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The impact of leasehold status on apartment price

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ABSTRACT

Based upon cooperative apartments sold in Stockholm, Sweden during the period of 2012 to mid-2014, we find that leasehold status (meaning that the cooperative does not own the land that the apartment building occupies) has a small but statistically significant impact on price of −2.3% when controlling for location and apartment characteristics in a hedonic model. At the time of renegotiation (i.e. a lease duration of 0), leasehold depreciates price with 4.2%. We also apply propensity score matching, which results in slightly larger negative impact on the price being estimated. As current lease payments are covered by monthly fees that are to be paid to the cooperative, a negative effect on price should mostly be attributed to an increased uncertainty of future levels of monthly fees. We therefore extend the existing literature by examining the impact on price by the remaining leasehold term whilst still controlling for monthly fees. Consistent with our hypothesis, apartment prices are found to increase with 0.22% for each additional year that remains until renegotiation of the lease contract.

1. Introduction

Since Hayek's (1945) seminal paper on *the use of knowledge in society*, efficiency through the price system has been a central idea in economics. Nevertheless, the ability of prices to reflect all available information sometimes comes into question. The housing market, where households typically make their single-largest investment, is no exception. Of course, since households tend to finance housing by incurring debt, the decision of buying a home is of great importance to the financial wellbeing of both the individual household and society at large. A potentially large problem occurs if buyers lack information about the rights and obligations associated with buying a home. The aim of this paper is twofold: we want to study the effect on apartment prices by one such piece of information, namely leasehold status, and the uncertainty that is associated with it. In Stockholm, it has been common practice that housing cooperatives are built on leasehold land from the municipality, rather than freehold land, something that historically has lowered the costs through land rent subsidies. This has helped when cooperatives were formed, and in addition, has given the municipality greater influence over land use (Caesar and Kopsch, 2018). It has also been an ideological issue, with leasehold contracts (in contrast to sales of land) being more common during periods of left-wing governance of the municipality.

Up until now, ground lease rents have been set at low levels, with small increases at renegotiations. This system has however begun to come into question, as the municipality of Stockholm has a stated aim of charging market level rents in leasehold agreements. Although problematic to estimate (as there are few or no comparable market rents to observe), this has led to substantial increases of ground lease rents. Although having a somewhat different legal framework, cooperative ownership is present in countries such as the U.S., Canada, Germany, Finland and Sweden. In sum, this form of ownership implies buying a share of a housing cooperative, which in turn gives the owner the right to live in an apartment. Housing cooperatives carry debt and have contractual rights and obligations towards the tenants and third parties. The housing cooperative is also responsible for all structural repairs and maintenance of the property, this includes things such as roofing, landscaping of common areas and trash removal. The housing cooperative finances these expenses through the monthly fees.

Notable is that cooperative ownership is the only type of owner-occupied apartments in Sweden.[1] Consequently, one would expect high levels of knowledge about this form of tenure among market participants. Recent media coverage has however highlighted that informational problems do persist, as buyers' lack knowledge to properly analyze the finances of the housing cooperative. One such example being that recently converted cooperatives (previously being rental apartments) do not set their monthly fees (necessary to cover running costs and future expenditures) at sufficient levels (Donner and Kopsch, 2018). Another example, and the focus of the current paper, concerns the question of housing cooperatives owning or renting their

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[1] In 2009, the possibility to build condominiums was introduced in Sweden. There has however been limited construction of such apartments, whose total number is less than 1000 in Sweden.

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land. This piece of information can affect prices for two reasons. First, any parcel of land may be represented as a bundle of ownership rights. For a leasehold, only a part of these ownership rights may convey to the lessee. This means that the price should, all else equal, be lower for an apartment in cooperative on a leasehold. Second, since ground lease rents are renegotiated over time, there is a portion of uncertainty as to how future rents will be decided. A larger portion of uncertainty will, all else equal, result in a lower price.

The aim of this current paper is to both study the effect of leasehold on apartment price, but in addition add to this, a perhaps more important perspective of uncertainty. Since the political ambition in Stockholm has moved towards more market oriented ground rents, we see a possibility to study the effects of uncertainty on prices, and as a result of that answer a wider question of information and efficiency on housing markets. A short institutional clarification is necessary. Leasehold agreements imply two different types of contract durations. The first concerns the leasehold agreement, and the second concerns specific details of the leasehold agreement, most notably the ground lease rent. A leasehold agreement with the municipality of Stockholm is typically (with few exceptions) valid for a duration of 60 years. After this the municipality has the possibility to terminate the leasehold agreement, if they opt to not doing so, the agreement is prolonged with 40 years. Termination of leasehold agreements for land used for housing is uncommon, to not say non-existent. During these periods of which the leasehold agreement is in place (60 or 40 years) the terms may be renegotiated. Renegotiation typically occurs every ten years (with a few exceptions of older leasehold agreement allowing 20 years between renegotiation). This implies that ground lease rents can be renegotiated every ten years, and with increasing land values during the past decades, this has meant increasing ground lease rents with ten year intervals. A previously unanswered question in relation to leasehold status is: how does contract duration affect prices?

The remainder of this paper is structured as follows; Section 2 provides a literature review, Section 3 describes the data, Section 4 covers the methodology and results. Section 5 concludes.

2. Literature review

Two strands of literature are of interest for the current paper. First there is the literature on land values. This strand of literature contains questions that have interested economists for centuries, with early works developed by Ricardo (1821) and von Thünen (1826). Much of the literature on land values, as in the early works, is focused on location. In a seminal contribution on bid rents, Alonso (1964), among other results, show a trade-off between input factors of production. Where von Thünen (1826) assumed the mix of non-land and land input factors of production was fixed, Alonso (1964) allows these to vary. The resulting models better explains the structure of cities that we can observe, at central locations, where land is more valuable, capital is traded for land and we observe higher structures. On the contrary, at the periphery of cities, where land values are low, we observe low rise construction. This first strand of literature largely ties into the second important strand of literature for this current paper, the one focused on leasehold status. As discussed in the introduction of this paper, from a political perspective, leasehold has been used as a tool to keep land costs low for residential construction, with the aim of a greater social mix in residential areas. However, this has never been combined with any restrictions aimed towards which social demography has been built for. Therefore, there are no obvious reasons to expect any underlying differences, for example with respect to quality, between houses originally built on a leasehold compared to freehold. Leasehold has also been a tool to steer away from the most profitable land use, e.g. office space, in favor of housing at some central locations. In a recent paper, Tyvimaa et al. (2015) study the price effect of leasehold status on apartment prices in Helsinki, Finland. The authors attempt to study both the price effect of leasehold status on apartment prices, but in addition also attempt to estimate the uncertainty effect of leasehold status. They find a significant price effect of leasehold status of roughly 5% when controlling for other attributes using the hedonic approach. When it comes to the uncertainty effects data limitations only allow the authors to study the average effects on price of apartments on leaseholds before and after an announcement made in 2007 stating potential large future increases in fees. The findings indicate that this increase in uncertainty helps explain part of the discount for apartments on leaseholds. Several other papers have estimated the price effect of leasehold status, either as a direct aim, or as one of the control variables included in hedonic modeling when studying some other relationship. Janssen (2003) studies the effect of leasehold status on the price if income property in Stockholm, Sweden. Over a three-year period of study, Janssen does however not find evidence suggesting that market values leasehold positively nor negatively. Irumba (2015) studies the value of leasehold status on residential property in Kampala, Uganda. Using hedonic modeling, and data on newly constructed dwellings for 2011 an estimate of 23% price premium is found. This is interesting, as we will see later the expected value of a leasehold is lesser than a freehold. However, as is argued by Irumba (2015), institutional settings play a key role. The price premium found for leasehold in Kampala may be explained by the lack of institutions and regulations providing necessary information of land value, this implies that the value to the lessee, comes at a cost to the lessor. Such lessor and lessee perspectives are developed and explained by Mandell (2002).

This current paper builds on the work by Tyvimaa et al. (2015). Where their analysis falls short due to data limitations on leasehold contracts, our database allows us to study the effects of leasehold duration, as this information is available for all apartments in our dataset. Which means we can study the effects of uncertainty without the use of proxy variables, and instead use the direct and precise measure of remaining contract duration.

3. The model

The model in this paper largely follows that of Tyvimaa et al. (2015), with some alterations to account for one of the primary questions to be answered herein, namely, how price is affected the closer in time to the date of renegotiation of the lease contract we are. Before the model is introduced, a crucial assumption needs to be stated; namely that households are risk-averse. Although risk preferences tend to vary between individuals and households (see Pålsson, 1996), they are commonly viewed as being risk-averse. To begin with we want to establish the differences in values, and expected transaction price, that a leasehold implies compared to a freehold. The value of a freehold can be represented as the sum of the ownership interests in both the building, and the land:

$$V_{FS}^{Free} = V_{FB} + V_{FL} \tag{1}$$

where V_{FS}^{Free} is the total value of a freehold, V_{FB} is the freehold value of the building and V_{FL} is the freehold value of the land upon which the building is constructed. The difference between a freehold and a leasehold is that the value of the land is split between the lessor and the lessee, such that:

$$V_{FS}^{Lease} = V_{FB} + V_{LL} + V_{LF} \tag{2}$$

where V_{FS}^{Lease} is the total value of the leasehold, V_{LL} is the value of the land to the lessee and V_{LF} is the value of the land to the lessor. Since $V_{LL} + V_{LF} \le V_{FL}$ it follows that the value of the land to the lessee of owning a house or an apartment on a leasehold (V_{LL}) is less than owning a house or an apartment on a freehold (V_{FL}). Furthermore, we can represent the price of a dwelling as:

$$Price = f(x,\ z,\ v) \text{ where } v = \begin{cases} V_{FL} \text{ if freehold} \\ V_{LL} \text{ if leasehold} \end{cases} \tag{3}$$

where x is a vector of dwelling specific attributes and z is a vector of locational attributes. Since we have established that $V_{FL} > V_{LL}$ and we know that $\partial Price/\partial v > 0$ is follows that the price of a dwelling on a freehold should be higher than the price of dwelling on a leasehold.

In addition, we are with this present study interested in analyzing the effect on price that remaining contract time has on price. For this we need to expand the value of the leasehold to the lessee in order to study its components. For simplicity, we will here consider an economy consisting of two contract periods over a number of time periods. Contract period one spans over time periods 1 through n, and contract period two spans over time periods $n + 1$ through N. The value of the land to the lessee can then be stated as:

$$V_{LL}^{t} = \left[\sum\nolimits_{t=1}^{n}\left(\frac{R_m^1 - R_c^1}{(1 + r_h)^t}\right) + \sum\nolimits_{t=n+1}^{N}\left(\frac{R_m^2 - R_c^2}{(1 + r_h)^t}\right)\right] \quad (4)$$

where V_{LL}^{t} is the value of the land to lessee in time period t, or the beginning of the first contract period. R_m^1 and R_m^2 are the market values of the land in both contract periods. In reality, market values will of course differ between all time periods, but here we are simplifying to only allowing the market value to differ between contract periods. This assumption makes calculations much less cumbersome but has no implication for the point we're making. R_c^1 and R_c^2 are the leasehold fees to paid by the lessee to the lessor in both contract periods. r_h is a discount rate. At the beginning of the first contract period, neither R_m^2 nor R_c^2 are known. There are certain types of decision rules to be considered with regards to how the fee (R_e) us to be set. As mentioned, the common practice in Stockholm up to date has been to increase fees with relatively small amounts in renegotiations. This is however changing and now the common practice is that the fee should in some way be based on market values of the land. For Eq. (4) this would mean that, while R_c^1 could have been set without taking R_m^1 into account, the expectation of R_c^2 can now be expressed as something like:

$$E(R_c^2) = f(R_m^2) \quad (5)$$

That is, the expectation of the negotiated fee is some function of the market value realized in the second contract period. What happens then as we draw closer to the end of the first contract period? We can update Eq. (4) to the following time period, then we get:

$$V_{LL}^{t+1} = \left[\sum_{t=1}^{n}\left(\frac{R_m^1 - R_c^1}{(1 + r_h)^t}\right) + \sum_{t=n+1}^{N}\left(\frac{R_m^2 - R_c^2}{(1 + r_h)^t}\right)\right] \quad (6)$$

where V_{LL}^{t+1} is the value of the land to the lessee in the second-time period of the first contract period. We are interested in what happens to the value as we approach the end of the first contract period. More precise, we are interested in the relation between V_{LL}^{t} and V_{LL}^{t+1}. It will be easy to see this relation if we assume there to be no uncertainty with regards to R_m^2. Furthermore, we assume a more precise decision rule than that given by Eq. (5), namely that $R_c^2 > R_m^2$, and that this is known to all agents on the market. It is easy to see then that the second expressions of both Eqs. (4) and (6) becomes zero. What becomes interesting then is the relationship between R_m^1 and R_c^1. On a booming market, $R_m^1 > R_c^1$, that is, the fee paid by the lessee to the lessor can be lower than the market value. On a bust market, the opposite relation can hold, the fee paid by the lessee to the lessor could then be greater than the market value, if the values on the bust market drop enough. Of course, current fees can be lower or higher than market values for other reasons than the booming or bust markets. We can summarize this with:

$$V_{LL}^{t+1}\begin{Bmatrix} < \\ = \\ > \end{Bmatrix} V_{LL}^{t} \text{ if } R_m^1 \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} R_c^1 \quad (7)$$

The same results would hold even if we do not assume such a strict decision rule in renegotiation such as $R_c^2 = R_m^2$. In Eq. (3) we described the relation of the value of the land to the lessee and the expected transaction price of the dwelling. We established that $\partial Price/\partial V_{LL} > 0$. This would mean, that on a booming housing market, such as the one we have observed in Stockholm during the past two decades, the effect on price while approaching the end of the contract period for a leasehold would be:

$$Price^{t} = f(x,\ z,\ V_{LL}^{t}) > Price^{t+1} = f(x,\ z,\ V_{LL}^{t+1}) \quad (8)$$

That is, as we approach the date of renegotiation on a booming market, the price of the dwelling will increase less rapidly than for a freehold dwelling. Here, the assumption of risk-averse households becomes crucial, as risk-aversion is one of the driving forces (together with the discount rate) that explains the price difference in relation to contract length.

4. Data

Data with transactions of cooperative apartments sold through real estate agents in the inner city of Stockholm, Sweden, during the period of 2012 to mid-2014 has been provided from the company *Valueguard* that constructs real estate indices. This results in 36,912 and have very high market coverage, in addition to also being rich with property characteristics typically used in hedonic models that explain property price.

However, this data does not include information regarding the cooperative to which an apartment belongs. Although a very important aspect when buying an apartment in Sweden, cooperative information is typically not included in transaction data. We resolved this issue by matching each observation to its housing cooperative through address information. This was done by the company *Hitta Brf* that specializes in compiling data on Swedish housing cooperatives. Finally, information about whether an apartment is in a building that is located on leasehold land is needed. This was enabled by a report by *Sveriges Radio* (the government owned radio broadcaster) that provided a list of all housing cooperatives with properties on leasehold land owned by the municipality of Stockholm. This gives a dataset with a binary variable indicating if an apartment is located on leasehold land.

To extend on the dynamics of how leasehold is capitalized in price by buyers, information about the annual leasehold fee that is to be paid to the municipality and the date for renewal of the annual leasehold fee has been added to the dataset. This information has been collected through the online tool provided by the company *Datscha* that provides real estate market information.

After exclusion of observations in neighborhoods without any leasehold apartments, the final dataset consists of 22,673 transactions in 2897 distinct housing cooperatives, of which 2617 observations are in 246 housing cooperatives with leasehold status. Summary statistics with property characteristics for the two sub-groups of apartments are shown in Table 1. The samples deviate in terms of mean size, no. of rooms, floor and age – as leasehold apartments are larger, with a greater number of rooms as well as being newer. Also, prices vary, with higher prices for leasehold apartments, which is consistent with the differences in characteristics. That monthly fees that are to be paid to the housing cooperatives are higher in leasehold apartments is a likely consequence of such cooperatives having the financial burden of paying the leasehold fee. Somewhat higher monthly fees are however to be expected, as the fee is determined by the fraction of the housing cooperative than an apartment occupies, therefore increasing with apartment size.

The geographical distribution between leasehold and non-leasehold apartments is however similar between the groups.

5. Methodology and results

5.1. Hedonic modeling

To test leasehold status impact on price of leaseholds status, a hedonic model as defined by Rosen (1974) is applied. Following

Table 1
Summary statistics of cooperative apartment transactions spanning 2012 to mid-2014 (mean values with standard deviations in parenthesis).

	Non-leasehold	Leasehold
No. obs.	20,056	2617
Sale price (SEK)	3,718,465	3,861,853***
	(1,881,035)	(1,564,782)
Living area (m^2)	59.2	68.7***
	(28.7)	(25.7)
No. of rooms	2.13	2.55***
	(1.02)	(1.02)
Monthly fee (SEK)	2737.7	3581.2***
	(1280.9)	(1402.8)
Elevator (1/0)	0.7634	0.8356***
	(0.4249)	(0.3706)
Balcony (1/0)	0.0844	0.0871
	(0.2780)	(0.2820)
Floor	2.26	2.45***
	(2.35)	(2.46)
Age	78.1	49.3***
	(38.7)	(44.2)

SEK = Swedish Crowns.
*Two-sample *t*-test of difference in means is significant at the 10% level.
**Two-sample *t*-test of difference in means is significant at the 5% level.
***Two-sample *t*-test of difference in means is significant at the 1% level.

customary procedure in housing research, the dependent variable is in its natural logarithm. This therefore yields a linear regression model in which the price of a given apartment i is a function of X which is a matrix of apartment characteristics that theoretically should influence price, in addition to leasehold (D_i)status which we expect to negatively influence price. We can reformulate (8) into a regression model which is given by (9):

$$Price_i = e^{X_i\beta+\delta_1 D_i+\varepsilon_i} \tag{9}$$

As the uncertainty associated with leasehold status is influenced by the remaining time left before renegotiation of the leasehold fee, a second model in which this relationship is captured. This model adds an interaction variable of a variable that indicates the time until renegotiation for each leasehold apartment ($(t-\tau)_i$).This therefore yields the model given by (10):

$$Price_i = e^{X_i\beta+ \ \delta_1 D_i+\delta_2 D_i(t-\tau)_i+\varepsilon_i} \tag{10}$$

Given that uncertainty regarding future cash flows are discounted to present value, the expected result of the second model is that price increases with time until renegotiation, or stated differently, the negative impact of leasehold status decreases with increased certainty regarding future cash flows. This variable is the time between the date of sale and the expiration date on the current leasehold contract. If a housing cooperative has several leaseholds (which is possible when a housing cooperative consists of several properties), the expiration date is the average of those contract expiration dates. Although estimated in days, this duration is converted to years to simplify interpretation.

The results of the regression models are presented in Table 2. In the first model, all variables show their expected signs. In addition to variables capturing apartment characteristics and leasehold status, binary variables that indicate the quarter of sale and parish are included as controls for time and location. Noteworthy is that price increases with age, which is to be expected for those familiar with the property market in Stockholm were apartments in old properties typically sell at a premium. As in the first model, age^2 is not statistically significant.

Focusing on the variables of interest, the first model yields results that leasehold status depreciates price by 2.3% and that this impact is statistically different from zero. In the second model, the impact is larger, indicating a depreciation of 4.2%. As the second model includes an interaction variable for the duration of the leasehold contract, the impact should be interpreted as the depreciation on price when the leasehold duration is 0, i.e. at the time of renegotiation. Keeping in mind that monthly fees are controlled for, this negative capitalization corresponds is due to the uncertainty associated with leasehold status. Most notably, the risk that leasehold fees might increase in the future. This relationship between uncertainty and leasehold status is further explored in the second model. In this model, it is found that price increases with time until renegotiation and that this effect is statistically different from zero. This effect is in line with our hypothesis, it is however found to be very small, with price increasing with 0.22% for each additional year until renegotiation. An apartment with 15 years remaining on the lease contract will therefore sell at a 3.3% higher price compared to an apartment with a lapsing lease contract.

Table 2
Regression results. The dependent variable is the natural logarithm of sale price. *T*-values are shown in parenthesis below the coefficients.

Variable	Model 1	Model 2	Model 3
Leasehold (1/0)	−0.0228218	−0.0418811	−0.1197654
	(−6.86)	(−4.57)	(−5.74)
Leasehold duration (Years)		0.002213	0.0231851
		(2.23)	(4.40)
Leasehold duration^2 (Years^2)			−0.0012378
			(−3.98)
Monthly fee (SEK)	−0.000024	−0.0000241	−0.0000239
	(−9.01)	(−9.02)	(−8.96)
Living area (m^2)	0.0120232	0.0120279	0.0120186
	(53.08)	(53.02)	(52.97)
No. of rooms	0.070396	0.0704225	0.0705577
	(16.31)	(16.31)	(16.34)
Floor	0.0132315	0.0132084	0.013265
	(27.18)	(27.11)	(27.18)
Age	0.0012826	0.0012724	0.001287
	(11.45)	(11.28)	(11.38)
Age^2	−10.04e−06	−10.01e−06	−10.04e−06
	(−1.71)	(−1.66)	(−1.70)
Elevator	0.0312442	0.0311408	0.0309429
	(12.30)	(12.25)	(12.19)
Balcony	−0.0100095	−0.0099798	−0.010085
	(−2.86)	(−2.85)	(−2.88)
No. of obs.	22,673	22,673	22,673
R^2	0.8758	0.8759	0.8759

Binary variables indicating the quarter of transaction and binary variables indicating the location (parish) are suppressed from the output to save space.

In model 3, we add allow for a non-linear effect of duration until renegotiation of the leasehold contract. The results indicate that as the leasehold contract draws to an end, and renegotiation of contract terms (most importantly the ground lease rent to be paid) approaches, the price of a dwelling on a leasehold deviate more from an equal apartment on a freehold. We also find a negative effect i.e. the positive impact of a longer leasehold contract is diminishing.

The estimated effects of leasehold status are presented graphically in Fig. 1. The effect of leasehold, depending on the model estimated, is depicted as a comparison to an apartment on a freehold. The price effect of an apartment on a leasehold receives a price discount, regardless of the model used to estimate the price effect. Recall that the typical leasehold agreement admits to adjustments with respect to the ground lease rent every tenth year. For apartments located on a leasehold with a long outstanding duration of the contract (five or more years) the estimated price effect does not differ dramatically depending on the model used to estimate the discount. The large difference can be observed when remaining contract length, duration of contract, is modeled assuming a non-linear relationship. The discount increases rapidly as the date of renegotiation approaches. This is consistent with households being risk-averse, and cannot simply be explained solely by the discount factor of future expected ground lease rents Furthermore, previous studies aimed at estimating the price effect of leasehold status, have failed to account for the contract duration, which seemingly plays a crucial role in explaining the discount.

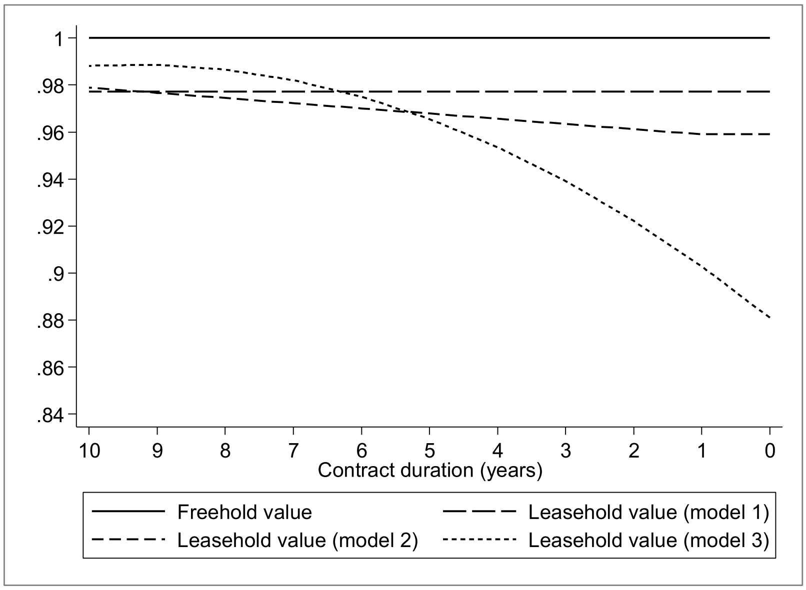

Fig. 1. Estimated effects on price of leasehold and contract duration compared (as percentage) to freehold for models 1 through 3.

5.2. Propensity score matching

A primary concern is that leasehold status is not randomly distributed across apartments, therefore causing a bias in our estimates if leasehold status is endogenously related to apartment characteristics that impact price. A way of controlling for this type confounding factors is propensity score matching as proposed by Rosenbaum and Rubin (1983). This implies that we through probit regression estimate the probability of an apartment having leasehold status, given apartment location and characteristics (this regression is shown in Table 3). This is formalized by (11):

$$p(X) \equiv \Pr(D = 1 \mid X) = E(D|X), \tag{11}$$

with D = (0,1) denoting leasehold status and X being a vector of apartment characteristics. To estimate the effect of leasehold status on price, we assume that an apartment having leasehold status is independent of potential prices, given the covariates X. This is expressed in (12):

$$Y(0),\ \ Y(1) \perp D \tag{12}$$

with $Y(1)$ denoting the outcome for treated observations and $Y(0)$ for control observations and ⊥ signifying independence. This assumption of exogenous assignment to some type of treatment is that of *unconfoundedness* Rosenbaum and Rubin, 1983). An additional assumption is that of *common support* that ensures that apartment characteristics do not perfectly predict leasehold status. Consequently, the probability of an apartment having leasehold status is bound between zero and one as seen in ((13):

$$0 \ < \Pr(D = 1|X) \ < 1 \tag{13}$$

The effect of leasehold status on price is referred to as the average treatment effect on the treated (ATT) and is a counterfactual outcome that is estimated by comparing prices of apartments with leasehold status to prices of non-leasehold apartments. The ATT is given by (14):

$$ATT = E(\tau \mid D = 1) = E[Y(1)|D = 1] - E[Y(1)|D = 1], \tag{14}$$

with τ denoting the effect of leasehold status. To estimate the ATT, we apply three matching schemes: (1) matching each leasehold observation with its non-leasehold closest match on propensity scores; (2) matching each leasehold observation with its four non-leasehold closest matches on propensity scores; and (3) kernel matching, meaning that leasehold apartments are matched with a weighted sample of all non-leasehold apartments, with weighs being determined by the inverse distance of propensity scores.

Before matching, observations that are outside the range of common support (i.e. their propensity scores perfectly predict leasehold-status) and duplicate observations on the propensity score are removed, taking the total number of observations to 22,441. Results of the propensity score matching are presented in Table 4. The probit regression that estimated the propensity scores in Table 3. It is reassuring that all matching schemes are consistent in the sense that they indicate that leasehold status negatively impacts price and that the results do not deviate much depending on matching scheme. The effect on price ranges from −337,575 SEK when matching on the nearest match to −300,330 SEK when matching on the four nearest matches. Kernel matching produces a difference of −247,966 SEK. The impact on price larger than that from the hedonic model. As illustrated by the mean price of matched non-leasehold apartments when applying nearest neighbor matching being 4,225,601 SEK, so that a negative impact of −337,575 SEK corresponds to an impact of −8.0% for an apartment with an average value selling at an average discount.

Table 3
Probit regression results for estimation of the propensity scores. The dependent variable is leasehold-status. Z-values are shown in parenthesis below the coefficients.

Variable	
Monthly fee (SEK)	0.0001783
	(10.46)
Living area (m^2)	−0.0080428
	(−6.83)
No. of rooms	0.1274108
	(4.66)
Floor number	−0.0079205
	(−1.48)
Age	−0.0086149
	(−21.46)
Elevator (1/0)	0.0747371
	(2.18)
Balcony (1/0)	−0.0882891
	(−1.98)
No. of obs.	22,441
Pseudo-R^2	0.1748

Binary variables indicating the quarter of transaction and binary variables indicating the location (parish) are suppressed from the output to save space.

Table 4
Estimated effect of leasehold status on sale price after propensity score matching.

Variable	Leasehold	Nearest neighbor 1:1 Non-leasehold	Difference (ATT)	Std. Err.	Nearest neighbor 1:4 Non-leasehold	Difference (ATT)	Std. Err.	Kernel (Gaussian) Non-leasehold	Difference (ATT)	Std. Err.
Sale price (SEK)	3,888,025.92	4,225,601.21	−337,575.293***	51,496.4	4,188,355.49	−300,329.569***	39,248.02	4,135,992.47	−247,966.553***	26,983.43
Monthly fee (SEK)	3547.39035	3752.3441	−204.953748***		3727.11673	−179.726376***		3680.32864	−132.938285***	
Living area (m^2)	68.8564593	73.7013557	−4.84489633***		72.8924442	−4.03598485***		72.194252	−3.33779271***	
No. of rooms	2.54984051	2.75239234	−0.202551834***		2.7164075	−0.166566986***		2.69152273	−0.141682217	
Floor number	2.45933014	2.37539872	0.083931419		2.41691587	0.042414274		2.3780386	0.081291541	
Age	49.6941786	51.2185008	−1.52432217		51.2909689	−1.59679027		51.8739783	−2.17979963*	
Elevator (1/0)	0.846491228	0.843700159	0.002791069		0.857854864	−0.011363636		0.848298619	−0.001807391	
Balcony (1)	0.086523126	0.080940989	0.005582137		0.086822169	−0.000299043		0.089741788	−0.003218662	
No. of obs.	22,441									

Variables indicating the quarter of sale and neighborhood are included in the model but suppressed from the output to save space. As Abadie and Imbens (2008) showed that bootstrapping of standard errors is invalid for non-smooth estimators (i.e. nearest neighbor matching), standard errors are estimated following Abadie and Imbens (2006) for matching on the nearest and four nearest neighbors. Bootstrapping with 250 replications is applied for kernel matching.
*Two-sample *t*-test of difference in means is significant at the 10% level.
**Two-sample *t*-test of difference in means is significant at the 5% level.
***Two-sample *t*-test of difference in means is significant at the 1% level6.

Of some concern is that the samples do exhibit statistically significant differences: the monthly fee, living area, and the number of rooms exhibit differences at a 1% level of significance for all matching schemes, while the age variable is significantly different at the 10% level when applying kernel matching. This is a likely consequence of the large number of matching variables for estimation of the propensity scores. We do however believe that inclusion of as many as possible variables that impact the outcome is the most appropriate model specification. Although statistically significant, these differences are small from an economic perspective, as an example going from the mean of 2.55 rooms for leasehold apartments to 2.75 rooms for non-leasehold apartments when matching on the closest match. Leasehold apartments are slightly smaller than non-leasehold apartments, with an average size of 69 m^2 and non-leasehold apartments ranging between about 72 to 74 m^2 for all matching schemes.

Binary variables indicating the quarter of sale and neighborhood are included when estimating the propensity scores but are suppressed from the output to save space. When matching on the nearest match two variables indicating the quarter of the sale deviates at a 1% level of significance, and one such variable deviates at the 5% level. No such differences are present when matching on the four nearest matches and kernel matching.

Out of 15 neighborhoods, 2 neighborhoods deviate statistically when applying Kernel matching (at the 10% level and 5% level, respectively), one neighborhood when matching on the four nearest matches (at a 10% level of significance) and three neighborhoods when matching on the nearest match (two at the 5% level of significance and one at a 10% level of significance).

We test the robustness of the results following the approach proposed by Rosenbaum (2002). Basically, given that the above-mentioned assumption of unconfoundedness is untestable, we test how sensitive the estimate of the treatment effect is to the presence of an unmeasured confounding variable (i.e. a variable that impacts the probability of having leasehold-status in addition to also having an impact on sale price). So, if π_i is the probability of a apartment *i* having leasehold-status, a corresponding odds ratio for leasehold status is as follows:

$$\pi_i/(1-\pi_i) \tag{15}$$

A measure of sensitivity is provided by an odds ratio between observations *i* and *j,* which is defined as Γ and is as follows:

$$\frac{\pi_i/(1-\pi_i)}{\pi_j/(1-\pi_j)} \equiv \Gamma \tag{16}$$

So that Γ can be viewed as a multiplier of the degree of department from random assignment if two apartments with identical characteristics have odds of having leasehold-status that diverge by Γ. In other words, $\Gamma = 1$ implies that there is no hidden bias while $\Gamma = 2$ means that two apartments with the same observed characteristics, one is twice as likely to have leasehold-status.

Our models are sensitive to hidden bias, with the confidence bounds of *p* values of the estimated effect on sale price exceeding .05 at $\Gamma = 1.3$ when matching on the nearest match, $\Gamma = 1.5$ when matching on the four nearest matches, and $\Gamma = 1.7$ when applying Kernel matching.

6. Conclusions

The aim of this paper is to study how the information and knowledge of leasehold status for housing cooperatives and its corresponding effect on the price of apartments. We argue that the fact that the housing cooperative leases its land should have a negative impact on the price of its apartments, this has also been found in previous studies. In addition, the added uncertainty introduced when it comes to renegotiating the ground lease rents should have a further, and additional negative impact. Risk-averse households should, all else being equal, be willing to pay less for an apartment on a leasehold close to its renegotiation date when future ground lease rents are uncertain. Using data on apartment transactions in Stockholm, Sweden, paired with information of leasehold status, that is leasehold or freehold, we can answer the first question. Apartments belonging to cooperatives on leasehold land are sold at a small, but statistically significant discount of roughly 2%. We find consistent results when applying propensity score matching, indicating a similar although slightly larger negative price impact. This is where previous studies have stopped.

By adding information of duration of current ground lease rent contracts we can also answer the second question. At the time of renegotiation, apartments in cooperatives on leasehold land are sold at 4.2% lower prices compared to non-leasehold apartments, if the relationship is modeled linearly. When allowing the effect of contract duration to be non-linear with respect to remaining time of the contract, the estimated discount becomes even larger when the date of renegotiation approaches. This is consistent with the assumption of risk-averse households and cannot be explained by the discount factor alone. We find that the further away from the date of renegotiating the ground lease rent, that is, the longer the duration of the current contract, the higher the price. These findings are interesting, but not surprising. They do confirm that on the housing market, leasehold status, and the uncertainty that comes with it, is accounted for through the price mechanism.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jhe.2019.04.001.

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