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Rental Prices for Housing Units in Norway

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Abstract

While information on rental prices is critical from a policy perspective, there is limited knowledge on rental prices in Norway. To fill this gap, we estimate a hedonic model for rental prices in Norway, drawing on three data sources. Our framework provides predicted rental prices for housing units in all Norwegian municipalities, whereas the national survey is primarily limited to rental prices in six major Norwegian cities.

We find that the rental price is clearly dependent on the number of bedrooms. Moreover, the rent differs by type of housing: terraced housing has the highest rent (everything else being equal), followed by semi-detached housing, apartment and finally detached housing. We also identify that proximity to service centers has a sizable impact on rental prices. Finally, location matters: the rental price in major cities may be more than twice as high as in small towns and rural areas (for housing units with identical attributes).

Keywords
rental prices, housing policy, hedonic model, estimation, prediction

1 Introduction

According to the national registry on housing units, around 20% of Norwegian households rent dwellings (Statistics Norway, 2024). Still, there is limited knowledge on rental prices in Norway. Eiendom Norge (2023) and Statistics Norway (2023a) offer information on rental prices in the largest Norwegian cities. The survey by Statistics Norway (2023a) also provides information on rental prices outside the six largest cities, but this information is limited to three national price zones; these are clustered by population density. This study aims at filling the information gap on spatial rental prices in Norway.

From a policy perspective, information on rental prices is critical. In Norway, low-income households obtain financial support to rent. The basic idea of such housing allowances is to cover a substantial share of reasonable housing expenses. Without detailed information on spatial rental prices, and how they depend on attributes such as size and number of bedrooms, it is hardly possible to provide adequate support to the target group.

In Norway, an expert group appointed by the government has assessed the current support scheme (KMD, 2020). According to the group, there is reason to believe that the increase in the financial support to the low-income households has been too low relative to the actual increase in the rental price, in particular in large cities and also for one-person households. This calls for a revision of the arrangement, but such a revision requires an improved information set.

A number of municipalities in Norway own a selection of housing units that are reserved for vulnerable groups to rent. For the majority of municipalities, the rent is supposed to reflect the average rent for similar units in the local area (Osnes & Sørvoll, 2023). Without accurate information on the local rental market, the imposed rent may easily deviate from what the rent should have been. Therefore, detailed, nationwide information on rental prices would clearly be welcome by municipalities, in particular those in rural areas where alternative sources of rental prices are de facto missing.

Both the state of the economy and various policy instruments may impact the rental market—for example, the growth in GDP, the rate of interest and financial packages to support development of dwellings directed at low-income families. Clearly, with detailed information on spatial rental markets, the impact of general economic conditions, as well as effects of policy instruments directed at the rental market, can be identified. To examine how various policy initiatives impact rental prices, it is crucial to have a proper measure of spatial rental prices. Hence, also for research purposes, a credible and fine-grained estimate for rental costs may turn out to be useful.

Information on spatial rental prices may also be useful for groups other than those mentioned above, for example, families considering renting out their dwelling (or part of it), commercial actors considering housing investment projects, and the Norwegian rent-control board ("Husleienemnda"). Our results and methodology may form the basis for a "rent calculator" which can be made available online for anyone to use.

Our paper uses the hedonic price model to estimate spatial rental prices in Norway. Hedonic modeling offers a framework to estimate the value of a good with multiple characteristics. The basic assumption in the hedonic model is that goods are valued based on consumers' valuation of the various attributes of a good (see the seminal paper by Lancaster from 1966). This approach deviates from the traditional approach where goods are the direct objects of utility. Instead, Lancaster (1966) assumed that consumers derive utility from the characteristics or attributes of the goods.

The hedonic model deviates from a strict neoclassical understanding of the housing market where housing services are regarded as a homogenous good, not a heterogeneous good with various attributes. In the strict, neoclassical model, the value of a specific housing unit is the equilibrium price of the homogenous good "housing services" times the magnitude of the housing services of this housing unit. In contrast, in the hedonic framework the value of each attribute is estimated, and the value of any (real or hypothetical) dwelling can be calculated by adding up the estimated values of the separate attributes of the dwelling.

Various versions of the core hedonic methodology have been used for over 50 years, and empirical applications of this approach have been applied to estimate the price for different types of goods, including farmland, automobiles, real estate, and environmental qualities like fresh air. Hedonic regression has become the standard approach in economics to estimate the implicit prices of non-marketable goods; see Rosen (1974) for an influential paper that has shaped the field. Hence, the hedonic methodology allows us to identify how each attribute contributes to the total rental price, although each attribute is not a good traded in a market: there is of course no market for, say, bedrooms, as these cannot be separated from the housing unit.

In this paper, we estimate a hedonic model for the rental price in Norway where the attributes of housing units cover i) type of housing, for example, detached housing versus apartment, ii) physical characteristics of the housing unit, for example, size and number of bedrooms, iii) additional housing services, like free access to the internet and supply of electricity, and iv) location of the housing unit, for example, in which municipality it is located and how far it is to the closest service center.

The rest of the paper is organized as follows. In Section 2, we present the data sources, which cover (i) commercial housing advertisements, (ii) geodata from Statistics Norway, and (iii) administrative register data from Statistics Norway on income. In Section 3, we present our framework to estimate the rent for housing units and explain how these estimates are used to predict the rent for *any* hypothetical housing unit in Norway in the data year 2022. The estimates for three alternative econometric models are presented in Section 4. The models use the same set of housing characteristics but differ with respect to additional explanatory variables (local average income level and geodata). We also provide information on the estimated fixed location effects.

In Section 5, we compare our predicted rents to the corresponding predictions by Statistics Norway, focusing on six major Norwegian cities. Here, we also compare our predictions to other Norwegian studies. Finally, concluding remarks are offered in Section 6.

2 Data

We have three main sources of data: The website Finn.no (see Finn.no, 2023), provides key information on attributes and rent for housing units available for rent. Second, Statistics Norway provides information on service centers, including their locations, so that the distance between a housing unit and a service center can be calculated. Finally, we have access to administrative register data on individuals.

2.1 Data Source I: Finn.no

The website Finn.no provides ads for housing units that are for rent. When posting an ad, a structured form has to be filled out. Table 1 lists the information from Finn.no that we use in the estimations.

Table 1. Information at Finn.no

Name of variable	Description
Address	Complete street address with postal code
Type of housing unit	Single-family/detached housing; duplex/semi-detached housing; townhouse/row house/ terraced housing; apartment
Size	Size of housing unit in square meters
Floor	Basement, first floor, second floor, etc.
Number of bedrooms	
Attributes type I	Whether the rent includes electricity, or a TV set, or internet services, or heating, or hot water
Attributes type II	Whether the housing unit has access to TV, or internet access, or a balcony, or an elevator, or is partly or fully furnished, or has a view, or there is walking distance to recreational areas
Rent	Asking price per month in Norwegian kroner
Location	Exact latitude and longitude
Date for posting the ad	
Headline	
Detailed text	

We conducted a comprehensive data cleansing. From the downloaded Finn.no data we removed duplicates; housing units with addresses for which we did not find a match in the official Norwegian address registry (and thus for these units we cannot calculate the distance to a service center); housing units belonging to the categories "room in shared apartment", "basement suite/dorm", "parking spot" and "other"; housing units with unreasonable characteristics; ads where the words in the headline of the ads or in the explanatory text of the ads clearly indicate that these units are either "room in shared apartment" or "basement suite/dorm"; and housing units located in neighborhoods where we did not have data on individual income. For more information on the data cleansing, see the supplementary material A available online.

We know the addresses of each of the remaining housing units (25,251). Using the national property registry ("Matrikkelen", see Kartverket (2022)), we can identify in which "neighborhood" (basic geographical unit), statistical tract and municipality this dwelling is located; all these geographical levels are used in the estimation.[1]

2.2 Data Source II: Geodata

From Statistics Norway (2022) we have information on all service centers in Norway—that is, the size of service centers (measured in m^2), in which municipality they are located, and their location.[2]

For each of the 25,251 housing units from Finn.no, we use the haversine formula to calculate

(i) the distance to the service center that is located closest to the dwelling (independent of whether the service center is located in the same municipality as the housing unit), and
(ii) the distance between the housing unit and the biggest service center located in the same municipality as this dwelling.

These two distances, as well as the size of the service center located closest to the housing unit, are used to estimate the rent in Section 3.

2.3 Data Source III: Administrative Register Data

We have access to administrative register data from Statistics Norway on income by individuals and where they live. Hence, we can calculate the average income of neighborhoods (basic geographical units), which is used in the estimations.

2.4 Descriptive Statistics

Table 2 and Table 3 provide descriptive statistics on the average rent, average size of housing units, average distance to closest service center, and the distribution of bedrooms.

1 A municipality consists of a number of statistical tracts ("delområder"), and each of these consists of a number of "neighborhoods" or basic geographical units ("grunnkretser"). Norway is divided into 356 municipalities, around 1,550 statistical tracts, and around 14,400 basic geographical units. The exact numbers of these geographical units change somewhat from one year to the next.

2 A service center has at least three service units from different sectors of which at least one unit belongs to retail and at least one unit represents either public services or social services or health services. The distance between these units should be less than 50 meters and the number of aggregate employees should be at least 50. Center kernels located less than 100 meters from each other are merged into a service center. There are a total of 663 such service centers in Norway. The location of a service center is represented by a polygon with edges expressed in UTM zone 32N. For each service center, we calculate its central point in the polygon (expressed in latitude and longitude).

Table 2 provides this information for the four types of housing units, whereas Table 3 provides the same type of information for groups of municipalities sorted by number of inhabitants ("size").

Table 2. Descriptive Statistics by Type of Housing Unit. Means

	Detached housing (N = 2,703)	**Apartment (N = 21,437)**	**Terraced housing (N = 346)**	**Semi-detached housing (N = 765)**	**All housing units (N = 25,251)**
Monthly rent (NOK)	14,965	12,154	15,758	14,408	12,572
Size (m^2)	133	61	103	101	70
Distance to closest service center (km)	4.3	1.7	2.3	2.8	2.0
Distribution of number of bedrooms (%)					
0	0.4	3.0	1.7	0.0	2.6
1	5.8	45.9	8.7	7.6	39.9
2	18.9	38.4	22.8	40.0	36.2
3	36.6	9.9	48.6	36.1	14.1
4	25.2	2.0	15.6	12.5	5.0
5^+	13.1	0.7	2.6	3.8	2.1

Table 3. Descriptive Statistics by Size of Municipality. Means

Number of inhabitants	**1–1,999 N = 85**	**2,000–3,999 N = 256**	**4,000–7,999 N = 781**	**8,000–19,999 N = 2,585**	**20,000–99,999 N = 10,951**	**100,000–199,999 N = 2,784**	**200,000+ N = 7,809**
Monthly rent (NOK)	8,497	8,370	8,926	10,245	11,283	13,298	15,439
Size (m^2)	106	95	86	81	73	73	59
Distance to closest service center (km)	20	14	5	3	2	1	1
Distribution of number of bedrooms (%)							
0	0.0	0.4	0.5	0.6	1.9	1.9	4.9
1	12.9	26.6	29.1	32.7	37.9	39.2	47.2
2	30.6	35.9	36.6	39.6	39.4	37.5	30.0
3	28.2	20.3	21.8	17.4	14.3	14.1	11.7
4	20.0	10.9	9.5	6.7	4.7	5.0	4.2
5^+	8.2	5.9	2.6	3.0	1.8	2.3	2.1

As seen from Table 2, the average rent is highest for terraced housing (15,758 NOK per month), followed by detached housing, semi-detached housing, and apartments (12,154 NOK). The average size of housing units is by far highest among detached housing (133 m^2), and by far lowest for apartments (61 m^2). The same ranking applies to average distance to the closest service center: 4.3 km for detached housing versus 1.7 km for apartments. There are also distinct differences between the distribution of bedrooms. Whereas around 6% of the detached housing units have less than two rooms, the corresponding number for apartments is almost 50%. Furthermore, 13.1% of the detached housing units have at least five bedrooms, whereas the corresponding number for apartments, terraced housing and semi-detached housing is 0.7%, 2.6% and 3.8%, respectively.

Turning to descriptive statistics of housing units sorted by size of municipality, there is a clear tendency that the average rent increases with the size of the municipality. On the other hand, there is a clear tendency that both average size of housing unit and distance to closest service center decreases with the size of the municipality. Also, the shares of housing units with at least three bedrooms are higher in small municipalities than in large municipalities.

3 Estimation and Prediction

We estimate a statistical model that relates attributes of housing units and their location to rental prices. In order to capture geographic variation in rental prices, the model also contains fixed effects for the municipality in which the housing unit is located. However, for the seven municipalities that had more than 100,000 inhabitants in 2021, we use statistical tract as the geographical unit to capture geographical variation on a more granular level.[3]

Let P be the rental price, measured in Norwegian kroner per month, and let $p = \ln P$. Furthermore, let X be the vector of covariates and β_X the associated parameter vector to be estimated. We want to estimate a standard hedonic model:

$$p = \beta_X X + L_X + \varepsilon_X \tag{1}$$

where L_X is the fixed location effect (to be estimated) and ε_X is the error term, which is assumed normally distributed with zero mean and constant variance σ_X^2.

We predict the rent $P = \exp(p)$, which we denote $\widehat{P}$, by estimating (1) and use the estimated coefficients for prediction, i.e.,

$$\widehat{P} = \exp\left(\widehat{\beta}_X X + \widehat{L}_X + \frac{\hat{\sigma}_X^2}{2}\right) = \exp\,(\widehat{\beta}_X X)^{*}\,\exp(\widehat{L}_X)^{*}\,\exp\left(\frac{\hat{\sigma}_X^2}{2}\right). \tag{2}$$

Because we want to predict P, not $\ln P$, the term ε_X in (1) is transformed to $\exp(\varepsilon_X)$. This stochastic variable is log normally distributed and we denote its estimate by $\exp\left(\frac{\hat{\sigma}_X^2}{2}\right)$.

4 Estimated Coefficients

Table 4 provides an overview of the three hedonic models we estimate. In our models, the rental price partly reflects the attributes of a housing unit, and partly reflects the location of the housing unit. We impose fixed location effects. According to Hill and Rambaldi (2021), who offer a taxonomy of hedonic models for house prices, this is the most common way to capture the spatial dimension of rental prices. With fixed location effects, the impact of location on rental prices is independent of housing characteristics, and correspondingly, the impact of housing characteristics on rental prices is independent of the location of the housing unit.

In Model 1 ("Basic model"), we use all covariates from Finn.no; type of housing unit, size, floor, number of bedrooms, and all other attributes, see Table 1. As specified in Section 3, for housing units located in municipalities with more than 100,000 inhabitants, we use statistical tract as the geographical unit, i.e., we estimate a fixed location effect for each statistical tract, whereas for all other housing units we use municipality as the geographical unit.

3 The number of statistical tracts in these municipalities are: Oslo (57), Bergen (20), Trondheim (25), Stavanger (25), Bærum (22), Kristiansand (22), and Drammen (17). The reason we do not use this granular level in all municipalities is that the data material is too sparse.

The two other models are extensions of the basic model. Our starting point is that rental prices may depend on a number of local attributes. In Model 2 ("Local average income") we add a measure of the average income in the basic geographical unit where the housing unit is located to the list of covariates (a municipality/statistical tract covers a number of basic geographical units). We refer to this measure as *relative local income*, defined as average income in the basic geographical unit where the housing unit is located relative to the mean of local average income of the entire sample of housing units. We use Model 2 to examine whether the parameter estimates and/or the fixed location effects change when we control for local average income of housing units. We can therefore identify whether the appreciation of attributes—for example, size—is related to the level of local income, or whether a high local income mainly increases the general level of the rental price.

In Model 3 ("Geo"), we use the same covariates as in Model 2 in addition to geodata on distance to closest service center, size of closest service center, and distance to biggest service center in the same municipality as the dwelling; these are various measures of local attributes. We measure distance to closest service center in the same way as we measure local average income: distance to closest service center of the housing unit relative to the mean of distance to local service center of the entire sample of housing units. We measure size of closest service center and distance to biggest service center in the same municipality correspondingly. With Model 3, we can identify the importance of proximity to service centers; it seems reasonable that cost of travel, here measured by the distance to a service center, as well as the selection of local stores and local public and private services, may impact the willingness to pay for housing locations.

Table 4. Estimated Models

Model	Data source	Covariates	Reference values	Geographical unit for fixed effect
1	Finn.no	Housing type, size, floor, number of bedrooms, other attributes	Detached housing unit, 100 m^2, first floor, 1 bedroom, no attributes	Municipality/ statistical tract
2	Finn.no Register data	Like Model 1, but in addition relative local income in the basic geographical unit	Like Model 1 Average local income equal to sample mean	Municipality/ statistical tract
3	Finn.no Register data Geo data	Like Model 2, but in addition relative distance to closest service center, relative size of closest service center, and relative distance to biggest service center in the same municipality	Like Model 2 Distances to and size of service centers equal to corresponding sample means	Municipality/ statistical tract

Note that for all models, the reference housing unit is detached housing of size 100 m^2 with one bedroom, where the dwelling is situated on the first floor and has no other attributes, i.e., electricity, heating, etc. are not included. Hence, the parameter estimates of type of housing, size, number of bedrooms and floor provide information on how deviations from the reference housing unit impact the rent. Furthermore, the parameter estimates of relative local income, relative distance to closest service center, relative size of closest service center and relative distance to biggest service center in the same municipality provide information on how deviations from the sample means impact the rent. This means that the predicted rental price of a dwelling with reference housing characteristics and relative values equal to the sample means is simply the predicted fixed location effect of this unit.

Type of Housing

Table 5 shows the estimated parameters for the alternative models. Almost all estimated parameters in all models are significant with a p-value less than 1%; these estimates are marked by three stars in Table 5.

For all models, the rent for detached housing (the reference type of housing) is the cheapest one, all other things being controlled for, i.e., same size, same number of bedrooms, same floor, same location, etc. Terraced housing is the most expensive type of housing, followed by semi-detached housing and then apartment. In Model 1 (basic model) and Model 2 (local average income), terraced housing is around 10% more expensive than detached housing. However, once we control for distances to and size of service centers, the gap is reduced to around 8.5% (Model 3). Because proximity to service centers tends to increase the rent (see discussion below) this means that on average, terraced housing is located closer to service centers than detached housing: this is in line with the information in Table 2.

The rent premium of semi-detached housing and apartments (relative to detached housing) is also reduced when controlling for distance to and size of service centers. In Model 3 (geodata), the premium for semi-detached housing is around 3%, whereas it is slightly less than 2% for apartments.

Size, Floor and Bedrooms

We find that for all models, size matters. In all models, we have imposed both a linear and a quadratic effect of size; the estimate of the latter coefficient is tiny (less than 0.0001). Neglecting this quadratic effect, we find that if size is increased by 1 m^2, the rent (in all models) is increased by (approximately) 0.4% (everything else being equal), whereas the rent is increased by (approximately) 4.1% if size is increased by 10 m^2.

Table 5 shows that floor matters somewhat. The rent for a basement unit is about 5% lower than for a unit on the first floor. The rent depends positively on the floor up to level four. We find that this floor effect is stronger in Model 1 and Model 2 than in Model 3. For this last model, the rent is around 2.5% higher on floor 4 than on floor 1 (everything else being equal). For floors higher than floor 4, the estimated parameters are not significant, i.e., we cannot conclude that the rent differs from the rent on floor 1 (everything else being equal). Note that there is a (floor) category named "missing". For all models, the estimated coefficient of this category is negative and significant, which may reflect that some landlords advertising basement units do not specify the floor of the housing unit.

We find that more bedrooms has a large and significant effect on the rent. In all models, the rent increases by around 12% if the number of bedrooms is increased from zero to one, or is increased from one to two bedrooms. The increase from two to three bedrooms, and from three to four bedrooms, is around 10 percentage points and 7 percentage points, respectively.

Local Average Income

In Model 2, we include the covariate relative local income in the basic geographical unit where the housing unit is situated. With our definition of relative local income, the parameter estimate shows the effect on rental prices for a housing unit with a local average income that is 100% greater than the mean of local income of the entire sample.

As seen from Table 5, the parameter estimate of relative local income is 0.017 in Model 2. Because the mean of local income is 420,000 NOK, a housing unit located in a basic geographical unit with local average income equal to 840,000 NOK has a rental price that is 1.7% higher than a similar dwelling located in a basic geographical unit with local income equal to the mean (420,000 NOK). The corresponding number of a housing unit located in a basic geographical unit with local average income one standard deviation (117,000 NOK) above the mean is around 0.4%, which is not sizable. As seen from Table 5, adding the variable relative local income hardly affects the parameter estimates.

The parameter estimate of relative local income is slightly lower in Model 3 (0.013) than in Model 2 (0.017). This is due to the effects of the additional covariates in Model 3.

Proximity to Service Centers

Adding geodata (Model 3), we find that proximity to service centers impacts the rent. If a housing unit has twice as long a distance to the closest service center than the mean, the rental price is decreased by 2.1% (see Table 5). Because average distance to the closest service center is 2.0 km (see Table 2), we find that if the distance to the closest service center increases by 1 km, the rental price decreases by around 1%. Similarly, we find that if a housing unit has twice as long a distance to the biggest service center in the same municipality than the mean, the rental price decreases by 3.2%. Because average distance to the biggest service center in the same municipality is 4.1 km, we find that if the distance to the biggest service center increases by 1 km, the rental price decreases by around 0.8%.

Finally, the parameter estimate of relative size of closest service center is less than 0.001 and clearly not significant. Hence, we find that size of the local service center is of no importance for rental prices.

Other Attributes

The list of additional attributes is long; see Table 1. Still, for most of the additional attributes, we find significant effects. The largest effect is found for electricity; if electricity is included in the rent, then the rent increases by 4.6% (in all models).[4]

For two attributes, the estimated coefficients are not as expected. First, we find that if hot water is included, the rent is decreased by 1.4% (in all models). This effect may reflect that it is hard to disentangle the effects of electricity, heating and hot water: in Norway, heating and hot water are almost entirely based on electricity. Alternatively, the estimated negative parameter of hot water supply may reflect noisy data—for example, inaccurate specification of what is actually included in the rent. Second, in Model 1 and Model 2 the rent is lower (and significant) if there is a short distance to hiking opportunities. However, once we include geodata (Model 3), the estimated parameter for distance to hiking opportunities is no longer significant (and also much smaller).

Estimated Fixed Effects

For each municipality, we estimate a fixed location effect. However, for the seven largest municipalities, each with inhabitants exceeding 100,000 people, we estimate a fixed location effect for each statistical tract in a municipality. The fixed effects estimates for Model 1 vary from 2,646 NOK to 20,851 NOK (per month), with a mean equal to 10,986 NOK and

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4 In 2022, the price of electricity was exceptionally high in Norway (like all over Europe), reflecting partly the high price of natural gas (gas power was the marginal technology in a number of European countries in 2022), and partly very low inflow of water to the Norwegian hydroelectric system, which covers around 90% of Norwegian electricity production.

a standard deviation of 2,723 NOK. For Model 3, the fixed effects vary from 3,875 NOK to 21,745 NOK, with a mean equal to 11,651 NOK and a standard deviation of 2,753 NOK.

Figure 1 shows a scatter plot of the estimated fixed location effects of Model 1 (horizontal axis) and Model 3 (vertical axis). As seen from Figure 1, most of the points are located above the 45 degree line. Hence, there is a tendency that the estimated fixed effects are higher for Model 3 than for Model 1 (for the same housing unit).

We use the Kolmogorov-Smirnov test (see Kolmogorov (1933) and Smirnov (1933)) to test whether the two distributions differ. This test compares the cumulative distribution functions and provides a p-value indicating their degree of similarity. We reject the null hypothesis that the two distributions do not differ (p-value less than 0.1%).

Table 5. Estimated Parameters. Standard Error in Parentheses

	Model 1 Basic model	**Model 2 Average local income**	**Model 3 Geodata**
Type of housing (Ref: detached)			
Apartment	0.041*** (0.005)	0.042*** (0.005)	0.019*** (0.005)
Terraced	0.103*** (0.012)	0.103*** (0.012)	0.087*** (0.011)
Semi-detached	0.045*** (0.008)	0.045*** (0.008)	0.030*** (0.008)
Size	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)
Size square	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Bedrooms (Ref: 1 bedroom)			
0 bedroom	–0.118*** (0.008)	–0.117*** (0.008)	–0.119*** (0.008)
2 bedrooms	0.125*** (0.003)	0.125*** (0.003)	0.124*** (0.003)
3 bedrooms	0.230*** (0.006)	0.231*** (0.006)	0.227*** (0.005)
4 bedrooms	0.301*** (0.008)	0.302*** (0.008)	0.294*** (0.008)
More than four bedrooms	0.399*** (0.011)	0.400*** (0.011)	0.391*** (0.011)
Floor (Ref: first floor)			
Basement	–0.048*** (0.007)	–0.049*** (0.007)	–0.049*** (0.007)
2nd floor	0.005 (0.004)	0.005 (0.004)	0.001 (0.004)
3rd floor	0.014*** (0.005)	0.015*** (0.005)	0.007 (0.005)
4th floor	0.034*** (0.007)	0.035*** (0.007	0.025*** (0.007)
5th floor	0.016* (0.009)	0.017* (0.009)	0.009 (0.009)
Higher than 5th floor	0.014 (0.010)	0.015 (0.010)	0.009 (0.010)
Missing information	–0.017*** (0.004)	–0.017*** (0.004)	–0.016*** (0.003)
Relative local income		0.017*** (0.006)	0.013** (0.006)
Relative distance to closest service center			–0.021*** (0.002)
Relative size of closest service center			0.000 (0.001)
Relative distance to largest service center in the same municipality			–0.032*** (0.002)
Additional attributes			
Including electricity	0.042*** (0.005)	0.041*** (0.005)	0.046*** (0.004)
Including TV set	0.006 (0.004)	0.006 (0.004)	0.007** (0.004)
Including heating	0.020*** (0.003)	0.020*** (0.003)	0.020*** (0.003)
Including hot water	–0.014*** (0.005)	–0.014*** (0.005)	–0.014*** (0.005)
Including hot water supply	0.034*** (0.005)	0.033*** (0.005)	0.033*** (0.005)
Access to TV	0.015*** (0.003)	0.015*** (0.003)	0.009*** (0.003)

(*Continued*)

Table 5. (*Continued*)

	Model 1 Basic model	Model 2 Average local income	Model 3 Geodata
Access to internet	0.016*** (0.003)	0.016*** (0.003)	0.014*** (0.003)
Balcony	0.062*** (0.003)	0.062*** (0.003)	0.061*** (0.003)
Elevator	0.101*** (0.004)	0.101*** (0.004)	0.094*** (0.004)
Partly furnished	0.010*** (0.003)	0.010*** (0.003)	0.011*** (0.003)
Fully furnished	0.061*** (0.004)	0.061*** (0.004)	0.061*** (0.003)
Has a view	0.003 (0.003)	0.002 (0.003)	0.006** (0.003)
Walking distance to hiking	−0.015*** (0.003)	−0.016*** (0.003)	−0.001 (0.003)

***$p<0.01$, **$p<0.05$, *$p<0.1$.

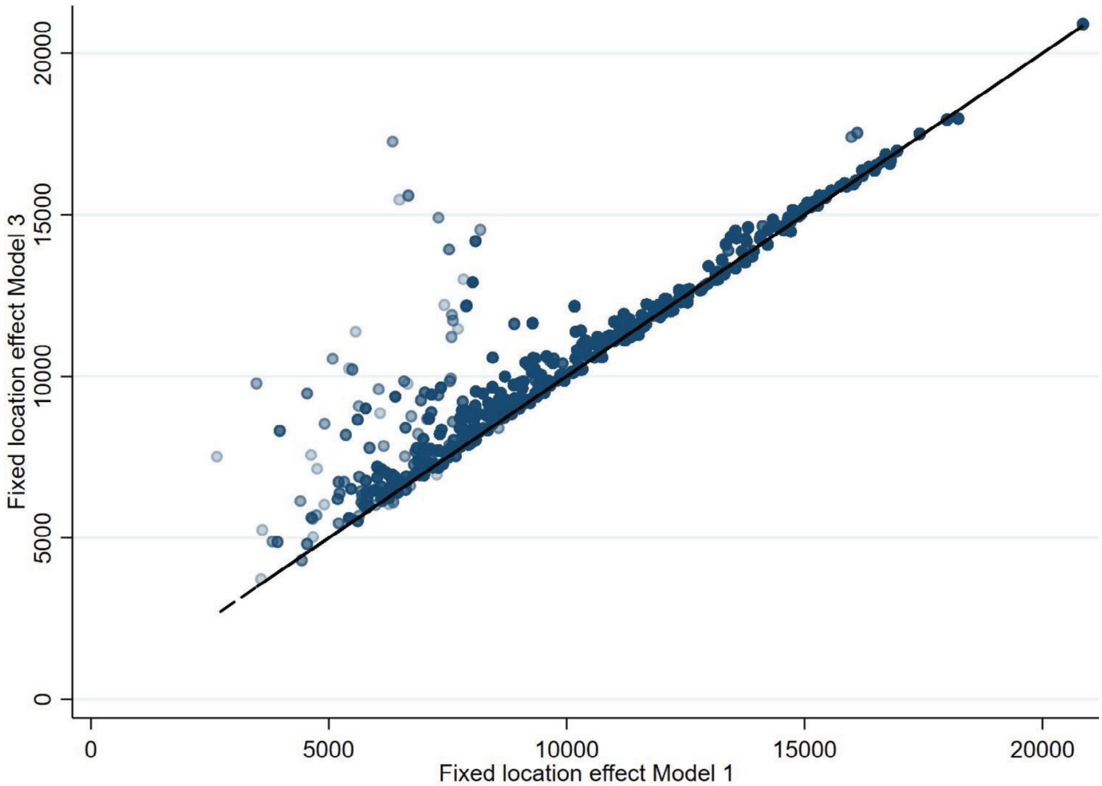

Figure 1. Scatter Plot of Fixed Effects. Model 1 Versus Model 3. NOK per Month.

Comparison with Estimates in Other Studies

There is a comprehensive empirical literature applying the basic principles of hedonic modeling to identify how various types of attributes—like physical attributes, additional housing services, neighborhood characteristics, and location—impact the housing rent.

First, regarding physical attributes, several studies find that size increases the rent. Song et al. (2020) use data for apartments from various parts of China for the period 2016–2018 to estimate a hedonic model for the rental market. This study finds that a partial increase in the size of the housing unit by 1 m^2 increases the rent by 0.6%; the corresponding estimate in our study is 0.4%.

Røed Larsen and Sommervoll (2009) uses interview data on dwelling characteristics (attributes and location), as well as information on characteristics of 12,955 landlords and tenants (from 2005), to estimate hedonic models for the Norwegian rental market. They find that an increase in size from 50 square meters to 60 square meters will increase the rent by 6.9%. In our model, any increase of 10 square meters will increase the rent by 4.1%. These results are, however, not directly comparable because Røed Larsen and Sommervoll (2009) do not have information on number of rooms/bedrooms, whereas we use number of bedrooms as a covariate. Hence, in the Røed Larsen and Sommervoll study, an increase in dwelling size also picks up the partial effect of having more rooms.

Several papers do not have data on number of rooms, or number of bedrooms, or they use rent relative to the size of the housing unit as the dependent variable. In contrast, we use rent as the dependent variable: for a rational actor, what matters is how much she pays for a housing unit with some specific attributes, not the cost of a dwelling per unit of square meter.

There are some studies, using the hedonic approach, which have data on number of (bed)rooms. Thomson (1999) found that the number of bedrooms does *not* have a significant impact on the monthly rent. In contrast, Guntermann and Norrbin (1987) and Rosiers and Thériault (1996) find a significant relationship between number of bedrooms and the rental price.

Also Djurdjevic et al. (2008) finds a significant positive effect of rooms. They use data for new rental contracts and find that more rooms increases the rental price and this effect is also robust with respect to model specification. Finally, Song et al. (2020) (see above) find that additional bedrooms increase the rent. For example, a partial increase in the number of bedrooms from one to two increases the rent by 8.2%, whereas the increase is 14.4% if there is a partial increase in the number of bedrooms from one to three. These numbers are in line with our results, although we obtain higher estimates: 12.5% (versus 8.2%) and 23.0% (versus 14.3%).

Second, according to several studies (see, for example, Fanning (2014)), distance to the city center and also to the public transport system, impact the rent. Also, the commute distance between where people live and where they work may impact rental prices, see Wheaton (1977). Benjamin and Sirmans (1996) show that distance from a metro station has a negative effect on the rent: an increase in the distance of 0.1 mile lowers the rent by 2.5%.

Song et al. (2020) find that the number of supermarkets, banks and restaurants located less than 1000 meters from a dwelling does not have a significant impact on the rental price. In our study, we do not have information on number of service units located less than 1000 meters from the dwelling. Rather, we have information on distance to the closest service center and size of this center. We find that, *cet. par.*, a longer distance to the closest service center lowers the rental price (if the distance to the closest service center increases by 1 km, the rental price decreases by around 1%), whereas size of the service center is no of importance for the rental price.

Third, there is a spatial dimension in rental prices; see, for example, McCord et al. (2014) on spatial heterogeneity in residential rental prices. Local features of neighborhoods, such as the crime rate, racial segregation and environmental qualities (like amount of pollution and noise) may also impact rents; see, for example, Ceccato and Wilhelmsson (2018). In addition, economic factors like income may be of importance; see Ogur (1973). In our study, we use fixed municipality effects to pick up the spatial heterogeneity. We also investigate how local average income impacts the estimates. We find that if a housing unit is located in a neighborhood where the average local income is twice as high as the national average, the rent increases by 1.7%. However, adding the variable local income hardly affects the parameter estimates.

Ayouba et al. (2021) shows that hedonic estimates differ across cities. Similarly, Smith and Kroll (1988, 1989) show that the price elasticity for residential attributes vary across geographical zones. In our reference model, we impose that coefficients do not vary across the spatial dimension (municipalities). However, we also divide the data into two groups by number of inhabitants in a municipality and estimate the set of coefficients for each of these two groups. We find that for some covariates only, for example, size of housing unit and housing units with four bedrooms, there is a significant difference in the estimates.[5]

5. Comparison of Predicted Rental Prices in Other Studies

5.1 Statistics Norway

Statistics Norway has an annual survey on rental prices. Around 35,000 people receive the questionnaire, and the response rate is around one-third. Among the 10,000 responses, tenants in large municipalities are overrepresented. The survey does not provide information on type of housing, but it offers information on how rental prices differ by size and number of rooms in six major Norwegian cities and in four price zones outside these cities.

Table 6 compares predictions from the Statistics Norway survey with our predictions—where we have used Model 3—for the six cities covered by Statistics Norway. Here, we consider a three-room apartment (one living room and two bedrooms) of size 70 m^2. Like Statistics Norway, we assume the apartments have no additional attributes, i.e., electricity is not covered by the rent, there is no balcony, the apartment is not furnished, etc.

Table 6. Predicted Monthly Rent in 2022 for a Two-Bedroom Apartment of Size 70 m^2 with no Additional Attributes. NOK

Municipality	Statistics Norway	Model 3
Bergen	12,350	12,832
Kristiansand	10,300	10,077
Oslo	15,200	16,638
Stavanger	11,100	11,663
Tromsø	13,000	12,618
Trondheim	12,750	13,248

As seen from Table 6, for five cities the predicted differences in the rental price is less than 600 NOK, i.e., less than 6%, and predictions based on Model 3 are highest for some of these cities only. Hence, the big picture is that the predictions are fairly similar and there are no systematic differences. This is the case although there are some distinct differences between the data sources.

First, Model 3 relies on Finn.no, which offers *asking prices* for housing units for rent, whereas Statistics Norway has access to *contract prices*. While the asking price may not frequently deviate significantly from the contract price, in recessions the asking price may exceed the contract price, whereas the contract price may exceed the asking price during

5 The literature on Norwegian rental prices is thin. In addition to Røed Larsen and Sommervoll (2009) and a study by Statistics Norway referred to later in this paper, there is a study by Oust from 2013. The latter study uses 24,257 newspaper advertisements for housing rentals in Oslo, combined with hedonic regression, to construct indices for the rental price for the period 1970–2008. Several indices are constructed; these differ with respect to number of bedrooms and type of dwelling (apartment versus house).

economic booms. For mainland Norway, the GDP growth rate was 3.8% in 2022 (measured in fixed prices; see Statistics Norway (2023b)) and hence this year was somewhere between an ordinary year and a year with a boom. If anything, this may imply that some contract prices may have exceeded the asking prices.

Second, because of fairly good economic conditions in Norway in 2022, it seems reasonable that most housing units that were posted at Finn.no were actually rented, i.e., the vacancy rate was close to zero.

Third, the landlord may adjust the rent more when there is a change of tenancy than at the annual regular adjustment of the rent. Because Finn.no is directed at new tenants, whereas Statistics Norway has information on a set of tenants that are followed over a number of years, this suggests that the Model 3 predictions, everything else being equal, may exceed the Statistics Norway predictions.

Finally, the share of brand new housing units is probably higher in the Finn.no data than in the data used by Statistics Norway, where the same tenants are followed over time. Therefore, the average quality of the housing units may be slightly higher in the Finn.no data, and thus (everything else being equal) the average rental price at Finn.no may exceed the average contract price gathered by Statistics Norway.

To sum up, it is hard to argue that the asking prices from Finn.no in 2022 are significantly different from the contract prices used by Statistics Norway.

5.2 Other Data Sources

Eiendom Norge. As mentioned in the Introduction, Eiendom Norge publishes information on rental prices. Its reports are, however, limited to four major Norwegian cities (Bergen, Oslo, Stavanger/Sandnes, and Trondheim). The statistics are based on data from Finn.no as well as data from a number of commercial rental agencies. Because the Eiendom Norge report does not provide information on attributes like size and number of rooms—only the average rental price for apartments and houses are offered—the published rental prices are not easily comparable to our predicted rental prices. We can, however, compare the average rental price for apartments and houses in the Eiendom Norge report to a) the average rental prices at Finn.no (for apartments and houses), and to b) our average predictions (for apartments and houses); see Table 7.

Table 7. Average Rental Prices for Apartments and Houses. Eiendom Norge, Finn.no and our Predictions. NOK

Municipality	Eiendom Norge		Finn.no		Own predictions	
	apartment	house	apartment	house	apartment	house
Bergen	12,933	19,163	13,158	17,877	13,074	18,191
Oslo	15,629	26,077	16,963	24,442	17,031	22,591
Stavanger/Sandnes	13,442	20,279	11,706	20,963	11,872	18,324
Trondheim	12,305	17,005	13,576	19,650	13,481	19,159

As seen from Table 7, the average rental price for an apartment in Bergen is 12,933 NOK according to Eiendom Norge, which is close to our prediction (13,074 NOK). For houses in Bergen, the difference is larger. For Oslo, Stavanger/Sandnes, and Trondheim, the differences between Eiendom Norge and our predictions are sizable, but there is no clear pattern with respect to ranking. Finally, note that our predictions are in general close to the average rental prices announced at Finn.no.

Boligbygg. Another source of rental prices is Boligbygg. This agency, which is owned by the municipality of Oslo, offers information on rental prices (NOK per m^2) for five price zones in Oslo; see Boligbygg (2023). This source distinguishes between dorms, one-bedroom apartments, two-bedroom apartments, three-bedroom apartments, four-bedroom apartments, and five-bedroom apartments. Because the price zones are not directly comparable to the statistical tracts in Oslo, on which our predictions are based, it is not straightforward to compare the rental prices from Boligbygg with our predictions for Oslo. Still, we find that the unweighted average of a three-room apartment of size 70 m^2 from Boligbygg is 18,690 NOK in the second quarter in 2023, whereas our predicted rental price for a two-bedroom apartment of size 70 m^2 in Oslo in 2022 (without any additional attributes) is 17,866 NOK. This difference is somewhat smaller than the increase in the rental price in Oslo from 2022 to 2023, i.e., the two estimates are fairly similar.

hybel.no. Our last source of rental prices is hybel.no. This is a commercial firm offering statistics on average rental prices for five Norwegian cities (Bergen, Oslo, Kristiansand, Stavanger, and Trondheim), distinguishing between rooms in shared apartments, one-bedroom apartments, two-bedroom apartments, and three-bedroom apartments; see Hybel (2023). The statistics are based on ads posted at hybel.no. There is, however, no information on the size of the apartment, so it is not straightforward to compare these rental prices to our predictions. The rental prices at hybel.no for a three-room apartment in 2022 are 12,590 in Bergen; 11,646 in Kristiansand; 17,562 in Oslo; 11,419 in Stavanger; and 13,295 in Trondheim. Assuming these numbers apply for a 70 m^2 apartment with two bedrooms and no additional attributes, they are on average somewhat higher than our predictions; see Table 6.[6]

5.3 Predicted Rent by Municipality

Above, we compared our predictions with other sources of rental prices restricting attention to a 70 m^2 apartment with two bedrooms and no additional attributes in major Norwegian cities. From the discussion in Section 4, we know that the estimated fixed location effect differs significantly across municipalities. Therefore, we now provide predictions for a 70 m^2 apartment with two bedrooms and no additional attributes for all municipalities in Norway.

In Figure 2, each circle shows predicted rent for a specific municipality. From visual inspection of the scatter plot, we see that there is a clear tendency that the higher the number of inhabitants in a municipality, the higher the predicted rent. This is confirmed by running a simple OLS; the p-value of the estimated positive coefficient is by far less than 1%. Finally, almost all of the predictions vary between 5,000 NOK and 15,000 NOK. Hence, the rental price in major cities may be more than twice as high as in small towns and rural areas (for housing units with identical attributes).

5.4 Prediction Error

We have also compare observed rent (from our data) to predicted rent, and provide information on how the prediction error varies across dimensions like (i) type of housing unit, (ii) size of housing unit, and (iii) size of municipality in which the housing units are located; see the online supplementary material B.

6 The Norwegian State Housing Bank also has information on rental prices. Because this register does not have information on size and number of rooms, it is not useful for comparison with our predictions.

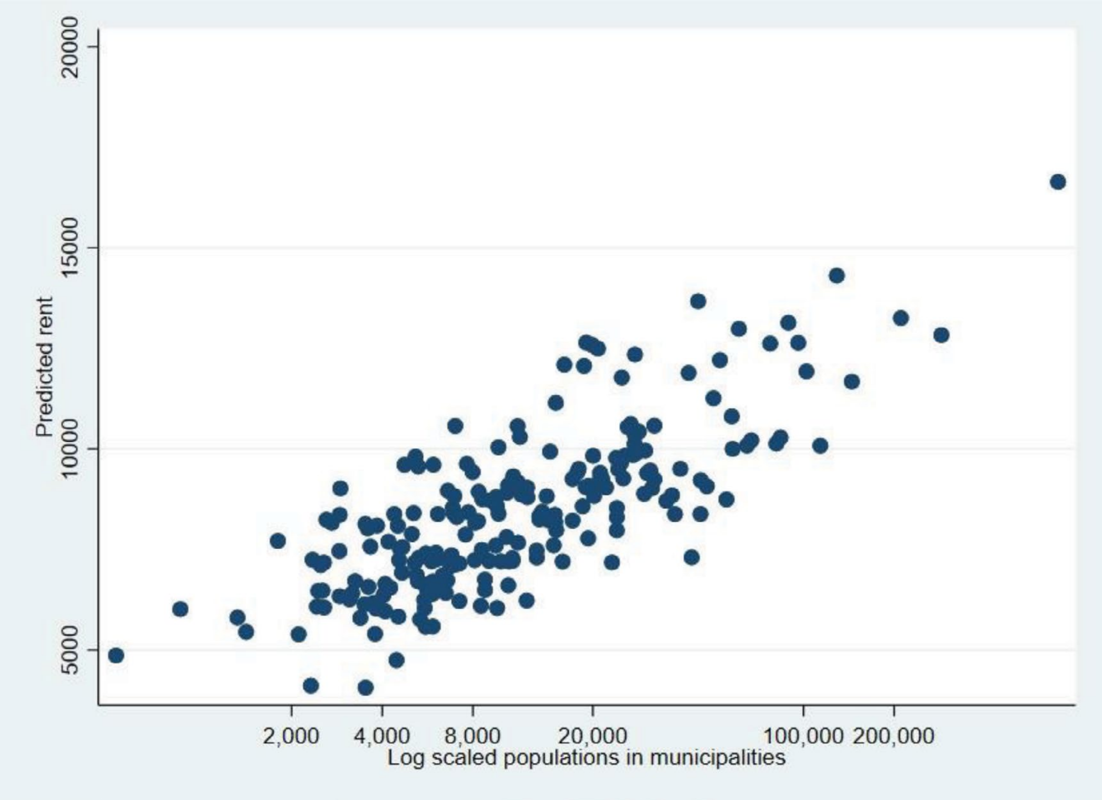

Figure 2. Predicted Monthly Rent (NOK) in 2022 for a Two-Bedroom Apartment of Size 70 m^2 with no Additional Attributes. Norwegian Municipalities.

6 Concluding Remarks

Information on rental prices is critical from a policy perspective. Yet, there is limited knowledge on rental prices in Norway. To fill this gap, we have estimated rental prices in Norway by drawing on three data sources. Our framework provides predicted rental prices for housing units in all Norwegian municipalities, whereas the national survey conducted by Statistics Norway is primarily limited to six major Norwegian cities.

We find that the rental price is clearly dependent on the number of bedrooms. Moreover, the rent differs by type of housing: terraced housing has the highest rent (everything else being equal), followed by semi-detached housing, apartment and finally detached housing. We also identify that proximity to service centers has a sizable impact on rental prices. Finally, location matters: the rental price in major cities may be more than twice as high as in small towns and rural areas (for housing units with identical attributes).

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