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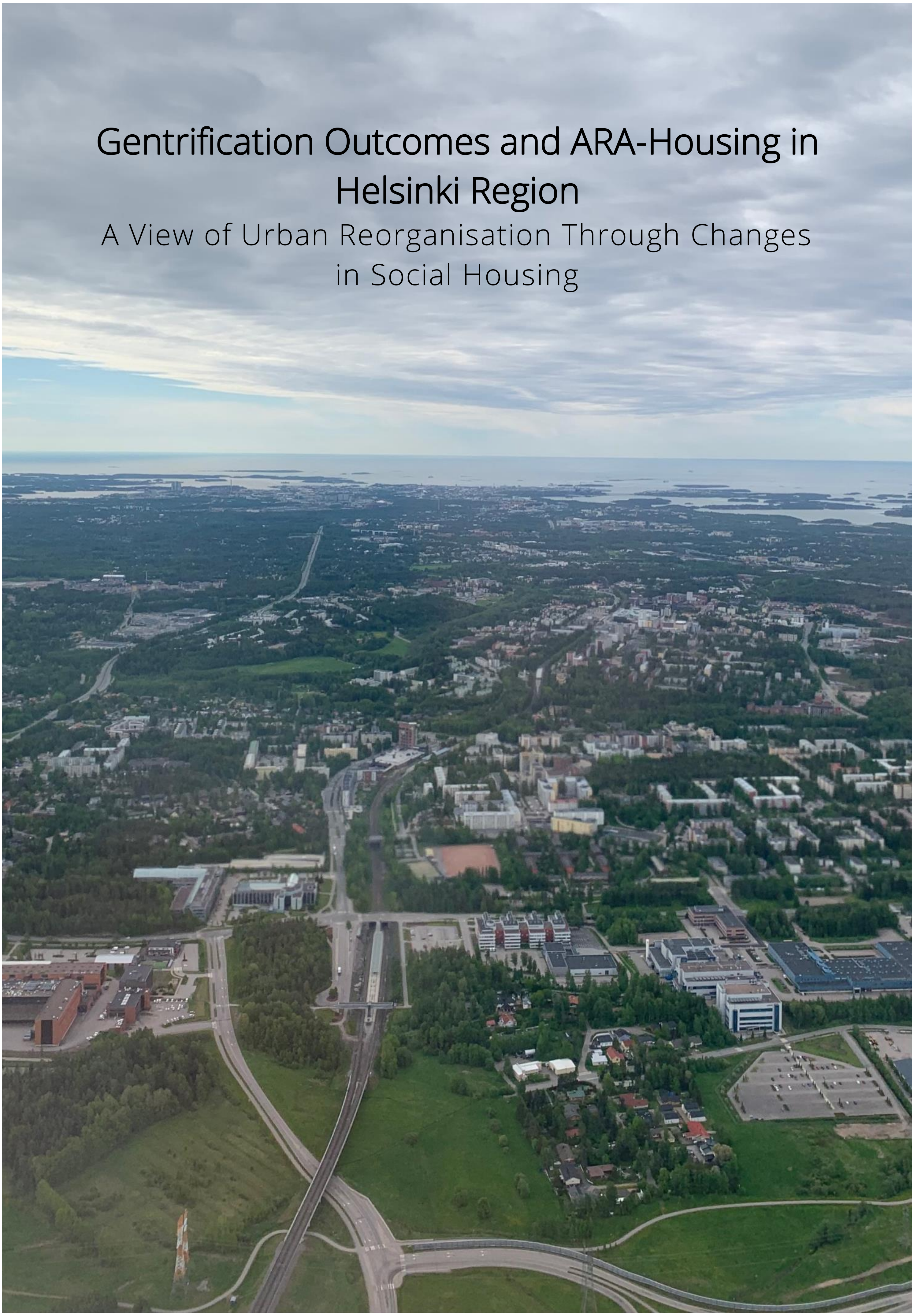

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ABSTRACT
This research attempted to establish what are the relationships between gentrification and changes is social housing in Helsinki Region. The area has seen great amounts of regeneration and new constructions in the recent years, while social housing model has been changing, and the amounts decreasing on average. Traditionally, these processes have been found as cause for gentrification. The prevalence of the ARA-financed social housing in Helsinki region creates a unique research environment. The findings show that on a neighbourhood level, changes in social housing are related to gentrification outcomes, although they don't seem to have an impact on the intensity of gentrification when measured with a change in income. The increases in the proportion of social housing prevent gentrification outcomes, possibly proving that social mixing policies work as desired in Helsinki region. Further research should be conducted to find out, what types of social mixing are the most effective at steering gentrification in addition to ARA-housing and how social housing change high/low clusters relate to gentrification processes.

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1. Introduction

Urban regeneration and resulting changes in the neighbourhood fabric are widely considered as driving gentrification, through either making the environment more attractive and as a result encouraging socioeconomic change, or by decreasing supply for low-income residents through up zoning (Rouwendal et al., 2018; Hochstenbach & Musterd, 2018; Rodriguez-Pose & Storper, 2019; Ley & Dobson, 2008; Murphy, 2008; Smith, 1982). This process is not exclusive for traditional Neo-liberal societies such as the US. In Europe where traditional strong government-subsidised housing markets have transformed into Neo-liberal markets (Hedin et al., 2012; van Gent & Hochstenbach, 2019) where processes as controversial as “state-led gentrification” have emerged (Hochstenbach, 2016; Nevin, 2010; Uitermark & Bosker, 2016). Finland, a country with strong social policy, isn’t as established with research on gentrification as The Netherlands or Sweden are, although urban regeneration as a phenomenon has been explored (Lilius & Hirvonen, 2021). Lack of gentrification research in Finland is surprising, as the housing policy has led to housing being less accessible for younger people in Helsinki region (Lilius & Lapintie, 2020), while at the same time the year 2019 saw a record-breaking amount of new housing constructed within a calendar year (Vuori, 2020). Following the financial crisis of 2008, the housing production was at low levels, but rebounded right after 2010. Gentrification has been a theme in multiple major European cities, including Helsinki to some capacity, although more limited due to late urbanisation of Finland. There has been no extensive need for urban regeneration yet when comparing to older European cities. As such, it’s extremely relevant to look at this situation in Finland, where strong social welfare policy is combined with a social housing policy, creating an experimental environment with social mixing and gentrification (Väättövaara & Kortteinen, 2003; Lilies & Hirvonen, 2021). Social housing in Finland was implemented through state-subsidised ARAVA loans, transforming into interest subsidy loans later recently, although the long-term interest subsidy ARA-housing still existing. ARA-housing is the social housing equivalent in Finland. The period for the loan agreement was 40 years, during which time the tenants in the buildings should be selected on socioeconomic grounds (Ministry of the Environment, n.d.). It has to be noted, that social housing is not the only form of housing assistance in Finland, where 15.5% of people receive the housing allowance welfare (Kela, 2022). The Marin government programme for years 2019-2023 states, that the housing policy encourages diverse, market-driven housing construction supplemented by social housing.

> “Meeting the needs of growing areas will require a wide range of measures to increase the volume of housing construction and lower construction costs. We will increase the volume of state-subsidised, affordable housing to supplement the market-driven and private housing supply and to balance fluctuations in the market. We will take into account the significance and special needs of the Greater Helsinki region. “
>
> - (Valtioneuvosto, 2019)

Lilius & Lapintie (2020) have discussed the impacts of Neo-liberal discourse and social-housing subsidies in the context of Helsinki region. Other researchers who have focused on the Neo-liberal housing market discourse often dismiss the social and welfare policy dimensions of the urban regeneration and how gentrification is shown. The findings of Lilius & Lapintie (2020) showed that the housing policies enacted in Finland lead to less security, i.e. possible displacement of vulnerable groups, such as lower income families - also known as gentrification. Despite this, Lilius & Lapintie (2020) did not discuss social housing or gentrification processes directly. There is still an urgent need to study the implication, that the state is preventing displacement, while "housing allowances act as a state-led tool which is fuelling the financialization of rental housing" in Helsinki region (Lilius & Hirvonen, 2021). Thus, the research question in this paper is:

What role does social housing specifically, in the form of ARA-housing, play in gentrification in Helsinki region?

Answering this question will help determine future social housing policies in Helsinki in regard to gentrification. Further questions include determining whether there are differences between forms of gentrification and the processes behind them. This will be done through a literature review on urban regeneration, gentrification and social housing, followed by the methodology, data description and terminology definitions. A quantitative analysis of key identified metrics and a discussion about the results will finalise this paper.

2. Theoretical Framework

Gentrification, Social Housing and Neoliberalism

Gentrification is defined as a process of socioeconomic change, where low income residents in neighbourhoods are displaced by high-income residents moving in (Smith, 1982; Le Zhang & Pryce, 2017; Hedin et al., 2012; Wegmann, 2019; Mullenbach & Baker, 2018). Social housing as part of anti-gentrification, or more generally as preventing gentrification and providing support for disadvantaged communities bodes surprisingly well across the political spectrum and is seen as effective in combating gentrification (Dobson & Ley, 2008). The authors do continue that public investment in social housing has been more difficult under the Neo-liberal regimes of 2000s, as is also argued by Hedin et al. (2012). The Neo-liberal discourse does not only discourage social housing, but the policies have had an impact on public-private partnerships and types of investments, which pursue self-interest, possibly leading to gentrification through transformation of the environment (Mullenbach & Baker, 2018). The Neo-liberal discourse has additionally led to the integration of gentrification to policy, where the government is involved in the urban regeneration as a provider (Lees & Ley, 2008; Murphy, 2008). The so-called 'third-wave urbanisation', or 'state-led gentrification' (Hochstenbach, 2016; Nevin, 2010; Uitermark & Bosker, 2016) has been dubbed by the Lees and Lay (2008) as 'positive gentrification', but with negative undertone, while Murphy (2008) concludes that state involvement in urban regeneration can be beneficial for social outcomes such as gentrification. Countries, such as The Netherlands with traditionally strong social housing systems have transformed towards market-oriented housing policies in the 2000s as part of the Neo-liberal state-led gentrification, which is indicated to have an impact on the socioeconomic change within Dutch cities (van Kempen & Priemus, 2002; van Gent & Hochstenbach, 2020; van Bortel & Elsinga, 2007). Van Gent & Hochstenbach (2020) additionally note that the transformation from changes in social housing and housing market structure take time and happen in a non-linear fashion. Outside of The Netherlands, there has been limited research on the connection between Neo-liberal policies especially with focus on social housing as a preventative or contributing measure to gentrification, although there have been suggestions that they could have a relationship in Helsinki region (Lilius & Lapintie, 2020; Lilius & Hirvonen, 2021).

Multiple other authors have mentioned that there is no consensus on what gentrification is and how it should be measured (Vigdor et al., 2002; McKinnish et al., 2010; Barton, 2014; Mujahid et al., 2019). There are multiple approaches to measuring gentrification, including income and education data (Hedin et al., 2012), racial data and property data - as a result, multiple outcomes could be determined depending on the definition of gentrification which has been a problem in gentrification research (McKinnish et al., 2010; Barton, 2014; Mujahid et al., 2019). The intensity of gentrification can be measured through income levels on a neighbourhood scale, Hedin et al (2012, p. 447) stating that “income provides the most adequate, coherent and precise measure of socioeconomic change.”. They continue and that gentrification can be divided into three different categories, or types, based on income class quartiles at the start of the examination period - bottom 25% represent classical gentrification, middle 50% ordinary gentrification and top 25% super gentrification, when neighbourhoods in these categories experience above average income increases. The measure used was tied to residential mobility related increase in income, where a threshold for classifying for gentrification was set at top 10% in income change. More conservative measures and thresholds have also been employed, where an income increase of $4000 classifies for gentrification, or only an increase in median income that is greater than increase in average income (McKinnish et al., 2010; Wilhelmsson et al., 2021). The study on gentrification and its impact on housing prices by Wilhelmsson et al (2021) uses Getis-Ord statistics to locate gentrification hotspots based on income and population changes, akin to Hedin et al (2012). Both Wilhelmsson et al. (2021) and Hedin et al. (2012) were studying Swedish cities, which as a context resembles that of Helsinki Region, making the measures applicable for Helsinki Region as well.

Rodriquez-Pose & Storper (2019), theories such as the housing-as-opportunity have neglected labour demand as part of a main reason behind socioeconomic change and the sorting of population. Agglomeration of jobs, seems to have contributed to the rising incomes in Western Helsinki (Väättövaara & Kortteinen, 2003) and thus to gentrification.

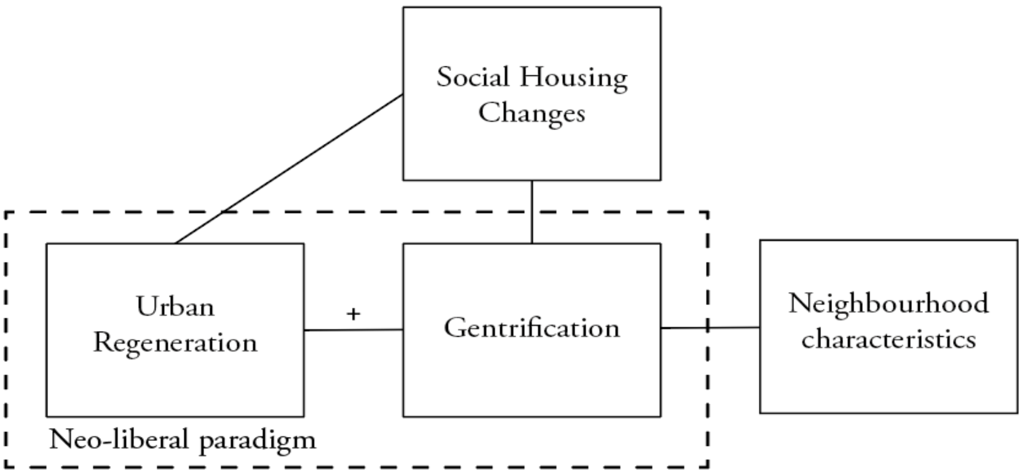
Hochstenbach & Mustard (2017) used a change in the allocation of social housing in a gentrification context as a way to identify mobility of low-income household. Lees (2008) and Lees & Ley (2008) have stated that social mixing could be used to prevent gentrification or to “move towards an inclusive urban renaissance” (Lees, 2008) as urban regeneration is seen as an unstoppable force causing gentrification (Dobson & Ley, 2008).

Gentrification and Urban Regeneration

Gentrification not only includes a shift in incomes, but also an “associated reinvestment in the built environment” (Hedin et al., 2012 p 447-448). The usual context of gentrification is urban renewal or regeneration instead of social housing. Often, the construction of new housing in the urban centre is seen as a cause for gentrification (Dobson & Ley, 2008), although urban regeneration and housing developments might not be inherently deleterious, especially when combined with strong social policy (Murphy, 2008; Lilius & Hirvonen, 2021). Arrigoitia (2018) mentioned that social housing can often be combined with gentrification goals. In Helsinki region investment and construction in the private rental market, urban regeneration, and as such ’investification’ of lower income neighbourhoods has led to an increase in housing prices, while not leading to an increase in income (Lilius & Hirvonen, 2021). Lilius & Hirvonen (2021) continue that active gentrifying was a strategy employed in a Helsinki region neighbourhood Myllypuro, where social housing rents were increased to attract the middle-class instead of the ‘already out-priced’ lower income classes. The housing developments in these areas were focused on larger-scale flats and apartments (Lilius & Hirvonen, 2021), which might indicate that the changes in the social housing fabric in Helsinki have been actively promoting gentrification. Urban regeneration with governmental involvement can be conducted in a manner, which leads to gentrification by design, while still retaining access to public space, proving successful community construction and development (Murphy, 2008). This form of gentrification, which actively transforms spaces from degenerating to high-end, desired areas was already researched by Smith (1982), who concluded that the goal of urban liveability often masks the true goals, which are profit-driven instead of having altruistic goals. Contrary, public sector driven urban regeneration, performed to replenish fading neighbourhoods, has been proven to reverse negative trends in neighbourhoods in Liverpool, although in this context the public sector -led regeneration was not done to prevent, or promote gentrification (Nevin, 2010).

Helms (2003) recognized that housing characteristics play a major role in gentrification. The renovation amount in a neighbourhood was found to be significant in relation to gentrification and finding that heavily gentrifying areas have a disproportionately great change in the characteristics of housing in the form of upgrades. Lee & Newman (2021) additionally found out that changes in non-residential property characteristics, such as vacancy rate also have implications and a relationship with gentrification. They found out that higher non-residential vacancy rate clusters are more likely to have gentrification nearby.

Figure 1 - Conceptual model of gentrification with social housing changes

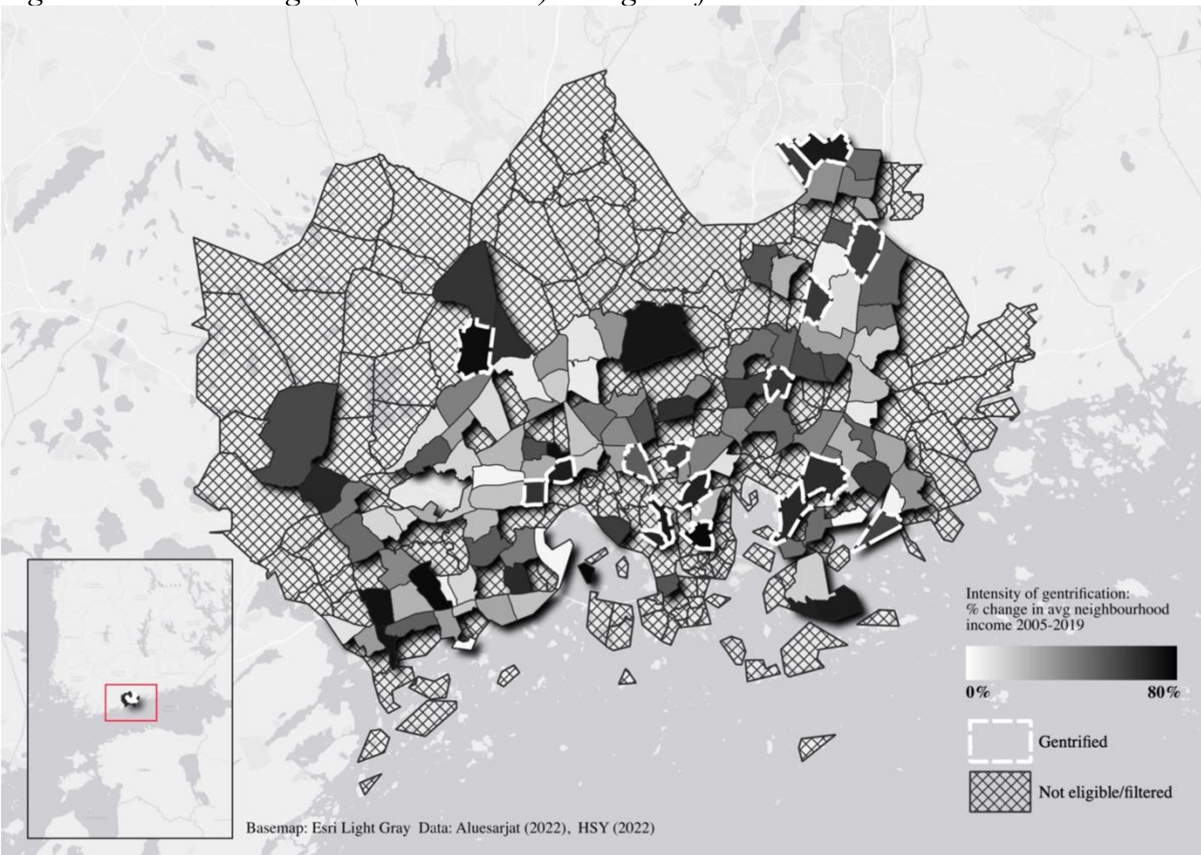


The conceptual model is a visualisation of the expected relationships between the variables that will be employed in the analysis, based on the literature. The Neo-liberal paradigm was recognised as being impactful for the context behind changes in social housing. The model is used to visualise the relationship between the different gentrification causes researched in this paper, and to structure the discussion section.

3. Method

3.1 Research Area and Period

Figure 2 - Helsinki Region (research area) with gentrification metrics



The research area consists of the Helsinki Region (Figure 2), namely the cities of Helsinki, Vantaa and Espoo (excluding Kauniainen). For Helsinki and Espoo, the neighbourhood level "sub-district" is used, which is a subdivision of districts. For Vantaa "kaupunginosa" [transl. district/neighbourhood] is the smallest statistical measurement scale available, still being comparable to the smaller districts. The research area was selected due to the unique characteristics of the Finnish social housing policy, where a state-owned corporation Arava is assigned to implement the social housing policy of the country through interest-rate-subsidies and low-rent housing in both high demand and low demand areas (Väättövaara & Kortteinen, 2003; Lilius & Lapintie, 2020; Lilius & Hirvonen, 2021). This allows the research of the implications of social housing changes on gentrification, as Helsinki and Vantaa have encouraging social mixing as parts of their policies and try to encourage ARA-housing production in highly sought-after areas (Lilius & Hirvonen, 2021).

The research period begins from the year 2005, which is the first year with full documentation for Helsinki Region data. The research period extends to 2019 to prevent capturing the impact of the COVID-19 pandemic. A 15-year period is adequate to research gentrification, as researchers have used periods ranging from 15 years (Hedin et al., 2012) to 20 years (Rouwendal et al., 2018).

3.2 Data

3.2.1 Methodology and data collection

This research will use quantitative methods. Data used in this study is secondary data available from open data portals, combining key metrics relevant for the research. Most of the data was collected through the Helsinki Region Infoshare[HRI]: "Helsingin seudun aluesarjat" by combining data from Helsinki, Espoo and Vantaa tables, which were available separately, but on the same scale of measurement. The GIS files were extracted from the WFS service of the HRI and the map service available from Helsingin Seudun Ymparistopalvelut [HSY]. The datasets utilised in this research are all from Helsingin seudun aluesarjat, combined into a single dataset. The database, Helsingin seudun aluesarjat, is the official statistical service of the Helsinki Region. New variables were calculated based on the 2005 and 2019 statistics to get variables, which indicate change between these two points in time.

3.2.2 Operationalisation

Table 1 - List of variables

Variable	Type	Measurement levels	Purpose	Literature
Δ Average Income (%)	Dependent	continuous	Indicate the intensity of gentrification in a neighbourhood	Hedin et al (2012), Wilhelmsson et al (2021)
Gentrifying	Dependent (outcome)	binary 0 = No 1 = Yes	Indicate is the neighbourhood gentrified based on changes in income levels and original income levels	Hedin et al (2012), Wilhelmsson et al (2021)
Δ % of ARA-housing	Independent	continuous	Change in the proportion of ARA-housing: test whether addition/removal of social housing has a relationship with gentrification to answer research question	Lilius & Hirvonen (2021) n.b. the authors did not define metrics, but speculated that social housing changes might have an impact on gentrification
Δ % of owned housing	Independent (control)	continuous	Control: increases in houses that are owned by the resident might contribute to gentrification	Hochstenbach (2017)
Δ % of empty housing	Independent (control)	continuous	Control: increases in houses that are kept empty might contribute to gentrification due to speculation on increased property values	Helms (2003)

Δ % of residential buildings	Independent (control)	continuous	Control: construction and urban regeneration have been shown to contribute on gentrification	Lilius & Hirvonen (2021), Dobson & Ley (2008), Hedin et al. (2012)
Δ % of non-residential buildings	Independent (control)	continuous	Control: construction and urban regeneration have been shown to contribute on gentrification	Lee & Newman (2021)
Δ Mean floor area of houses (%)	Independent (control)	continuous	Control: Change in size of houses could lead to gentrification due to more inaccessible type of housing	Seong-Kyu (2004) Helms (2003)
Δ Jobs (%)	Independent (control)	continuous	Control: Employment hubs have been areas suspectable to gentrification in Helsinki Region	Väättövaara & Kortteinen, 2003

Table 2 - Descriptive statistics

Descriptives

	N	Mean	Median	SD	Minimum	Maximum
Δ Avg Income (%)	120	42.004	41.650	9.44	8.15	79.43
Δ % of ARA-housing	120	-5.469	-3.266	6.75	-26.55	8.04
Δ % of owned housing	120	-1.998	-2.124	4.92	-16.34	10.41
Δ % of empty housing	120	2.302	1.943	2.51	-3.00	18.14
Δ % of residential buildings	120	15.255	13.432	9.86	0.00	61.81
Δ % of non-residential buildings	120	-2.252	-5.184	22.08	-44.85	134.87
Δ Mean floor area of houses (%)	120	0.551	0.672	3.47	-11.35	12.20
Δ Jobs (%)	120	18.916	8.025	44.56	-71.45	191.21

Table 3 - Frequencies of Gentrification

Frequencies

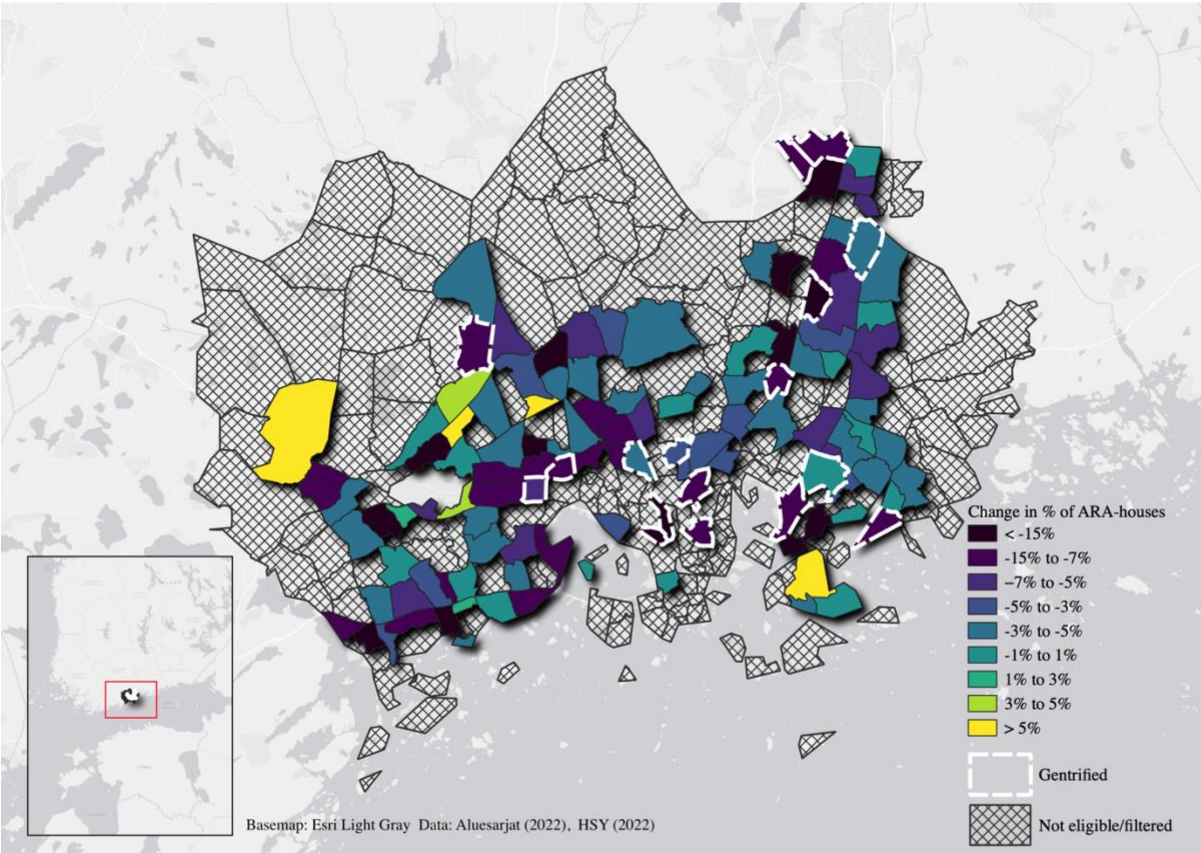
Gentrifying	Counts	% of Total	Cumulative %
No	103	85.8 %	85.8 %
Yes	17	14.2 %	100.0 %

The variables are selected based on a description of factors impacting gentrification processes identified from the literature, mainly focused on neighbourhood characteristics. The variables which might convey geographical bias are made into proportion and calculated as a percentage points which were later transformed into percentages. Environmental factors and amenities are also factors impacting gentrification, albeit limited when analysing aggregated data according to Mullenbach & Baker (2018), which is why most were excluded, except the ones that concern changes in building proportions. , all areas with 0 households in 2005 were excluded, as a newly built area does not yet qualify for gentrification due to the lack of a process of socioeconomic change. The neighbourhoods not experiencing urban regeneration, namely construction of new housing, are excluded from the analysis. The threshold is set at 5% new housing compared to the housing stock of 2005 for a neighbourhood to be qualified for the analysis. An upper limit was set at 50% new housing, to remove neighbourhoods which have been almost completely built from scratch instead of regenerating them. Additionally, two neighbourhoods were excluded due to the extreme difference in change of average income, which was up more than a 100%, where a cut-off was set. The final pre-requisite was, that the neighbourhood had to have ARA-housing in either 2005 or 2019, so statistical inference could be done on neighbourhoods which actually display the characteristics that are being researched. With these filters, 120 neighbourhoods were included in the analysis.

The dataset initially included only absolute numbers, based on which the variables used in the analysis were calculated. Two datapoints were selected in this research, 2005 and 2019 to have a 15-year period as the research period. For the percentage change in average income, the values were calculated based on dividing the 2019 value with the 2005 value and subtracting one from it to get the percentage point increase in income. Calculating income change this way allows the capturing of proportionally large increases in average income in a neighbourhood, as a 10000€ increase in a 50000€ average income neighbourhood might not have as significant impact in regards to intensity of gentrification, as a 20000€ neighbourhood going up to a 30000€ average income in 15 years. The mean increase in income is around 42% in all neighbourhoods, and in the filtered dataset growth varied from 8.15% to 79% increase in average income with a standard deviation of 9.44. The gentrification outcome uses the previously calculated percentage increase in average income as a basis in combination with the requirement for a neighbourhood to be classified as gentrified, it had to be below the median income of the region in 2005, which was calculated based on all valid neighbourhood incomes and taking the median neighbourhood income value, which was at 20830€. A neighbourhood was classified as gentrified, if it was below this level in average income in 2005 and had an above average increase in the average income over the 15-year period. Based on this, 17 neighbourhoods out of a n=120 were classified as Gentrifying. The gentrification outcome allows the determination, whether the intensity of changes over a given time period has an impact on whether a neighbourhood will gentrify, according to the definition described in this research. The gentrification metrics

The Δ % of ARA-housing, Δ % of owned housing and Δ % of empty housing were calculated as a change in the proportion of total housing stock. This would mean, that if a neighbourhood had 20% ARA-housing out of the total houses in 2005, and 15% in 2019, the variable Δ % of ARA-housing would get the value 5%. The mean change in the proportion of ARA-housing in the dataset was around -5.5%, which indicates that there has been a general proportional decrease in ARA-housing over the period. Figure 3 indicates the changes in ARA-housing proportions across Helsinki, indicating that in most neighbourhoods the changes have been relatively limited. Also, the proportion change of owned housing had decreased by an average of 1.998%, which would suggest a rise in the private rental markets. The owned housing change variables both houses, that are completely owned by the owner, but also housing stocks that are held by the owner in apartment complexes. The empty housing variable uses the status of houses in a neighbourhood and compares them to the total housing stock, where the status is either occupied, or not occupied. The proportional amount of empty housing had increased by an average of 2.302%, with the interesting note that the maximum value for this, 18.14% indicating that there has probably been heavy, rapid regeneration in some neighbourhoods with the residents yet to move in.

Figure 3 - Changes in the proportion of ARA-housing 2005-2019



The process of gentrification requires urban regeneration, which is concerned with the transformation of existing urban areas (Couch et al., 2003). Δ % of residential buildings, Δ % of non-residential buildings measure this aspect of gentrification which concerns changes in land use. Instead of using houses as a basis, these variables use the amount of buildings, which might differ greatly from the number of houses. For the last housing characteristics control variable, Δ Mean floor area of houses (%), a calculation was done based on the available variables, which were the total m2 floor area of housing in a neighbourhood divided by the number of houses in a neighbourhood. The variable is used to account for the fact, that houses with greater floor area tend to be more expensive (Seong-Kyu, 2004), and thus possibly contributing to gentrification. There only was an average of 0.555% increase in floor area in houses in the dataset, although the SD=3.47 and the min and max values indicate that there have been consistent changes across neighbourhoods in average m2. Lastly, the Δ Jobs (%) was calculated to account for the impact of employment cluster changes based on the research of Väättövaara & Kortteinen (2003), where increases in jobs especially on the tech sector were shown to contribute in gentrification processes in nearby areas. The value is calculated as the percentage increase in jobs within a neighbourhood between 2005 and 2019.

3.3 Analysis

Two types of analysis were performed to analyse the different gentrification scenarios and metrics of gentrification. The first analysis employs multiple linear regression to determine how the change in average income in a neighbourhood is impacted by the changes in social housing. The hypothesis is that change in the proportion of ARA-housing will have a negative relationship with change in income. Residuals plots and VIF statistics were calculated to determine the suitability of variables for the analysis and that we could proceed with the analysis according to the following regression specification:

$$I_{d,t} = \alpha + \beta_1 A_{d,t} + \beta_2 x2_{d,t} + \beta_3 x3_{d,t} + \beta_4 x4_{d,t} + \beta_5 x5_{d,t} + \beta_6 x6_{d,t} + \beta 7x7_{d,t} + \epsilon$$

The formula indicated the regression specification for determining gentrification intensity. The $I_{d,t}$ describes the change in average income in a given neighbourhood/district *d* over a given time period *t*, which in this case is between 2005 and 2019. $A_{d,t}$ is the main focus in this equation, as it indicates the proportion ARA-housing in a neighbourhood over a time period, indicating change. $\beta_2 x2_{d,t} \ldots \beta_2 x2_{d,t}$ indicates the control variables visible in Table 1 and their changes in neighbourhoods over a time period.

The second analysis will use binary logistic regression to determine what is impacting the gentrification outcome with focus on the social housing variable. Change in the proportion of social housing should have a significant relationship with the gentrification outcome. Based on the literature of Lees (2008), social mixing is used to mask negative gentrification outcomes, while a more neoliberal approach leads to gentrification and filtering to specific neighbourhoods (van Gent & Hochstenbach, 2019; Hedin et al., 2012). Should the increase in social housing lead to gentrification, there should be a re-assessment and further analysis on whether the social housing is constructed on gentrifying areas by chance, or whether social housing is highlighting the displacement of low-income residents through a wider process of urban regeneration. The neighbourhood level characteristics should have a relationship with gentrification. The following equation is associated with the binary logistic regression, where the outcomes are 1 = Yes and 0 = No for Gentrifying as G. The following specification is used for the logistic regression, where gentrification outcome is predicted with the same change variables as used in the multiple linear regression.

$$P(G) = \frac{e^{\alpha + \beta 1Ad,t + \beta 2x2d,t + \ldots + \beta 7x7d,t}}{1 + e^{\alpha + \beta 1Ad,t + \beta 2x2d,t + \ldots + \beta 7x7d,t}}$$

4. Results

4.1 Gentrification intensity

Table 4 - Factors affecting gentrification intensity

Coefficients - Δ Avg Income (%)	Model 1		Model 2		Model 3		Model 4	
Predictor	**B**	**p**	**B**	**p**	**B**	**p**	**B**	**p**
Intercept	41.272***	< .001	43.24729***	< .001	40.4628***	< .001	40.04426***	< .001
Δ % of ARA-housing	-0.134	0.298	0.00106	0.993	-0.0306	0.794	-0.06220	0.607
Δ % of owned housing			0.93242***	< .001	0.8496***	< .001	0.69716***	< .001
Δ % of empty housing			0.27169	0.385	0.3197	0.310	0.33133	0.290
Δ % of residential buildings					0.1506	0.070	0.12359	0.140
Δ % of non-residential buildings					-0.0170	0.628	-0.02030	0.592
Δ Jobs (%)							0.00274	0.888
Δ Mean floor area of houses (%)							0.48478	0.060

* p < .05 *N=120*
** p < .01
*** p < .001

The multiple linear regression shows significant models after controlling for changes in owned housing and empty housing in Model 2 (p < .001), and further control variables in Model 3 (p < .001) and Model 4 (p < .001). The regression was not significant, when only using Δ % of ARA-housing as in independent variable in Model 1 (p = 0.298). An R2 of 27% was achieved in Model 4, which means that a significant part of the variance in Δ Avg Income (%) is explained by the variables in the model. The variable which measures the changes in ARA-housing to answer the research question is not significant in any model at 95% confidence level, which indicated that there is no linear relationship between the Δ Avg Income (%), intensity of gentrification, and Δ % of ARA-housing. When looking at Model 4 with all the control variables as part of the regression, only the Δ % of owned housing (p < .001) is significant at the 95% confidence level and has a positive linear relationship with the change in income. For each one percentage increase in the proportion of resident-owned housing in a given neighbourhood, the average income can be said to rise by ~0.697%. The minimum and maximum values for the Δ % of owned housing were -16.34% and 10.41% respectively, which means that we can generalise income changes within this range based on the coefficient. A neighbourhood with a 16% decrease in resident-owned housing would have a 11.15% lower average income change, when all the other coefficients are equal to 0. The changes in ARA-housing might be insignificant due to the fact that it takes time for the changes to manifest, especially if the drop off has been recent.

4.2 Gentrification outcome

Coefficients: Gentrifying [Yes, No]	Model 1		Model 2		Model 3		Model 4	
Predictor	**Log-odds**	**Odds ratio**	**Log-odds**	**Odds ratio**	**Log-odds**	**Odds ratio**	**Log-odds**	**Odds ratio**
Intercept	-2.3822	0.0924	-2.20952	0.110	-3.83110	0.0217	-4.24457	0.0143
Δ % of ARA-housing	-0.0847*	0.9188*	-0.07644*	0.926*	-0.09609*	0.9084*	-0.12186*	0.8853*
Δ % of empty housing			-0.00426	0.996	0.02983	1.0303	0.04088	1.0417
Δ % of owned housing			0.12994*	1.139*	0.08030	1.0836	0.05451	1.0560
Δ % of residential buildings					0.07694**	1.0800**	0.07211*	1.0748*
Δ % of non-residential buildings					-0.00795	0.9921	-0.01087	0.9892
Δ Mean floor area of houses (%)							0.10864	1.1148
Δ Jobs (%)							0.00600	1.0060

* p < .05 *N=120*
** p < .01
*** p < .001
Note: Gentrifying = 1 [Yes] vs Gentrifying = 0 [No]

The binary logistic regression models show significant regressions in all models with p-values ranging from 0.018 in Model 1 to p = 0.005 in Model 4. The outcomes were set as 1 = Yes and 0 = No, indicating whether a neighbourhood is classified as gentrifying based on the average income at the start of the change period being below the median income and the increase in income above the average increase. The pseudo R2 (Nagelkerke) is at 28% and a classification accuracy of 88.3%. The changes in a proportion of ARA-housing are significant at the 95% confidence level in all models. In Model 4 with all the control variables added in, the log-odds of Δ % of ARA-housing are -.12186, indicating that for each percentage increase in the proportion of ARA-housing in a given neighbourhood, the likelihood that a neighbourhood gentrifies is 0.8853 times that of the original likelihood when all the other log-odds are equal to 0. The range for Δ % of ARA-housing in a neighbourhood is between -25.55% and 8.04% in the dataset, which means that changes can be generalised within the range, which extends to both positive and negative values with 95% confidence. Additionally, the Δ % of residential buildings was significant at the 95% confidence level in Model 4 and at the 99% confidence level in Model 3. This indicates that for each percent increase in change of residential buildings, meaning new construction of housing, the likelihood for a neighbourhood to gentrify increases 1.0748 times with 95% confidence. An interesting finding is that only in Model 2 the changes in resident-owned housing were significant at the 95% confidence level, whereas in other models they were not. This effect on likelihood to gentrify could be captured by the control variables, especially the change in residential buildings, if most of the new building construction was resident-owned housing. No other variables were found to be significant for determining the likelihood for a neighbourhood to gentrify at the 95% confidence level. The drawback of this logistic regression analysis is that it does not consider super gentrification as gentrification.

5. Discussion

The results are interesting not only from the perspective of social housing, but also from the process, and factors increasing susceptibility behind gentrification which is partly captured by the control variables in the analysis. Helsinki has seen somewhat of a decline in the proportion of social housing spread in neighbourhoods, where the mean change in the proportion of total housing stock had declined by more than 5%. It's relevant to make comparisons to the extensive literature on Dutch social housing policies which have been clearly identified as Neo-liberal, actively reducing the number of social housing, unlike in Finland, although same signs of an active decreasing of social housing are showing (Lilius & Hirvonen, 2021). As the results show, for normal gentrification, the predictions of van Kempen & Priemus (2002) hold true also in Helsinki region, where social housing changes have a positive linear relationship with the gentrification outcome. Higher proportion increases social housing seem to be beneficial, if the goal is to combat gentrification. This applies to the other direction as well, as some neighbourhoods in Helsinki have had 20+ % decreases in the proportion of social housing which according to this analysis will greatly increase the likelihood of gentrification in a neighbourhood. Lilius & Hirvonen (2021) were speculating, that within the Helsinki Region, the social housing policy is used to gentrify neighbourhoods and steer them in a desired direction, and this analysis confirms that it seems to be an effective strategy.

On the other hand, the intensity of gentrification was unaffected by social housing changes, which might indicate that the process of gentrification is not impacted by the planning and social housing policies in Helsinki region but is more of a result of other types of housing characteristics, such as proportion of resident-owned housing which was deemed to have a significant positive linear relationship with the changes in average income. It can also be, that the changes on income caused by ARA-housing changes are part of a longer gentrification process, which takes time as Hochstenbach & Musterd (2018) have mentioned before. The analysis might have also benefited from multiple shorter time periods instead of the 15 year period, as the changes in ARA-housing could be happening in a shorter time span as a part of larger redevelopment processes, and thus their impact is masked by the long period employed in this study. The intensity being unaffected by social housing could partly be explained by the social mixing and planning policy, if social housing is placed in, or removed from a certain location to further goals of diversifying neighbourhoods. If this is the case, then social housing is a response to changing social conditions instead of attributing to gentrification. This calls for attention to gentrification-like processes which are actively steered, such as state-led gentrification as described by Hochstenbach (2017) and van Gent & Hochstenbach (2019). The findings and the possible indication of social mixing policies being at play in gentrifying neighbourhoods relate to those of Hochstenbach (2016), where government housing policy and social mixing had an impact on gentrification in The Netherlands. Based on the results in this paper, there is now some indication that at least social housing changes are related to gentrification, preventatively if the change is positive, in the Helsinki Region. Although Lees (2008) argued that social mixing is not a feasible strategy in cities, this research at least established that social housing placement and allocation can be used to impact desired gentrification outcomes. Because of this, the main point in further research would be to find out the shorter timespan impact of social housing changes on a citywide scale to account for the fallbacks this research had in regards to gentrification intensity, and a greater scale, who city or region instead of two neighbourhoods like Lilius & Hirvonen (2021) researched. Another point to research is whether steering neighbourhoods towards gentrification is easier through removing social housing than preventing gentrification by creating more social housing. Although population changes have been included in some previous gentrification research such as in Hedin et al (2012), they have not been included in regard to social housing. This paper did not address it due to the main focus on income gentrification, which was employed in this research. Thus, this research should extend to compare, whether there’s a difference in population changes and outmigration of low wealth, and influx of high wealth residents in proximity to clusters of areas which experience high positive changes in social housing, and areas which experience high negative changes in social housing.

6. Conclusion

The aim of this research was to find out what is the role of social housing in the form of ARA-housing on gentrification. ARA-housing was identified as way to organise social housing through interest and rent subsidies on the housing itself in Finland, and it was recognised as having gone through a shift towards interest subsidies from low-interest loans. A thorough literature search established that there is limited research outside a few countries on the role of social housing in gentrification, and that gentrification as a concept is relatively ambiguous although there is a great deal of literature on gentrification by itself. The role of social housing policies in Helsinki region had been researched, although a gap was recognised by Lilius & Hirvonen (2021) stating that Helsinki might be using social housing as a tool to steer gentrification of neighbourhoods, while causing 'investification' of rental housing. The importance of the Neo-liberal paradigm was recognised as a force behind gentrification, private-markets and the following possible changes in social housing policies. The research to was formulated to bridge this gap between social housing, regeneration and gentrification research, and to confirm earlier speculation and research gap about social housing and gentrification in Helsinki Region, that was indicated by Lilius & Hirvonen (2021).

It was found out that social housing changes are related to gentrification outcomes, but not the intensity of gentrification. A possible explanation behind this could be that social housing itself is more of a policy tool used move social mixing forward in neighbourhoods that are projected to be intensively gentrifying, and thus having no impact on the intensity even if there is a relation to the outcomes. Based on this, I established that the higher the change in the proportion of social housing in a neighbourhood, the less likely it is to gentrify. Social mixing as a policy looks to be effective in Helsinki region to prevent gentrification, or alternatively, decrease in the amount of social housing in a neighbourhood can be used to drive gentrification on purpose, as speculated by Lilius & Hirvonen (2021) and demonstrated by the results. The importance of changes in the proportion of house ownership was identified to have a positive relationship with the changes in average income on a neighbourhood level, indicating that there are housing characteristics other than ARA-housing as a type, that have implications on gentrification processes.

Further research should be conducted on a smaller spatial scale in Helsinki region using the SeutuData datasets, which come at 100m, or 500m grid scale. These datasets are only available for domestic university researchers in Finland without options to access them otherwise. Thus, a surprising policy implication would be to release these datasets for wider public use, which would allow more specific analyses on gentrification processes based on building and neighbourhood characteristics. Another implication is that social mixing is effective in Helsinki and should be recognised as a tool to help guide neighbourhoods towards or away from gentrification. The second point for future research would then be to find out, whether the purposeful social mixing policies are harmful from the point of gentrification, and should they be done through social housing, or other means, such as the housing rent subsidy available in Finland. A third call for further research is to look at differences in outmigration of low wealth residents, and whether this is higher closer to gentrifying areas, and the same for closer to areas that are high net loss or net gain in social housing.

7. Reflection

The research process in this case proved more complicated than expected due to gentrification terminology being ambiguous. Previous researchers have used in different contexts to mean different things. In the US, gentrification usually includes demographic elements such as race and household size, whereas in Europe it's usually used to indicate rising incomes and pushing the lower income residents out from a neighbourhood. Finding good compromise for the metrics and calculations proved difficult, as small changes can have significant impacts for the results. In retrospect, I would have benefited from a larger research area, perhaps with less variables. Datasets, such as the square 100m x 100m statistics available in the Netherlands would be a good dataset to research gentrification, albeit they are not as openly available in other countries, like Finland. The small dataset size made it difficult to draw definitive conclusions, even when the dataset was carefully compiled and constructed on the smallest openly available level of measurement, with latest and most accurate data. Feedback from my supervisor, dr. Liu made me remove variables that were not change variables. This had implications for my dataset, as I could expand it from the original Helsinki-Vantaa dataset to a Helsinki-Vantaa-Espoo dataset, which was available for the variables that were remaining. Requesting the 100m grid SeutuData dataset was not successful due to me not being affiliated with a Finnish university, which is why I had to use a larger spatial scale.

The process would have benefited from a more straightforward and simplified quantitative analysis, and perhaps the questions would have better been answered with including qualitative data in the form of neighbourhood observation in Helsinki region in selected target areas, as Lilius & Hirvonen (2021) did with their case study of 2 neighbourhoods in Helsinki region. This was not feasible at the start of the process due to the danger of further COVID restrictions but is still an important consideration as a fallback of this paper and the results it presents. I would like to give thanks to my peer reviewer, who was kind enough to give me feedback, some of which I incorporated here. Lastly, I would like to thank my thesis supervisor, dr. Xiaolong Liu, who gave me feedback on my drafts.

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APPENDIX - STATISTICS

Results

Linear Regression

Model Fit Measures

				Overall Model Test			
Model	R	R^2	Adjusted R^2	F	df1	df2	p
1	0.0958	0.00917	7.73e-4	1.09	1	118	0.298
2	0.4797	0.23015	0.210	11.56	3	116	< .001
3	0.5036	0.25356	0.221	7.75	5	114	< .001
4	0.5266	0.27733	0.232	6.14	7	112	< .001

Model Comparisons

Comparison							
Model		Model	ΔR^2	F	df1	df2	p
1	-	2	0.2210	16.65	2	116	< .001
2	-	3	0.0234	1.79	2	114	0.172
3	-	4	0.0238	1.84	2	112	0.163

Model Specific ResultsModel 1Model 2Model 3Model 4

Model Coefficients - income_change_pc

			95% Confidence Interval			
Predictor	Estimate	SE	Lower	Upper	t	p
Intercept	41.272	1.110	39.074	43.470	37.18	< .001
ara_change_pc	-0.134	0.128	-0.387	0.120	-1.05	0.298

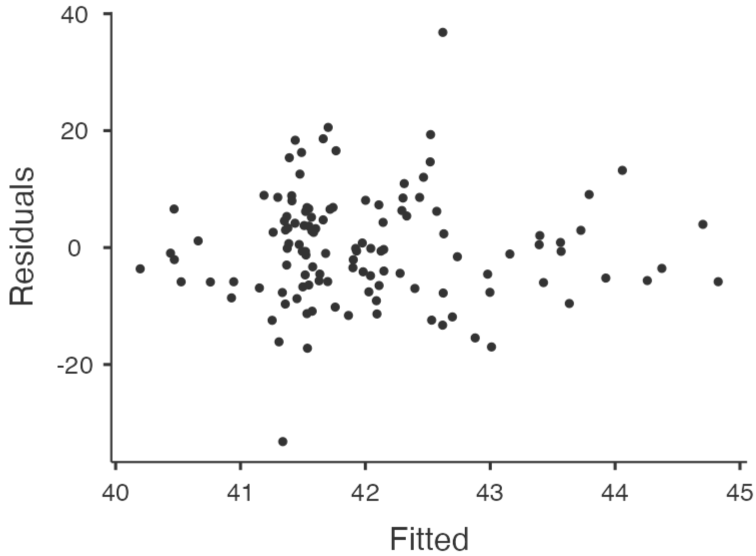
Assumption Checks

Collinearity Statistics

	VIF	Tolerance
ara_change_pc	1.00	1.00

[3]

Residuals Plots



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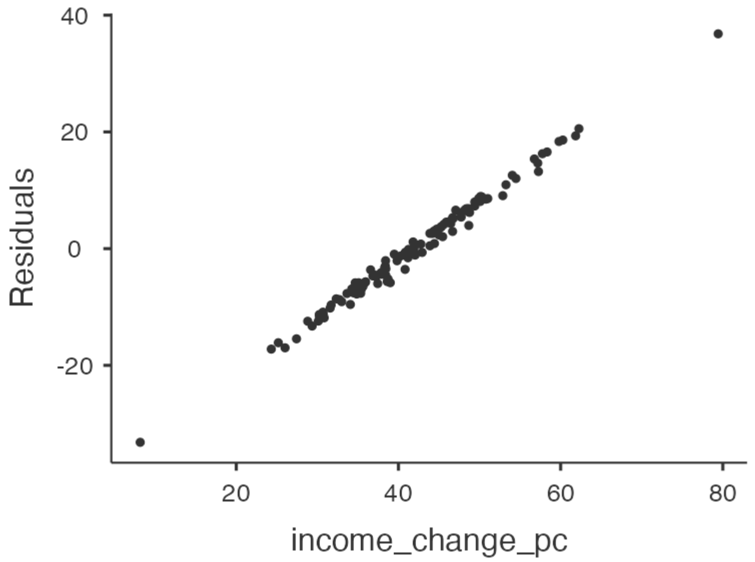

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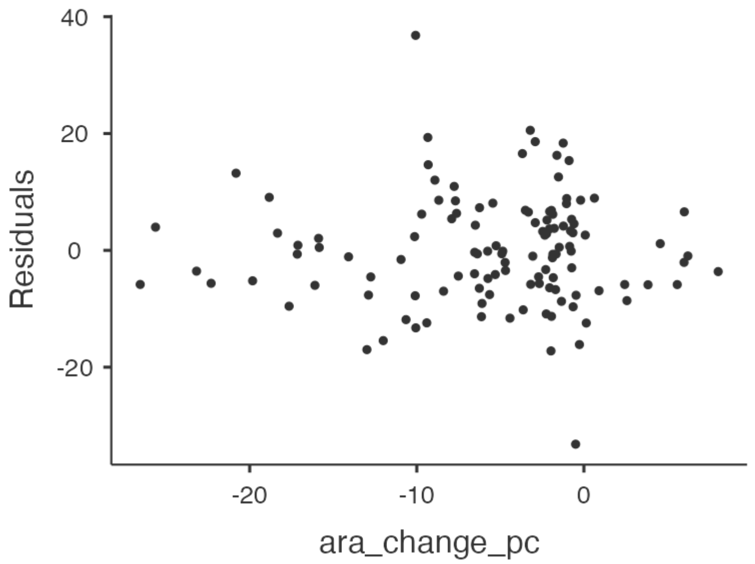

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Model Coefficients - income_change_pc

Predictor	Estimate	SE	95% Confidence Interval Lower	Upper	t	p
Intercept	43.24729	1.233	40.804	45.690	35.06470	< .001
ara_change_pc	0.00106	0.117	-0.230	0.232	0.00913	0.993
own_change_pc	0.93242	0.162	0.612	1.253	5.76801	< .001
empty_change_pc	0.27169	0.312	-0.346	0.889	0.87137	0.385

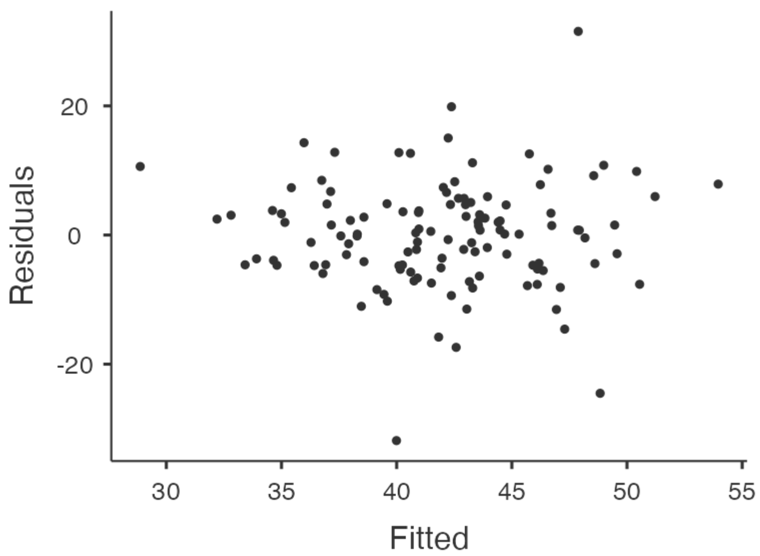
Assumption Checks

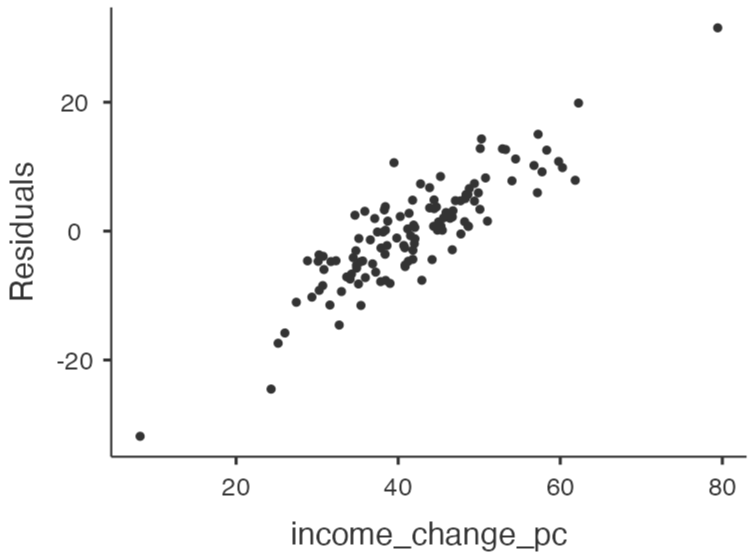
Collinearity Statistics

	VIF	Tolerance
ara_change_pc	1.05	0.955
own_change_pc	1.07	0.933
empty_change_pc	1.04	0.964

[3]

Residuals Plots

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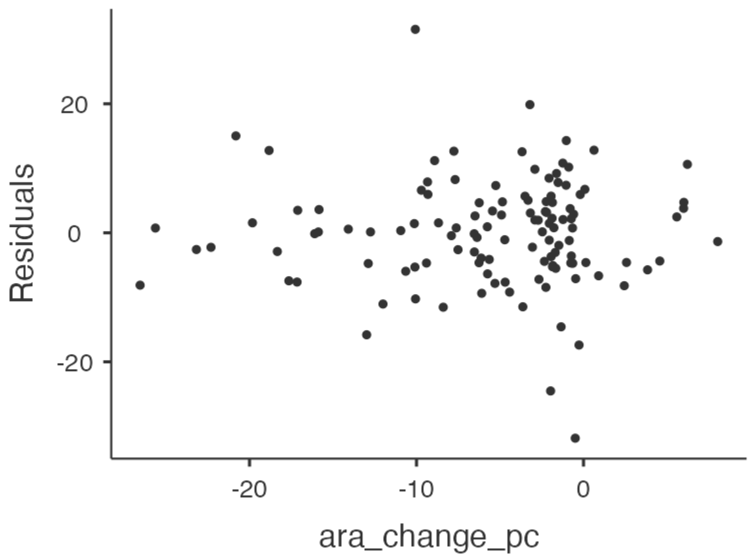
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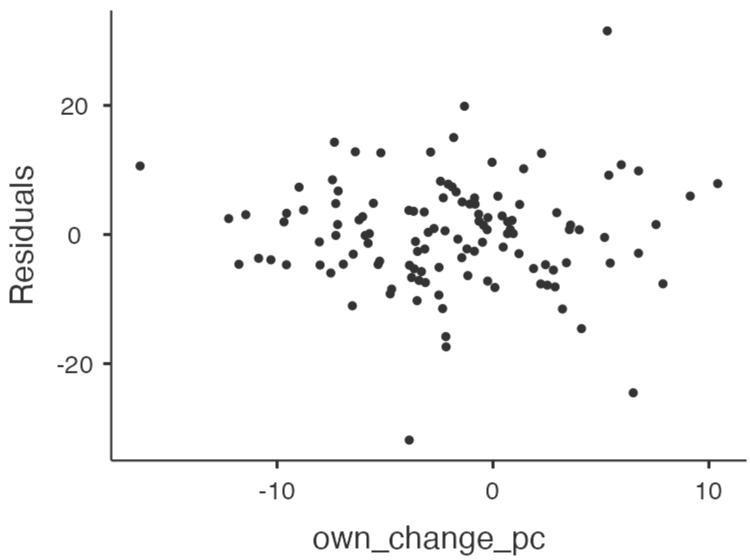
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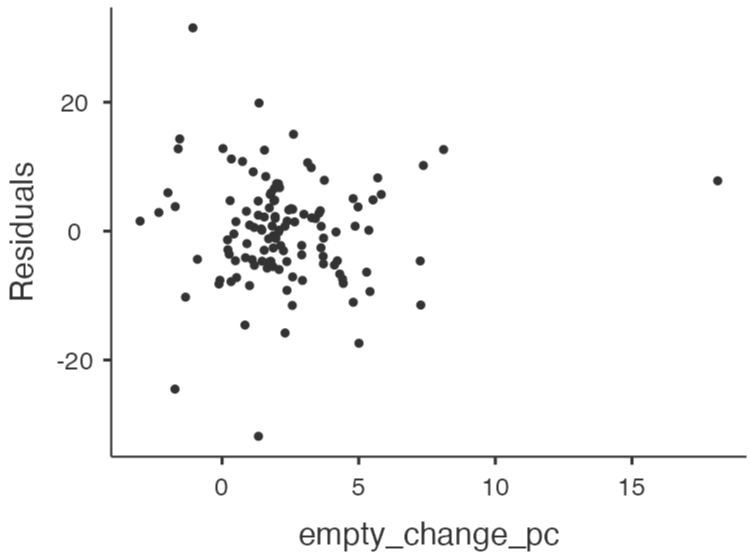
own_change_pc



Model Coefficients - income_change_pc

			95% Confidence Interval			
Predictor	Estimate	SE	Lower	Upper	t	p
Intercept	40.4628	1.9564	36.5872	44.3383	20.683	< .001
ara_change_pc	-0.0306	0.1170	-0.2623	0.2012	-0.261	0.794
own_change_pc	0.8496	0.1678	0.5172	1.1820	5.063	< .001
empty_change_pc	0.3197	0.3135	-0.3013	0.9407	1.020	0.310
residentialbuildings_change_pc	0.1506	0.0823	-0.0124	0.3136	1.830	0.070
non_residential_change_pc	-0.0170	0.0349	-0.0861	0.0522	-0.486	0.628

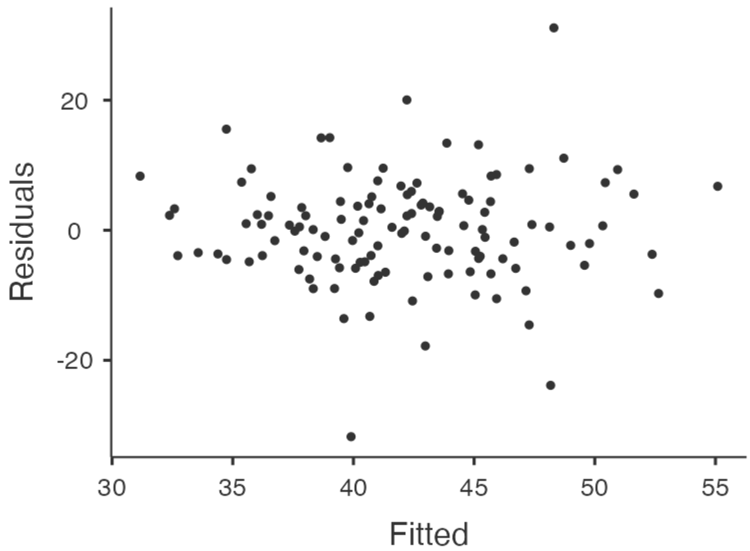
Assumption Checks

Collinearity Statistics

	VIF	Tolerance
ara_change_pc	1.07	0.934
own_change_pc	1.17	0.855
empty_change_pc	1.06	0.941
residentialbuildings_change_pc	1.13	0.887
non_residential_change_pc	1.02	0.982

[3]

Residuals Plots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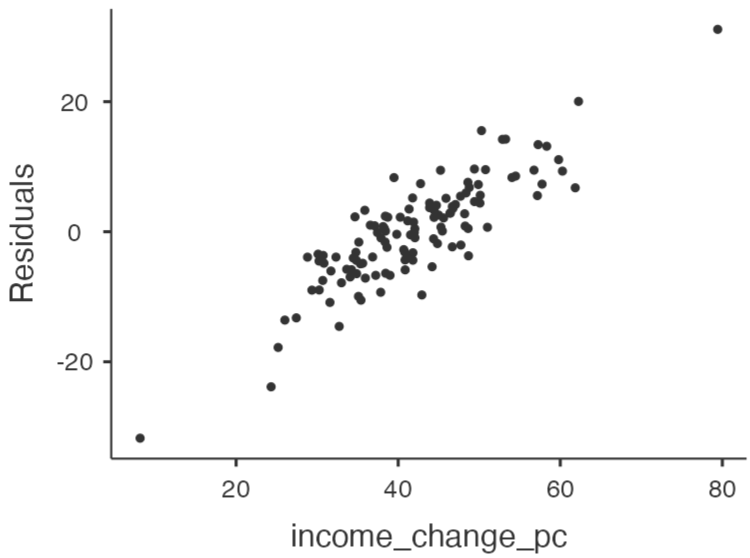
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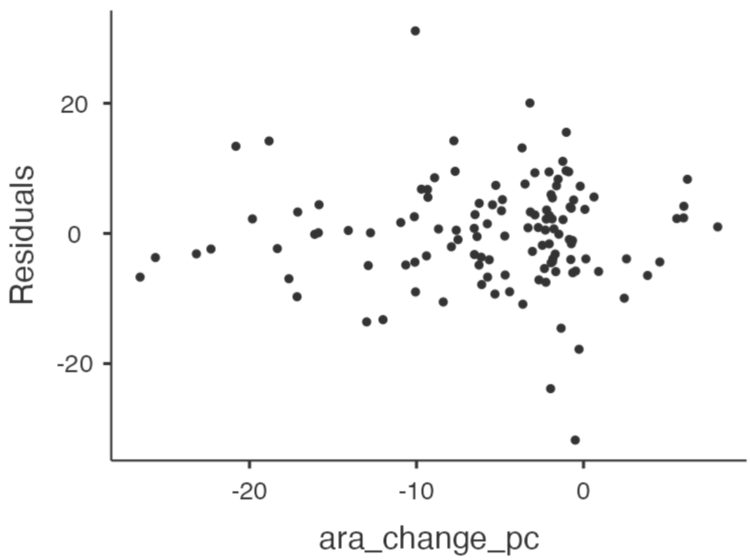
income_change_pc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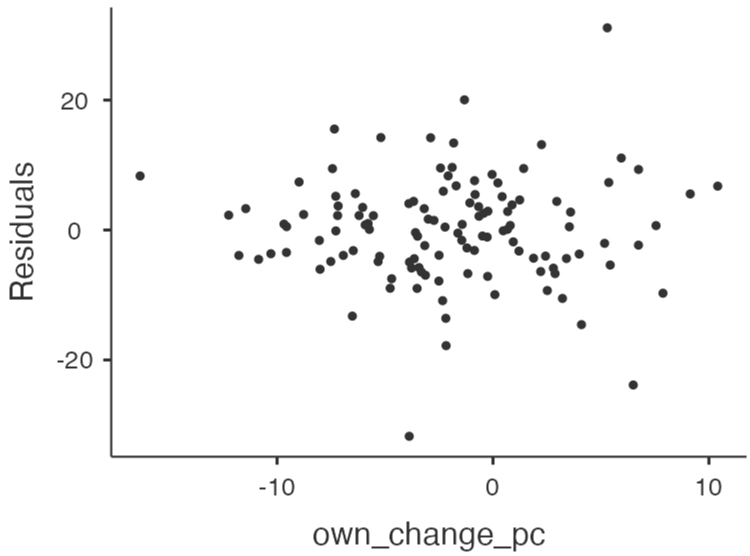
ara_change_pc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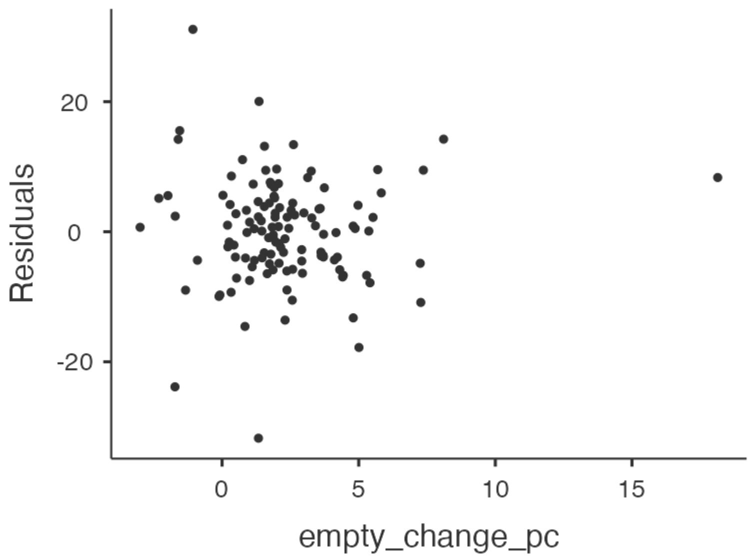
own_change_pc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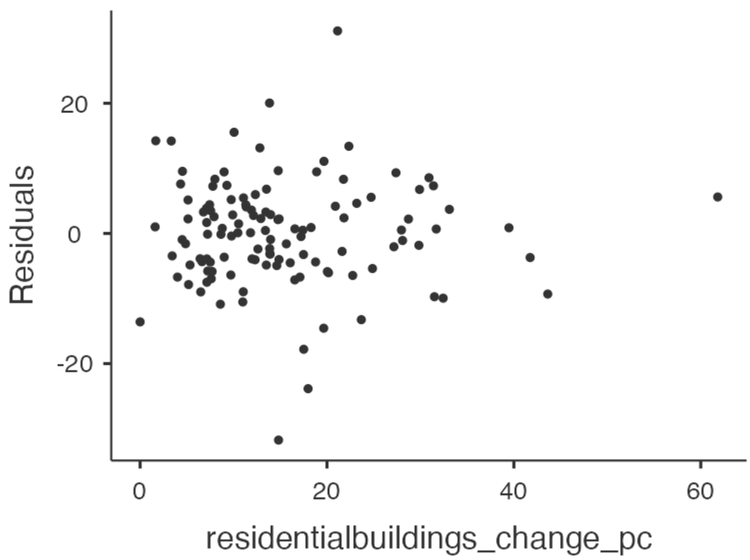
empty_change_pc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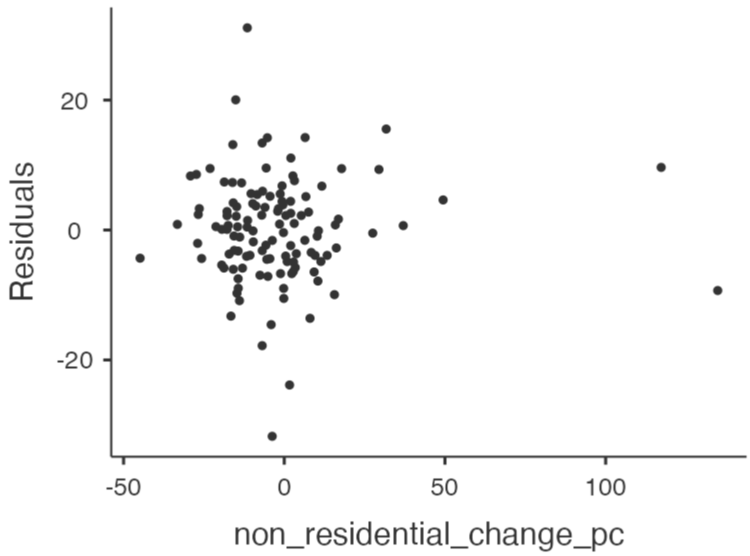
residentialbuildings_change_pc



Model Coefficients - income_change_pc

Predictor	Estimate	SE	95% Confidence Interval		t	p
			Lower	Upper		
Intercept	40.04426	1.9975	36.0865	44.0020	20.047	< .001
ara_change_pc	-0.06220	0.1207	-0.3014	0.1769	-0.515	0.607
own_change_pc	0.69716	0.1852	0.3301	1.0642	3.764	< .001
empty_change_pc	0.33133	0.3114	-0.2857	0.9483	1.064	0.290
residentialbuildings_change_pc	0.12359	0.0832	-0.0413	0.2885	1.485	0.140
non_residential_change_pc	-0.02030	0.0377	-0.0951	0.0545	-0.538	0.592
jobs_change_pc	0.00274	0.0194	-0.0357	0.0412	0.141	0.888
m2_change_pc	0.48478	0.2555	-0.0215	0.9910	1.897	0.060

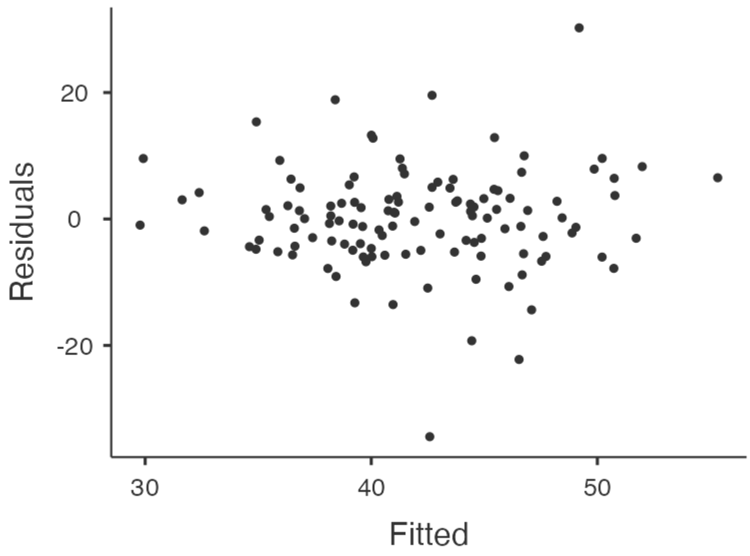
Assumption Checks

Collinearity Statistics

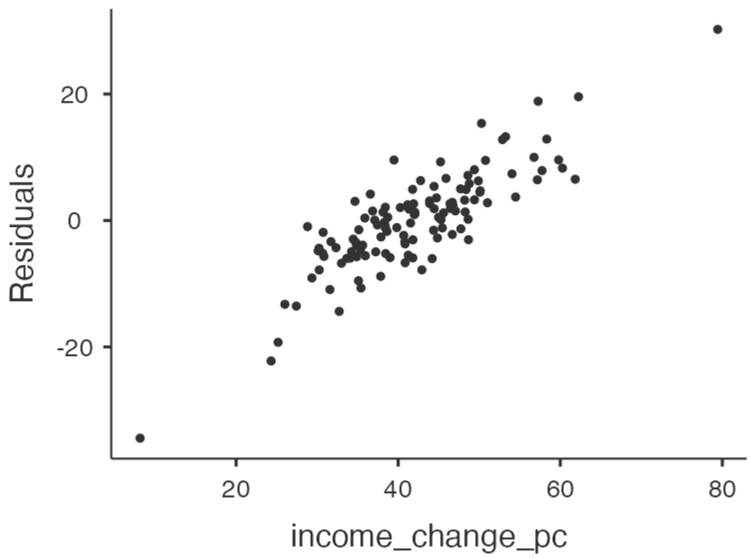
	VIF	Tolerance
ara_change_pc	1.16	0.865
own_change_pc	1.45	0.691
empty_change_pc	1.06	0.939
residentialbuildings_change_pc	1.17	0.855
non_residential_change_pc	1.21	0.827
jobs_change_pc	1.30	0.768
m2_change_pc	1.37	0.732

[3]

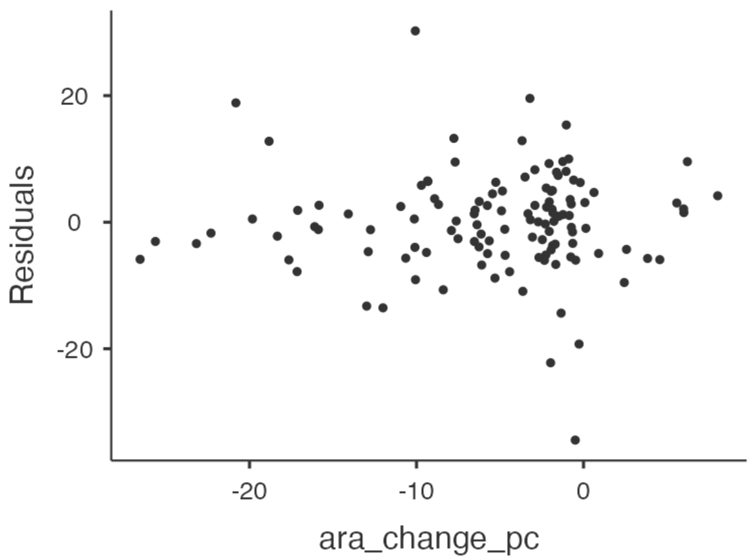
Residuals Plots



Residuals
20
0
-20
30
40
50
Fitted



Residuals
20
0
-20
20
40
60
80
income_change_pc



Residuals
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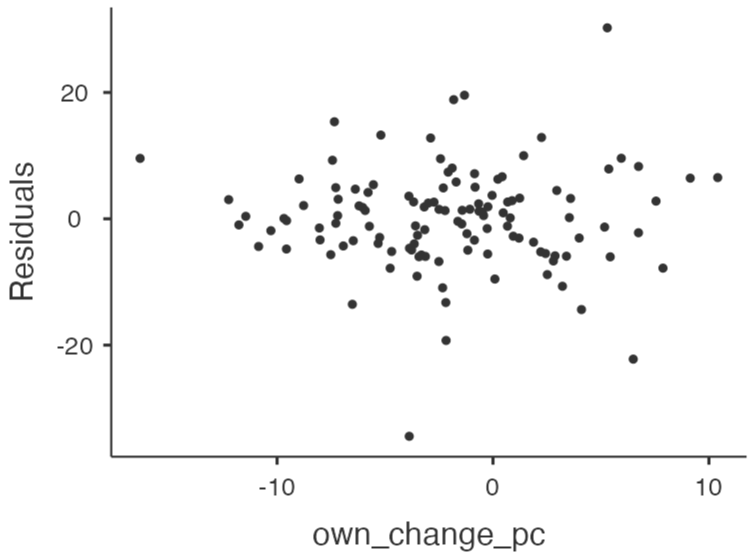
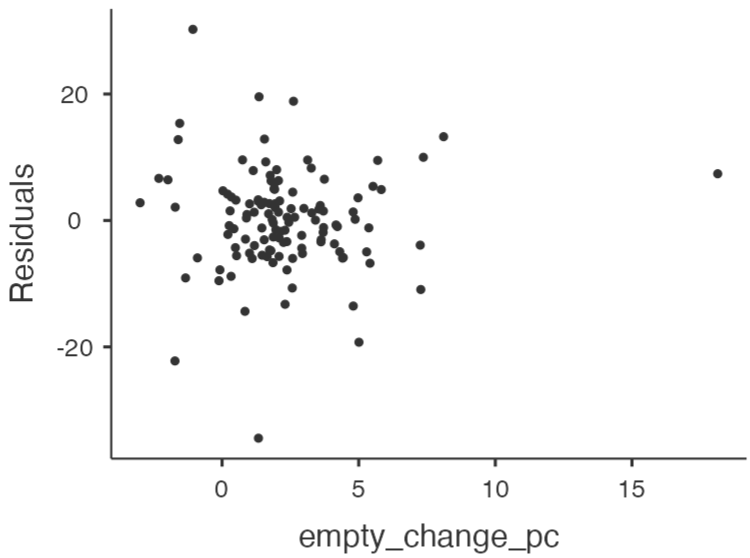
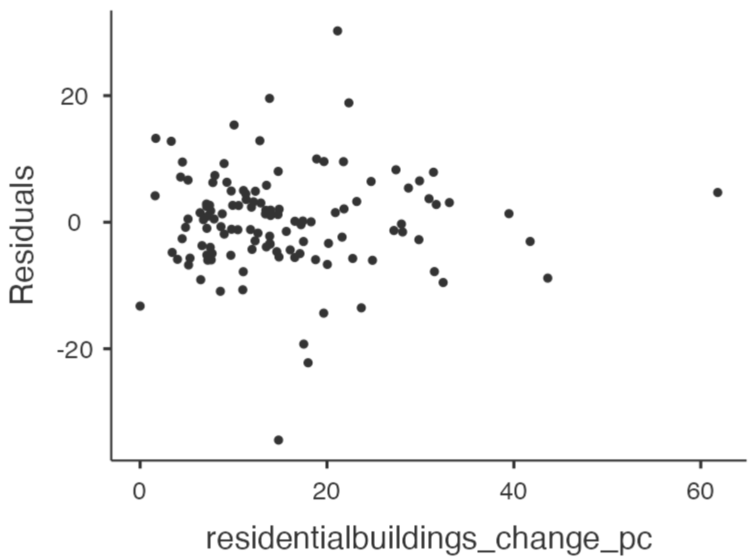
0
-20
-20
-10
0
ara_change_pc



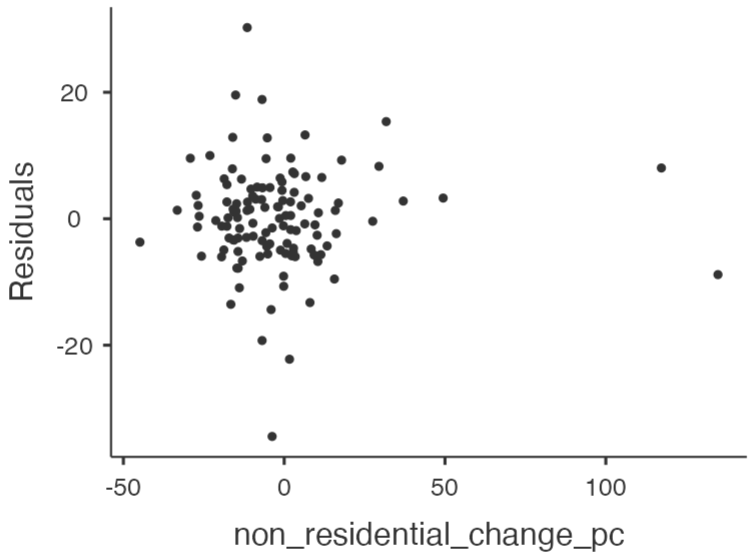
Residuals
20
0
-20
-10
0
10
own_change_pc

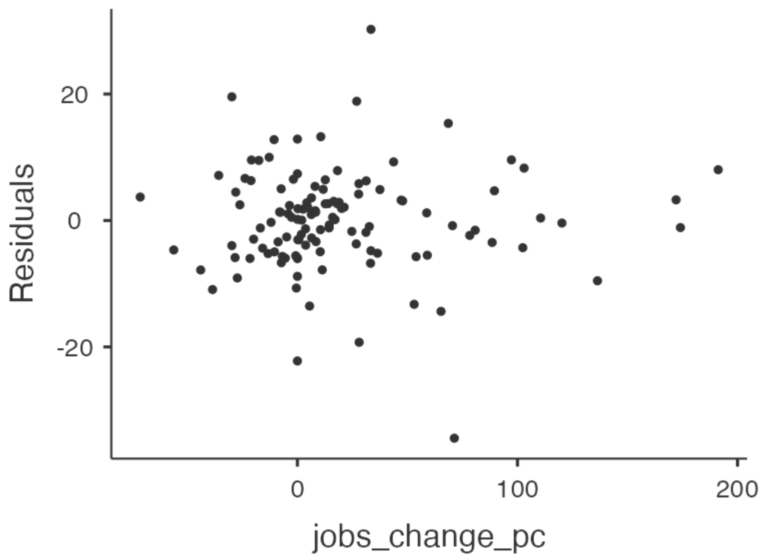


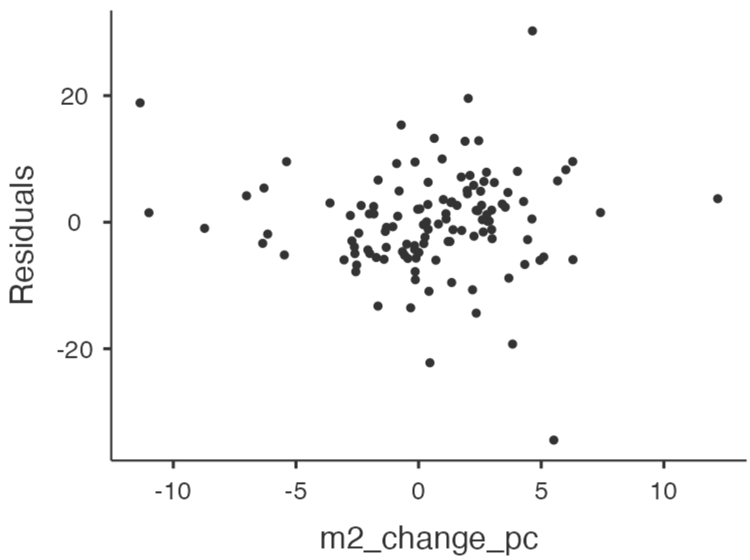
Residuals
20
0
-20
0
5
10
15
empty_change_pc



Residuals
20
0
-20
0
20
40
60
residentialbuildings_change_pc







Binomial Logistic Regression

Model Fit Measures

		Overall Model Test		
Model	R^2_N	χ^2	df	p
1	0.0811	5.55	1	0.018
2	0.1519	10.62	3	0.014
3	0.2571	18.58	5	0.002
4	0.2802	20.40	7	0.005

Model Comparisons

Comparison					
Model		Model	χ^2	df	p
1	-	2	5.07	2	0.079
2	-	3	7.95	2	0.019
3	-	4	1.82	2	0.402

Model Specific ResultsModel 1Model 2Model 3Model 4

Model Coefficients - gentrifying

						95% Confidence Interval	
Predictor	Estimate	SE	Z	p	Odds ratio	Lower	Upper
Intercept	-2.3822	0.3964	-6.01	< .001	0.0924	0.0425	0.201
ara_change_pc	-0.0847	0.0356	-2.38	0.017	0.9188	0.8568	0.985

Note. Estimates represent the log odds of "gentrifying = 1" vs. "gentrifying = 0"

Model Coefficients - gentrifying

						95% Confidence Interval	
Predictor	Estimate	SE	Z	p	Odds ratio	Lower	Upper
Intercept	-2.20952	0.4683	-4.7180	< .001	0.110	0.0438	0.275
ara_change_pc	-0.07644	0.0374	-2.0443	0.041	0.926	0.8609	0.997
empty_change_pc	-0.00426	0.1189	-0.0358	0.971	0.996	0.7887	1.257
own_change_pc	0.12994	0.0624	2.0823	0.037	1.139	1.0077	1.287

Note. Estimates represent the log odds of "gentrifying = 1" vs. "gentrifying = 0"

Model Coefficients - gentrifying

Predictor	Estimate	SE	Z	p	Odds ratio	95% Confidence Interval	
						Lower	Upper
Intercept	-3.83110	0.8442	-4.538	< .001	0.0217	0.00415	0.113
ara_change_pc	-0.09609	0.0418	-2.299	0.021	0.9084	0.83693	0.986
empty_change_pc	0.02983	0.1305	0.229	0.819	1.0303	0.79782	1.330
own_change_pc	0.08030	0.0641	1.252	0.211	1.0836	0.95562	1.229
residentialbuildings_change_pc	0.07694	0.0280	2.752	0.006	1.0800	1.02240	1.141
non_residential_change_pc	-0.00795	0.0121	-0.658	0.511	0.9921	0.96885	1.016

Note. Estimates represent the log odds of "gentrifying = 1" vs. "gentrifying = 0"

Model Coefficients - gentrifying

Predictor	Estimate	SE	Z	p	Odds ratio	95% Confidence Interval	
						Lower	Upper
Intercept	-4.24457	0.95687	-4.436	< .001	0.0143	0.00220	0.0936
ara_change_pc	-0.12186	0.04720	-2.581	0.010	0.8853	0.80704	0.9711
empty_change_pc	0.04088	0.13343	0.306	0.759	1.0417	0.80201	1.3531
own_change_pc	0.05451	0.06973	0.782	0.434	1.0560	0.92112	1.2107
residentialbuildings_change_pc	0.07211	0.02938	2.454	0.014	1.0748	1.01462	1.1385
non_residential_change_pc	-0.01087	0.01324	-0.821	0.411	0.9892	0.96385	1.0152
m2_change_pc	0.10864	0.10139	1.071	0.284	1.1148	0.91385	1.3598
jobs_change_pc	0.00600	0.00708	0.848	0.397	1.0060	0.99216	1.0201

Note. Estimates represent the log odds of "gentrifying = 1" vs. "gentrifying = 0"

Descriptives

Descriptives

	N	Mean	Median	Mode	SD	Minimum	Maximum
gentrifying	120	0.142	0.00	0.00	0.350	0	1
gentrification_categorized	120	0.417	0.00	0.00	0.894	0	3

Frequencies

Frequencies of gentrifying

gentrifying	Counts	% of Total	Cumulative %
0	103	85.8 %	85.8 %
1	17	14.2 %	100.0 %

Frequencies of gentrification_categorized

gentrification_categorized	Counts	% of Total	Cumulative %
0	94	78.3 %	78.3 %
1	11	9.2 %	87.5 %
2	6	5.0 %	92.5 %
3	9	7.5 %	100.0 %

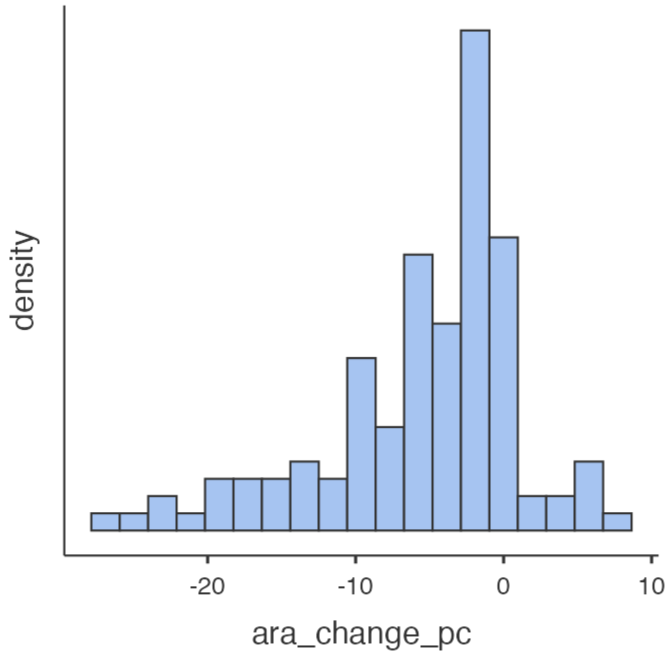
Descriptives

Descriptives

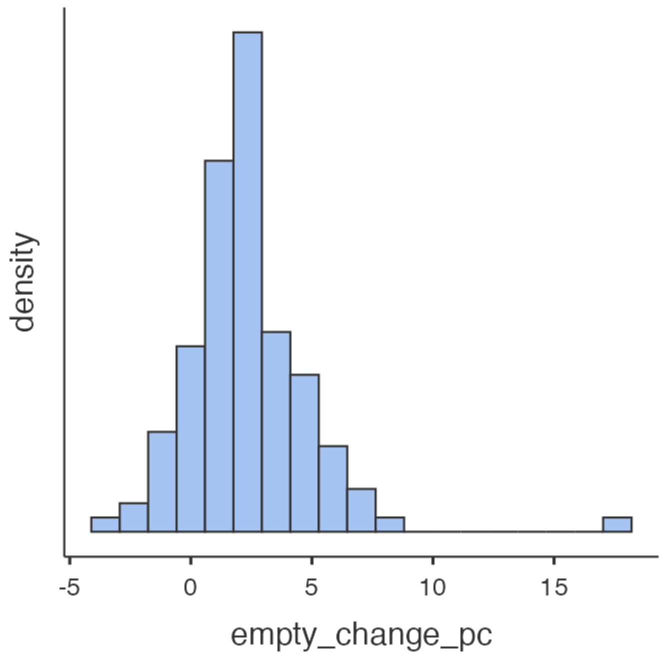
	N	Mean	Median	SD	Minimum	Maximum
ara_change_pc	120	-5.469	-3.266	6.75	-26.55	8.04
empty_change_pc	120	2.302	1.943	2.51	-3.00	18.14
own_change_pc	120	-1.998	-2.124	4.92	-16.34	10.41
m2_change_pc	120	0.551	0.672	3.47	-11.35	12.20
residentialbuildings_change_pc	120	15.255	13.432	9.86	0.00	61.81
jobs_change_pc	120	18.916	8.025	44.56	-71.45	191.21
non_residential_change_pc	120	-2.252	-5.184	22.08	-44.85	134.87
income_change_pc	120	42.004	41.650	9.44	8.15	79.43

Plots

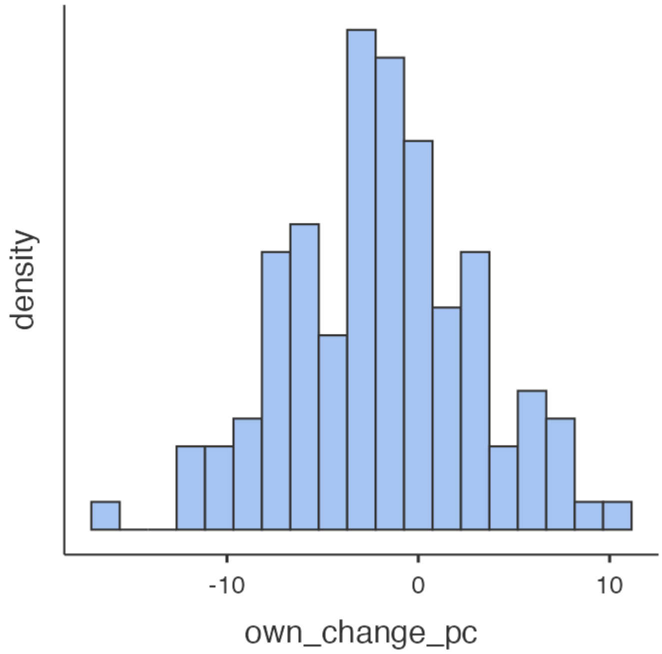
ara_change_pc



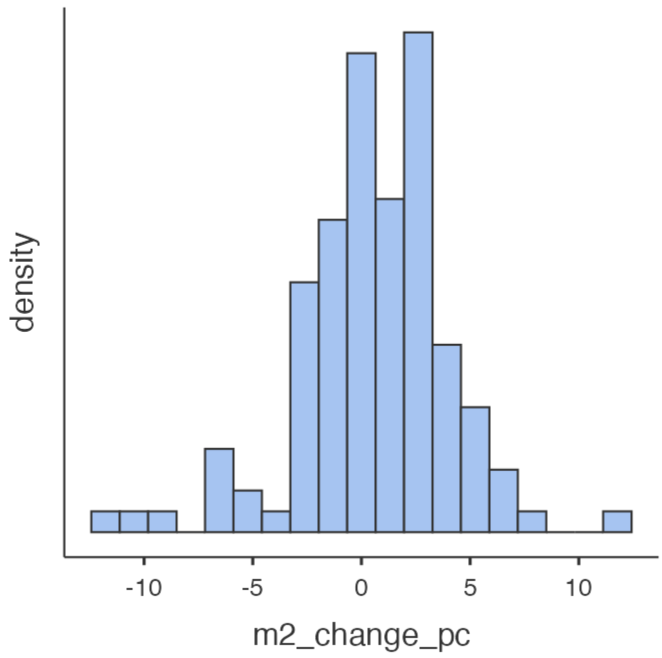
empty_change_pc



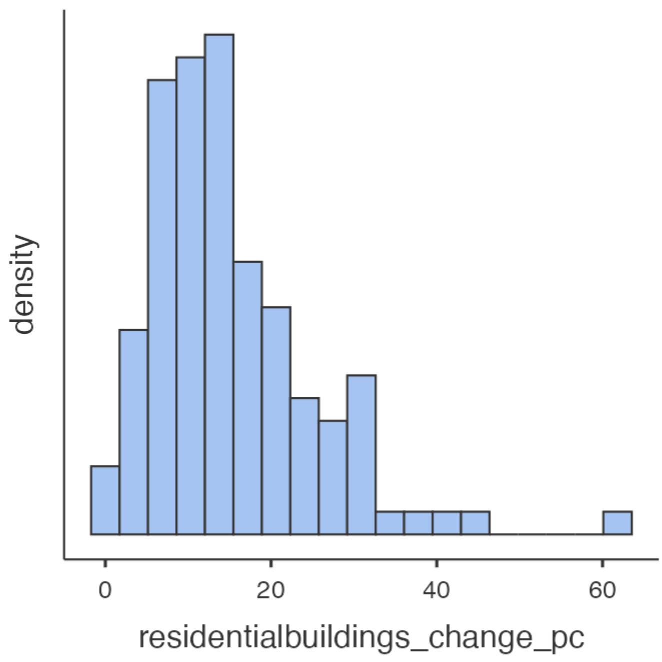
own_change_pc



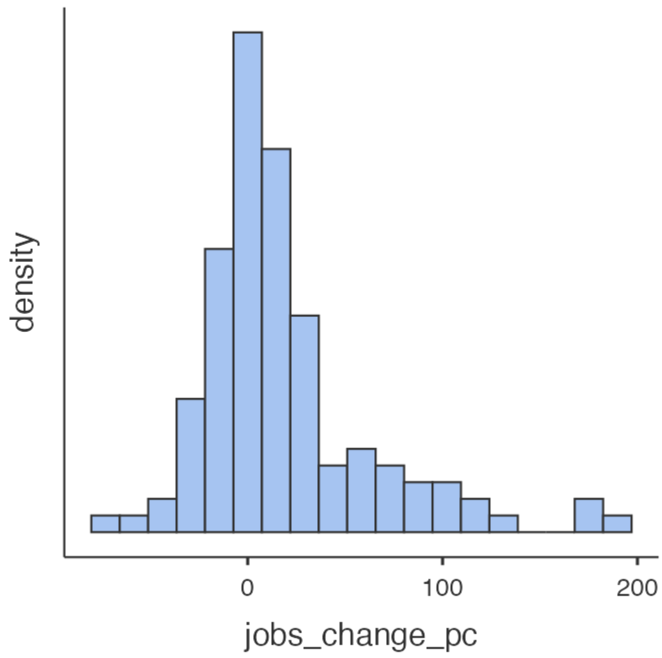
m2_change_pc



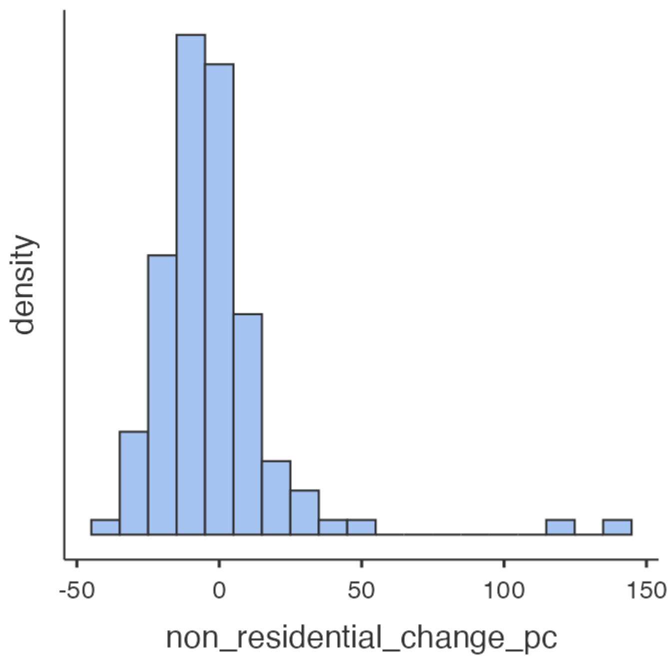
residentialbuildings_change_pc



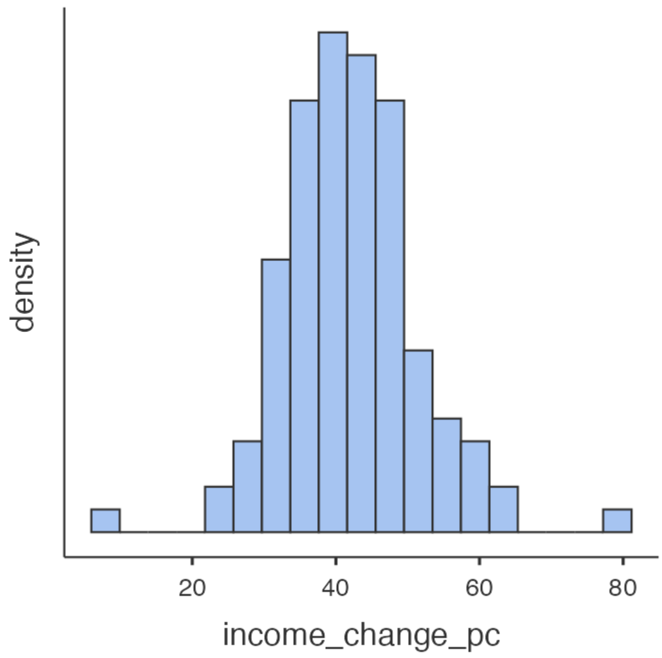
jobs_change_pc



non_residential_change_pc



income_change_pc



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[1] The jamovi project (2022). *jamovi*. (Version 2.3) [Computer Software]. Retrieved from https://www.jamovi.org.

[2] R Core Team (2021). *R: A Language and environment for statistical computing*. (Version 4.1) [Computer software]. Retrieved from https://cran.r-project.org. (R packages retrieved from MRAN snapshot 2022-01-01).

[3] Fox, J., & Weisberg, S. (2020). *car: Companion to Applied Regression*. [R package]. Retrieved from https://cran.r-project.org/package=car.