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Rent control and tenancy duration

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Abstract

This paper investigates how rent control affects mobility in the Danish housing market. We apply a proportional hazard duration model, that encompasses both the presence of left truncated tenancy durations, right censored observations and allows for a very flexible specification of the time dependency of the hazard rate. Tenancy mobility is severely reduced by rent control. For a typical household in the private rental sector tenancy duration is found to be more than six years longer if the apartment belongs to the 10% most regulated units than if it belongs to the 10% least regulated units.

JEL classification: C41; D45; L51; R31

Keywords: Rent control; Mobility; Duration model

1. Introduction

Since 1939 the Danish housing market has been subjected to severe regulations on rent determination. Among economists there seems to be consensus on the misfortunes of rent control when it comes to the effects on quantity and quality of housing (Alston et al. [1]). The opponents of rent control have argued that regulations imply serious inefficiencies in the housing market. These inefficiencies range from lack of maintenance due to low economic profits for landlords (Gyourko and Linneman [9]) over misallocation of housing (Glaeser and Luttmer [7]) to reduced mobility in the housing market (Clark and Heskin [5],

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Gyourko and Linneman [8], Ault et al. [4], and Nagy [18]). On the other hand, proponents of rent control claim that the regulations could be well suited for distributional reasons, i.e., alleviation of rent control would imply major shifts in welfare from the lower deciles of the income distribution to the higher deciles. More recently it has been argued that the presence of (mild) rent control can be welfare improving since landlords have monopsony power and therefore tend to set rents above marginal cost levels. Hence, a mild rent control can distribute some of the economic rent from landlords to tenants (Arnott and Igarashi [3]).

The empirical evidence on the effects of rent control on tenancy mobility is not conclusive. Gyourko and Linneman [8] were the first to econometrically test the impact of rent control on mobility. Based on data from New York City they report a strongly significant positive association between the level of benefits from rent control and tenancy duration. Ault et al. [4] criticize the study of Gyourko and Linneman [8] and argue that their approach gives inconsistent estimates as it performs ordinary least squares estimation on grouped data. Instead, they suggest a grouped data regression model. They then estimate their model based on the same data set as Gyourko and Linneman [8] and find that households living in controlled housing are indeed less mobile, and that 80% of the difference in mobility can be explained by the presence of rent control. Nagy [18] argues that both of the previous papers ignore a duration censoring problem, because households, which were present to complete the survey that collected the data, obviously had not completed their entire duration. He then suggests using a duration model that nicely incorporates the possibility of right censored observations. In this study it is confirmed that tenants in controlled housing are less mobile than their uncontrolled counterparts, but here it is attributed to differences in observed characteristics of the tenants rather than to the existence of rent control.

In the present study we follow the approach suggested by Nagy [18]. However, we improve on Nagy's specification in two aspects. First, Nagy only estimates remaining durations. That is, he ignores the part of the tenancy duration that lies before his observation period. This is particularly dangerous in such a set-up since the hypothesis is that households in controlled areas are less mobile. By cutting off part of the tenancy duration he risks reducing the appropriate tenancy duration more in controlled housing. We show how to modify the likelihood function in order to incorporate left truncated observations. Second, Nagy specifies a hazard function where the baseline hazard function follows a Weibull distribution. The Weibull distribution is rather inflexible since it only allows for monotone duration dependence of the baseline hazard. In Nagy [18] the Weibull specification actually collapses to an exponential distribution, i.e., the hazard function exhibits no duration dependence. As noted by, e.g., Arnott [2] individuals tend to have lower mobility out of their current accommodation the longer they have lived there. A feature that actually could be captured by the Weibull distribution. In the present paper we allow for a more flexible specification of the baseline hazard function.

This article is organized as follows. In Section 2 we shortly discuss the main features of the Danish private rental housing market. The characteristics of rent control in Denmark fit well with the description of rental housing markets of several other countries. The data set is described in Section 3 along with the calculation of apartment specific rent control benefits. Section 4 contains a description of the econometric specification. In Section 5 we present the results, and in Section 6 we conclude.

2. The Danish private rental housing market

There are around 2.5 million housing units in the Danish housing market, and it comprises four main sectors, each characterized by a different set of legal regulations. The four sectors are *owner occupied housing* (51%), *cooperative housing* (6%), where the occupants own a part of the cooperative and have the right to use a specific apartment, *public rental housing* (19%), which is rented housing provided by housing associations, and *private rental housing* (18%). Here we only consider the market for private rental housing.

Rent controls have been a permanent feature of the private rental market for more than 60 years. Rents in most private rented dwellings in larger urban areas are cost-based, regulated rents. Landlords are allowed to pass on all costs (property taxes included) actually incurred in the day-to-day operation of the property and a prescribed charge to cover maintenance cost. The cost-based rent also allows for a capital charge, which can vary between 7 and 14% depending on the age of the dwelling. However, the capital charge is calculated on the basis of the value of the property in 1973 and no allowance for inflation on this part of the rent is permitted. Also, landlords cannot raise rents due to increased demand for housing. Thus the capital payoff is eroded by inflation and depreciation. Rents in all dwellings constructed after 1991 are exempted from rent control, but only a small number of private rented dwellings (about 6%) has been built since 1991.

In minor rural districts the local authorities are not imposing rent control in the traditional sense. Instead rents are determined by legislation at the “value of the rental unit,” which is not a market rent. The “value of the rental unit” is determined by comparing with similar housing units in the area, and so it is a rather vague concept. However, also housing units in urban areas can be rented at the “value of the rental unit” if they are thoroughly improved when they become vacant. In this way substantial rent increases are allowed for, and landlords sometimes use this route to escape rent control.

Another feature of the private rented sector is that whenever a private rented property is for sale, legislation gives current residents the right to take over the property at the offered price and convert it to a cooperative. The offered price typically reflects controlled rents, so most properties are taken over by residents under favorable conditions. As a result the total number of private rented dwellings has been in decline.

Recently, Lind [17] has surveyed existing rent regulating systems in a number of European countries and North American cities. The main message is that rent regulation exists in many countries (e.g., Austria, Germany, Sweden, certain states in the US, provinces in Canada, and others), and that traditional rent control systems that keeps rents below market rents are in decline but still widespread. So even though the present analysis is based on data from the Danish housing market, its implications are valid in a much wider context.

3. Data and the rent control benefit

The data used in this study are drawn from administrative registers made available by Statistics Denmark. The complete data set consists of a 10% random sample of the Danish adult population, and it comprises information on a large number of demographic and socio-economic variables as well as information about physical characteristics of all housing units occupied by the sample population in the years 1992–1999.

The sample has been restricted to include only those persons who lived in private rented housing on December 31, 1992. The date at which each person moved into their home is known, and if they moved out of their home during the period December 31, 1992–December 31, 1999, then this date is known too. That is, spells for tenancy duration are straightforwardly calculated.

In what follows the unit of analysis is the household, so among all persons in a given housing unit a household head is chosen.[1] That is, tenancy duration and some personal characteristics of the household head are used along with socio-economic indicators related to the entire household. To avoid endogeneity all variables for socio-economic status refer to the year before the household moves, or 1999 for those households who did not move in the period 1992–1999. We restrict attention to moves where the household consists of the same individuals before and after the move, i.e., we disregard moves that are due to, e.g., divorce or death. Table 1 presents means of the different measures of socio-economic status that are used in the analysis.

There are indicator variables for which age group the head belongs to (the age group 25–34 years is the reference group), a dummy for the presence of children below 18 years of age in the household, **children**, and indicators for households consisting of single males, **single male**, or single females, **single female** (two or more adults are used as reference group). There is also a variable for citizenship,

[1] Some households consist of more than one family. In families with two or more adults the oldest male is chosen as family head. In households with more than one family the household head is then chosen as the oldest family head.

Table 1
Summary statistics

Variable	Mean	Standard deviation
Children	0.122	0.327
Age 18–24	0.117	0.321
Age 35–44	0.138	0.345
Age 45–54	0.122	0.327
Age 55–64	0.094	0.292
Age 65	0.316	0.465
Unemployment ratio	0.039	0.181
Early retirement ratio	0.095	0.282
Student	0.068	0.252
Unskilled	0.561	0.496
Short	0.032	0.177
Medium	0.041	0.198
Long	0.032	0.175
Income	142,000	117,000
Wealth	−3000	124,000
Single female	0.375	0.484
Single male	0.327	0.469
Housing consumption (m^2/adult)	80.6	60.5
Non-OECD	0.012	0.109
Copenhagen	0.232	0.422
Large city	0.123	0.328
Rural	0.176	0.381
Duration (elapsed and remaining, in years)	11.68	8.408
Number of observations	39,934	
Number of these completed	23,449	

non-oecd, which takes the value 1, if the head is from a non-OECD country, and 0, otherwise. The variables **unemployment ratio** and **early retirement ratio** give the share of long term unemployed persons and persons on early retirement in each household.

Disposable household income, **income**, and household wealth, **wealth**, is measured in Danish Kroner (1999 level). There are six different categories for the educational attainment of the household head. The first indicates whether the head is a student, **student**, and the remaining five categories are defined in terms of the level of the most advanced completed education. The lowest level of education consists of persons with just primary schooling, **unskilled**. The next education category are those with vocational training and high school graduates. Graduates have been grouped into the last three categories (**short** (shortest), **medium**, and **long** (longest)) based on the length of time needed to obtain a degree. Persons with vocational training are used as reference group.

There are four geographical categories; the capital Copenhagen (**copenhagen**), the five largest cities after Copenhagen (**large city**), medium-sized municipalities (reference), and minor rural municipalities (**rural**). Finally, the variable **housing consumption** measures the size of the housing unit in square meters per adult occupant.

3.1. The rent control benefit

To determine the impact of rent control on tenancy duration a measure of the benefit associated with receiving a rent controlled apartment is required. We follow the approach taken by Gyourko and Linneman [8] by measuring a household's annual benefit from rent control as the difference between the uncontrolled rent predicted for that household's controlled housing unit and the actual rent paid on that unit.[2] However, due to the lack of a sufficiently sized random sample of uncontrolled housing units, we do not predict the uncontrolled rent for a controlled unit by estimating a hedonic rent function for the uncontrolled sector. Instead we employ the Danish Tax Authorities (henceforth DTA) model for owner occupied housing to estimate the value of the controlled unit as if it had been sold on the free market for owner occupied dwellings. From the estimated market value a predicted rent is deducted through an estimate of user costs in Denmark.[3] That is, the rent control benefit for housing unit i is

$$b_i = c_i p(Z_i, \hat{\alpha}) - r_i, \tag{1}$$

where c_i is user costs, Z_i is housing traits,[4] and r_i is the actual rent paid on housing unit i. $\hat{\alpha}$ is the estimated coefficient vector of the DTA model and so $p(Z_i, \hat{\alpha})$ gives the estimated price of housing unit i.

The DTA model for 1999 is basically a hedonic price function which is estimated using data on actual sales of owner occupied dwellings in the years 1996–1999 and a comprehensive list of housing traits. The DTA price estimates for all housing units in the owner occupied sector are used as property tax base, and so the quality of the model is highly regarded. In particular, the model has been constructed to accommodate a very high degree of geographical precision as each housing unit has been placed into one of more than 50,000 different areas with their own geographical coefficient (included in $\hat{\alpha}$).

[2] For a discussion on the properties of this measure, see, e.g., Gyourko and Linneman [8] or Gyourko and Linneman [10].

[3] The estimated user cost is made up of land taxes and assessments of the real interest rate, risk premium, depreciation and expected capital gain. The land tax rate varies over municipalities, but on average the user cost is 8.9%. Details on the derivation of the user cost can be found in Jespersen and Munch [13]. The user cost level of course directly influences the level of rent control benefits, but as discussed later the measure of the degree of rent control, which is used as a regressor in the duration model, is independent of the user cost level.

[4] The variables include, for example, square meters, number of rooms, construction year, year for major improvements, floor, number of apartments in property, the presence of kitchen, shower, and toilet, and type of heating installations.

When applying the price structure of owner occupied dwellings to that of private rented dwellings through the DTA model it should be kept in mind that rent control in the private rented sector spills over to the owner occupied sector. Theoretically, it is well established that rent control affects prices of owner occupied housing (see, e.g., Häckner and Nyberg [11]), and for the Danish housing market it is estimated that this spillover from rent control amounts to 12–15% of rents in owner occupied housing, cf. Rasmussen [19]. Therefore, our estimated market rents could all be biased upwards, but as discussed below we seek a relative measure of the degree of rent control for each unit that avoids such problems.

In order to employ the DTA model for the private rental sector, housing traits for all private rented housing units have been used. A problem with the data set, however, is that the yearly rent, r_i, is known for only about half of the private rented units in 1999. Therefore missing rent observations are estimated by the Heckman two-step procedure to control for sample selection bias. That is, the estimated rent for housing unit i is

$$\hat{r}_i = X_i\hat{\beta} + \hat{\psi}\frac{\varphi(W_i\hat{\gamma})}{\Phi(W_i\hat{\gamma})}, \tag{2}$$

where X_i and W_i are different housing trait vectors. W_i is used in the step 1 probit model and X_i is used in the step 2 OLS regression. Variables for number of apartments in building and indicator variables for type of heating installations are included in W_i but not in X_i, as these significantly affect the probability of observing a rent but are not important for the level of rents. The second part of the right-hand side is the inverse Mills ratio, where $\hat{\gamma}$ is the estimated coefficient vector from step 1 and $\hat{\beta}$ and $\hat{\psi}$ are estimated coefficients from step 2.[5]

We acknowledge, as noted by Ault et al. [4], that measuring the benefits of rent control as the difference between the observed rent and the market rent, where the market rent is the outcome of a hedonic rent function estimated for the owner occupied sector applied to the controlled sector's attributes, is likely to produce measurement errors, since the hedonic rent function (in our case the DTA model) is unlikely to fully explain rents. However, given the structure of the market for private rental housing in Denmark we are not able to compare households in controlled versus uncontrolled sectors since there is (in practice) no uncontrolled sector in the private rental housing market. In order to reduce the impact from the potential measurement error we construct a relative measure of the degree of benefit obtained due to rent control. More specifically, we divide all units into deciles according to their rent control degree, where the rent control degree is defined as the rent control benefit divided by the uncontrolled rent

$$d_i = decile\left[\frac{c_i p(Z_i, \hat{\alpha}) - r_i}{c_i p(Z_i, \hat{\alpha})}\right]. \tag{3}$$

[5] Additional details can be found in Jespersen and Munch [13].

Thus if the decile of unit i, d_i, is 10, then that unit is among the 10% of the units with highest rent control degrees, whereas if $d_i = 1$ then that unit is among the 10% of the units with lowest rent control degrees. This decile is used as a regressor in the subsequent duration analysis. Another convenient feature of this measure is that each unit's rank in the distribution over rent control degrees is not influenced by the level of user cost.[6]

The available DTA model is for 1999 and in addition rents are only observed for 1999, but we need a relative measure of the degree to which each housing unit is regulated within each of the years 1992–1999. The relative rent control degree, d_i, for a housing unit can change over time either because the number of private rented dwellings has decreased over the years (see Section 2) or because some of the physical characteristics have changed (which is known in the data set). Thus for a year prior to 1999, say 1992, the uncontrolled 1999 rent is calculated by use of the DTA model from the 1992 housing trait vectors. A housing unit is then only allocated the observed 1999 rent if it has not undergone a major improvement from 1992 to 1999. The remaining units have their rents estimated (based on the housing traits for 1992) as outlined above. In this way the relative rent control degree, d_i, for each of the years 1992–1999 has been constructed based on the 1999 DTA model and 1999 rents.

3.2. Rent control, equity, and efficiency

In order to get a first-hand impression of how rent control affects the Danish housing market this section presents some descriptive statistics on the relationship between the rent control benefit, personal wealth and tenancy duration.

The rent control benefit is very poorly targeted among tenants in private rental housing, as can be seen in Table 2. The average rent control benefit in 1999 is 10,700 DKK per tenant, but the rent control benefit is related to wealth, so that the most and least wealthy persons receive the highest benefits, while the lowest benefits accrue to persons in wealth deciles 2, 3, and 4.

Roughly the same picture emerges if the rent control benefit is related to personal income, cf. Danish Economic Council [6]. Furthermore, a regression of the rent control benefit on several socio-economic characteristics (along the lines of Gyourko and Linneman [8]) reveals that in particular a high level of education is associated with higher benefits, but that also household wealth and household income are positively correlated with the rent control benefit.[7] Thus

[6] There is no uncertainty tied to the variable part of the user cost as this is due to the different tax treatment of housing units between municipalities. However, the overall level of user cost is not well determined, but by inspection of Eq. (3) it is clear that scaling the user cost, $\tilde{c}_i = sc_i$, $s > 0$, leads to exactly the same ranking of housing units.

[7] Further details can be found in Jespersen and Munch [13].

Table 2
The rent control benefit and wealth, 1999

Decile	Maximum wealth	Rent control benefit
	1000 DKK	
1	−130	13.0
2	−66	9.3
3	−31	8.8
4	−8	8.7
5	1	11.4
6	9	9.8
7	27	10.5
8	84	11.5
9	278	11.2
10	898	13.1
All	62	10.7

For "decile 10" and "All" average wealth is reported.

Table 3
Rent control and tenancy duration, 1999

Rent control degree decile	Duration, years
1	5.5
2	6.0
3	5.9
4	6.0
5	6.3
6	6.6
7	7.4
8	7.7
9	8.3
10	8.7
All	6.8

The deciles refer to the ranking of rent control degrees as defined in Eq. (3).

the rent control benefits are not targeted towards those that would be the natural receiver, that is, the low income groups.

Rent control also seems to affect housing market efficiency as mobility is distorted. Table 3 shows that the average household had lived in their present accommodation for 6.8 years in 1999. However, the households with the lowest rent control degrees (decile 1) only had an average tenancy duration of 5.5 years, while those with the highest rent control degrees had lived in their present accommodation for 8.7 years. In the following we want to go into more detail with this relationship between rent control and tenancy duration. Specifically, we try to determine whether a household's housing unit's rank in the distribution of rent control degrees, d_i, significantly affects tenancy duration.

4. Methodology

In this section we describe the econometric model used to investigate how rent control affects mobility. The data allow us to observe household transitions in the housing market from 1992 to 1999. We have information on the date at which all households living in private rented housing on December 31, 1992 moved into their accommodation. Therefore we have what is known as left truncated observations. Since some households still live in their 1992 accommodation by the end of 1999 we also have what Nagy [18] addressed as the duration censoring problem or alternatively labeled right censored observations. In order to handle the features of the data we will apply a hazard model.

Let the continuous stochastic variable T, $T \in (0, \infty)$, denote tenancy duration. The hazard rate, which denotes the probability for households with characteristics x of moving in the interval $t + \mathrm{d}t$ given that the accommodation is still occupied at time t, is then given by

$$h(t|x) = \lim_{\mathrm{d}t \to 0} \frac{\mathbf{P}(t < T \leqslant t + \mathrm{d}t \mid T > t, x)}{\mathrm{d}t}. \tag{4}$$

The hazard function is specified as a proportional hazard model. That is, the hazard is the product of the baseline hazard, which captures the time dependence and a function of observed characteristics, x,

$$h(t|x) = \lambda(t) \cdot \varphi(x), \tag{5}$$

where $\lambda(t)$ is the baseline hazard and $\varphi(x)$ is the scaling function specified as $\exp(x\beta)$.

If the data are flow sampled, the contribution to the likelihood function for a given household is simply the density,[8] $f(t)$. However, here we sample from the stock of households living in private rental housing on December 31, 1992. In this case we have to adjust for the fact that we know when households moved into the housing unit where they resided in 1992. Let e denote the elapsed tenancy duration of household i in 1992. The contribution for this household to the likelihood function is then

$$f(t_i|t_i > e) = \frac{f(t_i)}{P(t_i > e)} = \frac{h(t_i)S(t_i)}{S(e)} = h(t_i)\exp\left(-\int_e^{t_i} h(s)\,\mathrm{d}s\right), \tag{6}$$

[8] Suppressing dependency on covariates.

where $S(e) = \exp(-\int_0^e h(s)\,\mathrm{d}s)$ is the survivor function. This adjustment is neglected by Nagy [18]. By ignoring the presence of left truncated observations (even though they are present in the data set from New York City) length biased sampling is created as elapsed durations are ignored.

Nagy [18] advocates, however, addressing the issue of right censored observations. For some households we only observe uncompleted tenancy durations since they still lived in their accommodation by the end of 1999. While households with completed tenancy durations contribute to the likelihood function with the conditional density $f(t_i|t_i > e)$, households with uncompleted tenancy durations only contribute with the survivor function. In sum, the likelihood function is

$$\mathcal{L}(\theta) = h(t|x)^c \exp\left(-\int_e^t h(s|x)\,\mathrm{d}s\right),$$

where c is an indicator variable that takes the value 1 if the household moves before the end of 1999 and 0 otherwise.

Nagy [18] also uses a hazard model to investigate tenancy durations, and he assumes that the baseline hazard is Weibull distributed. In his final model the Weibull collapses to a exponential distribution, which means that the model does not exhibit any duration dependence. We do not impose the same parametric restriction since we believe tenancy duration depicts duration dependence. Along the lines of Jovanovic [14] who considers matches on the labor market, we conjecture that the match quality of households and their accommodation reveals itself over time, and consequently that the hazard rate out of a housing unit diminishes with tenancy. We specify a baseline hazard function, that allows for a more flexible negative duration dependence or any other kind of duration dependence by imposing a piecewise constant baseline hazard with splitting times $\tau_0 = 0, \tau_1, \ldots, \tau_K = +\infty$. Notice, that the baseline can attain arbitrary flexibility by increasing the number of intervals. Let the value of the baseline hazard in the k'th interval be given by λ_k, and let $k(t) : \Re_+ \curvearrowright \{1, 2, \ldots, K-1, K\}$ be a function that maps the duration, t, into interval k. Then the likelihood function for a household can be written as

$$\mathcal{L}(\theta) = \left(\lambda_{k(t)} \exp(x\beta)\right)^c \exp\left[-\exp(x\beta)\left(\sum_{j=k(e)+1}^{k(t)-1} \lambda_j(\tau_j - \tau_{j-1}) + \lambda_{k(t)}(t - \tau_{k(t)-1})\right)\right]. \tag{7}$$

Note that the integrated hazard function (the term in square brackets) is now just the sum of the interval-specific areas under the hazard function (see Lancaster [15] for additional details on duration models).

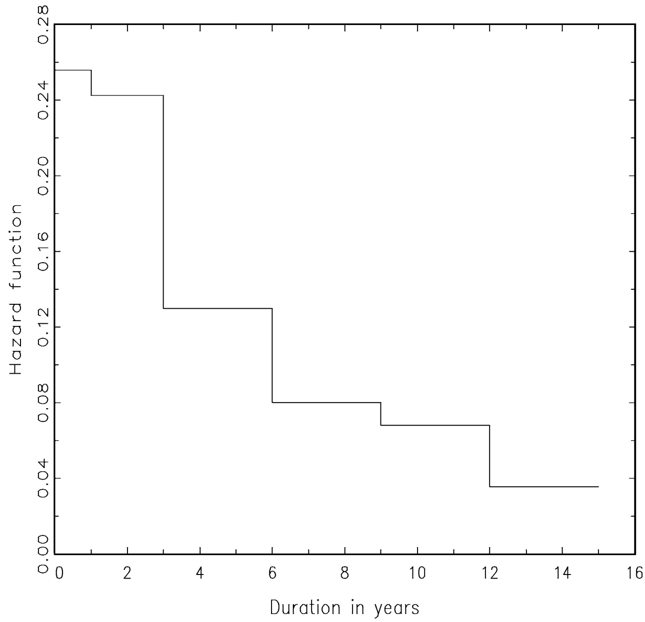

Fig. 1. Hazard function out of private rental housing

5. Results

First, we present the shape of the hazard rate out of private rental housing. Figure 1 shows that there is indeed negative duration dependence as suggested above. That is, our flexible baseline specification allows tenants with higher tenancy to have a lower escape rate from their accommodation.

Table 4 presents the effects of the covariates on the hazard rate out of private rental housing.

Before discussing the effect of rent control on household mobility patterns we shortly go through some of the most interesting control variables. The age of the household head is seen to be monotonic negatively correlated with the movement out of the housing unit. This is also what is found in the literature. There are, however, some attempts to describe the age effect by a second order polynomial. Nagy [18] follows this approach and finds—somewhat surprisingly—that age is positively correlated with tenancy duration until the household head reaches the age of 58, whereafter age is negatively correlated with tenancy duration. We suggest that this effect is spurious and emerges as a consequence of the polynomial structure imposed on the age variable.

Ault et al. [4] discuss two potential effects of family income on mobility. First, high income tenants, if currently residing in an up-scale unit, may view their options for alternative rental housing as quite limited, thereby reducing

Table 4
Results from hazard model

Variable	Coefficient	Standard error
Rent control degree (in deciles)	**−0.7975**	0.0316
Children	−0.0067	0.0273
Age 18–24	**0.3538**	0.0223
Age 35–44	**−0.4715**	0.0263
Age 45–54	**−0.7574**	0.0314
Age 55–64	**−0.8588**	0.0380
Age above 65	**−1.2535**	0.0325
Unemployment ratio	0.0331	0.0383
Early retirement ratio	**−0.0956**	0.0318
Student	**0.1273**	0.0276
Unskilled	*−0.0381*	0.0202
Short	**0.0899**	0.0426
Medium	0.0643	0.0404
Long	**0.1679**	0.0453
Income	**−0.4334**	0.0807
Wealth	**0.2159**	0.0597
Single female	**0.5363**	0.0248
Single male	**0.5931**	0.0247
Housing consumption	**0.0418**	0.0060
Non-OECD	0.0500	0.0591
Copenhagen	**−0.0972**	0.0232
Large city	*−0.0461*	0.0279
Rural	−0.0111	0.0205

Bold (italic) figures indicate that the parameter estimate is different from 0 at the 5% (10%) significance level. In order to aid maximization of the likelihood function we have scaled the rent control degree with 10, housing consumption/adult with 100, and income and wealth with 1,000,000.

their mobility. Alternatively, the cost of any potential move should comprise a smaller percentage of their budget than for their lower income counterparts, so that mobility is increased. In the empirical part of their paper they find that tenancy duration is positively associated with income. Similar results emerge in Table 4 and are also found by Nagy [18]. In contrast to the US-based investigations we also include information about family wealth. Wealth appears to be positively correlated with mobility. The positive association between wealth and mobility could be attributed to a savings motive. That is, households who wish to move to owner occupied housing need a substantial amount of liquidity for down payments, refurbishment etc. and therefore save some of their income before buying property. Also, households in the owner occupied sector receive an implicit subsidy through the tax system, because imputed rents from equity invested in the house are taxed at lower effective rates than private market rents, and so relatively wealthy households should be inclined to move to owner occupied housing.

We also find that households consisting of single individuals—women and men alike—are more prone to move. This result is consistently found in related studies. Likewise, we find that students move more frequently than others. This effect is found even though students tend to live in larger cities where rent control is known to be more binding. The effect, like the effect from singles, is probably associated with a more turbulent way of life. Since rent control is more binding in larger cities we also correct for this, and find that the coefficient to larger cities, i.e., Copenhagen and other large cities, is indeed negative. For large cities it is, however, marginally insignificant. We also control for additional characteristics of the household as reported in Table 4.

Even after controlling for a wide range of household characteristics as well as duration dependence we find a very significant negative association between the degree to which each unit is controlled, as measured by the ranking of rent control degrees into deciles, and mobility. That is, the higher the decile the lower is the hazard rate out of the housing unit. In order to obtain a clear impression of the magnitude of this effect we have calculated the expected tenancy duration for a hypothetical standard household in the Danish housing market.[9]

Table 5 contains the expected tenancy duration for such a household. If the household occupies a housing unit with a rent control degree in the lowest decile, the expected tenancy duration is 12.8 years. If the standard household, instead, occupies a housing unit with a rent control degree in the highest decile, the expected tenancy duration increases by more than 6 up to 19.5 years. These numbers are, of course, sensitive to the composition of the household. Couples are more stable than single-headed families (cf. Table 4). The last column shows expected tenancy durations for a household equal to the standard household except that it is headed by a single man without kids. For such household the expected tenancy durations are shorter, but the impact from rent control is still substantial.

5.1. Discussion

Arnott [2] argues that the empirical evidence concerning the effects of rent control on various outcomes is disappointingly uninformative. With respect to the effects on mobility he stresses that "...there is weak evidence that average mobility is somewhat lower in controlled housing...." However, that rent control encourages staying in a private rental housing unit longer can, according to Arnott, be attributed to three other effects. First, there is a tenancy composition effect. The mobility rate is lower, the longer the period of tenancy, and tenants in controlled housing have on average been in their units longer. Second, there is a landlord selection effect; landlords in the controlled sector have an incentive to

[9] See Appendix A for details on the calculation of expected durations.

Table 5
Expected tenancy durations (in years)

Rent control degree decile	Standard household (SH)	SH, single male without kids
1	12.8	7.1
2	13.6	7.7
3	14.4	8.5
4	15.2	9.2
5	16.0	10.3
6	16.7	10.8
7	17.4	11.6
8	18.1	12.4
9	18.8	13.2
10	19.5	14.0
Average	16.3	10.5

The household consists of a couple with children. They have a yearly disposable income of DKK 200,000, and wealth equal to DKK 40,000. They live in a large provincial town, and consume 60 m^2/person. The household head is between 35–44 years old and is educated as a skilled worker. The deciles refer to the ranking of rent control degrees as defined in Eq. (3).

choose low-mobility tenants because low mobility is correlated with stability and responsibility. Third, there is a tenant selection effect; low-mobility tenants have a stronger incentive to search for controlled housing, since their search costs are amortized over a longer period. The third effect implies that low-mobility tenants potentially are more likely to end up in controlled housing simply because they search harder and perhaps are more willing to engage in black market activities to obtain controlled accommodation. The observed association between rent control benefits and mobility could be due to the three effects Arnott lines up, but as will be argued below it is possible to purge the investigation for these effects by applying the appropriate econometric tools to the data, and so our results strongly suggest that mobility is indeed hampered by rent control.

First, by allowing for a flexible baseline hazard in the hazard model we control for the fact that hazard rate out of apartment is declining with tenancy duration.

Second, the landlord selection effect is hard to justify in the Danish housing market. Of course, landlords prefer responsible tenants, but long tenancy duration also complicates the possibility for improvements of the housing units. Improvements, as noted in Section 2, can lead to significant increases in the rent. Therefore we suggest that there is a trade-off for landlords with respect to preferring high mobility or low mobility tenants.

Third, the tenant selection effect is surely present. In order to correct as much as possible for this effect we include a vector of tenant characteristics along with the rent control benefits in the econometric analysis. This amounts to controlling for the selection based on observables (e.g., older individuals, who are less mobile on average, acknowledge this and put more effort into the search for high benefit accommodations). This selection effect can be accounted for by including age in the regression. The same applies to other covariates. If, on the other hand, the selection process is grounded on unobservable characteristics, i.e., there are some characteristics that are unobserved to the researcher, which influence the probability of obtaining a controlled unit of housing, a more advanced approach is called for. In the New York City data set, where there are two types of apartments (controlled and uncontrolled), a possible solution is to estimate the selection process into controlled and uncontrolled housing simultaneously with the tenancy duration model. In this type of modeling the correlation between the unobservable characteristics can be described, and one may then test whether—based on unobservables—low-mobility tenants are more inclined to end up in controlled housing (see, e.g., Lillard et al. [16] for a suitable econometric model). In the Danish context this is somewhat different since almost all housing units are controlled. However, it would be possible to divide the controlled housing units into categories based on the degree of rent control and then estimate the selection process into these categories simultaneously with the tenancy duration model in order to get an idea of the correlation between the unobservable parts of the two processes. We leave the more elaborated econometric model for future research.

6. Conclusions

Based on an extensive data set collected by administrative registers we analyze how the presence of rent control in the Danish private rental housing market affects mobility. We do this by applying a duration model that encompasses both the presence of left truncated tenancy durations, right censored observations and allows for a very flexible specification of the time dependency as captured by the baseline hazard function.

We find that tenancy mobility is clearly reduced by the presence of rent control. For a standard household we find that expected tenancy duration is increased by more than six years for households which receive benefits in the highest decile of the benefits distribution compared to households which obtain benefits in the lowest decile. Therefore, it is concluded that rent control has a very unfortunate effect on household mobility and that the efficiency of the housing market is seriously hampered.

A perhaps even more serious consequence of reduced mobility in the housing market is the spillover to the labor market. Hardman and Ioannides [12] argue that reduced mobility in the housing market dampens economic growth by virtue of inefficient labor market allocations. If households are less inclined to move due to rent control they are also less inclined to react to changes in labor market conditions. Presently, this hypothesis is only formulated theoretically, but in future research it should be possible to combine the two closely connected markets to investigate whether a positive association between benefits from rent control and mobility on the labor market can be found. If the theoretical hypothesis is confirmed this is yet another argument for loosening the rent regulating systems worldwide.

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Appendix A. Expected tenancy duration

Interpretation of estimation results in hazard models is more complicated than in other statistical models, since the size of the estimated coefficients for explanatory variables is not straightforward to evaluate. In order to accommodate this feature of hazard models we quantify the effect of the household characteristics on tenancy durations by calculating the expected duration of remaining tenancy. That is, for given household characteristics it is possible to calculate how the expected remaining tenancy changes when the size of a covariate changes. Below we illustrate how the calculations are done.

Suppressing the dependency of the hazard function on x, the integrated hazard is

$$H(t) = \int_0^t h(s)\,\mathrm{d}s = H_{k(t)-1} + (t - \tau_{k(t)-1})h_{k(t)},$$

where $H_{k(t)-1}$ is the integrated hazard up to the beginning of the k'th interval and $h_{k(t)}$ is shorthand for $h(t) = \lambda_{k(t)}\exp(x\beta)$.

The expected duration for a household that moved into the housing unit on December 31, 1992 (i.e., where $e = 0$) is then

$$E[T] = \int_0^\infty S(t)\,\mathrm{d}t = \int_0^\infty \exp\bigl(-H(t)\bigr)\,\mathrm{d}t$$

$$= \sum_{j=1}^{K} \int_{\tau_{j-1}}^{\tau_j} \exp\bigl(-H_{j-1} - (t - \tau_{j-1})h_j\bigr)\,\mathrm{d}t$$

$$= \sum_{j=1}^{K} \biggl(-\frac{1}{h_j} \exp\bigl(-H_{j-1} - (\tau_k - \tau_{k-1})h_j\bigr) + \frac{1}{h_j} \exp\bigl(-H_{j-1} - (\tau_{k-1} - \tau_{k-1})h_j\bigr)\biggr)$$

$$= \sum_{j=1}^{K} \frac{1}{h_j} \bigl(\exp(-H_{j-1}) - \exp(-H_j)\bigr).$$

This can also be expressed as

$$E[T] = \sum_{j=1}^{K} \frac{1}{h_j} P(\tau_{k-1} < T \leqslant \tau_k). \tag{A.1}$$

That is, the expected tenancy duration is simply the sum of the inverse interval-specific hazard functions weighted with the interval-specific occurrence probability.

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