Real estate ownership and the demand for cars in Denmark

- A pseudo-panel analysis

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Abstract

This paper examines how real estate ownership, increasing real estate values and the falling interest rates affect car demand. It uses data from the Danish Transport Diary Survey together with data from Statistics Denmark to estimate a simple partial adjustment model for car availability in Danish households. We find that car availability differs among households owning real estate and households not owning real estate. Furthermore we show that both households groups have increased their demand for cars due to the falling interest rate.

1. Introduction

The modeling and forecasting of car availability is often based on cross section data in a discrete model setting (e.g. logit or probit) where it is assumed that the parameters estimated remain constant over time. There are two underlying assumptions behind this. The first is that that the economy is in equilibrium. The other is that observed differences in consumption between, e.g., a high income person and a low income person is a valid description of what would happen if a low income person suddenly received the same income as the high income person, all other things being equal. Both these assumptions are probably not valid. What is needed is a dynamic model which explicitly takes account of this and recent models (e.g. Dargay and Vythoulkas (1999) and Fosgerau et al. (2004)) use this kind of specification.

Ideally, time series data should be used but since these are rarely available in the transport sector and since many cross section data exist the simpler approach of cross-section modeling is often adopted. The use of pseudo-panel data is an attempt to circumvent some of the shortcomings of the cross-sectional data and use the strength of the time series analysis. Deaton (1985) shows that it is possible to create panel data from repeated cross-section data named pseudo-panel data. He show that by using a characteristic that is invariant over time for given household types (e.g. year of birth) it is possible to create a pseudo panel describing average behavior for the household type in question. The pseudo panel approach also allows for the inclusion of macro variables which might affect both the transport behavior (e.g. number of kilometers traveled) and the demand for transport vehicles (e.g. cars).

The approach suggested by Deaton has since been utilized in a number of papers. The estimation of dynamic car ownership models is undertaken in Dargay and Vythoulkas (1999) where the UK Family Expenditure Survey was used. They demonstrate that the method can be applied giving satisfactory results when it comes to describe the dynamics of transport

behavior. They also show that there are large differences between short and long run elasticities with the latter being three times bigger than the former. Birkeland et al. (2000) use the Danish Tranport Diary Survey data in a pseudo panel analysis of personal transport in Denmark. They identify cohort effects and life-cycle effects and they compare income elasticities estimated by simple cross-section analysis with those found by the use of pseudo panel data concluding that the two approaches yield very different results. They conclude that pseudo panel methods are preferable when predicting future demand for transport. In Dargay (2001) the approach is used to show that hysteresis effects are present for car ownership. She shows that the elasticities with regard to rising income were higher than the elasticities for falling income. This hysteresis shows that a car after it is purchased becomes a necessity which is not easily disposed of. The approach was later used in Dargay (2002) to show that there are important differences in the elasticities between rural and urban households.

In Denmark the real estate values have increased steadily and at very high rates since 1993 and at the same time the long term interest rate has dropped from around 10% to around 5%. This is shown in figure 1 and figure 2.

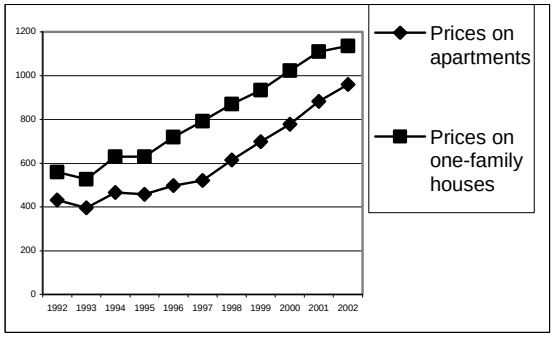

Figure 1: Real estate prices (1.000 DKr.)

Source: Statistics Denmark

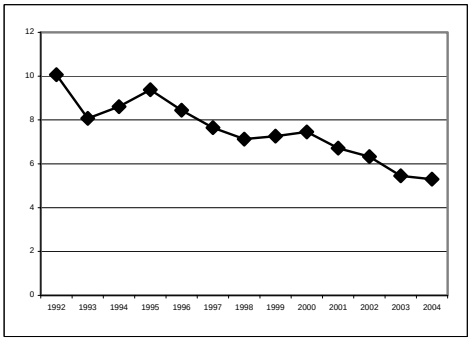

Figure 2: Interest on 30-years bonds

Source: Statistics Denmark

Households already owning real estate could (after a few years) capitalize wealth without increasing monthly mortgage payments due to the fall in the long term interest rate. Such an increase in wealth could increase the number of cars in households. For households entering the real estate market the effect is less clear. The fact that the real estate value increases will make it more expensive to purchase a house or an apartment and the mortgage payments will go up. The decreasing interest rate will counter this by reducing the mortgage payments. If the first effect dominates the households will have less income available for consumption which will reduce the number of cars. If the latter effect dominates the mortgage payments will go down and the household will have more income available for consumption which could increase the number of cars in the households.

Since the interest rate is the same for all households in the country we examine real estate owners and non-real estate owners separately. This enables us to see if the changing real estate prices and the changing interest rate has affected the two groups differently. Our expectation is that the falling interest rate could affect both groups but the increasing real estate values only affect the real estate owners. One problem is that the interest rate and the housing prices are correlated and that non-real estate owners may be more capital restricted than real estate owners. If this capital restriction is strong we expect that the interest rate has affected the real estate owners more and may even have had no effect on non real estate owners.

This paper utilizes the Danish Transport Diary Survey together with data from Statistics Denmark to create a pseudo-panel data set for the Danish population based on the year of birth for the interviewee. It examines how real estate ownership and a falling interest rate affect cars available in Danish households and to what extends these households differ with regards to income elasticities. The paper extends the findings in previous studies by looking at the differences between real estate owners and non-real estate owners thus providing more insight into the behavior of different household groups.

The paper proceeds as follows. Section 2 discusses the data and the construction of the pseudo-panel. Section 3 sets up the model and section 4 contains estimates and discussions as well as elasticities. Section 5 concludes.

2. The pseudo-panel data

The data utilized in the present paper come from two sources, the Danish Transport Diary Survey (DTDS) and Statistics Denmark (SD). The people participating in the DTDS are selected by random draw from the Danish Central Personal Registry (CPR). Data concerning the individual as well as the household is collected and the travel pattern for a single day for the interviewee is recorded. In the years 1992 to 1997 a monthly sample of 1800 was drawn for people between the age of 16 and 74. In 1998 this was extended to 2100 and the age group was extended to 10 to 84. The response rate in the survey is about 65-70%. The variables included in the present analysis are after-tax income, number of adult household members, degree of urbanization (living in a major Danish city or not), car availability (how many cars the household has access to), and information about whether the household owns real estate. Due to data limitations on certain variables the sample used here is restricted to the years 1996 to 2002.

Car availability includes both ownership of cars and other cars which the household can use for personal transport. Car availability is calculated as the total number of cars available to the households divided by the number of households for every cohort year. These are shown in figure 3 and figure 4 where the car availability for different cohorts over time according to age is shown. Figure 3 shows the cohorts for households living in owner-occupied houses and figure 4 shows the cohorts for households renting their home. It is clear from these figures

that there is a huge difference not only between households living in cities and on the countryside but also between real estate owning households and others.

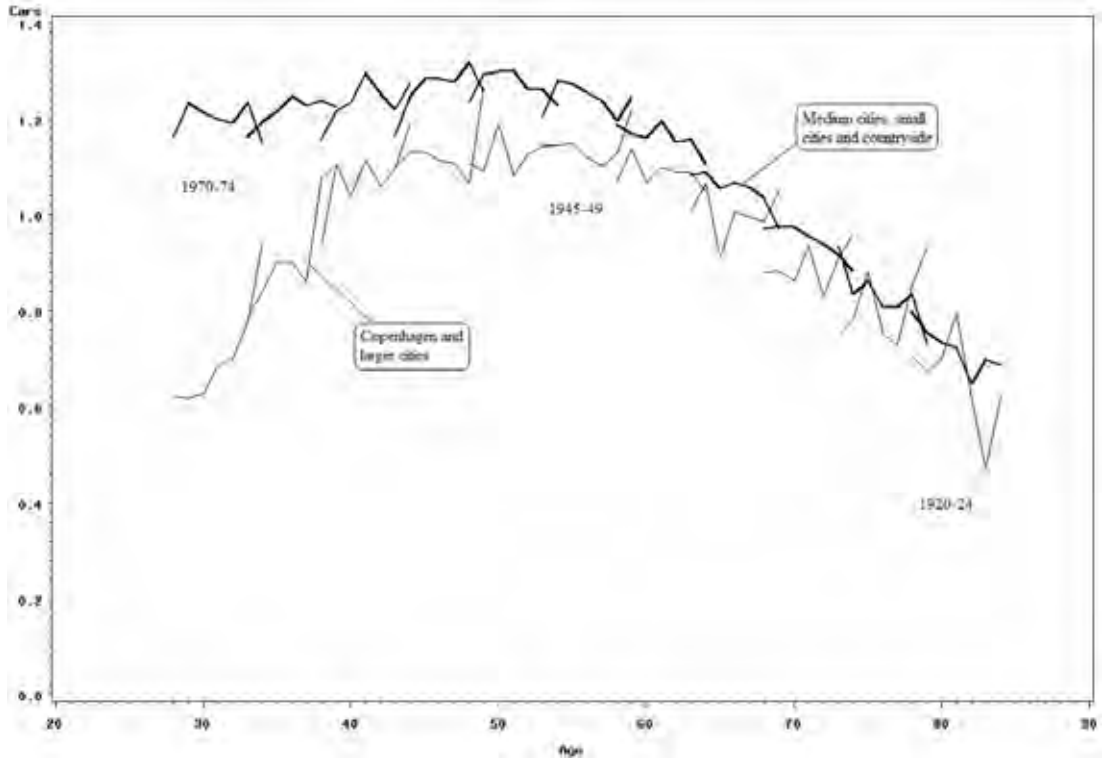

Figure 3: Car availability by cohort for real estate owners

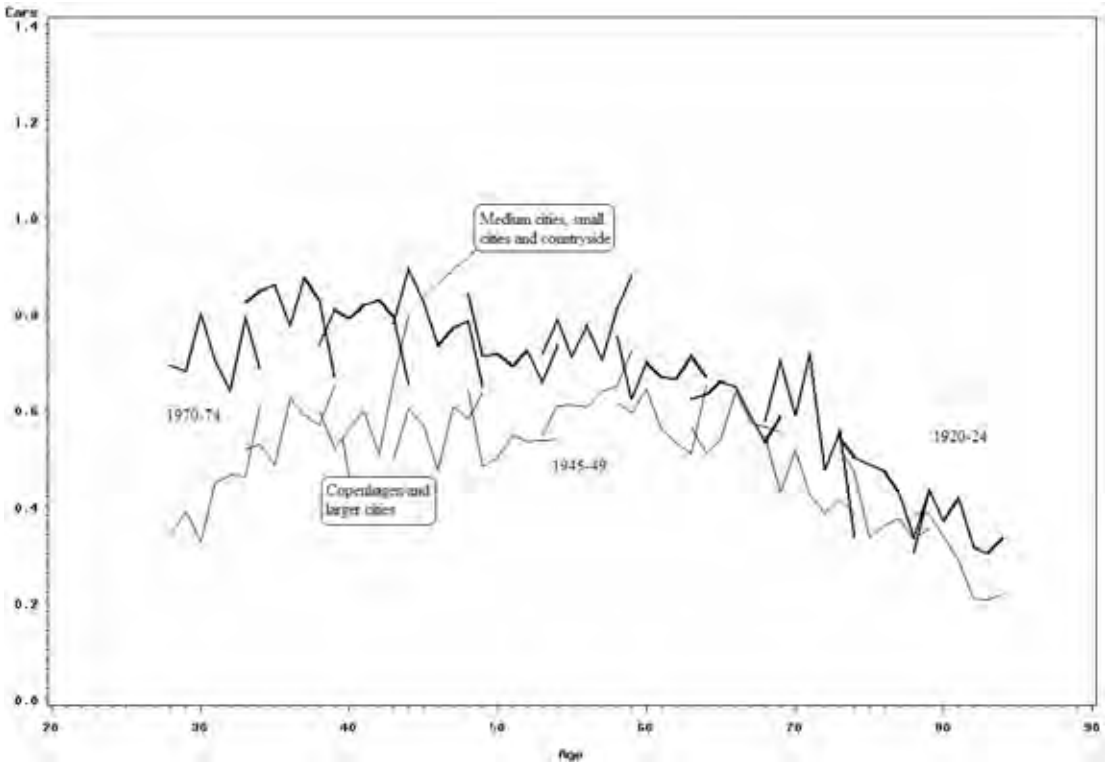

Figure 4: Car availability by cohort for non-real estate owners

The figures show that the life-cycle effect is larger for households living in owner-occupied houses. It is also clear that households living in less urbanized areas have higher car availability than households living in large cities or in Copenhagen. One explanation for this is the fact that the public transport network is better and distances are smaller in cities thus reducing the need for a car.

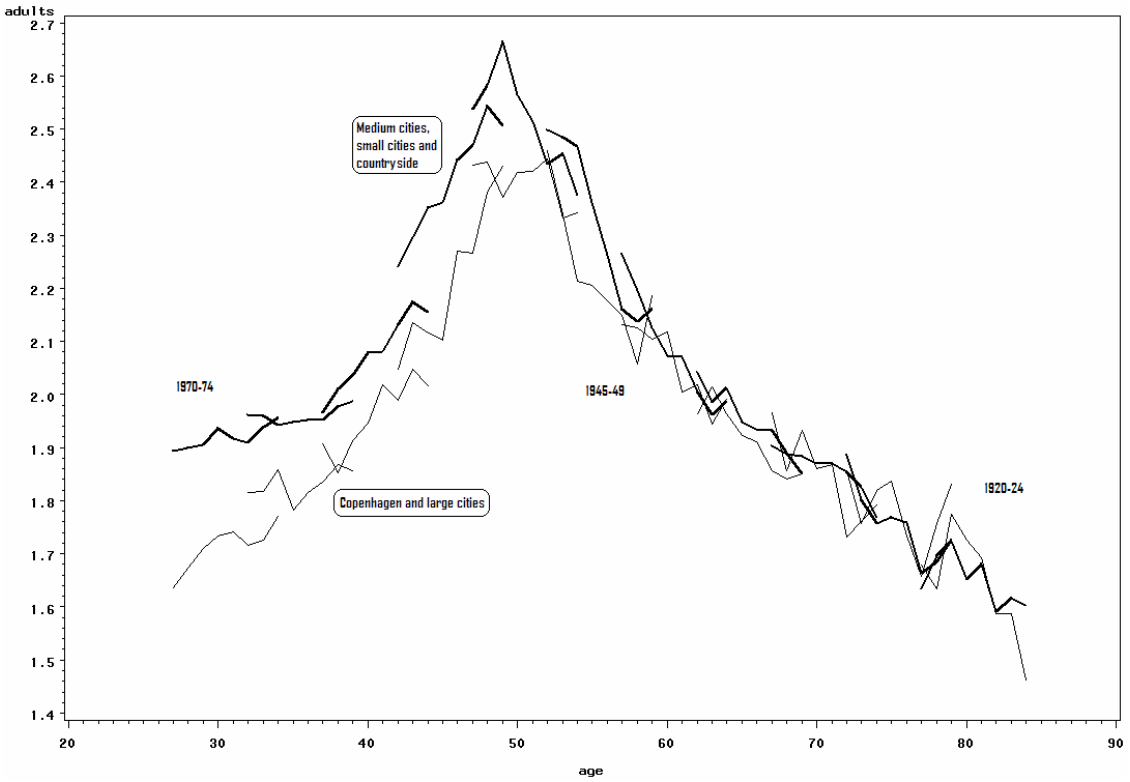

Figure 5: Number of adults in the household by cohort

Figure 5 gives another picture of a life cycle effect. It depicts the number of adults living in a household. As the age of the interviewee increases, the number of adults also increases. This is due to the fact that people get married and have children. We are not able to see if households move when these changes happen but it is likely that more adults and more children will increase the demand for cars. When the children reach a certain age they also count as adults[1]. This goes on until the interviewee reaches the age of 50 where the children start to move away from their parents thus reducing the size of the households. The size of the households also decreases as a result of divorce and death.

Unfortunately the DTDS does not hold information concerning the value of real estate owned by the households. It is well known that the development in housing prices have differed significantly between different regions in Denmark. Data for the average housing prices in the

separate municipalities can be obtained from SD and these data can be linked to the information in the DTDS for each household living in a given municipality and we thus assume that these average values are the same for each household in a given municipality. The interest rate is also obtained from SD on an annual basis. Since this is a general macro variable all households in the economy face the same interest rate. Some households might have limited access to the financial market but we ignore this and assume that all household have the same opportunities for borrowing money and that they all face the same long term interest rate.

The pseudo panel was constructed by dividing the data into cohorts. Following Deaton (1985) the cohorts have to be based on some characteristic that remain invariant in the period analyzed. In the present study we have used the year of birth of the interviewee as the determining factor. For each of the cohorts' averages for all the variables included are then calculated resulting in a 'representative' observation for the given cohort. This means that for a representative person born in e.g. 1945 or in 1960 we have a series of observations from 1996 to 2002 describing the behavior of the person each year. This data can then be linked to the macro data for development in housing prices and interest rate obtained from SD giving us the panel used in the paper.

3. The car availability model

With the examination of the real estate ownership and the interest rate as the objective we specify a simple partial adjustment model inspired by Dargay & Vythoulkas (1999). The data we use were described in section 2 and due to the aggregation each variable has the form of an average for the cohort it comes from. The average at the cohort levels is thus given by $\sum_i \frac{A_t^i}{n_t^c} = \overline{A}_t^c$ where n_t^c is the number of households in cohort c and A is the variable. In Dargay (2001) different specifications[2] are tested and compared. She conclude that the semi-log specification dominate and also argues that this specification makes most sense economically. Based on her result we use a semi-log specification. For each cohort-representative household we let $\overline{C}_t^i$ represent the number of cars at time t for cohort i, $\overline{I}_t^i$ the number of adults in the household, $\overline{G}^i$ the generation parameter (or cohort number), $\overline{R}_t$ the long term interest rate (which is identical for all cohorts), $\overline{Y}_t^i$ the yearly after tax income and $\overline{W}_t^i$ is the increase in real estate values experienced during the last year. This gives the functional form

$$\overline{C}_t^i = \alpha + \beta_Y \log(\overline{Y}_t^i) + \beta_W \log(\overline{W}_t^i) + \beta_R \overline{R}_t + \beta_I \overline{I}_t^i + \beta_G \overline{G}^i + \beta_C \overline{C}_{t-1}^i$$

where $\overline{C}_{t-1}^i$ is the number of cars in the previous period. We note that the increase in real estate value experienced by one cohort does not have to be identical to the increase experienced by other cohorts since we have been able to distinguish between the housing

[1] A problem with the classification of 'adults' in the DTDS is that people over the age of 16 are counted as adults but a driving license can not be acquired before the age of 18.
[2] Linear, Double-log and Semi-log.

prices in different municipalities. This means that if the households being part of a cohort primarily living in municipalities with high growth in real estate values the cohort will have experienced a high growth. To capture saturation effects in both income and increases in real estate values we take the logarithm of both $\overline{Y}_t^i$ and $\overline{W}_t^i$. As argued by Dargay & Vythoulkas this type of model can be estimated using standard techniques.

4. Estimates and discussion

A list of the variables included in the model can be seen in table 1 together with their sources. The hypothesis put forward in the introduction is modeled by the variables 'value increase' and 'interest rate'.

Variable	Source	***Description***
Cars	DTDS	Number of cars available to the household
Income (log)	DTDS	Household yearly after-tax income
Adults	DTDS	Number of adults in the household
Generation	DTDS	Generation effect (cohort number)
Value increase (log)	SD	Increase in housing prices during last year
Interest rate	SD	Average 30 years interest rate
Urbanization	DTDS	Living in urban area (Copenhagen or large city)
Real estate ownership	DTDS	Dummy for households owning real estate

Table 1: Variables used in the model

The number of observations used to construct each of the cohorts can be seen in table 2 divided into groups coming from urban areas (Copenhagen and suburbs together with the 3 largest cities) or rural areas (medium and small cities or the countryside) and owning or not owning real estate. It should be noted that especially for the rural non-owners the number of observations for some cohort is quite low. The number could be increased by reducing the number of cohorts and increasing the number of observations within each of these.

Cohort number	Cohort date of birth	Urban owner	Rural owner	Urban non-owner	Rural non-owner
1	1920-24	479	1323	688	482
2	1925-29	713	2079	767	617
3	1930-34	906	2565	720	519
4	1935-39	1079	3214	715	475
5	1940-44	1463	4254	714	510
6	1945-49	1772	5184	800	604
7	1950-54	1530	4818	702	584
8	1955-59	1592	4567	834	610
9	1960-64	1593	4458	1093	749
10	1965-69	1543	3831	1608	1030
11	1970-74	1125	2104	2162	1299
Average		1254	3491	982	680

Table 2: Number of observations

Since we have a lagged dependent variable in the specification we use the Durbin-h statistics to test for the presence of autocorrelation. The test confirms that autocorrelation is present in all the models. Furthermore we know that since the number of households in each cohort is not the same we face the problem of heteroscedasticity. To avoid this problem we weight all observations by the square root of the number of households in the given cohort. The error structure we specify as a simple AR(1). The estimation results are shown in table 3 together with test statistics. The models for non-real estate owners include the variable for the increasing real estate values. This we do to see if it is significant. If so we should be skeptical about our hypothesis since we do not expect non-real estate owners to benefit from increasing real estate values. The problem with the variable for wealth is that households who have lived in their house for a longer period of time have accumulated higher wealth than indicated by this variable. The dynamic model specification is capable of handling this since past increases in real estate values are included but moving patterns are still left out.

Variable	All	Real-estate owners	Non-real estate owners
Intercept	-0.1065 (-0.74)	-0.1013 (-0.29)	-0.0870 (-0.28)
Real estate owner	0.0736 (6.69)		
Urbanization	-0.0534 (-5.09)	-0.0835 (-3.97)	-0.0541 (-3.18)
Interest rate	-0.0572 (-5.38)	-0.0780 (-4.64)	-0.0600 (-3.73)
Value increase (log)	0.0187 (2.24)	0.0479 (3.01)	-0.0109 (-1.05)
Income (log)	0.0772 (4.06)	0.1056 (4.09)	0.1207 (3.19)
Generation (cohort)	0.0043 (3.49)	0.0040 (2.40)	0.0022 (0.81)
Adults	0.0691 (4.55)	0.0685 (3.62)	0.0489 (1.27)
Cars (t-1)	0.7158 (21.28)	0.6757 (13.45)	0.6591 (11.53)
AR1	0.2788 (4.73)	0.1973 (2.23)	0.3913 (4.85)
R^2	0.9941	0.9933	0.9112
SSE	139.1771	77.9114	53.7066
MSE	0.4686	0.5373	0.3730

Table 3: Estimates, t-values and summary statistics

All parameters have the expected sign and from the R^2 values we see that the models fit the data well. In the model for all households we have included a variable for real estate ownership. We see that this variable is positive and highly significant indicating that real estate owners have higher car ownership levels than non-real estate owners. In the model for all households the effect of the increase in real estate values is also positive. To determine if real estate owners and non-real estate owners are affected differently we split the sample and estimate the model on these two. A high degree of urbanization reduces the number of cars which we also saw in figure 3 and 4. This is not surprising since urban households generally have access to better public transport facilities, they have access to fewer parking spaces and in general have to travel shorter distances to reach their destination. Higher income affects car availability positively. Again this is expected since cars are assumed to be normal goods. Generation effects are found to be present for real estate owners. Younger generations have a higher tendency to purchase cars. For non-real estate owners the generation effect is also

positive but statistically insignificant. This is in line with findings of generation effects in Dargay (2001) and Dargay (2002) where less significant generational effects were found which could be seen as a confirmation of the findings here that the generation effects are not present in all household groups. We also have that the number of adults affect the demand for cars positively but the effects are only statistically significant for real estate owners. Turning to the interest rate we see that both real estate owners and non-real estate owners experience an increase in their demand for cars when the interest rate decreases. Looking at the effect of the increasing real estate values we get the expected result that only real estate owners are affected and as expected the households have increased their demand for cars as a consequence of the increasing wealth. Letting $\theta = (1 - \beta_C)$ we have $\theta = 0.28$ for real estate owners and $\theta = 0.32$ for non-real estate owners. We thus see that 28% and 32% of the adjustment in car availability for the two household groups happen within the first year. The high degree of significance for the adjustment parameter tells us that the dynamic specification is needed since households in general do not adjust to changes instantaneously.

4.1 Elasticities

Short run elasticities can be calculated directly from the estimated parameters, since we know that the short term elasticity, ε_i^{sr}, with regard to variable i is given by $\varepsilon_i^{sr} = \frac{\partial C}{\partial x_i}\frac{x_i}{C} = \beta_i \frac{x_i}{C}$. The long term elasticity, ε_i^{lr}, is given by $\varepsilon_i^{lr} = \frac{\varepsilon_i^{sq}}{\theta}$. For the different models estimated the elasticities are shown in table 5.

	Real estate owners	Non-real estate owners
Assuming car availability at group average[3]	(0.096) – (0.296)	(0.228) – (0.668)
Assuming car availability equal to 1	(0.106) – (0.326)	(0.121) – (0.354)

Table 5: Income elasticities for car availability (short run – long run).

What can be seen from table 5 is that real estate owning households in general have lower income elasticity than non-real estate owning households both in the short run and in the long run. One explanation for this could be that real estate owning households have higher car ownership and thus are closer to some kind of natural saturation point for car ownership. The value for the elasticities are lower than those found in other studies for Denmark (Dargay and Gately (1999), Christens and Fosgerau (2004)) and perhaps more in line with the findings in Bjørner (1999) and Birkeland et. al. (2000) but still below the values reported in these papers.

The influence of the interest rate on car availability can be seen directly from its parameter and the long run elasticity is calculated. The same goes for the elasticity of real estate values. The results are shown in table 6 below.

[3] For real estate owners and non-real estate owners the average car availability is 1.10 and 0.53.

All	Real estate owners	Non-real estate owners
Assuming car availability at group average	(-0.071) – (-0.219)	(-0.113) – (-0.332)
Assuming car availability equal to 1	(-0.078) – (-0.241)	(-0.060) – (-0.176)

Table 6: Elasticities for interest rates on car ownership (short run - long run)

From the models we know that the interest rate affects both owners and non owners of real estate and we see from table 6 that both short run elasticities and long run elasticities are lower for real estate owners.

5. Conclusion

We have shown that differences between real estate owners and non-real estate owners exist when it comes to car availability. We found indications of a wealth effect for real estate owners due to the increasing housing prices. The effect should be examined in more detail using real panel data but the findings here suggest that real estate owners have increased their car availability due to the increasing real estate values. Examining the effect of the falling interest rate we found that both real estate owners and non-real estate owners have increased their car availability due to the decreasing interest rate.

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