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Geographic and dynamic heterogeneity of home ownership

Jørgen Lauridsen · Niels Nannerup · Morten Skak

Abstract This paper analyses the determination of the demand for home ownership. The determinants include prices and short- and medium-term price changes, public regulation (regulation of house rent, housing subsidies, taxation), competition from alternative residence forms (measured by supply of subsidised housing), social composition of population (age, social benefit recipients, household composition, civil status, education, nationality), economic ability (income), and congestion (measured by population density and degree of urbanisation). The study applies Danish aggregate data for 270 Danish municipalities, available annually for the period 1999–2004. The effects of determinants on home ownership rates are allowed to be heterogeneous by years and municipalities using temporally and geographically expanded coefficients. Considerable parametric heterogeneity over time as well as across municipalities is found, even when residual dynamic heterogeneity and interdependency as well as residual spatial spillover is controlled for.

Keywords Housing market · Demand for home ownership · SUR ·
Spatial spillover · Spatial heterogeneity

1 Introduction

A recent study (Lauridsen et al. 2006a) established an econometric model for the fraction of homes that are owner-occupied in Denmark for the period 1999 to 2004. The authors

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summarised the determinants of demand for home ownership. Theoretical determinants included prices and short- and medium-term price changes, public regulation (regulation of house rent, housing subsidies, taxation), competition from alternative residence forms (measured by supply of subsidised housing), social composition of population (age, social benefit recipients, household composition, civil status, education, nationality), economic ability (income), and congestion (measured by population density and degree of urbanisation). Issues related to the application of pooled cross-sectional data were further discussed. Lauridsen et al. (2006a) included parametric instability over time, adjustment for dependency caused by repeated observation, and identification of the effect of prices on home ownership rates. It was found that parametric instability over time could be mostly ascribed to time trends in the parameters so that a simplified specification with common parameters across time, combined with time interactions, could be established.

Their study, however, ignored important issues related to spatial variation of the data applied. It is well known from studies concerning small-area variation that it is necessary to control for spatial spillover in order to reach proper conclusions on the effects of determinants (Anselin 1988; Anselin and Bera 1998; Anselin 2000). This evidence readily pertains to the study by Lauridsen et al. (2006a): the housing market is not restricted to act within the borders of each single municipality. Rather, market conditions and market behaviour of contiguous municipalities may be expected to spill over across the municipal boundaries. Thus, solely assuming the housing market behaviour of a municipality to be conditioned by the determining factors of this single municipality may well lead to skewed conclusions.

Specifically, it is the purpose of the present study to add to the results of Lauridsen et al. (2006a) by analysing the determinants of home ownership while controlling simultaneously, not only for dynamic heterogeneity, but also for spatial heterogeneity and spatial spillover effects.

Section 2 of the present paper briefly summarises the theoretical foundations set forth in Lauridsen et al. (2006a) regarding determinants of home ownership rates. The applied data are briefly described in Sect. 3, after which Sect. 4 outlines the methodological aspects. Spatial and temporal parametric heterogeneity is accounted for using parametric expansion. As pooled data are applied, a Seemingly Unrelated Regression (SUR) framework is advocated in order to capture dynamic patterns efficiently. Further, potential spatial spillover is controlled for by extending the SUR with a spatially autocorrelated (SAC) residual specification. Next, Sect. 5 outlines the estimation results. Throughout Sect. 5, the fallacies of not simultaneously controlling for parametric heterogeneity are demonstrated, as conclusions regarding effects on home ownership rates of determinants vary heavily across the adjusted and non-adjusted specifications. Finally, Sect. 6 rounds off the paper with a few comments and suggestions.

2 Demand for owner-occupied homes in Denmark

We address the basic household choice of owning or renting a residence, focusing on home ownership, by considering the demand for owner-occupied residential units relative to total demand for these units. Based on Danish data, empirically significant determinants for this fraction are identified. Theoretically speaking, a household will choose to own a dwelling if 'owning' is the outcome of its utility maximisation given specific economic conditions for this household. The following discussion on determinants for home ownership draws on theoretical findings by, among others, Linneman (1986); Rothemberg et al. (1991); Hansen and Skak (2005) and Elsinga and Hoekstra (2004). For a broader discussion of the

theoretical basics, see Lauridsen et al. (2006a). In addition, Atterhög (2005) surveys recent empirical studies on home ownership determinants from various countries.

In general, house prices and property values impact on ownership rates as mainly low-income groups may be expected to reduce or delay demand for ownership occupation when rising prices occur. As price changes over longer periods also lead to changing price expectations, this may again affect the demand for dwellings, the consequence being that there is no unique relationship between owner occupations and house prices, but rather distinctive short-term and medium- to long-term relationships.

Various forms of government intervention in housing markets via taxation and subsidisation tend to capitalise in market prices and may as well affect relative price expectations for owned and rented dwellings. These interventions may, therefore, play a significant role in the choice of tenure type. The most important tax and subsidy measures in the Danish housing market will be tested for, directly or indirectly, as explanatory factors in the analysis. We thus include the real property tax rate. Further, as rent subsidies are commonly offered to renters, we test for the influence of this policy by considering the share of households and the share of the population receiving rent subsidies.

In industrialised countries, mortgage loans typically constitute the major share of real estate finance. Mortgage terms and credit rating of households by lender institutions are likely to depend on a variety of individual characteristics. Chiuri and Jappelli (2003) provide empirical evidence from 14 countries that the mortgage availability affects home ownership distribution across age groups primarily due to income differences between the groups. Further, Canner and Smith (1991) find that ethnicity matters for mortgage availability. Other factors that may affect credit rating are educational level and job perspectives. In the analysis we test for such characteristics.

Comparing advantages and disadvantages of ownership relative to rented dwellings may help identify further potential determinants for the analysis. In more respects there are additional costs of owning rather than renting. The theoretical literature points to disadvantages of ownership as to switching costs of moving (salaries to real estate agencies and lawyers, uncertainty about sales prices etc.) which thereby cause a relatively low geographical mobility of owners. This indicates that individuals who are more inclined to move (such as younger people, unmarried people, and younger couples without children) may choose rented dwellings. In addition Linneman (1986) points out that high production efficiency by landlords (i.e., as to maintenance costs) in high-density areas is an important reason why ownership rates tend to fall from the countryside to urban areas. We seek evidence for this hypothesis by testing the significance of population density. One advantage of ownership is the wide scope for individual adaptation of the residence, and households clearly put different value on such an option. Preferences for housing autonomy may differ with age and career position as younger couples plan to have (more) children and educated people expect increasing future income. Further, one can argue that self-employed people may be more individualistically oriented than employees and for that reason prefer home ownership.

It appears from this reasoning, however, that the incentives for choosing tenure type are mixed for some of these groups. For instance, while younger couples may evade the switching costs of moving by being renters, they may on the other hand prefer ownership for reasons of housing autonomy (which in some sense can provide the same services as obtained from moving to a new residence). The same arguments in principle also apply to divorced people (anticipating future marriage).

All in all, these considerations lead us to test the variables shown in Table 1 for empirical significance in explaining home ownership rates in Denmark.

Table 1 Variables affecting home ownership rates

Variable	Explanation
Prices	High prices and short-run price increases make it difficult to buy a
Actual price (−)	home. Medium-term price changes stimulate the expectation of
One-year price change (−)	future increasing prices and thus the propensity to buy.
Three-year average price change (+)	
Favourable tax treatment of homeowners	A favourable tax treatment triggered by ownership tends to raise
Tax bracket (+)	ownership rates; such treatment, e.g., a low imputed rent, is typically more valuable for higher income tax brackets.
Rent subsidy (−)	Home ownership rates are reduced if an income subsidy is triggered
Rent control (−)	by renting versus owning. If rent control artificially keeps the rent
Urban restriction on ownership (−)	on rented homes below the market equilibrium this also reduces demand for owned housing. If, e.g. for social reasons, only a fraction of homes can be owned, this potentially reduce home ownership rates.
Financial capacity	With asymmetric information on financial markets, various indicators
Income (+)	of borrowers' (homeowners') repayment ability will influence
Nationality (?)	home ownership rates.
Educational level (+)	
Other personal characteristics	
Special life events (e.g. divorce, bequest, lottery)	
Expected occupation time	Ownership starts with closing or contracting costs that have to be
Age (−)	balanced against benefits in each occupation year. If the expected
Rate of "under education" (−)	number of occupation years is low, ownership rates tend to fall. Expected occupation years may also fall with some job types.
Job type	
Production efficiency for landlords vs. owner-occupiers	Where many live together, landlord scale economies for production of housing services may be pronounced.
Congestion (−)	
Households differ in benefit from adapting their home	Idiosyncratic variations in the benefit households or individuals get
Self-employed (+)	from individual adaptation of homes leads to a market screening
More than one child (+)	where owners benefit most. High rents reduce net benefit most for owners and squeeze some owners into renters.
High-rent area (−)	
Social heritage	People tend to demand the type of dwelling they used to live in as a
Parents' tenure choice	child.
Lifestyle	Modes of living, e.g., free single life vs. tied family life, influence
Rate of single households (−)	ownership rates.

Note: A (+) indicates a positive correlation between the variable and the home ownership rate

Source: Lauridsen et al. (2006a)

3 Data

The data to be applied are aggregate cross-sectional data observed for 270 Danish municipalities (five municipalities on the island of Bornholm were omitted due to data problems) annually from 1997 to 2004. Data were collected from five sources: The Statistical Bank at Statistics Denmark, the Key Figure Base [Nøgletalsbasen] at the Ministry of the Interior,

the Ministry of Urban and Housing Affairs' (2000) report on regulation of housing rents, and the Danish Tax Authority's [Told & Skat] (2004) report on property sales prices. Table 2 presents an overview of the data applied, including variable short-hands, definitions and a few descriptive statistics.

Figure 1 shows the distribution of the home ownership rates (averaged over years) across municipalities. Several indications of spatial clustering are observed for these. Thus spatial spillover may potentially be present and needs to be adjusted for. Likewise several of the explanatory variables exert spatial clustering which may potentially lead to spatial spillover; see Lauridsen et al. (2006b) for detailed maps of these.

4 Methodology

Assuming a cross-section of $N = 270$ municipalities, the basic linear regression model specifies

$$y_t = X_t \beta + v_t, \quad v_t \sim N\left(0, \sigma^2 I_N\right) \tag{1}$$

where X_t is an N by K dimensional matrix of explanatory variables, y_t is an N dimensional vector of endogenous observations, β is a K dimensional vector of coefficient, and v_t a residual with variance σ^2.

A restrictive assumption of the model (1) is that β is constant over time and across provinces. In order to allow these coefficients to vary across years and municipalities, we apply expansions (Casetti 1997; Jones and Casetti 1992), i.e., the effect of the k'th regressor ($k = 0,..K$, with the convention that β_0 is the constant term, i.e., $X_0 = 1$) is specified as

$$\beta_k = \alpha_{0k} + \alpha_{Tk} T + \alpha_{Hk} H + \alpha_{H^2 k} H^2 + \alpha_{Vk} V + \alpha_{V^2 k} V^2 + \alpha_{HVk} HV \tag{2}$$

where α_{jk} ($j = T, H, H^2, V, V^2, HV$) are coefficients, T is a time trend, and H and V the horizontal (west to east) and vertical (south to north) coordinates of the geographical midpoints of the regions respectively. The square terms H^2 and V^2 together with the interaction term HV are inserted to allow for non-linear and diagonal dispersion of the β coefficients. Inserting (2) in (1) gives the expanded specification

$$Y_t = \sum_{k=0}^{K} \alpha_{0k} X_{tk} + \alpha_{Tk} (TX_{tk}) + \alpha_{Hk} (HX_{tk}) + \alpha_{H^2 k} \left(H^2 X_{tk}\right) + \alpha_{Vk} (VX_{tk})$$
$$+ \alpha_{V^2 k} \left(V^2 X_{tk}\right) + \alpha_{HVk} (HVX_{tk})\} + v_t \tag{3}$$

Operationally, the expanded specification (3) can be estimated by applying multiplicative interaction terms between X_k and the T, H, H^2, V, V^2 and HV variables. Next, the β_k coefficients for each municipality by each time period, say β_{kit}, can be evaluated from (2) together with their standard errors, as the β parameters are simple linear functions of the α parameters. Calculation of the standard errors is performed using the Delta approach (Greene 2003). Finally, the averages for each time period and the averages for each municipality are readily obtained to serve illustrative and interpretational purposes.

It should be noted that the Casetti approach relies on the assumption that the country is characterised by a core-periphery structure. While this is a satisfactory description due to the Capital—province structure of Denmark, it may for other more decentralised structures be too restrictive. A potential solution for such cases would be to add higher polynomial

Table 2 Data applied

Variable short-hand	Definition	25% quartile	Median	75% quartile
Home ownership (dependent variable)[a]	% of housing units occupied by owner (cooperative housing and student hostels omitted)[a]	62.00	71.00	76.00
Price	Average sales price (real DKK) per square metre of one-family houses[b]	51.86	55.73	73.48
Short-term price change	Defined as $(PRICE_{i,t} - PRICE_{i,t-1})/PRICE_{i,t-1}$	0.034	0.055	0.079
Medium-term price change	Defined as $(PRICE_{i,t} - PRICE_{i,t-3})/PRICE_{i,t-3}$	0.095	0.225	0.285
Subsidised housing	of population living in subsidized housing [almennyttige boliger][c]	5.00	9.00	17.00
Housing subsidy	% of households receiving housing subsidies [boligydelse][c]	8.90	10.90	13.25
Rent subsidy	% of 15–66 year-olds receiving rent subsidies [boligsikring][c]	2.90	4.00	5.90
Regulated	Rent Regulation Act assumed by 2000 (1 = yes, 0 = no)[d]	Proportion "yes" = 0.556		
Property tax	Real Property Tax (in 0/00) [Grundskyldspromille][c]	8.00	12.00	15.00
Tax rate	Municipal + county tax rate (in %) [Udskrivningsprocent][c]	20.20	20.80	21.30
Tax base	Tax base [beskatningsgrundlag] per inhabitant (100.000 DKK)[c]	9.94	10.97	12.10
Population density	Inhabitants per square kilometre (10000[c]	48	69	147
Urbanisation	% of population living in urban areas[c]	61.00	71.00	86.00
7–16 year	% of population aged 7–16[a]	11.90	12.90	13.90
17–25 year	% of population aged 17–25[a]	8.07	9.09	10.21
26–35 year	% of population aged 26–35[a]	11.74	12.82	13.89
36–66 year	% of population aged 36–66[a]	40.55	42.33	44.27
67 + year	% of population aged 67 and over[a]	12.00	13.50	15.00
Widowed	% of population widowed[a]	5.91	6.61	7.37
Divorced	% of population divorced[a]	4.86	5.82	7.40
Unmarried	% of population unmarried[a]	41.91	43.54	44.80
Adult children	% of households with children over 18[a]	7.68	8.76	9.88
No children	% of households without children under 18[a]	0.00	3.06	5.62
Educated	% of population with higher education[c]	11.50	13.60	16.45
Social disability pension	% of population on social disability pension [førtidspension][c]	6.25	7.40	8.80
Social benefit receivers	% of population receiving social benefits [kontanthjælp][c]	6.70	8.00	9.60
Unemployed	% of population (aged 17–66 years) unemployed[c]	3.60	4.40	5.40
3rd countries	Number of citizens from countries outside EU, Scandinavia and North America per 10,000 inh.[c]	10.60	15.70	23.60
Finished new buildings	Finished new buildings (m² per capita)[a]	0.84	1.37	2.06

Sources: [a] Statistics Denmark; [b] The Danish Tax Authority; [c] The key figure base; [d] The Ministry of Urban and Housing Affairs
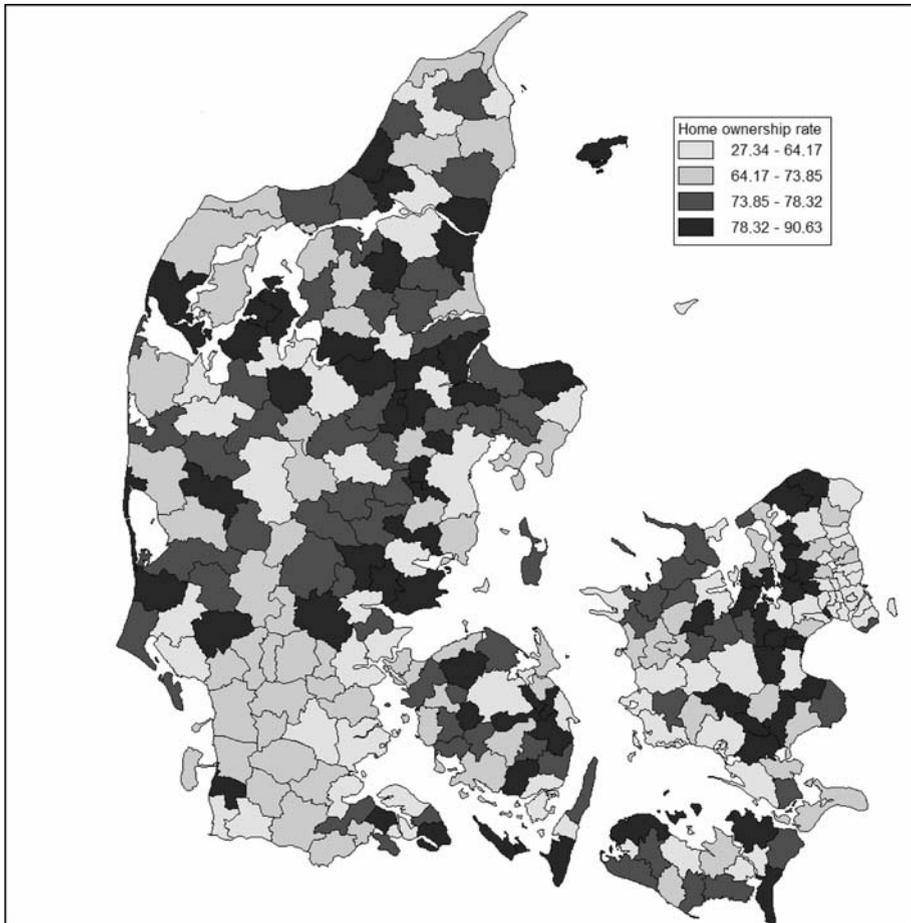
Fig. 1 Geographical distribution of home ownership rates (average 1999–2004)

orders of the time and space coordinates to the specification (2). Furthermore, it should be noted that the Casetti approach specifically addresses spatial and dynamic variation in the coefficients of the explanatory variables, rather than the variation in these variables themselves.

In order to obtain efficient estimation results, the structure of the residuals needs consideration. First, to account for residual spatial spillover, the spatially autocorrelated (SAC) specification (Anselin 1988) is applied to the residual of (3), i.e.,

$$v_t = \lambda W v_t + \varepsilon_t \qquad (4)$$

where λ is an autocorrelation parameter and W an $N \times N$ contiguity matrix defined by letting w_{ij} equal $\frac{1}{n_i}$ if municipalities i and j are neighbours ($i \neq j$) and 0 otherwise, as n_i is the number of neighbours to municipality i. Intuitively, the product $W v_t$ defines a variable, which for each municipality holds the average of v_t in the neighbouring provinces. Next, when applying pooled data for T periods, the residuals are inter-correlated across time, and

the variances for the cross-sections vary over time. Thus, between any two time periods, the residual covariance is specified as

$$E(\varepsilon_t \varepsilon_s\prime) = \sigma_{ts}^2 I_N, \quad t, s = 1, .., T. \tag{5}$$

The model defined by (3)–(4)–(5) was estimated efficiently by applying the following Maximum Likelihood approach. We did a grid search of the relevant values of λ from -1 to $+1$. Conditioned on each value of λ, a Feasible Generalised Least Squares (F-GLS) estimation (Zellner 1962) was applied to (3) using $(I_N - \lambda W)y_t$ instead of y_t and $(I_N - \lambda W)X_t$ instead of X_t to obtain SUR estimates of β. Finally, the set of results which maximised the log likelihood function was selected.

To provide devices for comparison of alternative models, some quantities are applied. One is a pseudo-R-square (R^2), calculated as the square of the correlation between y and its predicted values. A second device, which like the R-square measures can be used as a goodness-of-fit measure for comparison of models, is the familiar Akaike Information Criterion (AIC). Finally, Wald tests for the expansions are provided, i.e., for the hypotheses that α_T and/or $(\alpha_H, \alpha_{H^2}, \alpha_V, \alpha_{V^2}, \alpha_{HV})$ equal 0.

5 Results

The first column of Table 3 reports the unexpanded baseline SAC-SUR model. Several of the explanatory variables are found to be significant. This is the case for the short- and medium-term price changes, while a weakly significant effect of prices is seen. Considering regulation, all variables are found to exert the expected negative effects on home ownership. Property tax rates and personal tax rates hardly exert any influence. For property taxes, there is even a weak indication of a positive relation to home ownership, which contradicts the theoretical expectation. Congestion exerts the expected negative effect, as population density as well as urbanisation is negatively related to home ownership rates. Turning to demographic composition, it generally seems to be the case that high proportions of inhabitants in any age group over 18 years (and, consequently, low proportions of youngsters and children below 18) exert negative effects on home ownership. On the other hand, presence of many households with adult children seems to raise home ownership. Presence of households without children and youngsters seems to be unrelated to home ownership. While a large positive coefficient is reported for this determinant, an extraordinarily large standard error of the coefficient seems to indicate considerable heterogeneities of its relationship to home ownership. Several significant relationships are further seen to indicators of social composition of population. While the proportions of widowed, further educated and early retired seem to be unrelated to home ownership, large negative effects of the proportions of divorced, unmarried, social benefit receivers and inhabitants from third countries are evident. Finally, the presence of residual spatial spillover is evident as indicated by the significantly positive λ coefficient, just as the presence of considerable intertemporal residual correlations and heteroscedasticity are confirmed by the test for diagonality.

The remainder of Table 3 reports on the expanded SAC-SUR model. Quick glances through each column reveal that considerable parametric heterogeneity is present across years as well as in any of the geographical dimensions. This impression is further supported by the Wald tests, which are strongly significant for any of the dimensions. Finally, the spatial spillover seems to be removed by the spatial expansion, as the λ coefficient is

Table 3 Basic and expanded spatial SUR models

	[1] Unexp.	[2] Expanded						
	α_O	α_O	α_T	α_H	α_{HH}	α_V	α_{VV}	α_{HV}
Constant	159.03*** (10.17)	126.64*** (22.906)	2.285 (3.365)	15.916 (16.191)	39.987 (25.497)	18.889 (19.632)	22.380 (24.351)	39.015 (36.899)
Price	−0.006* (0.004)	−0.005 (0.011)	−0.002 (0.002)	−0.011* (0.007)	0.007 (0.010)	0.001 (0.008)	−0.001 (0.009)	0.004 (0.013)
Short-term price change	−2.431*** (0.643)	−2.638 (1.707)	−0.303 (0.599)	1.359 (0.896)	0.162 (1.527)	1.619 (1.165)	−0.021 (1.269)	0.171 (2.182)
Medium-term price change	1.804** (0.719)	6.489*** (1.846)	−0.809** (0.401)	−0.198 (1.117)	0.534 (1.796)	−0.301 (1.325)	−3.367** (1.474)	0.634 (2.530)
Subsidised housing	−0.480*** (0.024)	−0.370*** (0.059)	0.013*** (0.003)	0.054 (0.042)	−0.168** (0.070)	0.157*** (0.059)	−0.167** (0.084)	−0.122 (0.109)
Housing subsidies	−0.088*** (0.029)	−0.099 (0.088)	−0.016 (0.011)	−0.222*** (0.058)	−0.040 (0.125)	−0.256*** (0.082)	−0.202* (0.116)	−0.172 (0.162)
Rent subsidies	−0.334*** (0.058)	−0.352*** (0.128)	−0.051*** (0.018)	−0.215** (0.093)	0.436*** (0.140)	0.052 (0.115)	−0.043 (0.138)	−0.029 (0.203)
Regulated	−1.820*** (0.476)	−0.102 (0.878)	0.066 (0.041)	−0.659 (0.780)	−3.071** (1.243)	1.947** (0.914)	−1.464 (1.064)	3.257* (1.779)
Property tax	0.032* (0.018)	−0.199 (0.036)	−0.004 (0.004)	0.077** (0.031)	0.103** (0.048)	0.023 (0.037)	0.053 (0.035)	0.048 (0.074)
Tax rate	−0.076 (0.071)	0.068 (0.152)	0.005 (0.019)	−0.023 (0.104)	−0.297* (0.169)	−0.044 (0.127)	−0.076 (0.169)	−0.007 (0.261)
Tax base	0.030 (0.046)	0.066 (0.116)	−0.021 (0.016)	0.014 (0.064)	0.002 (0.118)	0.155 (0.113)	0.068 (0.139)	−0.069 (0.175)
Population density	−21.33*** (3.439)	−159.50*** (38.895)	0.239 (0.392)	119.09** (47.044)	−0.174 (43.517)	−88.39* (53.312)	−23.131 (79.773)	20.614 (77.912)
Urbanisation	−0.083*** (0.015)	−0.088*** (0.029)	0.003 (0.002)	0.002 (0.029)	−0.002 (0.041)	0.012 (0.028)	0.114*** (0.039)	0.117* (0.061)
7–16 years	−0.162 (0.103)	−0.123 (0.244)	−0.044 (0.046)	0.183 (0.170)	0.077 (0.271)	−0.124 (0.194)	0.133 (0.248)	−0.138 (0.372)
17–25 years	−0.572*** (0.105)	−0.419* (0.251)	0.010 (0.039)	−0.198 (0.168)	−0.302 (0.277)	−0.109 (0.201)	−0.337 (0.251)	−0.798*** (0.369)
26–35 years	−0.486*** (0.123)	−0.344 (0.292)	−0.041 (0.047)	−0.132 (0.195)	−0.046 (0.319)	−0.015 (0.240)	−0.230 (0.300)	−0.570 (0.441)
36–66 years	−0.361*** (0.112)	0.033 (0.246)	−0.024 (0.036)	−0.046 (0.180)	−0.420 (0.282)	−0.126 (0.220)	−0.579** (0.277)	−0.639 (0.401)
67+ years	−0.890*** (0.123)	−0393 (0.278)	−0.077** (0.038)	0.052 (0.195)	−0.175 (0.321)	−0.083 (0.216)	−0.305 (0.295)	−0.819* (0.453)
Widowed	−0.230 (0.146)	−0.369 (0.312)	0.082* (0.043)	−0.188 (0.244)	−0.403 (0.366)	−0.452* (0.239)	−0.048 (0.319)	−0.139 (0.455)
Divorced	−0.807*** (0.111)	−1.358*** (0.229)	0.063** (0.029)	−0.260 (0.197)	0.643** (0.295)	−0.114 (0.194)	0.428 (0.270)	0.649 (0.397)

Table 3 continued

	[1] Unexp.	[2] Expanded						
	α_0	α_0	α_T	α_H	α_{HH}	α_V	α_{VV}	α_{HV}
Unmarried	−0.655*** (0.077)	−0.260 (0.172)	−0.001 (0.022)	−0.089 (0.122)	−0.357* (0.189)	−0.121 (0.139)	−0.029 (0.188)	0.100 (0.270)
Adult children	0.235*** (0.048)	−0.035 (0.109)	0.021 (0.020)	−0.112 (0.077)	0.188 (0.121)	0.233** (0.091)	0.080 (0.120)	−0.019 (0.174)
No children	0.376 (0.410)	2.264* (1.218)	−0.719*** (0.241)	−0.027 (0.860)	0.452 (1.331)	−0.961 (0.759)	0.639 (1.067)	−2.808* (1.695)
Educated	−0.025 (0.041)	−0.066 (0.091)	0.010* (0.006)	−0.122* (0.063)	−0.050 (0.102)	−0.179* (0.092)	0.030 (0.106)	0.117 (0.177)
Social disability pensioned	−0.118 (0.076)	−0.378** (0.152)	0.003 (0.015)	−0.019 (0.130)	−0.057 (0.211)	−0.064 (0.129)	0.485*** (0.184)	0.032 (0.269)
Social benefit receivers	−0.134*** (0.041)	−0.229** (0.092)	0.009 (0.014)	0.046 (0.071)	0.095 (0.107)	−0.100 (0.069)	0.102 (0.093)	0.011 (0.145)
Unemployed	0.072 (0.048)	−0.046 (0.109)	0.011 (0.020)	0.084 (0.086)	0.101 (0.130)	0.116 (0.077)	0.220** (0.097)	−0.002 (0.156)
3rd countries	−0.045*** (0.008)	−0.055*** (0.019)	−0.002 (0.002)	−0.001 (0.013)	0.048** (0.021)	−0.015 (0.017)	−0.008 (0.021)	−0.034 (0.031)
LogL	−681.86	−477.66						
AIC	1463.73	1391.32						
R²	0.922	0.943						
λ	0.205*** (0.074)	0.095 (0.099)						
Diag. test		273.38***						
Expansion test	94.56***		314.24***					

Note: Standard errors in parentheses

Significance indicated by * (10%), ** (5%), *** (1%)

Test for diagonality is a Wald test; tests for expansions are LR tests

For a model with (α_0, α_T) only, LogL = −634.58, AIC = 1425.17, and R² = 0.928
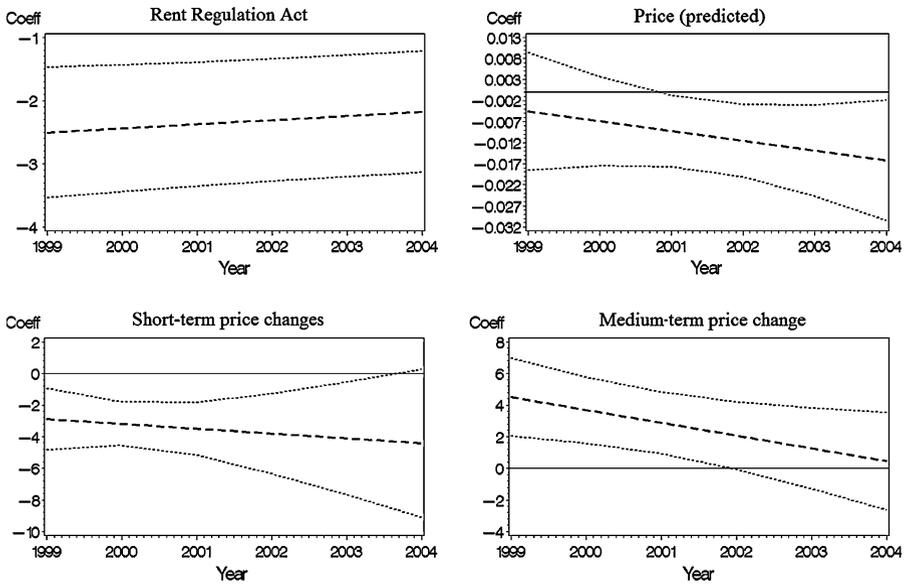
Fig. 2 Coefficients by year (average for 270 municipalities) for selected variables

substantially reduced and insignificant. Opposed to this, the SUR adjustment still seems to be relevant as indicated by the significant diagonality tests.

As the raw coefficients of the expanded model are not very supportive for interpretational purposes, the averages of coefficients by year for a few selected variables[1] are reported in Fig. 2, together with 95% confidence intervals. The effect of prices seems to be negative and growing through the years and turning significant (at the 5% level) after 2000. The effect of short-term price changes also turns slightly more negative, but the confidence interval spreads considerably in the last years, thus indicating an increasing cross-municipal heterogeneity in this effect. That is, there is a larger dispersion between these areas where the price changes have strong effects and those where they have hardly any. The medium-term price change seems to lose importance through the years, as it drops steadily from significantly positive in 1999–2001 and even approximates zero in 2004. A potential explanation may be that the expectation of further price increases, which were optimistic in the late nineties, turned into discussions of whether a price bubble might be expected. Turning to effects of regulation variables, the negative effects of rent regulation and supply of subsidised housing on home ownership seem to be slightly reduced, while the negative effects of cash payment housing subsidies and rent subsidies seem to be boosted. The tax variables as well as income (as measured by tax base) are insignificant throughout the period. Regarding congestion, the stable negative coefficient of population density seems to confirm that this effect is unchanged, while the slightly reduced coefficient of urbanisation seems to indicate that the congestion effect is turning slightly less important. Considering age composition, the effects reported for the unexpanded model seem to be increased over the years, i.e., high proportions of adults (and thus low proportions of children) exert an increasing negative effect on home ownership. On the other hand, the positive effect of having many households with children over 18 seems to increase. The

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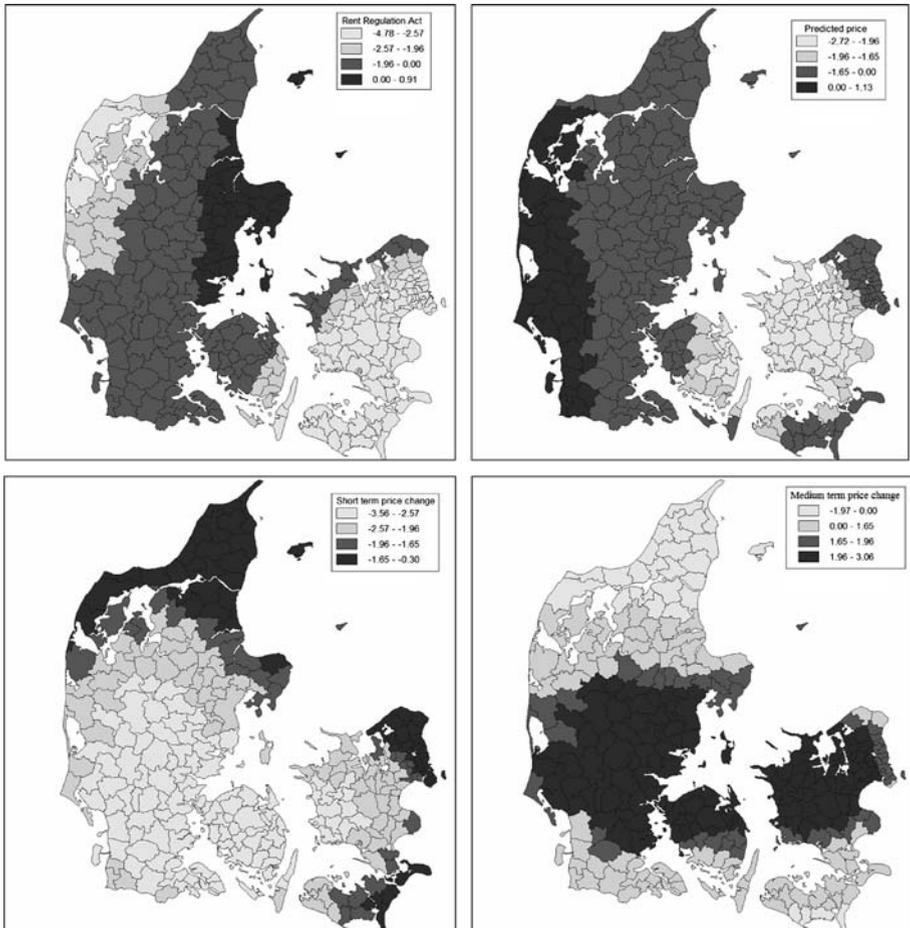[1] The full set of figures for all variables can be found in the extended report Lauridsen et al. (2008).

Fig. 3 T values of coefficients (average 1999–2004) by municipality for selected variables

effect of having many households without children below 18 exerts an interesting pattern, as it drops from significantly positive to being almost significantly negative in 2004. Turning to the effects of social composition, it is noticeable that the negative effects of 'late singleness', i.e., divorce and widowhood, seem to be reduced strongly. A potential explanation may be the improved economic conditions for these groups, due to larger pension savings and higher incomes. It is also noticeable that the effect of inhabitants from third countries is increasingly negative, which may be related to the worsening economic conditions of this group. Finally—and slightly surprisingly—the effect of unemployment seems to increase and even become significantly positive. A potential explanation for this may be the distinctive geographical pattern of the unemployment variable, as unemployment concentrates in rural areas—especially in the northern part of the country—where home ownership is also concentrated due to the lack of available rental housing (Lauridsen et al. 2006b). There is a recent debate in the economic literature on the linkages between home ownership and unemployment. For an immediate consideration, unemployment is likely to restrict the financial capacity of individuals and as such a negative relationship

between ownership and unemployment could be expected. In contrast, Oswald (1996) provides evidence from a number of countries for a positive correlation between the variables and argues that, for reasons of relatively high switching costs in housing markets, homeowners may be relatively more reluctant to move for job offers outside their home region. This hypothesis has subsequently gained support in other investigations such as those by Nickell and Layard (1999) and Green and Hendershott (2001). Of particular interest for the present analysis is Munch et al. (2006), as this study is based on Danish micro labour market data. In line with Oswald (1996); Munch et al. (2006) identifies a reduced geographical mobility for homeowners. This effect is however dominated by a *positive* effect for local labour markets, reflecting that homeowners may be more inclined to accept local jobs in order to avoid having to move. The study hence finds evidence for an overall negative correlation between unemployment and home ownership in Denmark. Munch et al. (2006) further suggests that only in countries with low 'innate' geographical mobility will effects stemming from higher local job willingness for homeowners dominate the negative effects from the low propensity to move.

Figure 3 provides a device for understanding the geographical patterning of the relationships between determinants and home ownership, as it reports the *t* values for the averages by municipalities of the expanded coefficients for a few selected variables.[2] Opposed to the above figures by time, where the statistical uncertainty could be captured by adding confidence bands, it is not possible simultaneously to report the absolute magnitude of the coefficients and measures for their statistical uncertainty simultaneously. This is the reason for applying the *t* values. The effects of prices are seen to exert considerable geographical variation. The expected significantly negative impact of prices is present in the Capital area, the middle part of Zeeland and the eastern part of Funen, while prices are not significantly related to ownership in Jutland as a whole. On the other hand, short-term price changes exert a significantly negative impact in most of the country, with northern Jutland as a predominant exception. Medium-term price change exerts the expected positive relation to home ownership in an east-west belt across the middle of the country, which essentially spans the six largest Danish cities, while the relationship is insignificant in the peripheral areas of northern and southern Jutland. Thus, the medium-term price expectation seems to be in play predominantly in areas surrounding larger cities. Considering the presence of rent regulation, an interesting relationship between the coefficient and the geographical distribution of the variable is seen. The presence of rent regulation clusters strongly on Zeeland, while the absence of regulation clusters in the western part of Jutland (Lauridsen, et al. 2006b). For these areas, the expected negative effect is confirmed. Thus, the absence of regulation in western Jutland increases home ownership, while the presence of regulation on Zeeland reduces home ownership. The effect of the amount of subsidised housing is significantly negative throughout, but strongest in a belt spanning Zeeland, Funen and southern Jutland. Housing subsidies exert a significantly negative impact on home ownership in the middle to northern parts of Zeeland and Jutland, while the effect of rent subsidies is negative throughout the country except for a belt of municipalities along the western coast of Jutland. Regarding taxation, it is seen that property taxes are unrelated to home ownership in most of the country except for the Capital area, where a significantly positive relationship is present, presumably indicating that municipalities in this area can increase property taxes without experiencing a reduction of the demand for owner-occupied housing. For income tax rates, the effect is mostly insignificant, with the exception of a small cluster of municipalities north of the Capital

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[2] The full set of figures for all variables can be found in the extended report Lauridsen et al. (2008).
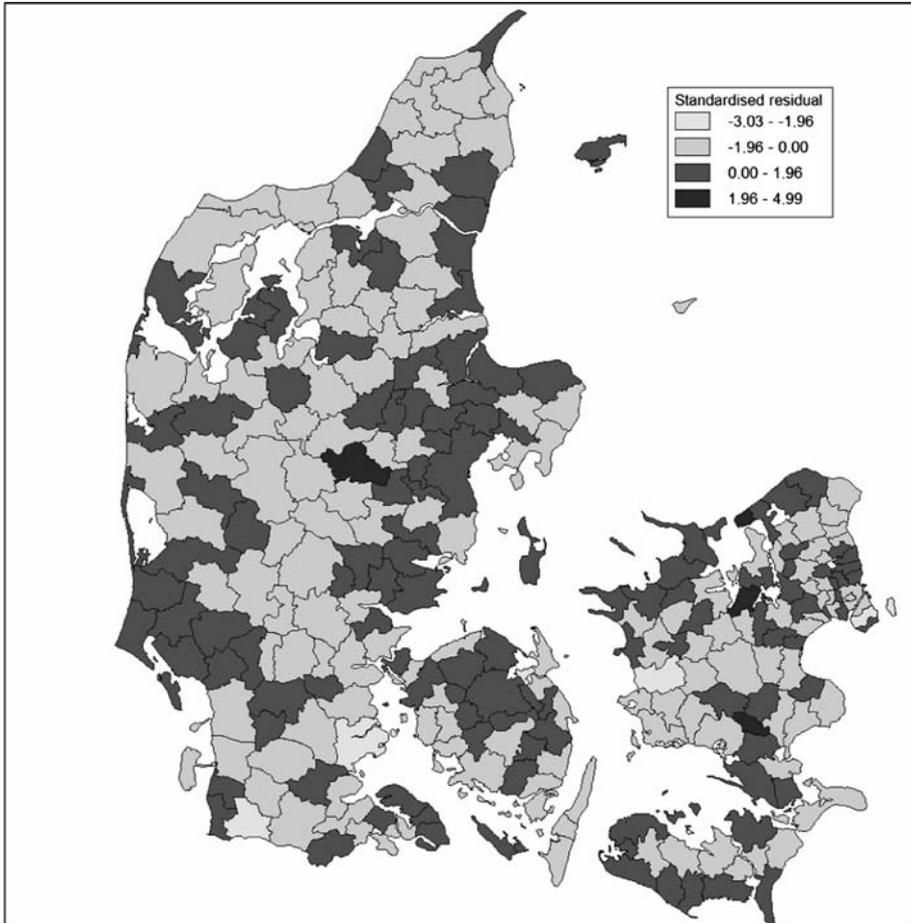
Fig. 4 Standardised residuals (average 1999–2004) by municipality

area. There, a significantly negative relationship is present, presumably expressing a common factor phenomenon; personal incomes are high in this area, which simultaneously enables the municipalities to maintain low tax rates and stimulate home ownership. The effect of income (measured by tax base) is insignificant throughout except for a cluster of municipalities in north-western Jutland, where the expected positive relationship is present. As the tax base is relatively low in this area (Lauridsen et al. 2006b), it seems to be the case that the tendency toward home ownership is dampened by low incomes. Considering congestion, the expected negative effect is present throughout with a few exceptions. Population density is insignificant in southern Zeeland, while urbanisation is significant in an east–west belt spanning the Capital area, northern Funen and middle-eastern Jutland, which contains the six largest Danish cities, and insignificant elsewhere, except for a small cluster in the very north of Jutland, where a positive relationship stands out. With respect to demographic composition, a somewhat mixed picture emerges. The proportion of 7–16-year-olds exerts a negative effect on home ownership in middle-eastern Jutland but is insignificant elsewhere. The negative effect of 17–25-year-olds is especially pronounced

outside middle-western Jutland and southern Zeeland. A more or less similar picture is seen for people aged 26–35 and 36–66 years, while the proportion of the elderly (67+) is significantly negative throughout, with the exception of two small clusters in the peripheral areas of western Jutland and southern Zeeland. Regarding household composition, a significantly positive relationship between the proportion of households with adult children and home ownership is seen in the predominantly rural areas of northern and western Jutland. The proportion of households without children under 18 is insignificant throughout, with the exception of a small cluster in the peripheral southern Zeeland, where a significantly positive relationship is present. The effects of social composition exert considerable geographical variation. Thus, a weakly significant effect of widowhood is seen in northern Jutland and Zeeland, while the effect of being divorced is significantly negative throughout, except for an insignificant belt along the peripheral west coast of Jutland. Being unmarried exerts the expected negative impact except for the area of Funen and some peripheral areas in northern and southern Jutland and southern Zeeland. Education is negatively related to home ownership around the Capital area and insignificant elsewhere, with the exception of a small cluster in southern Jutland, where a positive relationship is confirmed. The proportion of people on a social disability pension exerts a negative impact in the aforementioned east–west belt spanning the six largest cities but is insignificant elsewhere. A negative effect of the proportion of social benefit recipients is exerted in a large cluster spanning middle Jutland, northern Funen and the very westernmost part of Zeeland, while the effect is insignificant elsewhere. Whereas unemployment is largely insignificant, it is positively related to home ownership in northern Jutland. Presumably that is because, during the period of interest, this area experienced considerable outsourcing by large production companies, whereby many previously employed homeowners were simultaneously stuck with their houses and trapped in an area with few employment opportunities. Finally, the proportion of foreigners is significantly negatively related to home ownership throughout, with the exception of eastern and southern Zeeland and western Jutland.

As mentioned above, the insignificant spatial spillover parameter indicates that the spatial expansion seems to capture tendencies toward spatial spillover and spatial clustering well. This impression is confirmed by Fig. 4, which shows the standardised residuals by municipalities. With few exceptions, the standardised residual is within a reasonable band of +/− 1.96. Though there seem to be weak tendencies toward positive and negative clustering within this band, these tendencies are statistically and practically irrelevant.

6 Conclusions

While previous knowledge regarding the effects of determinants on home ownership is confirmed, it is revealed that considerable dynamics as well as geographical variation in these effects are present and should be accounted for in order to gain a deeper understanding of the functioning of important key determinants of the housing market. Thus, the expected negative effect of price is confirmed. It is found that this effect is strengthened over years in which prices rose steadily. But the effect is found to be significant for only a restricted geographical area spanning the Capital area, western Zeeland and Funen; particularly in peripheral areas, it is found to be insignificant. During the same period, short-term price change exerts an increasing negative impact on home ownership, but the effect becomes considerably more heterogeneous across geographical areas in the later years, and the effect seems to be less relevant for peripheral areas. While a positive effect of medium-

term price changes is confirmed for areas surrounding larger cities, the effect is found to decrease over the years, presumably reflecting uncertain expectations caused by a potential price bubble on the housing market. Regulation exerts the expected negative impact, but the effect seems to increase over the years for regulation in the form of cash payments. In contrast, the effects of applying supply-side regulation in the form of the supply of subsidised housing and the presence of rent regulation seem to decline. Geographically heterogeneous patterns of regulation effects are further revealed, with clear tendencies toward central-peripheral and urban-rural dispersions. Finally, the effects of taxations are weak and change only marginally through the years, whereby the geographical patterns of these effects indicate the distinctive geographical presence of common factors causing effects opposite to those expected.

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