

Termpaper

Sindre og Morten

“Data gitt med tillatelse fra King County” ^ (**KCGISC?**).

Oppgave 1

A

Hedoniske modeller blir tatt i bruk for å måle marginal «willingness to pay» (MWTP), denne blir tatt i bruk for å måle boligmarkedet sine miljømessige kvaliteter. Den hedoniske modellen ble fremstilt ved å ta i bruk et stort og avansert datasett fra boligmarkeder i store byer som har en avansert økonomi. Jo mer tilgang vi får på data til disse byområdene, desto bedre analyser får vi med bruk av en hedonisk modell.

Rosens første steg handler om å kunne definere et marked som vil tilfredsstille «law of one function». «Law of one function» er at hus som er identiske blir solgt for den samme prisen i et gitt marked. Steg to handler om data innsamling. Det forteller oss at det er met oppnålig med å ha et tilfeldig utvalg. Slike datainnsamlinger til en hedonisk modell som omhandler eiendomsverdi har som regel fokus på eneboliger.

C - Why could it be important to define a housing market as a single metropolitan (or travel to work) area and studying a relatively short period of time, when estimating

i. hedonic price function?

Bishop forklarer at i hedonisk modell innebærer det at markedet bør defineres slik at «loven om en prisfunksjon» oppfylles (Bishop mfl. 2020). Med en prisfunksjon menes det at identiske boliger vil selges til samme pris gjennom hele markedet. Likevel, de nøyaktige romlige og tidsmessige grensene som tilfredsstiller denne betingelsen kan variere på tvers av rom og tid ettersom informasjon, institusjoner og flyttekostnader endres (Bishop mfl. 2020). I praksis er det vanlig å definere markedet som et enkelt storbyområde (single metropolitan) over noen år. Flyttekostnader vil egentlig bryte med loven om en prisfunksjon, men for husholdninger som

flytter innenfor dette storbyområdet er det lite sannsynlig at disse kostnadene vil variere noe særlig.

Årsaken til det er at de fysiske kostnadene som vel som de økonomiske (f.eks lastebil-leie) ikke endrer seg på tvers av destinasjonssteder i hovedstadsområdet. De psykologiske kostnadene er også mer begrenset ved flytting fordi det tillates i lettere grad å opprettholde relasjonene til familie, venner og nabolag. Dette gjør at loven om én prisfunksjon opprettholdes mellom lokasjoner i et storbyområde gjennom arbitrasje. Altså, hvis to hus som er tilsvarende like i samme storbyområdet selges, så velger kjøperne naturligvis det rimeligste.

ii. Explain intuitively, by using an example, why it is important to avoid omitted variable bias when estimating a hedonic price model.

Gjennom empirien og teorien er det grunn til å tro av miljøfaciliteter er romlig korrelert på grunn av de naturlige trekken ved geografien som for eksempel fjell og hav, miljøtilbakemeldingseffekter (f.eks urbane varme øyer) og stemming på lokale felles goder. Dette potensialet for romlig korrelasjon har ført til utbredt bekymring for utelatt-variabel skjevhets (Bishop mfl. 2020). Det er først og fremst fordi det virker usannsynlig at forskere vil være i stand til å inkludere alle bekvemmeligheter som betyr noe for kjøpere. I tillegg vil uobserverte faciliteter sannsynligvis være korrelert med tilbuddet av interesse, og dermed forårsake skjevhets. Dette kan forklares ved et eksempel: Hvis velstående og velutdannede boligkjøpere flytter til områder med bedre luftkvalitet og deretter stemmer for å øke offentlig skolefinansiering, vil estimater av MWTP for luftkvalitet være skjev oppover hvis skolekvalitet utelates fra modellen. Potensialet for denne typen oppførsel fra huseiere betyr at for at de resulterende estimatene skal være troverdige, må forskningsdesignet isolere eksogen variasjon i tilbuddet av interesse (Bishop mfl. 2020).

Oppgave 2

i.

Så over variablene og definisjonene på dem hos Kaggle.

ii.

Laster inn data

```
kc_house_data <- read_csv("kc_house_data.csv")
```

```
Rows: 21613 Columns: 21
-- Column specification -----
Delimiter: ","
chr  (1): id
dbl (19): price, bedrooms, bathrooms, sqft_living, sqft_lot, floors, waterf...
dttm (1): date

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

iii.

```
kc_house_data <- arrange(kc_house_data, desc(date))
```

iv.

```
kc_house_data <- kc_house_data %>%
  distinct(id, .keep_all = TRUE)
```

v & vi.

```
kc_house_data_sf <- st_as_sf(kc_house_data,
  coords = c(x = "long",
             y = "lat"),
  crs = 4326) %>%
  st_transform(2926)
```

vii.

koordinatene til Seattle:

Norske (wikipedia): - 47.60621, -122.33207

Engelske (wikipedia): - 47.609722, -122.333056

```
cbd <- st_sfc(st_point(c(-122.33207, 47.60621)), crs = 4326) %>%
  st_transform(2926)
```

viii.

```
kc_house_data_sf <- kc_house_data_sf %>%
  mutate(dist_cbd = st_distance(cbd, .,
                                by_element = TRUE),
        dist_cbd_km = set_units(dist_cbd, km)
  )
```

Oppgave 3

```
kc_wadoh_map <- here("maps/WADOH_Environmental_Health_Disparities_Index_Calculated_for_King_County___wadoh_map.shp") %>%
  st_read() %>%
  st_transform(2926)

Reading layer `WADOH_Environmental_Health_Disparities_Index_Calculated_for_King_County___wadoh_map` from file
  using driver `ESRI Shapefile'
Simple feature collection with 398 features and 192 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: -122.528 ymin: 47.08446 xmax: -121.0657 ymax: 47.78058
Geodetic CRS:  WGS 84

kc_wadoh_map <- kc_wadoh_map %>%
  select(
    GEO_ID_TRT,
    EHD_percen,#Environmental Health Index, weighted score many vars
    linguist_2,#Pop. age 5+ speaking English less than "very well"
    poverty_pe,#Percentage people living in poverty
    POC_percen,#People of Color in percentage of pop. in tract
    transporta,#% of income spent on transportation median family in tract
    unemploy_2,#percentage unemployed
    housing_pe,#% of households in group "Unaffordable Housing" (>30% inc.)
    traffic_pe,#% of pop. near heavy traffic roadways
    diesel,# nox concentration
    ozone,# ozone concentration
    PM25, # concentration of Particulate Matter in air
    toxic_rele, # Toxic release from factories
    hazardous_, # Hazardous Waste Treatment Storage and disposal Facilities
    lead_perce, # measure of Lead paint in houses
```

```

superfund, # Proximity to contaminated sites on national list
facilities, # Proximity to Risk Management Plan Facilities
wastewater, # Proximity to wastewater facilities
sen_pop_pe, # % pop. over 65
socio_perc # score social economic determinants, low best
)

acs_b19101_fam_inc <- read.dbf("../maps/censusSHP/acs_b19101_familyincome.dbf")
attach(acs_b19101_fam_inc)

acs_b19101_fam_inc <- acs_b19101_fam_inc %>%
  mutate(low = (E19101138 + E19101139 + E19101140 + E19101141 +
               E19101142 + E19101143)/E19101137) %>%
  mutate(mid = (E19101144 + E19101145 + E19101146 + E19101147 +
                E19101148 + E19101149)/E19101137) %>%
  mutate(high = (E19101150 + E19101151 + E19101152 + E19101153)/E19101137)

acs_b19101_fam_inc <- acs_b19101_fam_inc %>%
  select(GEOIDTRT, low, mid, high) %>%
  rename(GEO_ID_TRT = GEOIDTRT)

kc_wadoh_map_2 <- left_join(
  acs_b19101_fam_inc,
  st_drop_geometry(kc_wadoh_map),
  by = "GEO_ID_TRT")

kc_tracts10 <- here("../maps/censusSHP/tracts10.shp") %>%
  st_read() %>%
  st_transform(2926)

Reading layer `tracts10' from data source
`/Users/sindreespedal/Documents/HVL /Høst 2022/MSB 204 - Bolig - R/maps/censusSHP/tracts10
using driver `ESRI Shapefile'
Simple feature collection with 398 features and 22 fields
Geometry type: POLYGON
Dimension:      XY
Bounding box:  xmin: 1217085 ymin: 31406.52 xmax: 1583210 ymax: 287947.2
Projected CRS: NAD83(HARN) / Washington North (ftUS)

```

```

kc_tracts10_shore <- here("../maps/censusSHP/tracts10_shore.shp") %>%
  st_read() %>%
  st_transform(2926)

Reading layer `tracts10_shore' from data source
  `/Users/sindreespedal/Documents/HVL /Høst 2022/MSB 204 - Bolig - R/maps/censusSHP/tracts10_
  using driver `ESRI Shapefile'
Simple feature collection with 398 features and 22 fields
Geometry type: MULTIPOLYGON
Dimension:      XY
Bounding box:  xmin: 1220306 ymin: 31406.52 xmax: 1583210 ymax: 287675.5
Projected CRS: NAD83(HARN) / Washington North (ftUS)

kc_tracts10_env_data <- left_join(
  kc_tracts10, kc_wadoh_map_2,
  by = "GEO_ID_TRT"
)
kc_tracts10_shore_env_data <- left_join(
  kc_tracts10_shore, kc_wadoh_map_2,
  by = "GEO_ID_TRT"
)

kc_houses_env_var <- st_join(kc_house_data_sf, kc_tracts10_env_data)
kc_tracts10_shore_env_var <- st_join(kc_house_data_sf, kc_tracts10_shore_env_data)

st_write(kc_house_data, "../maps/kc_house_data.gpkg", append = FALSE)

Deleting layer `kc_house_data' using driver `GPKG'
Writing layer `kc_house_data' to data source
`../maps/kc_house_data.gpkg' using driver `GPKG'
Writing 21436 features with 21 fields without geometries.

st_write(kc_tracts10, "../maps/kc_tracts10.gpkg", append = FALSE)

Deleting layer `kc_tracts10' using driver `GPKG'
Writing layer `kc_tracts10' to data source
`../maps/kc_tracts10.gpkg' using driver `GPKG'
Writing 398 features with 22 fields and geometry type Polygon.

```

```
st_write(kc_tracts10_shore, ".../maps/kc_tracts10_shore.gpkg", append = FALSE)
```

```
Deleting layer `kc_tracts10_shore' using driver `GPKG'  
Writing layer `kc_tracts10_shore' to data source  
`.../maps/kc_tracts10_shore.gpkg' using driver `GPKG'  
Writing 398 features with 22 fields and geometry type Multi Polygon.
```

```
st_write(kc_houses_env_var, ".../maps/kc_houses_env_var.gpkg", append = FALSE)
```

```
Deleting layer `kc_houses_env_var' using driver `GPKG'  
Writing layer `kc_houses_env_var' to data source  
`.../maps/kc_houses_env_var.gpkg' using driver `GPKG'  
Writing 21436 features with 65 fields and geometry type Point.
```

```
st_write(kc_tracts10_shore_env_var, ".../maps/kc_tracts10_shore_env_var.gpkg", append = FALSE)
```

```
Deleting layer `kc_tracts10_shore_env_var' using driver `GPKG'  
Writing layer `kc_tracts10_shore_env_var' to data source  
`.../maps/kc_tracts10_shore_env_var.gpkg' using driver `GPKG'  
Writing 21436 features with 65 fields and geometry type Point.
```

Oppgave 4

i.

```
summary(kc_tracts10_env_data)
```

| GEO_ID_TRT | FEATURE_ID | TRACT_LBL | TRACT_STR |
|------------------|---------------|------------------|------------------|
| Length:398 | Min. :10153 | Length:398 | Length:398 |
| Class :character | 1st Qu.:25818 | Class :character | Class :character |
| Mode :character | Median :44344 | Mode :character | Mode :character |
| | Mean :36731 | | |
| | 3rd Qu.:45226 | | |
| | Max. :45837 | | |

| TRACT_INT | TRACT_FLT | TRACT_DEL | TRTLABEL_F |
|-----------|-----------|-----------|------------|
|-----------|-----------|-----------|------------|

| | | | |
|----------------|-----------------|------------------|------------------|
| Min. : 100 | Min. : 1.00 | Length:398 | Length:398 |
| 1st Qu.: 9625 | 1st Qu.: 96.25 | Class :character | Class :character |
| Median : 24150 | Median : 241.50 | Mode :character | Mode :character |
| Mean : 23022 | Mean : 230.22 | | |
| 3rd Qu.: 30076 | 3rd Qu.: 300.76 | | |
| Max. :990100 | Max. :9901.00 | | |

| TRTLABEL_C | TRTLABEL_T | COUNTY_STR | COUNTY_INT |
|------------------|------------------|------------------|------------|
| Length:398 | Length:398 | Length:398 | Min. :33 |
| Class :character | Class :character | Class :character | 1st Qu.:33 |
| Mode :character | Mode :character | Mode :character | Median :33 |
| | | | Mean :33 |
| | | | 3rd Qu.:33 |
| | | | Max. :33 |

| STATE_STR | STATE_INT | LEVEL_1 | LEVEL_2 |
|------------------|------------|------------------|------------------|
| Length:398 | Min. :53 | Length:398 | Length:398 |
| Class :character | 1st Qu.:53 | Class :character | Class :character |
| Mode :character | Median :53 | Mode :character | Mode :character |
| | Mean :53 | | |
| | 3rd Qu.:53 | | |
| | Max. :53 | | |

| LEVEL_3 | TRACT_AREA | TRACT_PERI | LOGRECNO |
|------------------|-------------------|----------------|------------------|
| Length:398 | Min. :2.466e+06 | Min. : 7060 | Length:398 |
| Class :character | 1st Qu.:1.933e+07 | 1st Qu.: 20586 | Class :character |
| Mode :character | Median :3.362e+07 | Median : 29573 | Mode :character |
| | Mean :1.616e+08 | Mean : 44019 | |
| | 3rd Qu.:5.601e+07 | 3rd Qu.: 43667 | |
| | Max. :1.526e+10 | Max. :738820 | |

| Shape_area | Shape_len | low | mid |
|-------------------|----------------|------------------|----------------|
| Min. :2.466e+06 | Min. : 7060 | Min. :0.009298 | Min. :0.0000 |
| 1st Qu.:1.933e+07 | 1st Qu.: 20586 | 1st Qu.:0.053302 | 1st Qu.:0.2391 |
| Median :3.362e+07 | Median : 29573 | Median :0.092424 | Median :0.3339 |
| Mean :1.616e+08 | Mean : 44019 | Mean :0.125013 | Mean :0.3327 |
| 3rd Qu.:5.601e+07 | 3rd Qu.: 43667 | 3rd Qu.:0.166534 | 3rd Qu.:0.4261 |
| Max. :1.526e+10 | Max. :738820 | Max. :1.000000 | Max. :0.6790 |
| | | NA's :1 | NA's :1 |
| high | EHD_percen | linguist_2 | poverty_pe |
| Min. :0.0000 | Min. : 1.00 | Min. : 0.45 | Min. : 1.97 |
| 1st Qu.:0.4006 | 1st Qu.: 25.00 | 1st Qu.: 3.88 | 1st Qu.:10.53 |
| Median :0.5637 | Median : 50.00 | Median : 8.72 | Median :16.75 |

| | | | | | | | |
|------------|------------|------------|------------|------------|----------|------------|-----------|
| Mean | : 0.5423 | Mean | : 50.38 | Mean | : 10.62 | Mean | : 20.42 |
| 3rd Qu. | : 0.6955 | 3rd Qu. | : 75.00 | 3rd Qu. | : 15.38 | 3rd Qu. | : 27.48 |
| Max. | : 0.8816 | Max. | : 100.00 | Max. | : 46.76 | Max. | : 75.48 |
| NA's | : 1 | NA's | : 1 | NA's | : 5 | NA's | : 1 |
| POC_percen | | transporta | | unemploy_2 | | housing_pe | |
| Min. | : 7.54 | Min. | : 10.00 | Min. | : 1.000 | Min. | : 15.14 |
| 1st Qu. | : 23.36 | 1st Qu. | : 18.00 | 1st Qu. | : 3.350 | 1st Qu. | : 27.34 |
| Median | : 36.29 | Median | : 19.00 | Median | : 4.480 | Median | : 32.26 |
| Mean | : 38.64 | Mean | : 18.97 | Mean | : 5.099 | Mean | : 33.75 |
| 3rd Qu. | : 51.01 | 3rd Qu. | : 21.00 | 3rd Qu. | : 6.460 | 3rd Qu. | : 39.13 |
| Max. | : 92.70 | Max. | : 26.00 | Max. | : 24.400 | Max. | : 81.89 |
| NA's | : 1 | NA's | : 1 | NA's | : 3 | NA's | : 1 |
| traffic_pe | | diesel | | ozone | | PM25 | |
| Min. | : 0.00 | Min. | : 0.14 | Min. | : 46.73 | Min. | : 3.787 |
| 1st Qu. | : 0.00 | 1st Qu. | : 6.65 | 1st Qu. | : 48.91 | 1st Qu. | : 5.642 |
| Median | : 3.60 | Median | : 12.65 | Median | : 49.78 | Median | : 6.180 |
| Mean | : 16.07 | Mean | : 17.10 | Mean | : 50.62 | Mean | : 6.186 |
| 3rd Qu. | : 26.17 | 3rd Qu. | : 18.99 | 3rd Qu. | : 51.28 | 3rd Qu. | : 6.872 |
| Max. | : 97.75 | Max. | : 92.63 | Max. | : 62.89 | Max. | : 7.897 |
| NA's | : 1 | NA's | : 1 | NA's | : 1 | NA's | : 1 |
| toxic_rele | | hazardous_ | | lead_perce | | superfund | |
| Min. | : 823.9 | Min. | : 0.02303 | Min. | : 0.24 | Min. | : 0.03454 |
| 1st Qu. | : 5180.9 | 1st Qu. | : 0.04168 | 1st Qu. | : 6.46 | 1st Qu. | : 0.07358 |
| Median | : 10186.5 | Median | : 0.05160 | Median | : 13.79 | Median | : 0.13133 |
| Mean | : 19398.3 | Mean | : 0.08190 | Mean | : 17.08 | Mean | : 0.24645 |
| 3rd Qu. | : 20058.1 | 3rd Qu. | : 0.09280 | 3rd Qu. | : 26.20 | 3rd Qu. | : 0.28436 |
| Max. | : 186434.6 | Max. | : 0.63781 | Max. | : 54.68 | Max. | : 1.46778 |
| NA's | : 1 | NA's | : 1 | NA's | : 1 | NA's | : 1 |
| facilities | | wastewater | | sen_pop_pe | | socio_perc | |
| Min. | : 0.0523 | Min. | : 0.00e+00 | Min. | : 1.00 | Min. | : 1.00 |
| 1st Qu. | : 0.1612 | 1st Qu. | : 5.50e-06 | 1st Qu. | : 25.00 | 1st Qu. | : 25.00 |
| Median | : 0.3652 | Median | : 5.30e-04 | Median | : 50.00 | Median | : 50.00 |
| Mean | : 0.6046 | Mean | : 2.62e-02 | Mean | : 50.38 | Mean | : 50.38 |
| 3rd Qu. | : 0.9119 | 3rd Qu. | : 8.70e-03 | 3rd Qu. | : 75.00 | 3rd Qu. | : 75.00 |
| Max. | : 3.3682 | Max. | : 6.40e-01 | Max. | : 100.00 | Max. | : 100.00 |
| NA's | : 1 | NA's | : 1 | NA's | : 1 | NA's | : 1 |
| geometry | | | | | | | |
| POLYGON | : 398 | | | | | | |
| epsg:2926 | : 0 | | | | | | |
| +proj=lcc | ...: 0 | | | | | | |

```
summary(kc_tracts10_shore_env_var)
```

| | id | date | price |
|----------|----------------------|---------------------------------|----------------------|
| Length: | 21436 | Min. : 2014-05-02 00:00:00.00 | Min. : 75000 |
| Class : | character | 1st Qu.: 2014-07-22 00:00:00.00 | 1st Qu.: 324866 |
| Mode : | character | Median : 2014-10-17 00:00:00.00 | Median : 450000 |
| | | Mean : 2014-10-29 17:30:02.34 | Mean : 541650 |
| | | 3rd Qu.: 2015-02-18 00:00:00.00 | 3rd Qu.: 645000 |
| | | Max. : 2015-05-27 00:00:00.00 | Max. : 7700000 |
| | bedrooms | bathrooms | sqft_living |
| Min. : | 0.000 | Min. : 0.000 | Min. : 290 |
| 1st Qu.: | 3.000 | 1st Qu.: 1.750 | 1st Qu.: 1430 |
| Median : | 3.000 | Median : 2.250 | Median : 1920 |
| Mean : | 3.372 | Mean : 2.117 | Mean : 2083 |
| 3rd Qu.: | 4.000 | 3rd Qu.: 2.500 | 3rd Qu.: 2550 |
| Max. : | 33.000 | Max. : 8.000 | Max. : 13540 |
| | sqft_lot | | |
| Min. : | 520 | 1st Qu.: | 5040 |
| Median : | 7614 | Mean : | 15136 |
| 3rd Qu.: | 10696 | 3rd Qu.: | 10696 |
| Max. : | 1651359 | Max. : | 1651359 |
| | floors | waterfront | view |
| Min. : | 1.000 | Min. : 0.000000 | Min. : 0.0000 |
| 1st Qu.: | 1.000 | 1st Qu.: 0.000000 | 1st Qu.: 0.0000 |
| Median : | 1.500 | Median : 0.000000 | Median : 0.0000 |
| Mean : | 1.496 | Mean : 0.007604 | Mean : 0.2351 |
| 3rd Qu.: | 2.000 | 3rd Qu.: 0.000000 | 3rd Qu.: 0.0000 |
| Max. : | 3.500 | Max. : 1.000000 | Max. : 4.0000 |
| | condition | | |
| Min. : | 1.00 | 1st Qu.: | 3.00 |
| Median : | 3.00 | Mean : | 3.41 |
| 3rd Qu.: | 4.00 | 3rd Qu.: | 4.00 |
| Max. : | 5.00 | Max. : | 5.00 |
| | grade | sqft_above | sqft_basement |
| Min. : | 1.000 | Min. : 290 | Min. : 0.0 |
| 1st Qu.: | 7.000 | 1st Qu.: 1200 | 1st Qu.: 0.0 |
| Median : | 7.000 | Median : 1560 | Median : 0.0 |
| Mean : | 7.662 | Mean : 1791 | Mean : 291.7 |
| 3rd Qu.: | 8.000 | 3rd Qu.: 2220 | 3rd Qu.: 560.0 |
| Max. : | 13.000 | Max. : 9410 | Max. : 4820.0 |
| | yr_built | | |
| Min. : | 1900 | 1st Qu.: | 1952 |
| Median : | 1975 | Mean : | 1971 |
| 3rd Qu.: | 1997 | 3rd Qu.: | 1997 |
| Max. : | 2015 | Max. : | 2015 |
| | sqft_living15 | sqft_lot15 | |
| Min. : | 399 | Min. : 651 | Min. : 651 |
| 1st Qu.: | 1490 | 1st Qu.: 5100 | 1st Qu.: 5100 |
| Median : | 1840 | Median : 7620 | Median : 7620 |
| Mean : | 1988 | Mean : 12786 | Mean : 12786 |
| | zipcode | | |
| Min. : | 98001 | Min. : | 651 |
| 1st Qu.: | 98033 | 1st Qu.: 5100 | 1st Qu.: 5100 |
| Median : | 98065 | Median : 7620 | Median : 7620 |
| Mean : | 98078 | Mean : 12786 | Mean : 12786 |

| | | | | | | | | | | | | |
|----------|------|----------|-------|----------|------|----------|-------|---|------|------|---|--------|
| 3rd Qu.: | 0.00 | 3rd Qu.: | 98117 | 3rd Qu.: | 2370 | 3rd Qu.: | 10087 | | | | | |
| Max. | : | 2015.00 | | Max. | : | 98199 | Max. | : | 6210 | Max. | : | 871200 |

| | geometry | dist_cbd | dist_cbd_km | GEO_ID_TRT |
|-----------|----------|----------------|-----------------|------------------|
| POINT | :21436 | Min. : 3228 | Min. : 0.9838 | Length:21436 |
| epsg:2926 | : 0 | 1st Qu.: 32099 | 1st Qu.: 9.7837 | Class :character |
| +proj=lcc | ...: 0 | Median : 54280 | Median :16.5447 | Mode :character |
| | | Mean : 60638 | Mean :18.4824 | |
| | | 3rd Qu.: 83064 | 3rd Qu.:25.3178 | |
| | | Max. :253647 | Max. :77.3117 | |

| | FEATURE_ID | TRACT_LBL | TRACT_STR | TRACT_INT |
|------------------|------------|------------------|------------------|------------------|
| Min. | :10153 | Length:21436 | Length:21436 | Min. : 100 |
| 1st Qu.: | 36346 | Class :character | Class :character | 1st Qu.:10402 |
| Median : | 44764 | Mode :character | Mode :character | Median :24702 |
| Mean : | 38270 | | | Mean :21224 |
| 3rd Qu.: | 45279 | | | 3rd Qu.:31202 |
| Max. : | 45838 | | | Max. :32800 |
| NA's : | 25 | | | NA's :25 |
| | TRACT_FLT | TRACT_DEL | TRTLABEL_F | TRTLABEL_C |
| Min. : | 1.0 | Length:21436 | Length:21436 | Length:21436 |
| 1st Qu.: | 104.0 | Class :character | Class :character | Class :character |
| Median : | 247.0 | Mode :character | Mode :character | Mode :character |
| Mean : | 212.2 | | | |
| 3rd Qu.: | 312.0 | | | |
| Max. : | 328.0 | | | |
| NA's : | 25 | | | |
| | TRTLABEL_T | COUNTY_STR | COUNTY_INT | STATE_STR |
| Length:21436 | | Length:21436 | Min. :33 | Length:21436 |
| Class :character | | Class :character | 1st Qu.:33 | Class :character |
| Mode :character | | Mode :character | Median :33 | Mode :character |
| | | | Mean :33 | |
| | | | 3rd Qu.:33 | |
| | | | Max. :33 | |
| | | | NA's :25 | |
| | STATE_INT | LEVEL_1 | LEVEL_2 | LEVEL_3 |
| Min. : | 53 | Length:21436 | Length:21436 | Length:21436 |
| 1st Qu.: | 53 | Class :character | Class :character | Class :character |
| Median : | 53 | Mode :character | Mode :character | Mode :character |
| Mean : | 53 | | | |
| 3rd Qu.: | 53 | | | |
| Max. : | 53 | | | |
| NA's : | 25 | | | |

| | | | |
|--------------------|-------------------|------------------|--------------------|
| TRACT_AREA | TRACT_PERI | LOGRECNO | Shape_area |
| Min. : 2.792e+06 | Min. : 8012 | Length:21436 | Min. : 2.792e+06 |
| 1st Qu.: 2.485e+07 | 1st Qu.: 23500 | Class :character | 1st Qu.: 2.281e+07 |
| Median : 4.123e+07 | Median : 32920 | Mode :character | Median : 3.445e+07 |
| Mean : 1.809e+08 | Mean : 48212 | | Mean : 1.750e+08 |
| 3rd Qu.: 7.308e+07 | 3rd Qu.: 47962 | | 3rd Qu.: 6.628e+07 |
| Max. : 1.526e+10 | Max. : 738820 | | Max. : 1.526e+10 |
| NA's : 25 | NA's : 25 | | NA's : 25 |
| Shape_len | low | mid | high |
| Min. : 8012 | Min. : 0.009298 | Min. : 0.06768 | Min. : 0.06129 |
| 1st Qu.: 23204 | 1st Qu.: 0.047091 | 1st Qu.: 0.21668 | 1st Qu.: 0.47602 |
| Median : 31185 | Median : 0.074766 | Median : 0.30219 | Median : 0.61143 |
| Mean : 46861 | Mean : 0.100082 | Mean : 0.31115 | Mean : 0.58877 |
| 3rd Qu.: 46624 | 3rd Qu.: 0.133557 | 3rd Qu.: 0.39313 | 3rd Qu.: 0.72987 |
| Max. : 738820 | Max. : 0.501433 | Max. : 0.67904 | Max. : 0.88162 |
| NA's : 25 | NA's : 25 | NA's : 25 | NA's : 25 |
| EHD_percen | linguist_2 | poverty_pe | POC_percen |
| Min. : 1.00 | Min. : 0.450 | Min. : 1.97 | Min. : 7.54 |
| 1st Qu.: 19.00 | 1st Qu.: 3.120 | 1st Qu.: 8.93 | 1st Qu.: 21.13 |
| Median : 41.00 | Median : 7.000 | Median : 13.60 | Median : 33.26 |
| Mean : 43.64 | Mean : 9.003 | Mean : 16.65 | Mean : 35.33 |
| 3rd Qu.: 67.00 | 3rd Qu.: 12.730 | 3rd Qu.: 22.95 | 3rd Qu.: 46.34 |
| Max. : 100.00 | Max. : 40.350 | Max. : 75.48 | Max. : 92.70 |
| NA's : 25 | NA's : 220 | NA's : 25 | NA's : 25 |
| transporta | unemploy_2 | housing_pe | traffic_pe |
| Min. : 12.00 | Min. : 1.000 | Min. : 15.14 | Min. : 0.00 |
| 1st Qu.: 18.00 | 1st Qu.: 3.230 | 1st Qu.: 25.64 | 1st Qu.: 0.00 |
| Median : 20.00 | Median : 4.310 | Median : 30.46 | Median : 0.10 |
| Mean : 19.77 | Mean : 4.775 | Mean : 31.37 | Mean : 11.52 |
| 3rd Qu.: 21.00 | 3rd Qu.: 6.050 | 3rd Qu.: 35.73 | 3rd Qu.: 19.14 |
| Max. : 26.00 | Max. : 13.620 | Max. : 64.87 | Max. : 84.98 |
| NA's : 25 | NA's : 102 | NA's : 25 | NA's : 25 |
| diesel | ozone | PM25 | toxic_rele |
| Min. : 0.14 | Min. : 46.73 | Min. : 3.787 | Min. : 823.9 |
| 1st Qu.: 5.60 | 1st Qu.: 49.24 | 1st Qu.: 5.488 | 1st Qu.: 4143.8 |
| Median : 10.16 | Median : 49.97 | Median : 6.044 | Median : 8827.6 |
| Mean : 13.68 | Mean : 51.17 | Mean : 6.002 | Mean : 17251.1 |
| 3rd Qu.: 16.88 | 3rd Qu.: 52.32 | 3rd Qu.: 6.579 | 3rd Qu.: 17237.2 |
| Max. : 92.63 | Max. : 62.89 | Max. : 7.897 | Max. : 186434.6 |
| NA's : 25 | NA's : 25 | NA's : 25 | NA's : 25 |
| hazardous_ | lead_perce | superfund | facilities |
| Min. : 0.02303 | Min. : 0.24 | Min. : 0.03454 | Min. : 0.0523 |
| 1st Qu.: 0.03985 | 1st Qu.: 5.34 | 1st Qu.: 0.06595 | 1st Qu.: 0.1420 |

| | | | |
|------------------|---------------|-----------------|----------------|
| Median :0.05160 | Median :11.99 | Median :0.11046 | Median :0.2680 |
| Mean :0.07409 | Mean :16.60 | Mean :0.21696 | Mean :0.5248 |
| 3rd Qu.:0.07891 | 3rd Qu.:26.48 | 3rd Qu.:0.23841 | 3rd Qu.:0.7588 |
| Max. :0.63781 | Max. :54.68 | Max. :1.46778 | Max. :3.3682 |
| NA's :25 | NA's :25 | NA's :25 | NA's :25 |
| wastewater | sen_pop_pe | socio_perc | |
| Min. :0.000000 | Min. : 1.0 | Min. : 1.00 | |
| 1st Qu.:0.000003 | 1st Qu.: 25.0 | 1st Qu.: 20.00 | |
| Median :0.000290 | Median : 48.0 | Median : 43.00 | |
| Mean :0.016168 | Mean : 48.1 | Mean : 44.51 | |
| 3rd Qu.:0.002900 | 3rd Qu.: 71.0 | 3rd Qu.: 67.00 | |
| Max. :0.640000 | Max. :100.0 | Max. :100.00 | |
| NA's :25 | NA's :25 | NA's :25 | |

ii.

Tract10 kartet har ikke havet med seg og får med det en NA observasjon som er utenfor countygrensen. **Tracts10_shore** har med havet på kartet, som gjør at det er flere obserasjoner som “havner” ut i havet og med det blir de til NA verdier (25stk).

I QGIS fant vi følgende obserasjoner ved å se på *tracts10*, *tracts10_shore* & *kc_houses_env_var*:

iii.

Dropper Observasjonen 3518000180 ved å:

```
kc_houses_env_var <- arrange(kc_houses_env_var, desc(id))
kc_houses_env_var.omit <- kc_houses_env_var[-c(11997),]

st_write(kc_houses_env_var.omit, ".../maps/kc_houses_env_var.omit.gpkg", append = FALSE)
```

```
Deleting layer `kc_houses_env_var.omit' using driver `GPKG'
Writing layer `kc_houses_env_var.omit' to data source
`.../maps/kc_houses_env_var.omit.gpkg' using driver `GPKG'
Writing 21435 features with 65 fields and geometry type Point.
```

```
kc_houses_env_var.omit <- kc_houses_env_var.omit %>%
  mutate(
    year_month = substr(date, start = 1, stop = 7))
```

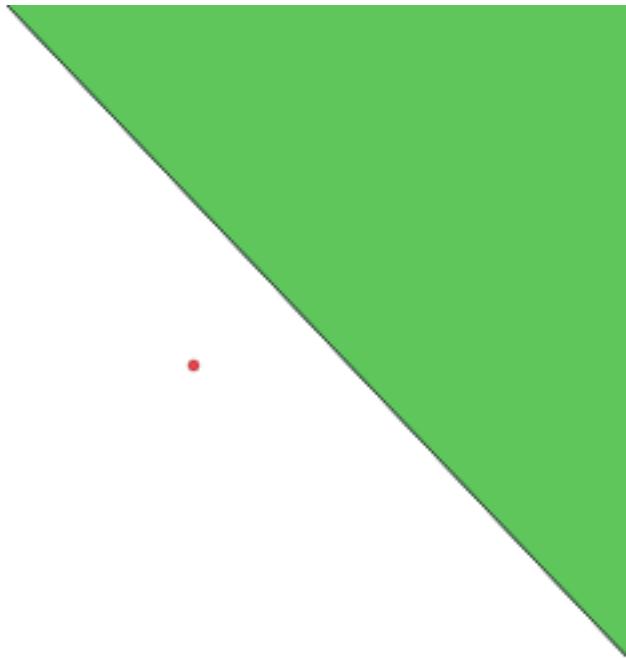


Figure 1: observasjon utenfor WA state

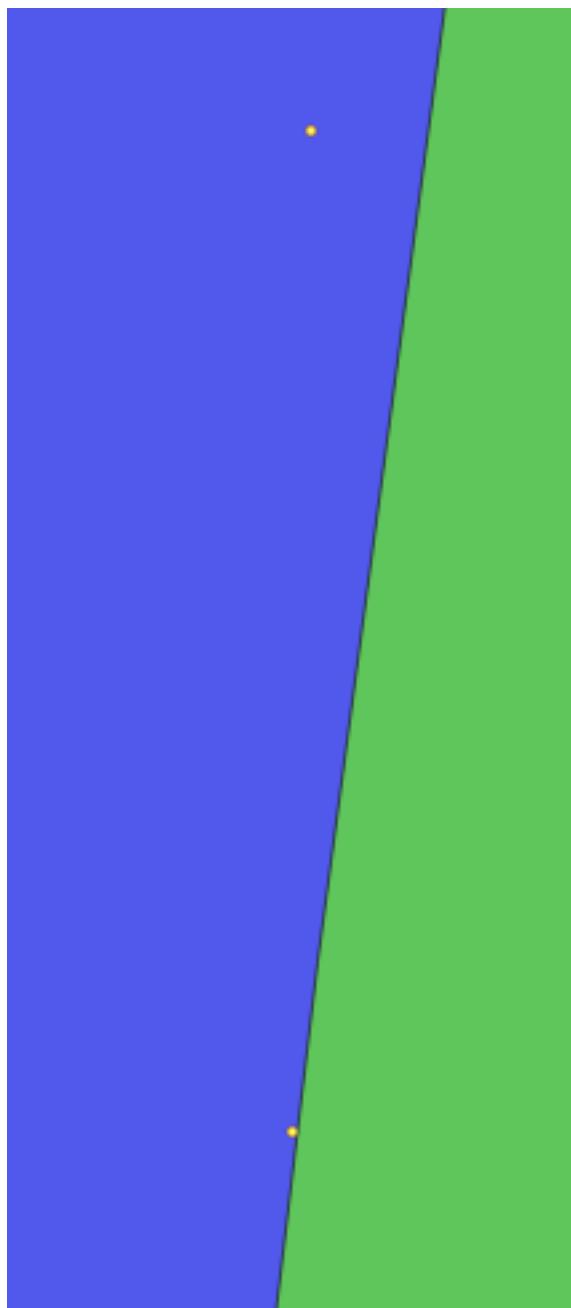


Figure 2: Observasjon utenfor kystlinjen.a



Figure 3: Observasjon utenfor kystlinjen.b

```
st_write(kc_houses_env_var OMIT, ".../maps/kc_houses_env_var OMIT.gpkg", append = FALSE)
```

```
Deleting layer `kc_houses_env_var OMIT' using driver `GPKG'  
Writing layer `kc_houses_env_var OMIT' to data source  
`.../maps/kc_houses_env_var OMIT.gpkg' using driver `GPKG'  
Writing 21435 features with 66 fields and geometry type Point.
```

Oppgave 5

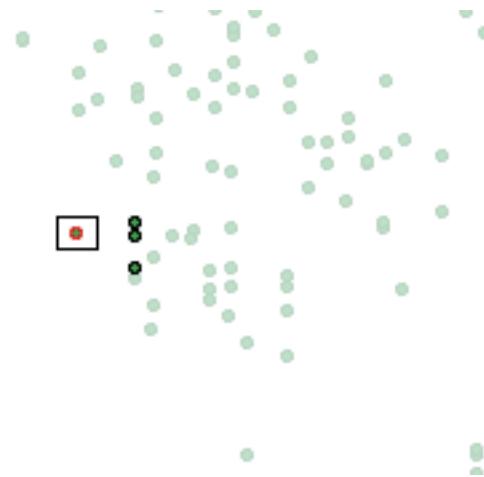


Figure 4: K-nearest 3

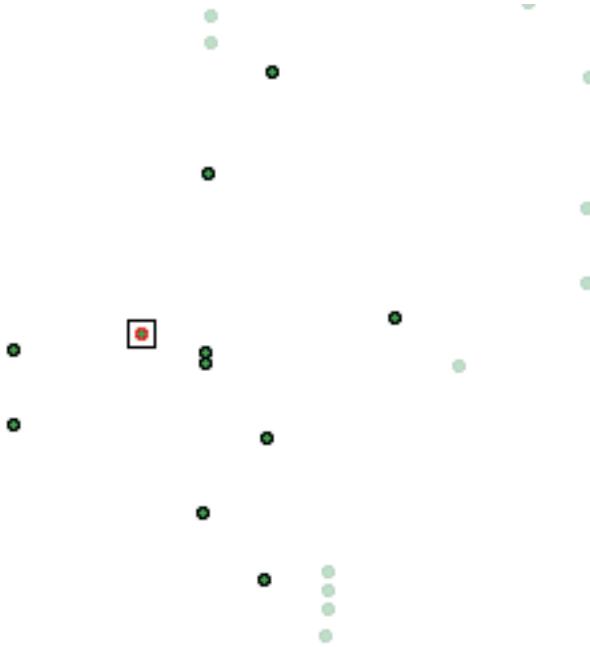


Figure 5: K-nearest 10

Oppgave 6

i)

Funn fra EDA

Vi ser at de store konsentrasjonene av store boliger til høye priser er i og rett rundt Seattle sentrum, vi kan også se at Mercer Island er veldig dyr plass og at vestsiden av Bellevue har store og dyre boliger.

Vi ser at store deler av små boliger til lave priser er i søre del King county.

Vi ser at de små og dyre boligene er rundt bykjernen, noe som gir mening med tanke på at det er mindre områder å bygge store boliger samt et populært område å bo.

Vi kan også se at de store og billige husene plasserer seg sammen med de små og billige boligene, dette sier oss at dette er et fattigere område hvor de lavlønnte bor.

Morans I verdien til K3 er på 0,398 og K10 sin er på 0,350. Når vi skulle regne ut Morgans I valgte vi å bruke price og sqft_living. Vi sammenlignet sqft_living og bedrooms, de så ganske like ut på kartet, men hadde forskjellige verdier på morans I. Verdien er finere med sqft_living fordi det er et tydligere mønster på at når sqft_living øker så blir det dyrere.

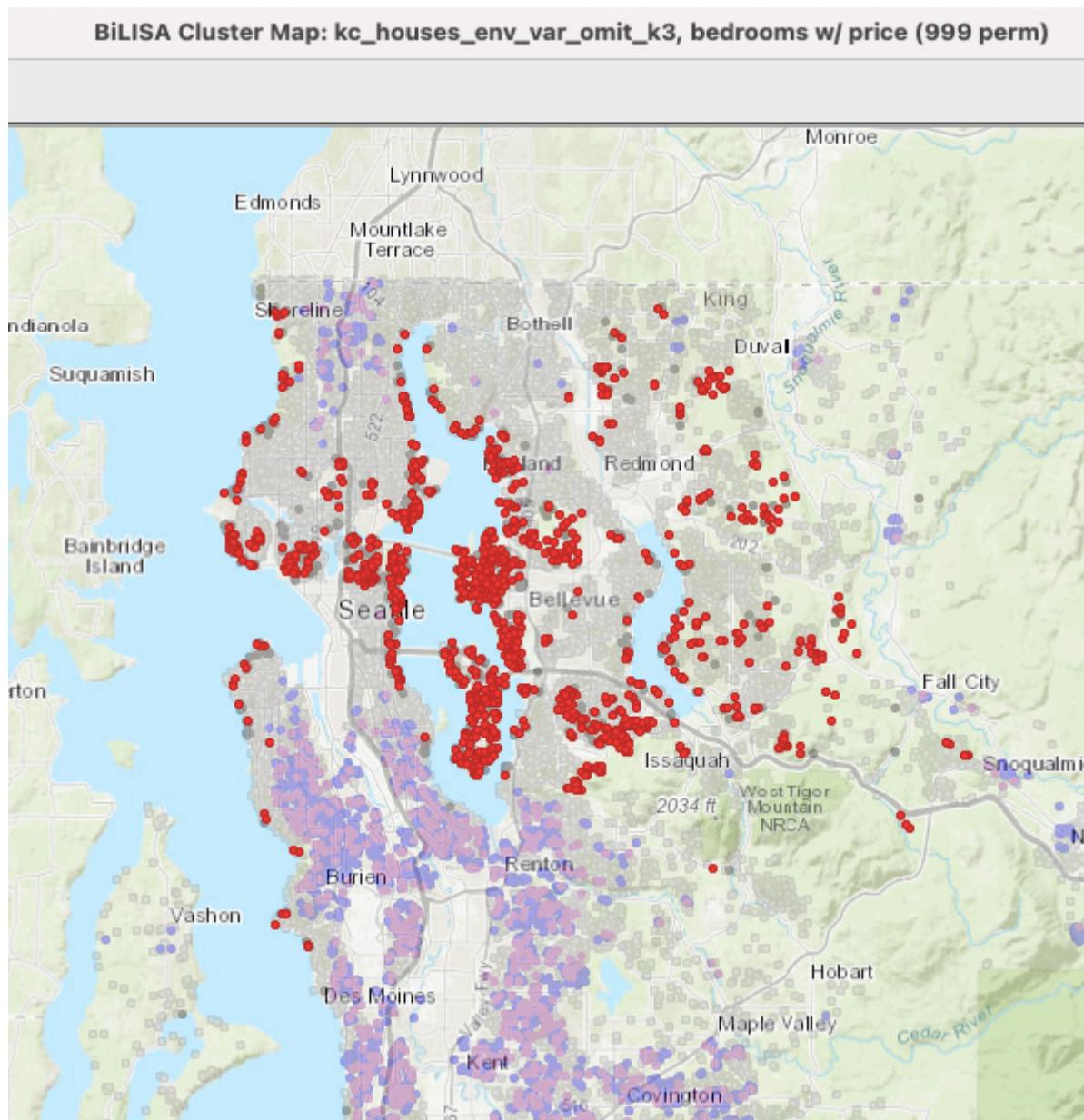


Figure 6: K3 - Store og dyre boliger

BiLISA Cluster Map: kc_houses_env_var_omit_k3, bedrooms w/ price (999 perm)

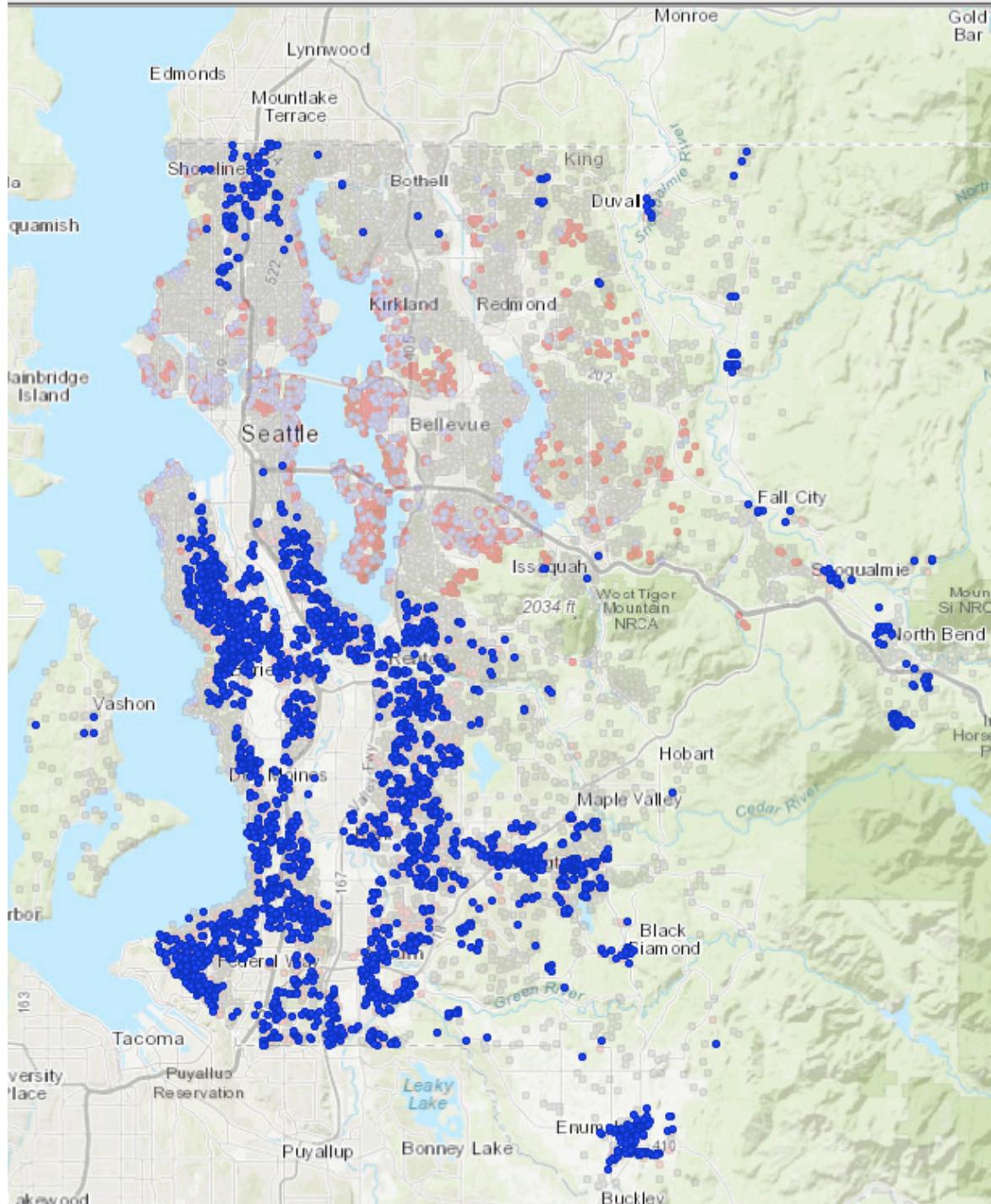


Figure 7: K3 - Små og billige boliger

BiLISA Cluster Map: kc_houses_env_var omit_k3, bedrooms w/ price (999 perm)

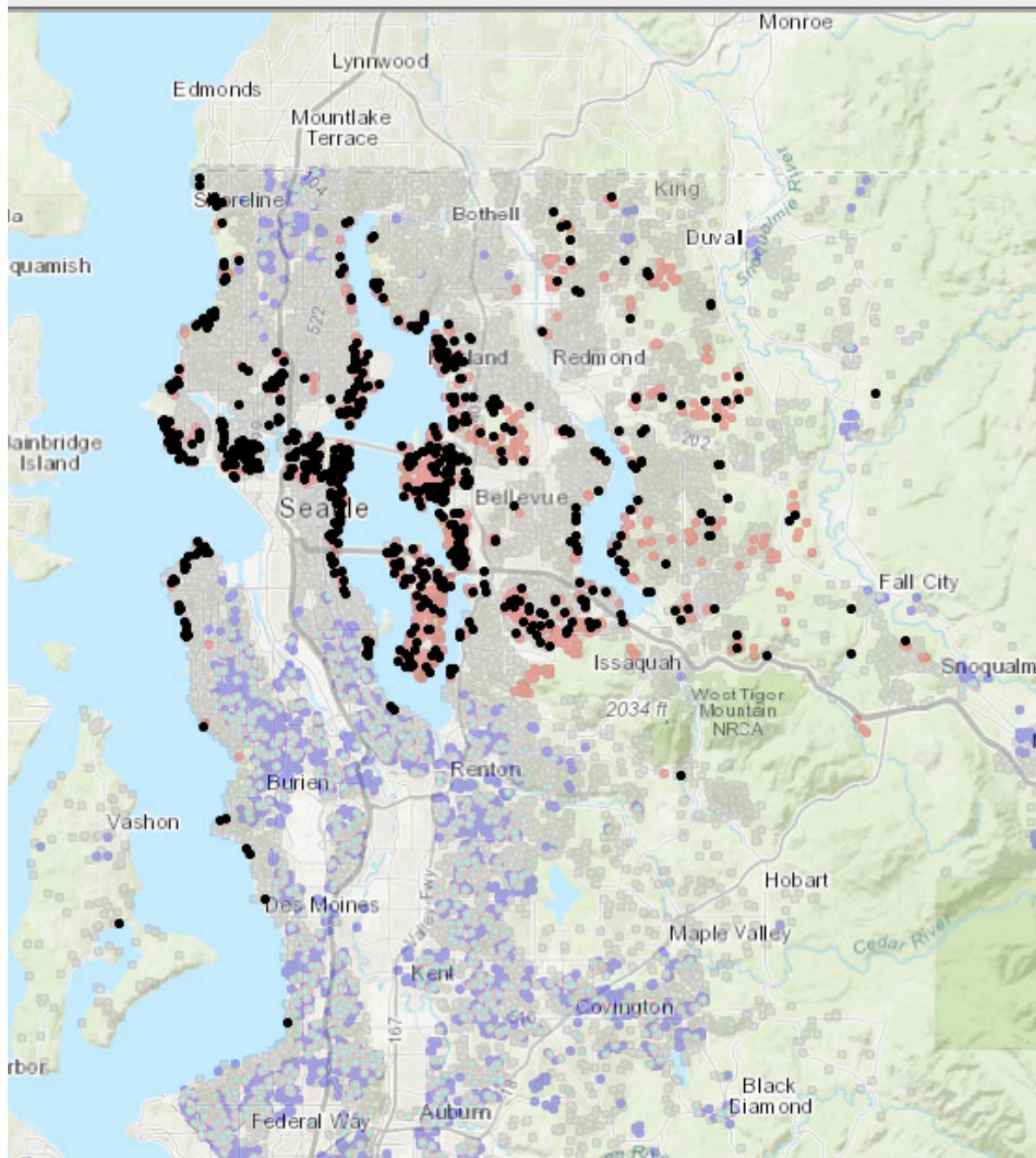


Figure 8: K3 - Små og dyre boliger

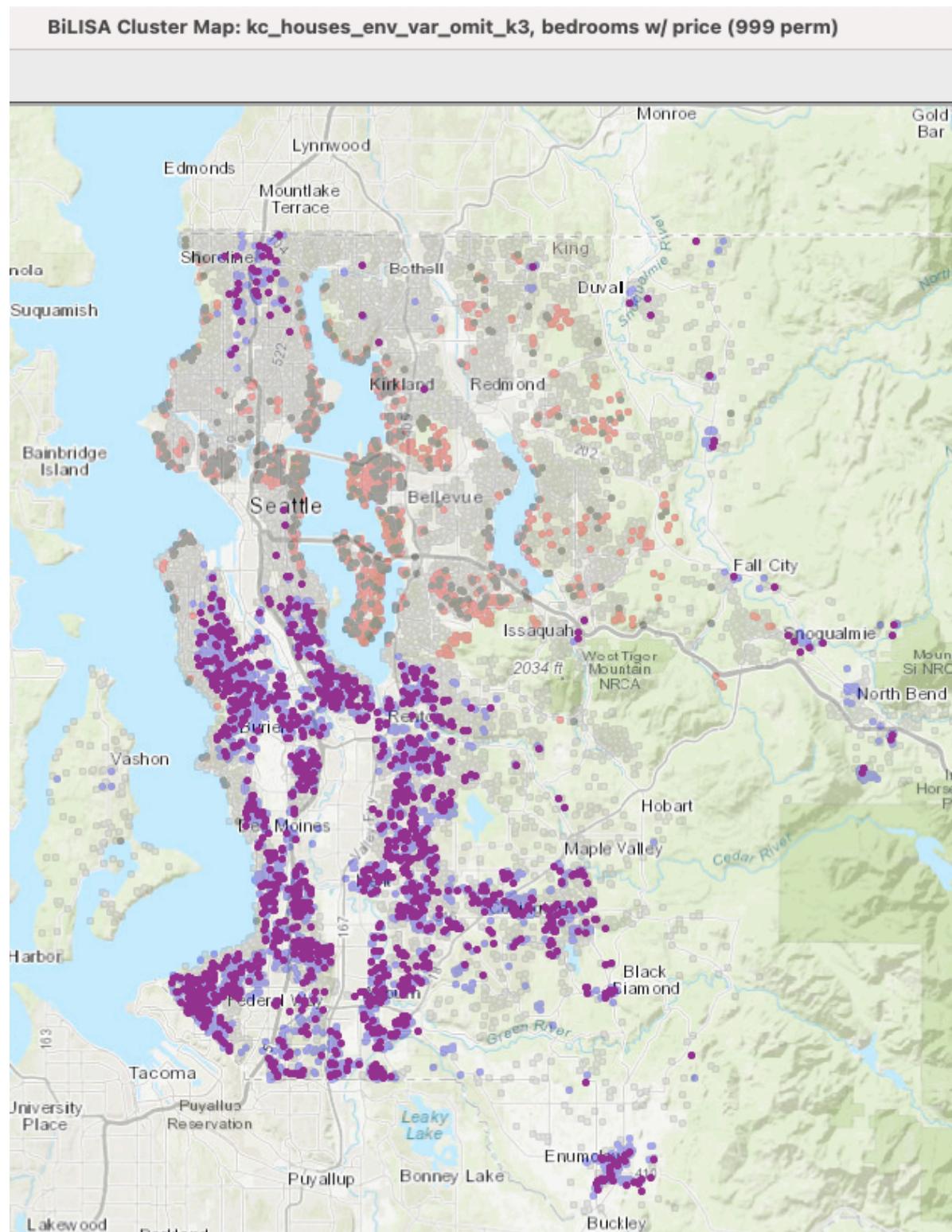


Figure 9: K3 - Store og billige boliger

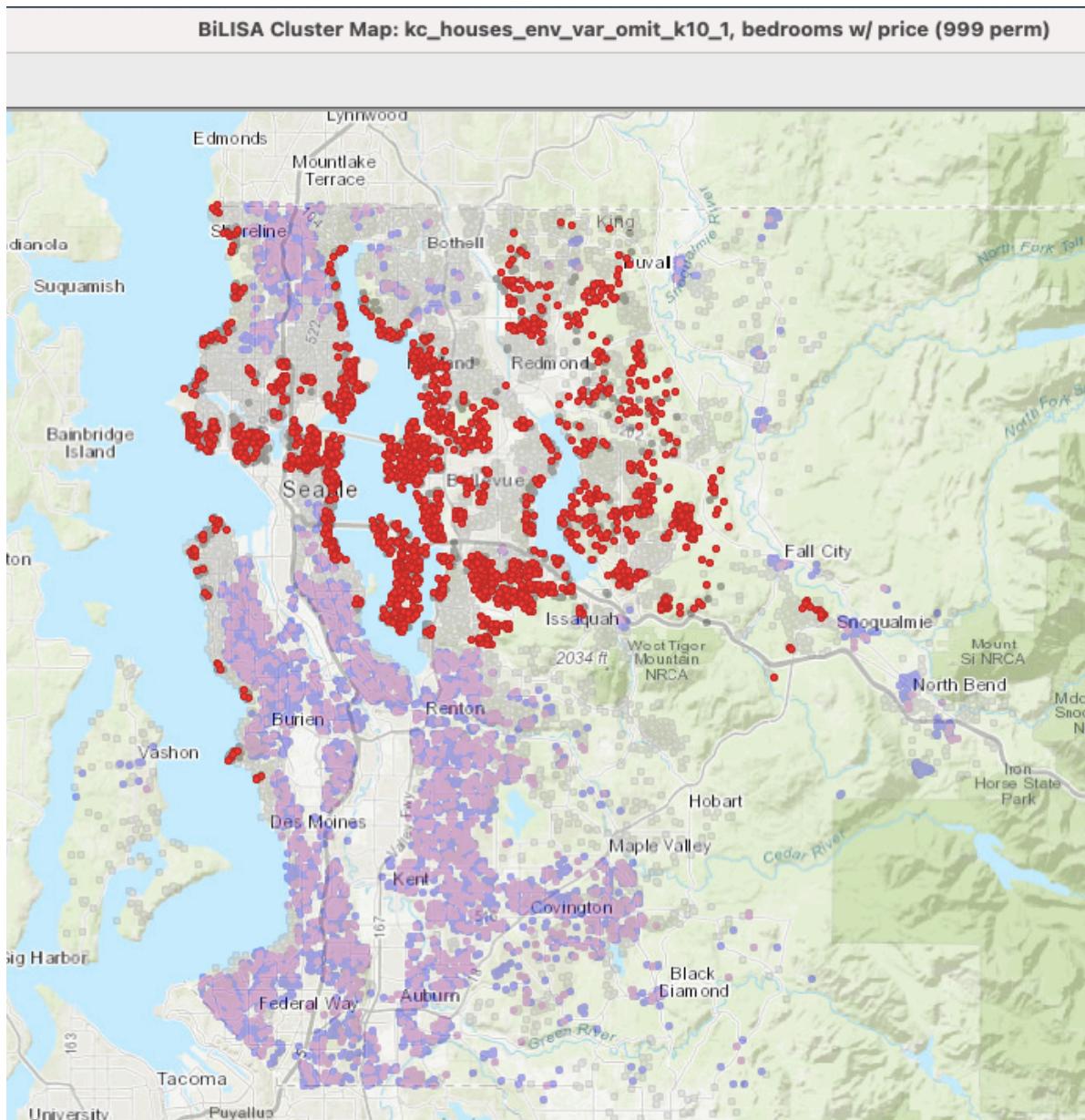


Figure 10: K10 - Store og dyre boliger

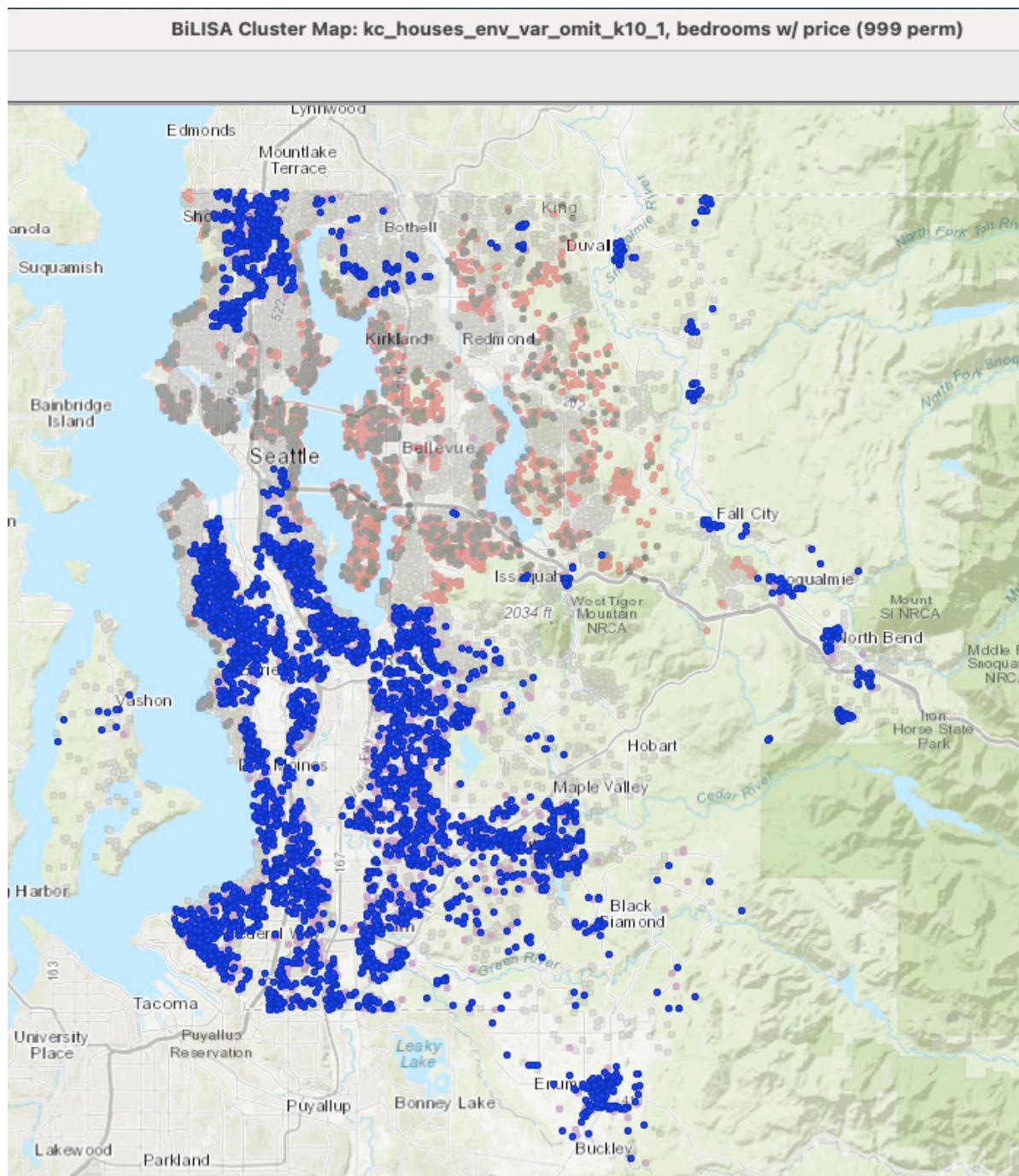


Figure 11: K10 - Små og billige boliger

BiLISA Cluster Map: kc_houses_env_var omit_k10_1, bedrooms w/ price (999 perm)

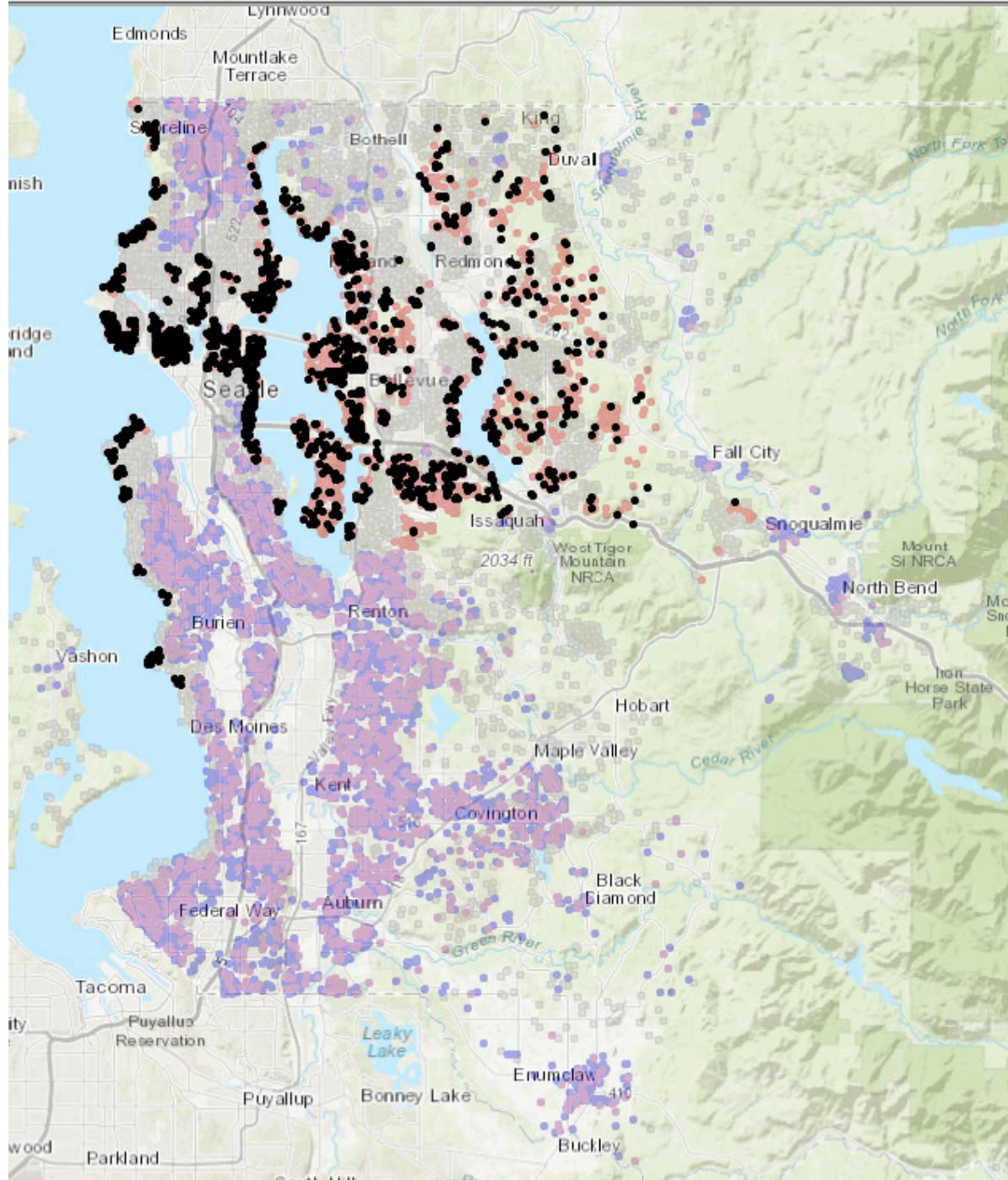


Figure 12: K10 - Små og dyre boliger

BiLISA Cluster Map: kc_houses_env_var omit_k10_1, bedrooms w/ price (999 perm)

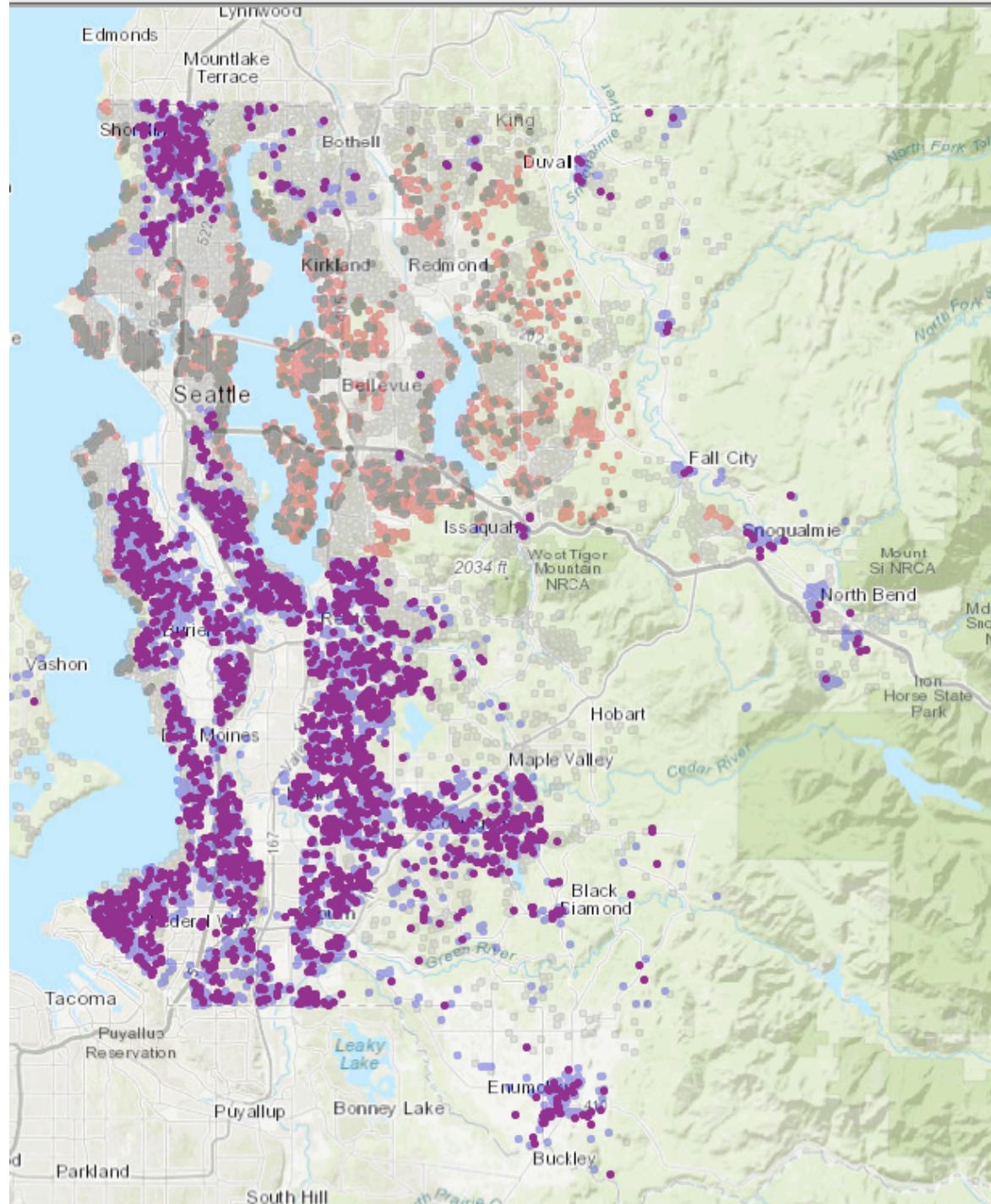


Figure 13: K10 - Store og billige boliger

Bivariate Moran's I (kc_houses_env_var_omit_k3): sqft_living and lagged price

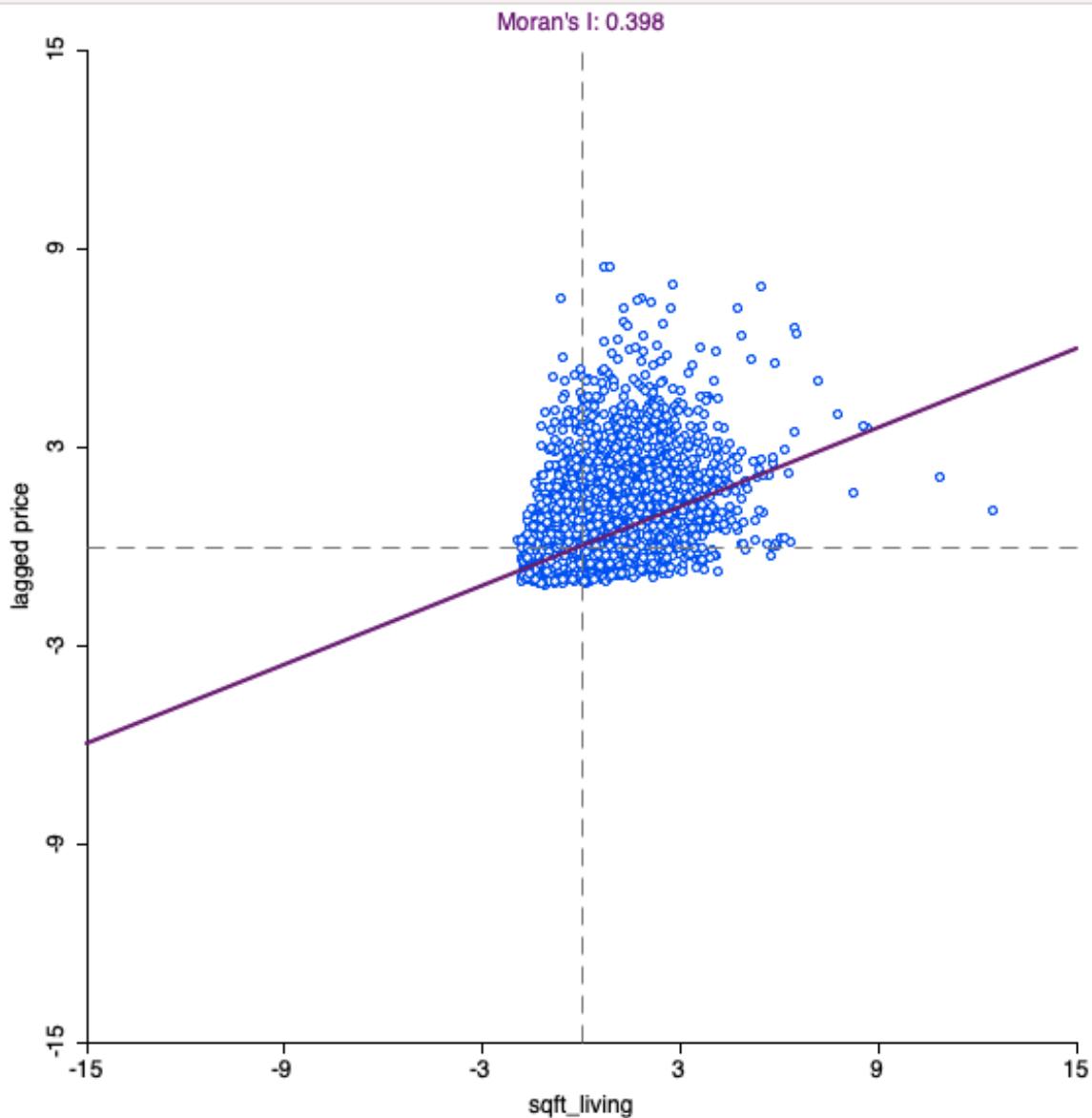


Figure 14: K3 - Bivariate Moran I

Bivariate Moran's I (kc_houses_env_var_omit_k10_1): sqft_living and lagged price

Moran's I: 0.350

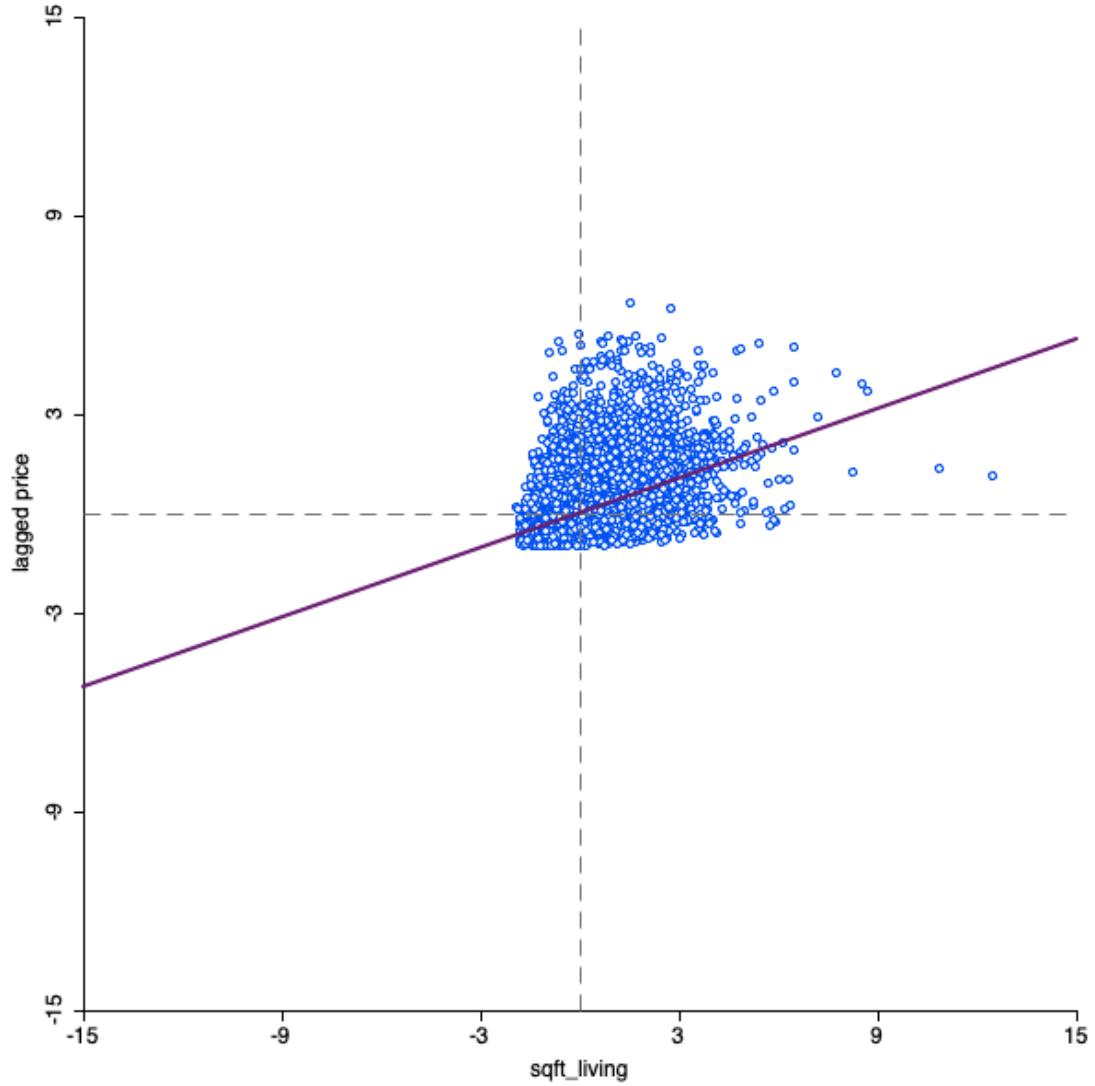


Figure 15: K10 - Bivariate Moran I

Verdier som er positive taler for klynging. 1 = perfekt klyning og 0 = perfekt tilfeldighet.

```
attach(kc_houses_env_var OMIT)
```

1. Huskarakteristika

```
mod1 <- "price ~ bedrooms + bathrooms + sqft_living + sqft_lot + sqft_above + floors + gra
```

2. Huskarakteristika + distanse til cbd + tracts_var

```
mod2 <- "price ~ bedrooms + bathrooms + sqft_living + sqft_lot + sqft_above + floors + gra
```

3. Huskarakteristika + distanse til cbd + EHD

```
mod3 <- "price ~ bedrooms + bathrooms + sqft_living + sqft_lot + sqft_above + floors + gra
```

```
hedon1 <- lm(mod1, data = kc_houses_env_var OMIT)
hedon2 <- lm(mod2, data = kc_houses_env_var OMIT)
hedon3 <- lm(mod3, data = kc_houses_env_var OMIT)
```

```
huxreg("Hedon1" = hedon1, "Hedon2" = hedon2, "Hedon3" = hedon3,
       error_format = "[{statistic}]",
       note = "{stars}. T statistic in brackets.")
```

(Kuminoff2010?) viser til at når en prisfunksjon skiftes over tiden, vil en modell som ignorerer tilfellet få resultater som er skjeve i estimatorer av helningen til prisfunksjonen, og også derfor estimatene av MWTP. Dette skjer fordi en standard DID-modellen kombinerer informasjon fra to hedoniske prisfunksjoner, altså beskrivelse av markedet før og etter tilfellet forklares i et estimat av MWTP (Bishop mfl. 2020).

Bishop forklarer videre at man kan møte på denne utfordringen ved å generalisere DID-modell ved å samhandle prisfunksjonsparametere med tidsperiode-dummy. Dette tillater en endring over tid på prisfunksjonsformen.

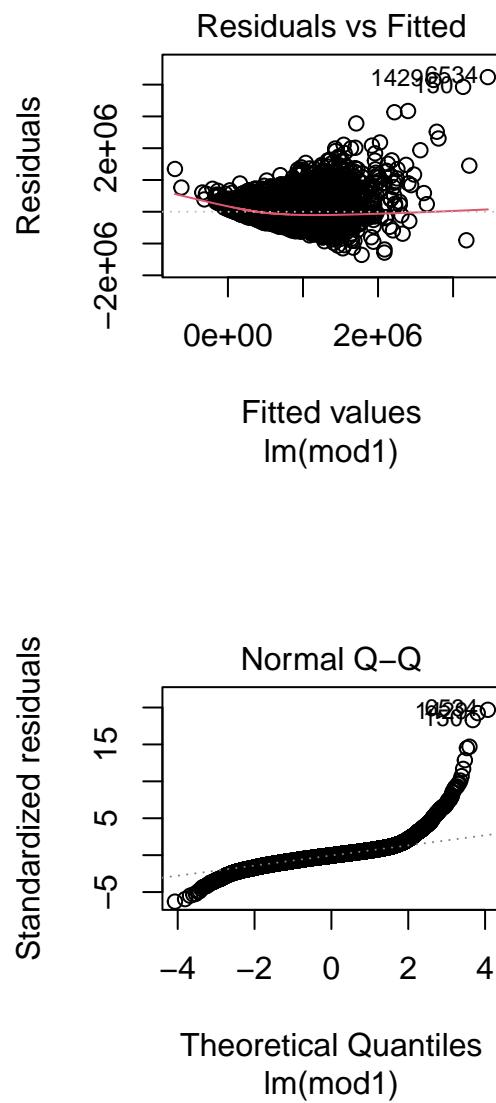
beskrivelse av huxreg

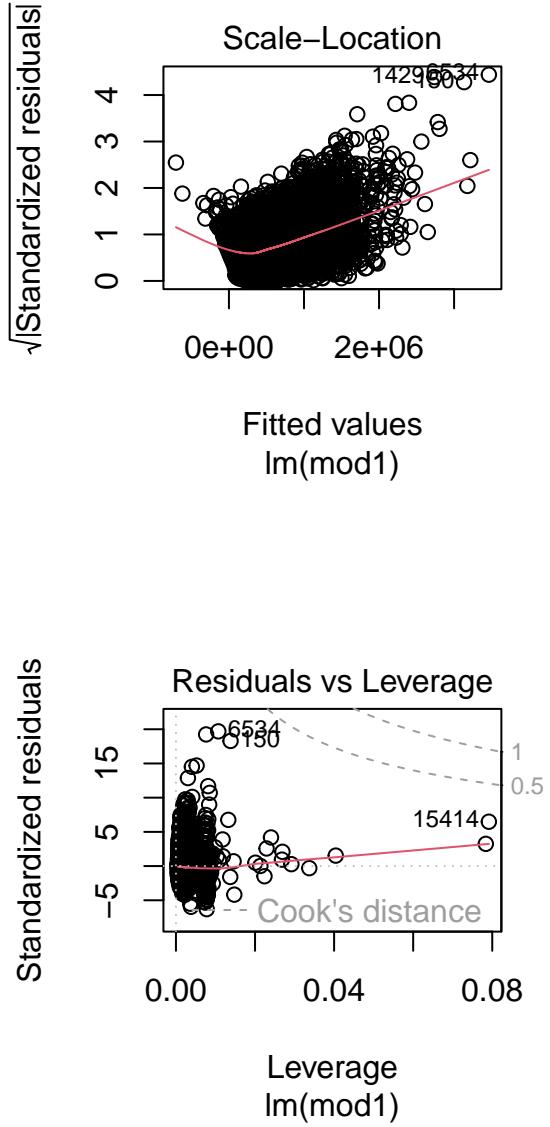
Vi kan se ut fra resultatene at forklaringskraften i mod2 er såvidt høyere enn forklaringskraften i mod3. Selvom mod2 har den sterkeste forklaringskraften så er den såpass marginal at vi velger

å gå for mod3 på grunn av færre variabler og med det lettere å arbeide med. I mod3 får vi samlet alle de miljømessige variablene i en variabel (EHD_percen).

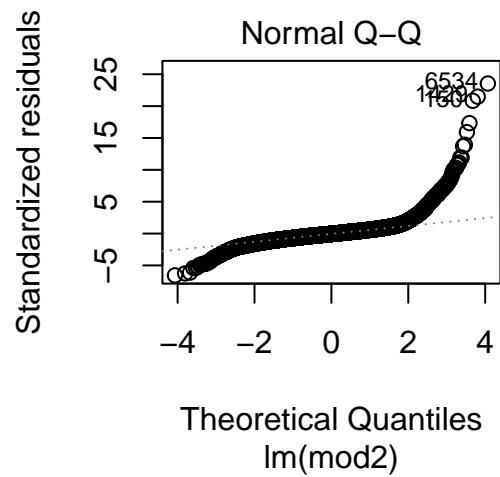
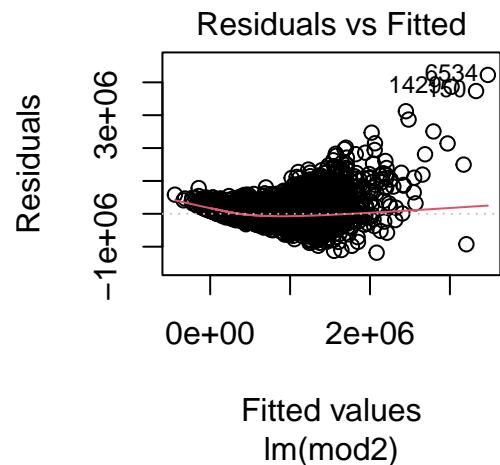
Plots

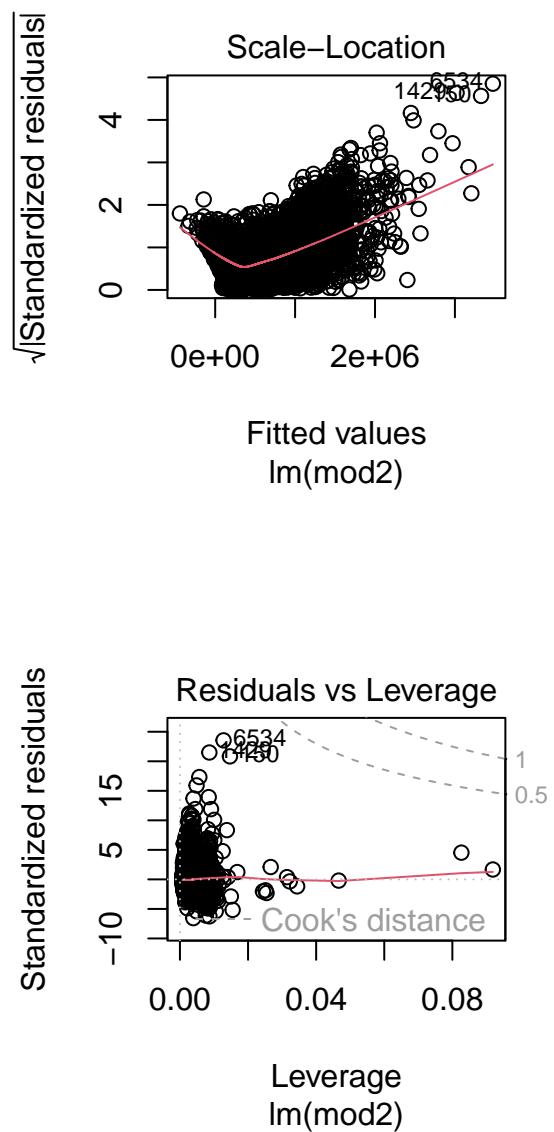
```
hedon1 %>%
  plot()
```



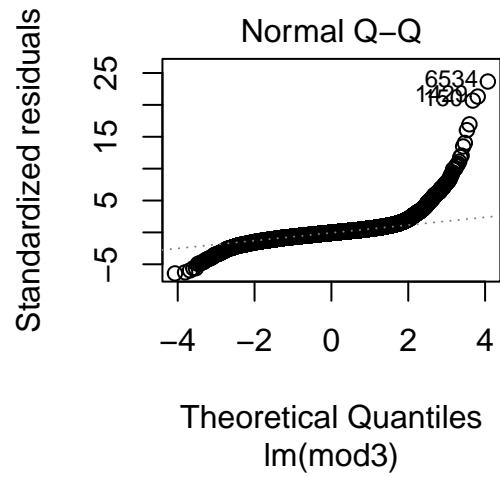
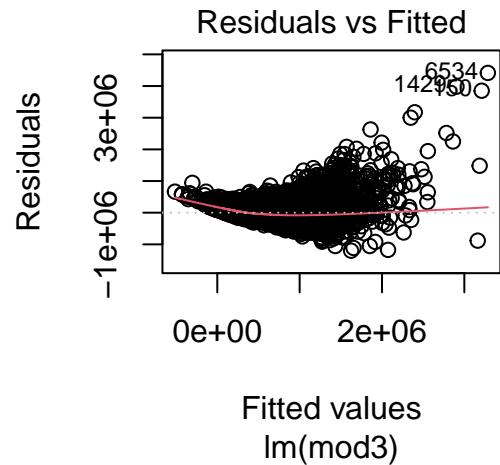


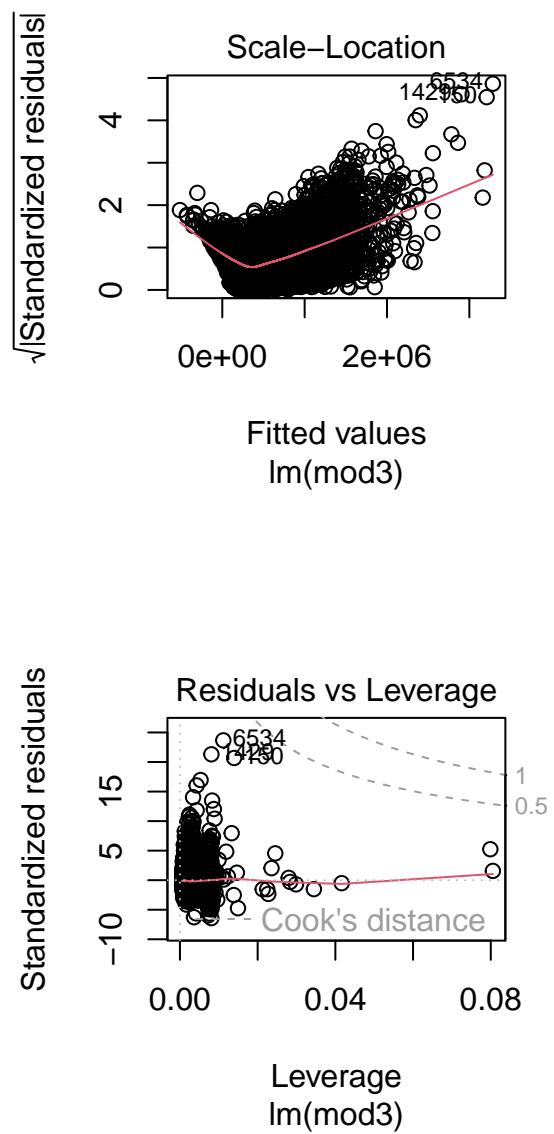
```
hedon2 %>%  
  plot()
```





```
hedon3 %>%
  plot()
```





Oppgave 7

```
hedon1 %>%
  linearHypothesis(c("year_month2014-06=0", "year_month2014-07=0",
                     "year_month2014-08=0", "year_month2014-09=0",
```

```

    "year_month2014-10=0", "year_month2014-11=0",
    "year_month2014-12=0", "year_month2015-01=0",
    "year_month2015-02=0", "year_month2015-03=0",
    "year_month2015-04=0", "year_month2015-05=0"),
white_adjust = hc3)

hedon2 %>%
  linearHypothesis(c("year_month2014-06=0", "year_month2014-07=0",
                     "year_month2014-08=0", "year_month2014-09=0",
                     "year_month2014-10=0", "year_month2014-11=0",
                     "year_month2014-12=0", "year_month2015-01=0",
                     "year_month2015-02=0", "year_month2015-03=0",
                     "year_month2015-04=0", "year_month2015-05=0"),
white_adjust = hc4)

hedon3 %>%
  linearHypothesis(c("year_month2014-06=0", "year_month2014-07=0",
                     "year_month2014-08=0", "year_month2014-09=0",
                     "year_month2014-10=0", "year_month2014-11=0",
                     "year_month2014-12=0", "year_month2015-01=0",
                     "year_month2015-02=0", "year_month2015-03=0",
                     "year_month2015-04=0", "year_month2015-05=0"),
white_adjust = hc1)

```

H_0 = Det er ikke forskjell mellom salgspris basert på salgstidspunktet.

Denne nullhypotesen kan vi forkaste på bakgrunn av signifikante F- og P-verdiene. Dette indikerer på at tidsdummyene vi bruker har en effekt, selvom de individuelt ikke er signifikante. Dette sier oss at det er forskjellige salgspriser ved forskjellige salgstidspunktet.

Oppgave 8

i.

```

kc_house_data_6666 <- here("maps/kc_house_data_6666_Sindre_og_Morten.gpkg") %>%
  st_read() %>%
  st_transform(2926)

```

Reading layer `kc_house_data_6666_Sindre_og_Morten' from data source

```

~/Users/sindreespedal/Documents/HVL /Høst 2022/MSB 204 - Bolig - R/Termpaper_msb_205_H22_S
using driver `GPKG'
Simple feature collection with 1887 features and 51 fields
Geometry type: POINT
Dimension:      XY
Bounding box:  xmin: 1226414 ymin: 72921.15 xmax: 1495965 ymax: 286273.8
Projected CRS: NAD83(HARN) / Washington North (ftUS)

```

```

kc_house_data_6666 <- kc_house_data_6666 %>%
  mutate(
    dist_cbd = st_distance(cbd, ., by_element = TRUE),
    dist_cbd_km = set_units(dist_cbd, km),
    year_month = substr(date, start = 1, stop = 7)
  )

kc_house_data_6666 <- kc_house_data_6666 %>%
  rename(low = inc_fam_low_per,
         mid = inc_fam_med_per,
         high = inc_fam_high_per)

```

ii.

```

hedon3_seed <- lm(mod3, data = kc_house_data_6666)

huxreg("Full" = hedon3, "seed" = hedon3_seed,
       error_format = "[{statistic}]",
       note = "{stars}. T statistic in brackets.")

kc_house_data_6666_mat_nb <- knearneigh(kc_house_data_6666, k = 3)
kc_house_data_6666_nb <- knn2nb(kc_house_data_6666_mat_nb)
kc_house_data_6666_W <- nb2listw(kc_house_data_6666_nb, style = "W")

kc_house_data_6666_mat_nb10 <- knearneigh(kc_house_data_6666, k = 10)
kc_house_data_6666_nb10 <- knn2nb(kc_house_data_6666_mat_nb10)
kc_house_data_6666_W10 <- nb2listw(kc_house_data_6666_nb10, style = "W")

lm.morantest(hedon3_seed, kc_house_data_6666_W)

```

```
Global Moran I for regression residuals
```

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W  
  
Moran I statistic standard deviate = 14.429, p-value < 2.2e-16  
alternative hypothesis: greater  
sample estimates:  
Observed Moran I      Expectation      Variance  
0.2493169179     -0.0031956991    0.0003062782
```

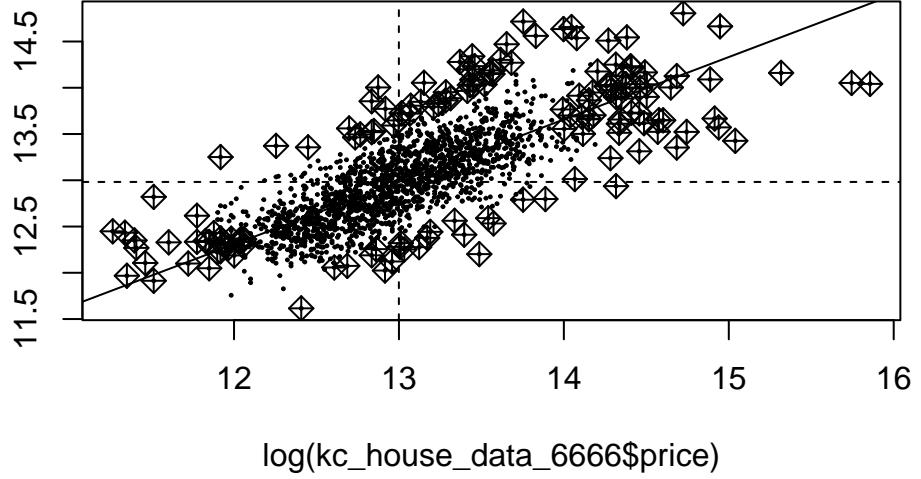
```
lm.morantest(hedon3_seed, kc_house_data_6666_W10)
```

```
Global Moran I for regression residuals
```

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W10  
  
Moran I statistic standard deviate = 23.341, p-value < 2.2e-16  
alternative hypothesis: greater  
sample estimates:  
Observed Moran I      Expectation      Variance  
2.224336e-01     -2.578743e-03    9.293224e-05
```

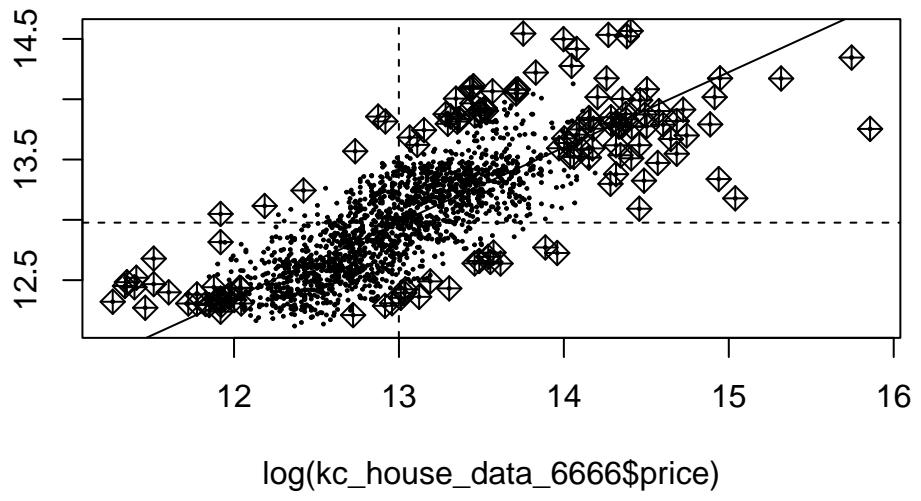
```
moran.plot(log(kc_house_data_6666$price), listw = kc_house_data_6666_W, labels = FALSE, po
```

spatially lagged log(kc_house_data_6666\$price)



```
moran.plot(log(kc_house_data_6666$price), listw = kc_house_data_6666_W10, labels = FALSE,
```

spatially lagged log(kc_house_data_6666\$price)



Ut i fra Global Morans I og plottene kan vi se at p-verdiene er signifikante som betyr vi kan forkaste $H_0 = \text{Ingen romlige effekt i residualene}$. Som betyr at vi har uforklarte spatial effects i residualene.

Vi kan se i plottene at de indikerer det samme. Vi ser at linjen har et positivt stigningstall. Dersom det ikke hadde vært noen effekt ville denne linjen vært mer vannrett ved den stippled linjen.

```
kc_lagrange_3 <- lm.LMtests(hedon3_seed, kc_house_data_6666_W,
                             test = "all")
kc_lagrange_3
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W

LMerr = 201.35, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W

LMlag = 158.33, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W

RLMerr = 58.563, df = 1, p-value = 1.965e-14
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W  
  
RLMlag = 15.537, df = 1, p-value = 8.091e-05
```

Lagrange multiplier diagnostics for spatial dependence

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W  
  
SARMA = 216.89, df = 2, p-value < 2.2e-16
```

```
kc_lagrange_10 <- lm.LMtests(hedon3_seed, kc_house_data_6666_W10,  
                               test = "all")  
kc_lagrange_10
```

Lagrange multiplier diagnostics for spatial dependence

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W10  
  
LMerr = 516.64, df = 1, p-value < 2.2e-16
```

Lagrange multiplier diagnostics for spatial dependence

```
data:  
model: lm(formula = mod3, data = kc_house_data_6666)  
weights: kc_house_data_6666_W10  
  
LMlag = 384.36, df = 1, p-value < 2.2e-16
```

Lagrange multiplier diagnostics for spatial dependence

```
data:
```

```
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W10

RLMerr = 195.48, df = 1, p-value < 2.2e-16
```

Lagrange multiplier diagnostics for spatial dependence

```
data:
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W10

RLMlag = 63.197, df = 1, p-value = 1.887e-15
```

Lagrange multiplier diagnostics for spatial dependence

```
data:
model: lm(formula = mod3, data = kc_house_data_6666)
weights: kc_house_data_6666_W10

SARMA = 579.84, df = 2, p-value < 2.2e-16
```

Står ovenfor et lokalt fenomen.

```
SDEM_seed <- errorsarlm(mod3, data = kc_house_data_6666, listw = kc_house_data_6666_W, Durbin = FALSE)
```

```
Warning in errorsarlm(mod3, data = kc_house_data_6666, listw = kc_house_data_6666_W, : inverse
reciprocal condition number = 3.55444e-22 - using numerical Hessian.
```

```
SLX_seed <- lmSLX(mod3, data = kc_house_data_6666, listw = kc_house_data_6666_W, Durbin = FALSE)
```

```
SEM_seed <- errorsarlm(mod3, data = kc_house_data_6666,
listw = kc_house_data_6666_W,
Durbin = FALSE)
```

```
Warning in errorsarlm(mod3, data = kc_house_data_6666, listw = kc_house_data_6666_W, : inverse
reciprocal condition number = 2.98752e-22 - using numerical Hessian.
```

```
summary(impacts(SDEM_seed), zstats = TRUE)
```

Impact measures (SDEM, estimable, n):

| | Direct | Indirect | Total |
|-------------------|---------------|---------------|---------------|
| bedrooms | -5.499710e+04 | -4.901160e+03 | -5.989826e+04 |
| bathrooms | 5.285257e+04 | 3.787409e+04 | 9.072666e+04 |
| sqft_living | 1.768634e+02 | 2.690962e+01 | 2.037730e+02 |
| sqft_lot | 2.596053e-01 | -1.065106e-01 | 1.530947e-01 |
| sqft_above | 1.519736e+02 | -2.785419e+01 | 1.241195e+02 |
| floors | -9.031067e+04 | 7.605223e+04 | -1.425845e+04 |
| grade | 1.495722e+04 | 2.822956e+04 | 4.318678e+04 |
| yr_built | -6.312618e+02 | -2.492492e+03 | -3.123753e+03 |
| yr_renovated | 5.825219e+00 | -4.537998e+00 | 1.287221e+00 |
| waterfront | 6.068063e+05 | 2.013749e+05 | 8.081812e+05 |
| condition | 2.929110e+04 | 3.150592e+04 | 6.079702e+04 |
| view | 6.410576e+04 | -3.681377e+04 | 2.729200e+04 |
| dist_cbd_km | -1.500263e+03 | -7.429483e+03 | -8.929746e+03 |
| EHD_percen | 3.381464e+02 | -1.685720e+03 | -1.347574e+03 |
| low | 3.285715e+03 | 2.381347e+05 | 2.414204e+05 |
| high | 5.472224e+04 | 1.967397e+05 | 2.514619e+05 |
| year_month2014-06 | 1.398950e+04 | NA | 1.398950e+04 |
| year_month2014-07 | 1.345523e+04 | NA | 1.345523e+04 |
| year_month2014-08 | 6.830114e+03 | NA | 6.830114e+03 |
| year_month2014-09 | -9.264447e+03 | NA | -9.264447e+03 |
| year_month2014-10 | 1.830891e+04 | NA | 1.830891e+04 |
| year_month2014-11 | 6.708168e+03 | NA | 6.708168e+03 |
| year_month2014-12 | -1.113140e+04 | NA | -1.113140e+04 |
| year_month2015-01 | 7.347229e+03 | NA | 7.347229e+03 |
| year_month2015-02 | -1.362163e+03 | NA | -1.362163e+03 |
| year_month2015-03 | 2.792870e+04 | NA | 2.792870e+04 |
| year_month2015-04 | 4.870156e+04 | NA | 4.870156e+04 |
| year_month2015-05 | 8.821624e+03 | NA | 8.821624e+03 |

=====

Standard errors:

| | Direct | Indirect | Total |
|-------------|--------------|--------------|--------------|
| bedrooms | 6.729454e+03 | 1.268870e+04 | 1.580682e+04 |
| bathrooms | 1.123226e+04 | 2.174456e+04 | 2.736907e+04 |
| sqft_living | 1.552549e+01 | 2.977009e+01 | 3.726593e+01 |
| sqft_lot | 9.997138e-02 | 1.777446e-01 | 2.048172e-01 |
| sqft_above | 1.547574e+01 | 2.951845e+01 | 3.661721e+01 |
| floors | 1.256966e+04 | 2.178506e+04 | 2.596963e+04 |
| grade | 7.415280e+03 | 1.368050e+04 | 1.638300e+04 |

| | | | |
|-------------------|--------------|--------------|-----------------|
| yr_built | 2.628897e+02 | 4.397516e+02 | 5.037085e+02 |
| yr_renovated | 1.306494e+01 | 2.534776e+01 | 3.198411e+01 |
| waterfront | 7.008149e+04 | 1.673386e+05 | 2.023185e+05 |
| condition | 7.901669e+03 | 1.528025e+04 | 1.909289e+04 |
| view | 7.159577e+03 | 1.321062e+04 | 1.544535e+04 |
| dist_cbd_km | 4.798613e+03 | 4.979985e+03 | 1.010028e+03 |
| EHD_percen | 6.419941e+02 | 7.246967e+02 | 4.280279e+02 |
| low | 1.410026e+05 | 1.780698e+05 | 1.435120e+05 |
| high | 9.820909e+04 | 1.248818e+05 | 1.022919e+05 |
| year_month2014-06 | 2.161892e+04 | | NA 2.161892e+04 |
| year_month2014-07 | 2.178440e+04 | | NA 2.178440e+04 |
| year_month2014-08 | 2.170979e+04 | | NA 2.170979e+04 |
| year_month2014-09 | 2.215994e+04 | | NA 2.215994e+04 |
| year_month2014-10 | 2.270132e+04 | | NA 2.270132e+04 |
| year_month2014-11 | 2.352435e+04 | | NA 2.352435e+04 |
| year_month2014-12 | 2.309511e+04 | | NA 2.309511e+04 |
| year_month2015-01 | 2.662155e+04 | | NA 2.662155e+04 |
| year_month2015-02 | 2.438627e+04 | | NA 2.438627e+04 |
| year_month2015-03 | 2.163065e+04 | | NA 2.163065e+04 |
| year_month2015-04 | 2.142501e+04 | | NA 2.142501e+04 |
| year_month2015-05 | 2.991329e+04 | | NA 2.991329e+04 |

Z-values:

| | Direct | Indirect | Total |
|-------------------|-------------|------------|---------------|
| bedrooms | -8.17259407 | -0.3862618 | -3.78939394 |
| bathrooms | 4.70542667 | 1.7417735 | 3.31493425 |
| sqft_living | 11.39180803 | 0.9039148 | 5.46807790 |
| sqft_lot | 2.59679594 | -0.5992336 | 0.74747001 |
| sqft_above | 9.82012284 | -0.9436200 | 3.38964798 |
| floors | -7.18481396 | 3.4910273 | -0.54904312 |
| grade | 2.01708067 | 2.0634886 | 2.63607280 |
| yr_built | -2.40124161 | -5.6679538 | -6.20151051 |
| yr_renovated | 0.44586639 | -0.1790295 | 0.04024564 |
| waterfront | 8.65858222 | 1.2033977 | 3.99459849 |
| condition | 3.70695155 | 2.0618718 | 3.18427474 |
| view | 8.95384811 | -2.7866804 | 1.76700385 |
| dist_cbd_km | -0.31264524 | -1.4918686 | -8.84109072 |
| EHD_percen | 0.52671262 | -2.3261044 | -3.14833177 |
| low | 0.02330252 | 1.3373115 | 1.68223180 |
| high | 0.55720137 | 1.5754063 | 2.45827818 |
| year_month2014-06 | 0.64709529 | | NA 0.64709529 |
| year_month2014-07 | 0.61765439 | | NA 0.61765439 |
| year_month2014-08 | 0.31460980 | | NA 0.31460980 |

| | | | |
|-------------------|-------------|----|-------------|
| year_month2014-09 | -0.41807190 | NA | -0.41807190 |
| year_month2014-10 | 0.80651331 | NA | 0.80651331 |
| year_month2014-11 | 0.28515843 | NA | 0.28515843 |
| year_month2014-12 | -0.48198069 | NA | -0.48198069 |
| year_month2015-01 | 0.27598803 | NA | 0.27598803 |
| year_month2015-02 | -0.05585779 | NA | -0.05585779 |
| year_month2015-03 | 1.29116344 | NA | 1.29116344 |
| year_month2015-04 | 2.27311699 | NA | 2.27311699 |
| year_month2015-05 | 0.29490656 | NA | 0.29490656 |

p-values:

| | Direct | Indirect | Total |
|-------------------|------------|------------|------------|
| bedrooms | 2.2204e-16 | 0.69930282 | 0.00015102 |
| bathrooms | 2.5334e-06 | 0.08154809 | 0.00091665 |
| sqft_living | < 2.22e-16 | 0.36604057 | 4.5494e-08 |
| sqft_lot | 0.00940978 | 0.54901709 | 0.45477990 |
| sqft_above | < 2.22e-16 | 0.34536388 | 0.00069982 |
| floors | 6.7302e-13 | 0.00048117 | 0.58297586 |
| grade | 0.04368710 | 0.03906623 | 0.00838717 |
| yr_built | 0.01633954 | 1.4451e-08 | 5.5924e-10 |
| yr_renovated | 0.65569376 | 0.85791452 | 0.96789729 |
| waterfront | < 2.22e-16 | 0.22882247 | 6.4804e-05 |
| condition | 0.00020977 | 0.03921995 | 0.00145117 |
| view | < 2.22e-16 | 0.00532510 | 0.07722758 |
| dist_cbd_km | 0.75455020 | 0.13573360 | < 2.22e-16 |
| EHD_percen | 0.59839317 | 0.02001298 | 0.00164205 |
| low | 0.98140896 | 0.18112098 | 0.09252390 |
| high | 0.57738985 | 0.11516269 | 0.01396050 |
| year_month2014-06 | 0.51757028 | NA | 0.51757028 |
| year_month2014-07 | 0.53680318 | NA | 0.53680318 |
| year_month2014-08 | 0.75305794 | NA | 0.75305794 |
| year_month2014-09 | 0.67589455 | NA | 0.67589455 |
| year_month2014-10 | 0.41994694 | NA | 0.41994694 |
| year_month2014-11 | 0.77552277 | NA | 0.77552277 |
| year_month2014-12 | 0.62981967 | NA | 0.62981967 |
| year_month2015-01 | 0.78255726 | NA | 0.78255726 |
| year_month2015-02 | 0.95545510 | NA | 0.95545510 |
| year_month2015-03 | 0.19664701 | NA | 0.19664701 |
| year_month2015-04 | 0.02301913 | NA | 0.02301913 |
| year_month2015-05 | 0.76806526 | NA | 0.76806526 |

```
huxreg("SEM" = SEM_seed, "OLS" = hedon3_seed,  
       error_format = "[{statistic}]",  
       note = "{stars}. T statistic in brackets.")
```

```
LR.Sarlm(SDEM_seed, SEM_seed)
```

Likelihood ratio for spatial linear models

```
data:  
Likelihood ratio = 95.981, df = 16, p-value = 1.952e-13  
sample estimates:  
Log likelihood of SDEM_seed Log likelihood of SEM_seed  
-25696.93 -25744.92
```

```
LR.Sarlm(SDEM_seed, SLX_seed)
```

Likelihood ratio for spatial linear models

```
data:  
Likelihood ratio = 157.78, df = 1, p-value < 2.2e-16  
sample estimates:  
Log likelihood of SDEM_seed Log likelihood of SLX_seed  
-25696.93 -25775.82
```

```
LR1.Sarlm(SDEM_seed)
```

Likelihood Ratio diagnostics for spatial dependence

```
data:  
Likelihood ratio = 157.78, df = 1, p-value < 2.2e-16  
sample estimates:  
Log likelihood of spatial error model Log likelihood of OLS fit y  
-25696.93 -25775.82
```

```
Hausman.test(SEM_seed)
```

```
Spatial Hausman test (asymptotic)
```

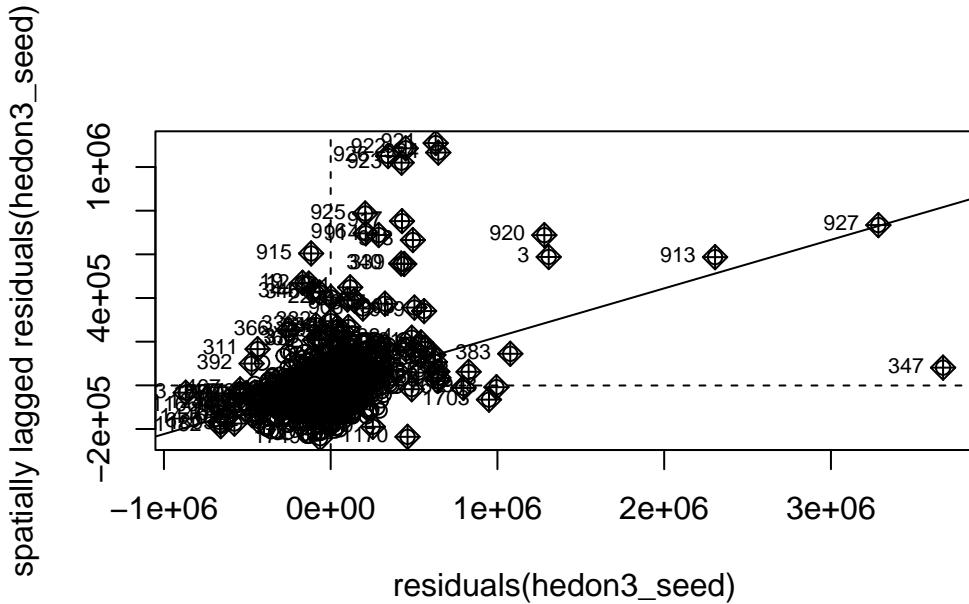
```
data: NULL  
Hausman test = 91.271, df = 29, p-value = 2.317e-08
```

```
bptest.Sarlm(SEM_seed, studentize = TRUE)
```

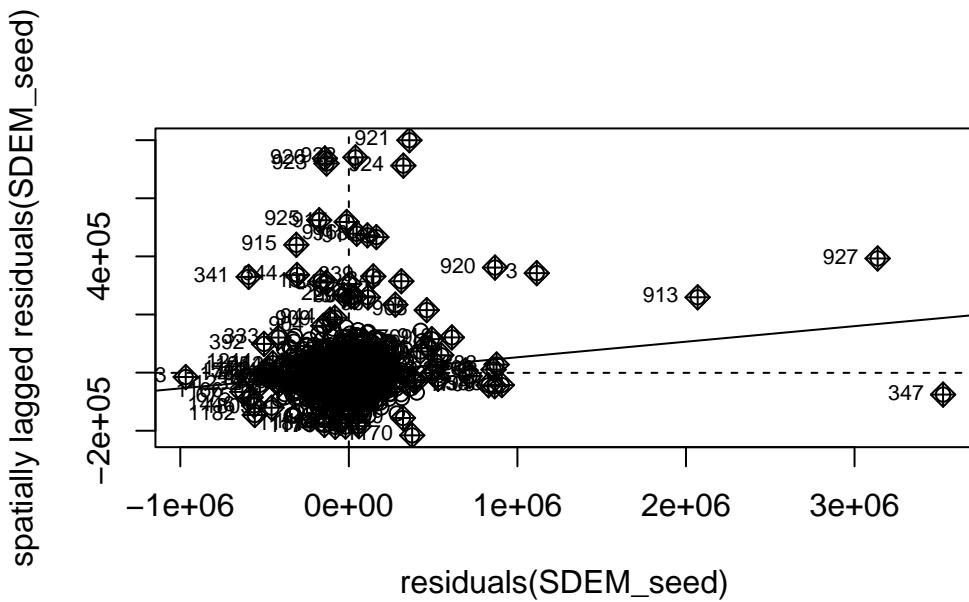
```
studentized Breusch-Pagan test
```

```
data:  
BP = 472.28, df = 28, p-value < 2.2e-16
```

```
moran.plot(residuals(hedon3_seed), listw = kc_house_data_6666_W10)
```



```
moran.plot(residuals(SDEM_seed), listw = kc_house_data_6666_W10)
```



```
moran.test(residuals(SDEM_seed), listw = kc_house_data_6666_W10)
```

Moran I test under randomisation

```
data: residuals(SDEM_seed)  
weights: kc_house_data_6666_W10
```

```
Moran I statistic standard deviate = 5.6986, p-value = 6.04e-09
alternative hypothesis: greater
sample estimates:
Moran I statistic      Expectation      Variance
      5.358418e-02    -5.302227e-04    9.017628e-05
```

Oppgave 9

```
set.seed(442)
kc_houses_env_var OMIT_2000 <- kc_houses_env_var OMIT[sample(1:nrow(
    kc_houses_env_var OMIT), 2000, replace = FALSE), ]
```

```

hedon3_2000 <- lm(mod3, data = kc_houses_env_var OMIT_2000)

huxreg("Full" = hedon3, "2000 Seed" = hedon3_2000, "666 Seed" = hedon3_seed,
       error_format = "[{statistic}]",
       note = "{stars}. T statistic in brackets.")

kc_house_data_2000_mat_nb <- knearneigh(kc_houses_env_var OMIT_2000, k = 3)

```

Warning in knearneigh(kc_houses_env_var OMIT_2000, k = 3): knearneigh: identical points found

Warning in knearneigh(kc_houses_env_var OMIT_2000, k = 3): knearneigh: kd_tree not available for identical points

```

kc_house_data_2000_nb <- knn2nb(kc_house_data_2000_mat_nb)
kc_house_data_2000_W <- nb2listw(kc_house_data_2000_nb, style = "W")
kc_house_data_2000_mat_nb10 <- knearneigh(kc_houses_env_var OMIT_2000, k = 10)

```

Warning in knearneigh(kc_houses_env_var OMIT_2000, k = 10): knearneigh: identical points found

Warning in knearneigh(kc_houses_env_var OMIT_2000, k = 10): knearneigh: kd_tree not available for identical points

```

kc_house_data_2000_nb10 <- knn2nb(kc_house_data_2000_mat_nb10)
kc_house_data_2000_W10 <- nb2listw(kc_house_data_2000_nb10, style = "W")

```

```
lm.morantest(hedon3_2000, kc_house_data_2000_W)
```

Global Moran I for regression residuals

```

data:
model: lm(formula = mod3, data = kc_houses_env_var OMIT_2000)
weights: kc_house_data_2000_W

```

```

Moran I statistic standard deviate = 19.702, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Observed Moran I      Expectation      Variance
0.3293899740     -0.0029972881    0.0002846206

```

```
lm.morantest(hedon3_2000, kc_house_data_2000_W10)
```

```

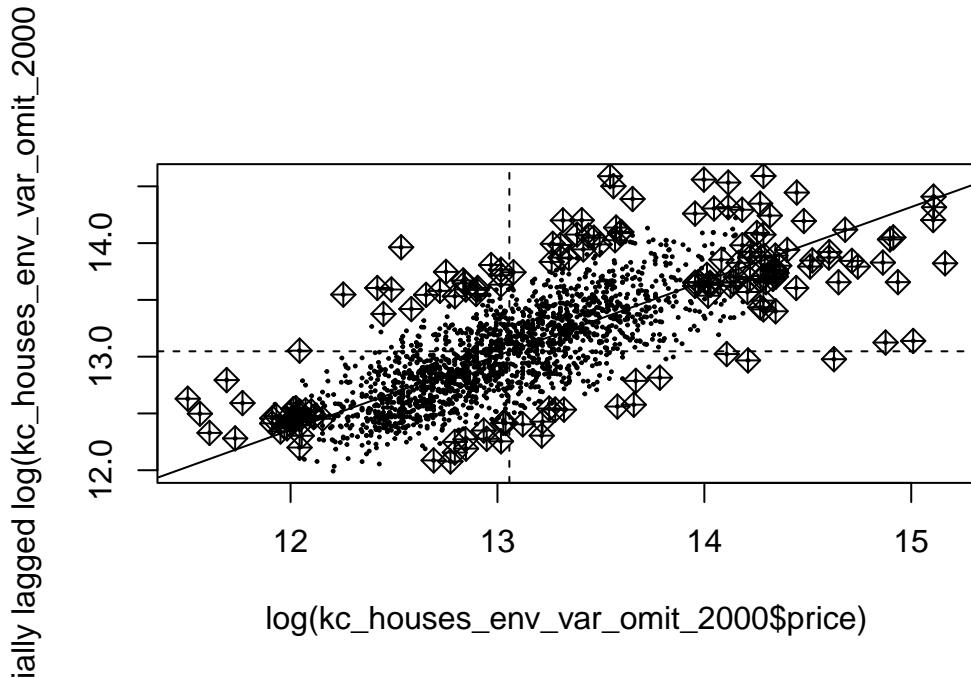
Global Moran I for regression residuals

data:
model: lm(formula = mod3, data = kc_houses_env_var OMIT_2000)
weights: kc_house_data_2000_W10

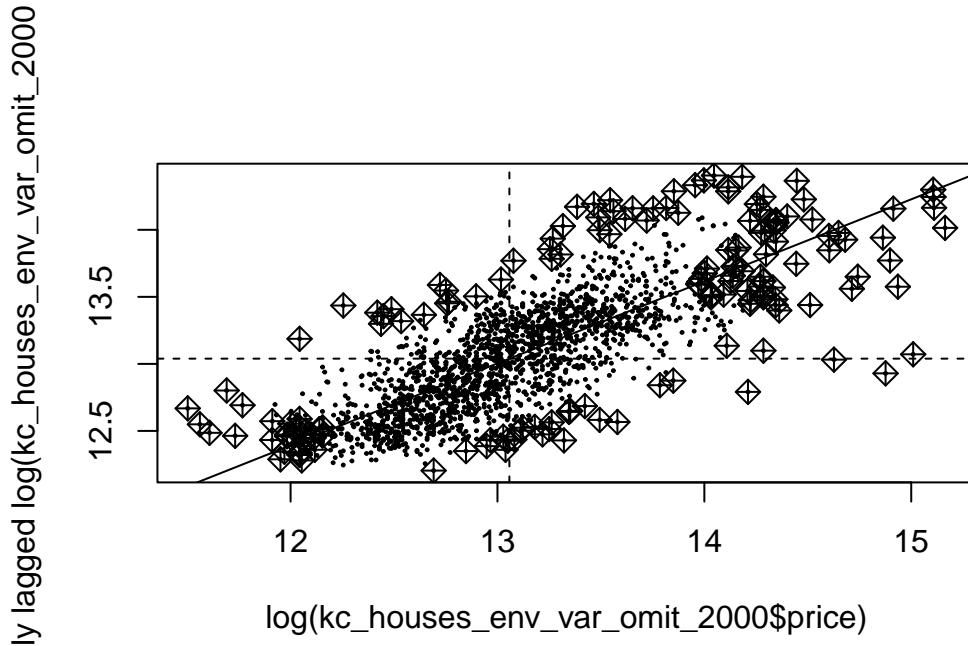
Moran I statistic standard deviate = 31.769, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Observed Moran I      Expectation      Variance
2.944919e-01     -2.498222e-03    8.739112e-05

```

```
moran.plot(log(kc_houses_env_var OMIT_2000$price), listw = kc_house_data_2000_W, labels =
```



```
moran.plot(log(kc_houses_env_var OMIT_2000$price), listw = kc_house_data_2000_W10, labels
```



```
kc_lagrange_3_2000 <- lm.LMtests(hedon3_2000, kc_house_data_2000_W,  
test = "all")  
kc_lagrange_3_2000
```

Lagrange multiplier diagnostics for spatial dependence

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var OMIT_2000)  
weights: kc_house_data_2000_W  
  
LMerr = 378.11, df = 1, p-value < 2.2e-16
```

Lagrange multiplier diagnostics for spatial dependence

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var OMIT_2000)  
weights: kc_house_data_2000_W
```

```
LMlag = 286.6, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W
```

```
RLMerr = 117.34, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W
```

```
RLMlag = 25.831, df = 1, p-value = 3.727e-07
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W
```

```
SARMA = 403.94, df = 2, p-value < 2.2e-16
```

```
kc_lagrange_10_2000 <- lm.LMtests(hedon3_2000, kc_house_data_2000_W10,  
                                     test = "all")  
kc_lagrange_10_2000
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W10
```

```
LMerr = 962.92, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W10
```

```
LMlag = 637.61, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W10
```

```
RLMerr = 414.65, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W10
```

```
RLMlag = 89.343, df = 1, p-value < 2.2e-16
```

```
Lagrange multiplier diagnostics for spatial dependence
```

```
data:  
model: lm(formula = mod3, data = kc_houses_env_var_omit_2000)  
weights: kc_house_data_2000_W10
```

```
SARMA = 1052.3, df = 2, p-value < 2.2e-16
```

```
SDEM_2000 <- errorsarlm(mod3, data = kc_houses_env_var_omit_2000, listw = kc_house_data_2000_W10  
                           Durbin = TRUE)
```

```
Warning in errorsarlm(mod3, data = kc_houses_env_var_omit_2000, listw = kc_house_data_2000_W10  
                           Durbin = TRUE):
```

```
reciprocal condition number = 6.28505e-22 - using numerical Hessian.
```

```
SLX_2000 <- lmSLX(mod3, data = kc_houses_env_var_omit_2000, listw = kc_house_data_2000_W,  
SEM_2000 <- errorsarlm(mod3, data = kc_houses_env_var_omit_2000, listw = kc_house_data_2000_W)
```

```
Warning in errorsarlm(mod3, data = kc_houses_env_var_omit_2000, listw = kc_house_data_2000_W  
reciprocal condition number = 5.33723e-22 - using numerical Hessian.
```

```
summary(impacts(SDEM_2000), zstats = TRUE)
```

Impact measures (SDEM, estimable, n):

| | Direct | Indirect | Total |
|-------------------|---------------|---------------|---------------|
| bedrooms | -3.059294e+04 | -2.010508e+04 | -5.069802e+04 |
| bathrooms | 3.476267e+04 | 1.461957e+02 | 3.490887e+04 |
| sqft_living | 1.254746e+02 | 6.001658e+01 | 1.854912e+02 |
| sqft_lot | 4.180504e-02 | -2.380269e-01 | -1.962219e-01 |
| sqft_above | 7.482344e+01 | -2.949924e+01 | 4.532419e+01 |
| floors | -5.687414e+04 | 1.357477e+04 | -4.329936e+04 |
| grade | 6.856663e+04 | 1.386057e+04 | 8.242720e+04 |
| yr_built | -4.807975e+02 | -5.367050e+02 | -1.017502e+03 |
| yr_renovated | 3.412060e+01 | 4.615105e+01 | 8.027166e+01 |
| waterfront | 6.813000e+05 | -1.554497e+05 | 5.258503e+05 |
| condition | 4.022494e+04 | 1.796266e+04 | 5.818759e+04 |
| view | 4.680992e+04 | -5.981352e+03 | 4.082856e+04 |
| dist_cbd_km | 1.100249e+04 | -2.009481e+04 | -9.092315e+03 |
| EHD_percen | -8.176400e+02 | 3.349964e+02 | -4.826436e+02 |
| low | 1.170380e+05 | 1.924335e+05 | 3.094715e+05 |
| high | 5.312959e+04 | 3.924290e+05 | 4.455586e+05 |
| year_month2014-06 | 2.037586e+04 | -1.555634e+03 | 1.882023e+04 |
| year_month2014-07 | 1.887931e+04 | 4.164023e+04 | 6.051954e+04 |
| year_month2014-08 | 1.902034e+04 | 2.094881e+04 | 3.996915e+04 |
| year_month2014-09 | 2.516814e+04 | 3.471477e+04 | 5.988291e+04 |
| year_month2014-10 | 3.423044e+04 | -2.405238e+04 | 1.017806e+04 |
| year_month2014-11 | 4.267269e+03 | 2.938472e+01 | 4.296653e+03 |
| year_month2014-12 | 2.260634e+04 | 1.875459e+04 | 4.136092e+04 |
| year_month2015-01 | 2.972134e+03 | -3.304853e+04 | -3.007639e+04 |
| year_month2015-02 | 5.291035e+04 | 4.213413e+04 | 9.504448e+04 |
| year_month2015-03 | 4.358439e+04 | -1.263931e+04 | 3.094508e+04 |

| | | | |
|-------------------|--------------|--------------|--------------|
| year_month2015-04 | 5.153377e+04 | 1.969835e+04 | 7.123212e+04 |
| year_month2015-05 | 9.842275e+04 | 8.246681e+04 | 1.808896e+05 |

Standard errors:

| | Direct | Indirect | Total |
|-------------------|--------------|--------------|--------------|
| bedrooms | 5.556456e+03 | 1.143437e+04 | 1.460055e+04 |
| bathrooms | 8.992679e+03 | 1.806296e+04 | 2.323258e+04 |
| sqft_living | 1.250160e+01 | 2.620794e+01 | 3.311206e+01 |
| sqft_lot | 1.004654e-01 | 2.102977e-01 | 2.495483e-01 |
| sqft_above | 1.227179e+01 | 2.480608e+01 | 3.095430e+01 |
| floors | 1.006009e+04 | 1.893008e+04 | 2.339106e+04 |
| grade | 5.949755e+03 | 1.130815e+04 | 1.401324e+04 |
| yr_built | 2.172641e+02 | 3.913989e+02 | 4.761497e+02 |
| yr_renovated | 1.048846e+01 | 2.211291e+01 | 2.808148e+01 |
| waterfront | 5.600521e+04 | 1.103948e+05 | 1.377824e+05 |
| condition | 6.557381e+03 | 1.310083e+04 | 1.659023e+04 |
| view | 5.952645e+03 | 1.152817e+04 | 1.392313e+04 |
| dist_cbd_km | 4.914460e+03 | 5.105604e+03 | 9.497499e+02 |
| EHD_percen | 4.886161e+02 | 5.819310e+02 | 4.101848e+02 |
| low | 1.202562e+05 | 1.682793e+05 | 1.580010e+05 |
| high | 8.434012e+04 | 1.103469e+05 | 9.444213e+04 |
| year_month2014-06 | 1.807961e+04 | 3.694836e+04 | 4.752226e+04 |
| year_month2014-07 | 1.869271e+04 | 3.835366e+04 | 4.922562e+04 |
| year_month2014-08 | 1.924128e+04 | 3.919310e+04 | 5.073045e+04 |
| year_month2014-09 | 1.927993e+04 | 3.985753e+04 | 5.158039e+04 |
| year_month2014-10 | 1.896609e+04 | 3.895057e+04 | 4.981351e+04 |
| year_month2014-11 | 2.116770e+04 | 4.360507e+04 | 5.606011e+04 |
| year_month2014-12 | 1.981960e+04 | 4.071989e+04 | 5.168408e+04 |
| year_month2015-01 | 2.364917e+04 | 4.909245e+04 | 6.267412e+04 |
| year_month2015-02 | 2.146927e+04 | 4.303710e+04 | 5.582607e+04 |
| year_month2015-03 | 1.913231e+04 | 3.858209e+04 | 4.992693e+04 |
| year_month2015-04 | 1.835127e+04 | 3.697253e+04 | 4.777909e+04 |
| year_month2015-05 | 2.469923e+04 | 5.125562e+04 | 6.583378e+04 |

Z-values:

| | Direct | Indirect | Total |
|-------------|------------|---------------|-------------|
| bedrooms | -5.5058376 | -1.7583031057 | -3.47233755 |
| bathrooms | 3.8656636 | 0.0080936739 | 1.50258224 |
| sqft_living | 10.0366845 | 2.2900146826 | 5.60192196 |
| sqft_lot | 0.4161138 | -1.1318570080 | -0.78630834 |
| sqft_above | 6.0971882 | -1.1891939824 | 1.46422924 |
| floors | -5.6534394 | 0.7171005409 | -1.85110719 |
| grade | 11.5242782 | 1.2257146566 | 5.88209293 |

| | | | |
|-------------------|------------|---------------|-------------|
| yr_built | -2.2129638 | -1.3712478633 | -2.13693817 |
| yr_renovated | 3.2531565 | 2.0870642524 | 2.85852673 |
| waterfront | 12.1649407 | -1.4081248523 | 3.81652633 |
| condition | 6.1342988 | 1.3711084405 | 3.50734164 |
| view | 7.8637177 | -0.5188465410 | 2.93242714 |
| dist_cbd_km | 2.2388001 | -3.9358334410 | -9.57337878 |
| EHD_percen | -1.6733793 | 0.5756634028 | -1.17664931 |
| low | 0.9732387 | 1.1435364496 | 1.95866751 |
| high | 0.6299444 | 3.5563202044 | 4.71779503 |
| year_month2014-06 | 1.1270080 | -0.0421029313 | 0.39602976 |
| year_month2014-07 | 1.0099823 | 1.0856911691 | 1.22943159 |
| year_month2014-08 | 0.9885173 | 0.5345025942 | 0.78787299 |
| year_month2014-09 | 1.3054066 | 0.8709713304 | 1.16096276 |
| year_month2014-10 | 1.8048227 | -0.6175103449 | 0.20432319 |
| year_month2014-11 | 0.2015934 | 0.0006738832 | 0.07664368 |
| year_month2014-12 | 1.1406052 | 0.4605756461 | 0.80026427 |
| year_month2015-01 | 0.1256760 | -0.6731896854 | -0.47988539 |
| year_month2015-02 | 2.4644686 | 0.9790188822 | 1.70251080 |
| year_month2015-03 | 2.2780513 | -0.3275951612 | 0.61980748 |
| year_month2015-04 | 2.8081850 | 0.5327834043 | 1.49086380 |
| year_month2015-05 | 3.9848508 | 1.6089318807 | 2.74767097 |

p-values:

| | Direct | Indirect | Total |
|-------------------|------------|------------|------------|
| bedrooms | 3.6742e-08 | 0.07869595 | 0.00051595 |
| bathrooms | 0.00011079 | 0.99354225 | 0.13294681 |
| sqft_living | < 2.22e-16 | 0.02202047 | 2.1199e-08 |
| sqft_lot | 0.67732676 | 0.25769456 | 0.43168687 |
| sqft_above | 1.0795e-09 | 0.23436334 | 0.14313132 |
| floors | 1.5727e-08 | 0.47331206 | 0.06415413 |
| grade | < 2.22e-16 | 0.22030607 | 4.0511e-09 |
| yr_built | 0.02690014 | 0.17029770 | 0.03260302 |
| yr_renovated | 0.00114131 | 0.03688233 | 0.00425613 |
| waterfront | < 2.22e-16 | 0.15909410 | 0.00013534 |
| condition | 8.5536e-10 | 0.17034115 | 0.00045261 |
| view | 3.7748e-15 | 0.60386776 | 0.00336324 |
| dist_cbd_km | 0.02516892 | 8.2908e-05 | < 2.22e-16 |
| EHD_percen | 0.09425265 | 0.56484272 | 0.23933551 |
| low | 0.33043467 | 0.25281593 | 0.05015174 |
| high | 0.52873093 | 0.00037609 | 2.3841e-06 |
| year_month2014-06 | 0.25973912 | 0.96641664 | 0.69208307 |
| year_month2014-07 | 0.31250377 | 0.27761565 | 0.21891003 |
| year_month2014-08 | 0.32289938 | 0.59299386 | 0.43077100 |

```
year_month2014-09 0.19175444 0.38376981 0.24565704  
year_month2014-10 0.07110244 0.53689816 0.83810095  
year_month2014-11 0.84023458 0.99946232 0.93890701  
year_month2014-12 0.25403424 0.64510309 0.42355770  
year_month2015-01 0.89998837 0.50082662 0.63130889  
year_month2015-02 0.01372166 0.32757065 0.08865966  
year_month2015-03 0.02272352 0.74321778 0.53538454  
year_month2015-04 0.00498216 0.59418352 0.13599726  
year_month2015-05 6.7523e-05 0.10763124 0.00600202
```

```
huxreg("SEM" = SEM_2000, "OLS" = hedon3_2000,  
       error_format = "[{statistic}]",  
       note = "{stars}. T statistic in brackets.")  
  
LR.Sarlm(SDEM_2000, SEM_2000)
```

```
Likelihood ratio for spatial linear models  
  
data:  
Likelihood ratio = 90.376, df = 28, p-value = 1.732e-08  
sample estimates:  
Log likelihood of SDEM_2000 Log likelihood of SEM_2000  
-26860.32 -26905.51
```

```
LR.Sarlm(SDEM_2000, SLX_2000)
```

```
Likelihood ratio for spatial linear models  
  
data:  
Likelihood ratio = 307.64, df = 1, p-value < 2.2e-16  
sample estimates:  
Log likelihood of SDEM_2000 Log likelihood of SLX_2000  
-26860.32 -27014.14
```

```
LR1.Sarlm(SDEM_2000)
```

```
Likelihood Ratio diagnostics for spatial dependence
```

```
data:  
Likelihood ratio = 307.64, df = 1, p-value < 2.2e-16  
sample estimates:  
Log likelihood of spatial error model           Log likelihood of OLS fit y  
-26860.32                                     -27014.14
```

```
Hausman.test(SEM_2000)
```

```
Spatial Hausman test (asymptotic)
```

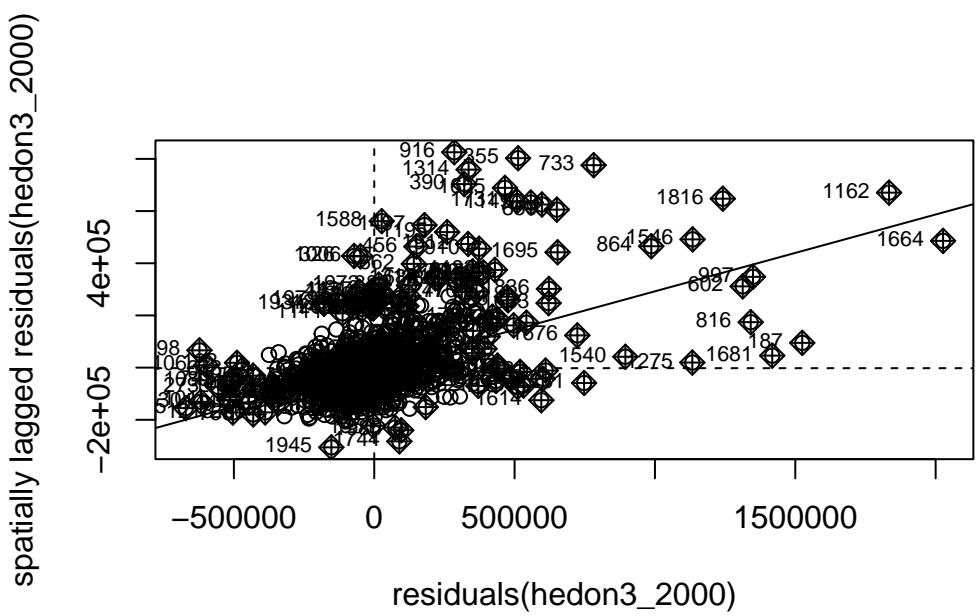
```
data: NULL  
Hausman test = 87.794, df = 29, p-value = 7.926e-08
```

```
bptest.Sarlm(SEM_2000, studentize = TRUE)
```

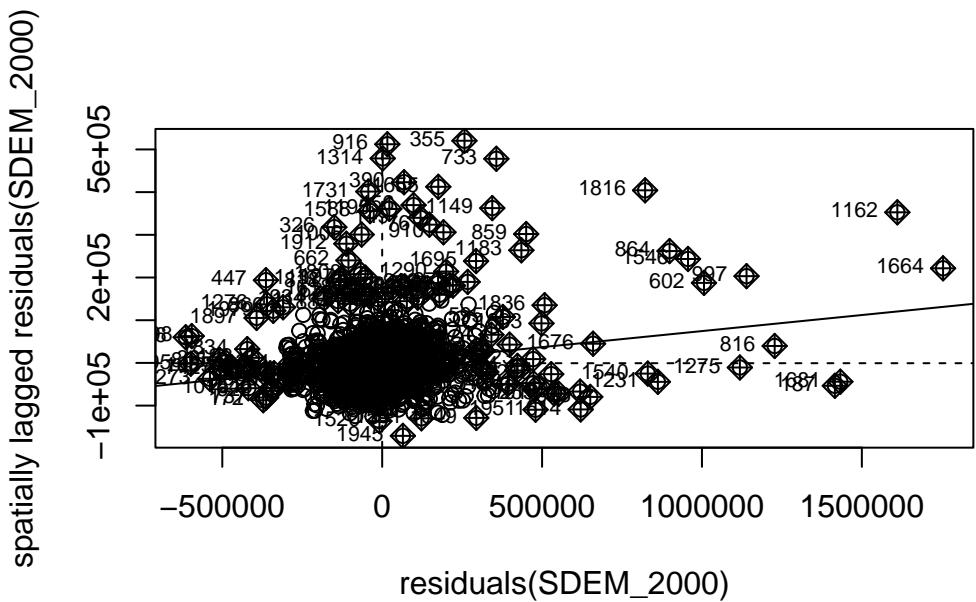
```
studentized Breusch-Pagan test
```

```
data:  
BP = 350.25, df = 28, p-value < 2.2e-16
```

```
moran.plot(residuals(hedon3_2000), listw = kc_house_data_2000_W10)
```



```
moran.plot(residuals(SDEM_2000), listw = kc_house_data_2000_W10)
```



```
moran.test(residuals(SDEM_2000), listw = kc_house_data_2000_W10)
```

Moran I test under randomisation

data: residuals(SDEM_2000)
weights: kc_house_data_2000_W10

Moran I statistic standard deviate = 8.052, p-value = 4.073e-16

alternative hypothesis: greater

sample estimates:

| Moran I statistic | Expectation | Variance |
|-------------------|---------------|--------------|
| 0.0752019576 | -0.0005002501 | 0.0000883917 |

References

Bishop, Kelly C., Nicolai V. Kuminoff, H. Spencer Banzhaf, Kevin J. Boyle, Kathrine von Gravenitz, Jaren C. Pope, V. Kerry Smith, og Christopher D. Timmins. 2020. «Best Practices for Using Hedonic Property Value Models to Measure Willingness to Pay for Environmental Quality». *Review of Environmental Economics and Policy* 14 (2): 260–81. <https://doi.org/10.1093/reep/reaa001>.

| | Hedon1 | Hedon2 | Hedon3 |
|-------------------|-----------------------------|-----------------------------|-----------------------------|
| (Intercept) | 6210939.368 *** [44.671] | 753975.919 *** [4.710] | 2061277.768 *** [15.431] |
| bedrooms | -39049.632 *** [-19.156] | -25328.756 *** [-14.673] | -28985.854 *** [-16.344] |
| bathrooms | 46453.883 *** [13.238] | 27307.508 *** [9.211] | 32395.209 *** [10.627] |
| sqft_living | 172.124 *** [37.305] | 133.612 *** [34.160] | 136.077 *** [33.757] |
| sqft_lot | -0.260 *** [-7.084] | 0.170 *** [5.062] | 0.145 *** [4.415] |
| sqft_above | -2.100 [-0.470] | 95.399 *** [23.754] | 72.713 *** [17.943] |
| floors | 24564.665 *** [6.558] | -67284.965 *** [-19.390] | -37074.484 *** [-11.038] |
| grade | 124528.853 *** [57.276] | 68800.113 *** [35.485] | 72917.129 *** [36.707] |
| yr_built | -3586.252 *** [-50.384] | -695.032 *** [-9.384] | -1277.559 *** [-18.400] |
| yr_renovated | 9.073 * [2.310] | 27.281 *** [8.189] | 25.515 *** [7.470] |
| waterfront | 574412.210 *** [30.786] | 609996.992 *** [38.808] | 605095.325 *** [37.367] |
| condition | 19563.382 *** [7.763] | 30535.045 *** [14.203] | 31399.330 *** [14.269] |
| view | 44765.891 *** [19.781] | 49887.512 *** [26.008] | 46864.744 *** [23.877] |
| year_month2014-06 | 3621.508 61 [0.520] | 8905.815 [1.519] | 7520.424 [1.244] |
| year_month2014-07 | -273.639 [-0.039] | 4115.231 [0.705] | 3527.267 [0.586] |
| year_month2014-08 | 4935.598 | 10538.047 | 8170.200 |

| Res.Df | RSS | Df | Sum of Sq | F | Pr(>F) |
|----------|----------|----|-----------|------|----------|
| 2.14e+04 | 1.01e+15 | | | | |
| 2.14e+04 | 1e+15 | 12 | 5.32e+12 | 9.47 | 1.29e-18 |

| Res.Df | RSS | Df | Sum of Sq | F | Pr(>F) |
|----------|----------|----|-----------|------|----------|
| 2.12e+04 | 6.96e+14 | | | | |
| 2.12e+04 | 6.9e+14 | 12 | 5.84e+12 | 14.9 | 9.97e-32 |

| Res.Df | RSS | Df | Sum of Sq | F | Pr(>F) |
|----------|----------|----|-----------|------|----------|
| 2.14e+04 | 7.59e+14 | | | | |
| 2.14e+04 | 7.53e+14 | 12 | 5.97e+12 | 14.1 | 7.69e-30 |

| | Full | seed |
|--------------|-----------------------------|-----------------------------|
| (Intercept) | 2061277.768 *** [15.431] | 2951606.497 *** [5.856] |
| bedrooms | -28985.854 *** [-16.344] | -56078.935 *** [-7.850] |
| bathrooms | 32395.209 *** [10.627] | 55620.735 *** [4.675] |
| sqft_living | 136.077 *** [33.757] | 180.269 *** [10.946] |
| sqft_lot | 0.145 *** [4.415] | 0.234 * [2.216] |
| sqft_above | 72.713 *** [17.943] | 135.065 *** [8.278] |
| floors | -37074.484 *** [-11.038] | -62111.658 *** [-4.828] |
| grade | 72917.129 *** [36.707] | 35767.297 *** [4.625] |
| yr_built | -1277.559 *** [-18.400] | -1605.519 *** [-6.107] |
| yr_renovated | 25.515 *** [7.470] | 4.871 [0.354] |
| waterfront | 605095.325 *** [37.367] | 535045.039 *** [7.286] |
| condition | 31399.330 *** [14.269] | 26646.594 ** [3.201] |
| view | 46864.744 *** [23.877] | 58143.104 *** [7.790] |
| dist_cbd_km | -9347.083 *** [-58.299] | -10371.011 *** [-16.627] |
| EHD_percen | -1174.710 *** [-15.393] | -1306.890 *** [-4.523] |
| low | 165562.375 *** | 172068.567 |

| | SEM | OLS |
|--------------|-------------------------------------------|-----------------------------|
| (Intercept) | 1517018.818 ** [2.978] | 2951606.497 *** [5.856] |
| bedrooms | -56861.333 *** [-8.620] | -56078.935 *** [-7.850] |
| bathrooms | 47921.645 *** [4.423] | 55620.735 *** [4.675] |
| sqft_living | 176.457 *** [11.696] | 180.269 *** [10.946] |
| sqft_lot | 0.278 ** [2.738] | 0.234 * [2.216] |
| sqft_above | 147.353 *** [9.745] | 135.065 *** [8.278] |
| floors | -90036.310 *** [-7.151] | -62111.658 *** [-4.828] |
| grade | 21291.047 ** [2.875] | 35767.297 *** [4.625] |
| yr_built | -774.223 ** [-2.919] | -1605.519 *** [-6.107] |
| yr_renovated | 2.695 [0.215] | 4.871 [0.354] |
| waterfront | 560430.090 *** [8.418] | 535045.039 *** [7.286] |
| condition | 20057.266 ** [2.622] | 26646.594 ** [3.201] |
| view | 69681.781 *** [9.622] | 58143.104 *** [7.790] |
| dist_cbd_km | -1155 ₆₄ 1471 *** [-14.198] | -10371.011 *** [-16.627] |
| EHD_percen | -1250.900 *** [-3.354] | -1306.890 *** [-4.523] |
| low | 143735.222 | 172068.567 |

| | Full | 2000 Seed | 666 Seed |
|--------------|----------------------------------|----------------------------|-----------------------------|
| (Intercept) | 2061277.768 *** [15.431] | 1210875.723 ** [2.786] | 2951606.497 *** [5.856] |
| bedrooms | -28985.854 *** [-16.344] | -32673.993 *** [-5.474] | -56078.935 *** [-7.850] |
| bathrooms | 32395.209 *** [10.627] | 37190.457 *** [3.854] | 55620.735 *** [4.675] |
| sqft_living | 136.077 *** [33.757] | 129.767 *** [9.623] | 180.269 *** [10.946] |
| sqft_lot | 0.145 *** [4.415] | 0.001 [0.005] | 0.234 * [2.216] |
| sqft_above | 72.713 *** [17.943] | 69.394 *** [5.267] | 135.065 *** [8.278] |
| floors | -37074.484 *** [-11.038] | -50159.047 *** [-4.702] | -62111.658 *** [-4.828] |
| grade | 72917.129 *** [36.707] | 77406.714 *** [12.162] | 35767.297 *** [4.625] |
| yr_built | -1277.559 *** [-18.400] | -917.749 *** [-4.033] | -1605.519 *** [-6.107] |
| yr_renovated | 25.515 *** [7.470] | 32.312 ** [2.866] | 4.871 [0.354] |
| waterfront | 605095.325 *** [37.367] | 651420.645 *** [10.743] | 535045.039 *** [7.286] |
| condition | 31399.330 *** [14.269] | 41317.349 *** [5.855] | 26646.594 ** [3.201] |
| view | 46864.744 *** [23.877] | 47129.031 *** [7.405] | 58143.104 *** [7.790] |
| dist_cbd_km | -9347.083 *** 65 [-58.299] | -9361.880 *** [-17.962] | -10371.011 *** [-16.627] |
| EHD_percen | -1174.710 *** [-15.393] | -866.591 *** [-3.527] | -1306.890 *** [-4.523] |
| low | 165562.375 *** | 317959.816 *** | 172068.567 |

| | SEM | OLS |
|--------------|-----------------------------------|----------------------------|
| (Intercept) | 493503.786 [1.191] | 1210875.723 ** [2.786] |
| bedrooms | -27143.081 *** [-5.298] | -32673.993 *** [-5.474] |
| bathrooms | 34985.810 *** [4.223] | 37190.457 *** [3.854] |
| sqft_living | 114.684 *** [9.876] | 129.767 *** [9.623] |
| sqft_lot | 0.071 [0.710] | 0.001 [0.005] |
| sqft_above | 80.237 *** [6.876] | 69.394 *** [5.267] |
| floors | -58151.130 *** [-5.900] | -50159.047 *** [-4.702] |
| grade | 68554.269 *** [11.793] | 77406.714 *** [12.162] |
| yr_built | -449.658 * [-2.081] | -917.749 *** [-4.033] |
| yr_renovated | 23.638 * [2.448] | 32.312 ** [2.866] |
| waterfront | 704814.899 *** [13.064] | 651420.645 *** [10.743] |
| condition | 35870.875 *** [5.806] | 41317.349 *** [5.855] |
| view | 50271.932 *** [8.552] | 47129.031 *** [7.405] |
| dist_cbd_km | -10019.088 *** 66 [-13.784] | -9361.880 *** [-17.962] |
| EHD_percen | -1250.388 *** [-3.767] | -866.591 *** [-3.527] |
| low | 264677.218 * | 317959.816 *** |