



What determines the supply of housing for the elderly, and how is it related to the spread of Covid-19 and future demographic changes?

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Abstract:

As in many other countries, the population in Sweden is getting older. It means that the number of older people in society increases in absolute numbers and relative terms. Consequently, this will mean that the need for elderly housing will increase and the cost of these investments will be high. The following study aims to quantitatively analyse the spatial distribution of the number and size of housing for the elderly in Sweden over 2013-2018. The number of elderly housing per capita is not evenly distributed, and a large part of the explanation is, of course, that the number of older people is not evenly distributed between municipalities. Nevertheless, we can also state that the municipality's income level and tax base, as well as the geographical size and degree of urbanisation, play a role. If the municipality has a surplus or deficit in the supply of special housing for the elderly, it has no correlation with the distribution of Covid-19 cases or with the forecast number of older people in the future.

Keywords: Elderly, Housing stock, Covid-19, Demographic

JEL-codes: J11, R23, R31

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1. Introduction

According to statistics from Statistics Sweden (SCB), the number of people over 80 will double within the next 30 years. Demand for nursing homes will thus increase gradually in the coming years. At the same time, it must be remembered that an 80-year-old ten years ago did not have the same needs as an 80-year-old today and surely 80-year-olds in 20-30 years will have completely different needs and make different demands on their housing than what we can see today. The number of older people as a proportion of the population began to increase simultaneously as the cost of long-term care (LTC) began to increase. As a result, many countries began to analyse the fiscal burden that this will entail in the future. As a result of these analyses, new types of financing models began to be used. Coleman (1995), for example, describes different models for LTC in northern Europe.

According to Karlsson et al. (2010), the Scandinavian countries differ from other European countries, mainly through a similar political tradition. The so-called *Scandinavian Model* for Sweden, Norway and Denmark presented is also called *the state responsibility model*. From the 1960s to the 1980s, the Scandinavian countries' focus was on dignity and medical care, with higher staff/user ratio, but a recession in Sweden during the 1990s made it harder to place the model into practice without also using private caregivers and relatives. The bourgeois parties advocated the change in Sweden, but care-takers are more interested in the service quality than who provide it – public or private sector (Suzuki, 2001).

To increase efficiency and quality, responsibility was changed to a local focus, fewer institutions were built, and the care was more adapted to each person need. In Sweden, the change of responsibility took effect in January 1992 when 20.3 million SEK were transferred to the different counties, through "Ädelreformen"¹ in order to cover the cost for the (special) housing and the LTC of the elderly (Suzuki, 2001). The new thing about "Ädelreformen" in Sweden, according to Karlsson et al. (2010), was that the former earmarked grants were replaced by three components – the income adjustment, the cost adjustment and structural grants – with reforms 1996, 2005 and 2008. In 2008, 58 billion SEK (€5.90 bn) were transferred to the local authorities (Karlsson et al., 2010). In special cases, also temporary grants or adjustment grants (regleringsbidrag) could be used.

The legislation takes place at the national level, and the municipalities are responsible for elderly care (nursing), while the regions are responsible for elderly health care. Today, the cost of the municipalities' elderly care is just under 20 per cent of the municipalities' total budget, something that Swedish Association of Local Authorities and Regions (SKL), among others, believes should increase to just under 30 per cent to meet the existing need. Underinvestment in elderly care has become even clearer

¹ Motion till riksdagen 1998/99: So 436 av Margareta Viklund (kd):
https://www.riksdagen.se/sv/webb-tv/video/motion/adelreformen_GM02So436

when it has been shown that the spread of covid-19 has been significantly greater in elderly care than in other parts of society. Over the years, there have been changes in leadership in terms of elderly care and elderly housing. From a more state-owned responsibility to a more local responsibility where the municipality plays an important role in the planning and dimensioning elderly care, see Riedel et al. (2016). This shift in responsibility has led to differences in the supply of elderly housing between Sweden's municipalities. For example, part of this distribution of elderly housing can be explained by the proportion of older people in the municipality, but not everything can be explained.

The following study aims to quantitatively analyse the spatial distribution of the number and size of housing for the elderly in Sweden over 2013-2018. Thus, the purpose is to analyse regional differences in nursing homes (LTC) in Sweden. We intend to analyse whether municipalities that have invested relatively much in nursing homes to meet future nursing home needs have also had a larger proportion infected in Covid-19. We place greater emphasis on institutional care because Sweden is a bit of an outlier if we compare ourselves with Europe. For example, there are approximately 75 beds per 1000 people older than 65 in Sweden, compared with just over three beds in Bulgaria (see Riedel et, 2016). Planning the capacity of nursing homes and developing key figures for planning is an important research issue. Relying solely on the proportion over a certain age is not enough, Gibson (2020). Our purpose is to develop new knowledge that improves the ability to dimension LTC in the long run.

Our main contribution is that we analyse the spatial dimension of the supply of nursing homes. Unlike housing supply, no studies have been done to explain regional differences in elderly housing per capita as far as we can find. Our unique database is a panel of all municipalities in Sweden over six years, enabling us to identify causal links between the housing stock and its explanatory factors. The analysis has also made it possible for us to relate the results to the distribution of Covid-19 infected in nursing homes and future forecasts of the number of older people in the municipalities.

The paper's disposition is as follows: in the next section 2, the theoretical framework is briefly presented, and in section 3, the choice of method is presented. Section 4 presents the empirical analysis with a focus on data and econometric analyses. Our results are also set in relation to the distribution of Covid-19 cases in Sweden's municipalities and future forecasts of the elderly in our municipalities. The report concludes with a conclusion and a discussion of policy implications.

2. The theoretical framework of LTC

The supply of elderly housing in a municipality is partly from market forces and a large extent from local and regional planning (Riedel et al., 2016). That is, the conventional starting point is to analyse the dimensioning from a demand and supply perspective. However, since care for the elderly and the supply

of housing for the elderly are primarily regulated, national, regional and local authorities also have an essential role. Hence, to see the problem as if we estimate supply based on the demand function and the supply function is not enough. The quantity offered is thus not only determined by preferences, relative prices, income and costs for land and construction. Since pricing in many cases does not occur on the market, other underlying factors must be considered when estimating the relationship between the quantity offered and the determining factors.

In Sweden, elderly care (LTC) is divided between authorities at the central level and their counterparts at the regional and local levels. The care for the elderly can be divided into institutional care and home-based care, as well as public care providers and private care providers. Our analysis will be on institutional care, but we make no distinction between private or public care. The primary level for legal and regulatory decisions regarding institutional care is at the central level, similar to, for example, the Netherlands. Home-based care is also at a central level.

On the other hand, the planning of capacity occurs at a non-central level in terms of institutional care and decisions about home care (see Riedel et al., 2016). Access to LTC is not based on income, i.e. LTC in Sweden is not only available to the poorer part of the population, such as in England, Italy and Spain. The same applies to the right to care, whether it concerns institutional care, home-based care or home nursing care.

Both in Sweden and Denmark consumer choice models make sure that the differences within the country are not too significant. Norway is used to providing service in remote areas, but Støre-Valen & Smistad (2019) discusses that this is now complemented by senior cooperative apartments and sheltered retirement housing, and they stresses the importance of agreeing with the goal of WHO of an age-friendly society². How then is the Scandinavian Model altered to be a sustainable model and attractive and efficient? This is discussed in Støre-Valen & Smistad (2019). The following categories are used – cooperative housing, service-oriented housing, sheltered housing and extra care housing – analysing seven projects in Stavanger and Kristiansand through semi-structured interviews (22 persons) and on-site walks. On the same theme³, Houben (2001) makes an international comparison of how national policies work locally. This is called "managed co-operation" in the article. Because people are ageing-in-place, the coordination is more important and the need for flexibility to adjust to each individual and the EMU rules, the IMF, and the World Bank. Riedel et al. (2016) discuss LTC systems in 21 EU countries focusing on the basic structure, service access and supply characteristics.

² <https://www.who.int/ageing/10-priorities/en/>

³ Housing, care and social services.

In the 1960s, having many institutions were considered a good thing, but now ageing in place is considered better. This can be done either by continue living in the same house as before but with home-based care, or to move to a very flexible home that is adapted enough so that no further movement is needed. Houben (2001) discusses the possibility that the problems had to do with a combined shortage of facilities for elderly locally with a shift in decision-making regionally. In Sweden, the change in system 1992 was also combined with insurance that the cost of the geriatric care in the hospitals should be paid locally, but that money should be transferred to the municipalities during a 5-year-period. The new thing in the future according to Houben (2001) is that until the 1990s there has been general rules or principles targeted group of peoples whereas there is now more individual and flexible solution targeting self-realisation.

In 1993 China experienced tightening monetary policies after years of chaos and bubbles, and falling investments and Leung & Wang (2007) describe different policies and its impacts on the Chinese housing market, adopting the DiPasquale Wheaton-model in trying to find an equilibrium model. Despite differences in the character of, for example, monopoly power, politics and leverage effect, the authors find that tools from the "western economics" are applicable also in China. In the model, two classes of housing units are used – above or under 90 m². According to Leung & Wang (2007), the short term effects of the different policies increase the number and proportion of small-size houses when developers need to meet a requirement that 70 % of the houses should comprise 90 m² or less. These houses require 20 % down payment while all other houses require 30 % down payment. To reach short—term equilibrium in the DiPasquale-Wheaton Model, some small developers may have to exit the market, as the barriers are too high due to high cost, and supply decreases. In the long-run demand is increasing as the economy increases and Leung & Wang (2007) talks about following rational behaviour. If the financial sector develops, people will move from the housing market into the financial market to a higher degree. In the DiPasqual-Wheaton Model rent (R) expects to rise, construction (C) and stock (S) expects to decrease, but the price (P) is uncertain in the long run according to the authors.

The stock of housing is a function of supply and demand, and this articles theoretical basis is a simplified DiPasquale-Wheaton model. Here we concentrate on the desired level of housing stock, like Steiner (2010) in the Swiss market, using a stock-flow-model, looking at its impact on prices and/or macroeconomic fundamentals, allowing for disequilibrium be adjusted in several periods. According to Steiner (2010), the stock depends on the stock in the time-period (t-1) and "time to build", and the depreciation rate is low. Its reactions to shocks are slow (4-5 years), but the prices and investments react faster. Long-run equilibrium exists if the stock in period t equates the long-run demand, where either population, income or wealth affects the demand. With lower case letter expressing logarithms, this could be expressed as the model used in Steiner (2010):

$$s_{it} = \alpha_1 + \alpha_2 p_{it} + \alpha_3 U_{it} + \varepsilon_{it}^s \quad (1)$$

where U_t is the welfare variable mentioned above, p is house prices, and the last term is the adjustment term, with an expected sign according to if it is excess demand or excess supply in the market. What may be included in U_t that will affect the supply of elderly housing? As previously discussed, the dimensioning of elderly housing in a municipality is a result of both the municipality's planning and thus various key figures that measure current and future needs, as well as factors that are affected by market factors. We start by looking at U_t in the following way:

$$U_{it} = f(\text{size, urbanization, financial strength, political factor, housing market}) \quad (2)$$

Size refers to the municipality's geographical size but also the number of inhabitants in the municipality. This also includes one of the key variables, namely the number of older people in the municipality. The expected sign of size is positive. Urbanisation refers to how many of the inhabitants live in urban areas. A higher degree of urbanisation means that there are economies of scale in, for example, the home care service, which enables the elderly to remain in the home to a greater extent. The expected sign of urbanisation is, therefore, negative. The municipality's financial strength is measured by the inhabitants' average income (i.e. its tax base), the municipality's income tax, and the tax equalisation system in Sweden. Financial strength has an expected positive effect on the dimensioning of elderly housing. The political variable is intended to measure political power on a right-left scale. Here we have included the proportion who voted for the Social Democrats in the local elections. The expected sign is unclear, but one could interpret that parties on the left side have a more significant attraction towards collective solutions, and thus the expected sign would be positive. By housing market is meant variables that measure how the housing market in general works in the municipality. Housing prices are included partly as a measure of housing supply and partly the alternative use of land. Higher prices are expected to dampen the dimensioning of elderly housing in the municipality. We have also included variables that measure how many of the elderly live in ownership. More owner-occupied housing is expected to have a negative effect.

3. Methodology

The theoretical model discussed in the previous section has been estimated using a standard ordinary least square. Here we have related four different dependent variables to several independent variables. The dependent variables have been partly the number of elderly housing in the municipality over time and the number per capita, partly the average size of elderly housing and its equivalent per capita.

The independent variables can be classified into three groups: the municipality's size, finances, and housing market. Variables that measure the municipality's size are its population size, the number of elderly people in the municipality, its geographical size and its degree of urbanisation. Here we can also include the variable whether the municipality is a moving-in municipality or not. The economic

variables that have been included are the municipality's average income, the municipality's tax base and its result from the equalisation system. Three variables are intended to streamline the housing market in the municipality. Average housing prices are intended to measure the alternative cost of land, and the proportion of housing in tenancies versus housing in owner-occupied homes is intended to measure the supply of substitutes for elderly housing.

Although we have a panel with many municipalities for some years, we have not used models as a fixed-effect model. The main reason for this is that (1) we have a relatively small panel over the time, (2) the variation in the dependent variable is limited, and (3) we have relatively many independent variables that are if not constant over time then at least with a minimal variation. Hill et al. (2020) discuss various shortcomings with fixed-effect models for panel data, where all our limitations are discussed in detail. Earlier literature discusses issues such as a time-invariant, restricted sample, and low statistical power is Trieman (2009), Nickell (1981), Angrist and Pischke (2009). However, we have complemented the basic model with year by year estimation to show that the pooled sample does not misrepresent the results. We have also estimated the model with the so-called between-effects model and a random effect model as simulation results by Clark and Linzer (2015) suggest that the support for a random effect specification is larger in smaller panels than the fixed-effects model.

Spatial dependence can occur, making it problematic to interpret coefficient estimates, but above all, to interpret the hypothesis test. We have chosen to test the residuals from the default model for spatial dependence with Moran's I. Then we have estimated a spatial error model and a spatial autocorrection model. The spatial weight matrix consists of the inverse of the distance between the municipalities.

When estimating the model, it is essential to test whether the variables are stationary or not. If the variables are not stationary, there is a risk that the relationships we estimate are only spurious. We have done this with a so-called Levin-Lin-Chu test (Levin et al., 2002) and an Im-Pesaran-Shin test (Im et al., 2003). The Levin-Lin-Chu test assumes a common autoregressive term for all panels, and the Im-Pesaran-Shin test relaxes this assumption. In general, all stationary tests work best when the number of periods is many. This also applies to the test above. However, we have a relatively limited number of periods available (6 or 7 years depending on the series), making it difficult to draw any reliable conclusions based on the tests.

4. The empirical analysis

The data and descriptive statistics

The database contains data for 290 municipalities in Sweden over the period 2013-2019. All data comes from Statistic Sweden. There is no consensus on how to define houses for the elderly (see Tinker et al., 2007). The housing supply for special housing for the elderly and disabled refers to an apartment that is

wholly or almost wholly used for the purpose. Apartment refers to housing in single-family houses and multi-family houses. Senior housing is not included in the data. The home is intended for the elderly or people with disabilities, and the accommodation is always combined with service, support and personal care. Common areas often consist of a kitchen, dining room and living room. The statistics consist of the number of dwellings and the size of the dwellings.

Maps 1 below illustrates the number of apartments per capita (blue map) and per number of older people (green map) in the municipality. The bluer or greener the municipality is, the more housing per population there is in the municipality. At the northern parts of Sweden, we can notice that many municipalities have more apartments than in the more populous municipalities in Sweden's southern parts. To find the imbalances in different parts of Sweden, the term ε_t^s is further analysed in equation (1) as it expresses if it is excess demand or excess supply in the specific area and the vector U_t in equation (2) helps determine changes in the stock. The term ε_{t-1}^s determines how the prices change according to this excess demand or excess supply.

Map 1: Number of elderly housing per capita and per elderly, the year 2018.

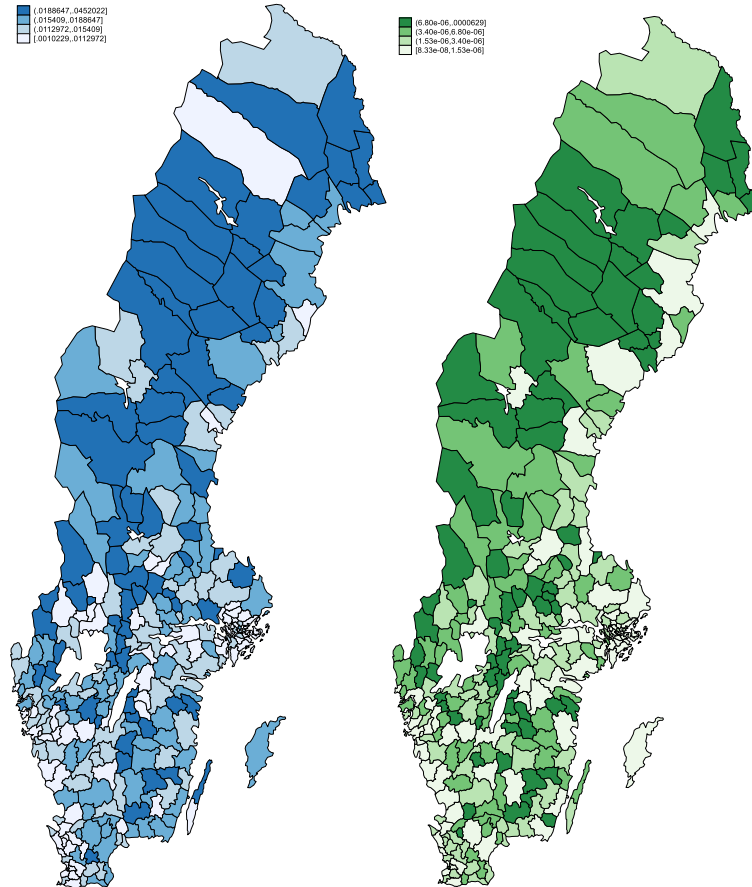
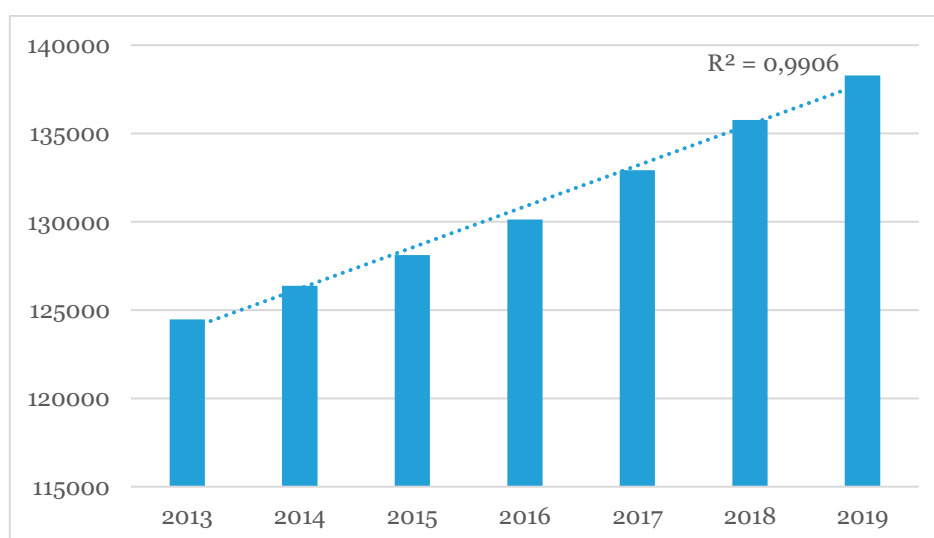


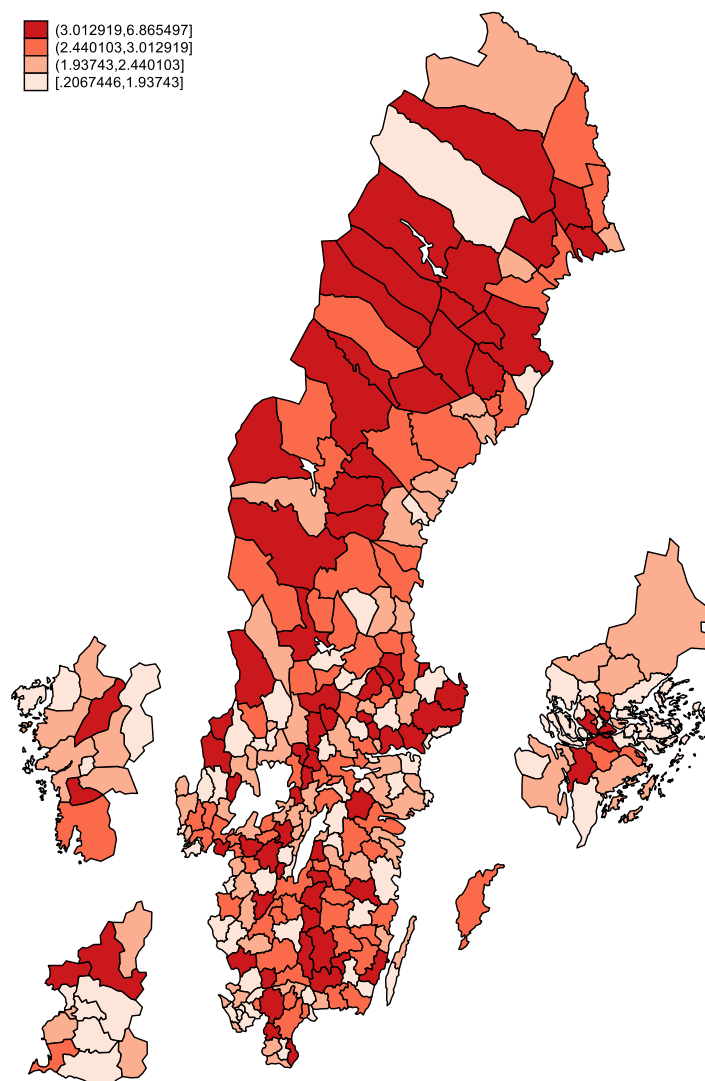
Figure 1 below shows that the number of special housing for the elderly and disabled has increased from 2013 to 2019. The increase in the figure corresponds to 11%. In relation to the population increase of 7% during the same period, there is an increase in special housing. However, the population has grown older, and in relation to people over the age of 75, the increase in special housing is relatively moderate. For example, the number of older people over 75 has increased by 18% during the same period. People over the age of 95 have increased by as much as 29%. The conclusion is that even though the number of special dwellings has grown over the period, it has not increased in step with the population increase in the older age ranges. We can also note that the distribution of special housing per capita (the green map) between the municipalities in Sweden is relatively large.

Figure 1: Number of elderly housing over time. Years 2013-2019.



We have also analysed the size of special housing. The information we have about the size is in size classes of 10 square meters, i.e. 0-10 square meters, 10-20 square meters up to larger than 60 square meters. We have used the class middle to estimate the size of the special housing available in the municipality. Map 2 illustrates the distribution between the municipalities regarding the size of elderly housing per number of older adults in the municipality. There is a relatively large spread between the municipalities, and many of the municipalities in the northern parts have more residents per older person and larger dwellings per older adult (darker red) compared with the southern parts of Sweden (pink). In the populous metropolitan regions, housing size is generally smaller than in other parts of Sweden.

Map 2: Size of elderly housing per elderly, the year 2018.



It is no surprise that the population size can largely explain the number of special housing units in a municipality. The number of special homes is, in many ways, a planning issue. Nevertheless, as we have seen, the number of special homes has changed over time, and there are regional differences in the number of homes per capita. In figure 2 below, we have related the number of homes for the elderly and disabled with the municipality's size. The population is represented in natural logarithm. It is clear that the connection is strong, but we can observe a variation, i.e. the connection does not consist of a straight line, but there is a variation between equally large municipalities. It becomes even more evident in Figure 3, where we illustrate the proportion of special housing per elderly person. The distribution of elderly homes per older person is almost a normal distribution where some municipalities have significantly fewer special housing units than others.

Figure 2: Number of elderly housing and population (natural logarithm). The year 2018.

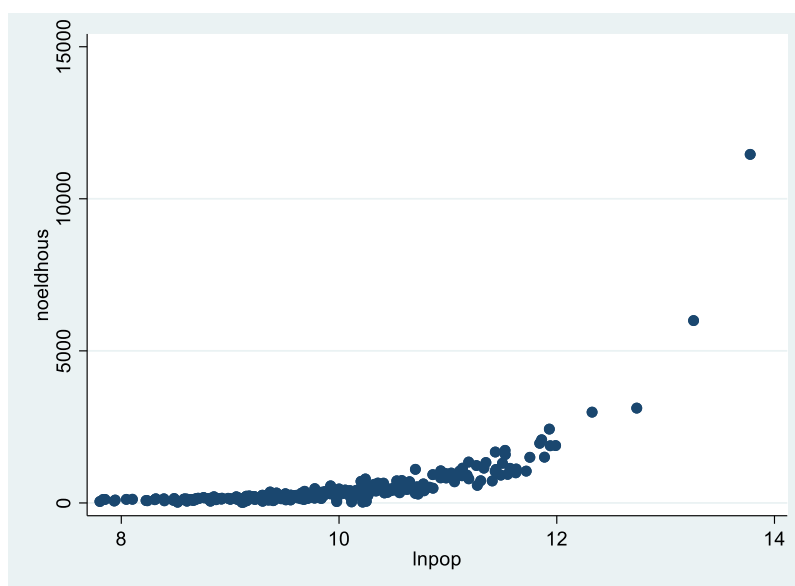


Figure 3: Histogram number of elderly housing per capita. The year 2018

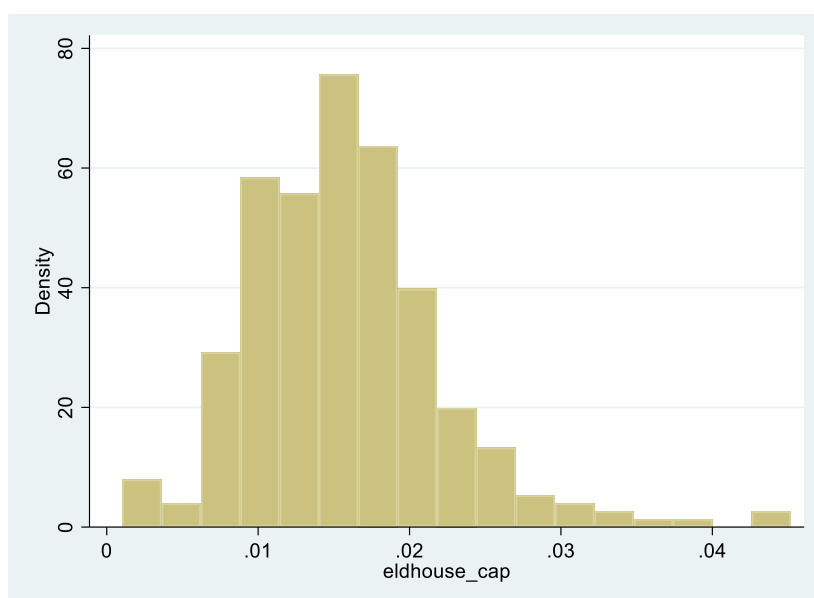


Table 1 below presents some descriptive statistics regarding the number and size of special housing for the elderly and the disabled, as well as the population size and the proportion of the elderly in the municipality. In addition to these variables, we intend to analyse whether other independent variables can explain the variation between municipalities and over time that we can observe. It consists of, for example, the average income in the municipality, the size of the municipal tax, and whether the municipality is an out or place of residence. The data source for all variables is Statistics Sweden.

Table 1: Descriptive statistics

Variable	Period	Mean	Std.Dev.
No of housing (no)	2013-2019	451.25	844.69
No of housing per capita (no.)	2013-2019	0.0154	0.0063
Size of housing (sq.meter)	2013-2019	17256.54	32690.06
Size of housing per capita (sq.meter)	2013-2019	0.5928	0.2722
Population (no.)	2013-2019	34441.58	71174.99
Net migration (%)	2013-2018	-0.1917	0.7914
Elderly (%)	2013-2019	0.2330	0.0409
Employment (no.)	2013-2018	79.3328	4.0895
Income (000 SEK)	2013-2018	186.3648	26.4176
Tax (%)	2013-2019	32.79	1.16
Equalisation (SEK)	2013-2019	10289.24	5853.272
Voting (%)	2013-2019	33.51	8.97
Ratio-rental (%)	2013-2019	22.2512	6.4340
Ratio-owning (%)	2013-2019	61.4874	13.3287
Urbanisation (%)	2013-2019	75.9054	14.0798
Areal (sq.kilometer)	2013-2019	1404.534	2433.525
House prices (000 SEK)	2013-2019	1956.438	1562.527

The size, measured as *population* and/or *employment*, of the municipality, naturally has a significant impact on the level of investment. Also, smaller municipalities may find it more challenging to maintain and make larger investments year after year; instead, the investments may come more sporadic in specific years. On average, the municipalities are relatively small, but the variation is considerable. There are three major metropolitan areas with more than 250,000 inhabitants, some medium-sized cities with 100,000 inhabitants, and many small towns. On average, the population size is only around 35,000 inhabitants, but the standard deviation is double. Whether it is a place of relocation or a place of occupancy also has a major impact on both the possibility of financing investments in homes for the elderly and the need for homes for the elderly. The number employed in the municipality is a consequence of the population size and whether the municipality is a place of emigration or not and the proportion of older people in the municipality.

If a municipality has a large positive or negative net migration, it also has a large impact on both the possibility of financing investments in homes for the elderly and the need for homes for the elderly. Many places are places of emigration where the younger population moves to the metropolitan regions. This, of course, put the municipalities' opportunity to invest in elderly housing to the test. The average net immigration in the municipalities is negative measured as a percentage of the population size. However, the variation around the average net occupancy is relatively large.

If population size was an important variable to explain the number of *elderly* people living in the municipality, then the number of older people in the municipality is essential. The number of older people, over 65, is on average, around 23% of the population. The variation measured as a standard deviation around the mean value is relatively modest, but the spread in the range is from 12% to 35%.

In addition to the municipality's size, its finances are essential for understanding the investments in elderly housing that the municipality has made historically. We will measure the municipality's financial strength with three variables, namely the municipal citizens' *average income*, the size of the municipal *income tax* and the outcome of the municipal *equalisation* mechanism. The average spread in income is relatively large. The spread, measured as a standard deviation, constitutes approximately 13% of the mean. The average income is SEK 186,000 with a minimum of SEK 134,000 and a maximum of SEK 381,000. The municipal tax rate varies from just under 29% to just over 35%. Significant less variation than for incomes, but together with the average income level, taxes significantly impact the municipalities' finances and ability to invest in elderly housing as part of its fiscal policy.

In Sweden, a system of equalisation between the regions has been implemented. The equalisation system aims to compensate for structural differences that affect the municipalities and regions' economic conditions to conduct their business. We have included information on whether the municipality is a net donor or a net recipient in the equalisation system measured per inhabitant in the municipality. The

average net grant that a municipality receives is approximately SEK 10,000 with a variation from minus SEK 17,000 to SEK 29,000. We hypothesise that the redistribution system's effect can positively and negatively impact the number of elderly housing in the municipality. An overcompensation for structural differences could lead to excessive investments in elderly housing, while less compensation can lead to too few elderly housing.

We also have a variable that measures how the population has voted in the local elections. The share that we have included in the model is how many people have voted for the Social Democrats in the local elections. On average, the proportion amounts to just over 30% with a standard deviation of 8%. The intention of including a variable that measures party sympathies is that parties on the left are generally perceived as more focused on welfare issues. The number of homes for the elderly could be perceived as a welfare issue.

The geographical size (variable name *areal*) of the municipality can impact the supply of elderly housing. Lower population density can lead to poorer economies of scale, leading to fewer homes for the elderly. The same also applies to the degree of *urbanisation* in the municipality. The more urbanised the municipality is, the higher the degree of scale economies and the more elderly housing. The degree of urbanisation is measured as a proportion of the population living in urban areas compared with those living in rural areas. The municipality's average size amounts to approximately 1404 square kilometres, and the degree of urbanisation amounts to approximately 76%. The variation around the average is substantial.

Finally, several variables are also included that measure housing types and housing costs in the municipality. The study includes two variables that measure the proportion of residents in the rental market and single-family homes. The proportion is calculated for people over 65 years of age (variable name *ratiorental65* and *ratioown65*). More housing in the rental sector is expected to lead to lower pressure on elderly housing. On average, 22% of people over 65 live in a rental apartment and 61% in single-family houses. The remaining part lives in condominiums in apartment buildings. The variation between the municipalities is great. The standard deviation is equal to 6% and 13%, respectively.

In addition to these variables, we have also measured the value of alternative land use, namely housing with ownership for all citizens in the municipality (variable name *House prices*). Higher house prices in a municipality mean that the alternative value is higher, which is expected to reduce the supply of elderly housing, all other things being equal. The variation in housing prices is substantial. On average, housing prices are equal to 1,956,000 kronor with a standard deviation of 1,562,000 kronor. We hypothesise that municipalities with higher housing prices show a lower proportion of homes for the elderly and smaller homes for the elderly than other municipalities with lower housing prices.

Pre-test of the data

As mentioned earlier, we analyse a panel of 290 municipalities over seven years. Both the number of LTC homes and the size of the LTC homes have increased over time, while the number of LTC homes per older person has decreased. We can also observe that some of the independent variables have also increased over time. Table 2 shows whether the series is stationary, trend stationary or non-stationary.

Table 2: Stationarity test of the panel data.

Variable	Levin-Lin-Chu test	Im-Pesaran-Shin test
No of housing	Stationary	Trend stationary
No of housing per capita	Stationary	Trend stationary
Size of housing	Trend stationary	Trend stationary
Size of housing per capita	Stationary	Trend stationary
Population	Stationary	Non-stationary
Elderly	Stationary	Trend stationary
Income	Stationary	Non-stationary
Tax	Stationary	Stationary
Equalisation	Stationary	Non-stationary
Net-migration	Stationary	Stationary
Voting	Stationary	Stationary
Ratio-rental	*	*
Ratio-owning	Stationary	*
Urbanisation	Stationary	Trend stationary
Areal	Stationary	Non-stationary
House prices	Stationary	Trend stationary

Note: * too few periods

As mentioned, we have a relatively short panel with only 6-7 years. Therefore, one should be careful not to draw too far-reaching conclusions from the tests. The results indicate that data regarding the number of nursing homes and the size of these homes are all stationary, which means that we can estimate our models' levels. The Levin-Lin-Chu test indicates that the series is stationary, while the Im-Pesaran-Shin test indicates that they are trend stationary, which indicates that it is essential that we currently time trend in the estimated models.

Overall, the Levin-Lin-Chu test shows that all panel data series are stationary (with the variable share in the rental sector as an exception). This suggests that all models can be estimated with level data. On the other hand, the Im-Pesaran-Shin test shows that most variables are trend stationary, suggesting that estimated models should contain fixed time effects. However, some exceptions can be noted. Population, income and the equalisation system are neither stationary nor trend stationary. Considering that the

Levin-Lin-Chu test still shows that the variables are stationary and that the strength of the tests is limited given the short period we are studying, we have concluded that the model parts can be estimated in level.

Basic Econometric Models

Table 3 shows four different models (1) - (4). The first two refer to models that explain the number of nursing homes and the number of nursing homes per capita. The next two models model the size of the elderly housing in the municipality and the size per capita. Fixed annual effects are included in the specification, but the results are not shown in the table.

Table 3: Results (OLS-models)

	(1) No House	(2) No HouseCapita	(3) Size House	(4) Size HouseCapita
Population	0.0121*** (209.39)	4.59e-09* (2.47)	0.464*** (153.28)	0.000000203* (2.33)
Net-migration	-2.814 (-0.52)	-0.00131*** (-7.57)	-148.5 (-0.53)	-0.0552*** (-6.79)
Elderly	901.2** (7.28)	0.0575*** (14.40)	38843.4*** (5.97)	2.305*** (12.32)
Employment	-1.430 (-1.06)	0.0000139 (0.32)	-20.26 (-0.29)	0.00158 (0.77)
Income	2.523*** (5.24)	0.000184*** (11.88)	137.3*** (5.43)	0.00788*** (10.84)
Equalisation	-0.00600*** (-4.38)	0.000000740*** (16.77)	-0.261*** (-3.63)	0.0000282*** (13.63)
Tax	-3.306 (-0.80)	0.000711*** (5.31)	-753.9*** (-3.45)	0.0223*** (3.55)
Voting	-0.577 (-1.12)	-0.000114*** (-6.85)	-14.26 (-0.52)	-0.00508*** (-6.50)
Ratio rental	0.146 (0.20)	-0.0000279 (-1.19)	-22.01 (-0.58)	-0.00142 (-1.29)
Ratio owning	-2.568*** (-4.69)	-0.000164*** (-9.26)	-122.7*** (-4.26)	-0.00694*** (-8.38)
Areal	0.00580*** (3.45)	-0.000000143** (-2.64)	0.184* (2.07)	-0.00000504* (-1.98)
Urbanisation	-1.434*** (-3.57)	-0.0000576*** (-4.45)	-61.91** (-2.93)	-0.000760 (-1.25)
House Prices	-0.0768*** (-11.71)	-0.00000181*** (-8.55)	-4.198*** (-12.17)	-0.0000994*** (-10.02)
Constant	50.52 (0.28)	-0.0394*** (-6.86)	16049.7 (1.71)	-1.588*** (-5.90)
Observations	1740	1740	1740	1740
R ²	0.974	0.518	0.952	0.426
Adjusted R ²	0.974	0.513	0.951	0.420
AIC	22075.3	-13914.5	35866.2	-523.6
VIF (mean)	3.68	3.68	3.68	3.68
Breusch–Pagen test	2246.55	170.96	7911.87	215.75
Moran's I (p-value)		0.8181		

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The degree of explanation (R^2 and Adjusted R^2) is very high in the two models that measure the number of homes for the elderly and the size of homes for the elderly (Models 1 and 3). On the other hand, the unrelated variables can only explain a small part of the variation across municipalities regarding number per capita and size per capita, respectively (models 2 and 4). Table 3 also presents the Breusch–Pagen test results for heteroscedasticity, with a test statistic from 170.96 to 2246.55. Compared to a Chi-Squared distribution with one degree of freedom, the resulting p-value falls well below the standard .05 level. Thus, we have clear evidence to reject the null hypothesis of homoscedasticity and accept the alternative hypothesis that we do have heteroscedasticity in this regression model's residual. All models have been estimated with White heteroscedasticity-consistent standard errors. The average VIF value (3.68) is low, which indicates that we have a low risk of multicollinearity. There are mainly two variables with a higher VIF value (around 10), income and house prices. Concerning these variables, some caution should be exercised when interpreting their effect.

Statistically, only the variables *Employment* and the proportion of housing in rental housing (*Rental Owning*) can explain either the number of elderly housing, its size, or its equivalents per capita. In model 1, where the number of older homes is the dependent variable, we can note that the population and the proportion of older people in the municipality have a high statistical significance. The same applies to the income variables Income and Equalisation. However, the tax level in the municipality does not affect. The population, the proportion of the elderly in the municipality and the average income in the municipality all have the expected signs, i.e. if the variable in question increases, the number of elderly housing increases, everything else being equal. The parameter estimate regarding *equalisation* has a negative sign, which could be considered unexpected. The interpretation is that if the municipality is a net recipient of municipal support, it has fewer elderly housing. Increases the proportion of people who have voted for the Social Democrats, so it does not affect the number of elderly housing. Of the housing variables, it can be stated that if the proportion of residents in single-family homes decreases, the number of elderly housing decreases. As mentioned earlier, the proportion of residents in rental housing does not affect. The level of housing prices has a statistically significant impact on the number of homes for the elderly. Increased price level reduces the number of homes for the elderly. Geographically larger municipalities have slightly more elderly housing, while municipalities with a higher degree of urbanisation have fewer elderly housing than rural municipalities.

In model 2, where we use the number of elderly housing per capita as a dependent variable, it can be noted that, as in model 1, the number of elderly housing per capita increases if the number of older people increases in the municipality. Unlike model 1, the estimates show that per capita, the number of homes for the elderly decreases if the municipality is a relocation municipality and a geographically larger municipality. Increased income, if the municipality is a net beneficiary and if taxes increase, leads

to more elderly housing per capita. As in model 1, more people in single-family homes, more residents in urban areas, and higher housing prices decrease the number of homes for the elderly.

The difference in parameter estimates in model 3 compared to model 1 is relatively small. In model 3, the estimated size of the elderly housing in the municipality is used as a dependent variable. The difference is mainly that the municipality's income tax level has a statistically significant effect on size. An increased tax level does not necessarily lead to more homes for the elderly but larger houses for the elderly. The differences between model 4 and model 2 are also small, but the results indicate that the degree of urbanisation does not play a role in the size of elderly housing. Otherwise, all other parameter estimates have the same sign and order of magnitude in model 4 as in model 2.

Between and Random Effect Models

We have also estimated between effect and random effect models to reduce the risk of omitted variable bias and heterogeneity. The results from these models are presented in the table below. Only the models where the intention is to explain the number and size of elderly housing per capita have been estimated. The results are presented in Table 4 and Table 5.

Table 4: Results (Between-effect, regression on group means)

	(1) No House	(2) No HouseCapita	(3) Size House	(4) Size HouseCapita
Population	0.0121*** (86.22)	4.07e-09 (0.92)	0.465*** (62.19)	0.000000183 (0.87)
Net-migration	-5.233 (-0.29)	-0.00236*** (-4.06)	-213.1 (-0.22)	-0.0987*** (-3.59)
Elderly	879.1** (2.89)	0.0553*** (5.72)	37731.9* (2.32)	2.217*** (4.83)
Employment	-1.807 (-0.51)	0.0000877 (0.78)	-41.00 (-0.22)	0.00463 (0.87)
Income	2.969* (2.39)	0.000197*** (4.98)	161.9* (2.44)	0.00846*** (4.51)
Equalisation	-0.00573 (-1.63)	0.000000762*** (6.81)	-0.239 (-1.27)	0.0000291*** (5.48)
Tax	-3.268 (-0.31)	0.000706* (2.11)	-805.6 (-1.43)	0.0219 (1.38)
Voting	-1.099 (-0.79)	-0.000160*** (-3.63)	-35.15 (-0.48)	-0.00705*** (-3.38)
Ratio rental	0.0922 (0.05)	-0.0000368 (-0.65)	-25.48 (-0.27)	-0.00181 (-0.68)
Ratio owning	-2.896* (-2.13)	-0.000195*** (-4.51)	-139.0 (-1.92)	-0.00828*** (-4.04)
Areal	0.00529 (1.27)	-0.000000235 (-1.78)	0.159 (0.71)	-0.00000890 (-1.42)
Urbanisation	-1.485 (-1.49)	-0.0000570 (-1.80)	-64.80 (-1.22)	-0.000707 (-0.47)
House Price	-0.0864*** (-5.02)	-0.00000214*** (-3.91)	-4.707*** (-5.12)	-0.000115*** (-4.42)
Constant	66.49 (0.15)	-0.0455** (-3.18)	18207.7 (0.76)	-1.829** (-2.69)
Observations	1740	1740	1740	1740
R^2	0.975	0.553	0.953	0.457
AIC	3682.9	-2324.2	5990.1	-85.69

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Results (Random effect, Maximum likelihood estimates)

	(1) No House	(2) No HouseCapita	(3) Size House	(4) Size HouseCapita
Population	0.0112*** (73.83)	-2.31e-09 (-0.51)	0.405*** (49.46)	3.25e-08 (0.15)
Net-migration	1.576 (0.86)	-0.0000805 (-1.62)	45.74 (0.74)	-0.00418 (-1.23)
Elderly	411.3* (2.24)	0.0450*** (8.39)	4814.6 (0.66)	2.070*** (6.75)
Employment	0.451 (0.44)	0.00000217 (0.08)	56.45 (1.51)	-0.000101 (-0.06)
Income	0.668** (3.14)	0.00000968 (1.66)	22.55** (3.03)	0.000619 (1.62)
Equalisation	0.000416 (0.49)	4.60e-08 (1.88)	0.0262 (0.83)	0.00000382* (2.52)
Tax	-0.282 (-0.11)	0.000237*** (3.32)	24.02 (0.26)	0.00761 (1.68)
Voting	0.105 (0.39)	0.00000383 (0.52)	0.638 (0.07)	0.000138 (0.28)
Ratio rental	-0.283 (-0.26)	0.0000398 (1.24)	-32.43 (-0.76)	0.000679 (0.36)
Ratio owning	-1.948* (-2.28)	-0.0000238 (-0.94)	-93.04** (-2.62)	-0.00204 (-1.44)
Areal	0.00937* (2.52)	0.000000435*** (3.50)	0.393 (1.92)	0.0000151** (2.70)
Urbanisation	-0.875* (-2.03)	-0.0000722*** (-5.89)	-19.67 (-1.23)	-0.00244** (-3.25)
House Price	-0.00664 (-1.47)	5.71e-08 (0.47)	-0.133 (-0.85)	-0.00000994 (-1.23)
Observations	1740	1740	1740	1740
AIC	18460.6	-18017.4	30989.9	-4538.2

t statistics in parentheses* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4 shows parameter estimates for all models where the effect has been estimated using the so-called between-effect model. The difference between these results and the OLS estimates in Table 3 is not dramatic. In principle, all variables have the same sign as in the OLS model, but some of the estimates are not significantly different from zero. We can observe the most significant difference: neither geographical size nor the degree of urbanisation influences the number or size of elderly housing.

Concerning the variable Net-migration, we can note that the effect appears to be of greater importance in the between-effect model than for the OLS model. Other estimates are within the margin of error. This suggests that the OLS estimates are relatively robust.

The result from the random effect model presented in Table 5 has remarkable similarities with the OLS result, although several estimates are not significantly different from zero. The population size does not have the same consistent positive effect, net migration has no significant effect at all, the income level has only one effect in the model parts that do not meet the per capita effect, and the equalisation system does not affect. The same applies to the proportion of residents in tenancies that only partially affects the various model specifications. On the other hand, the proportion of older people in the population has a positive impact together with the municipality's geographical size and degree of urbanisation.

Spatial Econometric Models

Spatial dependence is common in geographic data such as ours. In Table 3, Moran's I is reported as a measure of the prevalence of spatial dependence. We can note that spatial dependence is not present in the residual from estimated OLS models. However, as Moran's, I typically measure global spatial dependency we have addressed potential problems with local spatial dependency by estimating a spatial error model (S.E.M.) and a spatial autoregressive model (S.A.R.). The first two models (1) and (2) are the spatial autoregressive specification while the two latter (3) and (4) are the spatial error models. The result is illustrated in Table 6.

Table 6: Results (Spatial dependency-models)

	(1) No HouseCapita	(2) Size HouseCapita	(3) No HouseCapita	(4) Size HouseCapita
Population	-3.09e-09 (-0.67)	-0.000000188 (-0.93)	-3.51e-09 (-0.77)	-0.000000204 (-1.01)
Net-migration	-0.0000879 (-1.74)	-0.00360 (-1.88)	-0.0000915 (-1.82)	-0.00359 (-1.88)
Elderly	0.0446*** (8.10)	1.568*** (7.11)	0.0439*** (7.99)	1.525*** (6.89)
Employment	-0.0000241 (-0.69)	-0.000217 (-0.16)	-0.0000263 (-0.76)	-0.000131 (-0.10)
Income	0.0000145 (1.26)	0.000642 (1.45)	0.0000149 (1.30)	0.000693 (1.55)
Equalisation	6.33e-08 (1.81)	0.00000173 (1.30)	5.95e-08 (1.70)	0.00000168 (1.26)
Tax	0.000234* (2.32)	0.00481 (1.26)	0.000214* (2.12)	0.00411 (1.06)
Voting	0.0000135 (1.62)	0.000311 (0.98)	0.0000128 (1.55)	0.000308 (0.97)
Ratio rental	0.0000211 (0.62)	0.000786 (0.57)	0.0000217 (0.64)	0.000930 (0.68)
Ratio owning	-0.0000289 (-1.03)	-0.00144 (-1.23)	-0.0000278 (-0.99)	-0.00139 (-1.19)
Areal	0.000000431*** (3.43)	0.0000189*** (3.31)	0.000000277* (2.00)	0.0000112 (1.78)
Urbanisation	-0.0000752*** (-5.48)	-0.00244*** (-4.57)	-0.0000744*** (-5.45)	-0.00239*** (-4.47)
House Price	0.000000119 (0.91)	-0.00000408 (-0.84)	0.000000130 (1.03)	-0.00000500 (-1.03)
Constant	0.00187 (0.36)	0.178 (0.89)	0.00555 (1.03)	0.326 (1.55)
e.No HouseCapita	-0.0223 (-0.14)			
No HouseCapita			-0.204* (-2.52)	
e.Size HouseCapita		-0.191 (-1.14)		
Size HouseCapita				-0.259** (-2.81)
AIC	-18017.3	-5247.5	-18023.7	-5254.1

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results suggest that it is the spatial autoregressive models that are preferred. According to AIC, the value in models (3) and (4) is minimised. However, the difference is not large and not statistically significant. It can also be noted that in these models, the parameter estimation regarding the spatial component is significant. The results do not differ significantly from the random effect models, but relatively much from the OLS models and the between-effect models. Unsurprisingly, it is the proportion of older people who have a high explanatory power even when we take spatial dependence into account. The municipal tax is vital in the models that explain the number or size of elderly housing per capita. Furthermore, the municipality's geographical size has a positive impact, and the degree of urbanisation has a reproductive impact.

Cohorts effect

Having a high proportion of people older than 65 does not necessarily mean that the need for elderly housing is noticeable. Age is of great importance and a high proportion over 85 years of the population has a more significant impact on the need than a lower proportion. Therefore, we have divided the variable older than 65 years into 10-year cohorts and analysed the effect within each group. The table below illustrates the effect of the different age groups.

Table 7: Results (Cohorts effects)

	(1) No HouseCapita	(2) Size HouseCapita
Age 65-74	0.0202** (2.66)	0.902** (3.04)
Age 75-84	0.0599*** (6.13)	1.988*** (5.21)
Age 85-94	0.0991*** (5.28)	2.862*** (3.93)
Age >95	0.131 (1.88)	5.519* (2.07)
No HouseCapita	-0.217** (-2.73)	
Size HouseCapita		-0.268** (-2.94)
	(53.37)	(53.46)
AIC	-18039.5	-5259.0

t statistics in parentheses

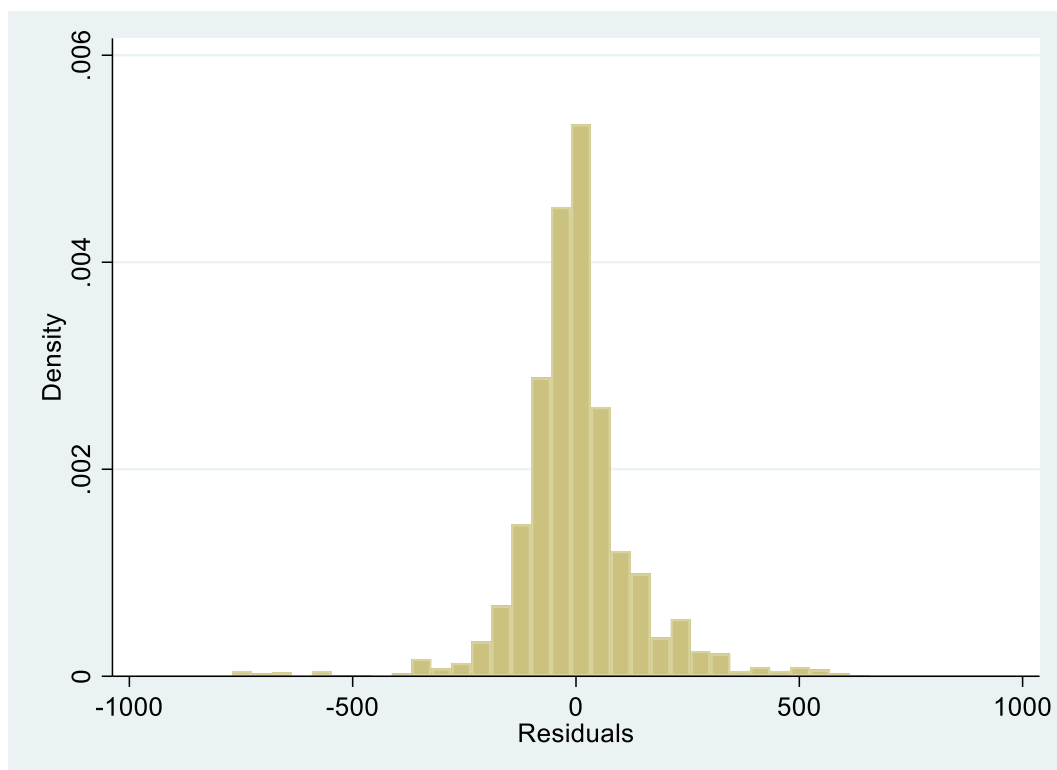
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We can note that the older age groups have a more significant impact on the number of elderly housing per capita and size per capita. The result itself is not surprising. Even if the need for elderly housing does not exist in the younger age groups, it is, of course, a good predictor of future needs. The expectation was that the proportion older than 95 years would have the most significant impact, but this is not the case. This may be partly because this group in many municipalities is relatively small, partly because the planning of the need for elderly housing often occurs based on the age groups younger than 95 years.

Analysis of the residuals

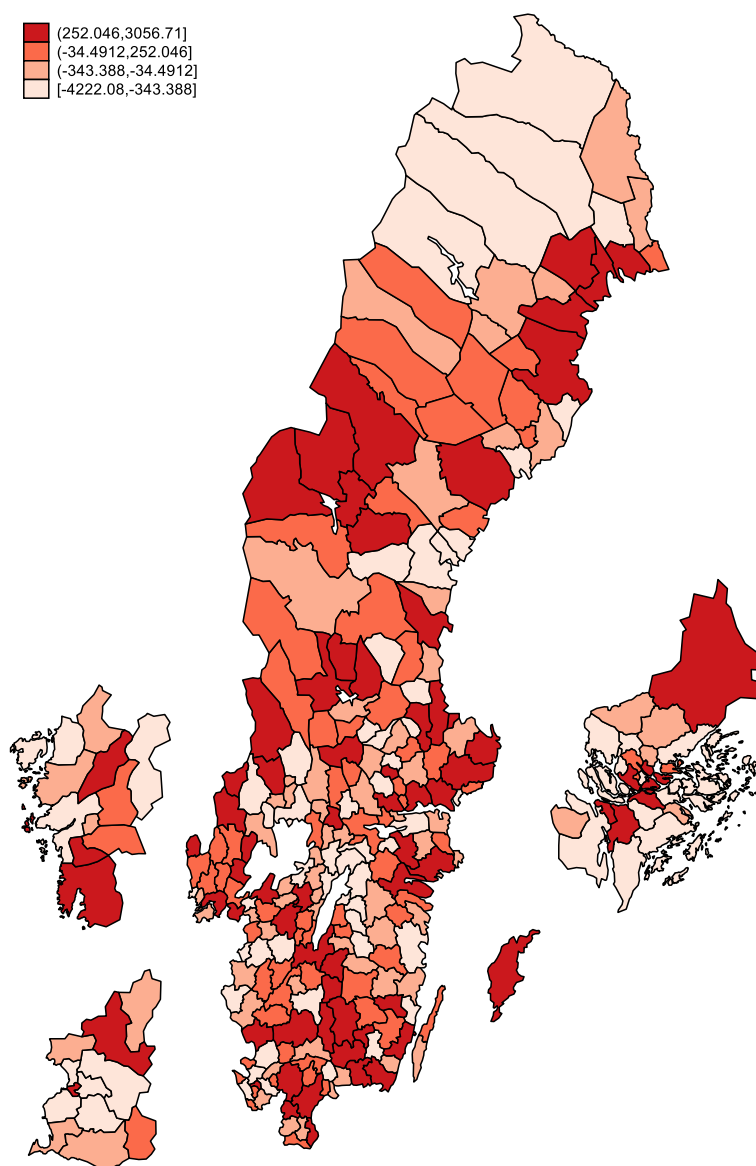
How to interpret the residuals/error? By definition, it shows the difference between the actual number or size of elderly housing in a municipality and the estimated number/size. In municipalities with a positive error term, this means that the observed housing stock is larger than the estimated, which can be interpreted as having an oversupply of elderly housing. On the contrary, in municipalities with a negative error term, i.e. a undersupply of elderly housing. We have previously tested for the presence of hot spoon stability and spatial dependence in the residual. The residuals are plotted in Figure 4.

Figure 4: Histogram residual, accumulated over the years 2013-2018.



The accumulated oversupply and undersupply of elderly housing for the years 2013-2018 are illustrated in Map 5. What we can observe is that there is a relatively large spread within the country. Per capita, the spread is between x and y is the number of homes for the elderly in the country. The variation is significant, especially if you relate it to the average number of elderly housing per capita that amounts to z. However, the pattern is not clear; for example, there are no spatial clusters with excess or deficit. A concentration can be discerned with an excess of elderly housing in the metropolitan regions.

Map 3: Residuals (over/undersupply), the years 2013-2018.



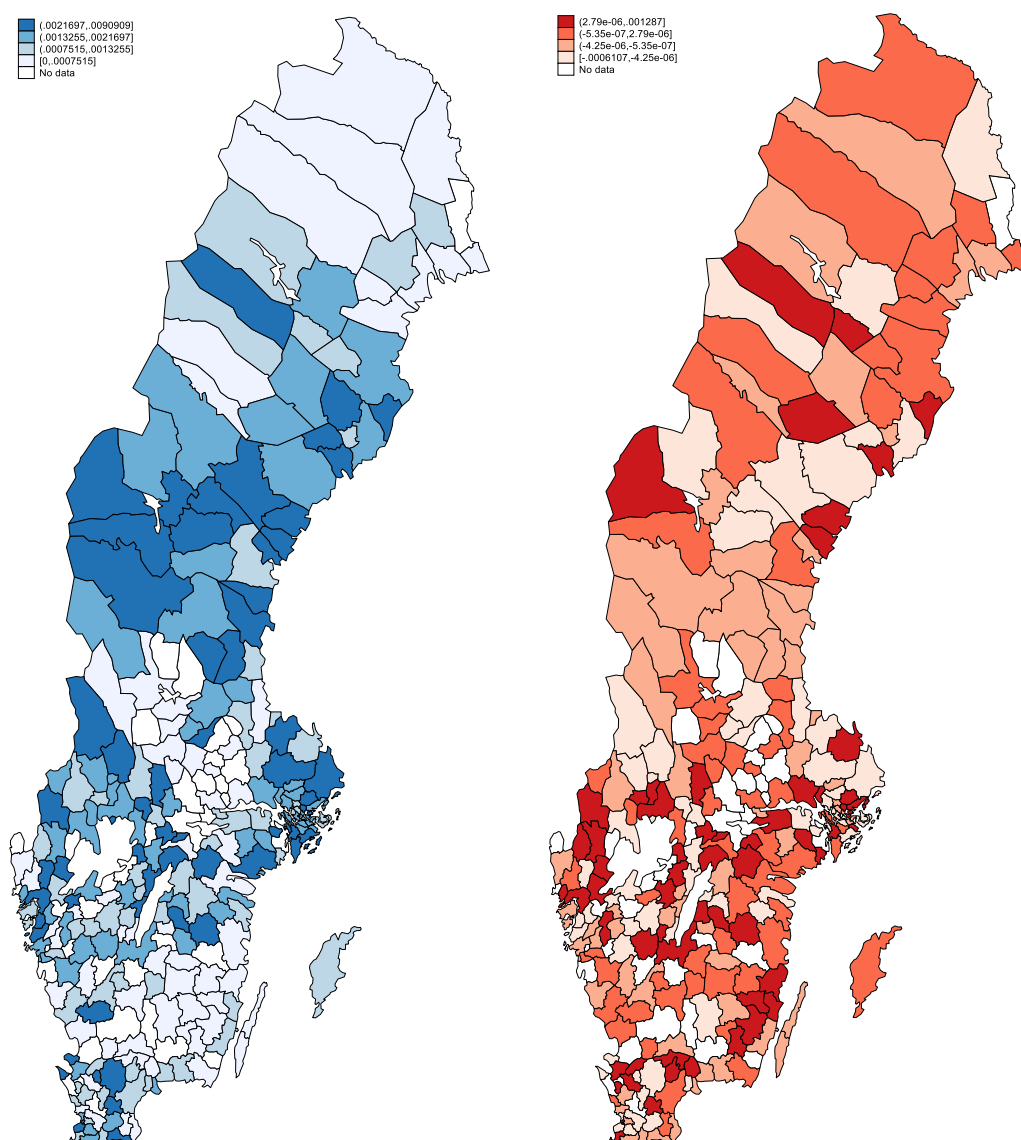
Relation to Covid-19 distribution

The year 2020 is marked by the pandemic of Covid-19. The number of infected and deceased has been extensive, and, above all, the elderly have been disproportionately hard hit (Burton et al., 2020). Of those affected by Covid-19 in Sweden, the median ages are 61 years, and approximately 78% have some form of a risk factor such as heart and lung disease, high blood pressure or diabetes. It is mainly men who have been affected, and in the upper age ranges, about twice as many men have been affected than women. In the age range over 70 years, 570 men have been affected by Covid-19 than 250 women. However, the survival rate of those who have been affected is approximately equal between men and women. (Source: Swedish Intensive Care Register, 2020-11-24).

Many of the elderly have been living in a special housing that is included in this survey. Statistics on deaths per municipality are challenging to analyse as in some municipalities there have been very few who have been affected and died. However, one figure that has been possible to produce at the regional level is the number of infected people over 70. The data comes from the National Board of Health and Welfare and refers to what the situation looked like during October 2020.

Map 4 illustrates the distribution of infected with Covid -19 per number of special housing in the municipality (Blue map), that is, we analyse whether there is a relationship between the number of infected and special housing. Moreover, we investigate whether there is a connection between over-/undersupply of special housing in the municipality and infected with Covid -19 (Red map), whether there is a spatial variation between the distribution of the expected number of special dwellings and Covid -19.

Map 4: Covid-19 per capita and by over/undersupply of elderly houses.



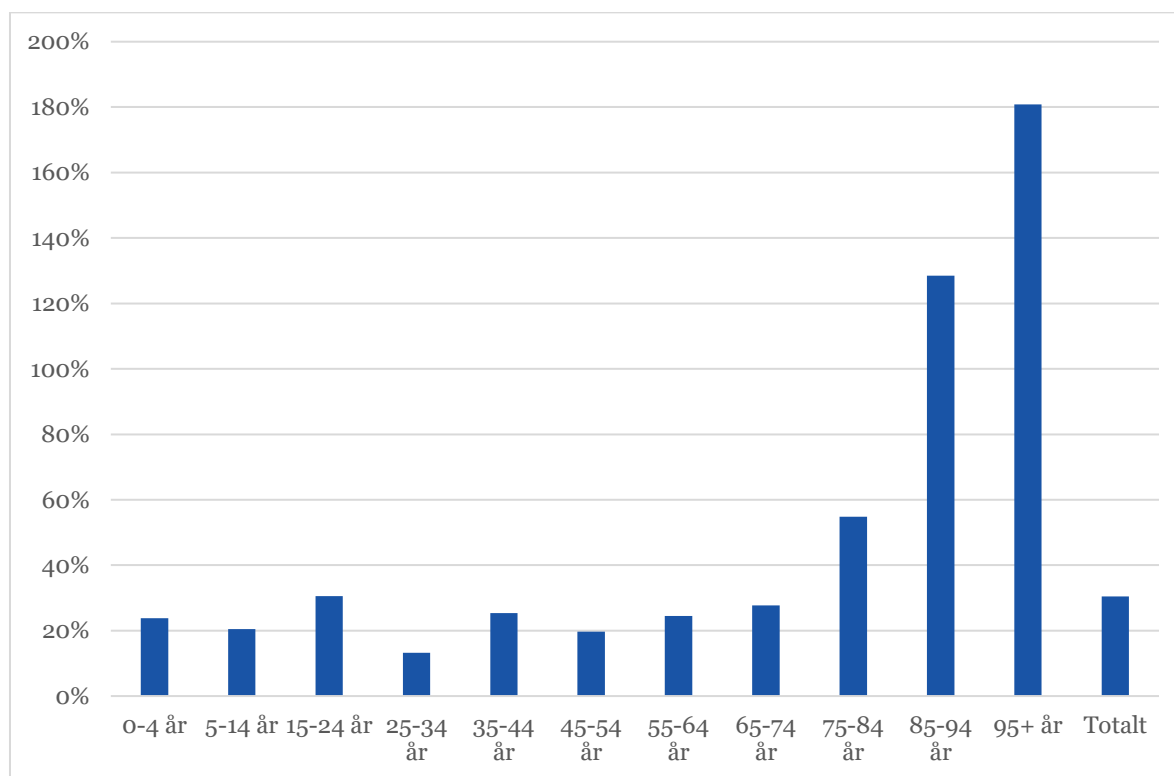
It is clear that there is a concentration of covid-19 cases to the metropolitan regions, but where the Stockholm region, in particular, has been hard hit. It is also noteworthy that the number of cases per capita has also been considerable in central Sweden. However, the correlation between the number of cases per capita and the number of elderly homes per capita or the size of the elderly homes per capita is almost zero. Furthermore, its correlation with oversupply or undersupply of elderly housing is also close to zero. Hence, the result is clear concerning Covid-19 cases and the accumulated over- and undersupplies of elderly hoses. The spatial variation in the number of Covid-19 cases is not correlated with the distribution of accumulated over and each sub-supply of elderly housing for 2013-2018. The conclusion is that municipal decisions to build more homes for the elderly or not build more homes for the elderly have not impacted Covid-19 cases among the population over 70.

Relation to demographic changes in the future

The population is getting older in Sweden, as in many other countries. The proportion of the population over the age of 80, for example, will increase dramatically. In the future, this will mean that the supply of elderly housing will increase. Long-term planning is required to achieve this, and the question is whether the municipalities have already taken into account the fact that the proportion of older people in the municipality is increasing. For example, Gibson (2020) suggests that long-term care planning requires careful review in choosing a more robust version of the provision ratio for the future.

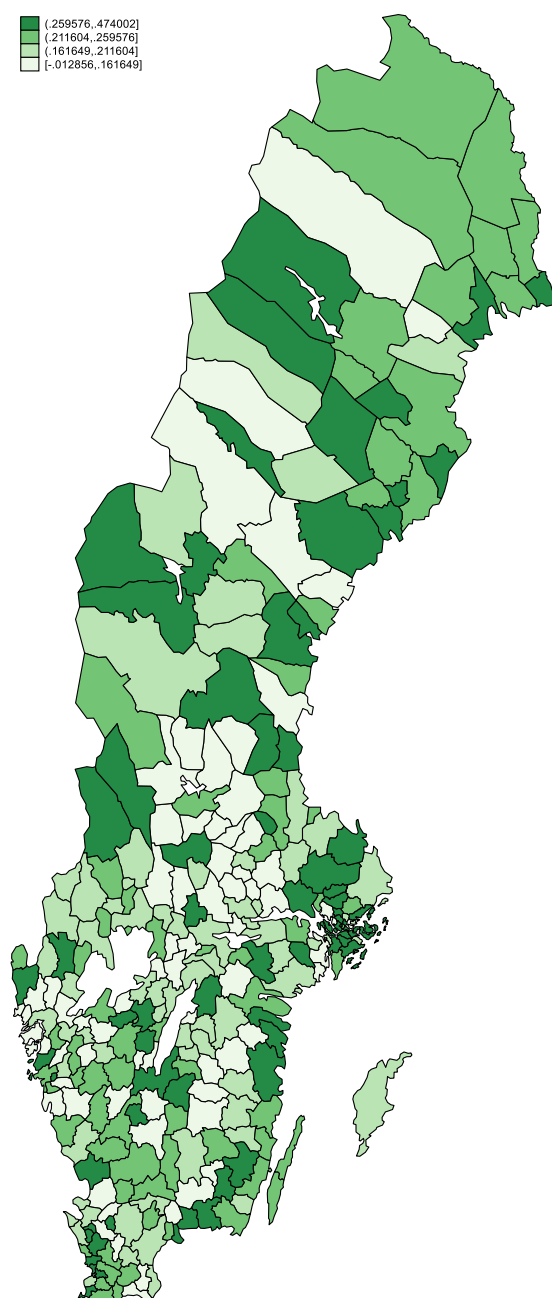
We have here related the oversupply or undersupply of elderly housing with a projection of the number of elderly in the municipality of 10 and 20 years, respectively.

Figure 5: Projection of changes in population in different cohorts from 2010 to 2100.



The increase in the age range 0-75 years is relatively constant at 20%. It is in the older age groups that the increase will be most dramatic. In the group 75-84 years, the increase will be about 60%, in the age group 85-94 years as much as 120% and older than 95 years is expected to increase by as much as 180%. Map 5 illustrates the spatial distribution of the percentage change in people older than 75 years.

Map 5: Projection of persons over 75 years (percentage change 2020-2030).



The percentage change is most significant in the country's most populous parts, which means that older people will increase both in absolute numbers and relative terms. That is, even in areas with a high influx, the proportion will grow rapidly. We can also note that in some places of relocation, the number of older people will increase significantly at the same time as younger people move away from these municipalities. Together, this will have a significant impact on the municipal economy. The correlation

between the expected percentage change of older people until 2030 and the number of elderly housing in the municipality and the average size of elderly housing is significantly negative (-0.41 and -0.39, respectively). This means that in municipalities where we already have relatively few homes for the elderly, the percentage change will also be greatest.

5. Conclusion

Significant demographic changes are taking place in Sweden as well as in many other countries. The proportion of older people will almost double, and people older than 80 will triple. It will place significant demands on care both in one's own home but also in elderly care. The dimensioning of elderly housing will be decisive for how well one can handle this demographic change. Today we can see that the distribution of elderly housing per capita varies considerably between municipalities.

The dimensioning is of course both a result of the municipality's planning of elderly housing and private actors in elderly care who decide on more market terms. We have been interested in how what can explain the spread in distribution that we can observe. The explanatory factors included in our explanatory model are partly the municipality's size, finances, political governance, and how well the housing market in general functions.

What we find in general is, not surprisingly, that the proportion of older people in the municipality is the variable that most explains the number of elderly homes in the municipality together with the size of the municipality. Geographically large municipalities have more homes for the elderly, and more urbanised municipalities have fewer. We can also note that the municipality's tax collection positively impacts the housing stock for the elderly. Other factors do not have an equally clear effect depending on the model specification and model estimation.

Planning for future needs of nursing homes is necessary. The population is getting older, which will mean that the costs to future generations will be high. Some municipalities are further ahead when it comes to investments in nursing homes, while others lag. In many cases, these municipalities trust the other housing market to function well enough and swallow the need to arise.

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