

# Comparing Housing Affordability in Major Alberta Cities

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**Abstract**—Using data obtained from open data portals and the Canadian Real Estate Association, we investigated the relationships between household income and benchmark pricing within Edmonton and Calgary. The goal was to determine the housing affordability in these cities and understand what factors impacted that affordability. Clustering and data visualization strategies were applied to discover these relationships. A comparison between the number of families in both cities that could afford a mortgage for all housing types revealed that, in general, Edmonton families more than Calgary families were able to afford a mortgage.

Through the methods employed, we found that housing type and age group played a significant factor in determining the affordability of a dwelling. Those in the 0 to 24-year category were unable to afford one or two-story housing. The 25 to 44-year category saw an increase in affordability, while the 45-year category saw a decrease that held across all housing types. Out of all housing types, apartments and townhouses tended to be more affordable for all age groups, while two-storey houses had a much lower affordability rate. Mortgage terms also affected the number of families that could afford housing, with the longer-term mortgages allowing for more affordability. Mortgage terms under 15 years for couple families were not affordable on average, and for lone-parent families, mortgage terms under 25 years were not affordable.

Finally, we compared Edmonton and Calgary and found that while there was a slight difference, Edmon-

ton's affordability count was higher than Calgary's. Thus, Edmonton is a slightly more affordable city to live in for every family type and age of the oldest adult in the family.

**Keywords**—Data Mining, Housing Affordability

## I. INTRODUCTION

Shelter is a basic human need. While the two biggest cities in Alberta, Edmonton and Calgary, contain a variety of housing options, it is naive to assume that all of these housing options are affordable. We defined housing as affordable if the homeowner's housing costs did not exceed seventy percent of the family's yearly income. Therefore, calculating affordability is dependant on the income of the family. We determined the number of families in Edmonton and Calgary that could afford a mortgage by comparing the benchmark price of different housing types and the yearly income of various family types (couple families, lone-parent families, and people not in census families). We based this determination on the mortgage length in years and the percentage of annual income directed towards mortgage payments. We also found that the age of the oldest adult in the family and the housing type primarily impacted the affordability of mortgages. We clustered housing benchmark and family income

data to find relationships between families and their affordability rates.

## II. RELATED WORKS

*Housing Market Prices in Canada: The Year in Review* is a publication by Statistics Canada detailing housing price changes over the previous year. In this case, it is the review for 2009, the year after the 2008 recession, using information collected by the agency. It summarizes how each province did over the last year concerning new housing. To do so, they use data like the New Housing Price Index, an index created to compare price changes that look at the contractor selling price of new homes, using the exact specifications over two years. This Index also includes an estimated land price of these houses. They adjust these indexes for quality and land to show the actual change between the same housing over time. The report also uses building permit surveys, which count the number of authorized residential buildings to build in an area, along with construction values in the residential sector, organized by the type of residence. The report collects average sale prices of housing from the Multiple Listing Service provided by the Canadian Real Estate Association (CREA), the only data not collected by Statistics Canada itself. They also use population, GDP, and hours of work. National data encompasses all provinces except for the NHPI.[1]

*Is the Canadian Housing Market Overvalued? A Post-crisis Assessment* is a working paper prepared by Evridiki Tsounta. The author discusses the effects of the 2008 housing crisis on housing prices in 2009 and estimates when the market will reach equilibrium while giving reasons as to why watching the changes in housing prices is essential. They found that before the 2008 decline, many houses in the western provinces were significantly overvalued compared to the rest of the country. The 2008 drop brought the prices down to a more comparable level to the rest of the province. The data they use is much like Statistics Canada; they also use the MLS data from CREA and regional data like disposable income, demographic developments and mortgage credit and adjust for errors and inflation. A footnote notes that CREA is the most used index for this analysis.[2]

*Canadian City Housing Prices and Urban Market Segmentation* by Allen et al. is a working paper from the Bank of Canada in December 2006, before the housing collapse of 2008. The authors seek to use modern time-series methods to explore the Canadian housing market. One of the main concerns here is that combining multiple municipalities into a single aggregate index drowns out individual cities can heavily skew results when put together with other cities, giving incorrect data for future market predictions. Instead, they utilize many empirical methods to compare the eight major Canadian cities according to the MLS data provided by CREA and Statistics Canada and test the stability of the data between cities.[3]

The last one is *Housing Affordability in Calgary*, written by the City of Calgary, Community and Neighborhood Services and Social Research Unit. This report was done in December 2008 to understand those in the city who need affordable housing, including renters and owners. The report breaks down statistical data into groups based on household income, income spent on housing, and whether they rent or own a home. They also note that Statistics Canada uses random rounding for confidentiality reasons, so some smaller data sets may not add together correctly compared to the sum shown. The first third of the report shows the income and spending information on renters, with the information provided by Statistics Canada. The second part is those who currently own homes requiring affordable housing to not overspend on shelter, which is less than those who rent. The last part amalgamates the two previous groups, giving an approximate total of three tables.[4]

## III. DATA MINING OVERVIEW

We obtained the family income data used in this study through the Statistics Canada data portal [5]. The Housing Price Index (HPI) data was obtained from The Canadian Real Estate Association [6]. We decided to limit the data scope to between 2005 and 2019 (inclusive), as some data for 2020 and 2021 was unavailable, and years prior to 2005 had insufficient HPI data.

The HPI data we collected consists of, for each month, the HPI and benchmark of various housing types. These housing types are as follows: one-

storey, two-storey, single-family (one-storey and two-storey combined), apartment, townhouse, and composite (all housing types combined). The HPI is the index of the average housing price, with January 2005 being the base index with a value of 100. The benchmark is the average price of the housing type, which Realtors use for determining the value of houses of the same type at that time. Both of these values are strong indicators of the value of housing at a given time. This data was available for many cities and provinces Canada-wide, but we discarded all data other than that for Alberta and Calgary. The data was available as seasonally adjusted or not seasonally adjusted, and we chose to exclude the seasonally adjusted HPI data to ensure the accuracy of the HPI benchmarks. As mentioned earlier, only data from 2005 to 2019 was collected. We split this data into two separate tables, one for each city. We will call these tables BenchmarksEdmonton and BenchmarksCalgary.

We found an extensive data set on the Statistics Canada data portal containing various information regarding Canada's family income. The data set listed the median family income for each year and every major city and province in Canada, based on the family type and the age of the oldest adult in the family. The family type can be a couple family (two parents), a lone-parent family, and a persons not in census families (an individual living alone, or anyone that does not fall under the other two categories).

Table I shows the categories of the age of the oldest adult in the family.[7].

| Age of Older Adult |
|--------------------|
| 0 to 24            |
| 25 to 34           |
| 35 to 44           |
| 45 to 54           |
| 55 to 64           |
| 65 to over         |

TABLE I  
AGE GROUP OF OLDEST ADULT IN FAMILY

For each of these combinations of attributes, there were rows for the count of families with a combined yearly income of greater than different specified monetary amounts. These values slightly varied per family type.

Table II is an example of the monetary intervals and the respective family counts from the couple families family type in Calgary in 2005.[7].

| Family Income | Family Count |
|---------------|--------------|
| < 10,000      | 5,780        |
| >= 10,000     | 248,760      |
| >= 20,000     | 241,270      |
| >= 30,000     | 227,010      |
| >= 40,000     | 209,540      |
| >= 50,000     | 191,070      |
| >= 60,000     | 171,600      |
| >= 70,000     | 151,740      |
| >= 75,000     | 141,960      |
| >= 80,000     | 132,460      |
| >= 90,000     | 114,630      |
| >= 100,000    | 98,530       |
| >= 150,000    | 46,450       |
| >= 200,000    | 25,270       |
| >= 250,000    | 16,160       |

TABLE II  
AGE GROUP OF OLDEST ADULT IN FAMILY

We omitted amounts smaller than \$10,000, as these families would most likely not be pursuing a mortgage while their annual income was this low. We split this data into two separate tables: FamilyIncomeCount and MedianFamilyIncome. Both tables had Alberta, Edmonton and Calgary data from 2005 to 2019. FamilyIncomeCount contained the count of families that made more than specified monetary intervals for each family type. MedianFamilyIncome contained the median family income and family count for each family type and age of the oldest adult.

#### IV. ASSUMPTIONS

While analyzing the data, we had to make assumptions. The first assumption was that the data provided by Statistics Canada was an accurate resource. With more than ten years of responses, we assumed that the difference in response numbers between data sets would not affect the overall result. The second assumption was that the HPI data provided by CREA was accurate and legitimate. It is not government-generated data, but it is assumed to be accurate benchmarks and HPI data to provide real-life prices for the agency. The last assumption is that all people were eligible for a mortgage. Typically, restrictions and requirements are needed to apply for a mortgage. We ignored

these requirements and assumed that all families were eligible for mortgages based on their income.

## V. DATA MINING METHODS

### A. Data Visualization

We decided the simplest way to compare the affordability between Edmonton and Calgary was to determine the actual number of families able to afford a mortgage. For this, we included FamilyIncomeCount, separated into two tables, one for Edmonton and Calgary, which we will call EdmontonFIC and CalgaryFIC. We also included BenchmarksEdmonton and BenchmarksCalgary, where we calculated the benchmark prices per each housing type and year by finding the average of the combined months in the year. We did not include the HPI values for this process. At this point, we combined the data sets, combining BenchmarksEdmonton and EdmontonFIC, and BenchmarksCalgary and CalgaryFIC by year. We will call these two new tables EdmontonCombined and CalgaryCombined.

We decided it would be best to calculate the affordability for all housing types (composite), so we omitted the other types. We set the initial mortgage length to be 25 years and the income amount for the mortgage to be 30 percent of a family's annual income. Therefore, we calculate affordability if 30 percent of a family's income was more than the composite benchmark price divided by 25 (25 years to pay off the mortgage). This calculation assumes that there is no interest rate on the mortgage.

We created new columns: the income required to afford the mortgage, the total family count, the count of families that can afford a mortgage, and the count of families who cannot. These would be for each family type and year. The income required was the composite benchmark price divided by 25 and multiplied by 3.33 (this results in the lowest income that is considered affordable by the 30 percent of income standard). The total family count was families at the \$10,000 or more income bracket.

The number of families who could afford a mortgage was the family count at the lowest income bracket with a higher income than the income required column. The number of families who could not afford a mortgage was the difference between the previous count and the total family count. With these amounts obtained, we only needed one row

per family type and year and discarded the rest. We performed this process for both EdmontonCombined and CalgaryCombined.

The two tables were joined by the year and family type, changing the column titles to indicate if the data was for Calgary or Edmonton. We discarded all columns except the year, family type, the total family counts for Edmonton and Calgary, the family count who can afford the mortgage in Edmonton and Calgary, and the family count of who cannot afford the mortgage in Edmonton and Calgary. We then converted these counts into percentages under new columns. Finally, we obtained the percent of families who could not afford a mortgage at the average benchmark housing price in their city for both Edmonton and Calgary. We present this information in Table III.

We also collected other affordability counts concerning different housing types. Figures 3-10 are visualizations of counts of family types that were able to afford a variable mortgage between 2005 and 2019. The age of the oldest adult categorizes each column, which we did not use for Table III.

To get these Figures, we started with BenchmarksEdmonton, BenchmarksCalgary, and MedianFamilyIncome. In BenchmarksEdmonton and BenchmarksCalgary, we calculated the yearly average prices and discarded the HPI data, as was done to calculate Table III. We split MedianFamilyIncome into two tables, one for Edmonton and one for Calgary. We combined these tables with their respective benchmarks table by city, called EdmontonCombined and CalgaryCombined.

We calculated the median income associated with each year for each of these combined tables. This calculation was done by dividing each housing type's benchmark prices by 25 (or 10, depending on the mortgage length for the Figure.) The median total income was multiplied by 0.3, which gives us 30 percent of the housing type's annual income and mortgage rate.

If the mortgage rate was more than 30 percent of the income, we set affordability for this housing type as "not affordable." Otherwise, it was "affordable." The figures were generated based on these affordability counts, counting each row with the selected age of the oldest adult for each bar in the chart.

| Date | Family Type            | Edmonton | Calgary |
|------|------------------------|----------|---------|
| 2005 | Couple families        | 91.8     | 84.2    |
| 2005 | Lone-parent families   | 63       | 52.3    |
| 2005 | Not in census families | 50.7     | 39.3    |
| 2006 | Couple families        | 86.9     | 80.2    |
| 2006 | Lone-parent families   | 53.1     | 45      |
| 2006 | Not in census families | 38.9     | 31.5    |
| 2007 | Couple families        | 81.1     | 75      |
| 2007 | Lone-parent families   | 42.9     | 38.3    |
| 2007 | Not in census families | 30.3     | 25.3    |
| 2008 | Couple families        | 82.3     | 75.8    |
| 2008 | Lone-parent families   | 46.4     | 41.1    |
| 2008 | Not in census families | 33.6     | 28.1    |
| 2009 | Couple families        | 87.6     | 80.6    |
| 2009 | Lone-parent families   | 59.6     | 50.4    |
| 2009 | Not in census families | 45.6     | 37.1    |
| 2010 | Couple families        | 81.7     | 80.7    |
| 2010 | Lone-parent families   | 46.4     | 50.1    |
| 2010 | Not in census families | 35       | 37.8    |
| 2011 | Couple families        | 82.8     | 81.9    |
| 2011 | Lone-parent families   | 48.4     | 51.7    |
| 2011 | Not in census families | 36.7     | 39.4    |
| 2012 | Couple families        | 84       | 83.4    |
| 2012 | Lone-parent families   | 51.1     | 54.9    |
| 2012 | Not in census families | 38.9     | 41.4    |
| 2013 | Couple families        | 84.5     | 78.5    |
| 2013 | Lone-parent families   | 53       | 46.7    |
| 2013 | Not in census families | 40.4     | 33.8    |
| 2014 | Couple families        | 85.1     | 79.6    |
| 2014 | Lone-parent families   | 54.5     | 48.5    |
| 2014 | Not in census families | 41.8     | 35.1    |
| 2015 | Couple families        | 85.9     | 80      |
| 2015 | Lone-parent families   | 55.2     | 49      |
| 2015 | Not in census families | 41.7     | 34.8    |
| 2016 | Couple families        | 85.4     | 78.7    |
| 2016 | Lone-parent families   | 54.4     | 47.6    |
| 2016 | Not in census families | 40.3     | 33.2    |
| 2017 | Couple families        | 86.4     | 79.7    |
| 2017 | Lone-parent families   | 55       | 48.1    |
| 2017 | Not in census families | 40.9     | 33.5    |
| 2018 | Couple families        | 87.1     | 80.6    |
| 2018 | Lone-parent families   | 56.2     | 49.4    |
| 2018 | Not in census families | 41.6     | 34      |
| 2019 | Couple families        | 87.6     | 81.4    |
| 2019 | Lone-parent families   | 58.6     | 51.6    |
| 2019 | Not in census families | 41.7     | 34.2    |

TABLE III  
PERCENTAGE OF FAMILIES THAT CAN AFFORD COMPOSITE  
HOUSING IN EDMONTON AND CALGARY

Figures 3 and 4 represent Calgary and Edmonton's combined housing affordability. Figure 3 is for 25-year mortgages, and Figure 4 is for 10-year mortgages. Figures 5 and 6 display the affordability of apartments, townhouses, one-storey and two-storey housing types under a 25-year mortgage in Calgary, and Figures 7 and 8 are the same but for

Edmonton.

Figures 9 and 10 display the difference between the counts represented in Figures 3-8 concerning the length of mortgage in years. We calculated affordability counts similarly to the previous counts, except the mortgage length was changed each time. The difference of affordability counts was calculated for each of these mortgage rates and plotted in a line graph. The dotted line in these Figures represents 0, where the difference between can afford and cannot afford counts is neutral.

### B. Clustering

After cleaning our data, we created clusters to see if there was anything that specific data points had in common. To do this, we took our cleaned data and further stripped it to numbers only, then normalized the data. We tried both a hierarchical clustering approach and K means clustering to see how the computer clustered things together.

Figure 1 is the result of the hierarchical clustering for the data for Edmonton. Each number represents a specific row in the data. Going back to the original data, we noticed that it tended to cluster together based on specific family types. For example, couple families tended to be part of either the same rank or just one before, and lone families tended to do the same. A similar trend happened with the Calgary set. We noticed that it seemed to do this because each family type would have a similar median income and a similar number of families that could and could not afford housing in that city.

Figure 2 shows the K means clustering model of our composite affordability data for Edmonton. We used a k center of 5 to make the model, which showed much the same as the hierarchical clustering. They clustered around family types based on similar median incomes and affordability counts.

## VI. ANALYSIS

After applying data mining processes to the benchmark and census data, we found some interesting results related to housing affordability. We discuss the effects of the age of the oldest adult, the housing type, the length of the mortgage term and the family type, and the difference between Edmonton and Calgary's affordability below.

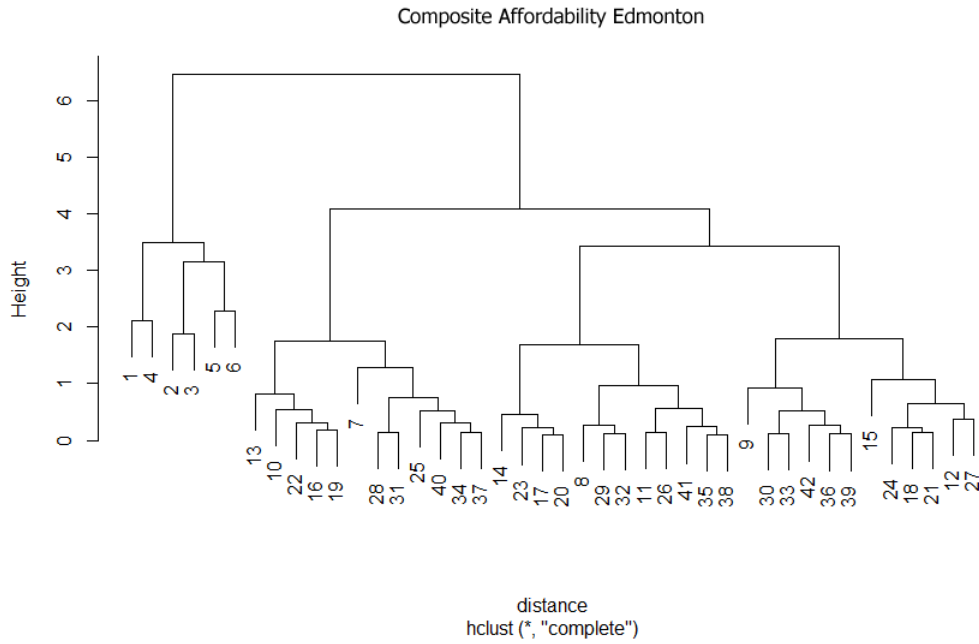


Fig. 1. Hierarchical Clustering of the composite affordability Edmonton

#### A. Age of Oldest Adult

Figure 3 shows that, until ages 45 to 54, the affordability count increases with the age of the oldest adult. The jump from 0 to 24, to 25 to 34 is quite significant in all Figures. We expected this jump, as most families and individuals at this age do not make enough to support a mortgage, and renting property is a more feasible option. After we reach the 45 to 54 point, the count that can afford the 25-year mortgage starts decreasing until the 65 and over point. This pattern holds for both cities. After the age group 45 to 54 years old, the figure shows that the number of yes counts are decreasing, but still, the number of affordable counts is much greater than not affordable. The drop-off in affordability counts after 45 to 54 years could be due to families retiring. According to Statistic Canada, the average retirement age of Canadians is 63 years old[8]. Therefore, retirement is causing the age group 45 to 54 years old to have higher counts than 65 and older. These findings hold for most of the individual housing types for each city. These results indicate that some families cannot afford

shelter in all age groups. Therefore, being in the highest affordable age group will not always result in affordable housing for families.

#### B. Housing Type

Figures 5, 6, 7, and 8 show the affordability count of the apartment, one-storey, two-storey, and townhouse housing types in Calgary and Edmonton. In these Figures, we can observe a trend between the housing type and the affordability counts. Apartment and townhouse housing types have much higher affordability rates than the one-storey and two-storey housing types do. Both cities gave out similar results of affordable counts for housing type.

While the youngest age group is still in the majority of not affordable for both townhouses and apartments, every age group other than 0 to 24 years has the vast majority of affordability. Some of these age groups have no count of being unable to afford these housing types. We can see that, on average, the apartment is more affordable than the townhouse, by the count. This difference is displayed by comparing Figure 5 and Figure 7.

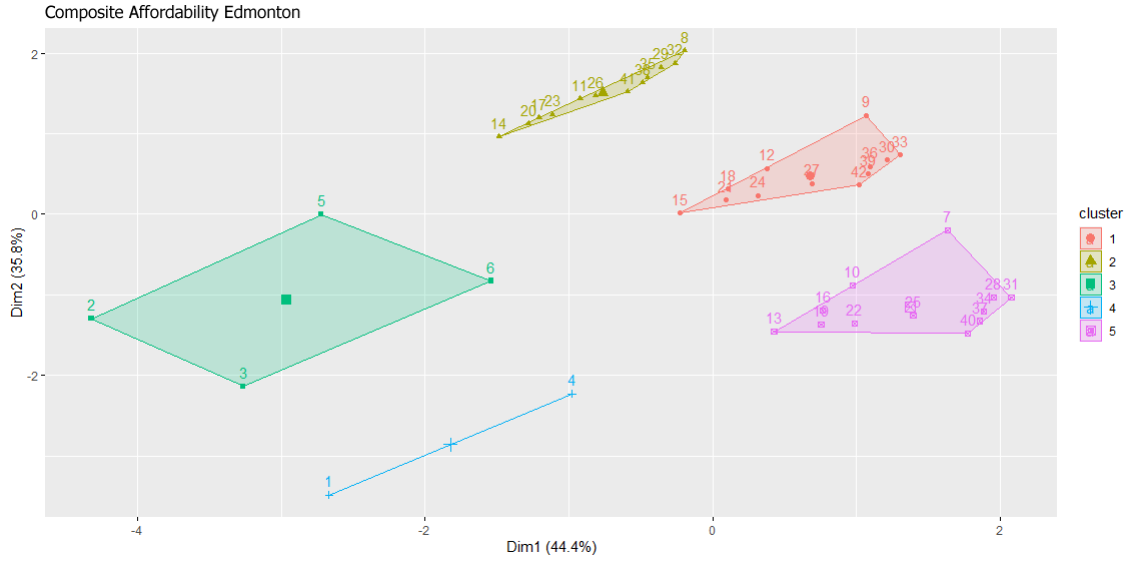


Fig. 2. K Means Clustering of the composite affordability of Edmonton

The one-storey and two-storey housing types were much less affordable than the townhouse and apartment types. Similarly, the 0 to 24 age group has a majority of being unable to afford these housing types, extending to the 25 to 34 and the 35 to 44 age range groups. The two-storey housing type has the highest count of family types unable to afford the mortgage. This difference can be seen by comparing Figure 6 and Figure 8. We can conclude that housing types that do not share common areas with other families are generally much more affordable than single-family housing types.

### C. Mortgage Term

The affordable counts in Figure 3 and Figure 4 show the result of affordability in 25-year and 10-year mortgage terms for both Calgary and Edmonton. As the term decrease, the affordable count greatly decreases and as the term increase, the affordable count increase. In Figure 3 we can see that there are some age groups with a higher number of affordable counts, but in Figure 4 we can see all of the counts are not affordable. Figures 9 and 10 also display this relationship between affordability and mortgage rates, separated by family type. We can conclude from these two Figures that a mortgage term length below 15 years for couple families

and 25 years for lone-parent families will not be advisable, as the majority of families over the years would not have been able to afford these mortgage rates.

### D. Family Type

Affordability increases as the mortgage term increases and decreases with it. However, how is affordability affected by the family type regarding the mortgage term? In Figures 9 and 10 we found out there is a relation between family type and the mortgage terms. We compared couple families and lone-parent families to find the results. The blue dotted line represents the zero horizontal line in the figures, and the curves represent the difference in the number of families who can and cannot afford housing. If the curve is a negative value, then the number of families that cannot afford housing is greater than those that can. As mentioned in the previous section, a mortgage term length below 15 years for couple families and 25 years for lone-parent families will not be advisable, as the majority of families over the years would not have been able to afford these mortgage rates. The couple families can afford shorter lengths of mortgage terms than the lone-parent families, as their median total incomes are greater than lone-parent families.

We can draw the same conclusion from Table III. The Table shows that, for every year and each location, the couple families have the highest affordability rates, followed by single-parent families, and finally, the persons not in census families. It is interesting to note that while the percentages fluctuate over the years, couple families hover approximately between 80 to 90 percent affordability, lone-parent families from 40 to 60 percent, and persons not in census families between 30 to 45. These rates make logical sense, as the higher the median income for a family type, the higher the count of families who can afford housing in this type.

The clustering analysis showed much the same regarding affordability among family types. Even when stripping the data down to purely numbers, the program would tend to group based on the family type. It could have been doing so based on median incomes and affordability rates being closer together in their respective categories even over several years, with couple families trending higher than other family types like the lone parent family.

#### E. Comparing Edmonton and Calgary

We found differences in affordability between Calgary and Edmonton by comparing all the results. Figure 3 displays the affordability count for all types of housing in Edmonton and Calgary. At first glance, the results are quite similar. However, if looked carefully, Calgary's not affordable count is slightly larger than the Edmonton for all age categories. Similarly, in Figure 4 Edmonton affordable count is slightly larger than Calgary's. In Figures 5, 6, 7, and 8, the result generally shows that the affordable count in Edmonton is higher than Calgary.

In Figures 10 and 9, the differences between the count of families who can and cannot afford the mortgage rate for all housing types is different. Couple families in Edmonton pass the zero line between 10 to 12.5 years, and in Calgary, they pass the line in between 12.5 to 15. Also, for Lone-parent families, Edmonton passes the zero line before 25 years, and Calgary passes the line at 25 years. Therefore, we can say that the Edmonton housing market has been slightly more affordable

the Calgary's over the years, even with different family types, age groups, and mortgage rates.

The results in Table III further this. Comparing the cities beside each other, for nearly every family type for each year, the percentage of families who can afford housing is more significant in Edmonton than in Calgary. We can conclude that overall, Edmonton has higher affordability rates than Calgary and has a slightly more affordable housing market.

#### VII. CONCLUSION

In our analysis of the data mining procedures we underwent, we discovered that the family type, the age of the oldest adult, the housing type, and the mortgage term had significant effects on housing affordability in Edmonton and Calgary. Families with the oldest adult in the 45 to 54 years age range had the highest affordability. Clustering the benchmark and income data resulted in getting the family types clustered together, as the family type significantly impacts housing affordability rates. Couple families had the highest affordability rates, followed by lone-parent families and persons not in census families. In terms of housing type, we discovered that townhouses and apartments are generally affordable for all age ranges, except the 0 to 24 year age range. However, those with the oldest adult under the age of 45 are most likely unable to afford a reasonable mortgage of the benchmark prices for one-storey and two-storey housing. We found that it is impractical for couple families to start mortgages under a 15-year term, as the average family will not be able to afford the price of a mortgage rate for the average benchmark pricing. For lone-parent families, mortgages under 25 years have the same effect. Finally, we concluded that Edmonton has higher rates of families able to afford mortgages than Calgary. We found this from actual counts of families and the mortgage rates they could afford, and Edmonton edges out Calgary for almost every category of age range, family type, housing type and mortgage length.

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Fig. 3. Count of family types of 2005 to 2019 in Calgary and Edmonton that can afford all housing combined per age of oldest adult for a 25 year mortgage.



Fig. 4. Count of family types of 2005 to 2019 in Calgary and Edmonton that can afford all housing combined per age of oldest adult for a 10 year mortgage.



Fig. 5. Count of family types of 2005 to 2019 in Calgary that can afford apartment and townhouse housing types combined per age of oldest adult for a 25 year mortgage.

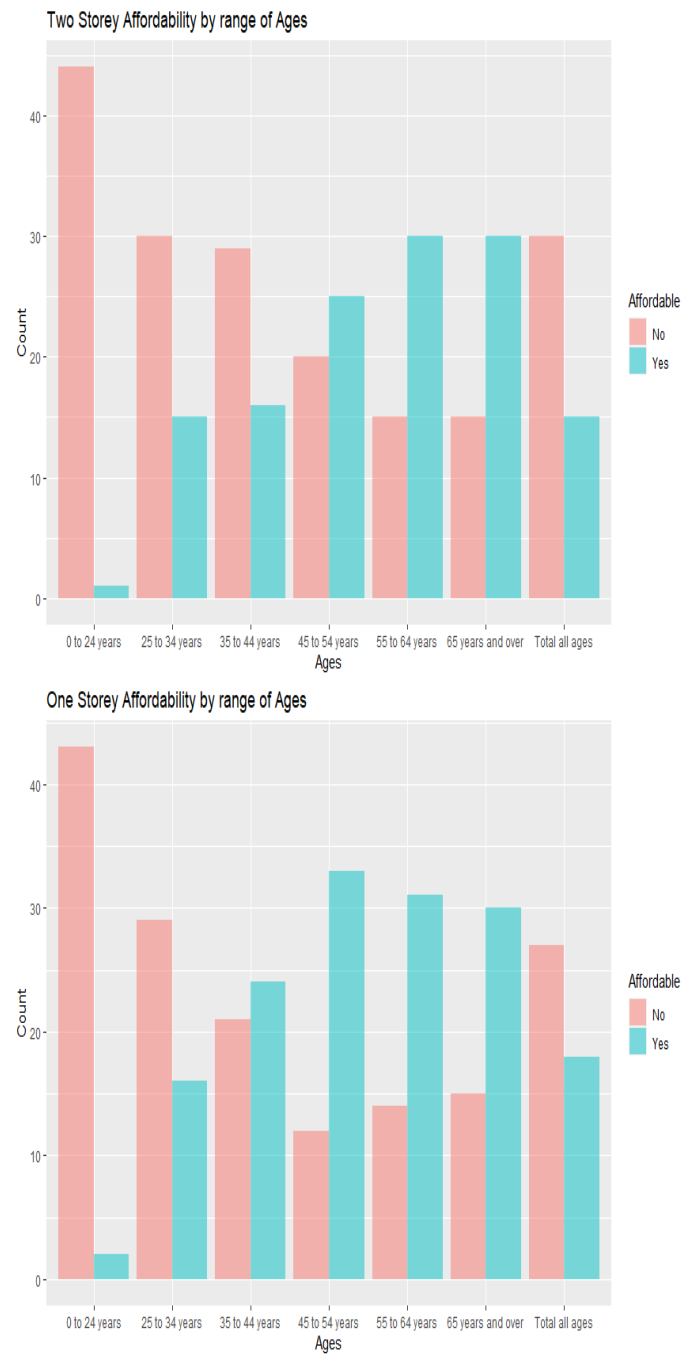


Fig. 6. Count of family types of 2005 to 2019 in Calgary that can afford one-storey and two-storey housing types combined per age of oldest adult for a 25 year mortgage.

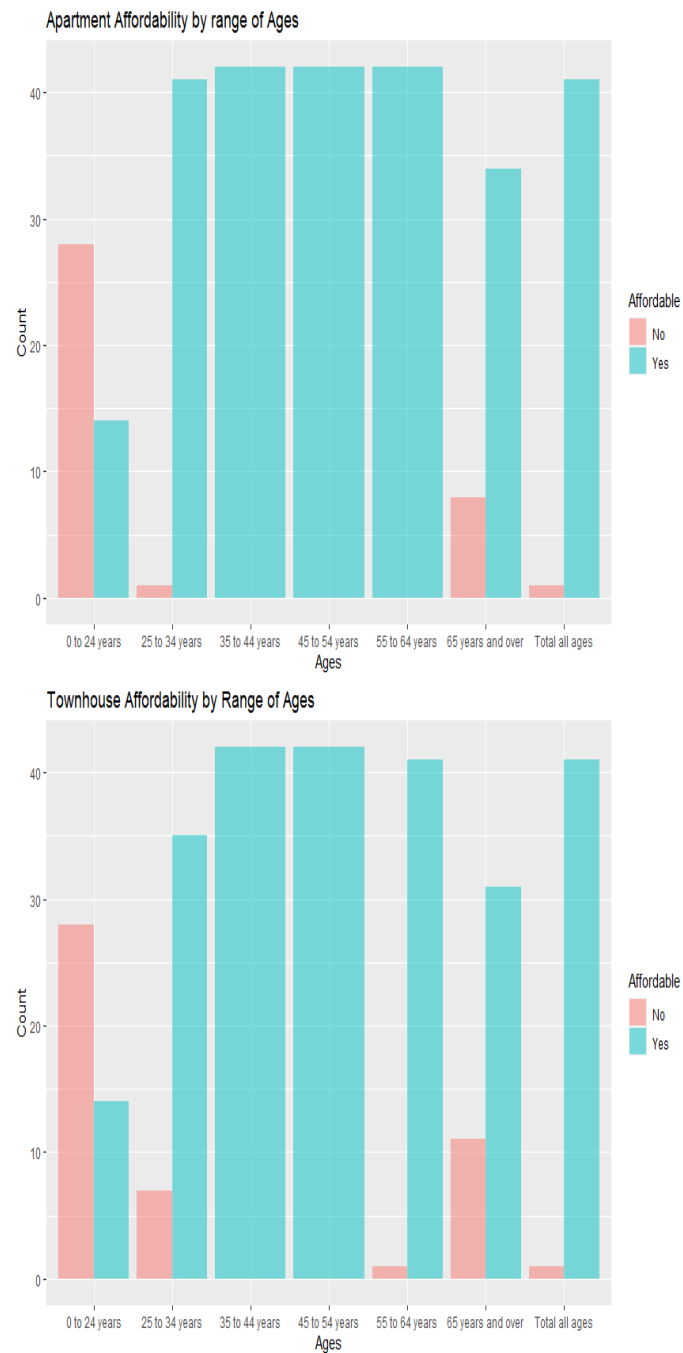


Fig. 7. Count of family types of 2005 to 2019 in Edmonton that can afford apartment and townhouse housing types combined per age of oldest adult for a 25 year mortgage.

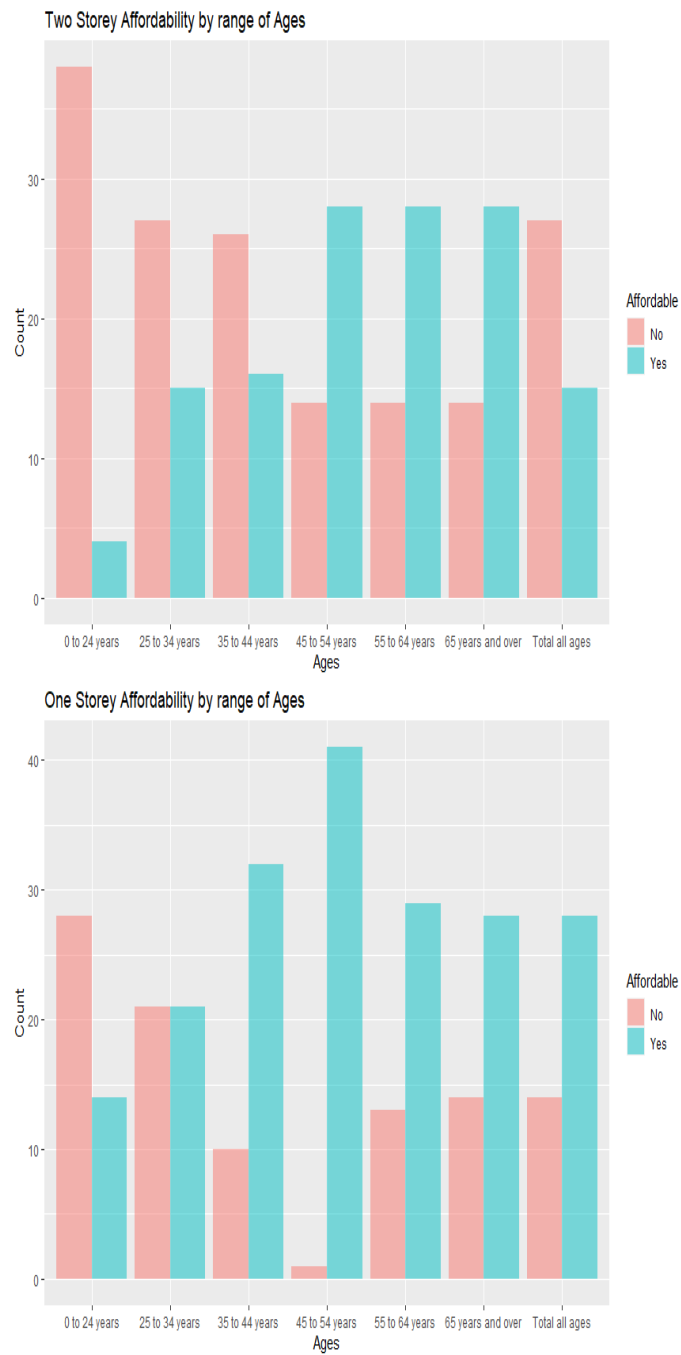


Fig. 8. Count of family types of 2005 to 2019 in Edmonton that can afford one-storey and two-storey housing types combined per age of oldest adult for a 25 year mortgage.

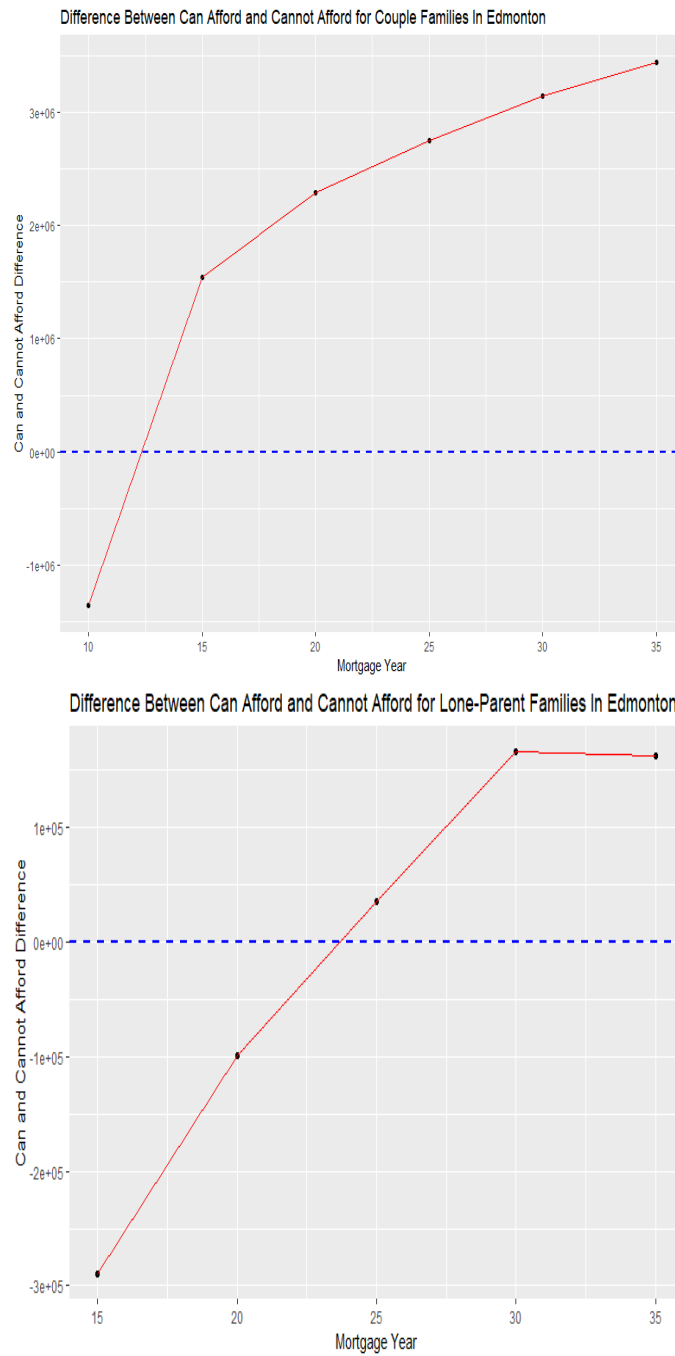


Fig. 9. Difference between counts of families who can and cannot afford different mortgage rates from 2005 to 2019 in Edmonton.



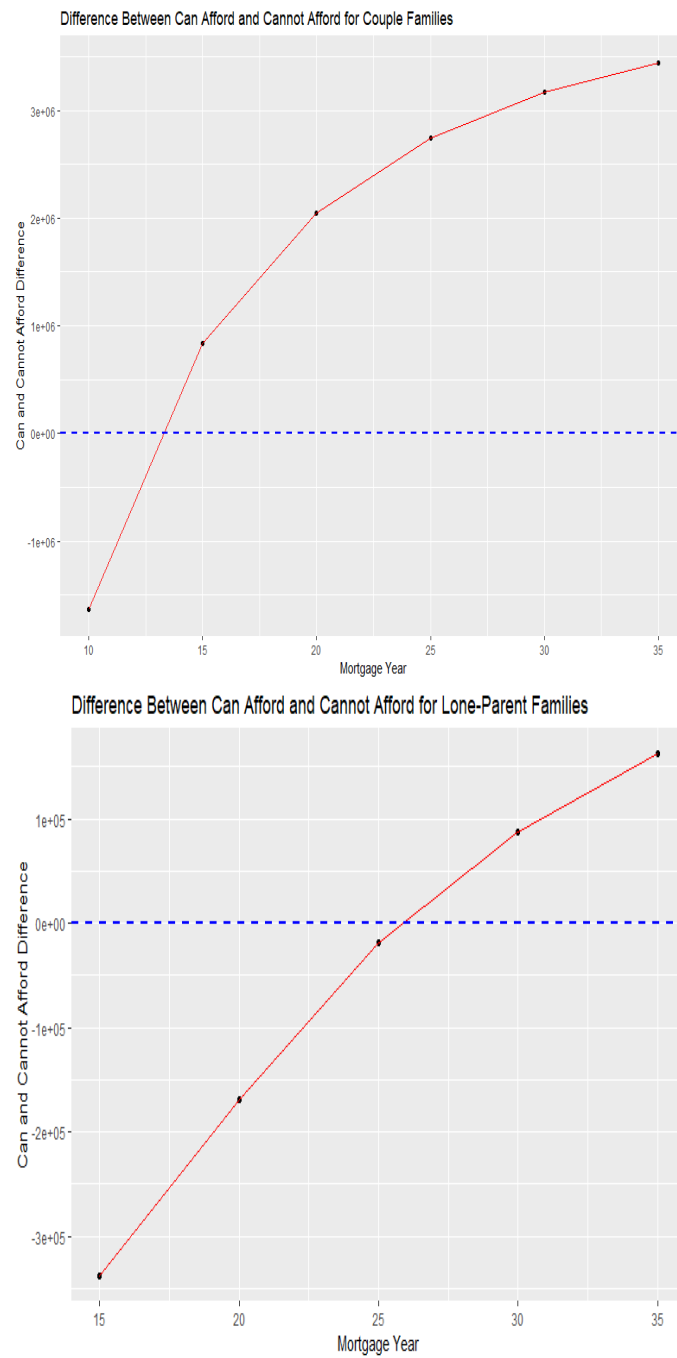


Fig. 10. Difference between counts of families who can and cannot afford different mortgage rates from 2005 to 2019 in Calgary.