091

Distances, accessibilities and attractiveness:

Urban form correlates of willingness to pay for dwellings examined by space syntax based measurements in GIS

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Abstract

The population of Oslo increases rapidly and the corresponding demand of housing is an issue of great public, political and professional interest. Today, we can see several interesting discrepancies in the housing market, such as very high prices for dwellings with low technical standards and for dwellings located in "cityscapes" very different from what is planned and built today. There is a great diversity in attractiveness of housing in terms of a households' willingness to pay. What are the patterns of such attractiveness in more detail and what might be the lessons to learn concerning what to build in the future? How can we plan and build housing that responds to the wide range of contemporary demands and that will also be attractive in decennials to come?

Economists and real estate businesses provide statistics on prices of dwellings, but the variables examined are usually too general for the results to be useful for actual planning and design. However, space syntax based research has shown that locations in cities can be measured more specifically and that analyses of these measurements correlate with numerous phenomenon related to activities and attractiveness of cities. By applying space syntax based measurements in GIS, comparing housing prices with presumed relevant variables of buildings and neighbourhoods by means of hedonic regression analysis, it is possible to seize new knowledge about how specific urban form variables of buildings and neighbourhoods correlate with housing prices. By this approach, willingness to pay for dwellings has been examined in two studies in Stockholm and Copenhagen. This paper presents methods and some result of these studies. In brief, we see that continuous urban form measurements in GIS are significant for willingness to pay for dwellings. Some of the significant measurements are distance to city centre and accessibility from dwellings to parks, public transport and waterfronts. Due to the specificity of these measurements achieved by GIS analyses applying the Place Syntax Tool, leaning on methods from space syntax and urban morphology rather than on the less building- and urban form specific measures of the real estate business, the method provides new and more detailed knowledge. This knowledge should be useful for the wide range of actors participating in housing design and development, actors ranging from politicians, local authorities, urban planners and architects to real estate businesses and constructors.

Keywords

Willingness to pay for dwellings, attractiveness of location, urban form correlates to housing prices.

1. Introduction

With contemporary urbanisation, housing is an acute issue all over the world. In Oslo, the capital of Norway, the population increases rapidly and the corresponding demand of housing is an issue of great public, political and professional interest. Even though the international financial crisis and the corresponding collapses in housing markets has also influenced the Norwegian economy, the prices of dwellings are higher than ever (SSB, 2015-1) and the number of new dwellings last year (2014) being about 10 % above the average since year 2000 (SSB, 2015-2). In the contemporary liberal real estate market of Norwegian dwellings, there is a large span of housing prices, illustrating a great diversity in attractiveness in terms of willingness to pay for dwellings of different kinds and of different locations. Regardless of the contemporary all-time-high prices of dwellings in Oslo, there are areas where the prices are lower than the expenses of even the cheapest construction of new housing. At other locations, prices are high regardless of a technical quality far below contemporary standards. It is also interesting to see that well-connected street network and continuous building blocks rarely exist in new housing projects. This is a scheme that through time has proven to work very well both as dwellings and as neighbourhoods and that now often is very highly priced (Manum, 2006; Sjaastad et al., 2008).

On this background, a substantial question is to what extent housing prices are determined by the particular dwelling, by the building and by the surrounding neighbourhoods. In Norway, economists and real estate businesses provide large amounts of statistics on prices of dwellings, but the issues are markets and politics rather than architecture and buildings. Explicit layouts of buildings or neighbourhoods are scarcely examined, and research results useful to architectural design are hard to find. The points of Jane Jacobs (Jacobs, 1961) about planning and design of housing being guided by ideals and theories with little or no empirical foundation and contradictory to existing well-working layouts, is still surprisingly relevant.

However, since the 1990's, research within the field of space syntax has shown that crucial aspects of buildings and urban form can be grasped with spatial measurements and that analyses of these measurements correlate with phenomenon related to activities, attractiveness of dwellings and neighbourhoods (Hanson, 1998; Manum, 2006; Marcus, 2000). By applying continuous measures of urban form in GIS, space syntax based measures included, and comparing these with housing prices it is possible to reveal patterns about how numerous variables concerning layouts of buildings and neighbourhood correlate with housing prices. By this approach, the willingness to pay for dwellings has recently been examined in Stockholm and Copenhagen (Kummel and Andersson, 2012; T. Lundhede et al., 2013; Ståhle and Bernow, 2011). This paper presents and discusses methods and results from these studies and explains the proceeding large scale analysis of housing and housing markets in Oslo with a focus on urban form correlates to housing prices.

2. The cases and their methodology

In the following, we look more closely into the studies conducted in Stockholm and Copenhagen. This section presents the methodological approach of the two studies of urban form correlates to housing prices. The first part explains the statistical analysis, the second describes the spatial analyses and, the third presents the data before briefly presenting the two studies, pointing out some similarities and differences.

2.1 The statistical analysis – a hedonic price model

There are numerous approaches to studying housing markets and examining what people find attractive. A relevant statistical approach is the so-called hedonic price model. Hedonic models are based on supply of a large number of items and a market characterised by many small actors who one by one have neglectable influence on market conditions and prices. In hedonic analyses, the heterogeneous goods or dependent variable (here: dwellings) are characterised by numerous properties or environmental variables (or attributes) that one by one provide benefit, i.e. effect the price, such as closeness to city centre or dwelling size. By multivariate regression analysis, the

method estimates the price-effect of a change in one attribute, other attributes being constant. A prerequisite for this kind of modelling is that the sample is one housing market only. In general this means that there should be few transactions between defined housing markets and that buyers generally do not consider two different markets at the same time (Palmquist, 2005). Hedonic modelling is a powerful tool for estimating price effects of numerous likely relevant properties in large samples (Sjaastad et al., 2008). The method estimates impact of every statistically significant variable on the price variation and thereby gives a hint of peoples' willingness to pay for different particular properties of a dwelling. However, as for any analytical tool, what is not captured by the modelling must be kept in mind before generalising the results (Maclennan, 2012).

In practice, picking out the environmental variables as sketched in Fig. 3 in the results section, is a kind of craftsmanship leaning on knowledge about urban form variables' influence on housing prices in general and knowledge about the particular housing market examined in particular. The first stage, choosing which environmental variables to measure and test in the model, is based on assumptions on what is likely to influence the price. This stage is extensive and it is not until the second stage where testing and elimination of variables is done, for example due to co-variation, where the variables to be analysed further are selected. In the third stage, the final model is composed of the variables found to be significant in the second stage.

2.2 The measurements applied

The properties that influence the price (or monetary value) of real estate are of two kinds. One is the physical properties of the particular real estate object being purchased, such as the actual building (or part of building) and the ground, the nature/vegetation and the other physical elements that belong to it. The other is the properties of the particular real estate object in relation to the surrounding neighbourhood, landscape, city or district. The studies examined in this paper focus on the latter, which is what is captured by "location-location-location" being the mantra for the real-estate business and is about distances and accessibilities from a specific location to exterior attractions as well as to disadvantageous features of the surroundings.

In the studies presented here, the price effect of "location" is examined by two kinds of measurements. One is measurements simply counted within an area, the "area" being the building, the block or a part of town. The issues measured are number of residents, number of people at work, floor area of buildings and other kinds of "density measurements" within an area. The other kind is so-called continuous measures. Continuous measures are more complex and consider accessibility/proximity. These are measured as "distance to", such as distance to children-playground or distance to motorway, or as "number or amount within a certain distance", such as number of restaurants or area of parks within a certain walking distance (Manum and Nordström, 2013; Ståhle and Bernow, 2011). Fig. 1 illustrates such measures represented in the GIS model.

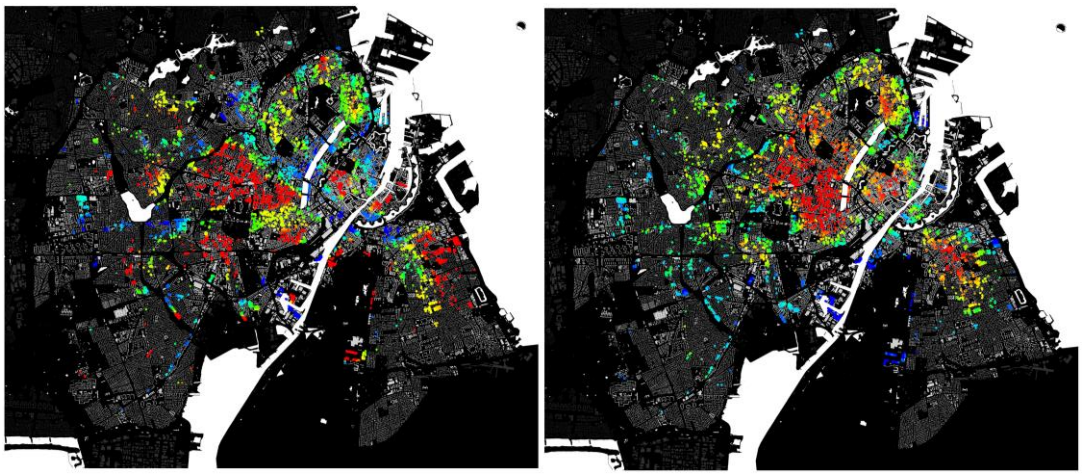

Figure 1. Two variables illustrated as map-images. Left: percentage of streets accessible within 500 m straight line distance that have speed restriction of 30 km/h or less. Right: functional compactness, measured as number of dwellers multiplied by workers within 500 m walking distance.

Distances can be measured in different ways (see Fig. 2). In the studies presented here, distances are measured in three ways. One is straight line distance, which is simply distance measured as the horizontal shortest route. The second is distance along route of real movement, such as walking or bicycling distances along safe/useful routes. The third is cognitive distance as grasped by the space syntax measurement axial steps, often applied in combination with metric distance along a route (Ståhle, Marcus, and Karlström, 2005). Apart from straight line distance measures, the measures are based on network distances. When calculating bicycle route distances, roads where bicycling is prohibited are excluded.

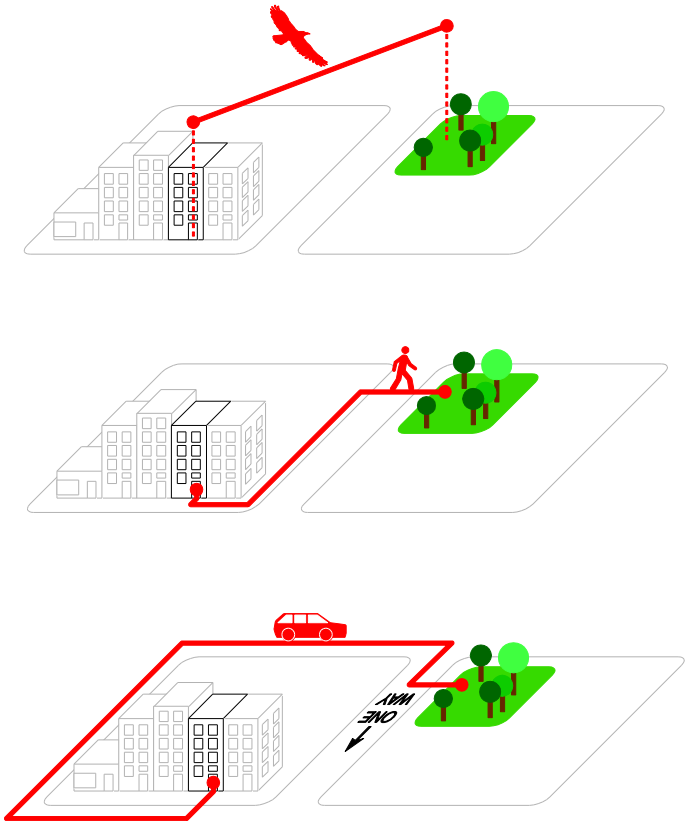

Figure 2. Different types of distance measurements. The origin of the measures is the dwelling entrance, the network distances differs by the travel mode examined.

In some cases, such as analysing the price effect of noise and pollution from a motorway, straight line distance will likely be the most useful distance measurement. Regarding other issues, such as price effect of distance from a dwelling to a children's playground, metric distance along safe walking routes will probably be more useful, maybe in combination with axial steps grasping cognitive aspects related to orientation and way finding.

2.3 Data

The total number of variables examined was about 1000 in Stockholm and 1300 in Copenhagen. This extensive amount of measures was possible due to the supply of precise and reliable GIS-data and the aim to test as many variables presumably significant for housing prices as possible. The GIS-data, which was provided by or gathered in close collaboration with local authorities, ranged from incomes and average grades in elementary schools to sizes of parks and locations of amenities and services.

The price data was also of great quantity. In Stockholm, the data included all sales of apartments in the first half of 2010 and all sales of single family houses in 2011, in total about 7 000. In Copenhagen, the time period was from 2007 to 2010 and the number was approximately 18 000 apartments and about 10 000 single family houses.

2.4 The cases

The first study was conducted for apartments in Stockholm in 2011 and was later completed with a study of single family houses in 2012. The study in Copenhagen included apartments and single family houses.

What makes the studies of Stockholm and Copenhagen especially interesting is the specificity of the measurements regarding accessibilities and distances and the measures being continuous rather than discrete or dummy variables, which have resulted in a new level of precision in analysing urban form correlates with housing prices. In both studies, the consultancy firm Spacescape performed the GIS-analyses applying the Place Syntax Tool, in Stockholm together with the consultancy firm Evidens and in Copenhagen/Aarhus together with researchers from the University of Copenhagen. (Kummel and Andersson, 2012; T. Lundhede et al., 2013; Ståhle and Bernow, 2011)

The two studies have similar setups of spatial measures. In total, more than 1000 variables were selected. Fig. 3 lists the main groups of variables examined. The variables were chosen for likely being significant and for being relevant to the practices of urban planning and architecture in the sense that planners and architects might have an actual impact on the phenomenon measured by the variables.

The methodological approach of the two studies differs in some respects. In Stockholm, the whole metropolitan area was considered as one market, only distinguishing between markets for apartments and single family houses. In Copenhagen, several markets were defined according to revealed differences in impact of location and geographical barriers such as expressways or green belts. Subsequently three markets were defined for apartments and four for single family houses in Copenhagen.

Another difference between the studies is how variance is handled. In Copenhagen, dwelling and building-specific features, such as number of bathrooms, balcony or not, façade material was included in the model, aiming to cover as many features assumed to be relevant for the price as possible. In Stockholm, another approach was used: the market was divided into geographical areas, 319 for apartments and 475 for single family houses, which were then appointed the mean value of the dwelling- and building-specific variables for all dwellings in the area. These mean values were then compared with the sale prices within the areas, as opposed to the variables being individually addressed to every individual sold dwelling, as was the case in Copenhagen. With this procedure in the Stockholm study, it was assumed that the variability of dwelling-specific variables was equally distributed over the area, and could therefore be excluded from the model due to lack of variance within each sample.

3. Results and discussion

The tables in Fig. 3 show the categories of variables examined and the main results in terms of variables found significant. In the study of Copenhagen, the main results are presented as ten “rule of thumb” (bottom list in Fig. 3). In addition to the results in common for the studies, such as the significance of accessibility to public transport, there are some interesting differences. One result is that typical factors of urbanity, such as accessibility to urban amenities and walking distance to city centre, are highly valued by apartment owners while single family house owners value typical rural factors, such as closeness to open water and to green spaces.

Another general remark is that no “negative” variables turned out as significant in the models in Stockholm, whereas for example noise was found significant in Copenhagen but not in Stockholm.

Axial integration turned out as significant, both locally and globally. It was significant in markets for apartments in both Copenhagen and Stockholm, but not among single family houses. This is an interesting result, considering that the model consists of some very strong determinants for housing prices. It should also be mentioned that walking distance correspond better to price variations than straight line distance.

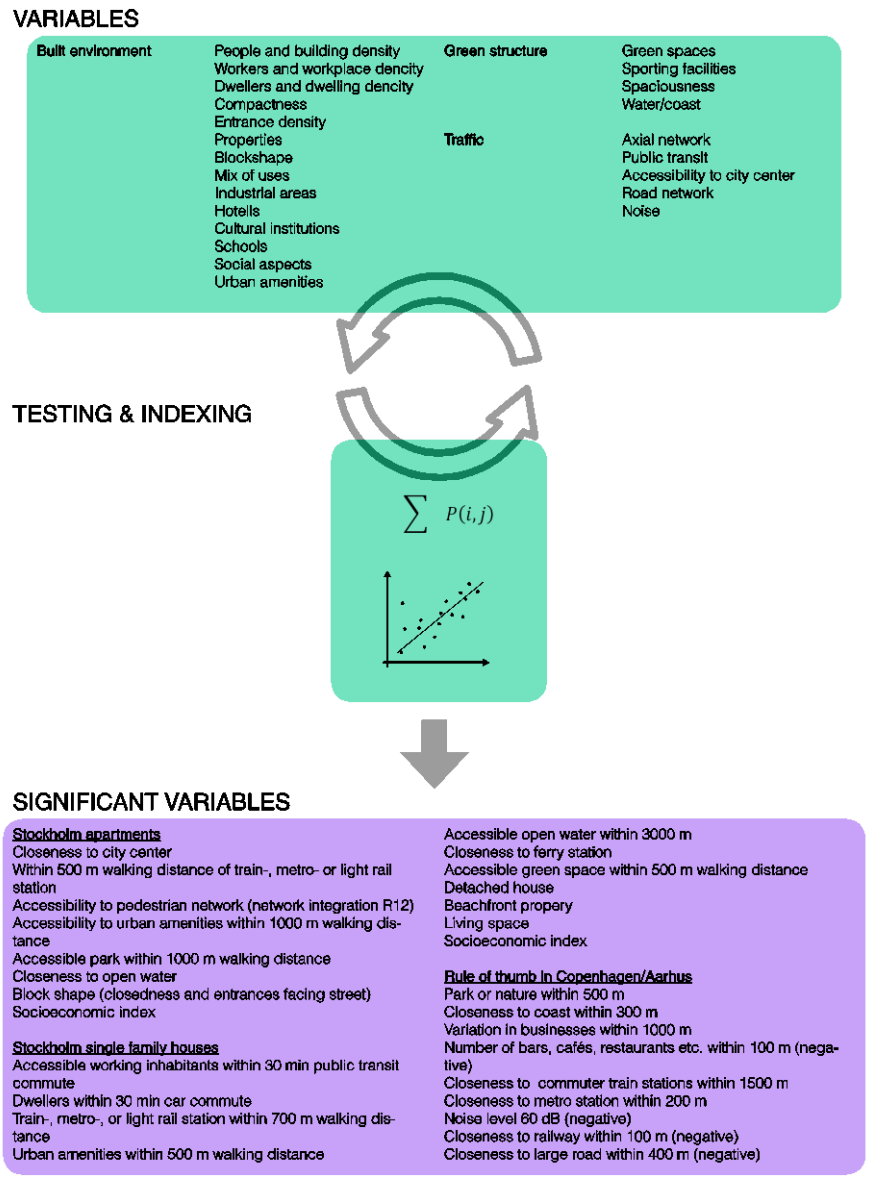

Figure 3. The working procedure for the hedonic model. First: selecting variables assumed to influence housing prices. Second: statistically testing the variables for co-variation, significance, and impact on housing prices, and accordingly grouping or indexing the variables to better explain the variation of prices. This stage iterates with the first stage. Third: the revised set of variables is examined by regression analysis. The table lists the variables found to be significant.

For architects and urban planners, results from hedonic price models are usually not very applicable since the variables usually are too general concerning actual layouts of buildings and urban form, corresponding less to peoples' actual behaviour and perceptions than walking distance along routes or space syntax integration. However, as stated before, the spatial measures in the studies in Stockholm and Copenhagen use walking distances and spatial distances as captured by space syntax, as opposed to mean values and straight line distance, and consequently have a precision and structure that differentiates them from most other studies (T. H. Lundhede et al., 2013; Ståhle and Bernow, 2011).

As previously explained, the hedonic model should use variables that correspond to how people actually perceive the phenomenon. For instance, axial steps should be included in the distance measurement when examining accessibility to parks (Ståhle, 2008). This is somewhat neglected in these studies, more so in Copenhagen than Stockholm.

Hedonic price models are considered as practise-friendly in terms of transparency and clarity. Due to the generality of the model the results are considered applicable in general policies for a city or region (Whitehead, 2012). Since the city of Copenhagen was divided into several markets, based on geographical statistical differences, some generality of the results are lost. For variables occurring in all markets, some general conclusions should still be valid. For variables that only occur in one market and not in the adjacent one, results can only be considered valid in that particular area. In general, a market should be defined as one (separated from other) only when there is little or no transactions across the border (Palmquist, 2005). We doubt that this is the case for two areas distinguished in the very centre of Copenhagen. Regarding single family houses and apartments, the division into separate markets more likely corresponds to the behaviour of households purchasing dwellings.

3.1 Space syntax measurements and housing prices

Chiaradia et al. (2009) , examining differences in prices in a northern borough of London, point out the importance of measures that correspond to actual urban conditions and argue that space syntax-based methods are highly useful in this respect. In the studies in Stockholm and Copenhagen, results point towards the same conclusions, i.e. that spatial accessibility in itself has an impact on housing prices. Spatial accessibility seems less important for people living in single family houses than for people living in apartments, perhaps due to lifestyles more dependent on private cars and consequently less so on a well-integrated street network.

3.2 Location, location, location

It is well known that location is decisive for housing prices. The specific urban variables that have shown to be significant in the studies presented here shed new light on what aspects of “locations” that are actually valued. Although most results of the two studies are similar there are also some differences between the two studies.

Urban amenities, defined as shops, excluding convenience stores, restaurants, cafés, bars and cultural amenities, were found to be significant in Stockholm. More explicitly, accessibility to urban amenities correlated with housing prices both for apartments and single family houses, within 1000 m and 500 m walking distances respectively. In Copenhagen, the result was more nuanced. It was found that restaurants, bars and cafés within 100 m correlated negatively to housing prices whereas accessibility to shops within 1000 m correlated positively. It was also found that variety in businesses, measured as number of different branches within distances between 800 and 1200 m walking distance correlated positively with housing prices. The results in Copenhagen indicates that restaurants, cafés and bars close to the dwelling are not appreciated by residents (because of noise or other disturbances) but the results in Stockholm suggests that they are appreciated at some larger distance. This issue; that correlation of some variables alters from positive to negative depending on the distance is discussed by (Heyman and Ståhle, 2013) and will be elaborated in further research.

In Copenhagen, distance to schools weighted by their average grades emerges as a significant variable, whereas in Stockholm it does not. This could be a matter of data supply, but it may also be that a schools’ average grades functions as a proxy for socioeconomic indexes, households’ income and parents’ education level. This was significant in Stockholm.

3.3 Urban Typologies versus continuous measures

The environmental variables in Stockholm and Copenhagen are constructed so that they measure only a single phenomenon. In contrast to this, for example, a study by Dittmar et al. (2007) aggregates several measures relevant for sustainable urbanism, such as mixed use, walkability etc. into one typology called “sustainable urbanism”, which is then compared to “old urbanism” and “standard urbanism” regarding correlation with dwelling prices. Even though the study indicates that such kinds of aggregated typologies might grasp some monetary issues, the urban form

characteristics are too general for the results to be applicable for architecture or urban planning. In comparison, the disaggregation of variables and the variables also being continuous makes the results of the studies in Stockholm and Copenhagen/Aarhus far more useful.

On the matter of typologies, the study by Sjaastad et al. (2008) in Oslo is relevant. It has the same basic approach as the studies in Stockholm and Copenhagen but does not have the space syntax based continuous measures as environmental variables and GIS-tools were not applied. Instead, they categorised neighbourhoods by urban typologies based on the idea that people are able to ascribe the properties they are looking for to urban typologies. This categorisation of neighbourhoods into a few types, does not capture any variations within neighbourhoods of the same type. A practitioner can consequently not differentiate which characteristics of a neighbourhood that are preferred and not from this study. Additionally some characteristics within a typology (e.g. “postmodern blocks”) might be well correlated to housing prices whilst some are not. However, the study has several interesting results, such as distance to parks in the centre correlates positively whereas distance to “un-programmed green areas”, a kind of area often found in post-war neighbourhoods, corresponding negatively with housing prices. In the studies in Stockholm and Copenhagen these typologies are instead disaggregated into variables not associated with only one typology, which makes the results more useful for practitioners.

3.4 Variables not captured by the analyses

In hedonic modelling, variables that are constant across the sample will not be found significant by the analysis but might very well be relevant in reality. One example is variables that are not present in the sample, such as price effect of adding a park in a city with no parks. Another is variables that are equally distributed all over the market. An example of the latter is the fact that neither of the studies found food stores to be significant. Accessibility to a food store is most likely relevant for people buying a dwelling, but since the stores are evenly distributed, giving little diversity in accessibility, it does not make any differences and is not captured by the analyses. This means that some variables can “disappear” in the statistical model even though they are, in reality, important for the willingness to pay for housing.

In our further research in Oslo we expect that accessibility to public transportation in the central parts of town might be one of those “invisible” variables that has an impact on price in reality but do not show in the model, due to the even distribution of bus routes, light rail and subway.

3.5 Prices, attractiveness and needs

In liberal real estate markets, such as the contemporary Norwegian housing market, the demand is often equalled with peoples’ needs. This is misleading; the demand in terms of the market’s willingness to pay for dwellings represents nothing more than the sum of requests of the households wanting and intending to buy a dwelling, it does not capture needs or preferences of households wanting a better dwelling without affording to buy one. (Aarland and Nordvik, 2009; Anderson and Duncan, 2011)

High price indicates that a number of people with a certain capability to pay find the actual commodity attractive and therefore worth the high price. People with lower income, such as average students or the unemployed, might agree that a highly priced dwelling is attractive (in terms of inheriting features to be appreciated), without ever considering buying the dwelling themselves. Concerning their own choice of dwellings, low-priced dwellings are likely the attractive ones, if we understand attractiveness as being sought for and purchased or rented.

The overall issue as well as the methodological approach of the studies presented in this paper are about built form and housing prices. This is a useful focus for carrying out certain work of research, but is at the same time a limitation that must be kept in mind before generalising results of this research to peoples’ needs for housing. Our further research will include elaborations on these kinds of relationships between housing prices and needs for housing, keeping in mind what is not captured

by the applied methodology and being aware of the tacit contemporary conception equalling peoples' need for housing with the demand of the liberal market.

4. Conclusions

The studies in Stockholm and Copenhagen suggest that continuous measures of accessibility and closeness/proximity as well as space syntax integration capture phenomenon relevant for people buying dwellings. Due to the specificity of accessibility and closeness/proximity analysed as continuous measures in GIS applying the Place Syntax Tool, the results are far more useful for planning and architectural design than economists' and real estate business' more general statistics on the housing market. The possibility to predict likely attractiveness of housing by space syntax and other GIS-based methods of analysis could have great impact on urban planning and housing development.

4.1 Further research

Based on the methodology and the results from the studies of Stockholm and Copenhagen, we are now conducting a similar study of Oslo. In addition to applying measurements and methods from the studies in Stockholm and Copenhagen, we will lean on a recent space syntax based study of Oslo where street networks and accessibilities are thoroughly examined. (Nordström et al., 2014)

Thanks to the extensive data on the housing markets, containing key data of all purchases of dwellings in Oslo over the last 20 years, we are able not only to examine price effects of different variables in the contemporary market, similarly to the studies in Stockholm and Copenhagen, we also have the opportunity to study development of prices over time. The time aspect hopefully can capture both fluctuations in demand for specific variables as well as differences among particular neighbourhoods' attractiveness over time. Such results might shed light on essential urban development issues related to gentrification. We hope to find patterns in price fluctuations that can be linked to urban form and consequently provide insights to how urban development, in addition to political and economic instruments, can be used to distribute monetary value of real estate more equally among the population. Through the methodological approach, we hope to reveal new knowledge of what could be attractive urban developments in the future. The studies in Stockholm and Copenhagen, perhaps due to their nature of consultancy reports, do not discuss peoples' needs versus ability or willingness to pay. This matter is briefly mentioned in previous section and will be elaborated in our ongoing research examining the housing market in Oslo.

Spatial measures, statistical testing, and the iterative process of analyses, is more closely linked in the Stockholm study than it is in the Copenhagen study. This might be part of the reason that straight line distances were most significant in Copenhagen whilst walking distance was most significant in Stockholm. In our study of Oslo we will elaborate the iterative process of comparing, selecting and grouping variables. We will have focus on measures that are known to have an impact on peoples' behaviour, instead of leaning too much on statistical suitability in the model. Although there are differences between the cities that will likely make the Oslo results somewhat different from those in Copenhagen and Stockholm, an important part of the Oslo study will be to synthesise the results with those of Copenhagen and Stockholm, looking for a general platform from which urban form can get a more central position in economical valuation of housing. Leaning on analytical theory of spatial capital as proposed by (Marcus, 2007) we might be able to provide new knowledge regarding variations of economic value due to spatial variability in cities. This knowledge should be useful for the wide range of actors participating in housing design and development, actors ranging from politicians, local authorities, urban planners and architects to real estate businesses and constructors.

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