Adaptation Investments and Homeownership

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Abstract

This paper develops a model in which ownership improves the efficiency of the housing market as it enhances the utility of housing consumption for some consumers. The model is based on an extended Hotelling-Lancaster utility approach where the ideal variant of housing is obtainable only by adapting the home through a supplementary investment. Ownership offers low costs of adaptation, but has high contract costs compared with renting. Consumers simultaneously decide housing demand and tenure, and because of the different cost structures only consumers with strong preferences for individual adaptation of the home choose homeownership. The paper analyzes the consumer's optimization. The model explains why homeowners typically live in bigger dwelling units than tenants, and why a high price on housing service tends to reduce homeownership rates.

1. Introduction

Housing is a dual good. On the one hand, the flow of services from housing capital generates utility and is consumed by households. On the other hand, residential capital represents an asset which households may include in their portfolio of wealth. Institutionally, the two goods are traded on separate markets. The flow of services from housing capital is traded on a rental market where tenants contract for use of residential capital during a period and pay rents to owners. Similarly, the stock of housing capital is traded on a market for residential capital.

In a free market economy with perfect foresight and absence of contracting costs, the consumer is in principle indifferent between owning or renting housing capital. However, these assumptions are not realistic and for at least four reasons the consumers may have opinions about whether to own or rent housing capital.

Firstly, consumers may include housing assets in their portfolio of wealth because of uncertainty. Because of its covariance with yields from other financial assets and human capital, housing capital may be considered a risky asset that allows consumers to improve the risk-return profile of their total portfolio and consumption flow. The seminal paper by Henderson and Ioannides (1983) on this aspect has been followed by a number of contributions; see e.g. the reference list of the paper by Ortalo-Magné and Rady (2002). Although this aspect is important for the housing market, it is equally important to emphasize that it does not explain why house owners generally choose to live in their own houses as homeowners[1]. Furthermore, the consumer may diversify his portfolio at the stock market and hence trade real estate assets indirectly. This allows the consumer to separate portfolio decisions from decisions about homeownership.

Secondly, homeownership typically has relevance because of institutional factors. In most countries income taxes incline consumers towards ownership of housing capital used for consumption. The reason is that implicit income (imputed rent) from owner-occupied residential capital is not taxed or taxed at a lower rate than other sources of

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[1] According to the U.S. Census Bureau, the difference between homeowner units and owner-occupied units consists of vacant for-sale-only homeowner units. The difference makes up less than 2 per cent of homeowner units and is therefore neglected in the following discussion.

income. If incomes are taxed under a progressive tax schedule, high income-earners are especially inclined towards owning housing capital for private consumption. This tax argument is used in several analyzes as a rationale for ownership; see e.g. Swan (1984). Imperfections on the capital market, persons' or households' financial capacity and/or rent control may also influence the choice between renting and owning residential capital for consumption; see the survey article about housing by Smith, Rosen and Fallis (1988) for these arguments.

Thirdly, Linneman (1986) invokes differences in production or cost efficiency between landlords and owner-occupiers as an important factor behind ownership rates. The housing costs include operating costs such as maintenance of the dwelling and the surrounding area. There may be both pecuniary and non pecuniary externalities for such activities in high density areas. A landlord who owns a multi-storey building is in a stronger bargaining position for negotiating contracts for maintenance than are individual home owners. Similarly with non-pecuniary externalities, e.g. related to cleaning of common facilities of a multi-storey building, coordination problems disappear with only one owner. Linneman concludes that high cost efficiency by landlords in high density residences is the reason why ownership rates tend to fall when one travels from the countryside and into city centers. However, cost efficiency from coordination or pooling may also be obtained by home owners if they organize in owner societies or other cooperation forms.

Fourthly, ownership matters in a world of contracting costs. For obvious reasons a rental contract of an asset only specifies a limited number of future eventualities and is in general incomplete, leaving the right to decide to the residual range of future outcomes to the owner. For the user of a complex asset it may therefore make sense to buy the asset in order to obtain the full decision right[2]. This basic point has been developed by Hart (1995) in his analysis of contracts and firms. Another aspect is the

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[2] On specific dimensions also owners may be limited in their use of the housing asset because of restricting covenants imposed to avoid negative externalities among owners, e.g. by regulating the exterior color of a house. The more restricting and widespread covenants are, the fewer will be the advantages of owning compared to renting. Nevertheless, restrictive covenants can raise the value of a home as they exclude future negative externalities inflicted on the home. The present paper does not deal with such externalities.

difference in contracting costs between tenants and owners. Tenants pay very modest contracting costs if any, whereas owners incur considerable costs to real estate agents, judicial assistance, duties and borrowing costs.

The purpose of this paper is to present a model where ownership of housing capital matters for the consumer of housing service because of incomplete and costly contracts. The model incorporates contracting costs and combines them with a Lancaster (1979) type of consumer of individual 'ideal' variants of housing services. Furthermore, the model assumes that the utility of the ideal variant (preference for specificity) varies among consumers. To give an example, a consumer may find the color on a wall very important: A light red color may be the ideal variant and other colors like white or yellow etc. may reduce the utility from living in the room markedly. For other consumers who have the same preferences for light red, the issue is less important and hence the utility they get from the ideal variant is smaller. Yet, other consumers may be close to completely indifferent as long as the color is not black, which indicates that the utility they get from the ideal variant compared to nearly any other variant is minuscule. Other important aspects of the complex good housing consumption are the design of the kitchen, bathrooms, choice of furniture, cultivation of the garden etc.[3]

The model illustrates the consumer's optimization with respect to the twin choices of tenureship and supplementary investments to achieve the ideal variant. The choice depends on the consumer's preferences, investment costs, and contract and transaction costs for alternative tenureships. Consumers are sorted into two groups; homeowners and tenants. The analysis shows how consumers who choose to be homeowners increase their utility compared to the utility they can obtain if only a rental market existed. Hence, ownership matters for welfare. The model also predicts that homeowners, who live in bigger homes, are more seriously affected by high housing costs and, hence, an increase in the price of housing service tends to reduce

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[3] To some extent this specification of preferences is similar to the assumptions in the migration analysis of Sinn (2000), who assumes that workers can be ranked according to the disutility they incur when migrating from their home country to work in another country. According to a survey by Byforum (2001) nearly 90 per cent of Danish homeowners and those who want homeownership point to the ability to freely dispose over the home and its surroundings as a very important reason for choosing homeownership. A good 70 per cent also stress financial considerations as very important.

homeownership rates. If tenants are allowed to make adaptation investments they invest less than owners, and finally, congested areas tend to have higher prices on housing service and lower proportions of homeowners.

An important implication of the model is that homeowners typically demand and live in bigger dwelling units because they get higher utility from their ideal housing variant. This pattern is corroborated by evidence from the Danish housing market; see Table 1, which shows a logit regression on a random sample of 278,738 Danish homes. The regressed equation is

$$own = \beta_0 + \beta_1 sqm + \beta_2 y + \beta_3 sem + \beta_4 sem(y - \bar{y}) + \beta_5 det + \beta_6 det(y - \bar{y}) + \beta_7 self + \beta_8 self(y - \bar{y})$$

Where *own* is a binary variable for ownership, *sqm* is the number of housing square meters, *y* is the total household labor income, $\bar{y}$ is the mean of *y*, *sem* is a binary variable for semi-detached dwelling, *det* is a binary variable for detached dwelling (the third possible category is attached), and *self* is a binary variable for self employed members in the household.

Table 1: Logit regression of owner versus renter

Variable	Coefficients	Mean value	Min value	Max value
intercept	-2.96***			
sqm	0.01***	111.8	16	4851
y	1.56e-06***	449,819	1	1.03e+07
sem	1.16***	0.12	0	1
$sem(y - \bar{y})$	-1.21e-07***	-7,794	-506,248	6,312,949
det	3.45***	0.47	0	1
$det(y - \bar{y})$	-3.21e-07***	36,356	-506,247	9,764,208
self	0.14***	0.09	0	1
$self(y - \bar{y})$	-1.16e-06***	-1,637	-506,249	9,764,208

Notes: Income *y* is only labor income. To avoid erroneous observations, only households with positive labor income have been included in the regression. Besides this, a number of "non-ordinary" households like old age institutions, student dormitories etc. have been excluded. The sample covers app. 20 per cent of the relevant types of dwellings. Significance at the 1% level is indicated by ***.
Source: A sample of Danish dwellings per 1 January 2004 randomly picked from register data.

Because the regression uses logistic values of the variables, the size of the coefficients cannot be interpreted directly. However, bigger homes in terms of square meters and

ownership probability go hand in hand. Also as expected, higher household income increases ownership probability. Furthermore, from attached to semi-detached dwellings (setting *sem* = 1) ownership probability clearly increases. However, as shown by the coefficient β_4, part of the income sensitivity disappears for those living in semi-detached dwellings. A similar picture is revealed among households in detached dwellings (setting *det* = 1). Here the probability of homeownership rises even further. Finally, the probability of homeownership is high for households with self employed members, and income sensitivity nearly disappears for these households. This last observation may indicate that self employed persons attach very high value to being in power of their own home.

The paper is organized as follows. Section 2 presents the basic models of residential demand in the simple case where the adaptation costs per square meter is exogenously given. Section 3 generalizes the model by introducing endogenous supplementary investments where the consumer chooses the optimal level of adaptation investments per square meter. Section 4 analyzes market equilibrium based on the demand function derived in section 2. Finally, section 5 concludes.

2. A model for residential demand

The consumer chooses between two composite goods: housing service from a residential unit and a composite good for all other goods. *Housing service* is assumed measurable in units of *square meters per year*, i.e. a variable which counts the volume of the flow good residential living. The service from housing might be enhanced by adapting the housing capital to the consumer's ideal variant by making a supplementary investment. The consumer holds the residential unit either as a tenant or as an owner. It is assumed that the consumer demands and gets only one *dwelling unit* consisting of the demanded number of square meters per year on the market, and that functions are not disturbed by discontinuities caused by minimum renting times, house and apartment sizes etc. In the following sections, *home* will be used synonymously with *dwelling unit*.

The preferences of each consumer belong to the same class of preference functions. The *i*'th consumer's utility is given by the linear-quadratic utility function

$$U_i = (\alpha + y_i)x_i - \frac{x_i^2}{2} + z_i, \quad 0 < \alpha, \tag{1}$$

where x_i is the consumer's housing consumption in terms of square meters per year, z_i his consumption of all other goods per year in units with a price equal to one and α is a fixed parameter. y_i is a binary variable which specifies the utility impact of adaptation of the dwelling to the consumers specific taste, i.e. y_i is 0 when no adaptation takes place, but is equal to the consumer specific preference parameter γ_i when the consumer makes adaptation investments[4]. The parameter γ_i is exogenously given for each consumer; it may come from a genetic code, but could also be influenced by living conditions during childhood etc. Marginal utility[5] with respect to housing consumption is a linearly decreasing function of the number of square meters per year x_i, but the intercept increases by γ_i if the consumer invest, i.e.:

$$\frac{\partial U_i}{\partial x_i} = \alpha + y_i - x_i. \tag{2}$$

The costs of housing consumption consist of three types. First, the consumer pays a rent r per standard square meter, i.e. the rent per year before adaptation of the dwelling. Institutional factors like income taxation, rent controls etc. are assumed away so that rent (for tenants) and user costs (for owners) are identical. Hence in the following, an increase of the rent does not signify an increase in the relative costs of renting versus owning, but an increase in the price of housing service compared to a composite price index for all other goods and services in the consumption basket. The second type of

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[4] In an analysis of housing by Black et al. (2002) a Stone-Geary utility function is introduced with a parameter for heterogeneity of the individual consumer's preferences. The analysis of Black et al. is related to the location of the population between two cities, whereas this paper focuses on the allocation between owners and tenants.

[5] The preference function implies zero income elasticity. This may seem strange, but the function is convenient for illustrating effects that stem solely from differences in individual utility from housing services. Moreover, income effects from changes in the price of housing service may be ambiguous, because the price of housing service translates into the asset value of housing capital. This more or less neutralizes the income effects for homeowners and partly also for tenants as they may be indirect homeowners through pension funds.

cost is adaptation costs which the consumer might or might not have incurred because of a supplementary investment. Adaptation costs are partly related to the size of the dwelling, e.g. painting, wall paper and carpets, and are partly independent of the size of the dwelling, e.g. kitchen and bathroom renovation. The third type of cost is the contracting costs of acquiring the dwelling. They consist both of the open costs for the contract setting, e.g. real estate agent fees, judicial assistance and duties, and of the opportunity costs reflecting the consumer's use of time to figure out the contract conditions. Also these costs have elements related to the size of the dwelling as well as fixed elements.

Basically the cost structure depends on the consumer's choice between renting and buying. It is impossible, or at least relatively difficult, to recoup the adaptations costs if the consumer chooses to rent the dwelling. The reason is that the contractual counterpart, the owner of a multi-storey building, in general is unwilling to accept any obligation to repay the tenant fully or partly for the costs of twisting the dwelling to the tenant's specific preferences. On the other hand, the contract cost is relatively low if the consumer rents the dwelling. The following model formalizes the trade off between adaptation costs and contract costs. To keep the analysis simple in the first version of the model, it is assumed that the annualized costs per square meter of adapting the dwelling are exogenously given. This assumption will be generalized later in the paper. The annual adaptation costs per square meter is κ for tenants and $\beta\kappa$ for owners, where $0 < \beta < 1$. This reflects that supplementary investments are more costly for tenants because landlords typically want apartments to be in "standard" condition when they are re-let. For homeowner dwellings, "standard" is an averagely adapted dwelling, which the new owner adapts to his specific preferences. A second simplifying assumption is that contract costs are independent of the size of the dwelling and zero for tenants, but positive for owners. The annualized contract costs for owners are specified by the parameter σ. This captures the point that contract costs are less sensitive to the size of the dwelling compared with supplementary investment costs and that contract costs are more important in case of ownership.

The consumer faces two basic choices. One is between renting and owning. The other is to make or not to make a supplementary investment. This leaves four possible outcomes. However, the choice of taking ownership and not making a supplementary

investment is cost inefficient and hence inferior in all situations as the consumer incurs unnecessary contracting costs. Notice here that imperfections on the capital markets as well as uncertainty are disregarded. Without these assumptions speculative considerations on return on assets may give a rationale for ownership even for consumers without intension of making a supplementary investment in the dwelling.

Figure 1: Alternative housing demand curves for the individual consumer
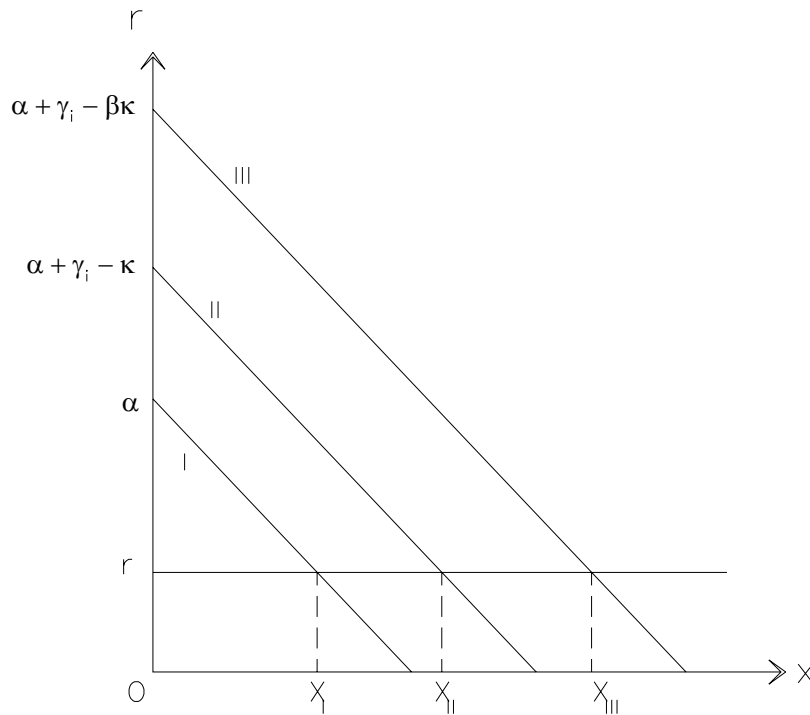
With the above elements introduced and a consumer income of I, the consumer's budget restriction[6] is $I \geq (rx + z)$ for a consumer acting as non-investing tenant, $I \geq ((r + \kappa)x + z)$ for a consumer acting as investing tenant, and $I \geq ((r + \beta\kappa)x + z - \sigma)$ for a consumer acting as owner. Maximizing utility[7] as specified in (1) subject to the restriction leads to the following demand functions for the three positions:

$$x = \alpha - r. \qquad\qquad (4a)$$

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[6] The subscript i is hereafter omitted for x, z and I to ease the notation.

[7] I.e. in the case of ownership, maximizing $L = (\alpha + \gamma_i)x - \dfrac{x^2}{2} + z - \lambda(I - (r + \beta\kappa)x - \sigma - z)$ with respect to x and z gives the demand function (4c).

$$x = \alpha + \gamma_i - \kappa - r. \tag{4b}$$

$$x = \alpha + \gamma_i - \beta\kappa - r. \tag{4c}$$

The consumers demand curves with respect to r for the three alternative options are illustrated in Figure 1.

It is assumed that $r < \alpha$, which secures all consumers have a dwelling. Note, that adaptation investment is associated with larger housing consumption, because investment raises marginal utility of housing consumption. Finally, consumers housing demand is larger when the consumer owns the dwelling compared with renting and investing because marginal costs of investment are lower in case of ownership.

The consumer chooses the option which offers the largest consumer surplus CS defined as total utility from housing minus the forsaken consumption of other goods and services due to payment of rents and annualized adaptation and contracting costs. From (1) and the assumptions about costs consumer surplus net of contracting costs for the three options appears to be: $(\alpha x - x^2/2 - rx)$, $((\alpha + \gamma_i) x - x^2/2 - (r + \kappa) x)$, and $((\alpha + \gamma_i) x - x^2/2 - (r + \beta\kappa) x - \sigma)$, respectively. Substituting x by using (4a)-(4c) gives

$$CS^t = (\alpha - r)^2 / 2, \tag{5a}$$

$$CS^{at} = (\alpha + \gamma_i - \kappa - r)^2 / 2, \tag{5b}$$

$$CS^{ao} = \frac{(\alpha + \gamma_i - \beta\kappa - r)^2}{2} - \sigma, \tag{5c}$$

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where CS^t is consumer surplus for the option of being a non-investing tenant, CS^{at} for the option of being an investing (and adapting) tenant and finally, CS^{ao} is consumer surplus in case the consumer chooses to own and adapt his dwelling[8].

Figure 2 illustrates CS as function of the consumer's preference parameter γ_i. Consumers are distributed along the horizontal axis according to their γ_i. CS^t is independent of γ_i while CS^{at} and CS^{ao} both increase with γ_i at an increasing rate. CS^{ao} increases at a faster rate than CS^{at} with respect to γ_i, but from a lower level[9]. The intuition behind this is that higher γ_i is associated with larger housing demand and this especially benefits owners because of lower adaptation costs per square meter; but on the other hand owners are burdened by high fixed contract costs.

The option which offers the largest net utility is illustrated in Figure 2 by the thick curve. With all three types of consumers on the market those with the low γ_i choose to rent without adaptation investments. If $\gamma_i > \kappa$ the option to rent and invest is superior to the option to rent without investing, see (5a) and (5b). For very large γ_i, the option to buy is superior to the option to rent and invest. To find the marginal owner who is indifferent between renting and adapting or buying, i.e. the consumer with the preference parameter γ' in Figure 2, set

$$CS^{ao} = CS^{at}$$

and solve for γ to get[10]

$$\gamma' = \frac{\sigma}{(1-\beta)\kappa} + \frac{1+\beta}{2}\kappa - (\alpha - r). \qquad (6)$$

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[8] The formulas only hold for non-negative values of consumer surplus. A non-investing tenant obtains non-negative consumer surplus for $(\alpha - r) \geq 0$, which previously has been assumed. For the investing tenant non-negative consumer surplus demands that $\gamma_i \geq \kappa - (\alpha - r)$ and for owners the demand is that $\gamma_i \geq \beta\kappa - (\alpha - r) + (2\sigma)^{0.5}$. For large values of κ (and σ) only consumers with a strong preference for adaptation might consider the option to rent and invest (or to own and invest).

[9] For the shape of the curves for CS^{at} and CS^{ao}, note that $\partial CS^{ao}/\partial\gamma_i = \alpha + \gamma_i - \beta\kappa - r > \partial CS^{at}/\partial\gamma_i = \alpha + \gamma_i - \kappa - r$, and that $\partial C^2 S^{at}/\partial\gamma_i^2 = \partial C^2 S^{ao}/\partial\gamma_i^2 = 1 > 0$.

[10] The sign of the first order derivatives of γ' are: $\gamma'_\sigma > 0$, $\gamma'_r > 0$, $\gamma'_\alpha < 0$, $\gamma'_\beta > 0$ and $\gamma'_\kappa < 0$ for $\kappa < (2\sigma/(1-\beta^2))^{0.5}$, $\gamma'_\kappa > 0$ for $\kappa > (2\sigma/(1-\beta^2))^{0.5}$.

In some cases of relatively low contract cost ownership is superior for all investing consumers and, hence, for increasing γ_i consumers will jump directly from non-investing tenants into ownership. This case appears when CS^{ao} curve illustrated by the dashed curve in Figure 2 cuts the CS^t curve for $\gamma = \gamma'' < \kappa$ where γ'' is determined by[11]:

$$CS^{ao} = CS^t.$$

Figure 2: Net utility from housing consumption
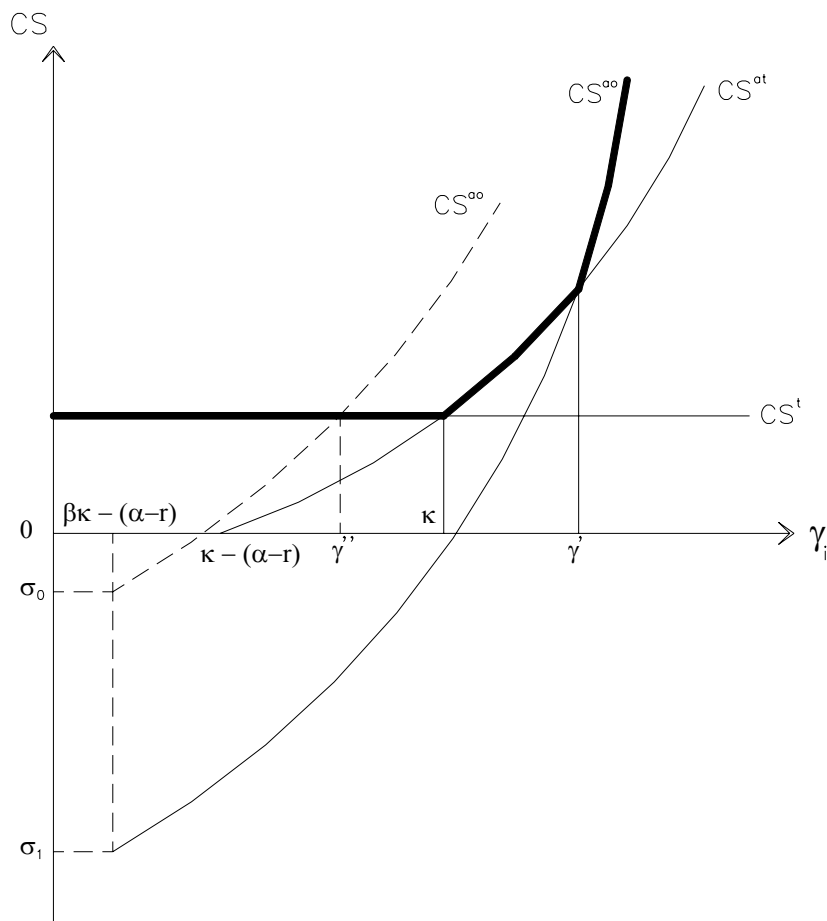
Clearly, low contracting costs σ and large owner cost advantage on adaptation investments, i.e. a small β, reduces γ' and so increases the *homeownership rate*, i.e. the

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[11] Solving for γ gives $\gamma'' = - (\alpha - r) + ((\alpha - r)^2 + 2\sigma)^{0.5} + \beta\kappa$ where $\gamma''_\sigma > 0$, $\gamma''_r > 0$, $\gamma''_\alpha < 0$, $\gamma''_\beta > 0$, and $\gamma''_\kappa > 0$. Using the condition $\gamma'' < \kappa$, gives $\sigma < (1-\beta)^2\kappa^2/2 + (\alpha - r)(1-\beta)\kappa$, i.e. the absence of investing tenants appears when contract costs are relatively low and/or the cost advantage of owners for making supplementary investment is relatively large (small values of β). As for the case shown in the main text, an increase in r increases γ'': $\gamma''_r = 1 - (\alpha - r)((\alpha - r)^2 + 2\sigma)^{-0.5} > 0$.

fraction of consumers with preference parameter above γ'. Also a change of the relative price on housing service r influences the homeownership rate, which leads to the following proposition.

Proposition 1: An increase in the price of housing relative to other consumer prices reduces the homeownership rate.

Proposition 1 also holds for the case without investing tenants on the market as shown in footnote 11. In their study of price variations between metropolitan areas Blackley and Follain (1988) find homeownership rates are negatively correlated with both housing prices and rents for tenants. They are puzzled by coefficients showing that increasing rents for tenants tends to reduce the homeownership rate. But as predicted in proposition 1, an increase in the general price level for housing service reduces homeownership rates. Malpezzi presents similar results in his 1996 study of price variations between metropolitan areas. Specifically, he finds that regulations which limit housing supply raise house values and rent for letting and lead to a reduction of the homeownership rate.

Figure 3: Housing space demand by individual consumers
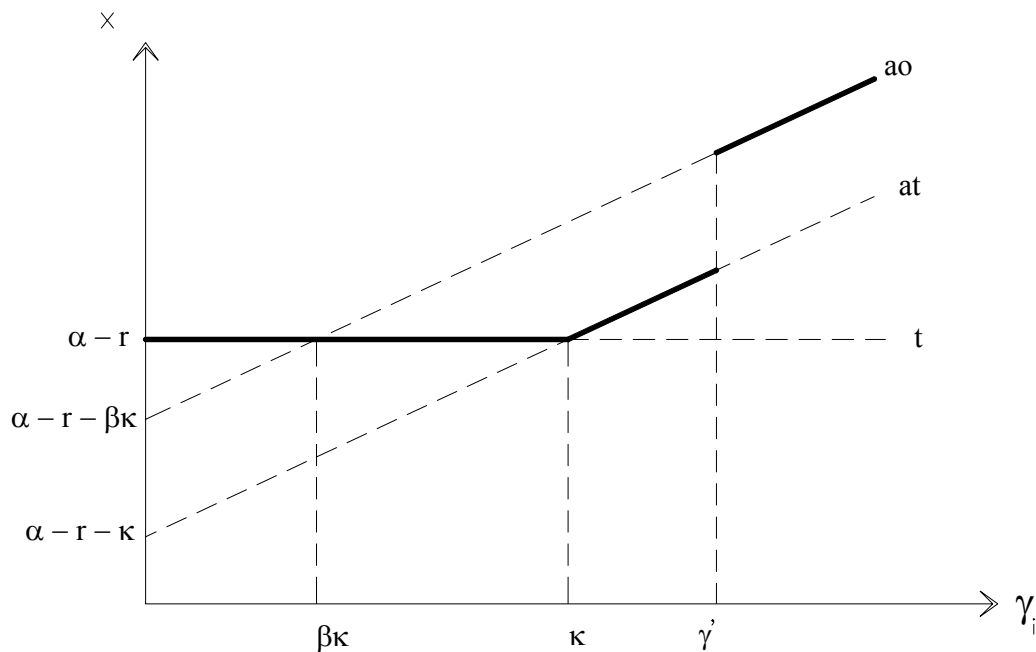
More insight can be gained from Figure 3, which, using equations (4a) to (4c), depicts the demand for housing square meters as a function of the preference parameter γ_i. The schedules *t*, *at*, and *ao* are for consumers who prefer to rent without investing, rent and invest, and buy and invest, respectively.

Notice the discontinuity of housing demand when the preference for adaptation passes the threshold value of γ' above which the consumer prefers ownership. The jump in housing demand for the consumer who buys the dwelling follows from the drop in investment costs per square meter when he goes from renting to ownership.

Proposition 2: Homeowners occupy bigger dwellings than investing tenants and investing tenants occupy bigger dwellings than non-investing tenants.

The proposition is nicely illustrated in Figure 3. The reason is that investment enhances the marginal utility of housing consumption, and those who invest therefore demand more housing units. As the group of owners has a larger marginal utility from adaptation and lower marginal investment costs, they demand more housing space than investing tenants. As shown in section 1, the evidence of Tables 1 and 2 seems to support proposition 2 by showing significantly bigger homes for homeowners compared to tenants.

3. Tenure choices with endogenous size of adaptation investments

As an extension of the utility function (1) the utility that consumers get from adaptation may depend on the size of investments per square meter. In the following discussion it is assumed that γ_i increases at a decreasing rate with respect to the size of adaptation investments per square meter, i.e. γ_i in (1) is given by

$$\gamma_i = \varphi_i \kappa_i^{\varepsilon}; \quad 0 < \varepsilon < 1, \; 0 < \varphi_i, \tag{7}$$

where the individual consumer *i* is now characterized by the size of the parameter φ_i. ε, a parameter common for all consumers, indicates the elasticity of marginal utility with respect to housing investments κ per square meter.

Inserting (7) in (5) gives the utility from housing consumption or net consumer surplus

$$CS^{at} = \frac{(\alpha + \varphi_i \kappa_i^{\varepsilon} - r - \kappa_i)^2}{2}, \tag{5b*}$$

$$CS^{ao} = \frac{(\alpha + \varphi_i \kappa_i^{\varepsilon} - r - \beta \kappa_i)^2}{2} - \sigma. \tag{5c*}$$

Maximizing CS_i with respect to κ_i gives the following optimal size of adaptation investments

$$\kappa_i^{at}* = \left(\varphi_i \varepsilon\right)^{\frac{1}{1-\varepsilon}}, \tag{8b}$$

$$\kappa_i^{ao}* = \left(\frac{\varphi_i \varepsilon}{\beta}\right)^{\frac{1}{1-\varepsilon}}. \tag{8c}$$

Proposition 3: If the size of adaptation investments is allowed to vary, tenants invest less than owners because of higher investment costs.

Equation (8) shows[12], with $\beta < 1$ for owners, that ownership induces consumers to invest more because of the difference in costs. Higher utility from adaptation investments φ_i naturally also gives rise to higher investments.

Inserting (8b) and (8c) in (5b*) and (5c*), respectively, gives the maximum utility from housing with endogenous investments $CS*$. As before, the marginal owner is found by setting the net utility of the investing tenant equal to the net utility from ownership, i.e.

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[12] Similar to the simple case, see footnote 7, only non-negative values of consumer surplus are relevant. It follows from (5b*) that consumer surplus is non-negative for tenants if $(\alpha - r) \geq 0$. For owners the restriction follows by inserting (8c) into (5c*), which leads to the condition $\varphi \geq \beta^{\varepsilon}((2\sigma)^{1/2} - (\alpha - r)^{1-\varepsilon}/\varepsilon^{\varepsilon}(1 - \varepsilon)^{1-\varepsilon})$.

$$CS^{ao}* = CS^{at}*,$$

which now determines φ' and hence κ' and γ'. In the appendix it is shown that the difference $CS^{ao}* - CS^{at}*$ increases in φ so that owners are found among consumers with high utility from adaptation investments and, hence, consumers with $\varphi_i > \varphi'$ become owners. Figure 4 shows optimal adaptation investments $\kappa*$ as a function of the consumer preference parameter φ.

As can be seen in the figure and from equations (8b) and (8c) a jump in investments takes place for the marginal consumer when he leaves the tenant position and buys his home taking advantage of the lower investment costs. Being at the margin, he is indifferent between renting the home with a modest adaptation investment and owning it with a bigger investment. A fourth proposition can be stated.

Proposition 4: When tenants become owners they increase adaptation investments.

Figure 4: Endogenous size of adaptation investments
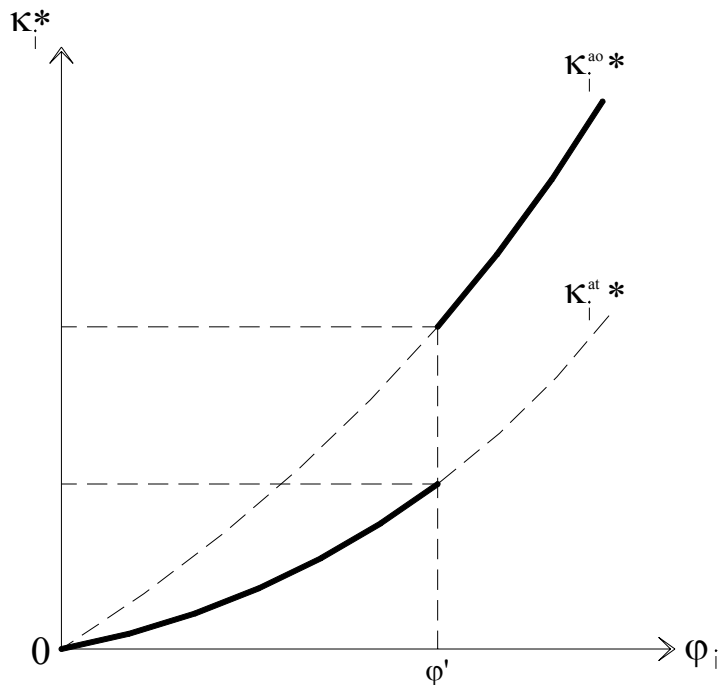
As for γ_i in equation (1), φ_i in equation (7) is exogenously given. However, some tenants will choose to become owners if the cost advantage for adaptation investments

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for owners increases (β is reduced) and/or if the cost of acquiring homeownership (σ) falls. φ' will be reduced and the homeownership rate will increase in both cases.

4. Market equilibrium, congestion and homeownership rates

In the previous sections, the individual consumers' housing choice is analyzed for given prices in the residential market. This section turns the analysis to the market level where market supply of residential units X^s equals market demand X^d in equilibrium.

To derive market demand X^d the simple model of section 2 is applied, i.e. it is assumed that in case of adaptation the invested amount κ per square meter is exogenously given. Furthermore, we look at the case where the parameters allow for both non-investing and investing tenants i.e. $\gamma' > \kappa$. Finally, it is assumed that the total number of consumers or households N is uniformly distributed by the preference parameter γ_i, over the interval $[0;\delta]$, i.e. the density of consumers in the interval is N/δ.

The market demand for housing square meters is then given by:

$$X^d = \frac{N}{\delta}\left[\int_0^\kappa (\alpha - r)d\gamma + \int_\kappa^{\gamma'} (\alpha - r + \gamma - \kappa)d\gamma + \int_{\gamma'}^\delta (\alpha - r + \gamma - \beta\kappa)d\gamma\right], \tag{9}$$

which after solving gives the following demand function:

$$X^d = \frac{N}{\delta}\left(\Omega - \left[(1-\beta)\kappa + \delta\right]r\right), \tag{10}$$

where $\Omega = \alpha(\delta + (1-\beta)\kappa) + (\delta - \beta\kappa)^2/2 - \sigma$.

The market demand is negatively sloped with respect to r as $0 < \beta < 1$. Furthermore, market demand varies proportionately to the total number of consumers or households for given parameters and rent.

The supply of residential units is perfectly elastic with respect to r, i.e. r is exogenously given, if all resources, including land, are fully available without scarcities. In this case

the supply of housing square meters varies proportionately with the number of consumers. All structures, including the homeownership rate, on the residential market are in this case unaffected by the change in the number of consumers. However, if the supply is less than perfectly elastic with respect to r, an increase of the density of consumers will translate into higher rent, reflecting a higher level of congestion. In this case, the higher rent (and user costs) reduces the homeownership rate and proposition 1 therefore transforms to proposition 5.

Proposition 5: Congested areas tend to have higher prices on housing service and hence lower homeownership rates.

Notice, however, that high population growth pushes up the prices on housing service, which may induce speculative considerations by consumers on the return on housing assets. This may give another rationale for homeownership and drive up rates. This phenomenon could to be present in the paper by Blackley and Follain (1988) where high homeownership rates are found in metropolitan areas with high population growth rates combined with a negative effect on the rate from housing prices.

5. Concluding remarks

In the seminal paper by Lancaster (1979) on monopolistic competition the menu of product variants is exogenously given at the consumer level and hence the market will only offer the consumer his ideal variant by chance. This perception of an ideal variant also applies to housing. However, as housing services represents a unique bundle of characteristics, it is assumed in this paper that the residential capital has to be adapted through an investment if the consumer wants to realize the ideal variant. This gives the consumer a rationale for ownership as it minimizes the cost of adapting the housing capital. This rationale for ownership might also apply for other durable consumer goods such as cars or leisure boats.

The possibility to adapt the housing capital (or other durable consumer goods) through an investment increases the utility of the good for consumers with a strong preference for realizing their ideal variant of the good. Ownership makes it cheaper for the consumer to adapt the housing capital to the ideal variant and, hence, allowing for

ownership improves welfare. Furthermore, the model shows that an increase in the price of housing service relative to other consumer prices reduces the homeownership rate, that homeowners occupy bigger dwelling units than tenants, that when tenants are allowed to make adaptation investments they invest less than owners, and finally, that congested areas tend to have higher prices on housing service and lower rates of homeowners.

Appendix

Endogenous adaptation investments

In section 3 the size of adaptation investments is endogenous. Inserting (8b) into (5b) and (8c) into (5c) gives

$$CS^{at}* = \frac{1}{2}\left(\alpha - r + \varphi(\varphi\varepsilon)^{\frac{\varepsilon}{1-\varepsilon}} - (\varphi\varepsilon)^{\frac{1}{1-\varepsilon}} \right)^2, \tag{A2b}$$

$$CS^{ao}* = \frac{1}{2}\left(\alpha - r + \varphi(\frac{\varphi\varepsilon}{\beta})^{\frac{\varepsilon}{1-\varepsilon}} - \beta(\frac{\varphi\varepsilon}{\beta})^{\frac{1}{1-\varepsilon}} \right)^2 - \sigma, \tag{A2c}$$

with $\dfrac{\partial CS^{at}*}{\partial\varphi} = x^{at}(\varphi\varepsilon)^{\frac{\varepsilon}{1-\varepsilon}}$ and $\dfrac{\partial CS^{ao}*}{\partial\varphi} = x^{ao}(\frac{\varphi\varepsilon}{\beta})^{\frac{\varepsilon}{1-\varepsilon}}$.

Thus, $DIF = CS*^{ao} - CS*^{at}$ has the derivative

$$\frac{\partial DIF}{\partial\varphi} = x^{ao}(\frac{\varphi\varepsilon}{\beta})^{\frac{\varepsilon}{1-\varepsilon}} - x^t(\varphi\varepsilon)^{\frac{\varepsilon}{1-\varepsilon}} > x^{at}\left[(\frac{\varphi\varepsilon}{\beta})^{\frac{\varepsilon}{1-\varepsilon}} - (\varphi\varepsilon)^{\frac{\varepsilon}{1-\varepsilon}} \right] > 0.$$

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