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The Impact on Rent from Tenant and Landlord Characteristics and Interaction

Abstract:
Owner-occupied housing services and rented housing services are often considered close substitutes, and both house price and rental price indices rely on regressions based on dwelling and location characteristics. However, while such characteristics are exhaustive in the owner's market, they cannot capture the additional complexity of rental markets. This paper offers a theoretical framework and an empirical analysis of additional factors that affect rent. The factors comprise three categories: Landlord characteristics, tenant characteristics, and characteristics of the landlord-tenant interaction. We analyze a novel data set sampled from the Norwegian rental market and obtain substantial improvements in explanatory power by including information on tenant and landlord characteristics and interaction. While variation in geographical variables explains 17 percent of the variation in monthly rent; variation in hedonic variables explain only 12 percent. Variation in tenant and landlord characteristics and interaction explains as much as 15 percent of rent variation. The full model captures 44 percent of rent variation and offers insights into the monetary values of landlord type, market mediation, tenure length, tenant type, and services. This additional explanatory power accentuates the difference between the owner's and renter's market, and the results come with ramifications for the general understanding of the rental market, for construction of rental indices, and for the assumption of a rental-equivalence principle in CPI-construction.

Keywords: hedonic regression, housing market, landlord, rent, rental index, rental market, tenant.

JEL classification: C21, D12, R21

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1. Introduction

A household needs shelter. It may own or rent. Because both choices can meet the household's needs, it is tempting to consider owning and renting substitutes. After all, demand that arises from the same source and supply that covers the same desire tend to form markets of substitutes. But the price negotiation processes in the owner's market and the renter's market may follow significantly different patterns. In the owner's market, the buyer and seller meet only during the transaction for a one-shot game of price negotiation. The resulting price is mostly a function of hedonic qualities, location of the object, and attributes of the neighborhood. In the renter's market, the buyer and seller establish a long-term interaction as repeated payments are done, deliveries of services made, and demands of up-grades met. This difference leads to a difference in how the two markets function, what prices emerge on what characteristics, and how customers self-select into one or the other market. The rental market includes many elements that the owner's market does not, including a complex inter-temporal interaction between tenant and landlord which comprises search mechanisms, selection processes, signal games, and contract challenges. This interaction has facets that look like types studied quite thoroughly in other markets, but which have been largely unexplored in the rental market. For example, both tenant and landlord employ search mechanisms that in some respects may be rental market equivalents of the network searches Marmaros and Sacerdote (2002) studied. Moreover, a landlord may be viewed as a principal that employs a tenant to secure for her an income stream from her ownership of a specific asset, a dwelling, and this article discusses applications of the trade-off between incentives and monitoring investigated recently by Demougin and Fluet (2001). Finally, tenant and landlord play signal games of quality and negotiate and re-negotiate the contract under various degrees of asymmetric information, where the contract itself may resemble the kind that motivated Schmitz (2002). This is the kind that puzzles contract theory with the incongruence between actual market contracts and optimal complete contracts. Thus, we argue, theoretically, that the renter's market is more complex than the owner's market and demonstrate, empirically, that hedonic regression analysis leads to novel findings consistent with this claim. The article explains how to characterize the different price formation processes and how to estimate the monetary values of the additional rental market elements.

We seek to use a new and wide-ranging data set to answer a number of questions that housing economists frequently have posed. For example, are owner-occupied housing and rented housing services completely similar commodities? Is the length of tenure irrelevant for the rent level? Is rent unaffected by the interaction between tenant and landlord? Can rent by analyzed and rental indices

constructed without considering whether or not the object was professionally mediated? Is rent independent of tenant type? Can we understand the rent negotiation process without controlling for tenant services such as snow shoveling or lawn mowing? This article answers "no" to all questions, and can, to the best of our knowledge, for the first time offer estimates on the monetary value of all such elements. The novelty of the estimates originates in a comprehensive survey with a unique questionnaire conducted in Norway during the summer of 2005 that allows investigators to put price tages on a long list of determinants of rent.

This article hypothesizes that the markets for owned and rented homes have different price formation processes, and presents supporting empirical evidence for this position. Such findings may be of substantial interest to economists, policy makers, and the general public. First, policy makers are able to improve their understanding of the rental market and the rent negotiation processes. They may inspect the social profiles of the rented housing services and quantify the differences in rent for segments of the population, between different types of landlords, and within different sub-groups of objects and regions. Second, the regression results presented offer an alternative to the judicial practice of referring to, in legal cases concerning the magnitude of rent level, rents in so-called comparable objects. Often, these studies face the challenge that there are, in fact, few (or none) truly comparable objects. Third, economists are in a position to inspect the commonly used assumption of a rental-equivalence principle underlying the construction of the consumer price index in many countries; see e.g. ILO's (2004) manual on CPI for an exhaustive coverage and Beatty, Røed Larsen, and Sommervoll (2005) for a recent critique of the rental-equivalence principle. The rental-equivalence principle presupposes exactly what this article cannot confirm, the substitutability between owned and rented housing services.

The differences between the housing market and the rental market are quite easy to grasp intuitively and surprisingly hard to quantify. The reason for both can be identified by pointing out that transactions in the housing markets are one-shot affairs while transactions in the rental market are repeated affairs. Most people find it easy to grasp that one transaction leads to a different outcome than does a number of repeated transactions. Most econometricians find it hard to quantify the monetary value of the different elements of such an on-going process. Why? This article points towards two factors. One factor is the theoretical challenge of establishing a framework that analysts may employ to understand the inter-temporal price negotiation process. Another factor is the empirical challenge of not having access to high-quality data with good coverage. This article's contribution is an attempt to improve our understanding on both accounts.

Our theoretical contribution starts with a de-composition of the elements relevant to the inter-temporal negotiation process. The elements comprise three categories: characteristics of the landlord, characteristics of the tenant, and characteristics of the interaction between them. We construct a model that emphasizes that both landlord and tenant only knows one of the three, their own characteristics, when they negotiate. Both agents attempt to acquire information on the other two categories and attempt to signal quality on own category. This two-way process of information-acquisition and signaling forces the participants to optimize a risk-management problem and it leads the agents to require premium elements and offer option prices. Our empirical contribution is the estimation of parameter magnitudes using a hedonic regression technique on the data set with new variables.

Using the standard econometric tool, a hedonic log-log model, we find some striking results. Variation in hedonic qualities alone appears to explain a surprisingly low12 percent of variation in monthly rent. Location matters, and variation in geographical variables explain, quite expectedly, 17 percent of variation in monthly rent. But, intriguingly, variation in landlord and tenant characteristics and interaction explains as much as 15 percent of variation in monthly rent. Since these variables per definition are excluded from the owner's market, and since they are important to the renter's market, the difference between the two markets cannot be ignored when indices are constructed. Moreover, we find clear evidence of market fragmentation, both with respect to tenure length as well as agent characteristics.

Small-scale landlords tend to set rents lower than large-scale landlords. Good tenant characteristics appear to lead to rent reductions. These two findings may be interpreted in tandem. It is consistent with a rental-market model where rental risk has an impact on prices. Small-scale landlords may scrutinize tenants more closely and be more inclined to offer discounts to desirable tenants than large-scale landlords. After all, small-scale landlords often have the tenant as neighbor. Landlord choices may thus involve adverse selection of separate tenant types. In this dynamic process of searching and matching, large-scale landlords may face a higher rental risk when or if good tenants are underrepresented in the sample of potential tenants they are able to recruit.

The role of mediation has been suppressed in other studies. It should not. We find that a private mediation channel, in contrast to announcements on the Internet or in a newspaper, tends to reduce rents even when we control for prior affiliation and interaction such as landlord being a relative or friend. One way to read this finding is that private mediation is an indicator of good tenant type beyond the signals included in affiliation and relation. To see this, keep in mind that informal

mediation often involves a process where a tenant is recommended by persons the landlord knows. Such a recommendation may be viewed as a signal of reduced risk for which the landlord has a willingness-to-pay and thus implies rent reduction.

Our article stands in a confluence of two strains of literature. One strain consists of studies into how hedonic qualities and location attributes affect owner prices and rents. This is the tradition that employs hedonic technique to study such associations in both the owner's and the renter's market. Another strain focuses attention on the specific qualities in and unique structure of the rental market. We cannot here offer a full review of both strains. Let it suffice to say that our theoretical model of how tenant bid function and landlord offer function emerge rests firmly upon the work of Freeman (1993, pp. 124-131), who again built upon Rosen (1974). This hedonic regression technique has been employed in numerous contributions, and it should be well known within the community. In the next section, we outline our use of it and how we extend it for the purpose at hand.

This article's choice of determinants was inspired by, but not limited to, both strains of literature. The reader may acquire a scent of these two fields by considering a small bouquet of recent studies. For example, in a highly readable account, Chay and Greenstone (2005) discuss the impact of air quality on house values. Bourassa, Hoesli, and Sun (2004) estimate the value of view. Theebe (2004) asks what impact traffic noise has on house prices. Shulz and Werwatz (2004) use a state space model to explain house prices in Berlin. Frew and Wilson (2002) estimate the connection between location and property value. Baranzini and Ramirez (2005) ask what tenants must pay for quietness in their study of what impact noise has on Geneva rents. The reader notices that these studies employ attributes with the physical units or properties of the physical surroundings when they explain variation in price and rent. This article points towards the importance of additional characteristics, those of the two agents, the tenant and the landlord, and their interaction. A few such attempts have been made before. For example, Goodman (1985) and Goodman (2003) seek to explain rental demand and rent discounts on the basis of length-of-residence. Barker (2003) asks whether long-term tenants should pay less than new tenants. This article argues that there are theoretical reasons why they should and shows empirically that, in fact, they do. Grenadier (1995) uses option-pricing theory to derive inter-temporally optimal tenant mix, and this article utilizes similar option values to interpret rent premium and discount given tenant signal. In order to do so, we build upon Igarashi's (1991) search behavior and matching-mechanisms in the relationship between rental markets and vacancy rates to establish why landlords may give discounts to tenants with low probability of exiting because such exits create vacancies. The possibility of a natural vacancy rate, with close resemblance to the sibling rate in the

labor market, immediately leads our thoughts to rent pressure when vacancies are few and discounts when vacancies are frequent. One implication is that landlords may not only charge for object attributes, but also for the timing of entering tenure, date of contract, and probability of vacancy. Recently, Gabriel and Nothaft (2001) used time-series data to assess the importance of vacancy indicators for the price adjustment mechanism. Our methodology is quite similarly motivated when we theorize that landlords use indicators of tenant type when they enter the price negotiation process. Such indicators are noteworthy, because recent research leads us to believe that landlords use them. For example, Rugg, Rhodes, and Jones (2002) study UK students and the private rented sector and Ondrich, Stricker, and Yinger (1999) seek to uncover whether landlords use markers and discriminate in rental markets.

It is convenient for the reader to get an idea of where this article is headed. In the next section, we present the theoretical framework for of how tenants and landlords construct and use bid and offer functions when they negotiate rent. We examine in some detail three categories of variables that are of no importance to purchasing prices in the owner's market but which are major determinants of rents in the renter's market. Then, we proceed to describe our data set and explain what estimation techniques we employ. The fourth section examines the empirical results. Subsequently, we discuss unexplored elements, some unresolved issues in data, and give pointers to future research. The sixth section summarizes and puts forward policy implications. In the appendix, we describe how we trimmed our data set and constructed our variables.

2. Theoretical framework

We apply the standard hedonic framework, as laid out by Freeman (1993). It rests upon the seminal contribution of Rosen (1974) and it is by now the conventional approach in the literature. Let us, briefly, describe how our model extends this work, starting with the classic set-up. Let *R* represent rented housing services and *G* other goods consumed by a tenant. A tenant extracts utility from rented housing services and other goods, as given in equation (1):

$$U = u\left(G, R(x); y_T\right), \tag{1}$$

where u is an unspecified utility function, *R* is a vector function consisting of rented housing elements that themselves are functions of *x*, which comprises hedonic qualities, location, and amenities of the rented object. The vector y_T consists of tenant characteristics, which allow the possibility that preferences may not be universally shared but are at least shared for pools of types. In empirical

regression techniques, this implies the use of segmentation frameworks. In other words, we allow, without loss of generality, that preferences vary across tenant types, but not within types. The tenant maximizes utility given the budget constraint:

(2) $$p_G G + rR \leq I ,$$

where p_G is the price vector of other goods, r is a vector consisting of implicit prices for housing services, and I is income (alternatively, total expenditure in models that incorporate saving decisions). Notice that in this terminology, the vector R is assumed to contain not only hedonic housing qualities, but also other qualities with the rental service offered. In particular, any paragraph in rental agreement and any element of the interaction between landlord and tenant may be viewed as a component of R and as such have an impact on utility maximization. The tenant observes the price vector of explicit or implicit prices, r, for each quality deemed relevant to the delivered multivariate service stream, R. The tenant solves the following constrained maximization problem:

(3) $$\max_{GR} u\left(G, R(x); y_T\right), \qquad s.t.\ p_G G + rR \leq I .$$

The solution to this optimization problem results in direct utility $u\left(G^*, R(x)^*, y_T\right)$[1] and demand for other goods G and rented housing services R. In general, we may derive the indirect utility function $v\left(p_G, r, I\right)$. This solution must satisfy the Gossen conditions:

(4) $$\frac{\partial u/\partial R_j}{\partial u/\partial R_k} = \frac{r_j}{p_k}, \quad j \in J, k \in K ,$$

where the sets J and K comprise elements of rented housing services and other goods, respectively. The solution to the optimization problem can also be written as $u\left(G^*, R_j^*, R_{notj}^*, y_T\right)$, or $v = u\left(\left(I - rR^*\right)/p_G, R_j^*, R_{notj}^*, y_T\right)$. This is useful because we see that this function may be solved for R_j when utility is at level v. We follow Rosen (1974) and Freeman (1993) and simplify by aggregating other goods G into one and letting G be a numeraire good with $p_G = 1$. The demand for element j, R_j,

[1] The asterix denotes optimal solution.

then is a function of utility level v, income I, price vector r, other elements R_{notj}, conditional on tenant type y_T.

In a diagram with quantity of element j and price for bundle R, Freeman explains that such preferences may be mapped as bid curves tenants present in the rent negotiation process in the rental market. The bid curves are assumed to be concave, reflecting diminishing willingness to bid for marginal increases in the quality in question. Since bid curves may be different for different tenants they outline the contour of a price function. A tenant's bid curve for quality j can be written, holding other things constant, as in equation (5):

$$B_j = b_j\left(R_j; R^*_{notj}, I, v, y_T\right), \tag{5}$$

in which a bid curve for element j is a function of the quantity of element j, R_j, given optimum choice R^*_{notj} for other rental services, income, utility level and tenant type.

However, prices do not emerge exogenously, but endogenously in a market with both tenants and landlords. Thus, the market also consists of profit-maximizing landlords who solve maximization problems. These solutions lead to landlords' offer curves for rented housing services R. In a diagram depicting quantity of element j, R_j, and the price for bundle R, following Freeman, the offer curves will be convex, and different for different landlords. The offer curve for quality j can be written:

$$O_j = o_j\left(R_j; R^*_{notj}, \pi, y_L\right), \tag{6}$$

where π is the level of the profits and y_L represent the characteristics of the landlord. The set of landlords comprise several types, from small-scale operators to large-scale businesses, and we assume, again without loss of generality, that they form a finite mixture of types. The variable y_L is thus a vector that comprises type of landlord, place of residence (within complex or not), operating scale (from small scale to large scale), or a governmental owner. In the market, tenants make bids and landlords make offers. The solution emerges in equilibrium, where bid curves and offer curves form a consistent price-curve of quality j, a double-envelope, as Freeman points out.

In summary, an agreement to rent consists of a hyper-plane comprising tangency between a tenant's computation of a bid curve for each quality and a landlord's computation of an offer curve for the each

quality. Together, the bid curves and offer curves form a consistent system with agreed-upon prices for elements of the housing services. Below, this article extends the standard model by including a list of rented housing elements, R, which encompasses several important elements that have been suppressed in theory or omitted in empirical analyses.

In housing markets, a transaction occurs if the highest bid from some kind of auction process meets, or exceeds, the seller's reservation price or offer. In rental markets, however, auctions are fairly infrequent. Usually, prospective tenants consider a given fixed rental price or enter a negotiation concerning both rent and rental terms. In the first case, the landlord wishes to set the rent as high as possible, but knows that a high rent tends to stimulate some types of tenants to move on. Thus, higher rents tend to go with longer and more frequent vacancy periods, or with more desperate tenants that cannot, for some reason, find contracts elsewhere. The landlord may attempt to account for this perspective in her optimization and, consequently, in her offer. Several empirically and model based studies illuminate this important point; confer e.g. with Igarashi (1991) and Gabriel and Nothaft (2001). In our framework, we extend this idea by allowing for the possibility of the second case, where rents evolve from a negotiation process and where the landlord considers employing various elements of price discrimination among possible tenants. The rationale for such behavior is obvious; renting to a tenant comes with several risks. If the landlord can reduce risk of delayed payments, probability of exits, damaged properties, and long legal processes, she will be inclined to offer a rent reduction. In mathematical terms, her proposed offer O for the bundle of qualities that comprise the whole object, is not only a function of the hedonic qualities of the object, amenities, and neighborhoods, but also of three vectors specific to the negotiation process:

$$O = o\left(R_L, \pi; y_L\right);\ R_L = \left(x, y_T, z_{LT}\right), \tag{7}$$

and where x is the standard vector from above of hedonic variables of the rental object, location, and neighborhood amenities, y_T consists of observed characteristics of the tenant, household size, marital status, employment, level of education, and choice of vocation. The vector z_{LT} represents additional parameters describing the tenant-landlord affiliation and interaction in their formal contract as well as their social contact. The vector R_L is simply a mental heuristic, a collection of elements, to help the reader identify what we claim is central to how the landlord computes the offer. This article claims that the vectors, y_T, z_{LT}, and y_L, are critical to understanding the rent formation process and that they can lead to different rent for otherwise identical objects. Without it, analysts may not obtain unbiased estimates of hedonic coefficients nor obtain high explanatory power of rent determination. It is

especially acute for agencies that construct indices that, if the variables are excluded, may lead to omitted variable biases.

Writing the proposed rent as a function in this way has several advantages. First of all, it represents a toolbox for separating hedonic parameters, which in principle capture all price variation in owner-occupied housing markets, from explanatory variables that are hard to observe, but tend to play a key role in landlords' risk management and profit maximization programs in the rental market. By introducing y_L we acknowledge that different types of landlords will set rents differently. For example, a landlord letting only one apartment has few tools for risk diversification. If the apartment is part of her own house, she not only chooses a tenant, but also a neighbor. This will not only stimulate more thorough background checking, but most probably also limit the number of admissible tenants. In contrast, large-scale landlords accept that some contracts may not be performing well, allow for higher frequency of exits, and/or a higher probability of damage to the property. Thus, large-scale landlords tend to include insurance premiums, against vacancy and object depreciation, in their offered rent. The presence or absence of such premiums is one of the factors that this article aims to capture by including landlord type in the analysis.

The affiliation and interaction vector z_{LT} includes two classes of variables. One includes the type and content of the contract, duration, liabilities and obligations for the tenant's behavior. The other includes social contact and proxies for perception of the other agent. In an initial negotiation process, rent reduction is expected if the landlord knows, directly or indirectly, something about the prospective tenant. Typical examples occur when the tenant is a relative, a colleague, a friend, or friends of friends and friends of colleagues. It must be emphasized that potential rent reductions driven by such relationships need not be, and probably in most cases are not, personal favors. A more likely explanation is that such tenants simply reduce rental risk because the information relayed through relatives, friends, or colleagues contains knowledge about agent type, and rents will reflect this by including a premium or discount. Equally important, as a landlord tenant relationship evolves and matures, both parties manage the challenge of asymmetric information. As a corollary, a tenant that pays rent on time, and takes good care of the dwelling, may get reductions over time either by re-negotiated terms or, probably more common, through an absence of nominal rent adjustments. The other type may find his contract terminated. When there is inflation, absence of nominal re-writing entails real rent reductions. Thus, from this theory longer tenures include a selection mechanism that lead to a potential rent reduction.

The prospective tenant faces a complex optimization process. In mathematical terms, his willingness to pay or bid for the bundle of qualities, i. e. the rental object, is a multivariate function as described in equation (8):

$$B = b\left(R_T, I, v; y_T\right),\ R_T = \left(x, y_L, z_{LT}\right), \tag{8}$$

again not only a function of the standard hedonic variables x, but also of landlord signals or characteristics y_L, and affiliation variables z. Without the latter two, biases may be introduced as we shall see below. The vector R_T is also a mental heuristic to illuminate the range of the spectrum of elements relevant to the negotiation process. The monthly rent agreed upon between tenant and landlord must consist of the union of elements in offer O and in bid B. Thus, we proceed below to inspect the association between the price of the bundle, monthly rent, and not only the determinant x, but also the novel elements y_L, z_{LT}, and y_T.

The exact form of the rent function that maps all elements into one price for the bundle cannot be determined by consumer or production theory. Some properties, e.g. curvature of bid functions for quality may be governed by the theory of diminishing marginal utility; other properties may be vaguer, but, perhaps, expected by intuition. Apart from certain general properties of signs, curvature, monotonicity, little more is known a priori, as has been discussed in the literature; see e.g. Freeman (1993, pp. 128-129). This leaves quite a bit to the art of estimation. This art emerges as the need to overcome two well-known challenges, functional form and omitted variables. In the empirical section below, we report what choices we made.

3. The rental survey, data, and empirical techniques

Estimating effects of rent determinants econometrically involves overcoming several major challenges. First, analysts must find the appropriate data set. Second, since possibly important explanatory variables remain unobserved, the exact specification of the model must be scrutinized. Third, sample sizes may severely limit the possibilities of exploration of functional form, different segmentation plans, and censoring techniques. In addition, sample size constrains analyses of how infrequent combinations of some variables affect the regression estimates. This induces an involuntary rigidity in the econometric modeling. Several of these challenges may be overcome using a new Norwegian data set, collected in the summer of 2005.

The motivation for data acquisition may also uncover insights into its benefits, so allow us a few words on its background. In 2003-2004, it became clear that the Government needed an improved rental index that could serve its need for precise information about developments in rental markets across geographical regions and object types. A rental survey was requested from a ministry ("Kommunal- og Regional Departementet"), which collaborated with the bank "Husbanken", which is regulated by the government, and asked Statistics Norway to acquire data in order to facilitate studies to improve the understanding of the mechanisms in the rental market, to identify determinants of rent, and to construct more accurate indices with broader range. It was a clearly formulated desire that politicians be furnished with knowledge about geographical variation of rent and policy-relevant socioeconomic determinants of rent formation in strata from different dwelling types and standards.

The sampling scheme[2] consisted of several stages since a simple, random sample from all addresses in Norway would be inefficient due to the infrequency of tenants compared to owners. In Norway, about one object out of four is a rental object, so sampling from the whole population of addresses would include a high proportion of owners. The first stage of sampling involved using registers to extract and remove addresses where owner resided in the object in order to increase tenant frequency in the sampling universe. The second stage involved sampling 21 000 interview objects (IOs), stratified by administrative region ("fylke"), for interview from the universe that consisted of a combination of 479 752 dwellings and 408 897 families. The third stage comprised obtaining contact with the interview object, using telephone as the main method of obtaining contact. Before interviews were attempted, information about the survey was sent the physical address in mail. Some interview object candidates could not be matched with existing telephone numbers, and these resulted in postal and manual attempts at recruitment. Out of a gross sample of 21 000 IO-candidates, 2 962 could not be matched with telephone numbers. The field period for data harvesting covered May 9 through July 10 in year 2005. The telephone interviews with tenants averaged 7 minutes. In addition, 109 personal visits were completed. In total, a combined number of interviews with 12 955 tenants and owners were performed. Analysis of non-respondents shows they typically were young, single, and only owning mobile phones.

The data set was complete during the summer of 2005, and is representative for the whole Norwegian economy. It is highly detailed, and contains 3 849 observations of positive rents for tenants. Information on an extensive list of hedonic qualities of each object is included. In addition, the data set

[2] An extensive description can be found in Belsby, L. et al. (2005): *Leiemarkedsundersøkelsen 2005* [The Rental Survey of 2005], Report 32/2005, Oslo: Statistics Norway.

contains information on tenants and landlords, specifications of their formal and social contract, and variables related to their interaction. To the best of our knowledge, this data set is the first to cover such a wide range of information on the additional elements pertaining to the rental market. In Table 3, we present a selection of these additional explanatory variables. In the appendix, we have included a full list of variables we use, including the conventional hedonic qualities and geographical determinants.

The first column in Table 1 lists a few examples of tenant and landlord characteristics that may affect realized rent according to the search theory outlined above. Tenant's household size will influence what will be considered rate of depreciation. Co-residence will affect how the perception of the parties evolves over time and the relative importance of variables. For example, if tenants and landlords reside within the same building, expected noise and inconvenience related to the tenants' household size and age distribution may affect the landlords' reservation rental price. On the other hand, households receiving full rent subsidy from the government, have less incentive to bargain, and the landlord may view rent subsidy as proxy for increased risk and potentially insist on higher rent. Finally, the variable "type of landlord" is relevant to the price formation process since different types have different approaches to risk management. Professional landlords with many rental objects and ability to employ risk differentiation techniques negotiate rent differently from governmental, institutional, and small-scale landlords with few objects, e.g. one or two small apartments in their own home. These landlords have different risk profiles and incentives in setting rents. Our data include variables that allow us to identify landlord type.

Table 1. Examples of elements in the rent formation process

Characteristics of tenant and landlord	**Characteristics of contract**	**Appliances, amenities, and services**	**Characteristics of interaction**
Number of children (T)	Deposit	Washing machine etc.	Same residence
Number of adults (T) Level of education (T)	Contract length, tenure length	Access to garage	Additional tenant services (lawn mowing, janitor services, snow shoveling etc.)
Person or institution paying the rent (T)	Contract date (signed), rental starting date	Cable TV	Family, friend, colleague
Reception, governmental aid (T)		Heating	Mediation channel used for finding tenant/landlord
Type of landlord (L)		Electricity	

Note: T represents tenant characteristic, L landlord characteristic.

Empirically, the analyst must specify the definition of rent. For example, some agreements include heating, electricity, or both. Other agreements include appliances such as washing machine, TV, cable TV access, while other include extra charges for the same items. In principle, every paragraph in the contract agreed upon influences the realized rent, and in principle every rental aspect may contain a paragraph, as Schmitz (2002) points out with respect to the optimal, complete contract. Contract paragraphs define liabilities and obligations for both parties, and include paragraphs on items where an agent has a willingness to pay for inclusion or exclusion. Thus, analysts seek data set with as complete coverage as possible. A rent, then, is a pre-defined collection of partial, implicit rents of different object attributes, options, and premiums. This article's data set includes information on such variables as tenure history, date of contract, inclusion or exclusion of electricity and heating, access to cable-TV or fiber optic network.

The last column in Table 1 labels a few interaction factors that may affect rents and rent adjustment over time. In cases where tenants and landlords reside in the same building, both parties will value a well-functioning relationship. This may prevent the landlord from enforcing rent adjustments in fear of losing a good tenant. The tenant faces serious transaction costs by moving, and values a well-functioning landlord-tenant relationship. In short, stickiness of rents for longer tenures is expected, especially since non-performing contracts lead to exit. Finally, rental agreements, irrespective of rental duration, may be expected to involve some kind of discount in the case where a non-professional tie exists between the parties. In the case of family ties, this is fairly easy to map. The data set contains variables on relatives and relations. However, a significant proportion of rental contracts in the case of small-scale landlords, involves tenants selected from informal channels. In these channels, recommendations of friends and colleagues may reduce the risk of renting out an apartment. The data set contains markers on such processes. The final entry in the last column lists a proxy for such hard-to-observe recommendations, and such proxies may be used to assess the monetary content in rent magnitude of informal risk management. The questionnaire contains a sequence of questions regarding how knowledge about the rental object was acquired.

4. Empirical Results

Our models consist of varieties of the following baseline hedonic regression:

$$\text{(9)} \qquad \text{Log}\left(\text{monthly rent}_i\right) = a + \sum_j b_j G_{ji} + \sum_k c_k H_{ki} + \sum_l d_l T_{li} + u_i, i \in S, j \in J, k \in K, l \in L,$$

where our first regression includes only an intercept and the geographical variables *G*, the second regression only an intercept and the hedonic variables *H*, and the third regression only an intercept and tenure characteristics *T*. The set *S* comprises the sample population of observations, in which each of the 3 849 tenant observations is denoted by subscript *i*. The letters *J*, *K*, and *L* represent the sets of the geographical, hedonic, and tenure variables, respectively. The full model encompasses all models mentioned above. Our inspection plan is the following: First, we investigate the impact on rent from hedonic qualities and geographical position, and whether our results are consistent with the literature. We proceed to argue that while other studies may involuntarily include other characteristics of tenure into these two, and thus risk confounding and omitted variable bias, it is possible to isolate these characteristics given the proper data set. Successful control for confounders and omitted variables may rehabilitate unbiasedness of parameter estimators and increase explanatory power. We start out this part of the argument by showing the impact on rent from landlord characteristics. Then we seek to answer objections that landlord type may be a proxy for, and thus include the effect of, mediation channel. We do this by examining the partial effect of mediation type, while controlling for landlord type. At this juncture, it is possible to continue with an objection that mediation is proxy for, and thus include the effect of, tenure lengths; mixing short and long ones; since co-variation between professional mediation and short tenure is fathomable. We answer by controlling for tenure length. Finally, the interaction between landlord and tenant may affect landlord type estimates, mediation type, or tenure length. Thus, we control for characteristics of interaction and characteristics of tenant in order to avoid omitted variable bias.

Table 2 summarizes the regression results. The first regression where only geographical variables are included as determinants yields the expected signs and plausible estimates with high t-values. This regression shall serve as a starting point for comparison of relative importance in explaining variation in rent between different candidate determinants. We observe a location effect, a rent premium that enhances the rent objects positioned in the nation's capital, Oslo, or in its surrounding areas, Akershus. The estimate of the binary variable for Oslo and Akershus is 0.23 for the reduced model; 0.22 in the full model. The estimate represents a rent mark-up for residence in the capital of 24 percent[3], everything else being the same. Second, there is a premium for position close to city centers and deductions for position in the periphery. The estimate of the effect of logarithm of distance to a center is -0.0187 in the reduced model and -0.0202 in the full model. Thus, if two identical objects were

[3] $P_{Oslo}/P_{not\ Oslo} = e^{0.219\ (1)} = 1.245$.

positioned differently from center, one 2 000 meters from center and one 1 000 meters from center, the distant object would rent at approximately 1.4 percent lower rent.[4]

Hedonic variables, or object characteristics, have a substantial impact on rents. The coefficients of size, access to balcony, and high material standard come with expected signs and plausible magnitudes. They are statistically significant and economically important. For example, the estimate of the coefficient of the logarithm of size is 0.224 in the reduced version and 0.365 in the full model. Thus, using the latter, an increase in an apartment's size from 50 to 60 square meters is associated with an increase in monthly rent of 6.9 percent[5].

Having established literature-consistent results and controlled for hedonics and geographical variables, let us turn to this article's more significant contributions. Our results support the notion that landlord characteristics play a role both in determining rent variation and in understanding the rent negotiation process. This article's set-up uses a multi-complex owner as the default for a landlord. In Table 2 we observe that objects let by small-scale landlords tend to be associated with lower rents than objects let by large-scale landlords. For example, when tenants negotiate with landlords of types “Other landlords” or "County, Employer, or Student Co-Op", we obtain parameter estimates of -0.240 and -0.0796, respectively, in the full model. T-values show that estimates are statistically significant. In other words, who is landlord contributes to determining rent, and thus matters to analysts of rental markets.

It is possible to argue that these parameter estimates may be the result of possible confounding or omitted variable bias, for example in a way such that large-scale landlords are able to set higher rent because they select tenants using professional agents. The objection would, in fact, be invalid here, because we control for mediation. Let us inspect this key variable, “Market Mediation” since it is essential to the theory presented above, as it is a proxy for the different examinations of candidate tenants between large-scale and small-scale landlords. In the full model, the coefficient estimate of "Market Mediation" is 0.116 with a t-value of 8.2. In other words, if two identical objects are compared, and one is mediated through a market channel while the other is not, our results indicate that the former has an expected rent 12 percent[6] higher than the latter. Thus, objects that pass through

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[4] $P_2/P_1=e^{-0,0202(\ln(2001)-\ln(1001))} = 0.986$. Notice the measurement units and the scaling to avoid ln(0). See the appendix for an explanation.

[5] $P_{60}/P_{50}=e^{0.365(\ln(60)-\ln(50))} = 1.0688$. Recall that we use the conventional notation "log" in the text, when, in fact, we mean more precisely the natural logarithm, ln. The size variable is not scaled.

[6] $P_{market}/P_{non\ market} = e^{0.116\ (1)} = 1.123$.

channels such as advertisements, newspapers, the Internet, or a professional agent typically rent at substantially higher monthly rents.

Notice, importantly, that the market mediation effect is net of relations between tenant and landlord. This is adamant since critics could argue that market mediation, or lack thereof, simply was a proxy for family or friend connection between tenant and landlord. We control for such effects both in the landlord type variables and in the variable called "Residence in Same Building as Owner". Again, one may fathom, and here compute the effect of, all four permutations of "yes" and "no" to "Market Mediation" and "Residence in Same Building as Owner". While a "yes" on "Market Mediation" is associated with substantially higher rent, a "yes" on "Residence in Same Building as Owner" is associated with considerably lower rent. The full model parameter estimate of same-building-residence is -0.0580, meaning that an object, market mediated or not, typically comes with a monthly rent that is 5.6 percent lower if the owner reside in the same building as the tenant.

Allow us to pause at a possible interpretation of these results. Our theory implies that the interaction between tenant and landlord is one with asymmetrical information. The type of the other negotiating party is hidden and latent, but one that both parties seek to uncover. Thus, both parties have a willingness-to-pay for information about the other's potential or probable type in order to make bid and offers. Over time, both parties receive information from the interaction itself that is relevant to uncovering which type the other party is. The landlord observes payments and treatment of the object. The tenant observes maintenance and other services rendered by the landlord. In other words, time allows revelation of type, and as a consequence, tenure length must be of essence. Our set-up includes control for tenure length, and let us turn to the examination of impact on rent from tenure length.

Both tenant and landlord appreciate these signals in the matching process, but only a limited amount of information can be acquired before signing the contract. Much, perhaps most, information will be relayed throughout the renting period. Over time, information acquisition implies a selection process that may make the landlord terminate some contracts. In others, tenants exit. Well-functioning tenures are renewed. This selection process may co-vary with mediation channel, thus our controlling for channel is a core part of the modelling. The surviving tenures are successful agreements where both bid and offer functions are compatible. It could have been an empirical question which way it affects rent since a landlord is willing to reduce rent for tenants of good type and a tenant is willing to accept

higher rent for good service streams from high-quality landlords.[7] However, some a priori analyses are possible which may imply reductions in rent for the remaining, not-exited tenures, if, as we think is natural to assume, the landlord has the strongest willingness-to-pay for information about tenant behavior. This follows from the assumption that she has the most to lose since she owns the object. In fact, we find results consistent with this ex ante belief since we do observe substantial rent reductions over time for identical objects. The full model yields an estimate on the coefficient of the logarithm of tenure length at -0.0886, with a t-value of -9.2. Put differently, we observe that tenure length is associated with a rent reduction, and that e.g. a tenant with a one-year-old tenure is estimated to pay 6 percent[8] lower rent than does a tenant who enters a new tenure of a similar object. We were somewhat surprised at the magnitude of this effect. Nevertheless, notice that one plausible interpretation is that the reduction does not entail a re-writing of nominal terms in old contracts. Rather, old contracts keep nominal terms and new contracts are written with higher nominal rents.

Recall that we have argued that characteristics are signals of type and thus perceived by landlord and tenant as predictors for future payment and service streams. The question remains whether or not we have controlled for the most salient signals, i.e. characteristics. In order to reduce omitted variable bias we need to control for further interaction between the parties. For example, the inter-temporal interaction between landlord and tenant is partly characterized by several service types. Services such as mowing the lawn and shovelling snow involve labor. If these services were purchased on a market, the buyer would have to match the service render's reservation wage. Thus, our theory implies that if the tenant performs such services, we should observe rent reductions. We do. Table 2 demonstrates this. The estimate on the coefficient of the logarithm of services rendered is -0.04 and its t-value is -2.8, indicative both of a statistically significant and an economically interpretable effect.

Other type markers have more dubious estimate significance. It is not a priori clear in what direction single-status would lead rents. A single tenant may cause less depreciation of the object than a couple. A single tenant is typically more socially active than a couple. Potentially, landlords view the former as positive and the latter as negative. The negative sign of the estimate of binary variable "single" is consistent with a stronger former effect, in the sense that landlords reduce rent for single tenants. We shall not stress the interpretations since others are possible. The binary variable "High education"

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[7] A landlord has willingness-to-pay for an attractive tenant. This implies a reduction of rent since the landlord's offer-curve shifts. The tenant also has willingness-to-pay for a good landlord. This implies an increase in rent since the tenant's bid-curve shifts.

[8] $P_1/P_0 = e^{-0,0886(\ln(1+1)-\ln(1))} = 0.940$, for difference between 1-year tenures and new (0-year) tenures. Again, notice how we scale the variable in order to avoid ln(0).

could, however, potentially be more reliable a signal as it would tend to be interpreted as an indicator of an attractive tenant, and would as such allow a risk-minimizing and vacancy-avoiding landlord to offer a rent reduction to educated tenants in order to make them sign the contract. The negative sign of the estimate is consistent with this story. However, the estimate is not statistically significant at our sample size. This is somewhat discouraging, and warrants a comment. We believe that our finding may be due to a co-linearity challenge in our set-up or due to omitted variable bias. The former could be caused by the possibility that well-educated tenants more often than less well-educated tenants rent certain central, large, high-quality objects in Oslo. If so, we cannot fully disentangle the education effect from object size and quality effect without a larger data set that spans and includes also well-educated tenants that rent peripheral, smaller, low-quality objects outside of Oslo. The omitted variable effect could be caused by the possibility that there may exist other variables, not observed and not controlled for, that affect rent for the objects rented by well-educated tenants. For example, if well-educated tenants rent objects in particularly attractive areas, and we are not in a position where we may control for all types of area attractiveness, this would in essence imply that education was a proxy both for education and area attractiveness. Moreover, if well-educated tenants tended to rent objects with hedonic qualities such as large, west-directed balconies with great views situated at the waterfront, these unobserved qualities would increase rents and co-vary with education and potentially off-set the effect of rent reductions from a risk-managing landlord.

Above, we have emphasized the important role played by *tenure length* in determining the level of rent. This is consistent with the interest in the literature on this matter; see e.g. Barker (2003), Gabriel and Nothaft (1999), Goodman (2003), and Goodman and Kawai (1985). In fact, this is a sufficiently information-rich variable that contains enough interest in the profession to warrant a separate analysis. Below follows a more specialized analysis on tenure length. Our general result from Table 2 shows that tenure length is inversely related to rent magnitude. To scrutinize the result further, we segment tenures into 4 tenure length types. In order to make other things as equal as possible, we select *one* geographical stratum that plausibly functions as one labor market, Oslo and Akershus. We do that in order to control for potential interactions between wages and rents. This trimming leaves us with 803 observations and Table 3 tabulates results from such exploration.

Our idea is to examine both the effect on estimated coefficients and the effect on explanatory power, measured as adjusted-R^2, when we study different tenure lengths. The former uncovers willingness-to-pay for different variables and different tenure characteristics. The latter tells us how well our model demonstrates the association between variation in determinants and variation in rent, so that when

explanatory power falls we are left with increasing non-explained variation in rent. This again may indicate several phenomena. It may hint at some omitted variables or it may hint at some not-controlled-for interaction between the two agent types, tenants and landlords. Thus, we relax the assumption that tenants and landlords with different history negotiate price similarly, and allow for the possibility that for different relationship types (classified by tenure length), there exist different negotiation processes with different monetary values on characteristics. In light of this, we segment our data set into four segments, and perform four separate regressions in order to approach the possibility of a finite mixture of relationship types: one in which the tenure length is two years or less, one for tenures between 2 and 5 years, one for tenures between 5 and 10 years, and one for all lengths.

We detect at least three very useful findings by doing this. They can be found in Table 3. First, consider the differences in explanatory power. For the segment in which tenure length is two years or less, variation in determinants explain as much 60 percent of variation in rent. In contrast, for the segment where length is between 5 and 10 years, variation in determinants explains only 18 percent of variation in rents. Thus, this remarkable reduction in explanatory power implies that longer tenures contain more idiosyncratic elements, something not accounted for by this model or any other model we are familiar with. The presence of old tenures is bound, then, to affect index construction and price development studies. Second, the intercept estimates are larger the longer the tenure is. Third, the estimates on object size are smaller the longer the tenure is. We consider these two findings in tandem. One interpretation is that as interaction between a tenant and a landlord matures, idiosyncratic elements, unique to the specific interaction between tenant and landlord, tend to dominate the factors that matter at the start of the tenure, and the importance of other elements, such as size, decreases.

As a concluding remark, and a final demonstration of the usefulness of including characteristics in rent regressions, let us continue the discussion of differences in explanatory power. The above discussion begs the question of explanatory power in the regressions for all of Norway in Table 2. It is striking, and perhaps quite surprising, that variation in geographical variables explains 17.2% of variation in rents while variation in hedonic variables explains 11.9%. This finding indicates the necessity for index constructors to consider location carefully when indices are constructed. However, even more noteworthy, our suggested tenure characteristic and interaction variables capture as much as 15.0% of the variation in rents. This opens a major avenue for research in the effort to understand how rental markets work and calls for focus of attention on tenure types.

Table 2. Regression estimates (t-values) from log(monthly rent) onto 4 sets of variables. Norway. 2005

Variable	Geography	Hedonics	Characteristics	Full, All Combined
Intercept	8.370 (406)	7.263 (104)	8.582 (318)	6.927 (97.1)
Geographics:				
Oslo and Akershus	0.228 (12.5)			0.219 (14.2)
City Center (High Density Population)	0.0659 (3.68)			0.104 (6.9)
Periphery (Low Density Population)	-0.147 (-6.49)			-0.175 (-9.0)
Log(Distance to Center)	-0.0187 (-7.01)			-0.0202 (-8.5)
Hedonics:				
Log(Size)		0.224 (13.7)		0.365 (23.8)
Balcony		0.0922 (6.1)		0.0462 (3.7)
Log(High Standard)		0.181 (11.5)		0.106 (8.0)
Furnished		0.0871 (4.6)		0.0147 (0.93)
Tenant:				
High Education Level			0.0292 (1.3)	-0.00364 (-0.19)
Single			-0.128 (-8.4)	-0.0641 (-4.8)
Landlord(Multi Complex Owner is default)				
(Other) Private Landlord			-0.0294 (-1.4)	0.00780 (0.43)
Relative or Friend			-0.220 (-8.0)	-0.213 (-9.3)
County, Employer, Student Co-Op			-0.183 (-7.6)	-0.0796 (-3.9)
Other Landlord			-0.283 (-7.6)	-0.240 (-7.9)
Characteristics of Interaction:				
Market Mediation			0.171 (10.0)	0.116 (8.2)
Log(Services)			-0.0337 (-2.0)	-0.0401 (-2.8)
Log(Tenure Length)			-0.0777 (-6.6)	-0.0886 (-9.2)
Residence in Same Building as Owner			-0.133 (-6.7)	-0.0580 (-3.4)
Log(Electricity and Heating)			0.0645 (3.4)	0.0802 (4.9)
Adjusted R^2	0.172	0.119	0.150	0.437

Table 3. Regression estimates (t-values) from log(monthly rent) onto all sets of variables for segments of tenure length. Oslo and Akershus. 2005

Variable	2 Years or Less	Between 2 and 5 Years[1]	Between 5 and 10 Years[2]	All Years
Intercept	6.456 (39.4)	6.945 (23.3)	7.944 (9.1)	6.894 (51.8)
Geographics:				
City Center (High Density Population)	0.154 (2.6)	0.00597 (0.08)	0.108 (0.68)	0.0748 (1.7)
Periphery (Low Density Population)	-0.0924 (-0.88)	-0.217 (-1.8)	0.0247 (0.09)	-0.164 (-2.2)
Log(Distance to Center)	-0.0364 (-6.1)	-0.0290 (-3.3)	-0.0156 (-0.87)	-0.0312 (-6.7)
Hedonics:				
Log(Size)	0.506 (15.2)	0.434 (7.4)	0.412 (3.6)	0.450 (15.9)
Balcony	0.0863 (2.9)	-0.0354 (-0.74)	0.0402 (0.42)	0.0451 (1.9)
Log(High Standard)	0.0395 (1.2)	0.0782 (1.6)	-0.0275 (-0.26)	0.0603 (2.3)
Furnished	0.0591 (1.8)	0.0556 (0.96)	0.00858 (0.07)	0.0374 (1.3)
Tenant:				
High Education Level	0.0113 (0.28)	0.0559 (0.84)	0.0624 (0.41)	0.00564 (0.16)
Single	0.0400 (1.2)	-0.0945 (-1.8)	-0.0113 (-0.11)	-0.0118 (-0.43)
Landlord(Multi Complex Owner is default)				
(Other) Private Landlord	-0.00513 (-0.13)	0.00371 (0.05)	-0.0548 (-0.37)	-0.00543 (-0.16)
Relative or Friend	-0.247 (-4.5)	-0.222 (-2.8)	-0.242 (-1.4)	-0.226 (-5.2)
County, Employer, Student Co-Op	-0.254 (-5.2)	-0.146 (-2.1)	-0.340 (-2.5)	-0.223 (-5.9)
Other Landlord	-0.271 (-3.9)	-0.213 (-1.9)	-0.502 (-2.4)	-0.306 (-5.4)
Characteristics of Interaction:				
Market Mediation	0.102 (3.2)	0.167 (3.1)	0.161 (1.3)	0.144 (5.2)
Log(Services)	-0.0773 (-1.8)	-0.0773 (-1.3)	0.0387 (0.36)	-0.0724 (-2.3)
Log(Tenure Length)	0.0762 (1.4)	0.00202 (0.02)	-0.535 (-2.0)	-0.0984 (-5.1)
Residence in Same Building as Owner	-0.00800 (-0.17)	0.0100 (-0.16)	0.0333 (0.021)	-0.0180 (-0.49)
Log(Electricity and Heating)	0.0195 (0.56)	0.0338 (0.66)	0.0430 (0.40)	0.0420 (1.5)
No. of Observations	402	243	108	803
Adjusted R^2	0.603	0.418	0.175	0.486

Note: [1]Including 5 years, excluding 2 years. [2]Including 10 years, excluding 5 years.

5. Discussion

There are two notorious challenges facing any analyst who wants to explain variation in rent and everyone who applies hedonic regression techniques. One is functional form. The other involves omitted variables. We consider both. For example, we performed sensitivity checks for functional form by experimenting in numerous regressions with linear, quadratic, linear-logarithmic, and logarithmic-logarithmic forms. The results are broadly in line with the ones we report, so we do not tabulate these findings. We chose quasi log-log-linear form (where we transform logarithmically the dependent and several independent variables but retain some non-transformed) since the log-log-linear form is the conventional default and quite easy to interpret. We kept binary variables non-transformed. The log-log-linear form has nice curvature features, including percentage-type increase from presence of variables instead of the absolute values that result from linearity. Moreover, we experimented with various curvature effects, quality effects, and service indicators. To give the reader a flavor, we examined a potential diminishing rent reduction effect of distance from center and/or interaction effects with other variables. However, we suppress the results and findings from other sophistications because we give priority to present a parsimonious model and a compact presentation of empirical results.[9]

Omitted variables are bound to affect any study of rents since no study will be able to list all factors that affect rent. Rent determination contains too many idiosyncratic elements. The question of impact on parameter estimates revolves around whether the omitted variables are orthogonal or not to the ones included. The latter involves omitted variable bias. In both cases, if determinants are omitted, explanatory power is reduced. We believe the most important variables missing in our data set are "view" and "neighborhood quality".

Noise is one important variable for rent determination, but our results above do not include that variable. Admittedly, we attempted an inclusion of a noise measure in an attempt to emulate how Chay and Greenstone (2005) studied air quality, and we were able to link a noise variable from another data set, but were forced to abandon the project since the results were non-sensical, most likely due to a classical example of confounding. Including noise, without including all other relevant variables that go hand-in-hand with noise, may even change the sign of the noise variable's effect on rent. The variable noise, then, would be picking up the partial effect of noise, everything else being the same, and contributions from other factors since we would not be able to control for everything else. In fact,

[9] Extended tables of larger models and different functional forms may be obtained by corresponding with the authors.

that is exactly what we found. Without qualification, this would be interpreted as a willingness-to-pay for noise, which does not make sense. Of course, it is most likely due to the fact that a high value of the noise variable appears in the data when certain measures of urban attractiveness also would have been high, and that low values of the noise variable are present when the attractiveness variables would have scored low. If so, a positive willingness-to-pay for attractiveness such as qualities as trendy neighborhoods, proximity to cafes, access to tram and metro stations, short distance to schools and kindergartens, and a negative willingness-to-pay for noise appear masked as a positive willingness-to-pay for noise.

View is to some extent a subjective entity, and was not included in the final questionnaire because the questionnaire committee deemed it too formidable a task to formulate questions that would be robust to subjective answers. Neighborhood quality, or the perception of it, was similarly deemed a subjective factor and not included.

6. Concluding Remarks and Policy Implications

This article aims to demonstrate that there are elements in the rent formation process in the rental-market that do not exist in the market for owner-occupied housing. Most ambitiously, we seek to quantify the effects of these elements in monetary terms. The elements emerge from the inter-temporal affiliation and interaction between a tenant and a landlord. This paves the way for price discrimination between tenant types, classification of landlords according to risk profiles, and potential rent adjustments conditional on present or evolving tenant-landlord interaction. In short, the price formation process in rental markets may be viewed as signalling games, where signals affect reservation prices for both tenants and landlords. This is in sharp contrast to housing markets (owners' markets) where an asset, a dwelling, is traded and prices are believed to reflect dwelling characteristics and location attributes only. In the rental markets, we argue theoretically and illuminate empirically that dwelling characteristics and location attributes are only part of the rent formation process.

Based on an extensive survey of the Norwegian rental market, we report, to the best of our knowledge, for the first time an analysis of a rental market which includes a substantial amount of tenant and landlord characteristics as well as detailed information about their formal contract and social contact. With the standard econometric specification, a hedonic log-log model, we find that including tenant, landlord, and interaction characteristics yields considerable increases in explanatory power. In fact, explained price variation by tenant and landlord characteristics alone is noticeably higher than a list of determinants comprising object characteristics exclusively. The numbers reveal that adjusted R^2 for

lists comprising, exclusively, geographical variables, hedonic qualities, and relation characteristics are 0.17, 0.12, and 0.15, respectively. Moreover, we find clear evidence of market fragmentation, both with respect to tenure length as well as agent characteristics.

The analysis shows that small-scale landlords tend to set rents lower than large-scale landlords. Furthermore, good tenant characteristics appear to give rent reductions. This finding is consistent with a rental-market model where rental risk has an impact on prices. In particular, small-scale landlords with few available instruments of risk-diversification tend to value signals of good tenants, and may therefore be more inclined to scrutinize potential tenants more closely. One implication is that small-scale landlords may be more inclined to offer discounts to desirable tenants. If this is the case, adverse selection may take place, and lead less attractive tenants mostly to be present in other parts of the rental markets. In other words, large-scale landlords may face a higher rental risk if attractive tenants are underrepresented in the sample of potential tenants they are faced with.

One particularly compelling finding is the role of mediation. A private mediation channel, in contrast to announcements on the Internet or in a newspaper, is associated with a reduction in rents even when we control for prior affiliation and interaction such as being a distant relative, friend, or acquaintance and for tenant residence in same building as owner. One interpretation is that private mediation is an indicator of good tenant type, in addition to the more objective information on tenant type the data set possesses. To see why this may be so, recall that informal mediation includes tenant references extended to landlord by persons the landlord knows and trusts. These references may be viewed as signals of reduced risk and imply rent reduction.

Our analysis shows a strong association between low rents and tenure length. This is in agreement with several previous studies on rental markets. Long tenure may be taken as a sign of a well-functioning tenant-landlord relationship, where both parties meet their obligations. If true, reduced rents should be expected as a response to reduced risk and reduced vacancy rates if the landlord's willingness-to-reduce rent is stronger than tenant's willingness-to-pay for a good landlord. However, nominal rigidity of contracts, as well as idiosyncratic factors of long tenures, may account for some of the observed price variation. In support of price rigidity is the well-known phenomenon of "jump rents", i. e. that rents tend to be adjusted when new tenants replace older ones in the rental object.

Our findings shed light on characteristics of rental markets that hitherto have not been systematically studied, neither theoretically nor empirically. Rental markets and housing markets are closely

monitored through rental and house price indices so price information is available in most countries. However, explanatory variables of rents tend to be limited to dwelling characteristics and location attributes as in the housing market case. Our findings show that neglecting tenant, landlord and interaction characteristics may reduce analysts' ability to understand variation in, and predict the level of, rents and may be vulnerable to omitted variable biases. Furthermore, price discrimination among tenants and adverse selection problems may play a key role in rental markets and be relevant to policymakers. In addition, price discrimination poses a challenge for statistical agencies. Why? It complicates computation of rental price indices. Analysts need to answer the following questions: Which observations shall we include? Shall we include only tenants with recently signed contracts? Should we include only large-scale landlords? Should we construct one index or several sub-market indices? These are delicate empirical questions, and sensitive political ones, and the answers are expected to depend on intended use. Nevertheless, this article demonstrates that the choices affect what prices are monitored and what indices capture of the market.

A potentially policy-relevant example of application of our findings includes the estimation of housing costs for the poor. If low income is associated with an undesirable tenant type, then renting an object from the large segment of the supply side consisting of small-scale landlords may not be an option for a poor household. Small-scale operators tend to scrutinize tenants and offer rent-reduced tenures only to those tenants passing the screening examinations. This may be the case because small-scale landlords may use much time and resources to screen prospective tenants. They do this because they will live in the same residence as the tenant; e.g. with the tenant in their ground floor. If analysts use a rental index based on broad market definition with respect to landlords when they estimate costs that poor tenants face, they will underestimate true costs since poor, or undesirable tenants, may only be invited to enter contracts with large-scale landlords that charge a risk premium. Conversely, estimating students' cost of living based on a broad index may overestimate true costs, if students largely seek, and are accepted by, small-scale landlords that offer rent reductions for desirable tenant types.

We cannot present an exhaustive list of research and policy questions that rely on rental indices. They are too numerous. Let us instead point towards a few more. The connection between consumer price indices (CPI) and rental indices makes the estimation of rental prices development of relevance to macroeconomic assessment. Many countries base their CPI on a weighed sum of sub-indices where rent indices enter in two ways. First, a rental index and its weight for tenants are computed, and second, an imputed rent for owner-occupied housing consumption is calculated for home-owners based on the rent owners have foregone by not letting their house. For the latter calculation, the rental

equivalence principle tends to be used. This principle implies the use of a rent estimation to impute owner rents using only house characteristics and location attributes. However, this article demonstrates that parameters estimated from rental surveys may not necessarily be unbiased if the analyses have not controlled for characteristics of agents and interactions. Moreover, even if they are sometime in the future, the convertibility from the renter's market to the owner's market is non-trivial. Should the practitioner compute the owner-occupied value of owner rent based on discounts of good tenant characteristics? Should owner-occupied consumption of housing services be considered as a long-term equivalent of renting? After all, this study shows that tenure length is a core variable in determining rent magnitude. It is important to emphasize that these questions are note only of academic importance. Housing consumption does, in most countries, amount to 20 or 30 percent of households' total consumption. This implies that the treatment of rents will have an important impact on how to compute the CPI, especially for agencies using the rental-equivalence principle, and, consequently, on how to measure inflation.

7. References

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Truncation and variable construction

Table A1: Truncation:

Variable	Description of criteria and losses of observations
1. Monthly rent	Includes observations with observed monthly rent in the interval [500, 25 000] NOK. We lose 115 observations in performing this truncation.
2. Size	The determinant "rented area" or "size" (measured in square meters) is truncated to include observations within the interval [10, 300]. We lose 190 observations in the size truncation, and the data set contains 3544 observations after the two truncations.
3. Tenure Length	We require that relationships be less than 15 years in length. The variable "Tenure Length" denotes how long the tenure has lasted by June 2005. It is converted to a number with two decimals, where the decimals represent a conversion from 12 months to parts of a scale from 00 to 99, i.e. proportion of a year. The truncation results in a reduction from 3544 observations to 3334 observations, a loss of 210 observations.
4. Tenure Length	We also truncate further by requiring positive length of relationship and by insisting upon including months in the computations. We lose an additional 71 since interview object did not know the exact start of rental relationship. The data set contains 3263 observations after all mentioned truncations.
5. Distance to Center	We require positive, i.e. observed, distance to center. The truncation implies a loss of 64 observations, and the resulting data set contains 3199 observations.

Table A2: Variable construction

Variable	Description of construction
Dependent variable:	
1. Log(P)	Log(P_i)" is the (natural) logarithm ln of monthly rent for observation i. The variable is not scaled since truncation disallows ln(0).
Determinants:	
2. Oslo and Akershus	Unity if observation belongs to Norwegian region Oslo and Akershus (capital area), zero otherwise
3. City Center (High Density Population)	The intermediate variable "Density" has three levels: high-density population, medium-density population, and low-density population. The former and the latter are included through binary variables, and the reference point (default) is a medium-density population. Thus, "0"s on both high density and low density represent a medium density population. The definitions of high, medium, and low density population are: more than 20 000 residents, between 1 000 and 20 000 residents, and below 1 000 residents.
4. Periphery (Low Density Population)	See above
5. Log(Distance to Center)	We use the variables "Distance to Center", measured in meters. The distance is measured with respect to closest public service center, which is defined as a center including a postal office, medical services offered, and availability of groceries. "Log" is short notation for the natural logarithm. It is scaled by adding 1 to Distance to Center to avoid ln(0). If distance to center is above 5 000 meters, it is set to 5 000 meters.
Hedonics:	
6. Log(Size)	Natural logarithm of size (which is measured in square meters). This variable is not scaled because truncation disallows ln(0), see above.
7. Balcony	The dummy variable "Balcony" is unity if the respondent has answered in the affirmative on the question of whether or not s/he had own balcony.

Table A2 (cont.)

Variable	Description of construction
8. Log(High Standard)	We construct a variable "High Standard". It is a composite variable that comprises the sum of "yes"-answers to questions whether the object has a central vacuum cleaner, heating cables in the bathroom, or tiles in the bathroom. In the variable "Log(High Standard)" we take the natural logarithm of "High Standard" and modify the scale to incorporate all "no"s (by taking the natural logarithm of the sum of "yes"-answers +1). Thus, it is scaled, as explained above.
9. Furnished	The dummy variable "Furnished" is 0 if and only if the respondent answered "not furnished"; otherwise it is unity. (Thus, it is an inverted unfurnished variable. The reason is that there are many degrees of partially furnished; we decided to include them all.)
Tenant:	
10. High Education Level	We construct a dummy variable "High Educational Level" which is unity if the tenant has at least 6 years of schooling after the mandatory 9 years of compulsory school and 0 otherwise.
11. Single	We use unity score on the dummy "Single" when the number of members of the household is exactly unity; 0 otherwise.
Landlord(Multi Complex Owner is default)	
12. (Other) Private Landlord	Landlord types are divided into "Multi Complex Owner" (default), "Other Private Landlord", "Relative or Friend", "County, Employer, or Student Co-Op", and "Other".
13. Relative or Friend	See above
14. County, Employer, Student Co-Op	See above
15. Other Landlord	See above
Relationship:	
16. Market Mediation	The variable "Market Mediation" represents the way the object was mediated from a vacant object to rented object. A "yes"-answer indicates that the tenant found the object observing an *advertisement*, in a *newspaper*, on the *Internet*, or through a *professional agency*.

Table A2 (cont.)

Variable	Description of construction
17. Log(Services)	"Log(Services Rendered)" is the natural logarithm of a scaled composite variable consisting of a summation of the number of affirmative answers to 9 questions on whether the tenant rendered services for the landlord: 1. Work in the garden. 2. Snow shovelling/work in the driveway. 3. Washing common areas. 4. Looking after children. 5. Looking after pets. 6. General maintenance. 7. Carpentry, plumbing, electrical adjustments. 8. Cleaning. 9. Other services. The scaling is explained above.
18. Log(Tenure Length)	The variable "Tenure Length" denotes how long the tenure has lasted in June 2005. It is converted to a number with two decimals, where the decimals represent a conversion from 12 months to parts of a scale from 00 to 99, i.e. proportion of a year. "Log(Tenure Length)" is the natural logarithm of "Tenure Length" and it is scaled as above.
19. Residence in Same Building as Owner	The variable indicates an affirmative answer to the question "Do you live in the same building as the owner?" If "yes", the variable has unity value; 0 otherwise.
20. Log(Electricity and Heating)	We constructed intermediate dummies for inclusion of electricity in monthly rent, "Electricity", and heating included, "Heating". The variable "Log(Electricity and Heating)" is the scaled natural logarithm of the sum of scores on "Electricity" and "Heating". Scaling as above.

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