and Paul Cheshire (eds.) *Handbook of Regional and Urban Economics*, pp. 1595-1635. Elsevier.

Silver, Mick, and Saeed Heravi (2001a) Scanner Data and the Measurement of Inflation. *Economic Journal* 111, pp. F383-F404.

Silver, Mick, and Saeed Heravi (2001b) *Why the CPI Matched-models Method May Fail Us: Results from an Hedonic and Matched Experiment Using Scanner Data*. Paper presented to the CEPR/ECB Workshop "Issues in the Measurement of Price Indices" in Frankfurt, Germany.

SOEP Group (2001): The German Socio-Economic Panel (GSOEP) after more than 15 years - Overview. In: Elke Holst, Dean R. Lillard and Thomas A. DiPrete (eds.) Proceedings of the 2000 Fourth International Conference of German Socio-Economic Panel Study Users (GSOEP2000) *Vierteljahreshefte zur Wirtschaftsforschung* 70, pp. 7-14.

Sonnenschein, Jürgen (1994) *Mietrecht: Wohnraummiete - eine Analyse des geltenden Rechts*. Anhang zum Gutachten Wohnungspolitik auf dem Prüfstand der Expertenkommission Wohnungspolitik, Bonn.

Szulc, Bohdan J. (1983) Linking Price Index Numbers. In: W. Erwin Diewert, and C. Montmarquette (eds.) *Price Level Measurement*. Proceedings from a Conference Sponsored by Statistics Canada. Ottawa: Statistics Canada, pp. 537-566.

Triplett, Jack E. (1987) Hedonic Functions and Hedonic Indexes. In: *The New Palgrave Dictionary of Economics*, Vol 2, pp. 630-634. New York: Macmillan.

Triplett, Jack E. (1989) Prices and Technological Change in a Capital Good: A Survey of Research on Computers. In: Dale W. Jorgenson and Ralph Landau (eds.) *Technology and Capital Formation*, pp. 127-213. Cambridge: MIT Press.

Triplett, Jack E. (2001) Should the Cost-of-Living Index Provide the Conceptual Framework for a Consumer Price Index? *Economic Journal* 111, pp. F311-F334.

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