Economic and Demographic Trends in Downtown Calgary

Downtown Strategy:
Final Presentation

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In today's presentation

Research Question

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Methodology

Regression Results

Visuals and Forecasting

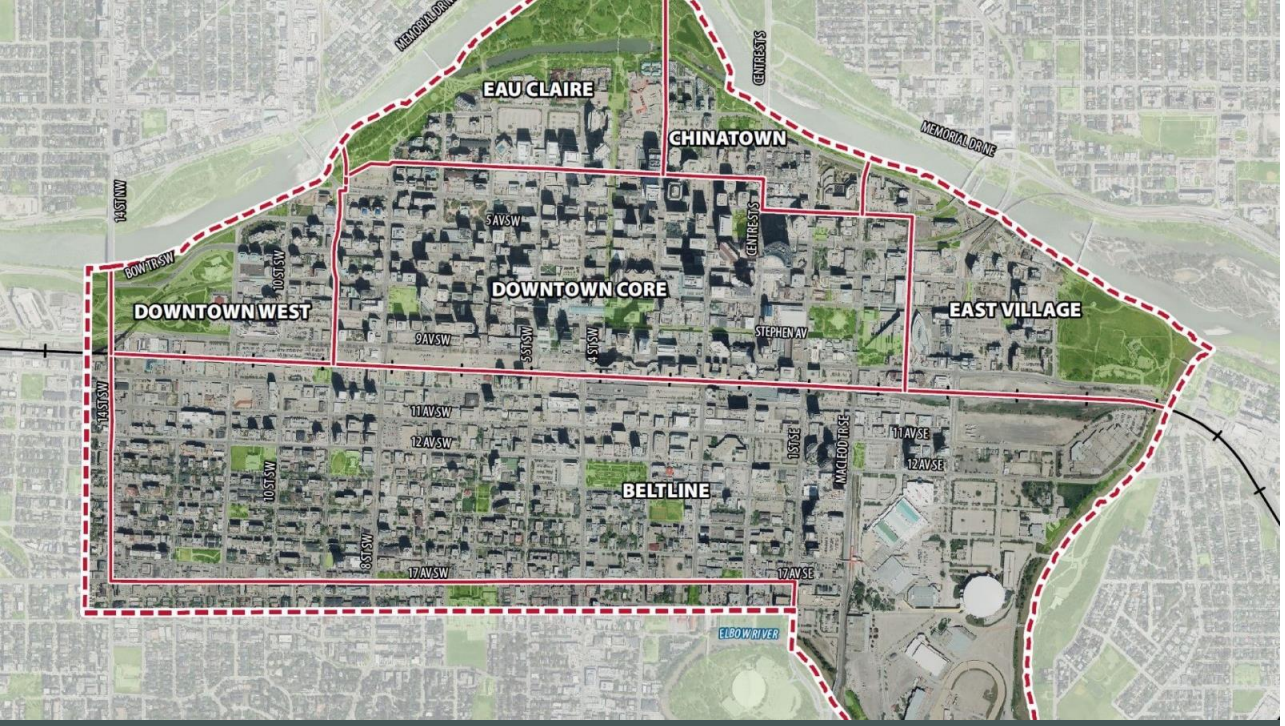
Noticeable Trends

Research Question

How have the population, age distribution, household size, and household types in downtown Calgary changed from 2011 to 2025, and what are the demographic projections for the future?

This will conduct the following analysis:

- What is the distribution of renters and home-owners?
- How can we measure population changes in downtown?
- What might the future look like?



Data (Community)

Datasets Used:

- Historical Population by Year (1968–2017) – *by community*
- 2021 Federal Community Housing & Dwelling Census – *by community*

Purpose of Merge:

- Connect long-term population trends with recent housing data
- Analyze how population growth aligns with housing availability

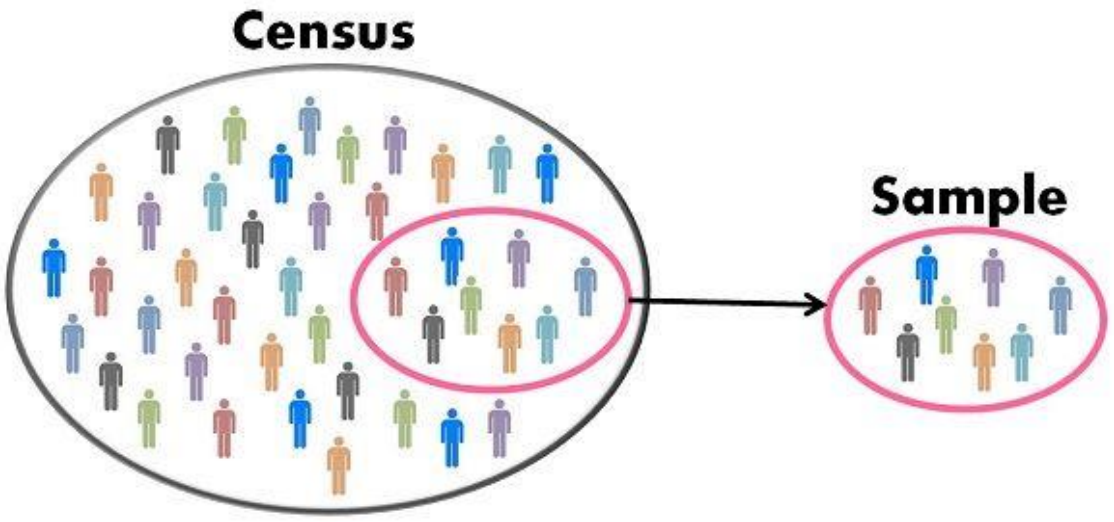
Key Variables Extracted:

- **Total Population**
- **Number of Dwellings**
- **Average People per Dwelling (Population/Dwellings)**

Why These Variables Matter:

- Show relationship between population and housing supply

Data (Ward)



Datasets Used:

- 2011 & 2016 Ward-Level Census
- 2021 Federal Community Housing & Dwelling Census (transformed to wards)

Key Variables Tracked:

- **Male/Female Population**
- **Dwelling Size**
- **Age Ranges:**
  - **0–4 years old**
  - **5–19 years old**

What We Did:

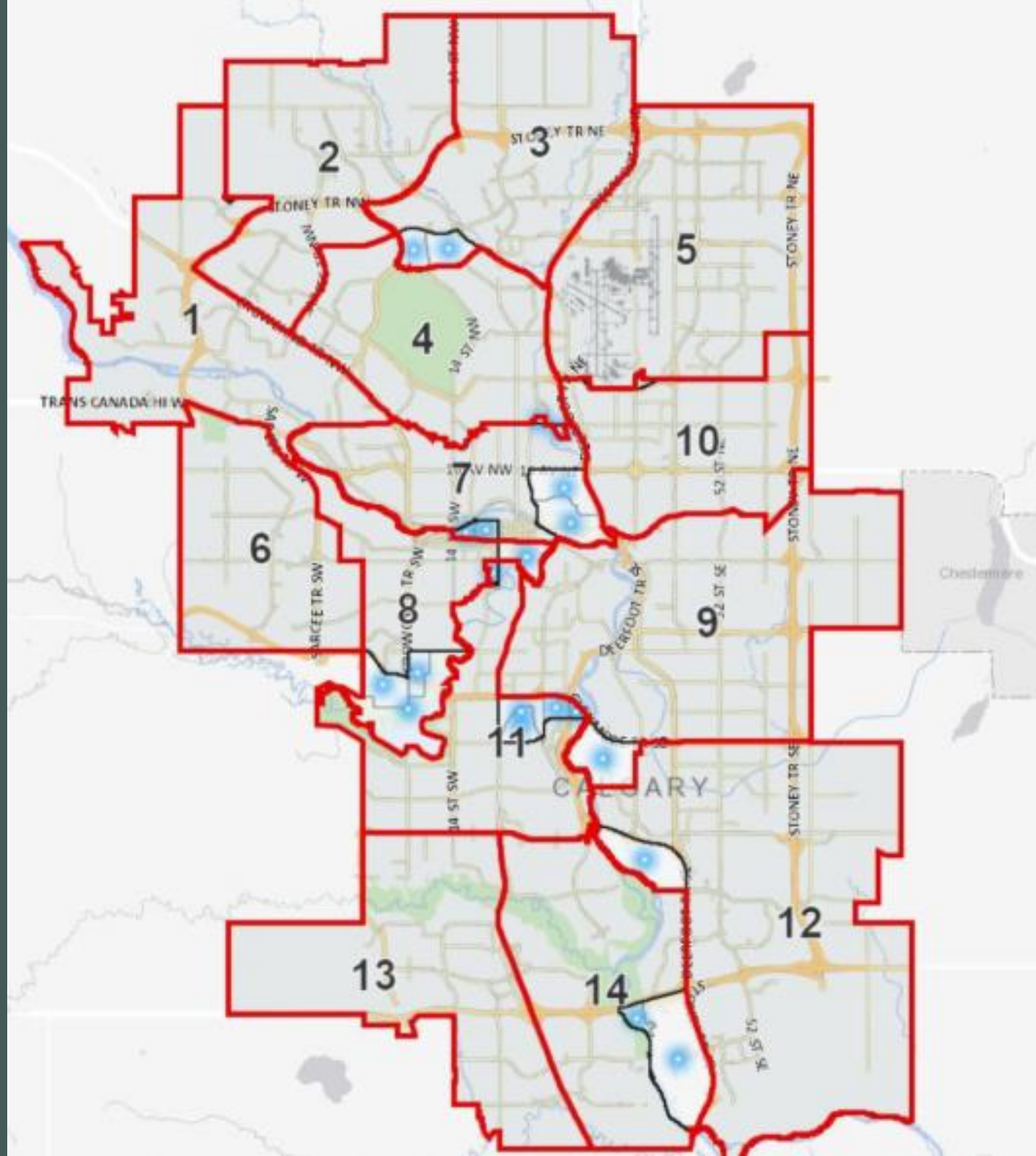
- Tracked demographic changes by ward (2011 & 2016)
- Estimated 2021 ward demographics by transforming **community-level data** into **ward boundaries**

Methodology (1 of 2)

Goal: Develop regression models to forecast demographic variables using population and occupied dwelling data

Challenge: Demographic data is only available every 5 years at the ward level, limiting real-time analysis. Needs to be scaled down to community level.

Solution: Use *annual* population and dwelling data to estimate interim demographic trends (e.g. age groups, household size)



Methodology (2 of 2)

Benefits:

- Enables “nowcasting” demographic changes without waiting 5 years
  - Nowcast will be tested on the Beltline community
- Can be enhanced with (archived) prior demographic observations
- Can understand and observe these changes as they are occurring
- Simplifies forecasting process by being able to compare with current, real-time data

Regression Model

$$Demographic = \beta_0 + \beta_1 Population + \beta_2 Dwellings + \beta_3 \left(\frac{Population}{Dwellings}\right) + \epsilon$$

$$Household\ Size = \beta_0 + \beta_1 Population + \beta_2 Dwelling\ Count + \beta_3 \left(\frac{Population}{Dwelling}\right) + \epsilon$$

This regression produced coefficients that can then applied to community population data to estimate their trends over time in the "gaps" between the census.

This regression estimated using *all* wards and then we compared it with ward 7 and 8.

Regression Results: Household Size

Independent Variable	Coefficient	P value	Standard Error	R-squared of Regression
Population	-0.255	0.004	0.084	0.914
Dwelling count	1.021	0.000	0.184	
Pop/Dwell ratio	3847.789	0.199	2946.552	

$$Household\ Size = \beta_0 + \beta_1 Population + \beta_2 Dwelling\ Count + \beta_3 \left(\frac{Population}{Dwelling}\right) + \epsilon$$

Regression Results: Demographic

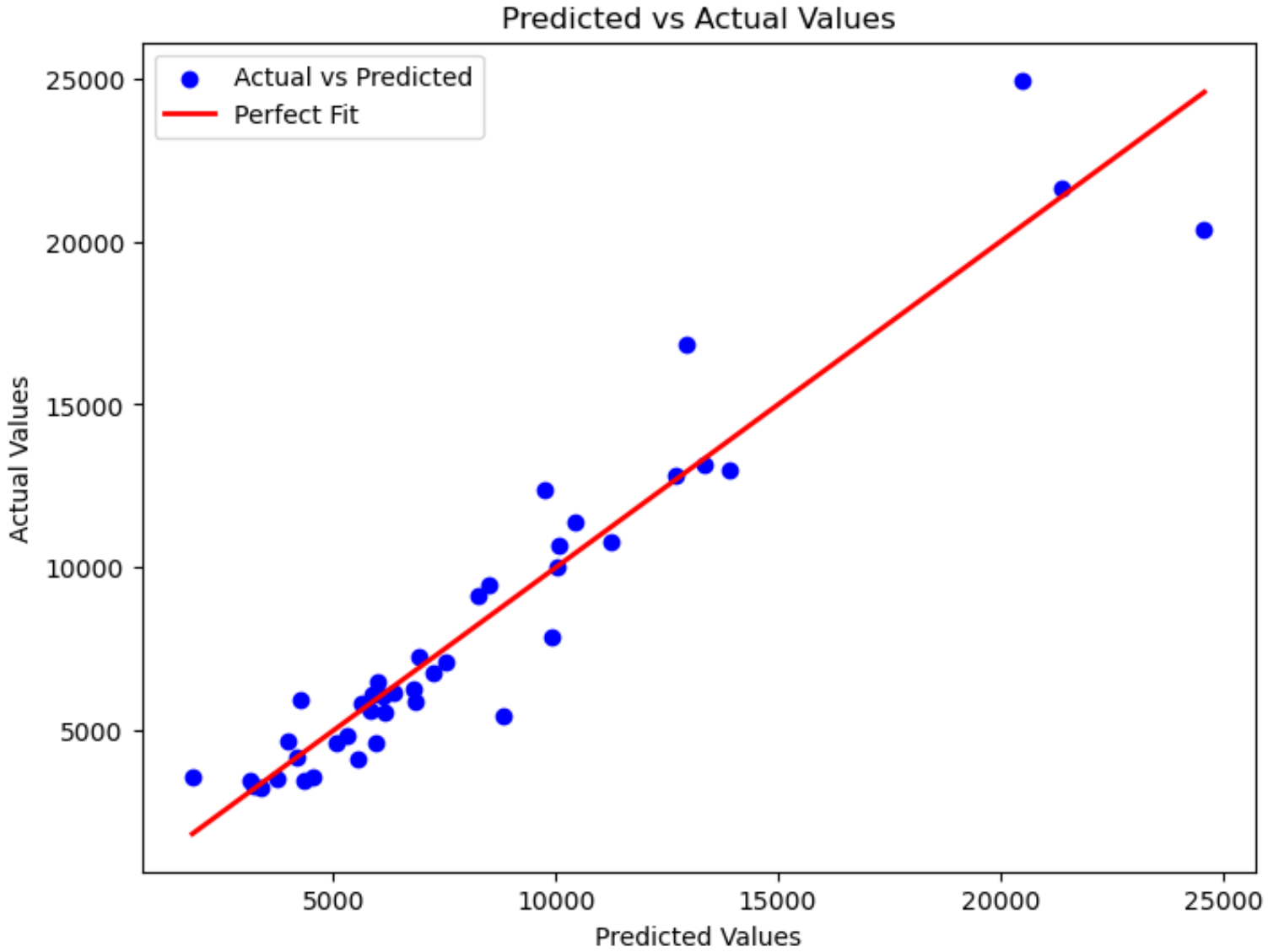
Independent Variable	Coefficient	P value	Standard Error	R-squared of Regression
Population	0.299	0.000	0.062	0.880
Dwelling count	-0.400	0.005	0.134	
Pop/Dwell ratio	-1126.414	0.603	2149.856	

Using the demographic variable of children ages 5-14

$$Demographic = \beta_0 + \beta_1 Population + \beta_2 Dwellings + \beta_3 \left(\frac{Population}{Dwellings}\right) + \epsilon$$

Visual: Household Size

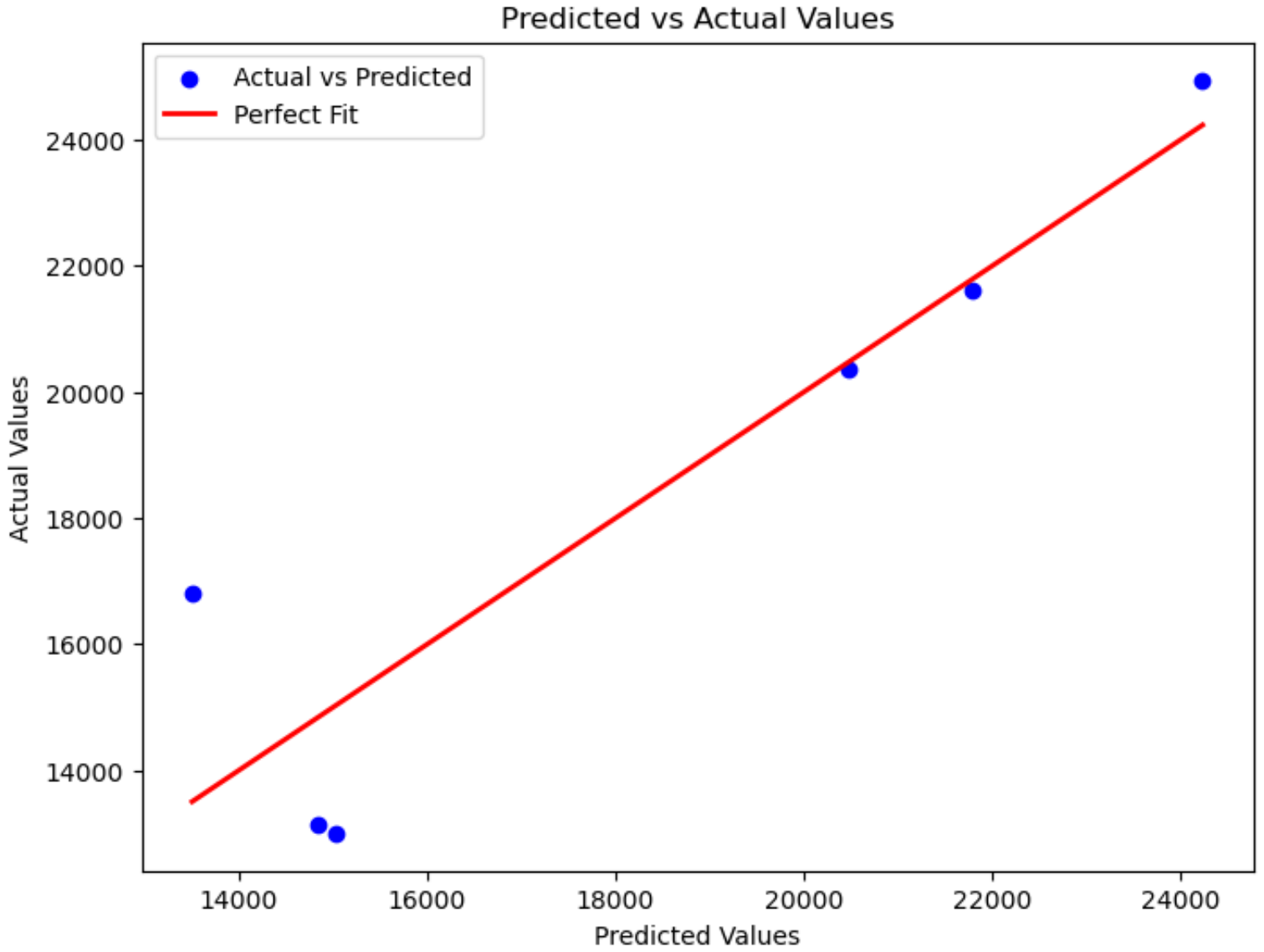
All wards



$$Household\ Size = \beta_0 + \beta_1 Population + \beta_2 Dwelling\ Count + \beta_3 \left(\frac{Population}{Dwelling}\right) + \epsilon$$

Visual: Household Size

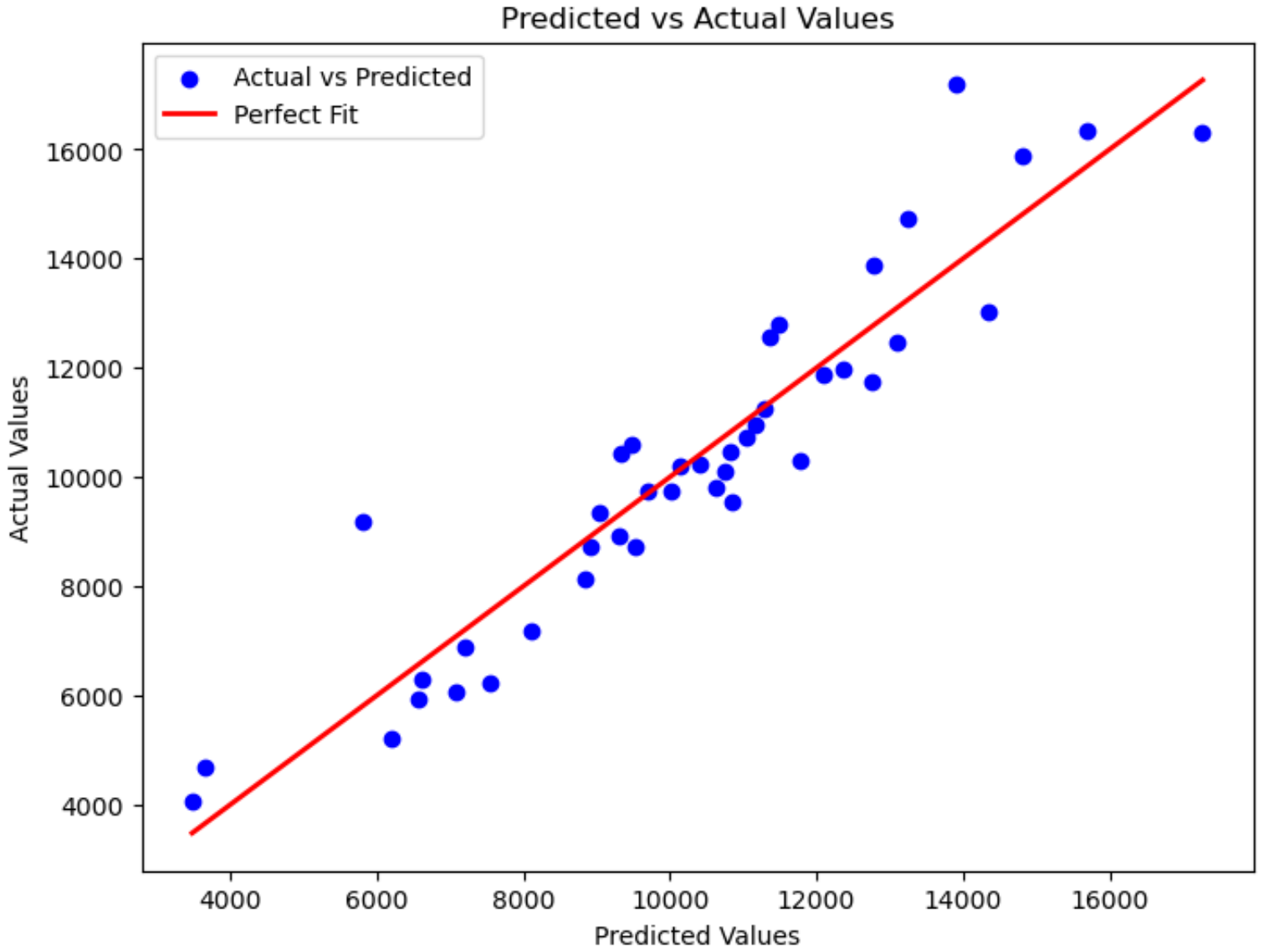
Wards 7 and 8



$$Household\ Size = \beta_0 + \beta_1 Population + \beta_2 Dwelling\ Count + \beta_3 \left(\frac{Population}{Dwelling}\right) + \epsilon$$

Visual: Demographic

Children ages 5-14



$$Demographic = \beta_0 + \beta_1 Population + \beta_2 Dwellings + \beta_3 \left(\frac{Population}{Dwellings}\right) + \epsilon$$

Estimation of Dwelling Count: Beltline

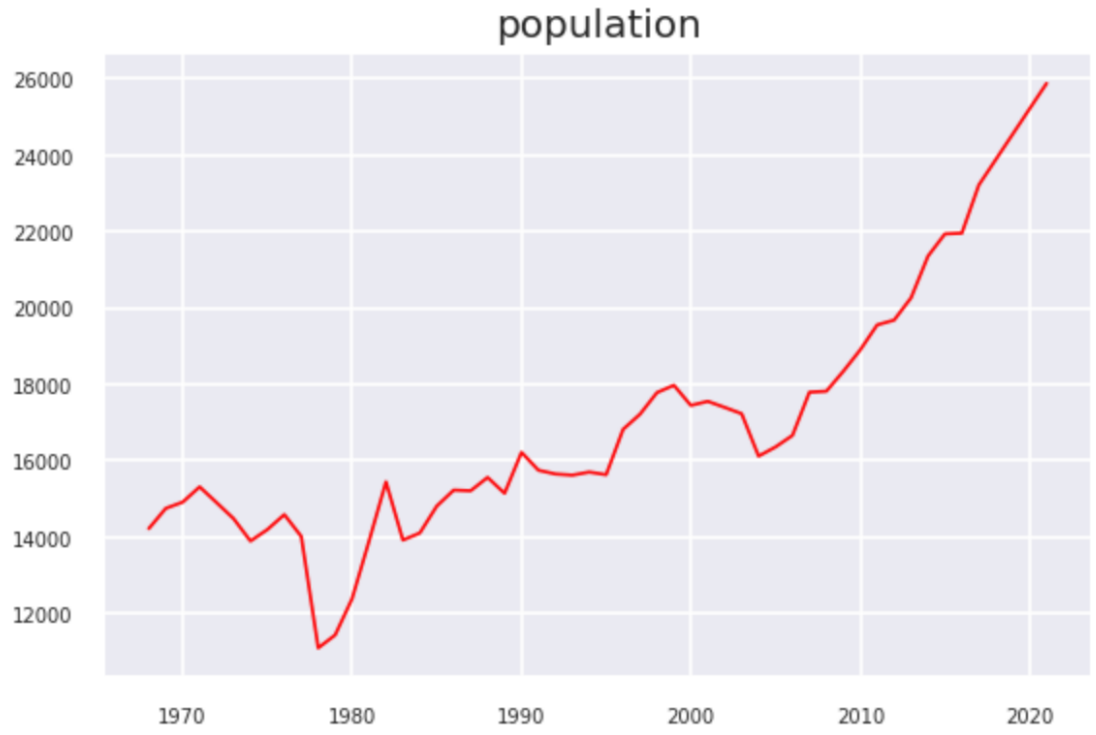
Year	Estimated Population	Actual Population	Percent Error (%)
2011	22,273	19,556	13.89
2016	21501	21,958	-2.08
2021	23284	25,880	-10.03

Values for 2016, 2011 filled in from Calgary Civic Census

Forecasting – Vector Autoregressions

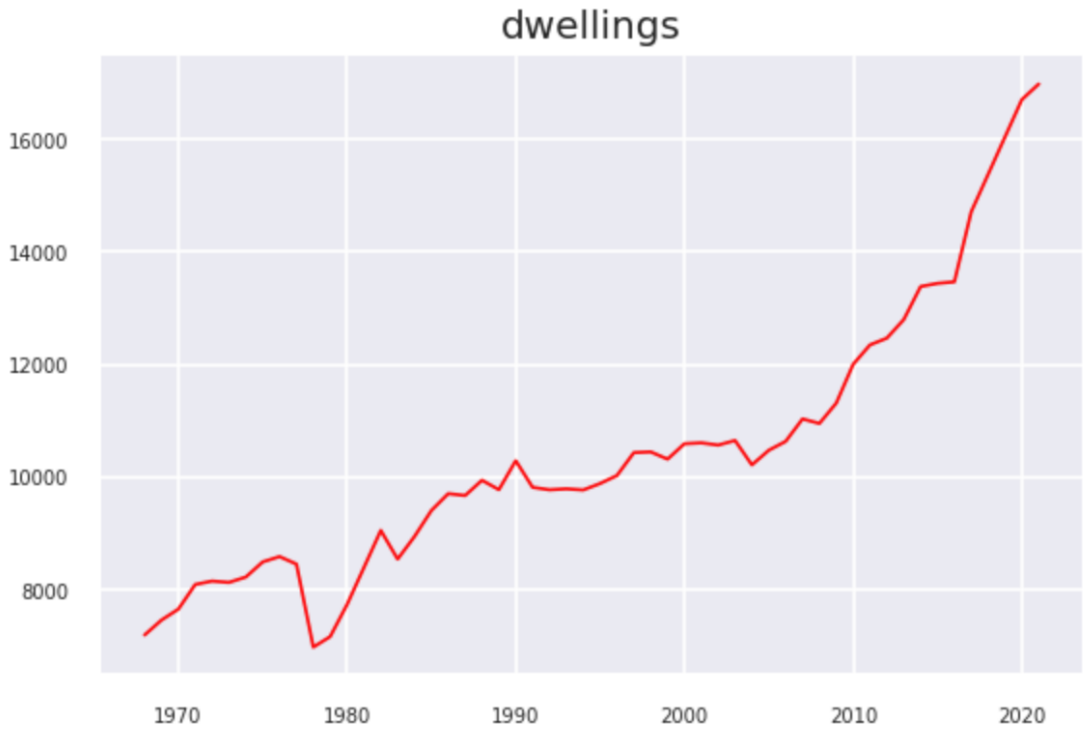
- Forecasting multiple variables with its impacts in each other
- To prepare the dataset, it was necessary to interpolate for the years 2017, 2018, 2019 and 2020
- The variables used: population, dwellings and persons per unit
- The estimation was done for Beltline community

Forecasting – Dickey Fuller test



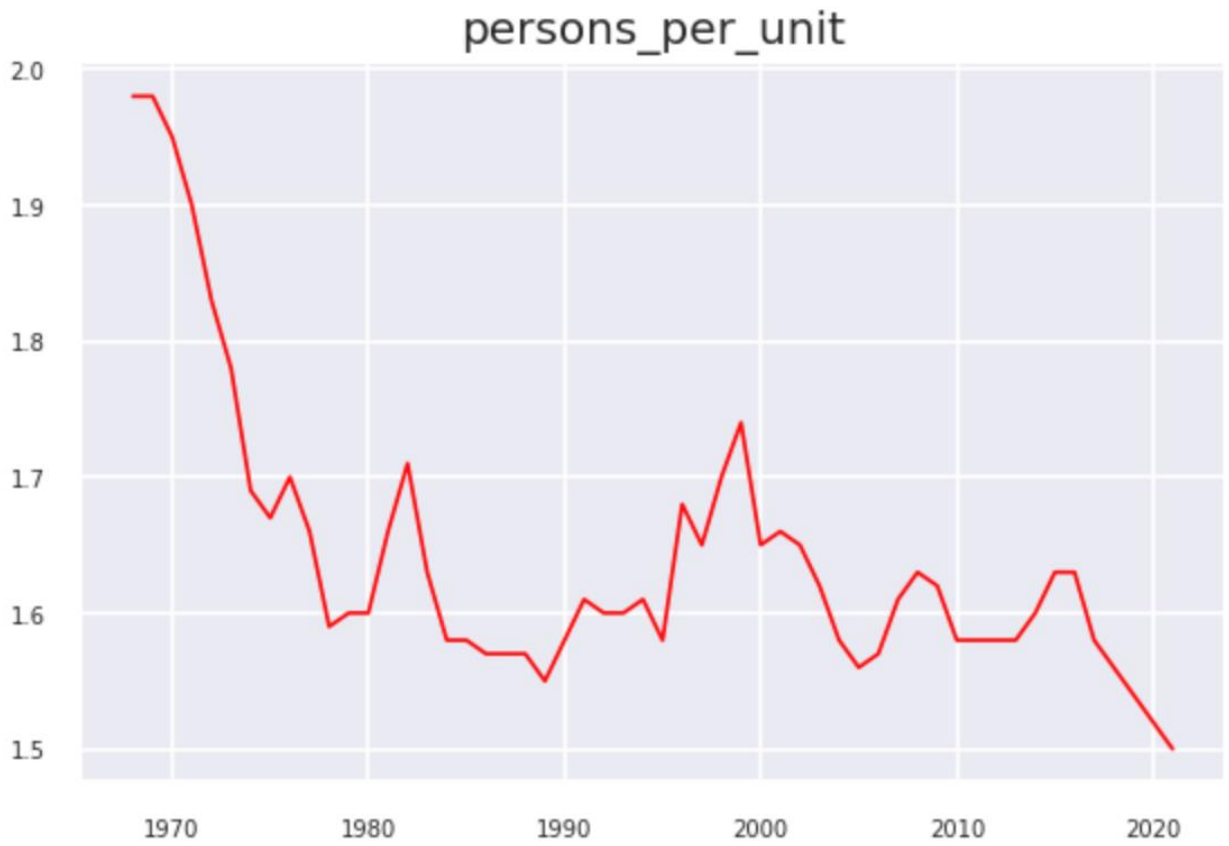

```
   Augmented Dickey-Fuller Test on "population"
   -----------------------------------------------
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level    = 0.05
Test Statistic        = 0.583
No. Lags Chosen       = 0
Critical value 1%     = -3.571
Critical value 5%     = -2.923
Critical value 10%    = -2.599
=> P-Value = 0.9872. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
```

Forecasting – Dickey Fuller test




```
   Augmented Dickey-Fuller Test on "dwellings"
   -----------------------------------------------
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level    = 0.05
Test Statistic        = 0.8487
No. Lags Chosen       = 0
Critical value 1%     = -3.571
Critical value 5%     = -2.923
Critical value 10%    = -2.599
=> P-Value = 0.9924. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
```

Forecasting – Dickey Fuller test




```
   Augmented Dickey-Fuller Test on "persons_per_unit"
   ----------------------------------------------
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level    = 0.05
Test Statistic        = -3.3662
No. Lags Chosen       = 0
Critical value 1%     = -3.571
Critical value 5%     = -2.923
Critical value 10%    = -2.599
=> P-Value = 0.0122. Rejecting Null Hypothesis.
=> Series is Stationary.
```

Forecasting – Granger causality

	population_x	dwellings_x	persons_per_unit_x
population_y	1.0000	0.0312	0.0144
dwellings_y	0.0343	1.0000	0.0254
persons_per_unit_y	0.0000	0.0000	1.0000

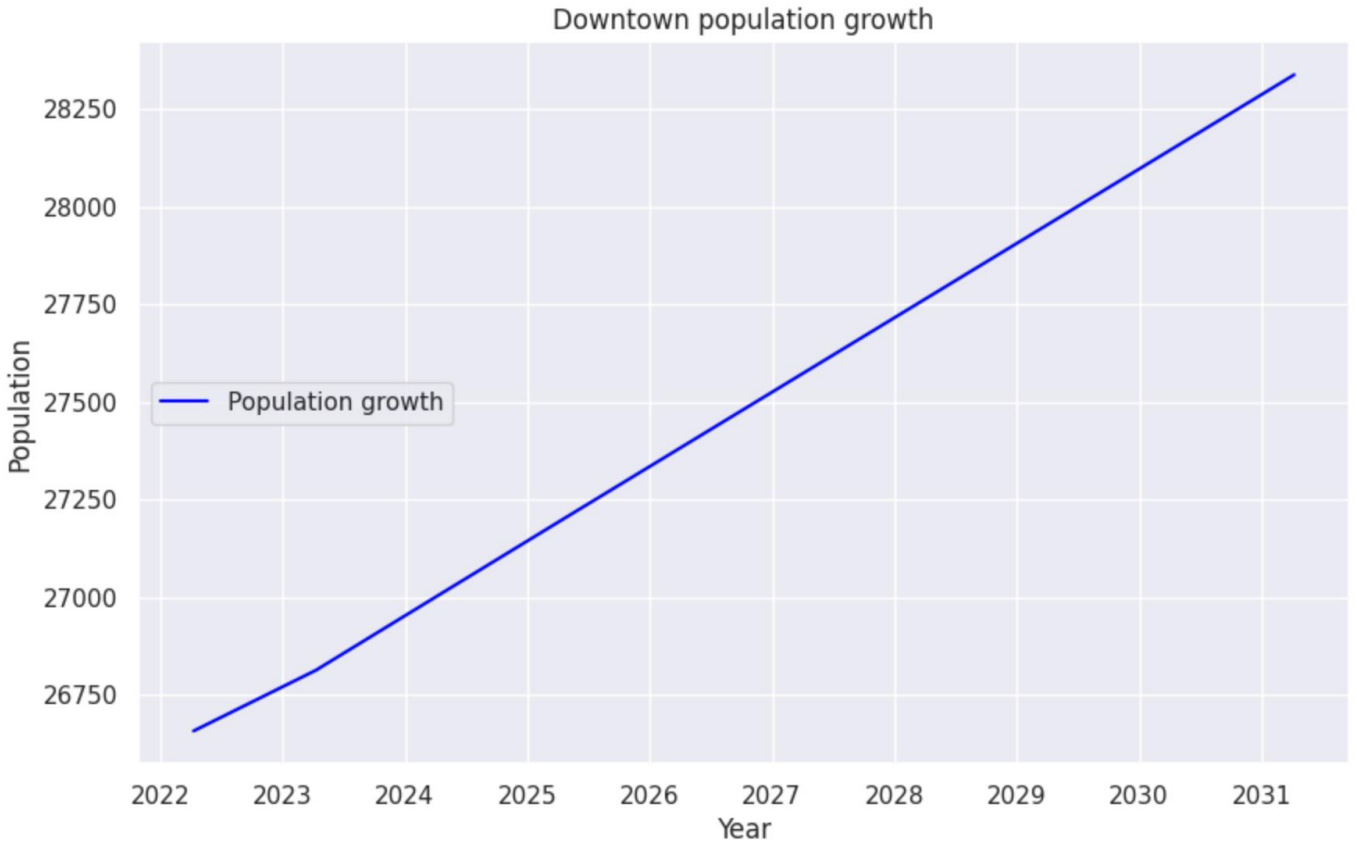
- The results indicates: population causes dwellings and persons per unit, dwellings causes population and persons per unit and, persons per unit causes population and dwellings

Forecasting – Cointegration test

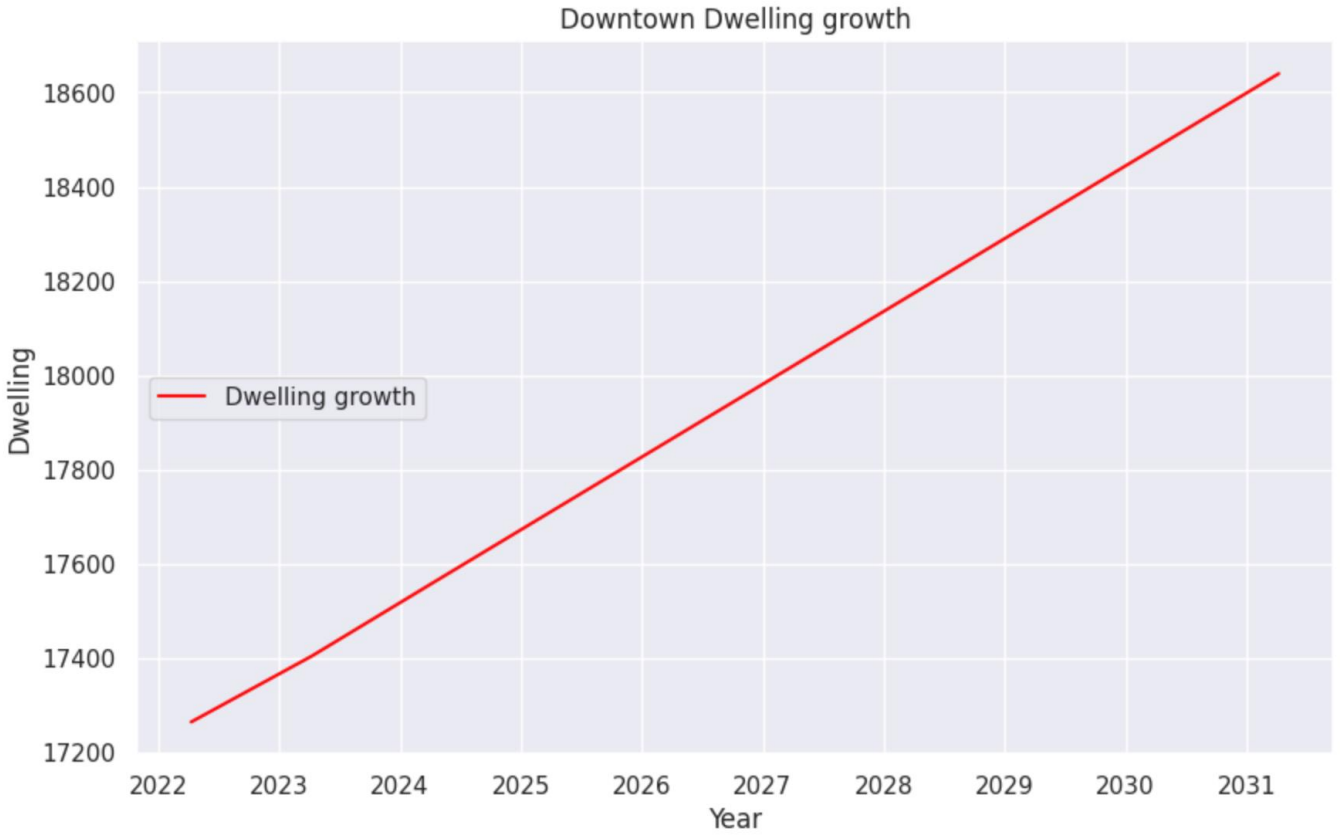
	::	Test Stat	>	C(95%)	=>	Signif
0	::	71.75	>	24.2761	=>	True
1	::	31.5	>	12.3212	=>	True
2	::	12.33	>	4.1296	=>	True

- There are two vector of cointegration for these three variables

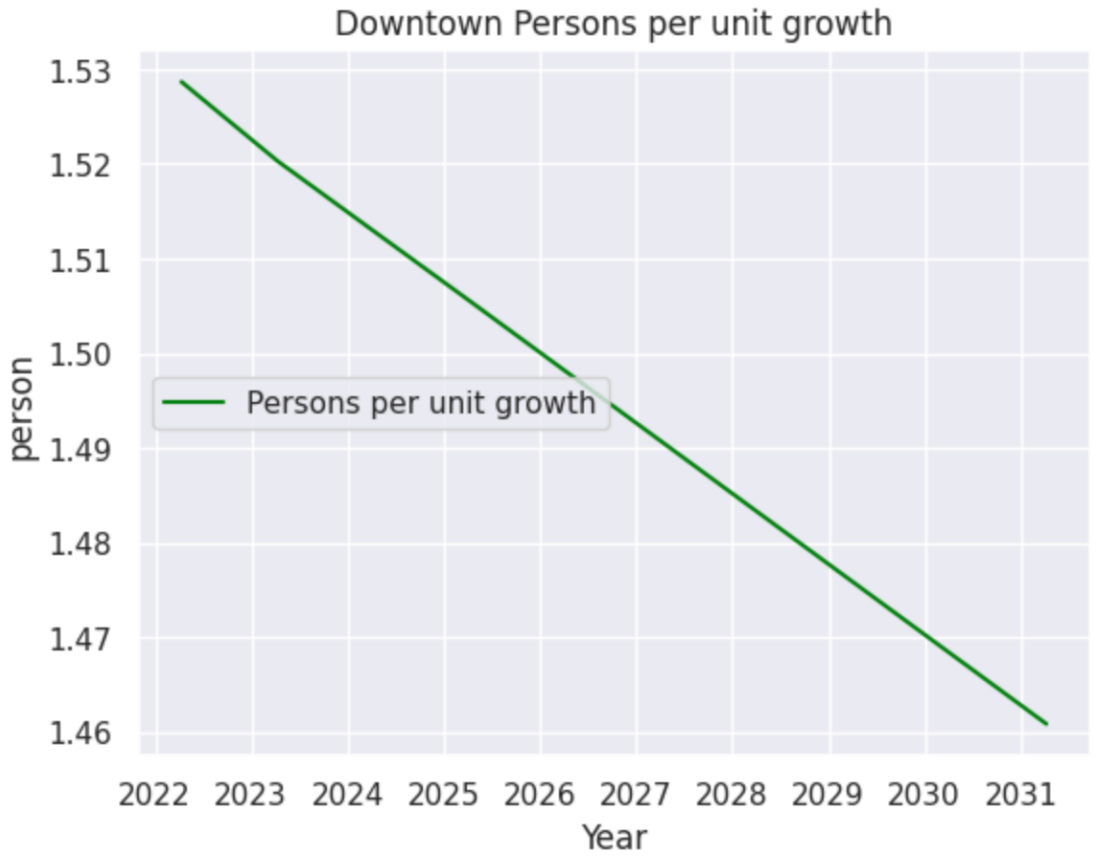
Forecasting – VAR Population

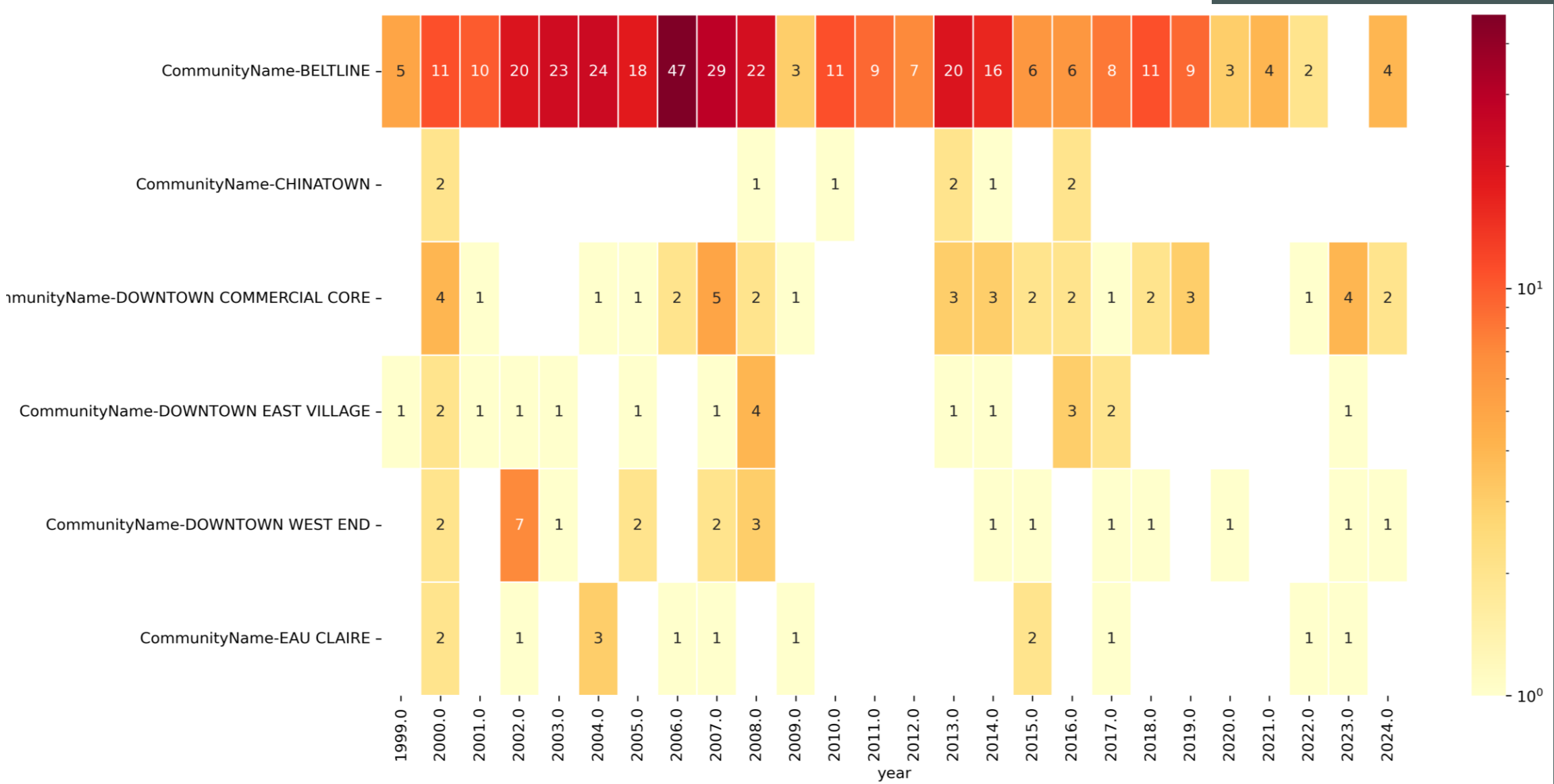


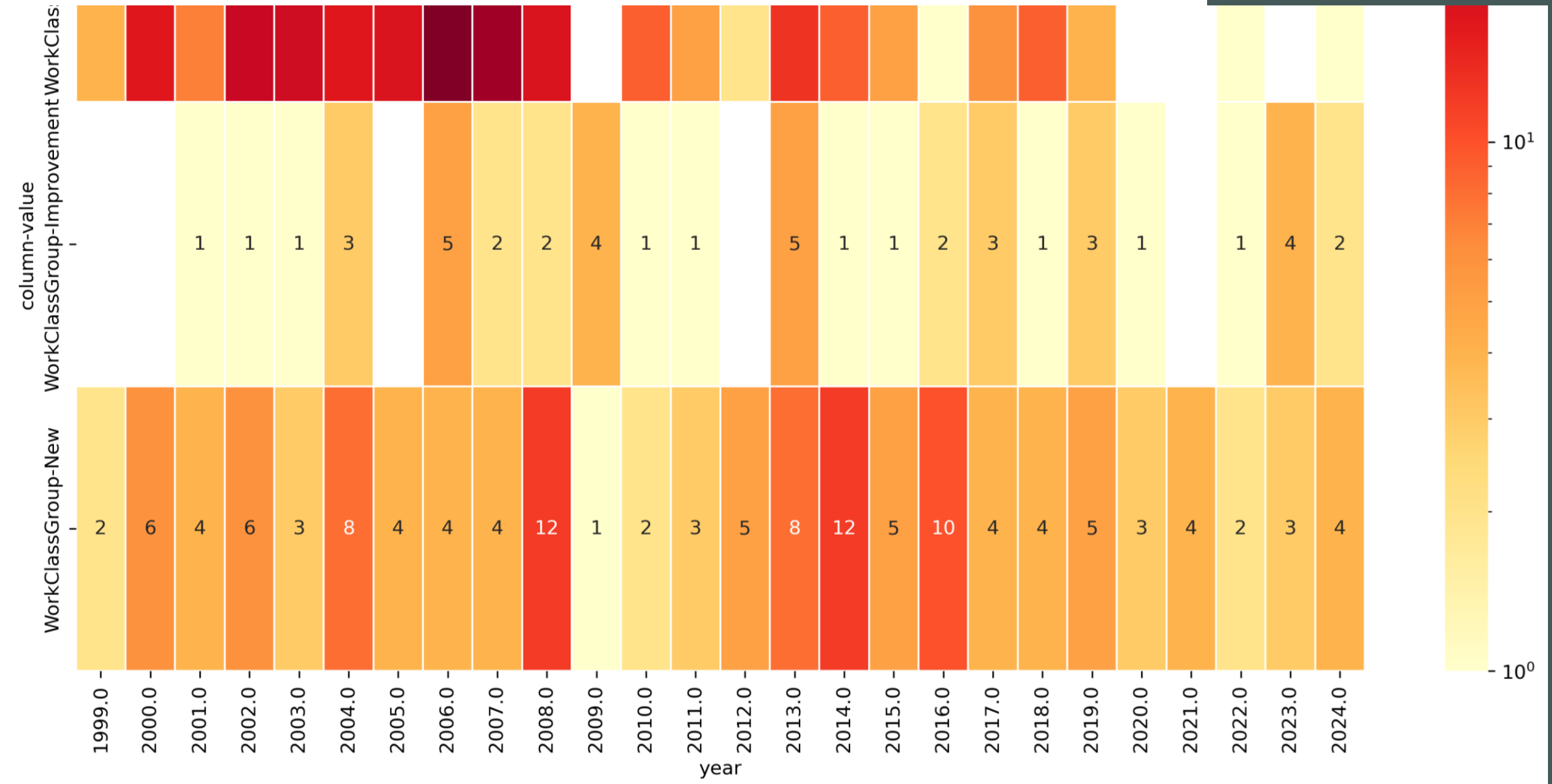
Forecasting – VAR Dwelling

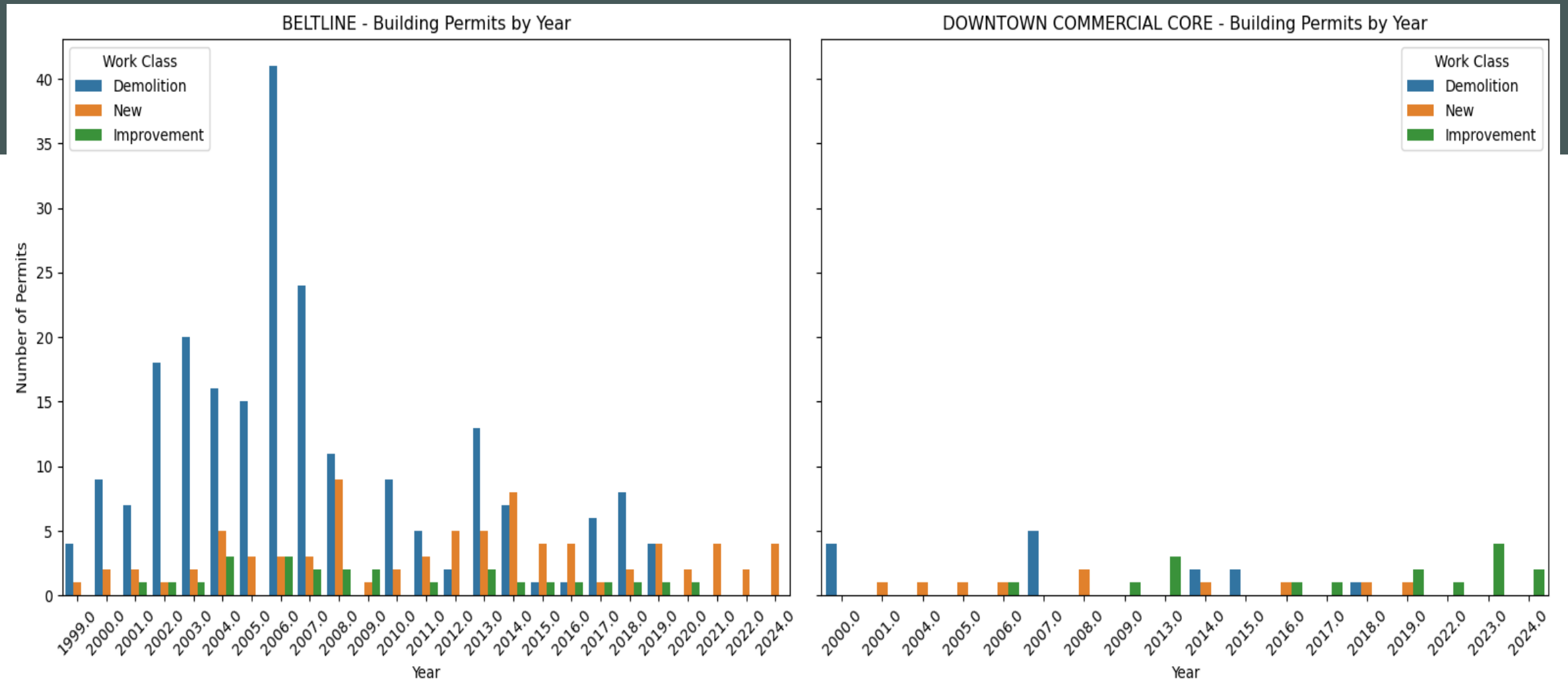


Forecasting – VAR Person per unit

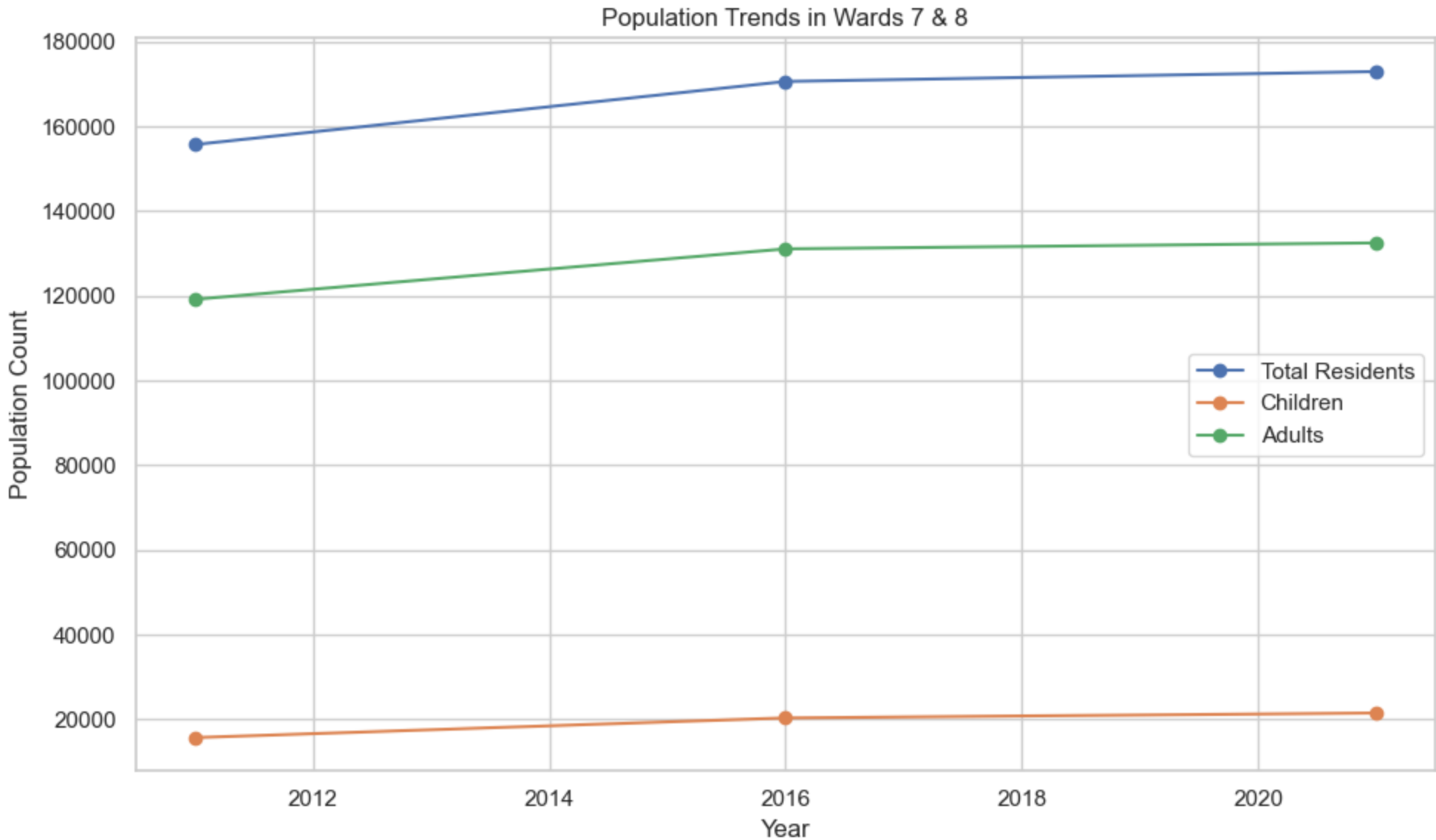


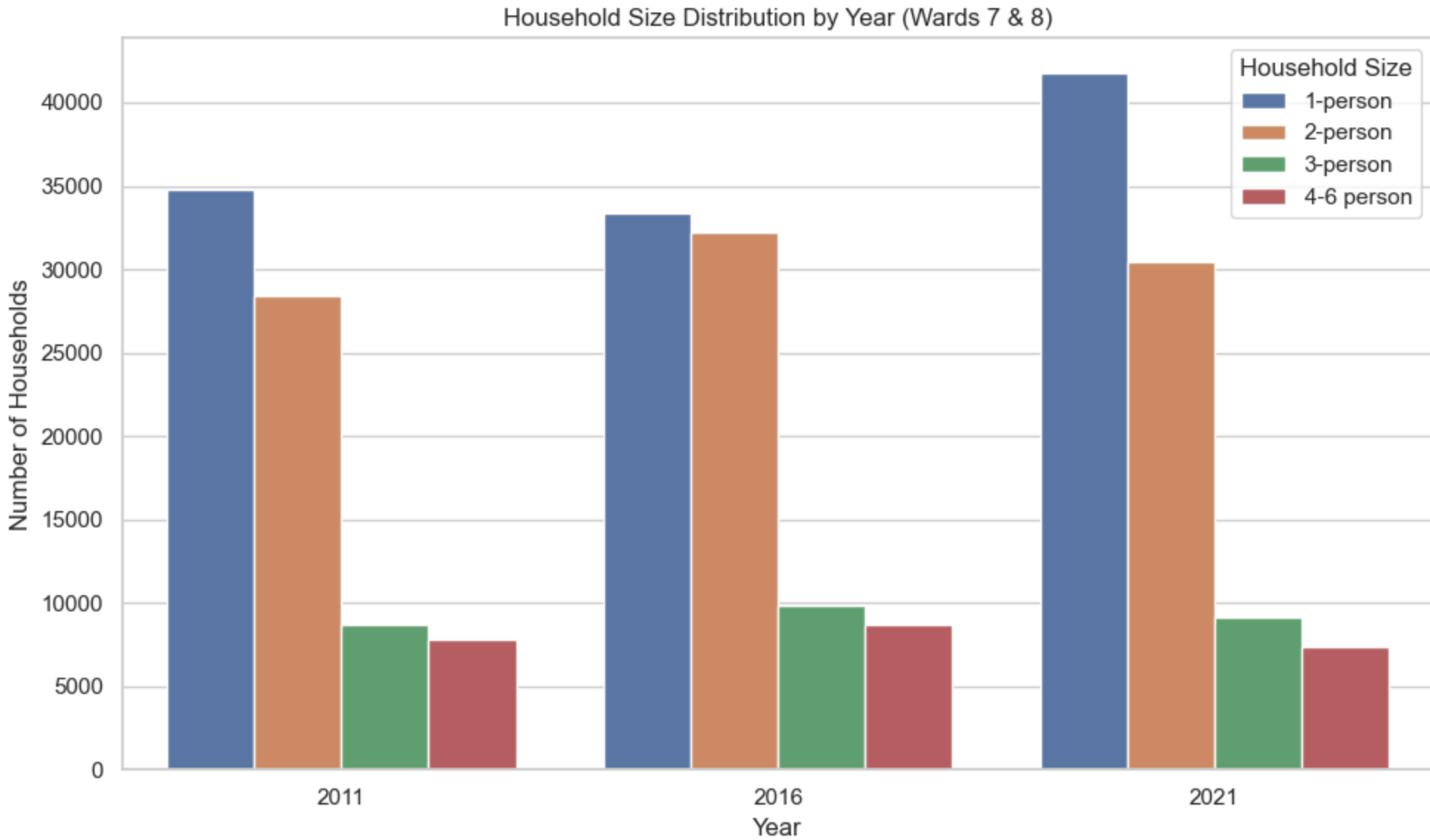

CommunityName-BELTLINE
CommunityName-CHINATOWN
mmunityName-DOWNTOWN COMMERCIAL CORE
CommunityName-DOWNTOWN EAST VILLAGE
CommunityName-DOWNTOWN WEST END
CommunityName-EAU CLAIRE
5 11 10 20 23 24 18 47 29 22 3 11 9 7 20 16 6 6 8 11 9 3 4 2 4
2 1 1 2 1 2
4 1 1 1 2 5 2 1 3 3 2 2 1 2 3 1 4 2
1 2 1 1 1 1 1 4 1 1 3 2 1
2 7 1 2 2 3 1 1 1 1 1 1
2 1 3 1 1 2 1 1 1 1
1999.0 2000.0 2001.0 2002.0 2003.0 2004.0 2005.0 2006.0 2007.0 2008.0 2009.0 2010.0 2011.0 2012.0 2013.0 2014.0 2015.0 2016.0 2017.0 2018.0 2019.0 2020.0 2021.0 2022.0 2023.0 2024.0
year
10^1
10^0

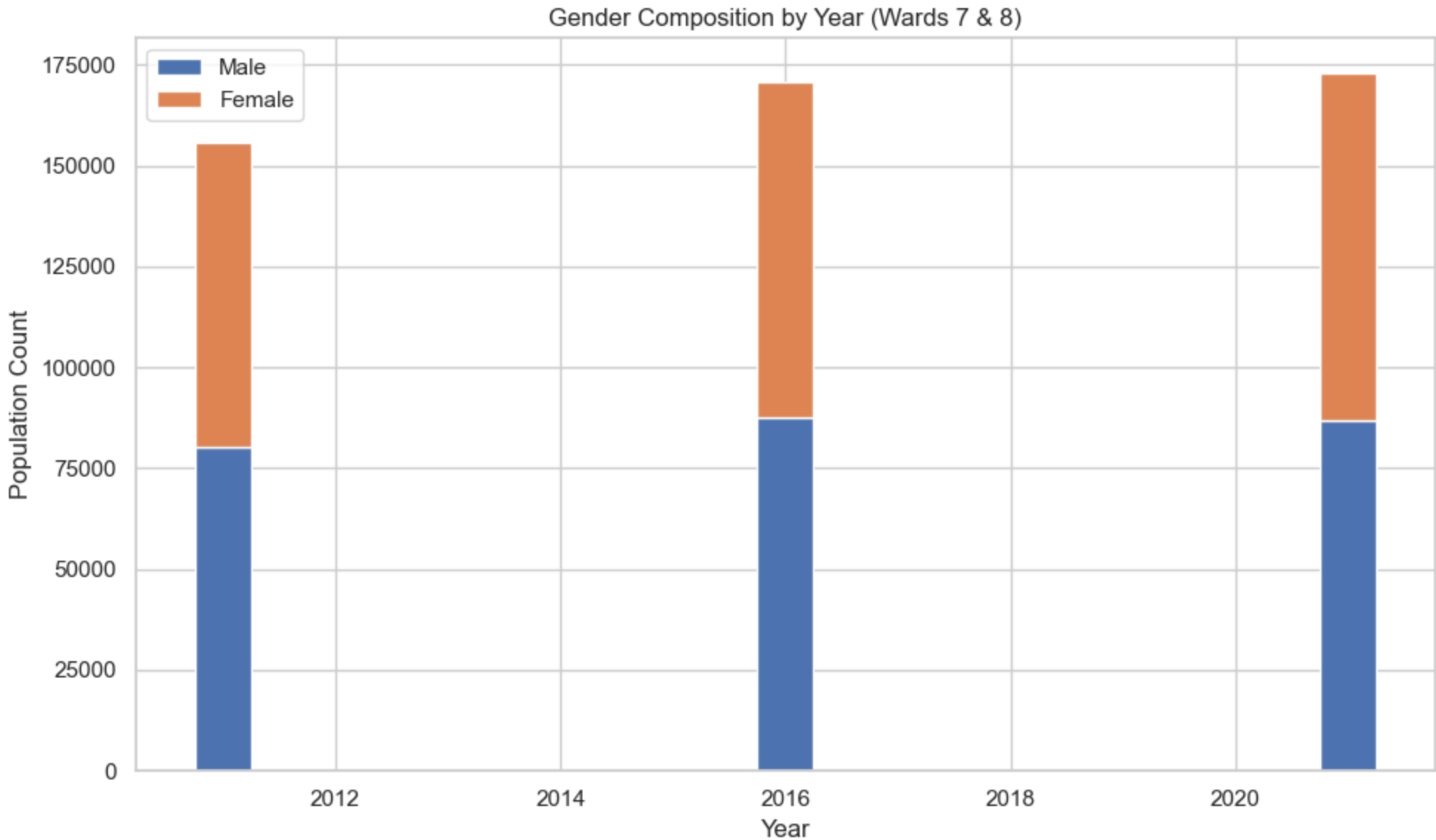

column-value
WorkClassGroup-Improvement
WorkClass
WorkClassGroup-New
year
1999.0
2000.0
2001.0
2002.0
2003.0
2004.0
2005.0
2006.0
2007.0
2008.0
2009.0
2010.0
2011.0
2012.0
2013.0
2014.0
2015.0
2016.0
2017.0
2018.0
2019.0
2020.0
2021.0
2022.0
2023.0
2024.0
10^1
10^0

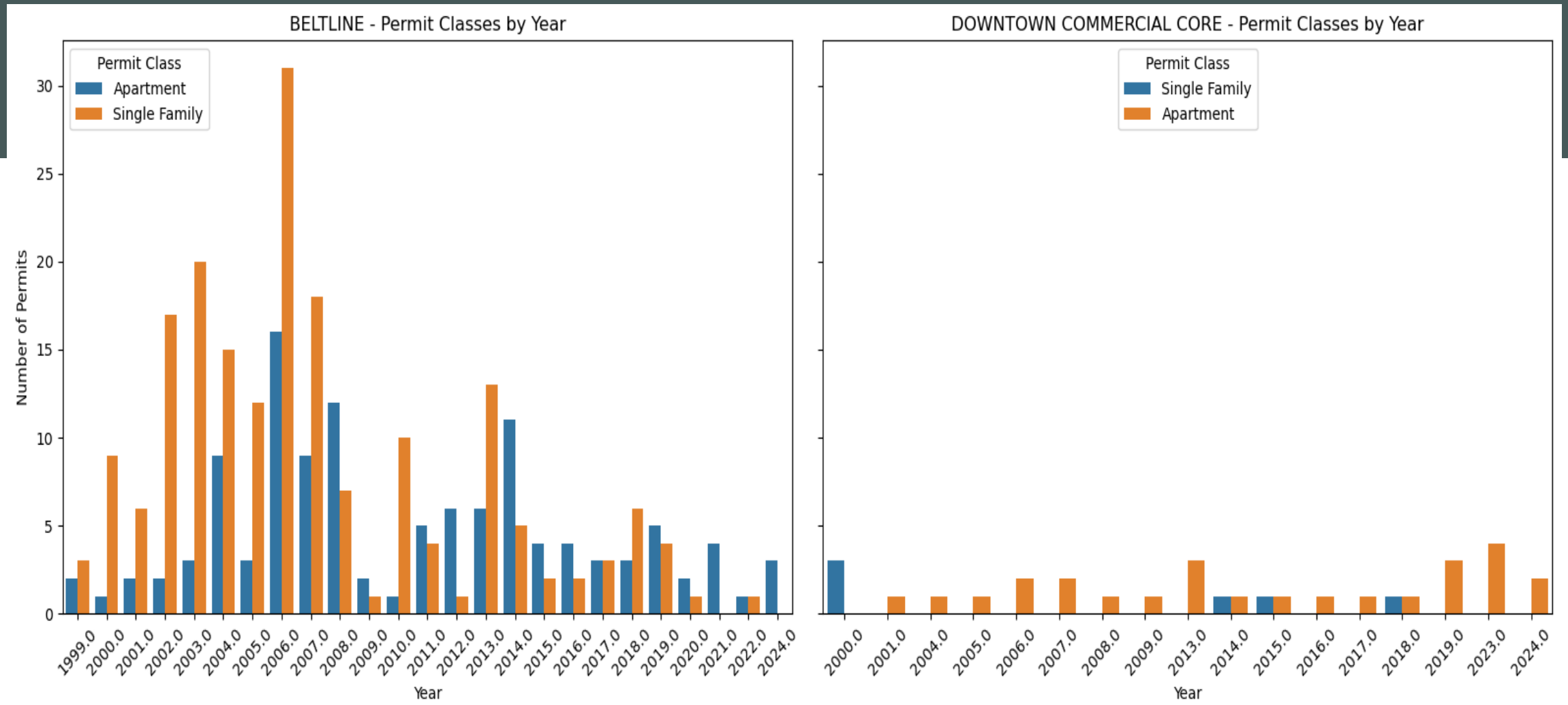

BELTLINE - Building Permits by Year
Work Class
Demolition
New
Improvement
Number of Permits
0
5
10
15
20
25
30
35
40
1999.0
2000.0
2001.0
2002.0
2003.0
2004.0
2005.0
2006.0
2007.0
2008.0
2009.0
2010.0
2011.0
2012.0
2013.0
2014.0
2015.0
2016.0
2017.0
2018.0
2019.0
2020.0
2021.0
2022.0
2024.0
Year
DOWNTOWN COMMERCIAL CORE - Building Permits by Year
Work Class
Demolition
New
Improvement
2000.0
2001.0
2004.0
2005.0
2006.0
2007.0
2008.0
2009.0
2013.0
2014.0
2015.0
2016.0
2017.0
2018.0
2019.0
2022.0
2023.0
2024.0
Year


PermitClassGroup-Apartment
PermitClassGroup-Commercial
PermitClassGroup-General
PermitClassGroup-Government
PermitClassGroup-Industrial
PermitClassGroup-Institutional
PermitClassGroup-Single Family
PermitClassGroup-Townhouse
PermitClassGroup-Two Family
column-value
3 5 4 7 4 13 4 19 12 14 4 1 5 6 12 15 7 10 8 5 8 3 4 1 7 5
2
1
1 5 2 1 2 1 2
1 1
1
1
1
3 16 6 21 21 15 15 31 21 13 1 10 4 1 13 6 4 2 3 7 4 1 1 1
1 1
1 2 1
1999.0
2000.0
2001.0
2002.0
2003.0
2004.0
2005.0
2006.0
2007.0
2008.0
2009.0
2010.0
2011.0
2012.0
2013.0
2014.0
2015.0
2016.0
2017.0
2018.0
2019.0
2020.0
2021.0
2022.0
2023.0
2024.0
year
10^1
10^0

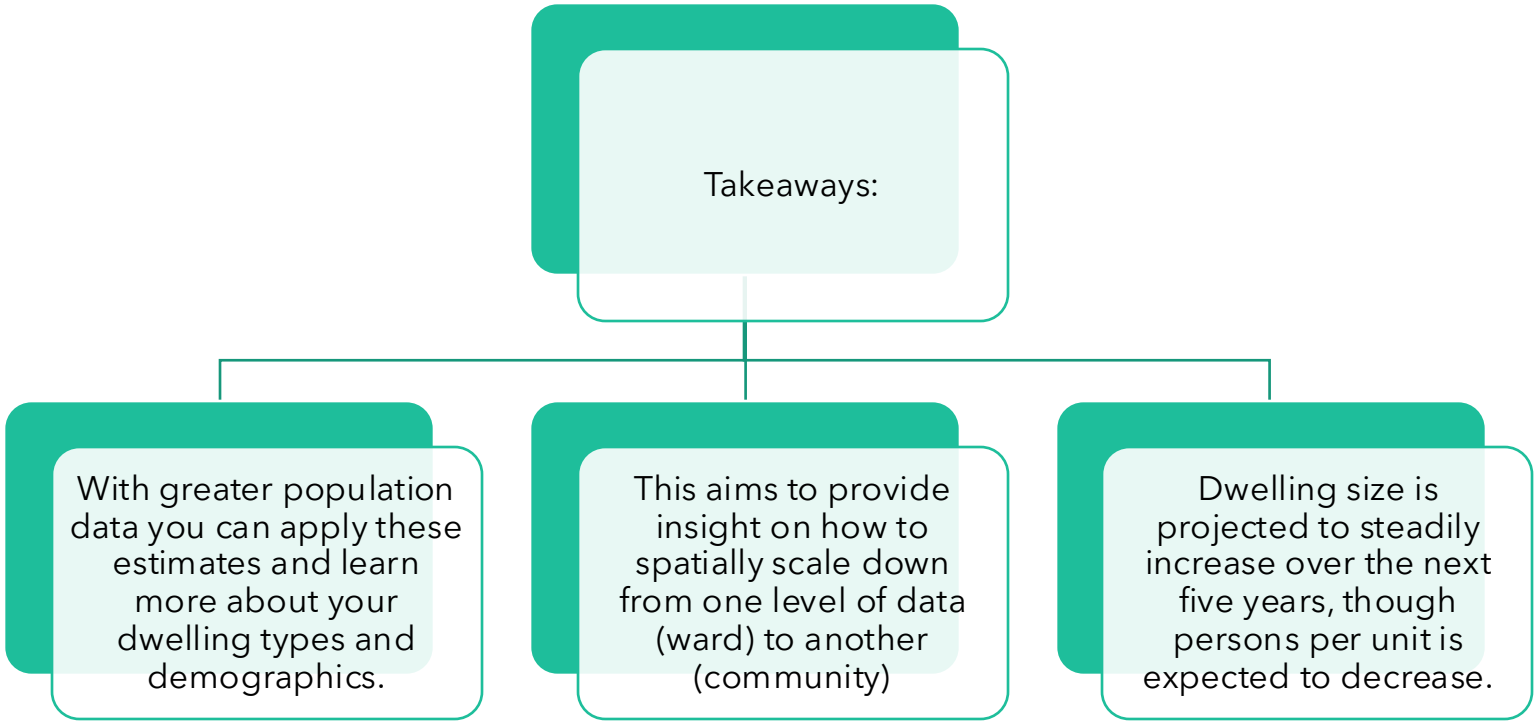

Population Trends in Wards 7 & 8
Population Count
180000
160000
140000
120000
100000
80000
60000
40000
20000
2012
2014
2016
2018
2020
Year
Total Residents
Children
Adults


Household Size Distribution by Year (Wards 7 & 8)
Household Size
1-person
2-person
3-person
4-6 person
Number of Households
0
5000
10000
15000
20000
25000
30000
35000
40000
2011
2016
2021
Year


Gender Composition by Year (Wards 7 & 8)
Male
Female
175000
150000
125000
100000
75000
50000
25000
0
Population Count
2012
2014
2016
2018
2020
Year


BELTLINE - Permit Classes by Year
Permit Class
Apartment
Single Family
Number of Permits
Year
DOWNTOWN COMMERCIAL CORE - Permit Classes by Year
Permit Class
Single Family
Apartment
Year

Summary


Takeaways:
With greater population data you can apply these estimates and learn more about your dwelling types and demographics.
This aims to provide insight on how to spatially scale down from one level of data (ward) to another (community)
Dwelling size is projected to steadily increase over the next five years, though persons per unit is expected to decrease.