# Utvecklingen på bostadsmarknaden i Södermanland efter Covid-19 pandemin i digitaliseringens spår
# En explorativ faktoranalys

Författare: Jie Li
Håkan Cavenius

Stockholm, November 2021

**RISE RESEARCH INSTITUTES OF SWEDEN**
Box 857, 501 15 Borås
info@ri.se

# Sammanfattning

Digitaliseringen har förändrat hur (och var) vi bor, arbetar och pendlar, och coronapandemin har sannolikt i viss utsträckning accelererat den förändringen samt givit oss en glimt om hur framtiden kan komma bli för vissa yrkesgrupper. Hur kommer kommunerna och regionerna utanför storstäder att påverkas på kort och lång sikt, och vilken roll kommer exempelvis tillgången till bostäder eller fritidshus med robust bredbandsuppkoppling och närheten till service och kommunikationer att spela för dessa eventuella strukturförändringar? Att få en bättre och fördjupad förståelse i denna fråga kommer att vara av stort värde för framtida planering av kommunala och regionala investeringar och insatser.

Under vintern 2020–21 påbörjade det statliga forskningsinstitutet RISE och Region Södermanland en dialog kring frågeställningar och eventuella samband mellan exempelvis bostadspriser, bredband, coronapandemin, distansarbete, pendlingsmöjligheter och tillhörande samhällsekonomiska effekter för regioner utanför storstäder, med särskilt fokus på effekterna på bostadsmarknaden och flyttmönster. Dialogen har rört olika typer av analyser som skulle kunna göras och modeller som dessa analyser skulle kunna utvärdera. Som en utkomst av dialogen har RISE nu genomfört en studie kring dessa eventuella samband, som presenteras i korthet nedan. En detaljerad rapportbilaga finns även som beskriver såväl metodik, analysresultat och diskussioner om möjliga framtida analyser.

I denna studie har vi analyserat utvecklingen inom bostadsmarknaden i hela Södermanland före och under coronapandemin med avseende på ett antal olika variabler. Vi har under en 28-månadersperiod från mars 2019 till juni 2021, före och under utbrottet av Covid-19, analyserat två 12-månadersperioder för att se om några mönster och skillnader kan detekteras. I analysen är bostadsmarknaden indelad i tre segment som är karakteristiska för den svenska bostadsmarknaden: bostadsrätter, villor och fritidshus.

Fyra grupper om närmare totalt 30 variabler om respektive bostadskaraktär, närhet till service och vatten, lokala socioekonomiska parametrar på DeSO-nivå, skolresultat (i termer av elever i grundskolan som genomgått årskurs 9), antal personer i arbetsför ålder som flyttar till Södermanland från Stockholmsregionen, utbildningsnivåer och disponibel inkomst har använts för att analysera och jämföra bostadsmarknadens attraktionskraft (i termer av pris per kvadratmeter) före och efter utbrottet av pandemin. Ju högre *kvadratmeterpris*, desto högre anses *attraktiviteten* vara för det aktuella boendeobjektet. Två olika analysmetoder har använts för att identifiera eventuella samband: multipel korrespondensanalys (MCA) och regressionsanalys.

### Stabilt antal bostadsaffärer med betydande prisökningar för fritidshus

När det gäller utvecklingen på bostadsmarknaden i allmänhet har det totala antalet bostadsaffärer för villor och fritidshus i stort sett varit oförändrat under de två analyserade 12-månadersperioderna i Södermanland, medan det har observerats en liten ökning av antalet affärer för bostadsrätter under period två, d v s efter pandemiutbrottet (vilket kan hänföras till den högre tillväxttakten av nybyggda bostadsrättslägenheter i Södermanland de senaste tio åren). Under hela den analyserade 28-månadersperioden sker betydande prisökningar för alla tre bostadskategorierna, framför allt för kategorin *fritidshus*. Mer specifikt har snittpriset per kvadratmeter ökat med 19 % för bostadsrätter, 24 % för villor och 39 % för fritidshus under samma kvartalsvisa 4-månadersperiod (mars-juni) från 2019 t.o.m. 2021. Dessutom är prisskillnaderna mellan de nio kommunerna i Södermanland relativt stora för villor och bostadsrättslägenheter, medan prisskillnaden för fritidshus är mycket mindre. Om fritidshus faktiskt används som just fritidshus så är de dock att betrakta som en lyxvara och bör därför vara mer utsatta för sjunkande priser vid en eventuell lågkonjunktur.

Genom att ytterligare dela upp bostadsaffärerna i de 177 DeSO-områden som Södermanland utgör kan vi också konstatera att bostadsrättsaffärerna främst sker i centralorterna (d v s i Eskilstuna, Nyköping, Strängnäs och Katrineholm samt Trosa), medan villa- och fritidshusaffärerna sker utanför stadskärnorna och ute på landsbygden. I de flesta av DeSO-områdena ökar kvadratmeterpriset för bostadsrätter särskilt i områdena runt Katrineholm. För kategorierna villa och fritidshus sker bostadsaffärerna däremot mestadels utanför stadskärnorna och ute på landsbygden. Villapriserna är generellt sett högre i DeSO-områdena i östra och sydöstra delen av Södermanland under båda perioderna, medan deras motsvarande öknings-/minskningstakt är mer jämnt fördelad i hela regionen. När det gäller fritidshus är både priserna och deras motsvarande öknings-/minskningstakt generellt sett jämnt fördelade i hela regionen förutom i områdena runt Nyköping (och till viss del också Katrineholm) där priset stiger markant efter pandemiutbrottet. En möjlig delförklaring till detta är att det sker en konvertering av fritidshus till villa (permanentning).

Figur I – Figur III illustrerar attraktivitet (kvadratmeterpris) för de tre bostadskategorierna på DeSO-nivå under ett år före och efter Covid-19-pandemin, och motsvarande öknings-/minskningstakt mellan de två perioder efter pandemiutbrottet.

**Bostadsrätter**

När det gäller bostadsrätters attraktionskraft, korrelerar högre bostadspriser mycket tydligt till den lokala socioekonomiska karaktären i det specifika DeSO-området (d v s invånarnas inkomst, ekonomiska standard, sysselsättningsgrad samt utbildningsnivå). När det gäller påverkan från själva karaktären och utformningen av bostadsrätter så är boarea, antal rum och månadsavgift starkt korrelerade med varandra, som förväntat (d v s ju större boarea, desto fler rum och desto högre månadsavgift). Bostadsrättens attraktivitet korrelerar negativt med högre månadsavgift samt positivt till byggår (ju nyare, desto högre attraktivitet), förekomsten av hiss och våningsplan (ju högre upp, desto högre attraktivitet).

En parameter av de som utgör bostadsrättens karaktär och utformning där vi identifierat en *skillnad* före och efter pandemiutbrottet (i jämförelsen mellan mätperiod 1 och 2) är om uppvärmningskostnaden ingår i månadsavgiften. Denna visar en negativ korrelation före pandemin, men en positiv korrelation efter pandemins utbrott till bostadspriset, d v s att om uppvärmningskostnaden ingår i månadsavgiften så får denna nu en påverkan uppåt på bostadspriset, vilket inte var fallet innan pandemin. En *möjlig* förklaring till detta kan vara att köparna förväntar sig att spendera mer tid hemma efter pandemin, t.ex. mer tid att arbeta hemifrån, och skulle därför förvänta sig högre kostnader för uppvärmningen än om uppvärmningskostnaden inte ingår som en fast (eller schablonbaserad) del av månadsavgiften. Här krävs dock ytterligare studier för att kunna förstå detta fenomen till fullo.

När det gäller skolresultaten (åk 9) korrelerar dessa i allmänhet för bostadsrätters attraktivitet positivt mer till resultaten från högskoleförberedande (teoretiska) program jämfört med yrkesförberedande (praktiska) program.

När det gäller personer (i arbetsför ålder) och hushåll som flyttar till en bostadsrätt i Södermanland från Stockholm, korrelerar överlag bostadsrätternas attraktivitet (och därmed kvadratmeterpriset) positivt mot det totala antalet inflyttade, med andra ord DeSO områden med högre attraktivitet för bostadsrätter har också högre antal inflyttade från Stockholmsområdet. Trots detta identifieras en *signifikant* skillnad före och efter pandemiutbrottet (d v s mellan mätperiod 1 och 2) när det gäller den genomsnittliga disponibla inkomsten hos de inflyttade, d v s de personer i arbetsför ålder som flyttar in med högre genomsnittlig disponibel inkomst tenderar också att flytta till de DeSO-områden med högre bostadsrättspriser efter pandemiutbrottet än före pandemin.

När det gäller närheten till centralorter, service och natur kan ingen skillnad detekteras mellan de två mätperioderna, det vill säga bostadsrätters attraktivitet korrelerar alltid positivt till närheten till Stockholm, lokala centralorter och vattenområden (hav eller sjöar).

Vad gäller tillgången till fiberbredband (eller motsvarande teknik) så är bostadsrätterna den kategori som har den klart högsta s k bredbandspenetrationen i Södermanland, och som köpare av en modern (eller upprustad) bostadsrätt förväntar man sig sannolikt att detta redan finns installerat.

En översikt över hur attraktiviteten för bostadsrätter är relaterad till de fyra grupperna av variabler före och efter pandemiutbrottet sammanfattas i Tabell I. Här redovisas på ett övergripande plan huvudsakliga observationer, skillnader och likheter mellan de två mätperioderna.

**Villor**

När det gäller villors attraktivitet, korrelerar högre bostadspriser mycket tydligt till den lokala socioekonomiska karaktären i det specifika DeSO-området (d v s invånarnas inkomst, ekonomiska standard, sysselsättningsgrad samt utbildningsnivå), dock för villaaffärer i DeSO-områden med de lägsta socioekonomiska nivåerna sjunker *inte* villapriserna likt samma trend för villaaffärer i andra DeSO-områden med högre socioekonomisk nivå.

När det gäller påverkan från själva karaktären och utformningen av villor är boarea och antal rum fortfarande (som väntat) korrelerade till varandra, och de korrelerar negativt till kvadratmeterpriset, med andra ord, ju större yta desto fler rum och ett lägre kvadratmeterpris. Högre kvadratmeterpris korrelerar positivt till storlek på tomtarea (ju större tomt, desto högre attraktivitet) och till taxeringsvärdet (ju högre taxeringsvärde, desto högre attraktivitet), samt i viss utsträckning negativt till byggår. Speciellt de villor som är byggda före 1940 visar en tydlig korrelation till högre priser, men även relativt nybyggda villor visar en tydlig korrelation till högre prisnivåer. En av flera möjliga förklaringar till detta är bl a att gamla småhus ofta har större tomtytor, och särskilt de som är byggda före 1940 kan vi konstatera är korrelerade till större tomter. Även andra kvaliteter, t ex av estetisk natur kan troligen också vara en av förklaringarna till ett högre pris (i synnerhet om fastigheten är i gott skick, på samma sätt som man får anta att nybyggda hus är).

När det gäller skolresultaten (åk 9) korrelerar dessa för villors attraktivitet mer efter pandemin *både* till resultaten från högskoleförberedande (teoretiska) program och till resultaten för yrkesförberedande (praktiska) program, totalt sett för hela Södermanland.

När det gäller personer (i arbetsför ålder) och hushåll som flyttar till en villa i Södermanland från Stockholm, är det generellt sett en tydlig korrelation mellan attraktiviteten (kvadratmeterpriset på villor) och det totala antalet personer som flyttar. Med andra ord, de DeSO-områden som har en högre attraktivitet för villor har också högre antal inflyttade från Stockholmsområdet. Trots det, när det gäller den genomsnittliga disponibla inkomsten före och efter pandemin (period 1 och 2; oavsett deras utbildningsnivå) finns en *tydlig skillnad*: före pandemin tenderade personerna att flytta till DeSO-områden med *lägre villapriser*, även om de hade högre genomsnittlig disponibel inkomst, medan denna tendens inte går att detektera efter pandemiutbrottet (period 2).

När det gäller närheten till centralorter, service och natur korrelerar villors attraktivitet alltid tydligt till närheten till Stockholm och till vattenområden (hav eller sjöar), medan det optimala (mest eftertraktade) avståndet till lokala centralorter (varierar mellan 2 och 10 km) korrelerar till högre villapriser, det vill säga, som villaägare vill man inte bo alltför nära centralorten (inte närmare än 2 km till centrala delar) men inte heller alltför långtifrån (helst inte mer än 10 km).

Dessutom har vi något oväntat observerat en negativ korrelation mellan höga villapriser och möjligheten att ansluta till fiberbredband. En möjlig förklaring till detta är att de villor som såldes utan tillgång till anslutningsmöjlighet för fiberbredband (ca 10% av villaaffärerna i period 1 och ca 7% av villaaffärerna i period 2) hade ett geografiskt läge som inte medgav en rimlig kostnad för anslutning till fiber (det genomsnittliga avståndet till centralorter för bostadsköp utan fibertillgång är faktiskt 7,5 km längre under den första mätperioden, respektive 5,8 km längre under den andra mätperioden, än de med möjlighet att ansluta till fiber), och att köparna därmed inte ansåg att detta var en särskiljande och avgörande faktor vid villaköpet.

En översikt över hur villors attraktivitet korrelerar till de fyra grupperna av variabler före och efter pandemiutbrottet sammanfattas i Tabell II. Här redovisas på ett övergripande plan huvudsakliga observationer, skillnader och likheter mellan de två mätperioderna.

## Fritidshus

När det gäller attraktiviteten för fritidshus, blir i allmänhet korrelationen mellan fritidshuspriserna och den lokala *socioekonomiska* karaktären (per DeSO-område) mycket *svagare*. En tänkbar förklaring till detta är att man som fritidshusköpare inte avser att bosätta sig permanent på platsen, vilket gör att de socioekonomiska faktorerna spelar mindre roll vid val av område för fritidshus samt att variationen av dessa faktorer sannolikt är större i dessa områden (som dessutom kan vara betydligt glesare befolkade).

När det gäller karaktären och utformningen av fritidshusen så korrelerar boyta fortfarande negativt till bostadspriset (per kvadratmeter), med andra ord, ju större yta desto lägre kvadratmeterpris. Ett högre kvadratmeterpris korrelerar också här positivt till tomtarean (ju större tomt, desto högre attraktivitet) och till taxeringsvärdet (ju högre taxeringsvärde, desto högre attraktivitet). En *anmärkningsvärd* skillnad mellan de två mätperioderna är att byggår, som var negativt korrelerad till fritidshusens attraktivitet före pandemin (ju äldre fritidshuset var, desto högre attraktivitet), inte längre är korrelerad till fritidshusens attraktivitet efter pandemins utbrott. Detta kan tyda på att köpare efter pandemins utbrott i större utsträckning söker efter nyare fritidshus med högre standard, möjligen kopplat till förväntningar om att de ska kunna bo i sina fritidshus oftare och under längre tidsperioder efter pandemin.

Slutligen, när det gäller betydelsen av fritidshusens närhet till centralorter, service och natur, kan vi förutom vad gäller avstånd till sjöar och hav se att betydelsen av avståndet till Stockholm hade en positiv korrelation med attraktiviteten innan pandemiutbrottet (ju längre från Stockholm desto högre priser), men att denna korrelation saknas i perioden efter pandemiutbrottet, vilket tyder på att fritidshus *närmare Stockholm* blivit mer attraktiva efter pandemiutbrottet. Avståndet till lokala centralorter är inte korrelerat till bostads-attraktiviteten, varken före eller efter pandemiutbrottet. När det gäller avstånd till sjöar och hav ser vi ett tydligt negativt samband med bostadsattraktiviteten under den andra mätperioden, vilket tyder på att fritidshus som ligger närmare vatten har blivit mer attraktiva efter pandemiutbrottet. En möjlig förklaring till detta är att fritidshusköparna planerar att spendera mer tid i sitt fritidshus, t ex att arbeta eller distansstudera därifrån, och då ökar behovet av närheten till värdefull natur, men också att det skall finnas rimliga möjligheter att resa till Stockholm över dagen om så behövs.

Vad gäller *tillgången till fiberbredband*, ser vi också en svagt positiv korrelation före pandemin och en signifikant korrelation till fritidshusattraktiviteten i perioden efter pandemiutbrottet. Fritidshus är den kategori bostäder med klart *lägst* tillgång till fiberbredband i dagsläget. Enligt den senaste bredbandsstatistiken från Södermanland (oktober 2020) är regionens totala fiberpenetration 63 % medan motsvarande siffra för fritidshus på landsbygden 30 %. Den totala fiberpenetrationen (oavsett huskategori) på landsbygden är 42 %. Detta innebär troligen att man som köpare av fritidshus i Södermanland nu (efter pandemiutbrottet) *värderar tillgången till bredband högre*, eftersom man eventuellt kommer att vistas mer i sitt fritidshus och därmed får ett ökat behov av bredband, t ex distansjobb/studier, mediekonsumtion, välfärdsteknik etc. Detta skulle i så fall innebära att behovet av att ansluta fler fritidshus till fiberbredband har ökat ytterligare.

En översikt över hur fritidshusens attraktivitet är relaterad till bostadskaraktär, lokala socioekonomiska parametrar på DeSO-nivå och närhet till service & vatten (exklusive skolresultat och inflyttningar då fritidshus inte är deras prioritet) före och efter pandemiutbrottet sammanfattas i Tabell III. Här redovisas på ett övergripande plan huvudsakliga observationer, skillnader och likheter mellan de två mätperioderna.

### Tankar om framtida studier och fördjupningar

Vi har i analysarbetet identifierat ett antal områden och frågeställningar som kan vara av intresse att studera vidare eller fördjupa sig i för att skapa ytterligare insikter i de mönster som framträder och möjligen ge oss ytterligare förklaringar. Exempel på idéer för fortsatta studier är:

- Återkommande analys av fler perioder över längre tid, och med uppdaterad statistik för att identifiera långvariga (eller tillfälliga) effekter och mönster.

- Kompletterande analys av personers res- och pendlingsmönster med hjälp av data från *Telia Crowd Insights*, för att kunna detektera mönster i hur ofta och länge exempelvis fritidshusägare (med permanent bostadsort utanför Södermanland) spenderar tiden i sitt fritidshus samt hur pendlingsmönstren har påverkats exempelvis till Stockholm, men även till andra tätorter i och utanför Södermanland.

- Fördjupad analys kring eventuella kopplingar till skolors geografiska närhet och skolresultat.
- Fördjupad analys kring närheten och tillgång till olika servicecentra, naturvärden och lokal/regionaltrafik.

# Summary

In this work, we analyzed the housing market evolution in Södermanland over 28-month period from March 2019 to June 2021 across the Covid-19 breakout in spring 2020. In the analysis, the housing market is divided into three segments characteristic to the Swedish housing market: *Bostadsrätt* apartments, *Villa* and *Fritidshus* small houses. Four groups of nearly 30 variables on the respective housing character, the locality and local DeSO socio-economic feature, school results (in terms of primary school grade-9 students) and working-age people moving into Södermanland from the Stockholm region (in regarding their education levels and disposable income) are used to analyze and compare the housing market attractivity (in the term of *price-per-square-meter*) before and after the pandemic breakout employing both multiple correspondence analysis (MCA) and regression analysis.

## Stable housing deals with significant price increase especially for *Fritidshus* small houses

As to the housing market evolution in general, the total number of housing deals for *Villa* and *Fritidshus* small houses largely remain the same over the 28-month period, while there is a slight increase for *Bostadsrätt* apartments after the pandemic breakout (which might be attributed to the higher growth rate of newly built *Bostadsrätt* apartments in Södermanland in the past ten years). In the meantime, there are significant price increases for all the three housing categories, especially for *Fritidshus* small houses. More specifically, the average price/m^2 has increased 19% for *Bostadrätt* apartments, 24% for *Villa* small houses, and up to 39% for *Fritidshus* small houses for the same quarterly 4-month period (March-June) from 2019 to 2021. Moreover, the price differences among the nine municipalities in Södermanland are quite significant for *Villa* small houses and *Bostadrätt* apartments, while for *Fritidshus* small houses the price difference is much smaller.

By further segregating the housing deals into the 177 DeSO areas in Södermanland we can also see that for *Bostadsrätt* apartments the housing deals are mainly located in the four main city centers (i.e., Eskilstuna, Nyköping, Strängnäs and Katrineholm) and Trosa municipality, and in most of the DeSO areas the price/m^2 increases as well, especially in DeSO areas around Katrineholm. For *Villa* and *Fritidshus* small houses, on the other hand, the housing deals are located around city centers and in the countryside. *Villa* small house prices are in general higher in the DeSO areas in the eastern and south-eastern part of Södermanland in both periods, while their corresponding increase/decrease rates are more evenly distributed in the whole region. In regarding *Fritidshu*s small houses both the prices and their corresponding increase/decrease rates are in general evenly distributed in the whole region except in DeSO areas around Nyköping where the price increases significantly after the pandemic breakout.

Figure I – Figure III illustrate the housing market attractivity (in the term of price/m^2) for the three segments at DeSO level over one year before and after the Covid-19 pandemic, and the corresponding increase/decrease rates between the two periods after the pandemic.

## *Bostadsrätt* apartments

As to *Bostadsrätt* apartment attractivity, higher housing prices clearly correlate positively to the local DeSO socio-economic characters (i.e. income, economic standards and employment rate) as well as the inhabitants education levels. In regarding the housing characters, the living area, number of rooms and monthly fee are highly correlated with each other, and the housing attractivity correlates negatively to the monthly-fee and positively to the build-year, elevator and apartment floor number. What makes a difference before and after the pandemic is if the heating cost is included (in the monthly fee) which shows a negative correlation before, but positive correspondence after the pandemic breakout to the housing price. One possible explanation on this might be that people would expect more time to be spent at home after the pandemic, e.g. more time to work from home, hence would expect more expense on the heating if the heating cost is not included. In regarding the school results in general the *Bostadsrätt* apartment attractivity correlates positively more to the high education preparation program (HEPP) performance compared to that of the professional program (PP). In regarding (walking-age) people moving into Södermanland from Stockholm, in general, the *Bostadsrätt* apartment attractivity corresponds positively to the total number of people moving-in. Even so, a significantly difference is identified before and after the pandemic in regarding the average disposable income, i.e., those working-age people moving-in with higher average disposable income also tend to move into those DeSO areas with higher price *Bostadrätt* apartments after the pandemic breakout. Moreover, in regarding the locality proxies, no difference can be seen between the two periods, i.e., the *Bostadrätt* housing attractivity always correlate positively to the closeness to Stockholm, local city centers and water area (sea or lakes).

An overview of how the *Bostadsrätt* apartment attractivity is related to the four groups of variables before and after the pandemic is summarized in Table I.

## *Villa* small houses

As to *Villa* small houses' attractivity, higher housing prices clearly correlate positively to the local DeSO socio-economic characters (income, economic standards and employment rate) as well as the inhabitants education levels, except for those *Villa* housing deals in DeSO areas with the lowest socio-economic levels where the *Villa* small house price does not drop according to the same trend as for *Villa* housing deals in other DeSO areas with higher socio-economic levels. In regarding the housing characters, the living area and number of rooms are still correlated to each other, and together with the build-year correlate negatively to the housing (per-square-meter) price, while the plot-area and the rateable-value correlate positively. In regarding the school results the *Villa* small house attractivity in general becomes more correlated to both HEPP and PP performance after the pandemic breakout. In regarding (walking-age) people moving into Södermanland from Stockholm, in general, the *Villa* small house attractivity corresponds positively to the total number of people moving-in. Even so, in regarding the average disposable income before and after the pandemic (irrespective of their education levels) a clear difference is that before the pandemic breakout these people moving-in tended to move into DeSO areas with lower *Villa* small house prices even if they had higher average disposable income, while after the pandemic breakout this tendency disappears. Moreover, in regarding the locality proxies, the *Villa* housing attractivity always correlate positively to the closeness to Stockholm and water area (sea or lakes), while the middle-level distance to local city centers (between 2-10 km) corresponds to higher *Villa* housing prices. Furthermore, a negative correlation to fiber availability is also seen. A possible explanation might be that for those housing deals without fiber availability (~10% of housing deals in *Period 1* before the pandemic and ~7% in *Period 2* after the pandemic) the locations of those

*Villa* small houses are too further away to be passed by fiber penetration in the foreseeable time ahead (indeed the average distance to local city centers for those housing deals without fiber availability is 7.5 km larger in *Period 1* and 5.8 km larger in *Period 2*, respectively, than those with fiber availability), hence the bidders did not consider the fiber availability to be a main distinguishing factor for the housing attractivity.

An overview of how the *Villa* small house attractivity is related to the four groups of variables before and after the pandemic is summarized in Table II.

## *Fritidshus* small houses

As to *Fritidshus* small houses, in general the correspondence of the *Fritidshus* small house price to the local DeSO socio-economic characters becomes much weaker. In regarding the housing characters, the living-area still correlates negatively to the housing (square meter) price, while the plot-area and the rateable-value correlate positively. A notable difference between the two periods is the build-year which is correlated negatively to the housing attractivity before the pandemic, but becomes insignificant after the pandemic breakout, which is attributed to those *Fritidshus* small houses built before 1940 corresponding to the lower price levels, suggesting that after the pandemic people are looking for relatively newer *Fritidshus* small houses with higher standards probably with the expectation that they would live in their vacation homes longer time after the pandemic In regarding the school results in general the *Fritidshus* small houses' attractivity is not correlated to any program results. In regarding people moving into Södermanland from Stockholm, apart from *Period 1* in which the average disposable income shows a positive correlation to DeSO areas with higher *Fritidshus* small house prices, no other correlation can be observed especially in *Period 2* after the pandemic breakout, suggesting that for those people moving into Södermanland from Stockholm the *Fritidshus* small house attractivity is not their priority.

Finally, in regarding the locality proxies, firstly, the distance to Stockholm is positively correlated in *Period 1*, but becomes insignificant in *Period 2*, indicating that *Fritidshus* small houses closer to Stockholm become more attractive after the pandemic breakout. Secondly, the distance to local city center remains insignificant in both periods. Thirdly we see clear negative correlation between the distance to water and housing attractivity in *Period* 2, suggesting that *Fritidshus* small houses more close to water have become more attractive after the pandemic. In addition, for the fiber availability, there is a weak positive correspondence to the housing attractivity in *Period 1* before the pandemic breakout, and a significantly positive correlation to the housing attractivity after the pandemic breakout, suggesting that people after the pandemic care even more on high-speed broadband availability, again probably with the expectation that they would live and even work in their vacation homes longer time after the pandemic.

An overview of how the *Fritidshus* small house attractivity is related to the housing and other locality & local DeSO socio-economic characters (not including school results and people moving-in as *Fritidshus* small house attractivity is not their priority) before and after the pandemic is summarized in Table III.

*Table I   Association of different group variables with Bostadsrätt apartment attractivity (price/m^2) before and after the Covid-19 pandemic*

| | | **Period1 (before the pandemic breakout)** | | | **Period 2 (after the pandemic breakout)** | | |
|---|---|---|---|---|---|---|---|
| Variable group | Variable | Positive | Negative | Neutral | Positive | Negative | Neutral |
| Housing characters | build_year | √ | | | √ | | |
| | monthly_fee | | √ | | | √ | |
| | heating_included | | √ | | √ | | |
| | living_area | | √ | | | √ | |
| | number_of_rooms | | √ | | | √ | |
| | floor_level | √ | | | √ | | |
| | elevator | √ | | | √ | | |
| DeSO socio-economic characters and other locality proxies | income_median | √ | | | √ | | |
| | economic standard | √ | | | √ | | |
| | employment rate | √ | | | √ | | |
| | education_high | √ | | | √ | | |
| | education_middle | | √ | | | √ | |
| | education_low | | √ | | | √ | |
| | distance_Stockholm | | √ | | | √ | |
| | distance_local center | | √ | | | √ | |
| | distance_water | | √ | | | √ | |
| | fiber_passing by | | | √ | | | √ |
| Grade-9 school program results | theoretical_number | √ | | | | | √ |
| | theoretical_Q-ratio | | √ | | √ | | |
| | practical_number | | √ | | | | √ |
| | practical_Q-ratio | | | √ | | √ | |
| Working-age people moving into Södermanland from Stockholm | disaposable income | | √ | | √ | | |
| | education_high | √ | | | √ | | |
| | education_low | | | √ | √ | | |
| | education_middle | | √ | | | √ | |

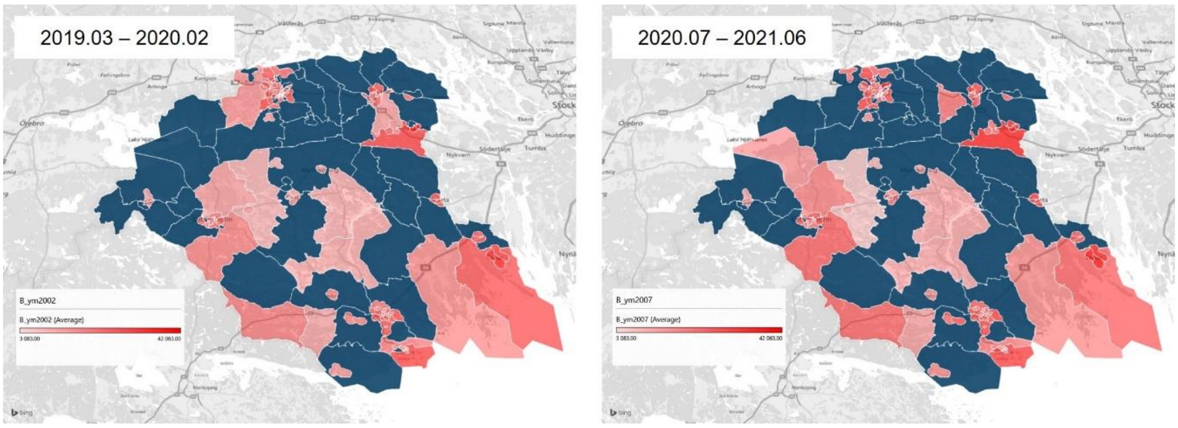
*Table II Association of different group variables with Villa small house attractivity (price/m^2) before and after the Covid-19 pandemic*

| | | **Period 1 (before the pandemic breakout)** | | | **Period 2 (after the pandemic breakout)** | | |
|---|---|---|---|---|---|---|---|
| Variable group | Variable | Positive | Negative | Neutral | Positive | Negative | Neutral |
| Housing characters | build_year | | √ | | | √ | |
| | living_area | | √ | | | √ | |
| | plot_area | √ | | | √ | | |
| | number_of_rooms | | √ | | | √ | |
| | rateable_value | √ | | | √ | | |
| | price_by_rateable_value | √ | | | √ | | |
| DeSO socio-economic characters and other locality proxies | income_median | √ | | | √ | | |
| | economic standard | √ | | | √ | | |
| | employment rate | √ | | | √ | | |
| | education_high | √ | | | √ | | |
| | education_middle | | √ | | | √ | |
| | education_low | | √ | | | √ | |
| | distance_Stockholm | | √ | | | √ | |
| | distance_local center | | √ * | | | √ * | |
| | distance_water | | √ | | | √ | |
| | fiber_passing by | | √ | | | √ | |
| Grade-9 school results | theoretical_number | | | √ | | √ | |
| | theoretical_Q-ratio | | √ | | | | √ |
| | practical_number | | | √ | √ | | |
| | practical_Q-ratio | | | √ | | | √ |
| Working-age people moving into Södermanland from Stockholm | disaposable income | | | √ | | | √ |
| | education_high | √ | | | | | √ |
| | education_low | | | √ | | | √ |
| | education_middle | | √ | | | | √ |

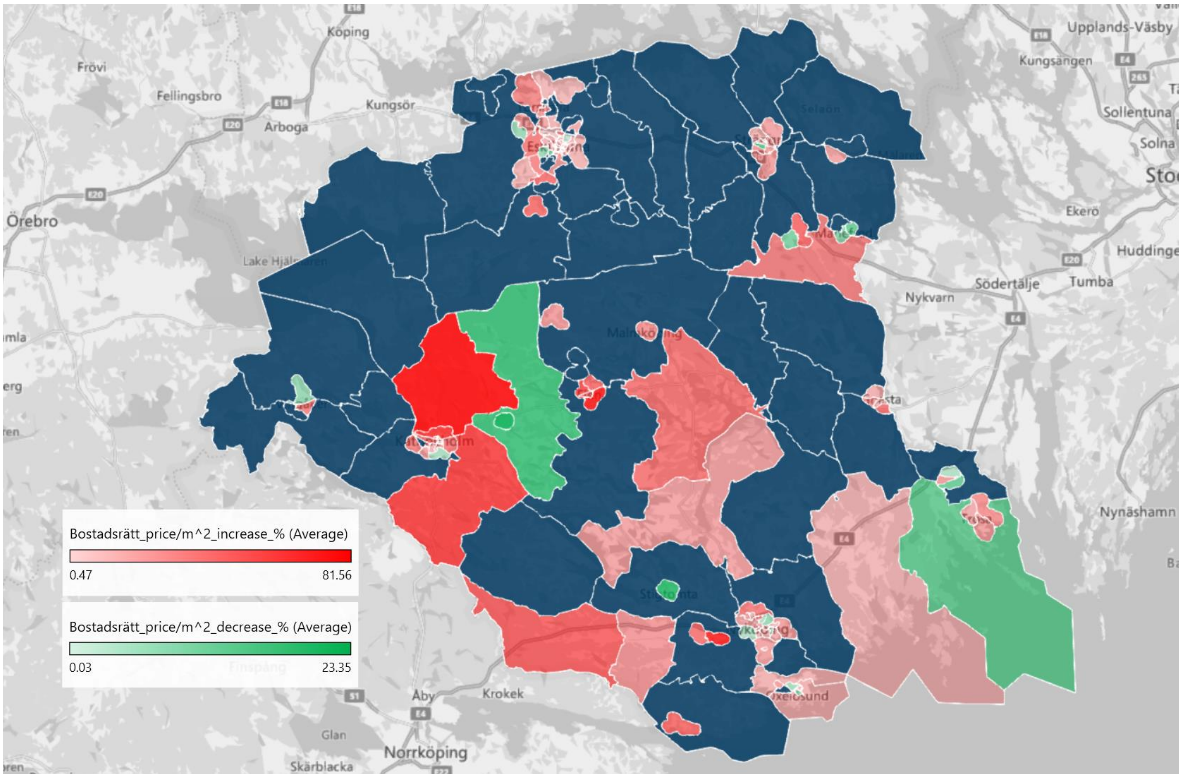
* Distance between 2-10 km to local city centers most attractive

*Table III Association of different group variables with Fritidshus small house attractivity (price/m^2) before and after the Covid-19 pandemic*

| | | Period 1 (before the pandemic breakout) | | | | Period 2 (after the pandemic breakout) | | |
|---|---|---|---|---|---|---|---|---|
| Variable group | Variable | Positive | Negative | Neutral | | Positive | Negative | Neutral |
| Housing characters | build_year | | √ | | | | | √ |
| | living_area | | √ | | | | √ | |
| | plot_area | √ | | | | √ | | |
| | number_of_rooms | | √ | | | | √ | |
| | rateable_value | √ | | | | √ | | |
| | price_by_rateable_value | √ | | | | √ | | |
| DeSO socio-economic characters and other locality proxies | income_median | | | √ | | | | √ |
| | economic standard | | | √ | | | | √ |
| | employment rate | | | √ | | | | √ |
| | education_high | √ | | | | √ | | |
| | education_middle | | | √ | | | | √ |
| | education_low | | √ | | | | √ | |
| | distance_Stockholm | √ | | | | | | √ |
| | distance_local center | | | √ | | | | √ |
| | distance_water | | | √ | | | √ | |
| | fiber_passing by | √ | | | | √ | | |

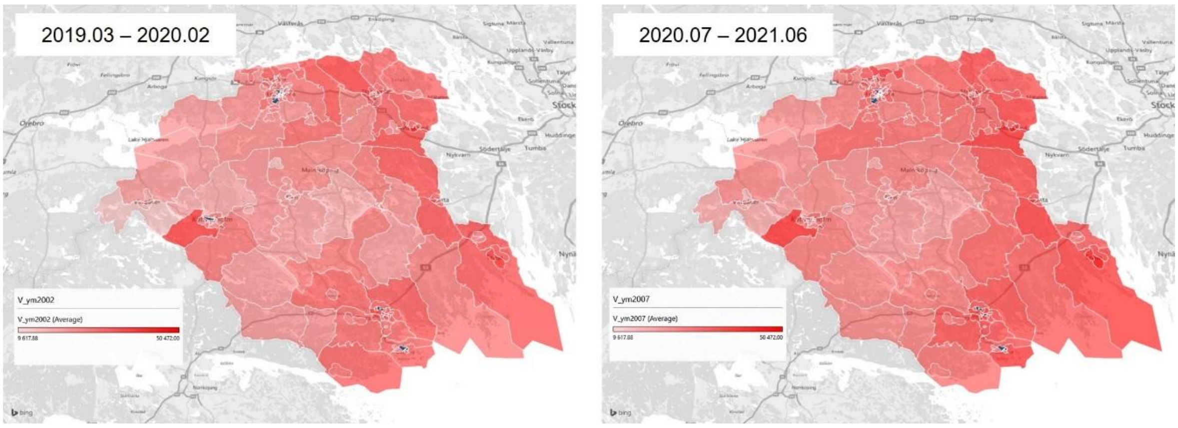



(a)

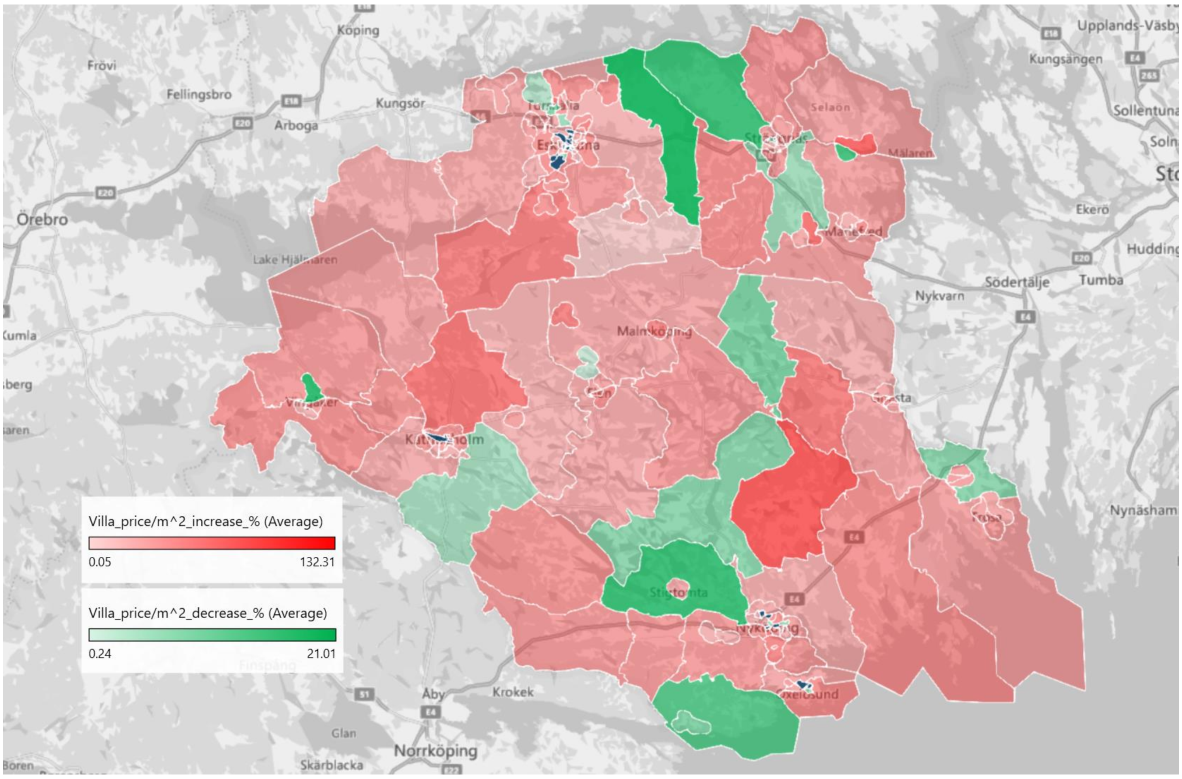



(b)

*Figure I Illustration on average price per square meter for Bostadsrätt apartments at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Bostadsrätt housing deals in (a) and those without any Bostadsrätt housing deal in either period (b).*

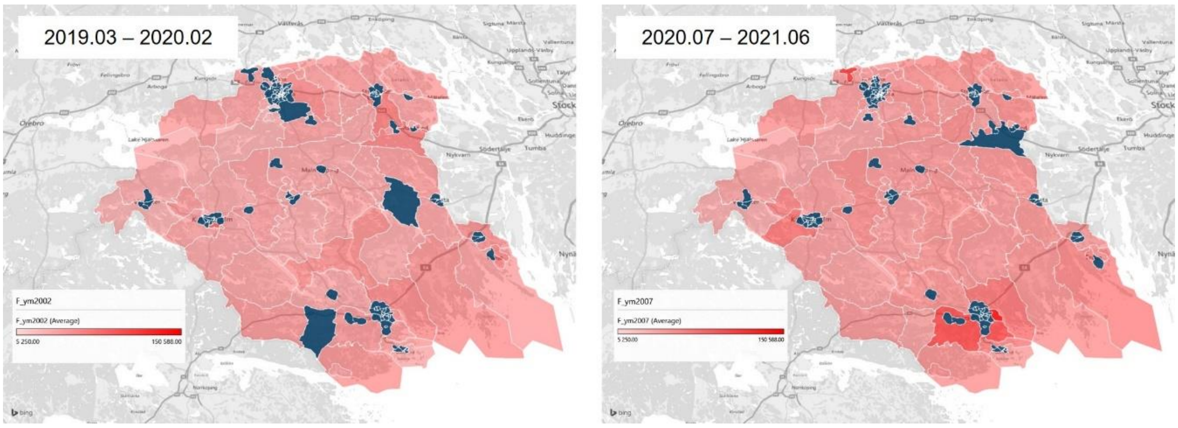



(a)

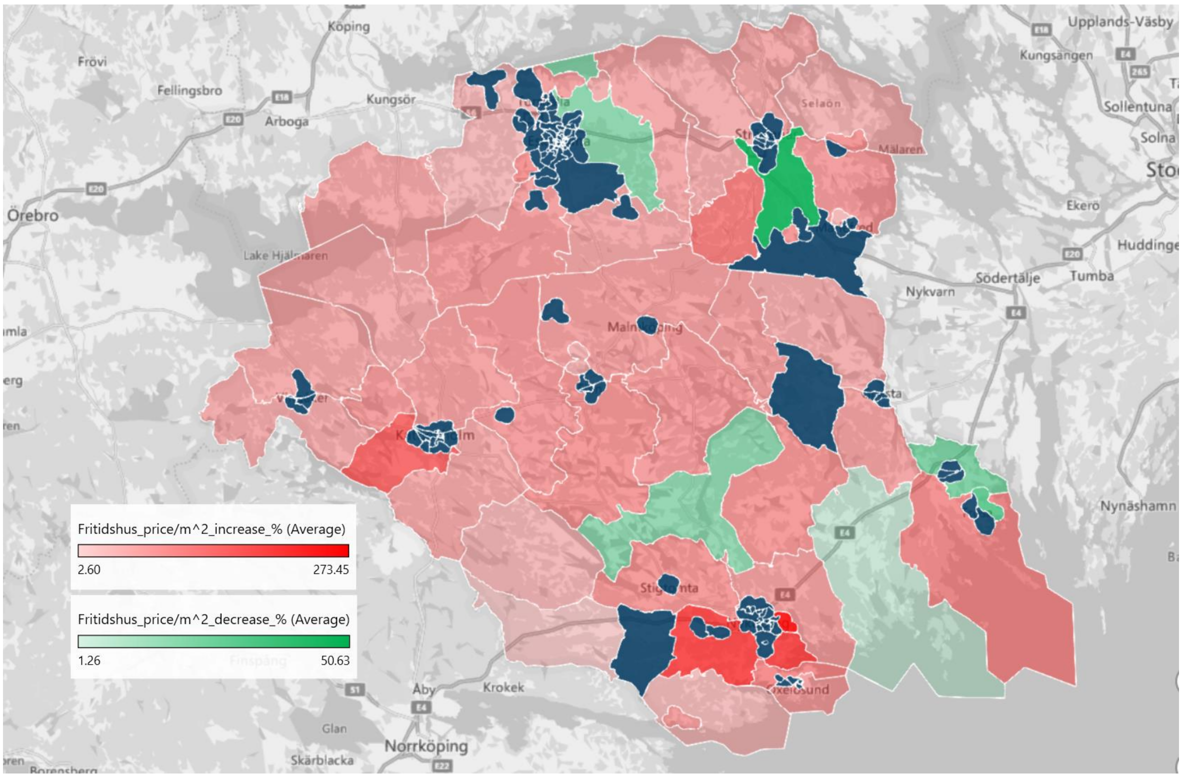



(b)

*Figure II Illustration on average price per square meter for Villa small house at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Villa housing deal in (a) and those without any Villa housing deal in either period (b).*




(a)




(b)

*Figure III Illustration on average price per square meter for Fritidshus small house at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Fritidshus housing deal in (a) and those without any Fritidshus housing deal in either period (b).*

# Table of Contents


**1 Introduction .......... 18**

**2 Data sources .......... 18**

*2.1 Data from Svensk Märklarstatistik .......... 18*

*2.2 SCB DeSo data .......... 19*

*2.3 Other data sources .......... 19*

2.3.1 Bing map API .......... 19

2.3.2 Data from Region Sörmland .......... 20

**3 Methodology .......... 20**

*3.1 Multiple correspondence analysis .......... 21*

**4 Analysis results .......... 22**

*4.1 Overall housing market evolution across the Covid-19 breakout period .......... 22*

*4.2 Factor analysis .......... 29*

4.2.1 Housing attractivity corresponding to the location, fiber availability and local DeSO socio-economic characters .......... 29

4.2.2 Housing attractivity corresponding to housing characters .......... 32

4.2.3 Housing attractivity corresponding to school results .......... 34

4.2.4 Housing attractivity corresponding to people moving into Södermanland from Stockholm .......... 35

*4.3 Regression analysis .......... 50*

4.3.1 *Bostadsrätt* apartments .......... 50

4.3.2 *Villa* small houses .......... 52

4.3.3 *Fritidshus* small houses .......... 54

**5 Summary and conclusions .......... 55**

**6 Limitations and future work .......... 58**

**A.1 Appendix I Selected variable list from Mäklarstatistik's database .......... 61**

**A.2 Appendix II Variable categorizations .......... 62**

**A.3 Appendix III Correspondence analysis and multiple correspondence analysis .......... 64**

*Correspondence analysis* .......... 64

*Multiple correspondence analysis* .......... 65

RISE
Research Institutes of Sweden

# 1 Introduction

In this work, we analyzed the housing market evolution in Södermanland over 28-month period from March 2019 to June 2021 across the Covid-19 breakout in spring 2020. In the analysis, the housing market is divided into three segments characteristic to the Swedish housing market: *Bostadsrätt* apartments, *Villa* and *Fritidshus* small houses. Four groups of nearly 30 variables on the respective housing character, the local DeSO socio-economic feature, school results (in terms of primary school grade-9 students) and working-age people moving into Södermanland from the Stockholm region (in regarding their education levels and disposable income) are used to analyze and compare the housing market attractivity (in the term of *price-per-square-meter*) before and after the pandemic breakout employing both multiple correspondence analysis (MCA) and regression analysis.

# 2 Data sources

The main data source for the housing market used in this study is Svensk Märklarstatistik's database with more than 100 variables for each housing deal[1]. The data for the local socio-economic characters are aggregated data at the DeSO level[2] in Sweden and publicly available from Statistics Sweden (SCB). Data on broadband availability, closeness to water and other complementing data (school results, population moving pattern from the Stockholm region to Södermanland) are from Region Sörmland. In addition, Bing map API was used to extract the distance and travel time to Stockholm (centration station) and local city centers in Södermanland for each housing deal location.

## 2.1 Data from Svensk Märklarstatistik

Svensk Mäklarstatistik's database covers up to now almost all (>98%) the housing trading deals in Sweden. The database is updated daily and comprises over 100 variables for the housing deals. In this analysis, we chose the period from March 2019 to June 2020 for all the housing deals in Södermanland with a set of variables for each housing deal, as listed in Appendix I, covering relevant aspects for each housing deal (i.e., price-by-rateable-value, location, housing category, real estate size/age/other feature, and contract time etc.). Table 1 shows the overall statistics for all the housing deals during the 28-month period from March 2019 to June 2020. (Note that in the original raw data there are 753 housing deals with incomplete major information or abnormal values, e.g., a housing deal without the living area information. These housing deals were taken away in the data pre-processing and hence are not included in Table 1). We see that among a total of 12645 housing deals, over 50% are *Bostadsrätt* apartments, over 40% are *Villa* small houses, and close to 9% are *Fritidshus* small houses. There are also 79 *Tomträtt* land deals (without any living area). Moreover, apart from *Tomträtt*, almost all the *Villa* and *Fritidshus* small houses are self-owned (*Äganderätt* housing tenure), except 6 *Arrendrätt* and 1 *Hyresrätt Fritidshus* small house. Note here that since these *Arrendrätt* and *Hyresrätt Fritidshus* small houses have low price/m^2 and high

[1] https://api.maklarstatistik.se/
[2] https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/deso---demografiska-statistikomraden/

monthly fees accompanying, rather than other "normal" *Äganderätt Fritidshus* small houses, they were taken away in the following factor and regression analysis.

*Table 1 Statistics for all the housing deals in Södermanland from March 2019 to June 2020*

| housing_tenure | housing_category | | | |
|---|---|---|---|---|
| | Bostadsrätt | Fritidshus | Villa | Total |
| Andel i bostadsförenin | 1 | | | 1 |
| Arrenderätt | | 6 | | 6 |
| Bostadsrätt | 6820 | | | 6820 |
| Hyresrätt | | 1 | | 1 |
| Tomträtt | | 2 | 77 | 79 |
| Äganderätt | | 1123 | 4615 | 5738 |
| Total | 6821 | 1132 | 4692 | 12645 |

## 2.2 SCB DeSo data

Table 2 lists the data variables for the 177 DeSO areas in Södermanland from SCB[3] that are utilized in this study.

*Table 2 Selected data variables for the 177 DeSO areas in Södermanland*

| Variable name | Note |
|---|---|
| Median income | Inhabitants over 20 years old |
| Average economic standard | Average household disposable income |
| Economic standard low | Percentage of inhabitants with less than 60% of national median economic standard |
| Economic standard high | Percentage of inhabitants with 2 times higher national median economic standard |
| Employment rate | Inhabitants 16-64 years old, private & public sector |
| Educational levels | Inhabitants 16-64 years old |

## 2.3 Other data sources

### 2.3.1 Bing map API

In this study Bing map API was used to extract the distance and travel (driving) time to Stockholm (central station) and the 4 local city centers (i.e., Eskilstuna, Nyköping, Strängnäs and Katrineholm) in Södermanland for each housing deal location. For distance and travel time to the local city centers, the shortest distance and travel time were selected for each housing deal location. Table 3 shows the corresponding statistics on the extracted data.

*Table 3 Extracted distance and travel (driving) time to Stockholm (central station) and local centers*

| | min | max |
|---|---|---|
| **distance_Stockholm, km** | 60.46 | 193.22 |
| **driving_time_Stockholm, km** | 46.15 | 147.85 |
| **distance_localcenter, min** | 0.03 | 53.29 |
| **driving_time_localcenter, min** | 0.05 | 53.8 |

[3] https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/deso---demografiska-statistikomraden/deso-tabellerna-i-ssd--information-och-instruktioner/

## 2.3.2 Data from Region Sörmland

In this study Region Sörmland also supplied data on broadband availability, distance to water, school results, and population moving pattern from the Stockholm region to Södermanland.

### 2.3.2.1 Broadband availability and distance to water

Access to optical fiber is used in this study for benchmarking broadband availability for each housing deal's location using the (latest available) data from The Swedish Post and Telecom Authority (Post- och telestyrelsen, PTS) on optical fiber-connected households in Södermandland. In doing this, the whole region is gridded into 500 by 500-meter squares, and if a housing deal is located in a square in which this is at least one household with permanent resident that has optical fiber connection, the housing deal's location is regarded as having fiber availability.

Distance to water is measured as the shortest line (bird distance) between the location of a housing deal and the closest body of water (polygon). Three types of water are eligible: a lake of six hectares or more, a watercourse of 100-meter width or more, and the coastline (Baltic Sea).

### 2.3.2.2 School results and moving pattern

Table 4 shows the data variables provided by Region Sörmland on the school results and working-age people moving into Södermanland from the Stockholm region during years 2019 and 2020.

*Table 4 Data on school results and population moving pattern used/investigated in the analysis*

| | DeSO | School |
|---|---|---|
| **Primary school 9th year results** | Total number qualified to professional high school program | Average grades (Genomsnittligt meritvärde) |
| | Total number qualified to university preparation high school pragram | Percentage reaching knowledge requirement (Andel som uppnått kunskapskraven) |
| **People 25-64 years old moving into Södermanland from Stockholm** | Education level | |
| | Disposable income 25-64 | |

# 3 Methodology

This work carried out analysis with the following steps:

- Step 1: an overview of the price evolution of the housing market in Södermanland at province/region, municipality and DeSO levels over the studied period from March 2019 (one year before the pandemic breakout) until June 2020. The housing market is segmented by the three major housing categories characteristic in Sweden: *Bostadsrätt* apartment, *Villa* and *Fritidshus* small houses;
- Step 2: factor analysis was carried out to explore how the housing market attractivity in Södermanland is associated with the location, broadband availability and local socio-economic characters (at DeSO level) in regarding income, employment rate, living standards, education level, school results etc. In addition, how the housing attractivity

is associated with working-age people moving into Södermanland from the Stockholm region in regarding their education levels and disposable income was also analyzed;

- Step 3: based on the factor analysis, regression analysis was also carried out for further explanations and understanding of the housing market attractivity in Södermanland before and after the Covid-19 pandemic breakout.

*Multiple correspondence analysis (MCA)* is the technique used in the exploratory factor analysis. A brief introduction on MCA is given here in the next section. For a more detailed description of correspondence analysis (CA) & MCA and reference literature, see Appendix III.

## 3.1 Multiple correspondence analysis

*Multiple correspondence analysis (MCA)* is a technique for analyzing *categorical variables*. It is essentially a form of exploratory factor analysis for categorical data. MCA is usually viewed as an extension of simple correspondence analysis (CA) to more than two variables. While CA analyzes a two-way contingency table, MCA directly analyzes a multiway table, i.e., the so-called indicator matrix (with observations as rows and categories of variables as columns) or the inner product of the indicator matrix, a so-called Burt matrix. For a more detailed description of CA&MCA and reference literature see Appendix III.

In general, unlike the many statistical techniques that test hypotheses, CA is an exploratory data technique that explores categorical data for which no specific hypotheses have been formed. The results provide information which is similar in nature to those produced by factor analysis techniques, and they allow one to explore the structure of categorical variables included in the table. CA analyzes two-way or multi-way tables with each row and column becoming a point on a multidimensional graphical map. This graphical map typically consists of two or three dimensions. Rows with comparable patterns of counts will have points that are close together on the graphical map and columns with comparable patterns of counts will also have points that are close together on the graphical map. The row and column points are shown on the same graphical display allowing for easier visualization of the associations among variables.

CA uses the chi-square statistic—a weighted Euclidean distance—to measure the distance between points on the graphical map. In other words, the chi-square distance measures the association between variables. Dimensions are formed by identifying axes for which the distance between the variables and axes is minimized while simultaneously maximizing the amount of explained inertia (*inertia* in CA is a measure of variance or dispersion of the individual variables around the average variable profile. The larger the differences are, the larger the inertia will be), and successive dimensions (which are independent of or orthogonal to each other) will "explain" less and less of the overall inertia. Dimensions can be interpreted based on how the variables distribute along and separate on either side of the dimensions. Moreover, the further away from the origin a variable is along a particular dimension, the greater its importance on that dimension. This positioning also provides insight into the dimensionality of each variable and which variables group or "load" together on a same dimension (Sourial et al. 2010).

One major advantage of CA is that it can simplify complex data from a potentially large table into a simpler display of categorical variables while preserving all of the valuable information in the data set. This is especially valuable when it would be inappropriate to use a table to display the data because the associations between variables would not be apparent due to the size of the table. CA focuses mainly on how variables correspond to one another. In addition, CA makes it easy to add supplementary data points that may aid in the interpretation of the model in the analysis afterwards (Abdi et al. 2010).

# 4 Analysis results

## 4.1 Overall housing market evolution across the Covid-19 breakout period

In this study, the *price-per-square-meter* is the key parameter used exclusively on the analysis of the housing attractivity irrespective of the housing categories. As an overview, Figure 1 shows the monthly total number of housing deals and average price evolution of the whole Södermanland region over the 28-month period across the Covid-19 breakout in spring 2020, for the three housing categories. For comparison, the Covid-19 breakout period is marked between March-June 2020, i.e., in this study we divide the 28-month into three periods, as shown in Table 5. From Figure 1 we see that the total number of housing deals for *Villa* and *Fritidshus* small houses largely remain the same before and after the pandemic breakout, while slightly increased for *Bostadsrätt* apartments in *Period 2*. This might be attributed to the higher growth rate of newly built *Bostadsrätt* apartments in Södermanland in the past ten years (i.e., increased by 40% during 1990-2020 as compared to +15% för *Villa/Fritidshus* small houses)[4]. In regarding the price evolution, on the other hand, we see clearly that there are significant price increases for all the three housing categories, especially for *Fritidshus* small houses. Table 6 shows the average prices and increasing rates for the same quarterly 4-month period (March-June) in 2019 and 2021 for the three housing categories at 19% for *Bostadrätt* apartments, 24% for *Villa* small houses, and up to 39% for *Fritidshus* small houses, respectively.

Figure 2 shows the monthly average price evolution under the period of this study for each municipality in Södermanland for the three housing categories. We see clearly that the price differences among the nine municipalities are quite significant for *Villa* small houses and *Bostadrätt* apartments, while for *Fritidshus* small houses the price differences become significantly smaller.

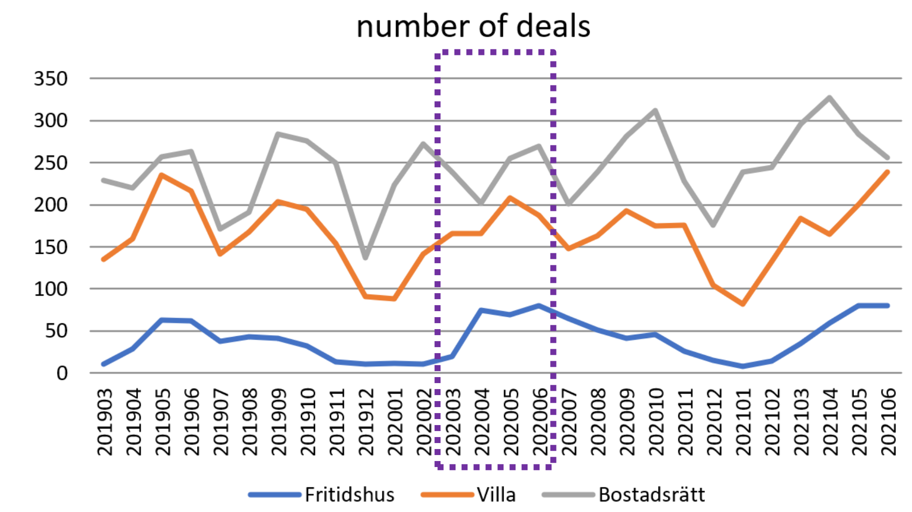
*Table 5 Three periods divided in this study*

| Period 1 | Covid-19 breakout | Period 2 |
|---|---|---|
| 2019.03 – 2020.02 | 2020.03 – 2020.06 | 2020.07 – 2021.06 |

[4] Tillgänglighet, Tobins Q Och bostadsbyggande i Sörmland, Rapportversion 2021-01-28, WSP Advisory

Table 6 *Average housing price of the first and last quarter for the studied period and the corresponding increasing rates*

| | First quarter 2019. 03 – 2019.06 | Last quarter 2021.03 – 2021.06 | Increasing rate |
|---|---|---|---|
| **Bostadsrätt** | 20531 | 24454 | 19% |
| **Villa** | 23363 | 29026 | 24% |
| **Fritidshus** | 28276 | 39360 | 39% |



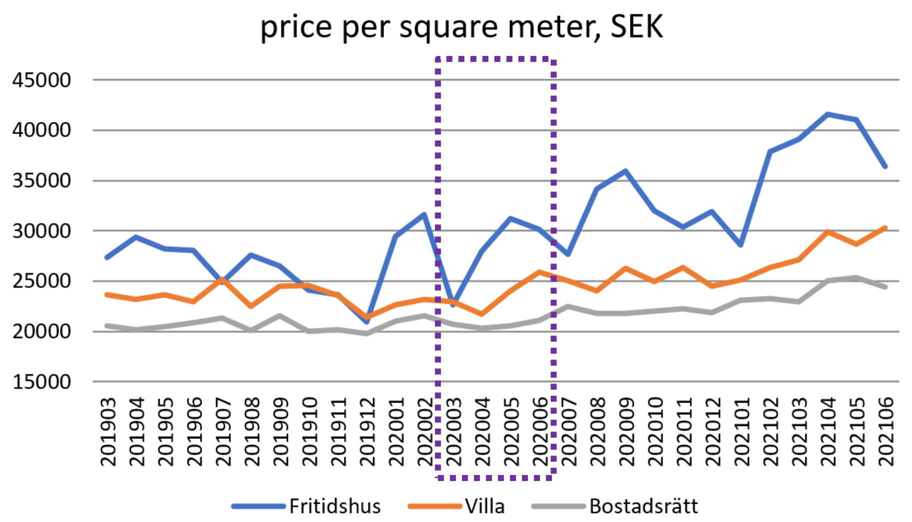




*Figure 1 Total number of deals and average price evolution of the whole Södermanland region over the 28-month period under this study for the three housing categories.*

Furthermore, Figure 3 - Figure 5 shows the heat map of the average price-per-square-meter for the three housing categories at the 177 DeSO areas in Södermanland over one year before (*Period 1*) and after (*Period 2*) the pandemic breakout, and their corresponding increase/decrease rates between the two periods (after the pandemic), if there were housing deals in the same DeSO area in both periods.. We see that, not surprisingly, for *Bostadsrätt* apartments the housing deals are mainly located in the four main city centers (i.e., Eskilstuna, Nyköping, Strängnäs and Katrineholm) and Trosa municipality, and in most of the DeSO areas (having housing deals in both periods) the price/m^2 increases as well, especially in DeSO areas around Katrineholm. For *Villa* and *Fritidshus* small houses, on the other hand, the housing deals are located around city centers and in the countryside. We see also clearly that *Villa* small house prices are in general higher in the DeSO areas in the eastern and south-eastern part of Södermanland in both periods, while their corresponding increase/decrease rates are more evenly distributed in the whole region. In regarding *Fritidshu*s small houses both the prices and their corresponding increase/decrease rates are in general evenly distributed in the whole region except in DeSO areas around Nyköping where the prices increase significantly in *Period 2*.

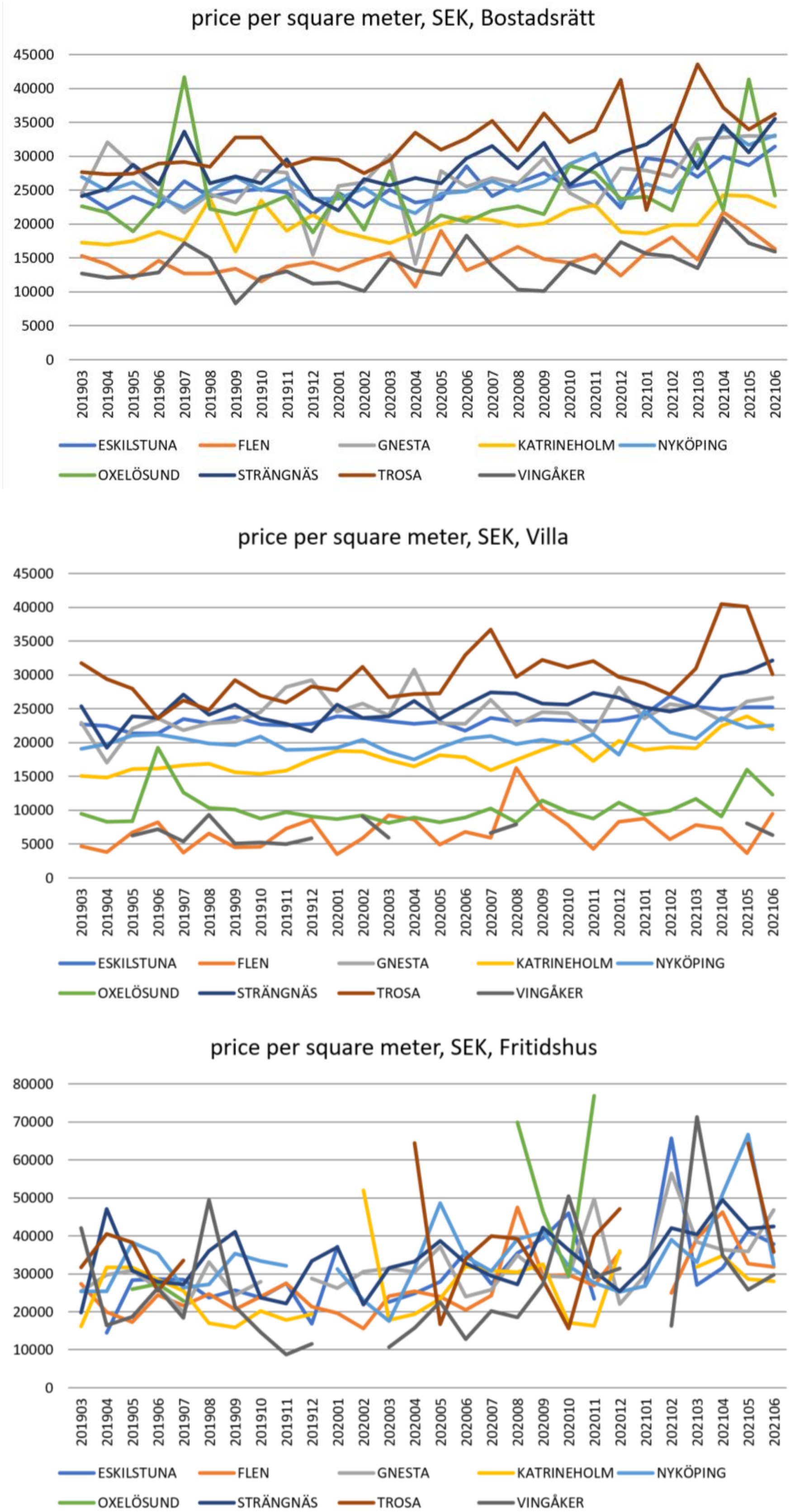
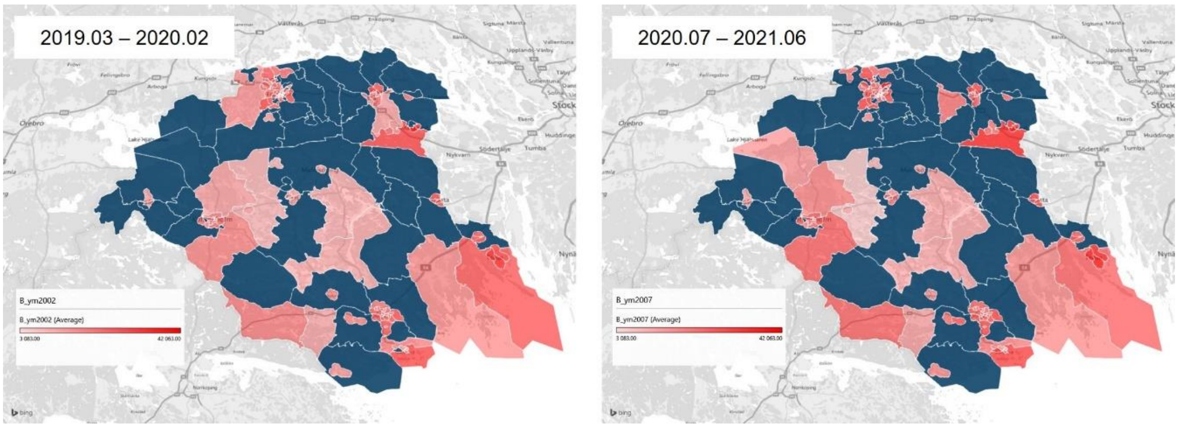
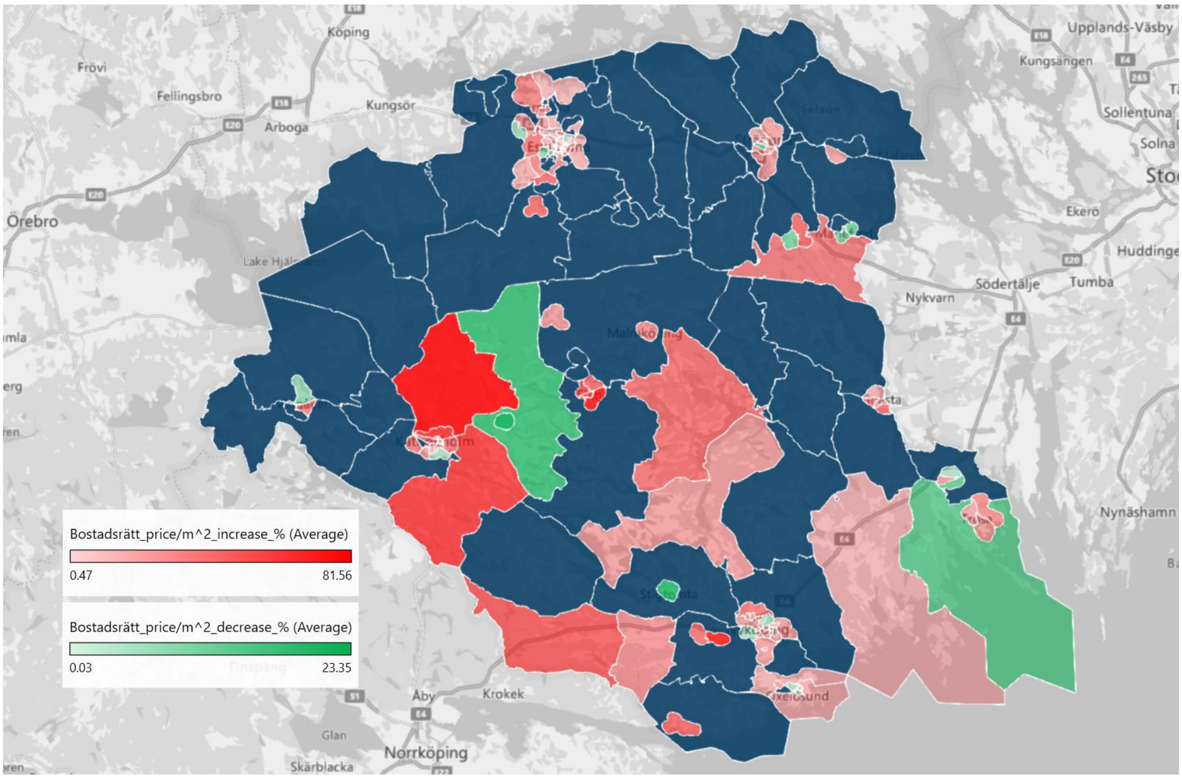



*Figure 2 Average price evolution over the 28-month period under this study for each municipality in Södermanland for the three housing categories.*

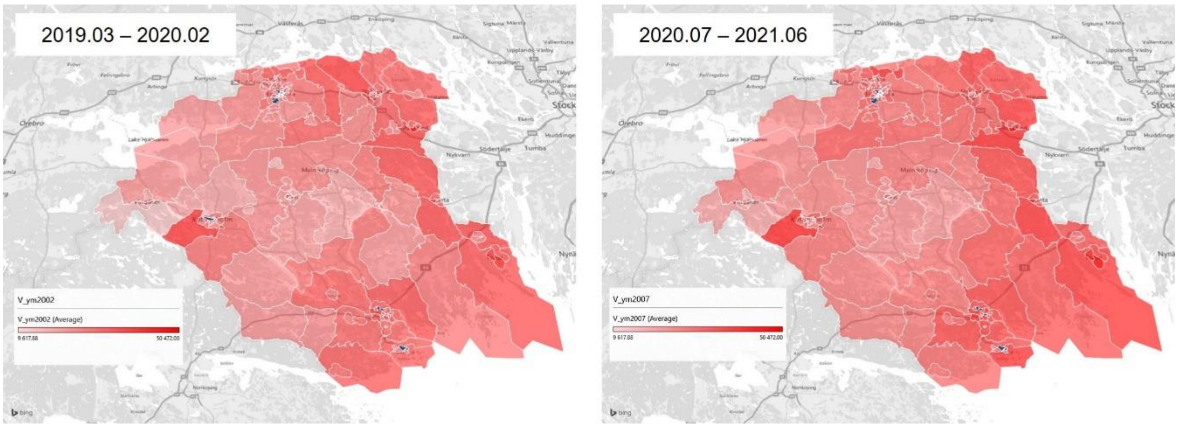



(a)

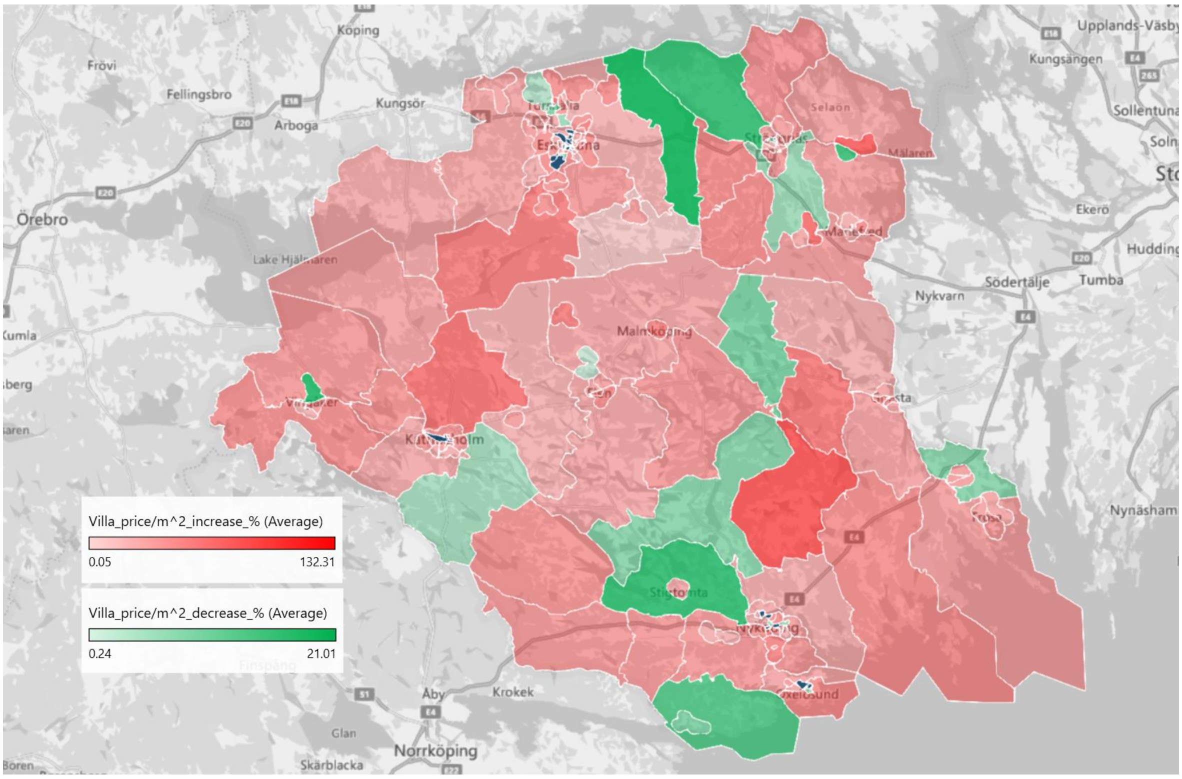



(b)

*Figure 3 Illustration on average price per square meter for Bostadsrätt apartments at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Bostadsrätt housing deals in (a) and those without any Bostadsrätt housing deal in either period (b).*

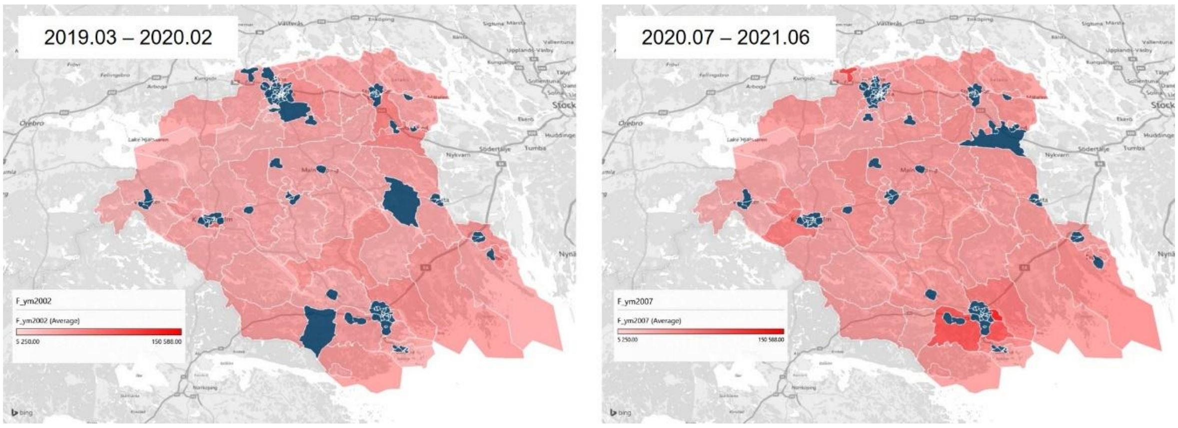



(a)

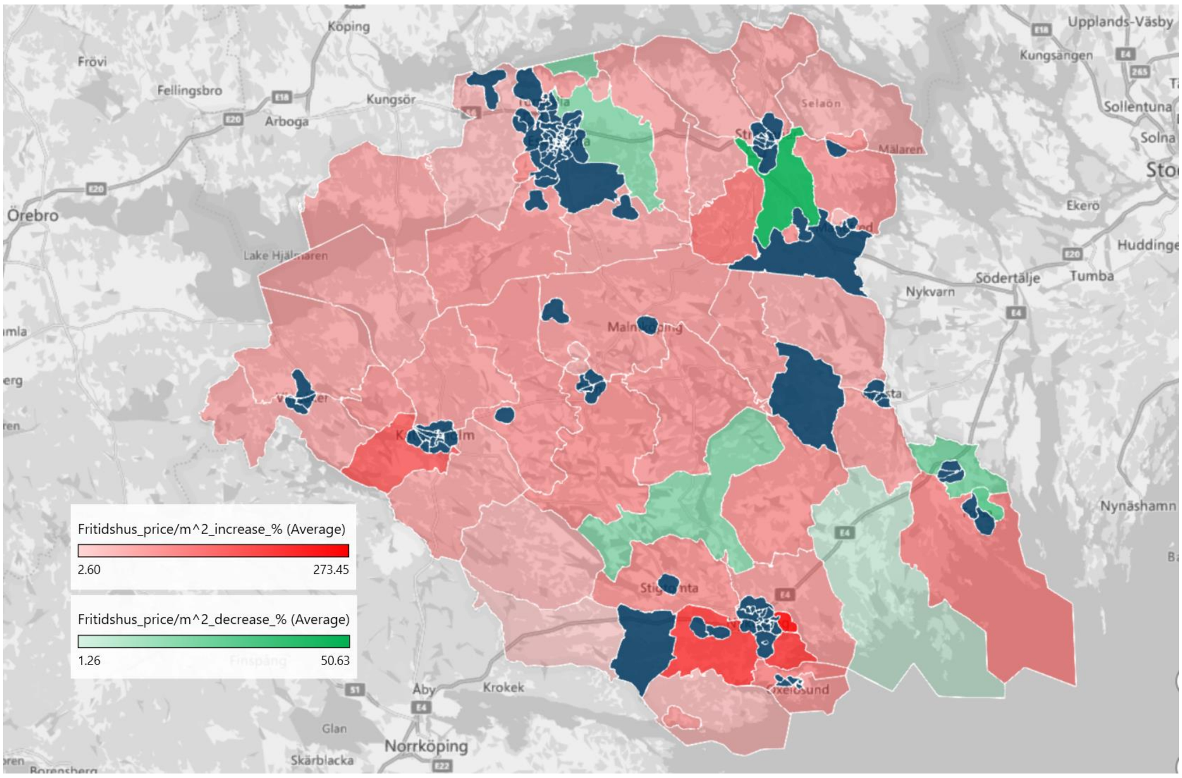



(b)

*Figure 4 Illustration on average price per square meter for Villa small house at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Villa housing deal in (a) and those without any Villa housing deal in either period (b).*




(a)




(b)

*Figure 5 Illustration on average price per square meter for Fritidshus small house at DeSO level over one year before (left) and after (right) Covid-19 pandemic (a), and increase/decrease rates between the two periods after the pandemic (b). Note: blue DeSO areas are those without any Fritidshus housing deal in (a) and those without any Fritidshus housing deal in either period (b).*

## 4.2 Factor analysis

In this section we show the factor analysis results using MCA on how the housing market attractivity in Södermanland is associated with the housing and the location, broadband availability and local socio-economic characters at the DeSO level in regarding income, employment rate, living standards, education level, school results etc., as well as how the housing attractivity is associated with working-age people moving into Södermanland from the Stockholm region in regarding their education levels and disposable income. Note that as described in section 3.1, MCA is a technique for analyzing *categorical variables,* therefore in order to adopt this analysis technique, the variable values need to be categorized if the raw data value is not categorical, which is the case in this study as most of the variables are non-categorical and need to be categorized accordingly. Details for all the variable categorizations are listed in Appendix II.

### 4.2.1 Housing attractivity corresponding to the location, fiber availability and local DeSO socio-economic characters

Figure 6 - Figure 8 shows the MCA factor spaces for housing attractivity (price/m^2) corresponding to the housing deal's location, fiber availability and local DeSO socio-economic characters over one year before (*Period 1*) and after (*Period 2*) the pandemic breakout for the three housing categories, respectively. Note here that in interpreting these factor spaces, the main general guide lines are as the following:

1. The closer the points on the factor space are located to each other, the more correspondent they are;
2. The closer to the origin of the factor space, the less characteristic a point is; conversely, the further away from the origin of the factor space, the more unique a point is;
3. If one point has similar closeness to other points on the factor space, the angle between straight lines connecting the points to the origin of the factor space determines their correspondence, i.e., if two straight lines connecting the two points to the origin of the factor space form the smallest angle from the origin than other points, they are more correspondent to each other.

In addition, in these factor spaces constructed using MCA each point represents a character value of those variables included. The dotted lines connecting different categorical values of the same variable are just for the ease of discriminating different variables to facilitate the interpretation of the factor space.

#### *4.2.1.1 Bostadsrätt* apartments

Figure 6 shows MCA factor spaces for *Bostadsrätt* apartments for the two periods. We see that for both periods up to 88% (*Period 1*) and 86% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 2773 deals included while for *Period 2* increased to 3083 deals. In regarding the correspondence among the variables in association with the housing attractivity we can find that, for both the periods before and after the pandemic:

- The local DeSO socio-economic characters in regarding the median income, average/high/low economic standards, and employment rate are highly correlated with each other, and not surprisingly, higher housing prices correspond to higher level of the local DeSO socio-economic characters, and vice versa;

- DeSo areas with higher levels of high-education working-age inhabitants correspond to higher housing price, and vice versa; Conversely, DeSo areas with higher level of low-education working-age inhabitants correspond to lower housing price, and vice versa;
- The closer to water a housing deal's location is, the higher price, and vice versa;
- The housing price has little correspondence to fiber availability. This is because almost all the housing deal locations have fiber availability. Note that in the factor spaces the point "no_fiber" is more correspondent to the "price_max" point. By tracing back to the raw data, these *Bostadsrätt* housing deals with "no_fiber" are actually newly built with higher prices, even though fiber was yet to be deployed in these newly developed areas;
- The driving time to Stockholm (central station) from each housing deal location also clearly corresponds to the housing price, i.e., the less driving time to Stockholm, the higher price, and vice versa;
- The distance to local city centers has no significant correspondence to the housing price.

Apparently, there are no significant difference can be observed between the two periods before and after the pandemic for the correspondence characteristics.

#### *4.2.1.2 Villa* small houses

Figure 7 shows MCA factor spaces for *Villa* small houses for the two periods. We see that for both periods up to 88% (*Period 1*) and 86% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 1927 housing deals while *Period 2* increased to 1961 deals. In regarding the correspondence among the variables in association with the housing price we can find that, for both the periods before and after the pandemic:

- The local DeSO socio-economic characters in regarding the median income, average/high/low economic standards, and employment rate are highly correlated with each other, and not surprisingly, higher housing prices correspond to higher levels of the local DeSO socio-economic characters, and vice versa. Even so, the correspondence of the minimum level of the local DeSO socio-economic characters to the *Villa* small house price disappears. In other words, for those *Villa* housing deals in DeSO areas with the lowest socio-economic levels the price does not drop according to the same trend as for *Villa* housing deals in other DeSO areas with higher socio-economic levels;
- DeSo areas with higher levels of high-education working-age inhabitants correspond to higher housing price, and vice versa; Conversely, DeSo areas with higher levels of low-education working-age inhabitants correspond to lower housing price, and vice versa. Nevertheless, the correspondence to the housing price in DeSO areas with the lowest/highest level of high/low-education disappears, in the same way as other socio-economic characters;

- The closer to water a housing deal's location is, the higher price, and vice versa. Likewise, the correspondence to the housing price for those housing deals furthest away from water disappears;
- The housing price has little correspondence to fiber availability (as can be seen that the point representing fiber availability is almost exactly at the origin of the factor spaces). For those housing deals without fiber availability (~10% of housing deals in *Period 1* and ~7% in *Period 2*), the correspondence is also not observable. A possible explanation might be that the locations of these *Villa* small houses are too far away to be passed by fiber deployment in the foreseeable time ahead, hence the bidders did not consider the fiber availability to be a main distinguishing factor to the housing attractivity;
- The driving time to Stockholm (central station) from each housing deal location also clearly corresponds to the housing price, i.e., the less driving time to Stockholm, the higher price, and vice versa. Note that unlike other variables above, the *Villa* housing price always decreases with the increasing of distance/driving time to Stockholm;
- The middle-level distance to local city centers (between 2-10 km, see Appendix II) shows certain correspondence to higher *Villa* housing prices, indicating that small houses located not too close or too far away from local city centers are most attractive.

Apparently, no significant difference can be observed between the two periods before and after the pandemic for respective correspondence behavior.

#### *4.2.1.3 Fritidshus* small houses

Figure 8 shows MCA factor spaces for *Fritidshus* small houses for the two periods. For both periods up to 88% (*Period 1*) and 84% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 362 *Fritidshus* housing deals while *Period 2* increased to 518 deals. In regarding the correspondence among the variables in association with the *Fritidshus* housing price we can find that:

- The points representing different housing price levels are much more concentrated to the origin of the factor spaces, indicating that the correspondence difference of the *Fritidshus* small house price levels to the local DeSO socio-economic characters and other locality features becomes much less than the other two housing categories;
- In general higher housing prices correspond to higher levels of the local DeSO socio-economic characters and education level,s and vice versa. Nevertheless, a notable feature is that highest economic-standard levels in the factor spaces do not correspond to the highest income level, which might not be surprising as *Fritidshu*s small houses would locate in those DeSO areas with houeholds having less/no children or with more non-taxable income;
- The closeness to water correspondence appears disappeared. By tracing back to the raw data, the explanation to this is that most of the (traded) *Fritidshus* small houses are actually located close to water (within 1500 m), hence this factor does not contribute to distinguish the housing price. Nevertheless, a (possibly phenomenal) exception is in *Period 1* in which the largest distance to water correspond somewhat to the maximum

housing price level, indicating that other factors (e.g. some historical features) might play a more significant role;

- In regarding the housing price correspondence to fiber availability, somewhat surprisingly, we do see a clear, even though weak, correspondence here. By tracing back to the raw data, it can be seen that the fiber penetration level for the *Fritidshus* small houses was at ~ 60% for both periods. Apparently at this relatively low penetration level the fiber availability indeed has an impact on the housing price;
- The driving time to Stockholm from each housing deal's location also clearly corresponds to the housing price;
- In regarding the distance to local city centers we see that in *Period 1*, there is a slight correspondence between the maximum housing price and minimum distance to the local center, while in *Period 2* this slight correspondence almost disappears.

### 4.2.2 Housing attractivity corresponding to housing characters

Figure 9 - Figure 11 show MCA factor spaces for housing attractivity (price/m^2) corresponding to various housing characters over one year before and after the pandemic for the three housing categories, respectively. Note that the housing characters for *Bostadsrätt* apartments differ with those for *Villa/Fritidshus* small houses due to their different housing ownership (housing tenure).

#### *4.2.2.1 Bostadsrätt* apartments

Figure 9 shows the MCA factor spaces for *Bostadsrätt* apartments for the two periods. We see that for both periods up to 85% (*Period 1*) and 82% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 1964 deals included while for *Period 2* increased to 2121 deals. Note here that the total number of housing deals decreased significantly as compared to those in the previous section. This is because that in *Mäklarstatistik*'s raw data there are missing values for a certain amount (~ 25%) of observations (housing deals) for variables (mainly floor number, elevator and heating-included) used in this analysis, and the MCA algorithm automatically dropped these observations in the calculation process. From this figure we see that:

- Living area, number of rooms and monthly fee are highly correlated with each other, and show somewhat negative correspondence to the per-square-meter price for apartments with ≥ 5 rooms;
- Housing build-year clearly correspond to the price levels, the newer the apartment the higher price, and vice versa;
- Apartments with elevator also show a clear correspondence to higher price levels;
- Apartments at higher floors (≥4) clearly correspond to higher price, while apartments at lower floors do not show significantly correspondence to the housing price levels;
- The heating-included (in the monthly fee) shows a slight correspondence to higher price levels in *Period 2*, while in *Period 1* this correspondence nearly disappears.

### 4.2.2.2 *Villa* small houses

Figure 10 shows the MCA factor spaces for *Villa* small houses for the two periods. We see that for both periods up to 81% (*Period 1*) and 86% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 1927 deals included while for *Period 2* increased to 1961 deals. Note here that, unlike the *Bostadsrätt* apartment case the total number of housing deals remains the same as in the previous section. From this figure we see that:

- Living area and number of rooms are correlated to each other, and clear negative correspondence to the price can also be seen;
- Plot area clearly corresponds to the price level, i.e., the higher plot area the higher price level, except for the minimum plot area where the correspondence disappears;
- The price-by-rateable-value also shows clearly correspondence to the price level, i.e., the higher the price-by-rateable-value the higher price;
- In regarding the build-year, older small houses built before 1940 show a correspondence to the highest price level. A possible explanation for this is that old small houses correspond to larger plot areas, especially those built before 1940 are highly correspondent to the maximum plot area level, as can also be seen from the factor spaces.

### 4.2.2.3 *Fritidshus* small houses

Figure 11 shows the MCA factor spaces for *Fritidshus* small houses for the two periods. We see that for both periods up to 76% (*Period 1*) and 77% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primany+secondary). For *Perion 1* there are 362 deals included while for *Period 2* increased to 518 deals. Note here that, similar to the *Villa* small house case the total number of housing deals remains the same as in the previous section. From this figure we see that:

- For *Period 1*, the housing price levels are much more concentrated to the origin of the factor space, indicating that in general the correspondence of the *Fritidshus* small house price to their housing characters becomes less significant. Even so, except for those with the maximum living area and number of rooms where the correspondence to the housing price becomes not obvious, other correspondence among the variables largely remain the same as *Villa* small houses;
- For *Period 2*, on the other hand, as the price levels stretch along the secondary dimension, interestingly enough, in regarding the living area/number of rooms and even plot area, we see a *moderate (lagom)* behavior of correspondence of these variables to the housing price levels, i.e., while the minimum level of these housing characters show little correspondence to the housing price, the maximum level of these housing characters correspond to the lower housing price levels, and in the meantime higher house prices correspond to those with moderate housing characters. In regarding the build-year similar correspondence can also be seen except that those built before 1940 show a correspondence to the lower price levels. Furthermore, the price-by-rateable-value still corresponds positively to the housing price except for those at the maximum level (>3.5) where the correspondence disappears.

### 4.2.3 Housing attractivity corresponding to school results

Closeness to primary schools (up to grade 9) is an important factor for families with school age children to consider where to live. There are two aspects in this context: the geographic closeness to a primary school where children can, preferably, walk to schools; the relative closeness to schools with e.g. higher grade 9 students records. To make a comprehensive analysis on how these two aspects would interact with the housing price is out of the range of this work. Instead, we analyze, as the first step, the correspondence between the housing prices and the total number/qualification ratio to high school of primary school (grade 9) students aggregated in DeSO areas to get a first insight on how the housing attractivity is related to these school results. Note here that the primary school results are divided into two categories: qualification to high school professional programs (PP) and qualification to higher education preparation programs (HEPP). Table 7 shows the total number of qualified students for the 177 DeSO areas in Södermanland in 2019-2020 respectively.

*Table 7 Total number of grade-9 students qualified to high school in Södermanland*

| **2019** | | **2020** | |
|---|---|---|---|
| Qualified to high school professional programs (PP) | Qualified to higher education preparation programs (HEPP) | Qualified to high school professional programs (PP) | Qualified to higher education preparation programs (HEPP) |
| 2751 | 1594 | 2839 | 1682 |

#### 4.2.3.1 *Bostadsrätt* apartments

Figure 12 shows MCA factor space for *Bostadsrätt* apartment attractivity (price/m^2) corresponding to the total number and qualification (to high school) ratio of primary school (grade 9) students in the housing deal's DeSO areas over one year before and after the pandemic breakout. For both periods up to 76% (*Period 1*) and 83% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Perion 1* there are 2773 deals included while for *Period 2* increased to 3083 deals. From this figure, we see that:

- *In Period 1*, for HEPP, the housing price clearly corresponds to the HEPP qualification ratio positively at the minimum and maximum levels; in regarding the total qualified student numbers, apart from the maximum level point (HEPP>15), the housing price levels still correspond to the total number of HEPP students positively. For PP, the qualification correspondence trend remains the same, though not as significant as HEPP; in regarding the total number of PP students, the minimum level (PP≤10) still corresponds to the minimum housing price, but with the increasing of the total number of students the correspondence disappears (PP>20);
- *In Period 2*, on the other hand, we see that the correspondence to the housing price is more obvious for PP, except at the minimum PP levels (i.e., PP≤10, PP-ratio<70%). For For HEPP; at the minimum levels we see a correspondence between low housing price level and low level of qualification ratio and total number of students, but at higher levels the correspondence becomes less significant, especially at the highest HEPP level point (≥90) where it is almost located at the factor space origin indicating its indiscriminate feature to the *Bostadrätt* housing price.

#### *4.2.3.2 Villa* small houses

Figure 13 shows MCA factor space for *Villa* small house attractivity (price/m^2) corresponding to the total number and qualification (to high school) ratio of primary school (grade 9) students in the housing deal's DeSO areas over one year before and after the pandemic breakout. For both periods up to 92% (*Period 1*) and 87% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Perion 1* there are 1927 deals included while for *Period 2* increased to 1961 deals. From this figure, we see that:

- In *Period 1*, first of all, we see that the price level points are relatively more concentrated to the origin of the factor space especially at higher price levels, indicating that *Villa* housing price is relatively less sensitive to the school results. For PP, both the total number and qualification ratio correspond in general positively to the housing price levels, while we can barely see obvious correspondence to HEPP;
- In *Period 2*, on the other hand, we see quite different behavior. Firstly, the price level points distribute almost evenly along the primary dimension. Secondly in regarding the correspondence behavior we see nicely positive correspondence to the *Villa* housing price levels for both HEPP and PP in regarding both the total number and qualification ratio of students qualified for high school studies.

#### *4.2.3.3 Fritidshus* small houses

Figure 14 shows MCA factor space for *Fritids* small house attractivity (price/m^2) corresponding to the total number and qualification (to high school) ratio of primary school (grade 9) students in the housing deal's DeSO areas over one year before and after the pandemic breakout. For both periods up to 83% (*Period 1*) and 78% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Period 1* there are 362 deals included while for *Period 2* increased to 518 deals. From this figure, we see that *Fritidshus* small house price levels are concentrated around the origins of the factor spaces in both periods, and apart from a clear correspondence of the minimum price level to the minimum levels of HEPP we can barely see significant correspondence of *Fritidshus* housing price levels with the school results. This is understandable as most of the *Fritidshus* small houses are not supposed to be daily homes for children, hence *Fritidshus* small house bidders would not care either the location or the performance of any schools near their vacation home places.

### 4.2.4 Housing attractivity corresponding to people moving into Södermanland from Stockholm

One motivation behind this study is that Södermanland as the "back garden" to Sweden's biggest city area, Stockholm region, with ~ 2.4 million people, has been continuously attracting people moving into it. Indeed, Södermanland has net people moving-in over the past 20 years except in year 2009 and during the period 2016-17[5]. With this background, one natural question is if the breakout of the Covid-19 pandemic would motivate people even more to move into Södermanland, especially from the Stockholm region, and how the education and income

[5] https://www.svt.se/datajournalistik/hit-och-dit-flyttar-svenskarna/

levels of these people moving into Södermanland would impact the housing market in Södermanland.

In this section, we show MCA results on how the housing attractivity is associated with working-age people moving into Södermanland from Stockholm region in regarding their education levels and disposable income, using the corresponding statistical data in Region Sörmland at each DeSO area.

*Table 8 Statistics on the number of people between 25-64 years old moving into Södermanland from Stockholm region with different education levels. Low: non high school: middle: high school; high: post high school*

| | 2019 | | | | 2020 | | | |
|---|---|---|---|---|---|---|---|---|
| | Low | Middle | High | N A | Low | Middle | High | N A |
| DeSO_min | -6 | -5 | -10 | -3 | -6 | -5 | -12 | -4 |
| DeSO_max | 9 | 36 | 43 | 4 | 20 | 39 | 58 | 5 |
| Total | 191 | 409 | 347 | 6 | 141 | 501 | 407 | 45 |

### *4.2.4.1 Bostadsrätt* apartments

Figure 15 shows MCA factor space for *Bostadsrätt* apartment attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from the Stockholm region in regarding their education levels and average disposable income over one year before and after the pandemic breakout. For both periods up to 87% (*Period 1*) and 89% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Perion 1* there are 2773 deals included while for *Period 2* increased to 3072 deals. From this figure, we see that:

- In *Period 1*, firstly, in regarding the education levels, we clearly see that, in, general, the housing price levels correspond positively to the total number of people moving-in irrespective of their education levels, except in those DeSO areas with the most total number of low-education people moving-in where they correspond to the minimum price level. Secondly, alongside the distribution of *Bostadsrätt* housing price levels along the primary dimension, the dispensable income levels show somewhat correspondence except at the highest disposable income level, indicating that people with high average income moving into Södermanland in this period may not necessarily looked for homes in DeSO areas with more expensive *Bostadsrätt* apartments.
- In *Period 2*, firstly, in regarding the total number of people moving-in, in general, the housing price levels correspond positively to the total number of people moving-in with high- and middle-educations, while for people moving-in with low-education the correspondence disappears in those DeSO areas where the total number increased to more than 10. Secondly, different to *Period 1*, alongside the distribution of *Bostadsrätt* housing price levels along the primary dimension, we also see a clear positive correspondence of disposable income levels even at the highest level, indicating that people moving-in with high average income in this period also tended to look for homes in DeSO areas with more expensive *Bostadsrätt* apartments.

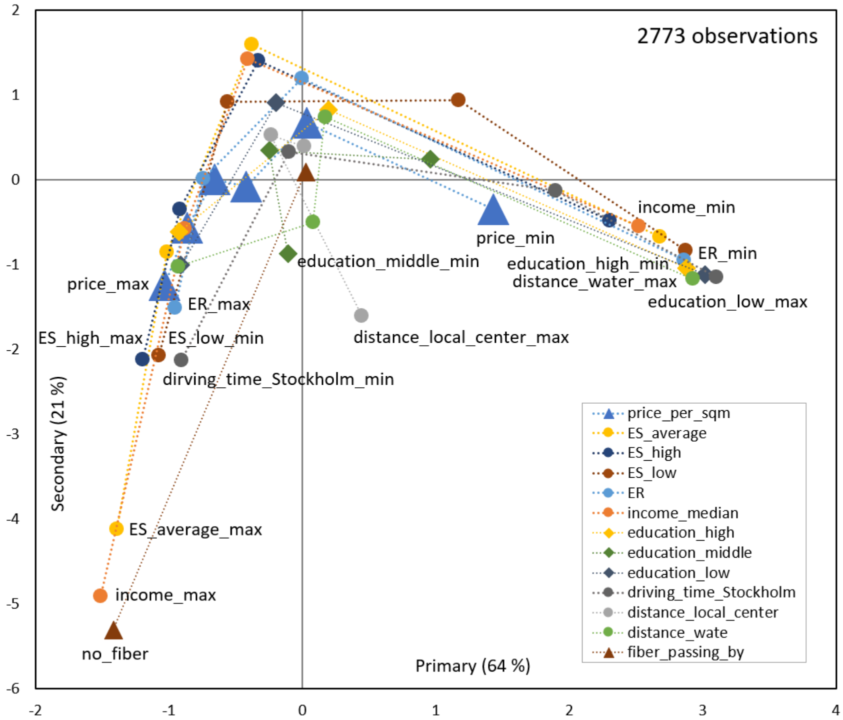
### *4.2.4.2 Villa* small houses

Figure 16 shows MCA factor space for *Villa* small house attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from the Stockholm region in regarding their education levels and average disposable income over one year before and after the pandemic breakout. For both periods up to 90% (*Period 1*) and 89% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Perion 1* there are 1927 deals included while for *Period 2* increased to 1937 deals. From this figure, we see that:

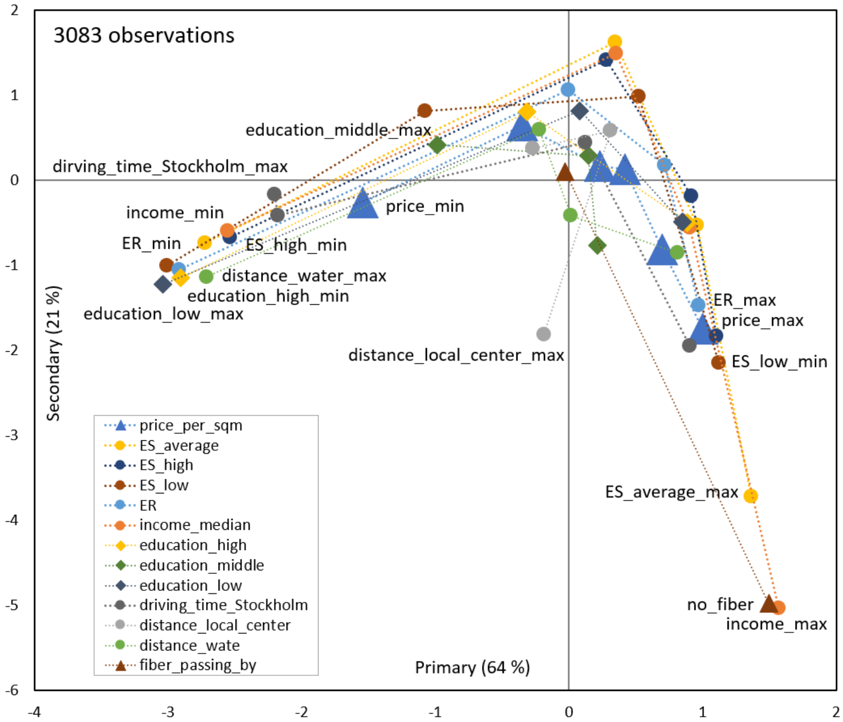
- In *Period 1*, firstly, in regarding the education levels, we see in general that the housing price levels correspond positively to the total number of people moving-in irrespective of their education levels, except in those DeSO areas with the most total number of low-education people moving-in. Secondly, alongside the distribution of *Villa* housing price levels the dispensable income levels follow closely except at the highest disposable income level, suggesting people with highest average income moving into Södermanland in this period tended not looking for *Villa* small house homes in DeSO areas with more expensive small houses.
- In *Period 2*, we see that compared to *Period 1,* even though we still see a clear distribution of the price levels distributed along the primary dimension, they are significantly more concentrated to the factor space origin at lower price levels, indicating that in this period people moving in tended even more to move into DeSO areas with lower price small house than in *Period 1*. This can also be seen by the distribution of the disposable income levels, as even though the maximum disposable income level corresponds to higher housing prices, and vice versa, the higher price levels are located close to the factor space origin, indicating that people moving-in did not have a strong tendency to move into DeSO areas with higher small house prices even if they have higher average disposable income. Nevertheless, in regarding the total number of people moving-in, the housing price levels correspond positively to the total number of people moving-in with high- and middle-educations, while for people moving-in with low-education the correspondence disappears in those DeSO areas with the highest total number (>15).

### *4.2.4.3 Fritidshus* small houses

Figure 17 shows MCA factor space for *Fritidshus* small house attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from the Stockholm region in regarding their education levels and average disposable income over one year before and after the pandemic breakout. For both periods up to 89% (*Period 1*) and 92% (*Period 2*) of the association information among the variables is maintained with the MCA constructed two dimensions (primary+secondary). For *Perion 1* there are 362 deals included while for *Period 2* increased to 516 deals. From this figure, we see that for both periods, in general, the housing price levels are concentrated around the factor space origins, indicating their correspondence to people moving-in becomes insignificant.

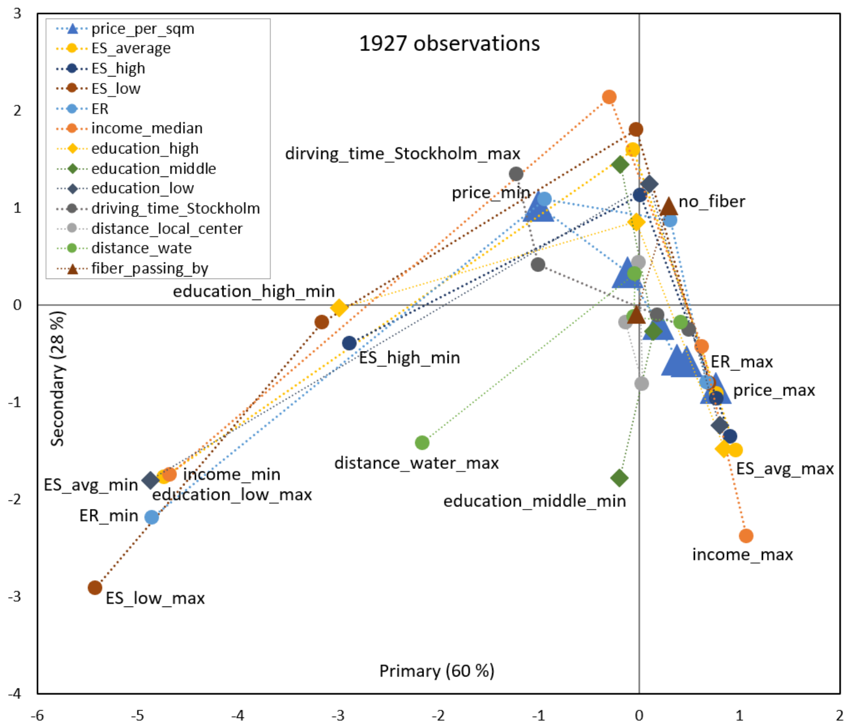



(a)

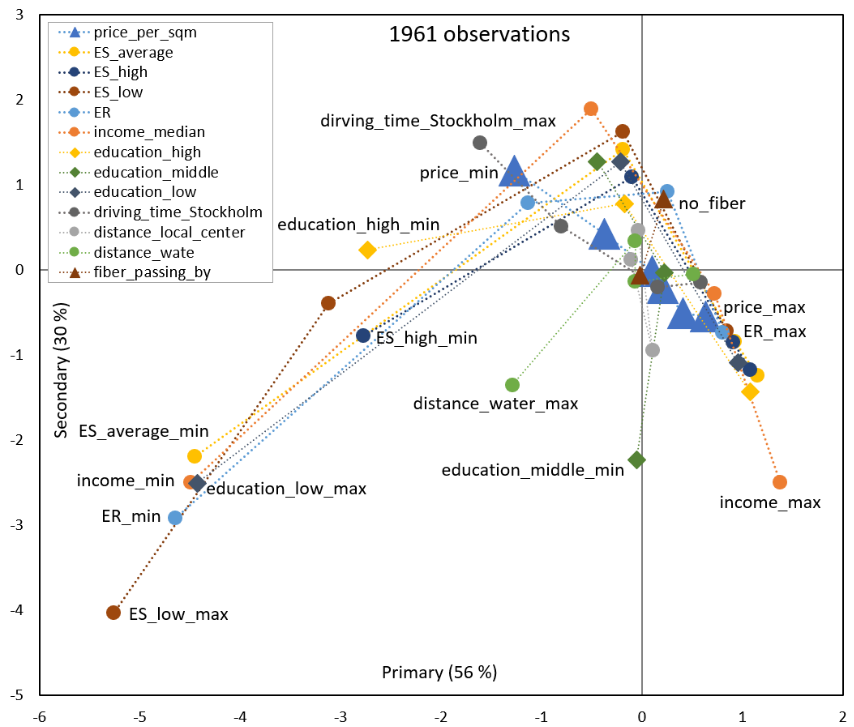



(b)

*Figure 6 MCA factor space for Bostadsrätt apartment attractivity (price/m^2) corresponding to the housing deal's location, fiber availability and local DeSO socio-economic characters over one year before (a) and after (b) Covid-19 pandemic. ES: economic standard; ER: employment rate; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

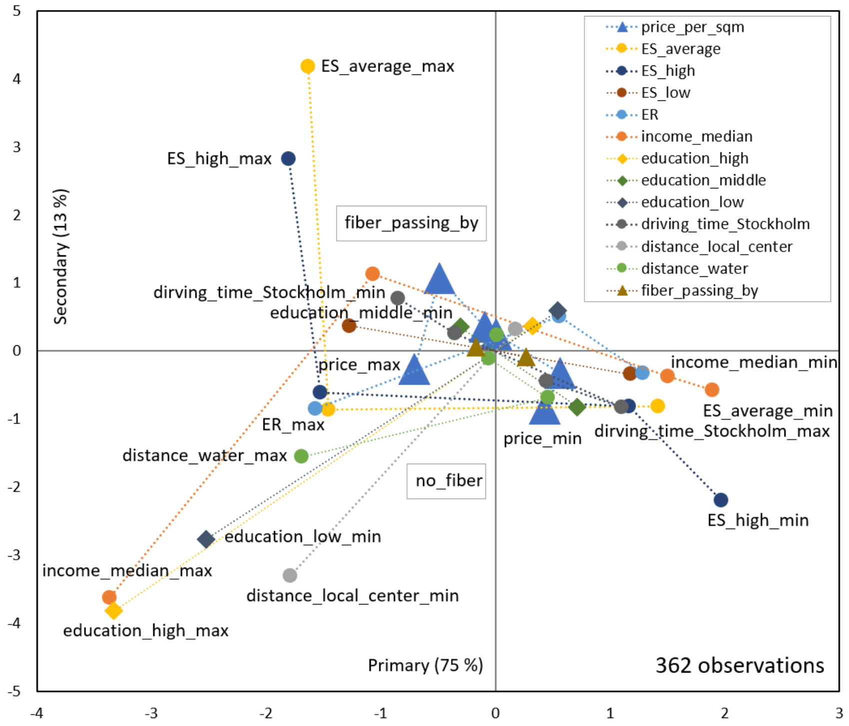



(a)

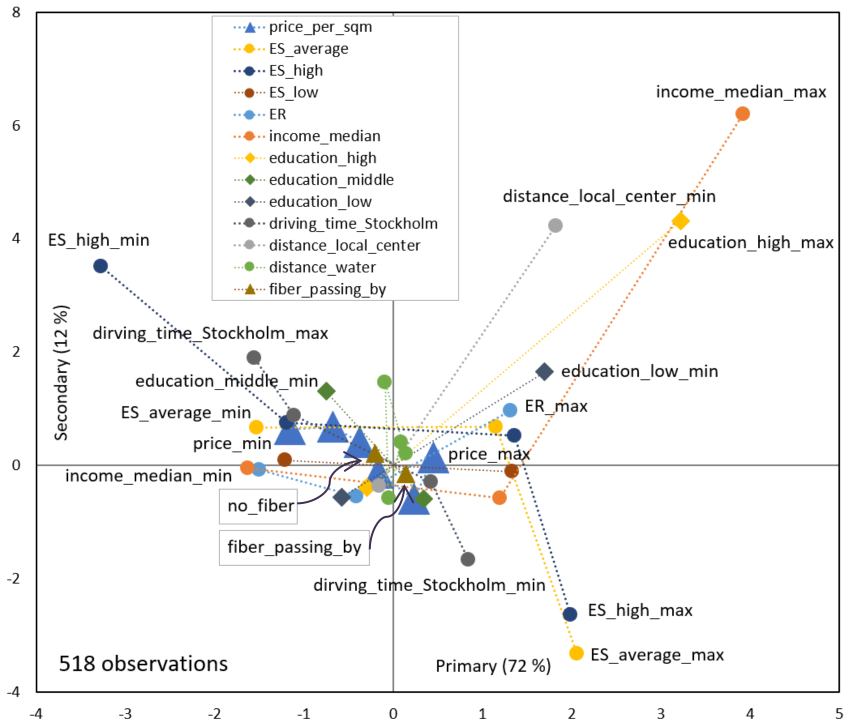



(b)

*Figure 7 MCA factor space for Villa small house attractivity (price/m^2) corresponding to the housing deal's location, fiber availability and local DeSO socio-economic characters over one year before (a) and after (b) Covid-19 pandemic. ES: economic standard; ER: employment rate; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*




(a)




(b)

*Figure 8 MCA factor space for Fritidshus small house attractivity (price/m^2) corresponding to the housing deal's location, fiber availability and local DeSO socio-economic characters over one year before (a) and after (b) Covid-19 pandemic. ES: economic standard; ER: employment rate; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

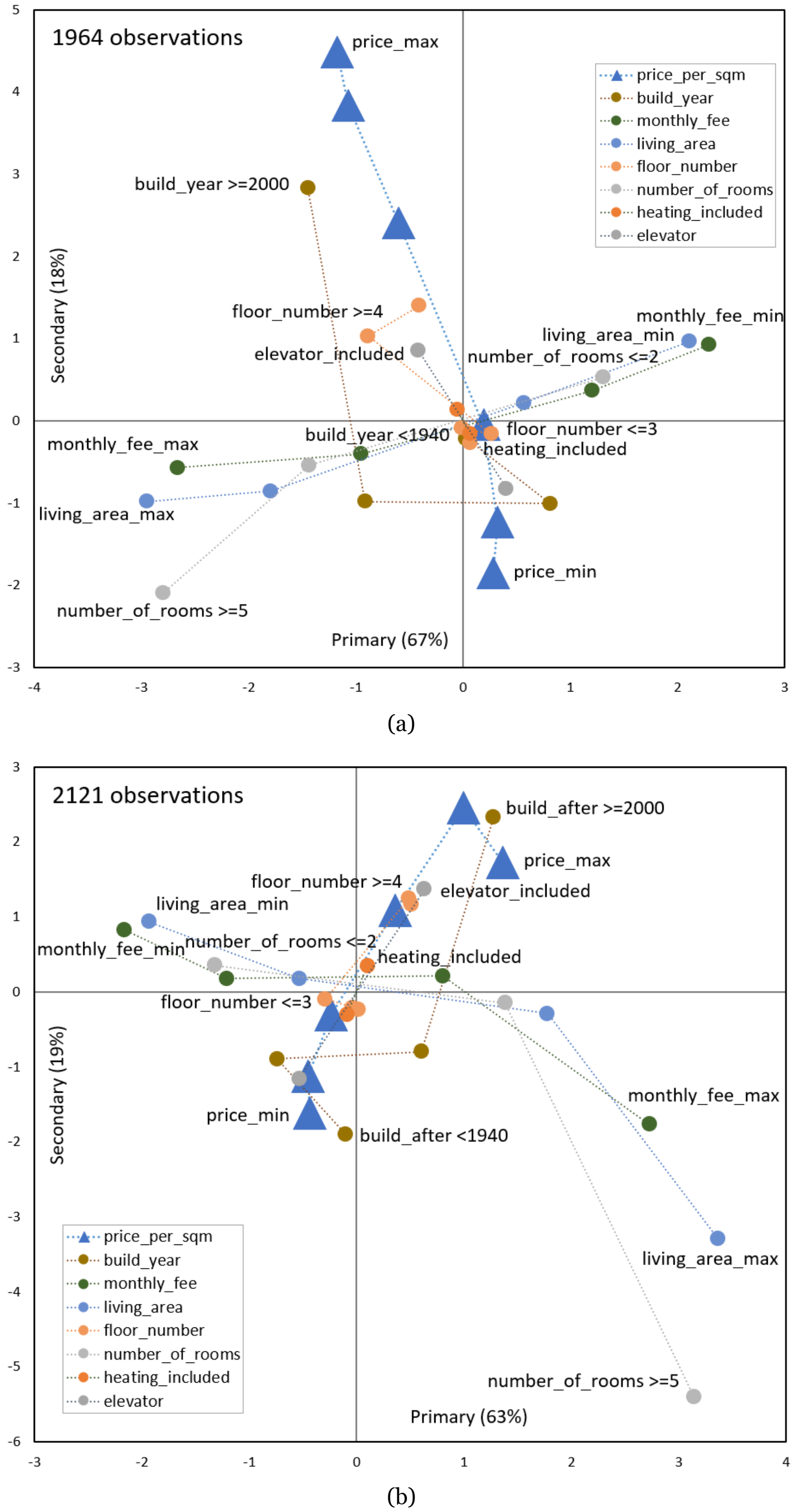
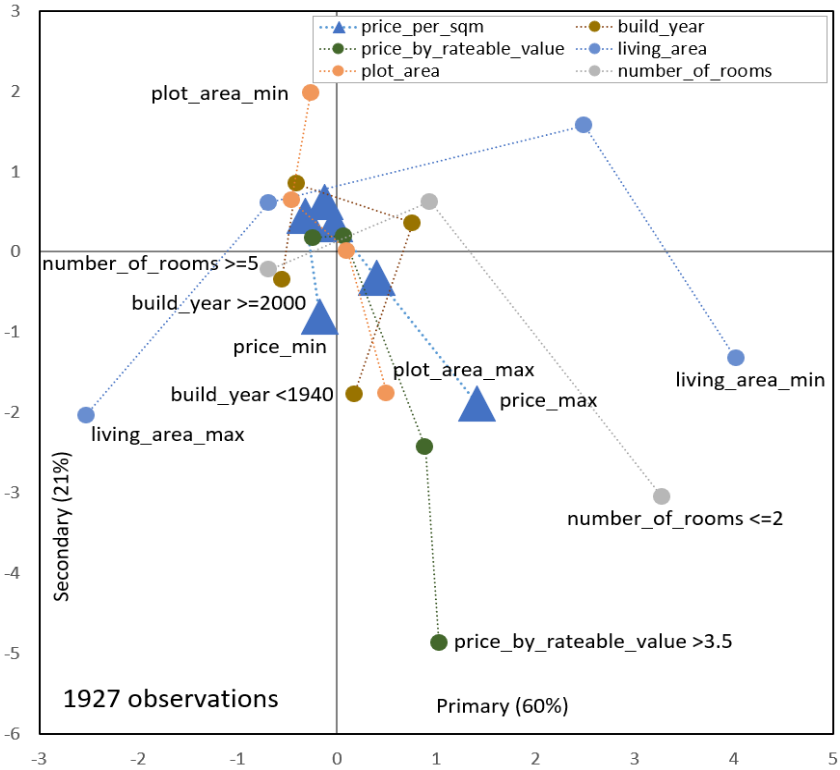
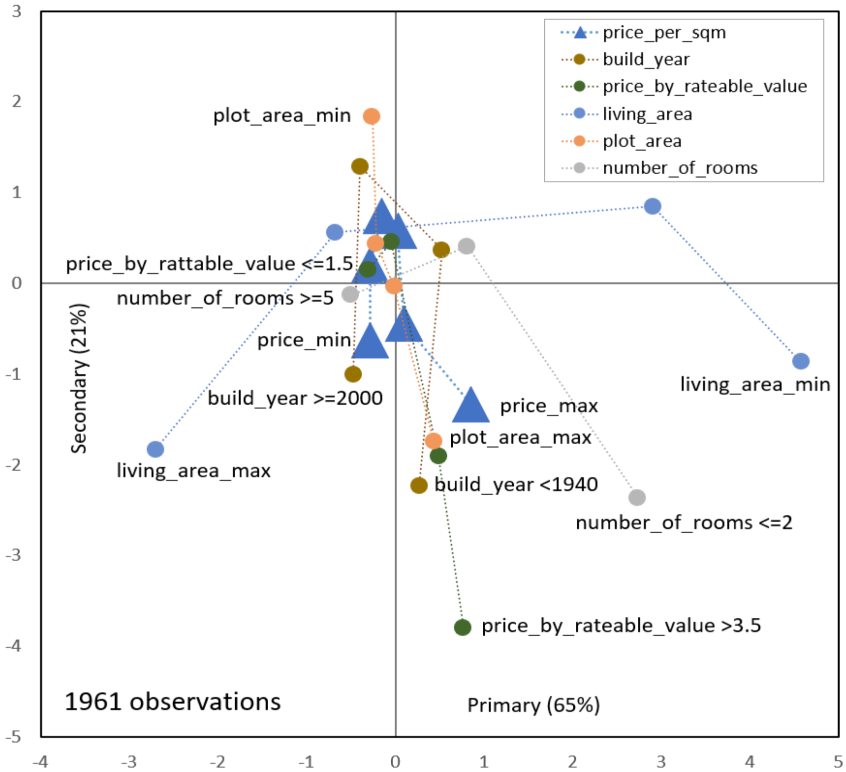



*Figure 9 MCA factor space for Bostadsrätt apartment attractivity (price/m^2) corresponding to the housing characters over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

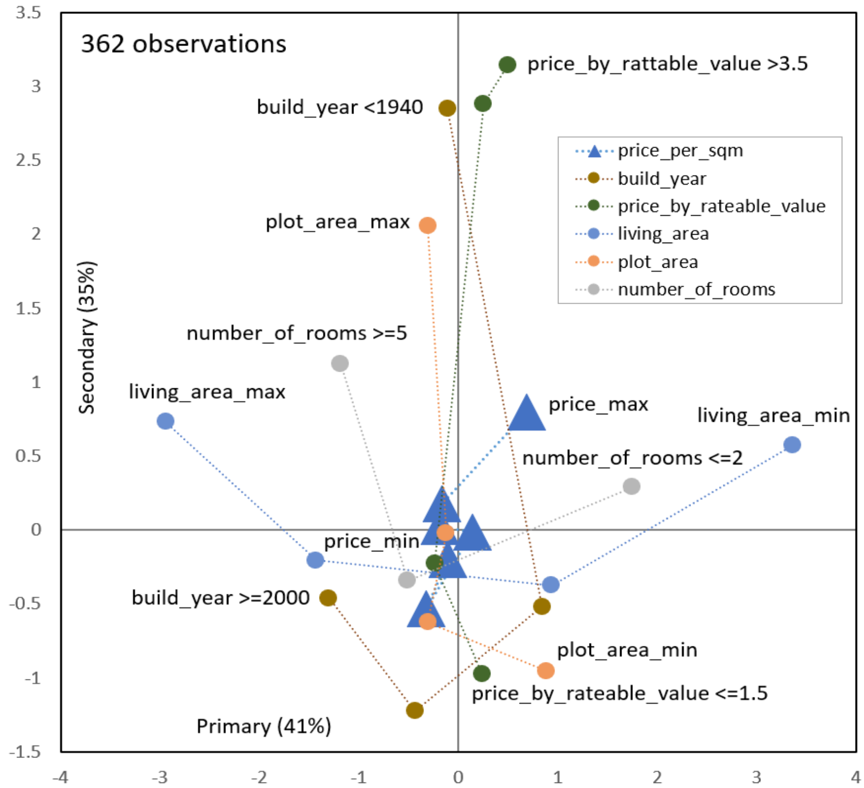



(a)

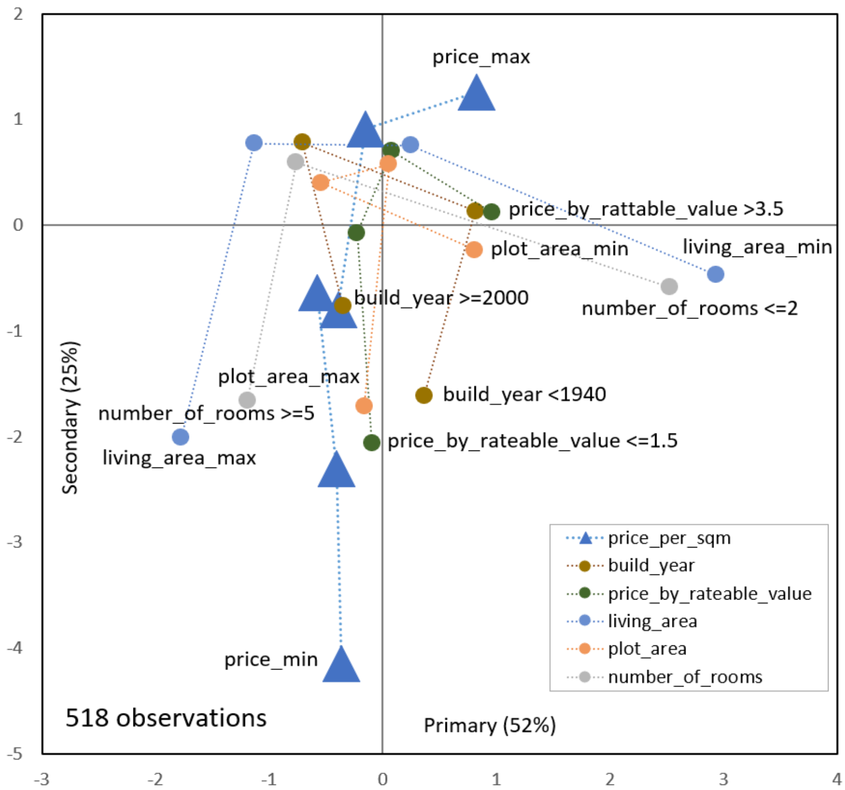



(b)

*Figure 10 MCA factor space for Villa small house attractivity (price/m^2) corresponding to the housing characters over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

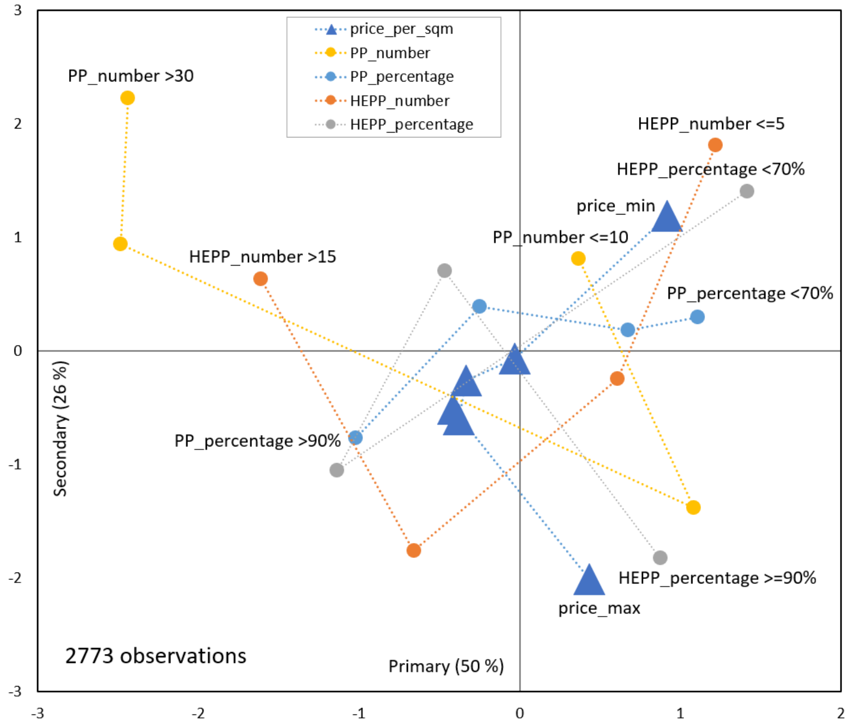



(a)

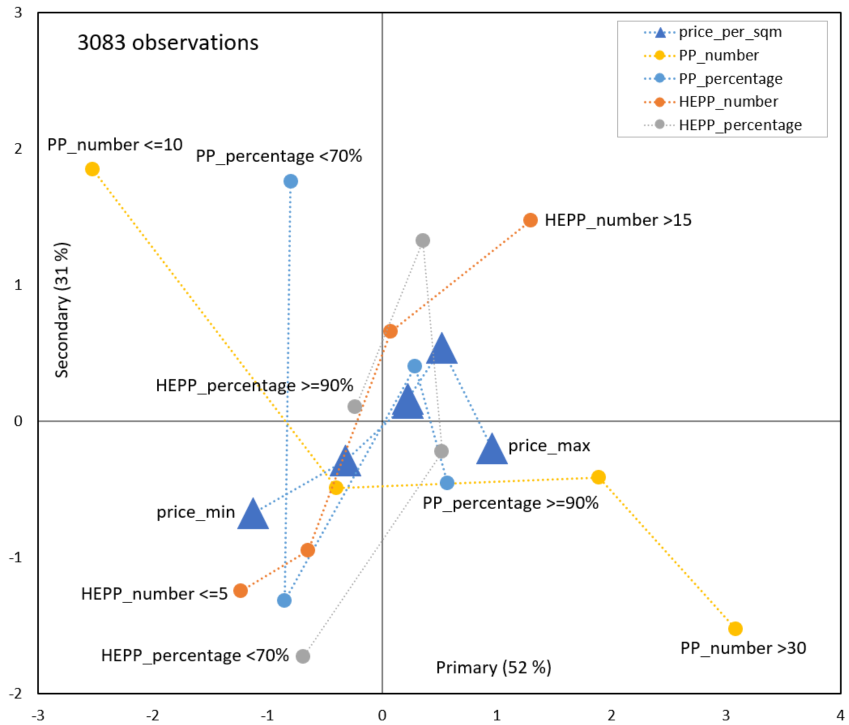



(b)

*Figure 11 MCA factor space for Fritidshus small house attractivity (price/m^2) corresponding to the housing characters over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

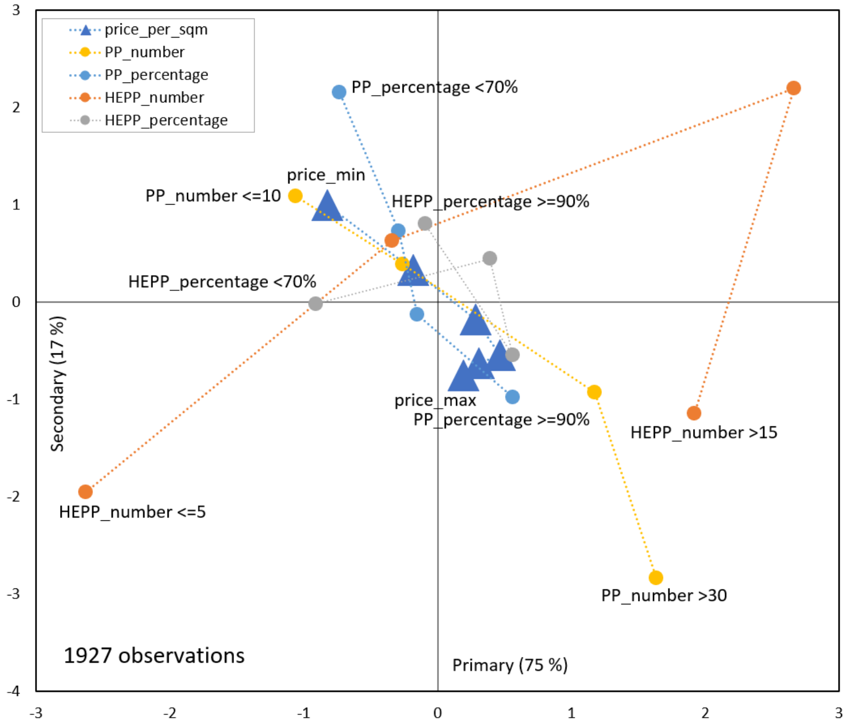



(a)

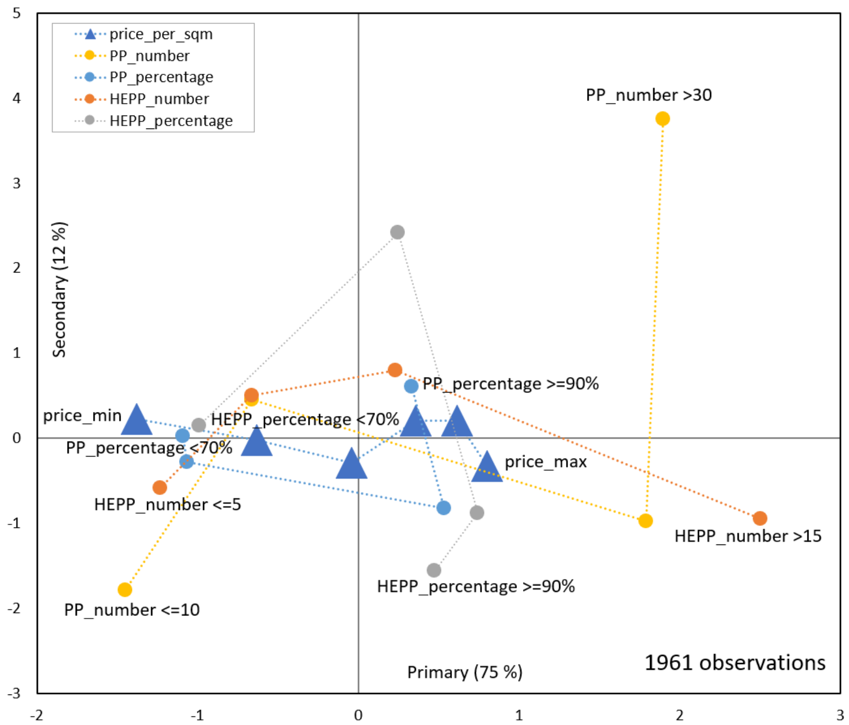



(b)

*Figure 12 MCA factor space for Bostadsrätt apartment attractivity (price/m^2) corresponding to the number and ratio of primary school (grade-9) students qualified for high school in the housing deal's DeSO areas over one year before (a) and after (b) Covid-19 pandemic. PP: professional program; HEPP: high-education-preparation program; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for complete variable categorizations.*

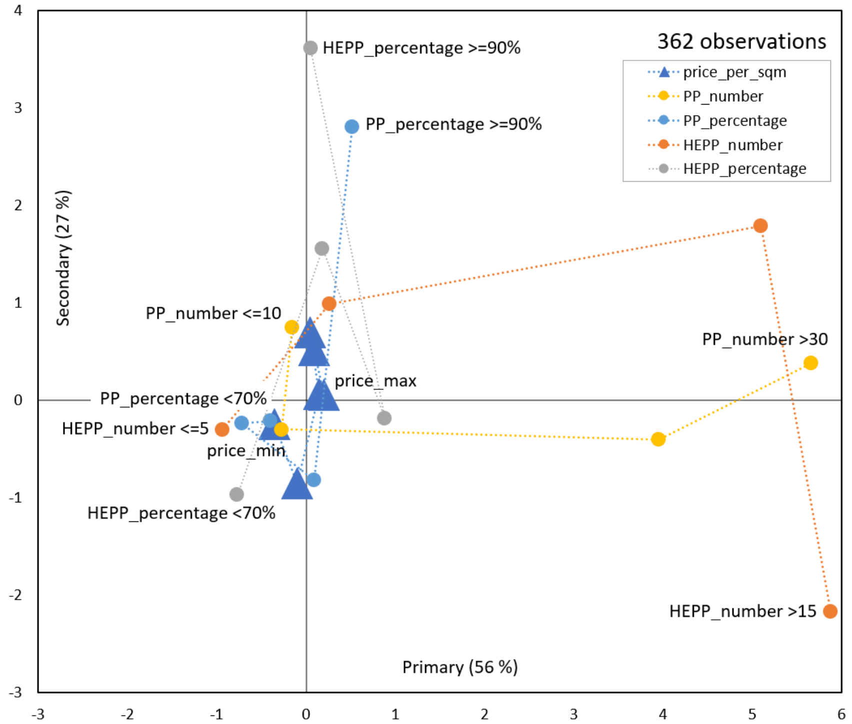



(a)

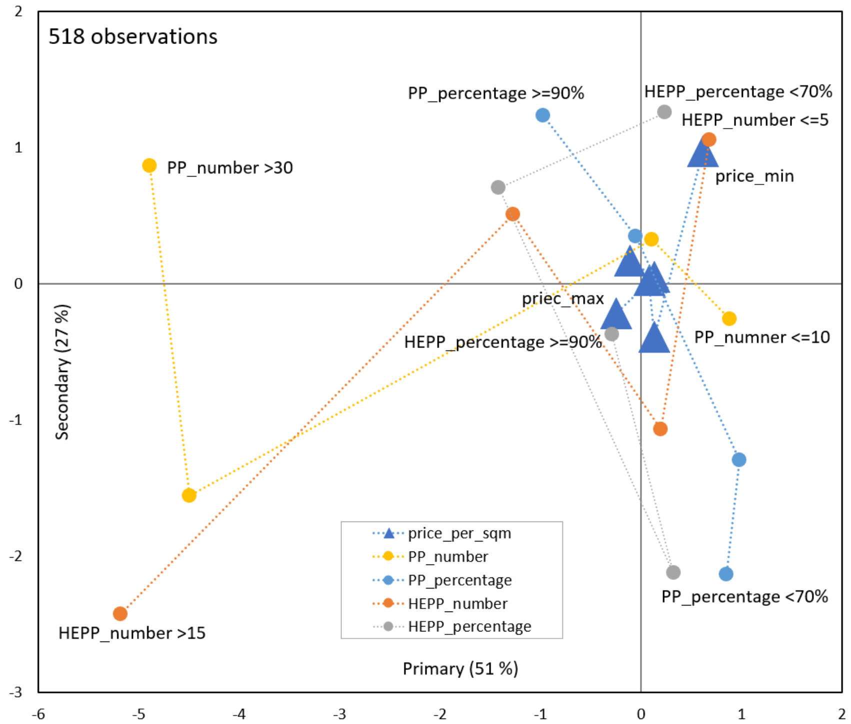



(b)

*Figure 13 MCA factor space for Villa small house attractivity (price/m^2) corresponding to the number and ratio of primary school (grade-9) students qualified for high school in the housing deal's DeSO areas over one year before (a) and after (b) Covid-19 pandemic. PP: professional program; HEPP: high-education-preparation program; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for complete variable categorizations.*

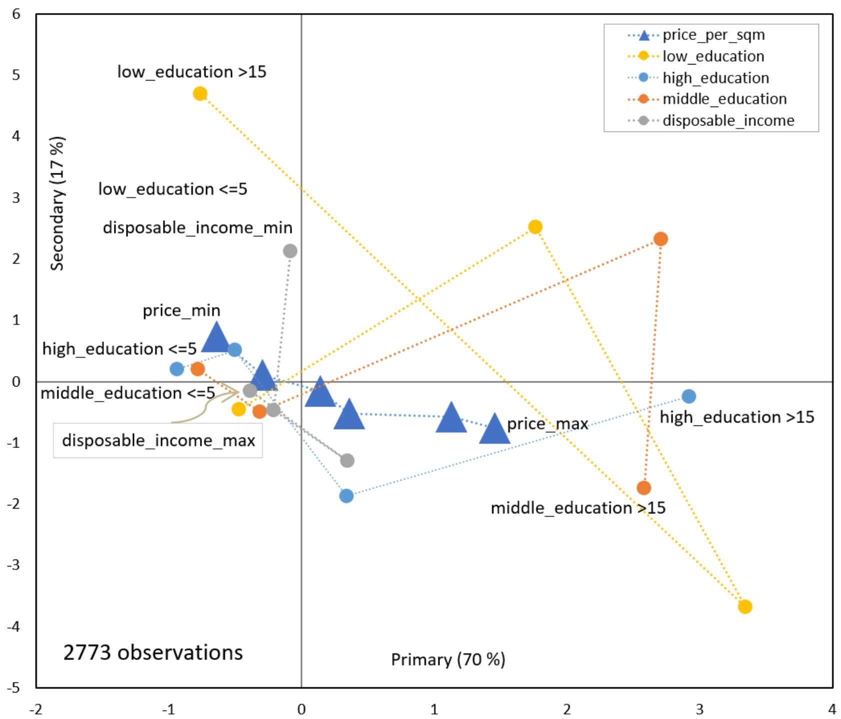



(a)

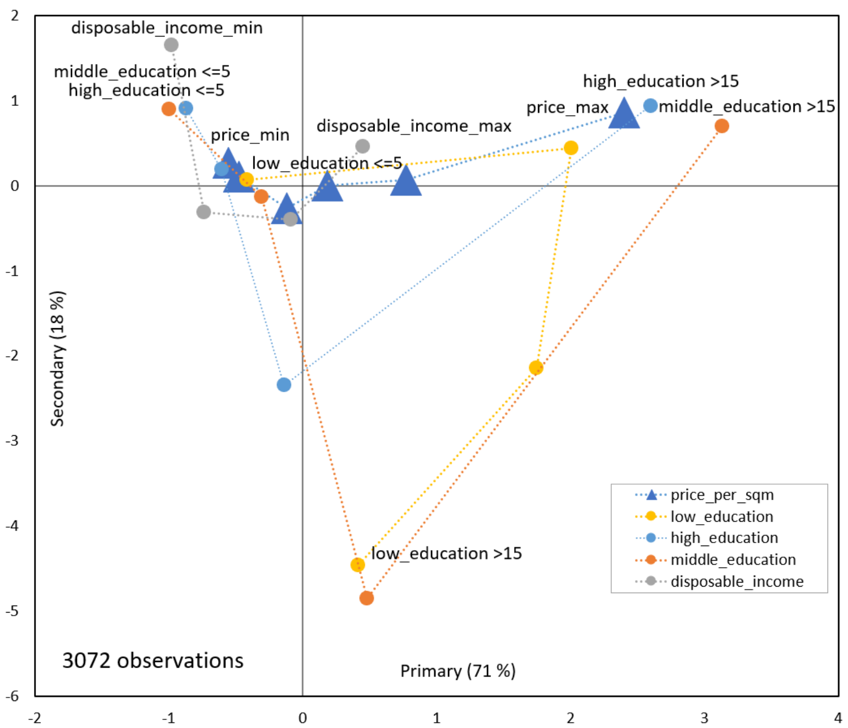



(b)

*Figure 14 MCA factor space for Villa small house attractivity (price/m^2) corresponding to the number and ratio of primary school (grade-9) students qualified for high school in the housing deal's DeSO areas over one year before (a) and after (b) Covid-19 pandemic. PP: professional program; HEPP: high-education-preparation program; price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for complete variable categorizations.*

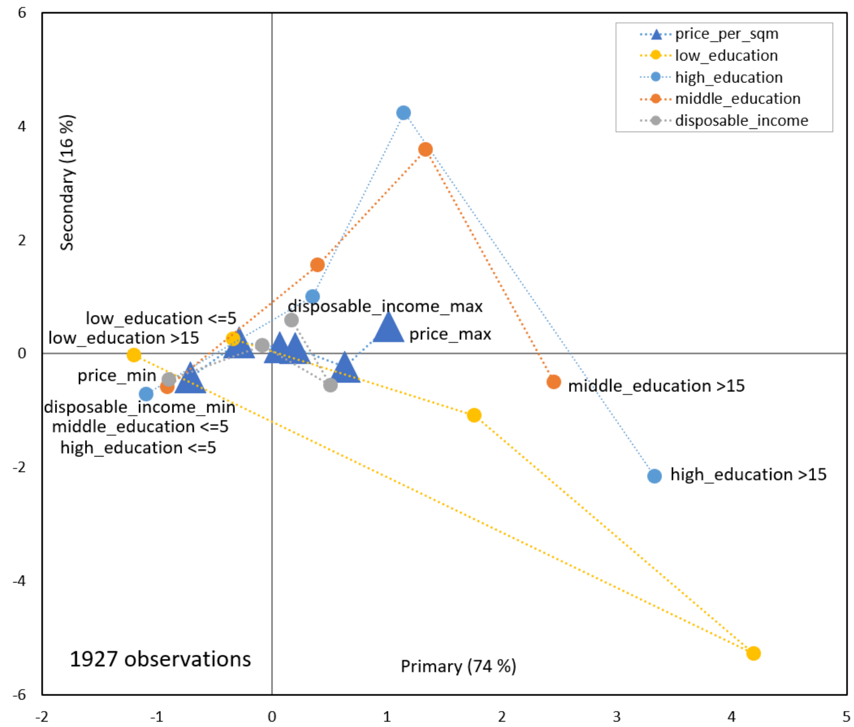



(a)

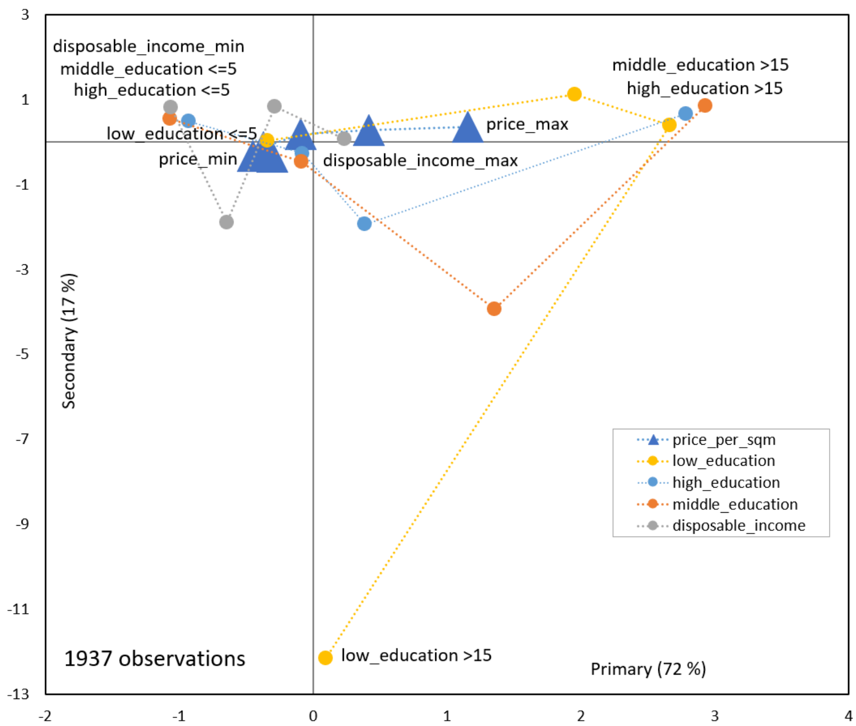



(b)

*Figure 15 MCA factor space for Bostadsrätt apartment attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from Stockholm in regarding their education levels and average disposable income over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

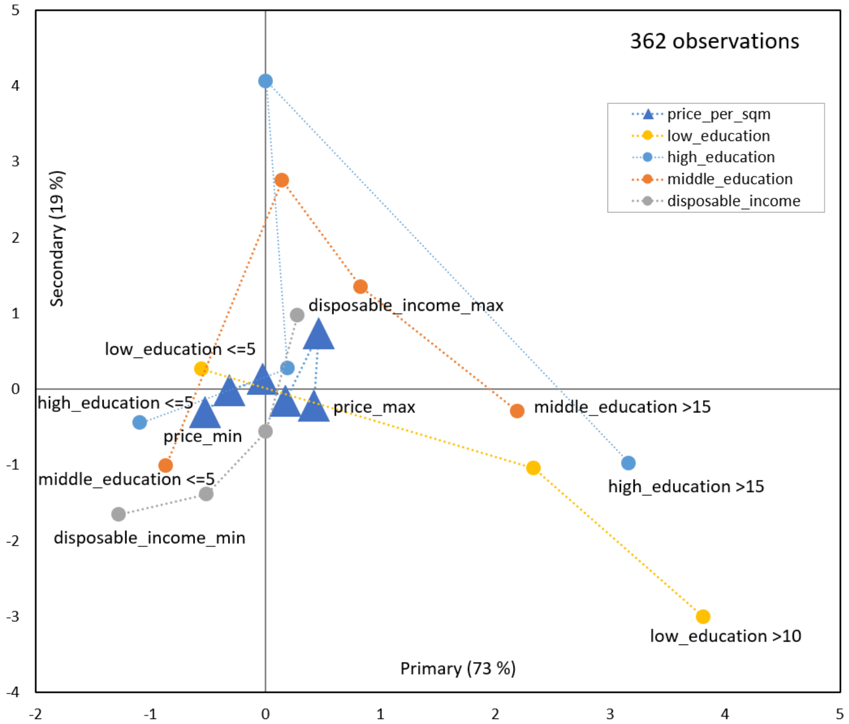



(a)

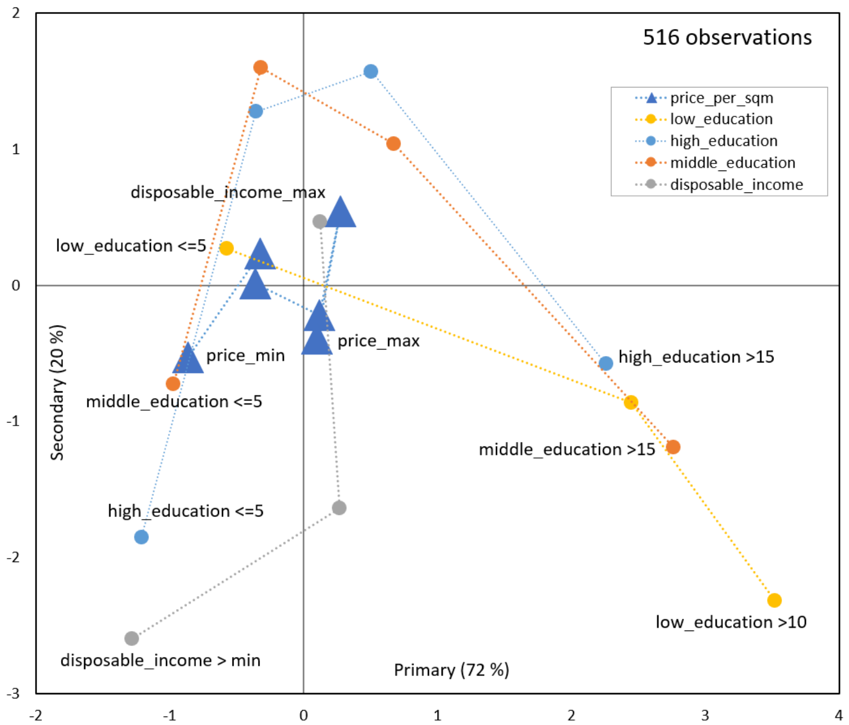



(b)

*Figure 16 MCA factor space for Villa small house attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from Stockholm in regarding their education levels and average disposable income over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*




(a)




(b)

*Figure 17 MCA factor space for Fritidshus small house attractivity (price/m^2) corresponding to the number of working-age people moving into the housing deal's DeSO areas from Stockholm in regarding their education levels and average disposable income over one year before (a) and after (b) Covid-19 pandemic. price_min: ≤ 15k kr/m^2; price_max: > 40k kr/m^2. See Appendix II for other variable categorizations.*

## 4.3 Regression analysis

Alongside the factor analysis, regression analysis was also carried out in this work for further and complementary explanations and understanding of the housing market attractivity in Södermanland before and after the Covid-19 pandemic breakout. In contrast to MCA, which uses nearly 30 variables in different aspects to explore their correspondence to the housing attractivity, the regression analysis needs carefully select the (hypothetical) independent variables in order to avoid the multicollinearity, as many socio-economic or housing characters in the MCA analysis are highly correlated to each other. More specifically, in regarding the local DeSO socio-economic characters, since the income, employment rate, economic standard and even low/high-education levels are highly associated with each other, as manifested in the MCA factor spaces in the previous section, we must choose just one variable among them in the regression modelling. After testing each of these variables, we found that the variable *economic-standard-high* (i.e., percentage of inhabitants with as 2 times or more as the national median economic standard) is most suitable to achieve the highest correlation (R-squared value). Furthermore, in regarding the housing characters, from the corresponding MCA factor spaces we also see clearly high association among the *living area*, *number of rooms* and *monthly fee* (for *Bostadsrätt* apartments). By testing each of these variables we found that the *monthly fee* is most suitable in the regression modelling (to achieve the highest R-squared value) for *Bostadsrätt* apartments, while for *Villa and Fritidshus* small houses the living area was chosen. Also note that for *Villa and Fritidshus* small houses the *rateable-value*, rather than the *price-by-rateable-value* in the MCA analysis, was used as the (hypothetical) explanatory variable in the regression modelling. In the meantime, we keep those variables for school results and people moving into Södermanland from Stockholm with the hypothesis that people's moving patterns and different school results are independent to each other. Moreover, the *distance to Stockholm* and *distance to local centers*, as well as the *distance to water* are always included in the regressions as a rough "proxy" to other local characters (e.g. travelling time for people working in Stockholm, closeness to local hospitals, public services, shops etc., which also implies that the municipality dummies[6] are not appropriate to be used in the regression modelling).

### 4.3.1 *Bostadsrätt* apartments

Table 12 shows the correlation of *Bostadsrätt* apartment attractivity (price/m^2) with the (hypothesized) independent variables in different aspects. Robust regression was used to mitigate the heteroscedasticity. For the ease of comparison those independent variables show different performance in the two periods are blue-marked. We see that, not surprisingly, for both periods the housing prices are strongly correlated with the local DeSO *economic-standard-high* levels. In regarding the housing characters, the monthly-fee correlates as expected negatively to the housing attractivity, while the build-year, elevator, and apartment floor correlate positively. What makes a difference between the two periods here is the variable heating-included, which shows a significant negative correlation in *Period 1*, but somewhat positive, though not significant, correlation to the housing price. This behavior is also found in the MCA analysis (see section 4.2.2.1), indicating that *Bostadsrätt* apartment bidders in *Period 2* seemingly care about this more after the pandemic breakout. One possible explanation on this might be that people would expect more time to be spent at home after the

[6] Tillgänglighet, Tobins Q Och bostadsbyggande i Sörmland, Rapportversion 2021-01-28, WSP Advisory

pandemic, e.g. more time to work from home, hence would expect more expense on the heating if the heating cost is not included (in the monthly fee).

In regarding the school results, for the high school preparation program (HEPP) in *Period 1* the total number correlate positively while the qualification ratio negatively; in *Period 2* the total number shows insignificant correlation while the qualification ratio becomes strongly positive. On the other hand, for the professional program (PP) in *Period 1* the total number correlates negatively, while the qualification ratio is not significant in *Period 1*, but becomes negative in *Period 2*. Overall, it seems that *Bostadsrätt* apartment attractivity is more positively correlated to the HEPP performance and negatively correlated to the PP performance.

*Table 9 Correlation of Bostadsrätt apartment attractivity to different groups of variables*

| Period | price_per_sqm | coefficient | Robust std. error | t ratio | significance |
|---|---|---|---|---|---|
| Period 1, 2019.03 – 2020.02 | Number of obs: 1579<br>R-squared: 0.5214 | | | | |
| | monthly_fee | -0.95 | 0.15 | -6.20 | *** |
| | build_year | 77.80 | 12.20 | 6.38 | *** |
| | heating_included | -804.13 | 281.52 | -2.86 | *** |
| | elevator | 1364.09 | 352.51 | 3.87 | *** |
| | apartment_floor | 418.11 | 86.71 | 4.82 | *** |
| | deso_ES_high | 1367.54 | 92.03 | 14.86 | *** |
| | PP_number | -123.98 | 21.91 | -5.66 | *** |
| | HEPP_number | 99.02 | 31.16 | 3.18 | *** |
| | PP_ratio | -675.66 | 1395.12 | -0.48 | |
| | HEPP_ratio | -3394.52 | 1113.97 | -3.05 | *** |
| | IN_low_edu | -72.99 | 87.77 | -0.83 | |
| | IN_middle_edu | -105.66 | 47.19 | -2.24 | *** |
| | IN_high_edu | 220.38 | 30.33 | 7.27 | *** |
| | IN_dispInc | -0.00732 | 0.00089 | -8.21 | *** |
| | distance_Stockholm | -49.59 | 11.06 | -4.48 | *** |
| | distance_localcenter | -93.35 | 20.66 | -4.52 | *** |
| | distance_water | 0.92 | 0.17 | 5.42 | *** |
| Period 2, 2020.07 – 2021.06 | Number of obs: 1706<br>R-squared: 0.5142 | | | | |
| | monthly_fee | -0.78 | 0.15 | -5.27 | *** |
| | build_year | 76.52 | 9.98 | 7.67 | *** |
| | heating_included | 292.19 | 287.49 | 1.02 | |
| | elevator | 1547.28 | 405.39 | 3.82 | *** |
| | apartment_floor | 259.32 | 99.24 | 2.61 | *** |
| | deso_ES_high | 1090.78 | 90.47 | 12.06 | *** |
| | PP_number | -36.17 | 23.14 | -1.56 | |
| | HEPP_number | 32.59 | 29.94 | 1.09 | |
| | PP_ratio | -3624.87 | 1587.65 | -2.28 | *** |
| | HEPP_ratio | 10509.79 | 1205.81 | 8.72 | *** |
| | IN_low_edu | 649.49 | 107.48 | 6.04 | *** |
| | IN_middle_edu | -63.74 | 47.34 | -1.35 | |
| | IN_high_edu | 42.32 | 24.42 | 1.73 | ** |
| | IN_dispInc | 0.00740 | 0.00247 | 2.99 | *** |
| | distance_Stockholm | -58.81 | 10.05 | -5.85 | *** |
| | distance_localcenter | -90.89 | 23.84 | -3.81 | *** |
| | distance_water | 0.88 | 0.18 | 4.98 | *** |

*** p<0.01, ** p<0.05, * p<0.1

In regarding people moving into Södermanland from Stockholm, we see that compared to *Period 1*, in *Period 2* the *Bostadrätt* housing attractivity remains positive for (working age) people moving-in with high education level and negative for people moving-in with middle education level, while becomes significantly positive for people moving in with low education level. We also see that the correlation of average disposable income to the housing attractivity for these working age people moving-in (irrespective of their education levels) has changed from strongly negative in *Period 1* to significantly positive in *Period 2*, suggesting that those working age people moving in with higher average disposable income also tend to move into those DeSo areas with higher price *Bostadrätt* apartments after the pandemic breakout. Note that this behavior is also found in the MCA analysis (see section 4.2.4.1).

In regarding the locality proxies, no difference can be seen between the two periods, i.e., not surprisingly the housing attractivity always correlate positively to Stockholm, and even local city centers (which is not obvious in the corresponding MCA factor spaces). Nevertheless, the notably discrepancy with MCA is the distance to water which shows a positive correlation to the housing attractivity here, while the corresponding MCA factor spaces show a clear negative correspondence (the shorter distance to water the higher price). The reason for this is that most of the *Bostadsrätt* apartment deals are located relatively further away from water, as can be seen in Table 10, hence while MCA can capture this differentiation irrespective of the weight (total number of) of the deals, the regression algorithm may average out this delicacy difference. Furthermore, the availability to fiber is not included here as the corresponding fiber penetration is almost 100% for *Bostadsrätt* apartments in Södermanland.

*Table 10 Number of Bostadsrätt apartment deals at different distance-to-water levels*

| distance to water | total number in Period 1 | total number in Period 2 |
|---|---|---|
| <= 300 m | 334 | 380 |
| 300-1500 m | 1172 | 1260 |
| 1500 – 5000 m | 1266 | 1442 |
| > 5000 m | 1 | 1 |

## 4.3.2 *Villa* small houses

Table 11 shows the correlation of *Villa* small houses' price/m^2 with the (hypothesized) independent variables in different aspects. Robust regression was used to mitigate the heteroscedasticity. For the ease of comparison those independent variables show different performance in the two periods are blue-marked. We see that, for both periods the housing prices are correlated positively with the local DeSO *economic-standard-high* levels. Even so, it should be noted here that in the corresponding MCA analysis (see section 4.2.1.2), we do find that for those *Villa* housing deals in DeSO areas with the lowest socio-economic levels the price does not drop according to the same trend as for *Villa* housing deals in other DeSO areas with higher socio-economic levels. Again, the regression algorithm may average out this delicacy difference. In regarding the housing characters, the living-area and the build-year correlates negatively to the housing attractivity. In the meantime, the rateable-value of the *Villa* small houses strongly correlates positively to the housing attractivity, i.e., the higher the rateable-value, the higher price/m^2. More specifically, if all other explanatory variables are kept unchanged, the increase of the rateable-value by 10k kr correlate to the increase of the price/m^2 by 87.5 kr in *Period 1* and 100 kr in *Period 2*. Moreover, a notably difference between the two periods is the plot-area which is correlated positively in *Period 1*, but becomes insignificant in *Period 2* after the pandemic breakout. This is different from the MCA analysis in section 4.2.2.2 which indicates that plot area clearly corresponds to the price level in both periods. A possible explanation for this is that old small houses correspond to larger plot areas, especially those built before 1940 are highly correspondent to the maximum plot area level, as can be seen from the MCA analysis in section 4.2.2.2.

In regarding the school results, for HEPP the qualification ratio in *Period 1* and the total number in *Period 2* correlate negatively. On the other hand, for the professional program the total number correlate positively in *Period 2*. Overall, it seems that the *Villa* small house attractivity becomes more correlated to both HEPP and PP performance after the pandemic breakout.

*Table 11 Correlation of Villa small house attractivity to different groups of variables*

| | | | | | |
|---|---|---|---|---|---|
| Period 1, 2019.03 – 2020.02 | Number of obs: 1911<br>R-squared: 0.5594 | | | | |
| | price_per_sqm | coefficient | Robust std. error | t ratio | significance |
| | living_area | -157.95 | 9.35 | -16.90 | *** |
| | build_year | -15.77 | 7.29 | -2.16 | ** |
| | plot_area | 0.31 | 0.07 | 4.22 | *** |
| | rateable_value | 0.00875 | .0.00040 | 21.82 | *** |
| | deso_ES_high | 447.45 | 81.76 | 5.47 | *** |
| | PP_number | -19.69 | 29.13 | -0.68 | |
| | HEPP_number | 42.36 | 48.60 | 0.87 | |
| | PP_ratio | 156.38 | 1884.58 | 0.08 | |
| | HEPP_ratio | -2778.75 | 1095.29 | -2.54 | ** |
| | IN_low_edu | 91.67 | 75.33 | 1.22 | |
| | IN_middle_edu | -78.09 | 36.32 | -2.15 | ** |
| | IN_high_edu | 81.45 | 29.36 | 2.77 | *** |
| | IN_dispInc | 0.00053 | 0.00134 | 0.40 | |
| | distance_Stockholm | -31.09 | 9.16 | -3.39 | *** |
| | distance_localcenter | -63.51 | 14.38 | -4.42 | *** |
| | distance_water | -0.60 | 0.13 | -4.51 | *** |
| | fiber_passing_by | -1146.63 | 915.38 | -1.25 | |
| Period 2, 2020.07 – 2021.06 | Number of obs: 1925<br>R-squared: 0.5714 | | | | |
| | living_area | -173.31 | 8.71 | -19.91 | *** |
| | build_year | -36.84 | 6.75 | -5.46 | *** |
| | plot_area | 0.04 | 0.04 | 0.92 | |
| | rateable_value | 0.0099997 | 0.00046 | 21.85 | *** |
| | deso_ES_high | 326.33 | 81.73 | 3.99 | *** |
| | PP_number | 71.40 | 33.08 | 2.16 | ** |
| | HEPP_number | -129.80 | 57.40 | -2.26 | ** |
| | PP_ratio | 2384.79 | 1627.32 | 1.47 | |
| | HEPP_ratio | 2326.94 | 1518.20 | 1.53 | |
| | IN_low_edu | -0.71 | 68.03 | -0.01 | |
| | IN_middle_edu | 76.43 | 49.86 | 1.53 | |
| | IN_high_edu | 8.94 | 32.38 | 0.28 | |
| | IN_dispInc | -0.00011 | 0.00151 | -0.07 | |
| | distance_Stockholm | -19.12 | 8.62 | -2.22 | ** |
| | distance_localcenter | -57.76 | 19.19 | -3.01 | *** |
| | distance_water | -0.67 | 0.15 | -4.46 | *** |
| | fiber_passing_by | -2253.34 | 1042.42 | -2.16 | ** |

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

In regarding people moving into Södermanland from Stockholm, we see that in *Period 1* the *Villa small house* attractivity is positively correlated to (working age) people moving-in with the high education level and negatively correlated to those with the middle education level, while in *Period 2* just a weak positive correlation can be seen for those with the middle education level. We also see that the correlation of average disposable income to the housing attractivity for these working age people moving-in (irrespective of their education levels) is nonsignificant, suggesting that people moving-in even after the pandemic breakout did not have a strong tendency to move into DeSO areas with either higher or lower *Villa* small house prices even if they have higher average disposable income. This behavior is also observed in the MCA analysis (see section 4.2.4.2).

In regarding the locality proxies, no difference can be seen between the two periods, i.e., not surprisingly the housing attractivity always correlate positively to Stockholm, and even local city centers. Nevertheless, it should be noted that from the MCA analysis (see section 4.2.1.2) we found that the middle-level distance to local city centers (between 2-10 km) corresponds to higher *Villa* housing prices, indicating that small houses located not too close or too far away from local centers are most attractive. Apparently this delicate differentiation is averaged out in the regression. In addition, we see a clear negative correlation between the small house attractivity with the distance to water, as expected. Furthermore, a negative correlation to fiber availability is also seen here, in accordance with similar observation in the MCA analysis. A possible explanation might be that (as described in section 4.2.1.2) for those housing deals without fiber availability (~10% of housing deals in *Period 1* and ~7% in *Period 2*) the locations of these *Villa* small houses are too further away to be passed by fiber penetration in the foreseeable time ahead (indeed the average distance to local city centers for those housing deals without fiber availability is 7.5 km larger in *Period 1* and 5.8 km larger in *Period 2*, respectively, than those with fiber availability), hence the bidders did not consider the fiber availability to be a main distinguishing factor for the housing attractivity.

### 4.3.3 *Fritidshus* small houses

Table 12 shows the correlation of *Fritidshus* small houses' price/m^2 with the (hypothesized) independent variables in different aspects. Robust regression was used to mitigate the heteroscedasticity. For the ease of comparison those independent variables show different performance in the two periods are blue-marked. We see that, the housing price correlation to the local DeSO *economic-standard-high* levels becomes insignificant. In regarding the housing characters, the living-area correlates negatively to the housing attractivity, while the plot-area and the rateable-value correlate positively. Nevertheless, a notable difference between the two periods is the build-year which is negative in *Period 1* and becomes insignificant in *Period 2*, similar to the MCA analysis in section 4.2.2.3 (which shows that *Fritidshus* small houses built before 1940 corresponds to the lower price levels).

In regarding the school results, it can be seen that the *Fritidshus* small houses' attractivity is not correlated significnantly to any program result.

In regarding people moving into Södermanland from Stockholm, we see clearly that apart from *Period 1* in which the average disposable income shows a positive correlation to DeSO areas with higher *Fritidshus* small house prices, no other correlation can be observed especially in *Period 2* after the pandemic breakout, suggesting that for these people moving into Södermanland from Stockholm the *Fritidshus* small house attractivity is not their priority.

Finally, in regarding the locality proxies, firstly, the distance to Stockholm is positively correlated in *Period 1*, but becomes insignificant in *Period 2*, indicating that *Fritidshus* small houses closer to Stockholm become more attractive after the pandemic breakout. Secondly, the distance to local city center remains insignificant in both periods. Thirdly we see clear negative correlation between the distance to water and housing attractivity in *Period* 2, which is not obvious in the MCA analysis (see section 4.2.1.3), suggesting that *Fritidshus* small houses more close to water have become more attractive after the pandemic. (Note that in MCA we have to categorize the distance to water into classes (and most of the *Fritidshus* small house are located within 1500 m to water) during which the tiny difference within the same class can be overlooked). In addition, for the fiber availability, while we do see a weak positive correspondence to the housing attractivity in MCA, we do not see significant correlation in

Table 12 before the pandemic breakout. By contrast. We do see a significantly positive correlation to the housing attractivity after the pandemic breakout.

*Table 12 Correlation of Fritidshus small house attractivity to different groups of variables*

| Period | price_per_sqm | coefficient | Robust std. error | t ratio | significance |
|---|---|---|---|---|---|
| Period 1, 2019.03 – 2020.02 | Number of obs: 353 | | | | |
| | R-squared: 0.5701 | | | | |
| | living_area | -292.14 | 29.17 | -10.01 | *** |
| | build_year | -20.27 | 12.28 | -1.65 | * |
| | plot_area | 0.52 | 0.17 | 2.99 | *** |
| | rateable_value | 0.02154 | 0.00217 | 9.93 | *** |
| | deso_ES_high | -281.85 | 272.62 | -1.03 | |
| | PP_number | -217.71 | 194.82 | -1.12 | |
| | HEPP_number | 215.28 | 226.97 | 0.95 | |
| | PP_ratio | -2453.94 | 5683.72 | -0.43 | |
| | HEPP_ratio | -2154.38 | 3603.47 | -0.60 | |
| | IN_low_edu | -270.78 | 376.41 | -0.72 | |
| | IN_middle_edu | 201.21 | 146.43 | 1.37 | |
| | IN_high_edu | 155.37 | 140.87 | 1.10 | |
| | IN_dispInc | 0.00440 | 0.00224 | 1.96 | * |
| | distance_Stockholm | 74.80 | 31.39 | 2.38 | ** |
| | distance_localcenter | -83.41 | 63.86 | -1.31 | |
| | distance_water | -0.50 | 0.84 | -0.60 | |
| | fiber_passing_by | 553.61 | 1151.18 | 0.48 | |
| Period 2, 2020.07 – 2021.06 | Number of obs: 509 | | | | |
| | R-squared: 0.4911 | | | | |
| | living_area | -487.20 | 49.99 | -9.75 | *** |
| | build_year | -13.91 | 13.13 | -1.06 | |
| | plot_area | 0.14 | 0.08 | 1.69 | * |
| | rateable_value | 0.02821 | 0.00312 | 9.05 | *** |
| | deso_ES_high | -94.93 | 516.11 | -0.18 | |
| | PP_number | -68.13 | 133.92 | -0.51 | |
| | HEPP_number | 362.32 | 504.98 | 0.72 | |
| | PP_ratio | -6794.65 | 8954.20 | -0.76 | |
| | HEPP_ratio | 233.68 | 6105.87 | 0.04 | |
| | IN_low_edu | 443.25 | 408.52 | 1.09 | |
| | IN_middle_edu | -249.79 | 178.90 | -1.40 | |
| | IN_high_edu | -37.47 | 198.75 | -0.19 | |
| | IN_dispInc | -0.00891 | 0.00589 | -1.51 | |
| | distance_Stockholm | 17.23 | 44.11 | 0.39 | |
| | distance_localcenter | 95.49 | 77.50 | 1.23 | |
| | distance_water | -2.04 | 0.87 | -2.34 | ** |
| | fiber_passing_by | 2041.06 | 1226.28 | 1.66 | * |

*** p<0.01, ** p<0.05, * p<0.1

# 5 Summary and conclusions

In this work, we analyzed the housing market evolution in Södermanland over 28-month period from March 2019 to June 2021 across the Covid-19 breakout in spring 2020. In the analysis, the housing market is divided into three segments characteristic to the Swedish housing market: *Bostadsrätt* apartments, *Villa* and *Fritidshus* small houses. Four groups of nearly 30 variables on the respective housing character, the locality and local DeSO socio-economic feature, school results (in terms of primary school grade-9 students) and working-age people moving into Södermanland from the Stockholm region (in regarding their education levels and disposable income) are used to analyze and compare the housing market attractivity (in the term of *price-per-square-meter*) before and after the pandemic breakout employing both multiple correspondence analysis (MCA) and regression analysis.

## Overall housing market evolution across the Covid-19 breakout period

As to the housing market evolution in general, the total number of housing deals for *Villa* and *Fritidshus* small houses largely remain the same over the 28-month period, while there is a slight increase for *Bostadsrätt* apartments after the pandemic breakout (which might be attributed to the higher growth rate of newly built *Bostadsrätt* apartments in Södermanland in the past ten years). In the meantime, there are significant price increases for all the three housing categories, especially for *Fritidshus* small houses. More specifically, the average price/m^2 has increased 19% for *Bostadrätt* apartments, 24% for *Villa* small houses, and up to 39% for *Fritidshus* small houses for the same quarterly 4-month period (March-June) from 2019 to 2021. Moreover, the price differences among the nine municipalities in Södermanland are quite significant for *Villa* small houses and *Bostadrätt* apartments, while for *Fritidshus* small houses the price difference is much smaller.

By further segregating the housing deals into the 177 DeSO areas in Södermanland we can also see that for *Bostadsrätt* apartments the housing deals are mainly located in the four main city centers (i.e., Eskilstuna, Nyköping, Strängnäs and Katrineholm) and Trosa municipality, and in most of the DeSO areas the price/m^2 increases as well, especially in DeSO areas around Katrineholm. For *Villa* and *Fritidshus* small houses, on the other hand, the housing deals are located around city centers and in the countryside. *Villa* small house prices are in general higher in the DeSO areas in the eastern and south-eastern part of Södermanland in both periods, while their corresponding increase/decrease rates are more evenly distributed in the whole region. In regarding *Fritidshus* small houses both the prices and their corresponding increase/decrease rates are in general evenly distributed in the whole region except in DeSO areas around Nyköping where the price increases significantly after the pandemic breakout.

Figure 3 - Figure 5 illustrate the housing market attractivity (in the term of price/m^2) for the three segments at DeSO level over one year before and after the Covid-19 pandemic, and the corresponding increase/decrease rates between the two periods after the pandemic.

## *Bostadsrätt* apartments

As to *Bostadsrätt* apartment attractivity, higher housing prices clearly correlate positively to the local DeSO socio-economic characters (i.e. income, economic standards and employment rate) as well as the inhabitants education levels. In regarding the housing characters, the living area, number of rooms and monthly fee are highly correlated with each other, and the housing attractivity correlates negatively to the monthly-fee and positively to the build-year, elevator and apartment floor number. What makes a difference before and after the pandemic is if the heating cost is included (in the monthly fee) which shows a negative correlation before, but positive correspondence after the pandemic breakout to the housing price. One possible explanation on this might be that people would expect more time to be spent at home after the pandemic, e.g. more time to work from home, hence would expect more expense on the heating if the heating cost is not included. In regarding the school results in general the *Bostadsrätt* apartment attractivity correlates positively more to the high education preparation program (HEPP) performance compared to that of the professional program (PP). In regarding (walking-age) people moving into Södermanland from Stockholm, in general, the *Bostadsrätt* apartment attractivity corresponds positively to the total number of people moving-in. Even so, a significantly difference is identified before and after the pandemic in regarding the average disposable income, i.e., those working-age people moving-in with higher average disposable income also tend to move into those DeSO areas with higher price *Bostadrätt* apartments after the pandemic breakout. Moreover, in regarding the locality proxies, no difference can be seen between the two periods, i.e., the *Bostadrätt* housing attractivity always correlate positively to the closeness to Stockholm, local city centers and water area (sea or lakes).

An overview of how the *Bostadsrätt* apartment attractivity is related to the four groups of variables before and after the pandemic is summarized in Table I.

## *Villa* small houses

As to *Villa* small houses' attractivity, higher housing prices clearly correlate positively to the local DeSO socio-economic characters (income, economic standards and employment rate) as well as the inhabitants education levels, except for those *Villa* housing deals in DeSO areas with the lowest socio-economic levels where the *Villa* small house price does not drop according to the same trend as for *Villa* housing deals in other DeSO areas with higher socio-economic levels. In regarding the housing characters, the living area and number of rooms are still correlated to each other, and together with the build-year correlate negatively to the housing (per-square-meter) price, while the plot-area and the rateable-value correlate positively. In regarding the school results the *Villa* small house attractivity in general becomes more correlated to both HEPP and PP performance after the pandemic breakout. In regarding (walking-age) people moving into Södermanland from Stockholm, in general, the *Villa* small house attractivity corresponds positively to the total number of people moving-in. Even so, in regarding the average disposable income before and after the pandemic (irrespective of their education levels) a clear difference is that before the pandemic breakout these people moving–in tended to move into DeSO areas with lower *Villa* small house prices even if they had higher average disposable income, while after the pandemic breakout this tendency disappears. Moreover, in regarding the locality proxies, the *Villa* housing attractivity always correlate positively to the closeness to Stockholm and water area (sea or lakes), while the middle-level distance to local city centers (between 2-10 km) corresponds to higher *Villa* housing prices. Furthermore, a negative correlation to fiber availability is also seen. A possible explanation might be that for those housing deals without fiber availability (~10% of housing deals in *Period 1* before the pandemic and ~7% in *Period 2* after the pandemic) the locations of those *Villa* small houses are too further away to be passed by fiber penetration in the foreseeable time ahead (indeed the average distance to local city centers for those housing deals without fiber availability is 7.5 km larger in *Period 1* and 5.8 km larger in *Period 2*, respectively, than those with fiber availability), hence the bidders did not consider the fiber availability to be a main distinguishing factor for the housing attractivity.

An overview of how the *Villa* small house attractivity is related to the four groups of variables before and after the pandemic is summarized in Table II.

## *Fritidshus* small houses

As to *Fritidshus* small houses, in general the correspondence of the *Fritidshus* small house price to the local DeSO socio-economic characters becomes much weaker. In regarding the housing characters, the living-area still correlates negatively to the housing (square meter) price, while the plot-area and the rateable-value correlate positively. A notable difference between the two periods is the build-year which is correlated negatively to the housing attractivity before the pandemic, but becomes insignificant after the pandemic breakout, which is attributed to those *Fritidshus* small houses built before 1940 corresponding to the lower price levels, suggesting that after the pandemic people are looking for relatively newer *Fritidshus* small houses with higher standards probably with the expectation that they would live in their vacation homes longer time after the pandemic In regarding the school results in general the *Fritidshus* small houses' attractivity is not correlated to any program results. In regarding people moving into Södermanland from Stockholm, apart from *Period 1* in which the average disposable income shows a positive correlation to DeSO areas with higher *Fritidshus* small house prices, no other correlation can be observed especially in *Period 2* after the pandemic breakout, suggesting that for those people moving into Södermanland from Stockholm the *Fritidshus* small house attractivity is not their priority.

Finally, in regarding the locality proxies, firstly, the distance to Stockholm is positively correlated in *Period 1*, but becomes insignificant in *Period 2*, indicating that *Fritidshus* small houses closer to Stockholm become more attractive after the pandemic breakout. Secondly, the distance to local city center remains insignificant in both periods. Thirdly we see clear negative correlation between the distance to water and housing attractivity in *Period* 2, suggesting that *Fritidshus* small houses closer to water have become more attractive after the pandemic. In addition, for the fiber availability, there is a weak positive correspondence to the housing attractivity in *Period 1* before the pandemic breakout, and a significantly positive correlation to the housing attractivity after the pandemic breakout, suggesting that people after the pandemic care even more on high-speed broadband availability, again probably with the expectation that they would live and even work in their vacation homes longer time after the pandemic.

An overview of how the *Fritidshus* small house attractivity is related to the housing and other locality & local DeSO socio-economic characters (not including school results and people moving-in as *Fritidshus* small house attractivity is not their priority) before and after the pandemic is summarized in Table III.

# 6 Limitations and future work

There are several limitations in this work. Firstly, the time frame is limited and relatively short. Ideally, we would like to compare the housing market in Södermanland before and after the pandemic breakout during the same calendar months, while in this work due to the limited time frame we compared the performance difference over one year with different calendar months (March 2019 – February 2020 in *Period 1* and July 2020 – June 2021 in *Period 2*), which might include some periodical bias in the housing market. In the meantime, we assume that after four months of the Covid-19 breakout (March-June 2020) the housing bidders would start to consider their housing priorities with longer perspective of the impact of the pandemic, primarily working from home even over a long period of time after the pandemic. Apparently even though we do see some significant differences before and after the pandemic breakout for all the three housing categories, it might still be too early to judge if these differences are just phenomenal temporary effects or imply any long-term trend change due to the limited time period (up to June 2021). Secondly, there are some time mismatches of variable data (again) due to the limited time frame, since most of the publicly available socio-economic data have a two-year delay from SCB, and we have to use the (latest available) 2019 data values for both periods before and after the pandemic breakout by assuming that these variable values would not change dramatically over the studied period of time. In addition, in this study the two periods (March 2019 – February 2020 and July 2020 – June 2021) are tailored to fit the Covid-19 breakout time (March-June 2020) rather than a full calendar year, which also results in the time mismatch between the housing market (*Mäklarstatistik*) data and those DeSO statistical data which are all over calendar years (2019/2020). Thirdly, in regarding the school results we just have a first touch on this aspect which is far away from comprehensive and hence would be worth for further studies, as described below.

In regarding future work along this track there are several aspects:

1. How the school location and results would interact with the housing markets. There are two aspects in this context: the geographic closeness to a primary school where children can, preferably, walk to schools; the relative closeness to schools with e.g. higher grade–9 students records. As an illustration, Figure 18 shows the locations of all schools with up to grade-9 students in Södermanland. We see that these schools are almost all located in the city centers, and families with higher grade school age children have not many choices if they live further away from the city centers. On the hand, (note that Figure 18 only shows those schools with grade-9 students), for families with lower grade school age children the closeness to a nearby school would be advantageous, even if the school is not in the city center. To make a comprehensive analysis on how these two aspects would interact with the housing market attractivity would be worth to be further explored;

2. In this study we use the shortest distance to the four city centers (Eskilstuna, Nyköping, Strängnäs and Katrineholm) in Södermanland as a "proxy" to the closeness to e.g. public train traffic, public services, hospitals, sports and cultural centers (libraries, cinemas, theatres etc.) and other living facilities (e.g. supermarket, gas stations etc.). This is a rough "proxy" that might hide significant local features to impact the housing market attractivity, which worth to be further explored;
3. *Telia Crowd Insights*' data on people's movement patterns provide us insight on residents' behavior, e.g. by comparing where people spend their time before and after the pandemic can give us further understanding on the effect of the pandemic, which in turn would also impact on the housing market in Södermanland from another dimension in parallel or complementary to other factors;
4. Last but not least, an annual/biannual upgrade in the next 5-10 years of the results in this study would also be very exciting to verify if the findings so far are just phenomenal temporary effects or indeed mean long-term trend change due to the Covid-19 pandemic.

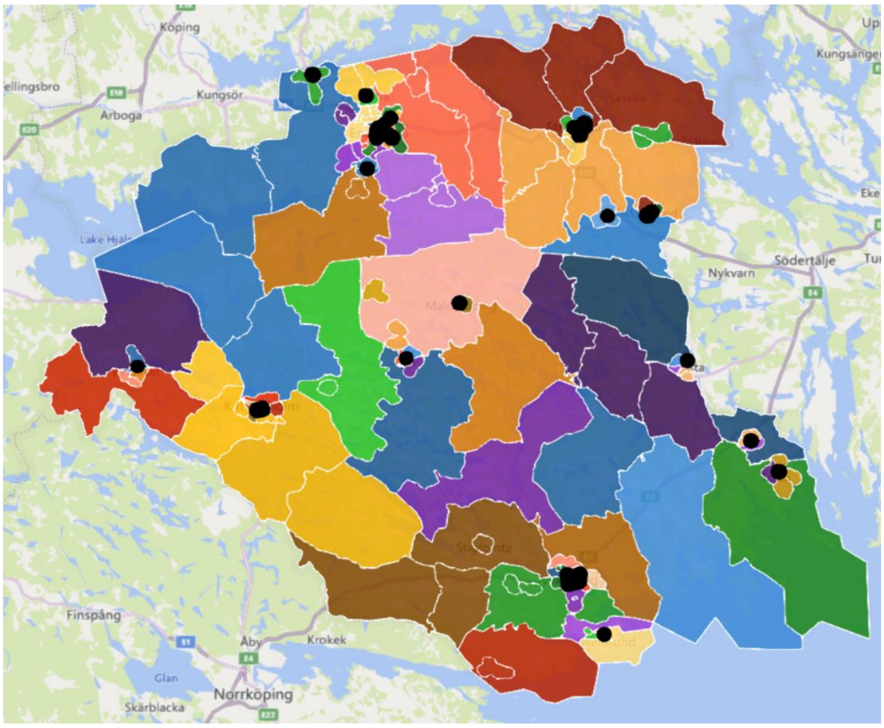



*Figure 18 Grade-9 primary school locations in Södermanland at geographical DeSO level.*

# A.1 Appendix I Selected variable list from Mäklarstatistik's database

| | Variable name | Note |
|---|---|---|
| **Price/rateable value** | contract_price | Transaction contract price in SEK |
| | price_per_sq_meter | The quotient contract_price / living_area in SEK (kvadratmeterpris) |
| | real_estate_ad_asking_price | Initial ad asking price in SEK |
| | monthly_fee | Monthly fee in SEK |
| | price_by_rateable_value | The quotient contract_price / rateable_value (KT-tal) |
| **Location** | location_rt90_geopt_east | RT90 geopt. latitude |
| | location_rt90_geopt_north | RT90 geopt. longitude |
| | latitude | WGS84 geopt. latitude |
| | longitude | WGS84 geopt. longitude |
| | congregation_lkf | Congregation LKF code (församlingskod) (e.g. 012701) |
| | district_code | District code (Distriktskod) within the province |
| | formatted_address | Formatted street address |
| | postal_code | Postal code |
| | postal_town | Postal town |
| **Housing category** | housing_category | Normalized housing category. Possible values are: V, B, F and T |
| | type_of_housing | Normalized type of housing |
| | housing_tenure | Normalized housing tenure: Bostadsrätt/Äganderätt/Tomträtt |
| **Real estate size** | living_area | Living area in square meters |
| | supplemental_area | Supplemental area in square meters |
| | plot_area | Plot area in square meters |
| **Real estate age** | build_year | Build year |
| | new_production | New production? |
| **Real estate feature** | decimal_apartment_floor | Apartment floor as float |
| | building_storeys | Number of building storeys |
| | number_of_rooms | Number of rooms |
| | elevator | Has elevator? |
| | balcony | Has balcony? |
| | energy_rating | Energy rating |
| | heating_included | Heating included? |
| **Timing and others** | contract_date | Transaction contract date |
| | real_estate_ad_publicized | Initial ad publication date |
| | sys_scb_invalidation_code | Invalidation code |

## A.2 Appendix II Variable categorizations

| price-per-square-meter | |
|---|---|
| category | range, kr |
| 1 | ≤ 15000 |
| 2 | 15000 - 20000 |
| 3 | 20000 - 30000 |
| 4 | 30000 - 35000 |
| 5 | 35000 - 40000 |
| 6 | > 40000 |
| economic standard and income | |
| category | range, kkr |
| 1 | ≤ 250 |
| 2 | 250 - 300 |
| 3 | 300 - 350 |
| 4 | < 350 |
| employment rate | |
| category | range, % |
| 1 | ≤ 70 |
| 2 | 70 - 80 |
| 3 | 80 - 85 |
| 4 | > 85 |
| high economic standard | |
| category | Range, % |
| 1 | ≤ 2.5 |
| 2 | 2.5 - 5 |
| 3 | 5 – 7.5 |
| 4 | > 7.5 |
| low economic standard | |
| category | Range, % |
| 1 | ≤ 10 |
| 2 | 10 - 20 |
| 3 | 20 - 30 |
| 4 | > 30 |
| disposable income | |
| category | range, kkr |
| 1 | ≤ 150 |
| 2 | 150 - 200 |
| 3 | 200 - 250 |
| 4 | > 250 |
| build-year | |
| category | range |
| 1 | ≥ 2000 |
| 2 | 2000 - 1970 |
| 3 | 1970 - 1940 |
| 4 | < 1940 |
| living area, *Bostadrätt* | |
| category | range, m^2 |
| 1 | ≤ 50 |
| 2 | 50 - 75 |
| 3 | 75 - 100 |
| 4 | >100 |
| living area, *Villa* | |
| category | range, m^2 |
| 1 | ≤ 75 |
| 2 | 75 - 100 |
| 3 | 100 - 150 |
| 4 | > 100 |
| living area, *Fritidshus* | |
| category | range, m^2 |
| 1 | ≤ 40 |
| 2 | 40 - 60 |
| 3 | 60 - 80 |
| 4 | > 80 |

| | |
|---|---|
| plot area, *Villa* | |
| category | range, m^2 |
| 1 | ≤ 500 |
| 2 | 500 - 1000 |
| 3 | 1000 - 1500 |
| 4 | > 1500 |
| plot area, *Fritidshus* | |
| category | range, m^2 |
| 1 | ≤ 1500 |
| 2 | 1500 - 2000 |
| 3 | 2000 - 3000 |
| 4 | > 3000 |
| monthly fee, *Bostadsrätt* | |
| category | range, kr |
| 1 | ≤ 2000 |
| 2 | 2000 - 3500 |
| 3 | 3500 - 5000 |
| 4 | >5000 |
| price-by-rateable-value, *Villa/Fritidshus* | |
| category | range |
| 1 | ≤ 1.5 |
| 2 | 1.5 – 2.5 |
| 3 | 2.5 – 3.5 |
| 4 | > 3.5 |
| distance to water | |
| category | Range, m |
| 1 | ≤ 300 |
| 2 | 300 – 1500 |
| 3 | 1500 – 5000 |
| 4 | > 5000 |
| qualification to high school, profession program, number | |
| category | Range |
| 1 | ≤ 10 |
| 2 | 10 – 20 |
| 3 | 20 – 30 |
| 4 | > 30 |
| qualification to high school, high education preparation program, number | |
| category | Range |
| 1 | ≤ 5 |
| 2 | 5 – 10 |
| 3 | 10 – 15 |
| 4 | > 15 |
| qualification to high school, both programs, ratio | |
| category | Range, % |
| 1 | ≥90 |
| 2 | 90 – 80 |
| 3 | 80 – 70 |
| 4 | > 70 |
| DeSO level people moving into Södermanland from Stockholm, number | |
| category | Range |
| 1 | ≤ 5 |
| 2 | 5 – 10 |
| 3 | 10 – 15 |
| 4 | > 15 |
| distance to nearest local center | |
| category | Range, km |
| 1 | ≤ 2 |
| 2 | 2 – 10 |
| 3 | > 10 |
| driving time to Stockholm central station | |
| category | Range, minute |
| 1 | ≤ 60 |
| 2 | 60 – 90 |
| 3 | 90 - 120 |
| 4 | > 120 |

# A.3 Appendix III Correspondence analysis and multiple correspondence analysis

## *Correspondence analysis*

Correspondence analysis (CA) is a descriptive/exploratory technique designed to analyze simple two-way and multi-way tables and offers a geometric representation of the rows and columns in order to facilitate understanding the similarities between the categories of variables and the association between the variables. The results provide information which is similar in nature to those produced by Factor Analysis techniques, allowing explore the structure of categorical variables included in the table. These methods were originally developed primarily in France by Jean-Paul Benzérci in the early 1960's and 1970's (Benzérci, 1973; Lebart, Morineau, and Tabard, 1977). For an informal introduction to CA and related metric approaches, see Weller and Romney (1990). Greenacre (2007) provides a much more thorough introduction with few mathematical prerequisites. More advanced treatments are given by Greenacre (1984) and Gower and Hand (1996). In some respects, CA can be thought of as an analogue to principal components for nominal variables. It is also possible to interpret CA in reciprocal averaging (Greenacre 1984, 96–102; Cox and Cox 2001, 193–200), in optimal scaling (Greenacre 1984, 102–108), and in canonical correlations (Greenacre 1984, 108–116; Gower and Hand 1996, 183–185). It should be noted that correspondence analysis is an exploratory technique. The method was developed based on a philosophical orientation that emphasizes the development of models that fit the data, rather than the rejection of hypotheses based on the lack of fit (see Greenacre, 1984). Therefore, the primary purpose of the technique is to produce a simplified (low- dimensional) representation of the information in a large frequency table (or tables with similar measures of correspondence).

Correspondence analysis is a method for decomposing the overall Chi-square statistic for two-way tables by identifying a small number of dimensions in which the deviations from the expected values can be represented. The maximum number of dimensions is equal to the minimum of the number of columns minus 1, and the number of rows minus 1. Obviously if one chooses to extract the maximum number of dimensions that can be extracted, then one can reproduce exactly all information contained in the table. Nevertheless, the goal of CA is to explain the most inertia, or variance in the model using the least number of dimensions. It is common for researchers to extract the minimum number of dimensions (usually two or three) in a CA to explain at least 90% of the inertia[7], analogous to similar heuristic rules on the number of components in principal component analysis. In practice, usually two dimensions are used (if at least 90% of the inertia is explained), and the standard output of a CA is a two-dimensional scatterplot, the so-called two-dimensional factor space with two factor axes. Even so, what each factor axis represents is not pre-defined. The meaning of each factor axis is interpreted afterwards using the two-dimensional factor space plot itself. CA can also add supplementary data points that may aid in the interpretation of the model in the analysis afterwards. In other words, CA allows for the addition of row or column points that carry zero inertia to the factor space after it has been constructed.

[7] https://www.stata.com/manuals13/mvca.pdf#mvca

For readers relatively new to CA, one may consider first reading "How correspondence analysis works (a simple explanation)"[8]. As mentioned above, one of the benefits of CA is that it can simplify complex data from a potentially large table into a two-dimensional visualization of categorical variables while preserving all of the valuable information in the data set. This is especially valuable when it would be inappropriate to use a table to display the data because the associations between variables would not be apparent due to the size of the table. Nevertheless, to interpret correspondence analysis plot is not straightforward, and one needs to bear the following general considerations in mind[9]:

- Check conclusions using the raw data;
- The further variables are from the origin, the more discriminating they are;
- The closer variables are to origin, the less distinct they probably are;
- The more variance explained, the fewer insights will be missed;
- Proximity between row labels probably indicates similarity (if properly normalized);
- Proximity between column labels indicates similarity (if properly normalized);
- If there is a small angle connecting a row and column label to the origin, they are probably associated;
- A row and column label are probably not associated if their angle to the origin is 90 degrees;
- A row and column label are probably negatively associated if they are on opposite sides of the origin;
- The further a point from the origin, the stronger their positive or negative association.

## *Multiple correspondence analysis*

Multiple correspondence analysis (MCA) is a method for analyzing observations on categorical variables. MCA is usually viewed as an extension of simple correspondence analysis (CA) to more than two variables. While CA analyzes a two-way contingency table; MCA analyzes a multiway table. Mathematically, MCA either performs a CA on a so-called indicator matrix (with observations as rows and categories of variables as columns), or on the inner product of the indicator matrix, a so-called Burt matrix, and explores the relationships within a set of variables.

For an introduction to MCA via CA, see Rencher and Christensen (2012) or Everitt and Dunn (2001). For an advanced introduction to MCA without previous discussion of CA, see Gower and Hand (1996). Greenacre (2006) approaches MCA from CA and gives a more advanced treatment. Gower (1990) explores MCA history.

Similar to CA the output of MCA is usually visualized by a two-dimensional factor space map (if the number of dimensions is 2 and at least 90% of the inertia is explained), and the

[8] https://www.displayr.com/How-correspondence-analysis-works/
[9] https://www.displayr.com/interpret-correspondence-analysis-plots-probably-isnt-way-think/

interpretation of the factor space plot in MCA is not straightforward and careful considerations need to be taken[10].

## References

*Benzécri, J.-P. (1973). L'Analyse des Données. Volume II. L'Analyse des Correspondances. Paris, France: Dunod.*

L. Lebart, A. Morineau, and N. Tabard (1977). *TECHNIQUES DE LA DESCRIPTION STATISTIQUE - METHODES ET LOGICIELS POUR L'ANALYSE DES GRANDS TABLEAUX. Paris, France: Dunod.*

Weller, S. C., and A. K. Romney (1990). *Metric Scaling: Correspondence Analysis*. Newbury Park, CA: Sage.

Greenacre, M. J. (2007). *Correspondence Analysis in Practice*, Second Edition. London: Chapman & Hall/CRC.

Greenacre, M. J. (2006). From *simple to multiple correspondence analysis*. In *Multiple Correspondence Analysis and Related Methods*, ed. M. J. Greenacre and J. Blasius. Boca Raton, FL: Chapman & Hall.

Greenacre, M. J. (1984). *Theory and Applications of Correspondence Analysis*. London: Academic Press.

Gower, J. C., and D. J. Hand (1996). *Biplots*. London: Chapman & Hall.

Cox, T. F., and M. A. A. Cox (2001). *Multidimensional Scaling*. 2nd ed. Boca Raton, FL: Chapman & Hall/CRC.

Rencher, A. C., and W. F. Christensen (2012). *Methods of Multivariate Analysis*. 3rd ed. Hoboken, NJ: Wiley.

Gower, J. C. (1990). *Fisher's optimal scores and multiple correspondence analysis*. Biometrics 46: 947–961.

N.Sourial et al. (2010). *Correspondence analysis is a useful tool to uncover the relationships among categorical variables*, Journal of Clinical Epidemiology, June 2010 Volume 63, Issue 6, Pages 638–646.

Herv´e Abdi and Lynne J. Williams (2010). *Correspondence Analysis*, In Neil Salkind (Ed.), Encyclopedia of Research Design. Thousand Oaks, CA: Sage.

[10] https://www.displayr.com/correspondence-analysis-versus-multiple-correspondence-analysis-use/