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COMP309 Assignment 2
Real-World Data Handling, Modelling and Visualization

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Part 1: Evidence related to rental costs in Wellington

The datasets are selected from the website of MBIE (The Ministry of Business, Innovation and Employment) linked from Data NZ (http://www.data.govt.nz/).

The raw data (http://www.mbie.govt.nz/info-services/housing-property/sector-information-and-statistics/rental-bond-data) are available under a Creative Commons licence.

7 .csv files are selected. They are:

- Geometric mean rents by TA [CSV 91KB],
- Detailed mean rents [CSV 7.5MB],
- Detailed geometric mean rents [CSV 7.5MB],
- Detailed synthetic upper quartile rents [CSV 7.5MB],
- Detailed synthetic lower quartile rents [CSV 7.5MB],
- Detailed lodged bonds [CSV 6.5MB],
- Geographical Table [CSV 89KB].

The data started from Jan 1993 until Jul 2018, which records all new rental bonds that are lodged each month.

1. Geometric mean rents by TA.csv

Geometric mean rents from 1993 to 2018 of Auckland (City, North Shore), Christchurch, Dunedin, Hamilton, Palmerston North, Wellington (City, Lower Hutt) and National Total were selected to compare the percentage increase of rent in the past years. The cities are selected according to the locations of the 8 universities in New Zealand.

2. Detailed *** rents.csv

Mean, geometric mean, upper and lower quartile rents from 1993 to 2018 in all the suburbs of the 8 targeted cities or area are recorded in these .csv. The data are detailed into different types of the accommodation with number of bedrooms:

- House (with 1, 2, 3, 4, 5+ bedrooms);
- Flat or Apartment (with 1, 2, 3, 4, 5+ bedrooms);
- Room (1 bedroom)

3. Detailed lodged bonds.csv

The newly lodged number of rent for different types of accommodation per month are recorded in this file, which can work together with the rental price detailed in the Detailed *** rents.csv, to investigate the relationship between supply and demand.

4. Geographical Table.csv

All the cities, towns, area recorded in the Detailed *** rents.csv are in the format of Statistical Area Unit (SAU) codes rather than their real names. So, this form is needed to correlate them.

The datasets are **manipulated** (integrated) in below **pipeline**:

1. For each *** rents.csv and *** bonds.csv, three new columns are added, which are
   - Town/Suburb
   - City/District
   - Region

2. A vlookup function is set up and implemented to fill each row of the 3 columns in each *** rents.csv and *** bonds.csv by looking up SAU code in Geographical Table.csv. In this way, the codes are translated into meaningful locations of the properties. For example:

	A	B	C	D	E
1	SAU	Property_Type	Bedrooms	1/03/19	1/06/19
2	500100	House	2	NA	NA
3	500100	House	3	NA	NA
4	500100	House	Bedrooms Total	NA	NA
5	500100	Property Type Total	2	NA	NA
6	500100	Property Type Total	3	NA	NA
7	500100	Property Type Total	Bedrooms Total	NA	NA
8	500202	Flat or Apartment	1	NA	NA
9	500202	Flat or Apartment	Bedrooms Total	NA	NA
10	500202	House	1	NA	NA
11	500202	House	2	NA	NA
12	500202	House	3	NA	NA
13	500202	House	4	NA	NA
14	500202	House	Bedrooms Total	NA	NA

==>

	A	B	C	D	E	F	G	H
1	SAU	Town/Suburb	City/District	Region	Property_Type	Bedrooms	1/03/19	1/06/19
2	500100	Awanui	Far North District	Northland	House	2	NA	NA
3	500100	Awanui	Far North District	Northland	House	3	NA	NA
4	500100	Awanui	Far North District	Northland	House	Bedrooms Total	NA	NA
5	500100	Awanui	Far North District	Northland	Property Type Total	2	NA	NA
6	500100	Awanui	Far North District	Northland	Property Type Total	3	NA	NA
7	500100	Awanui	Far North District	Northland	Property Type Total	Bedrooms Total	NA	NA
8	500202	Mangonui East	Far North District	Northland	Flat or Apartment	1	NA	NA
9	500202	Mangonui East	Far North District	Northland	Flat or Apartment	Bedrooms Total	NA	NA
10	500202	Mangonui East	Far North District	Northland	House	1	NA	NA
11	500202	Mangonui East	Far North District	Northland	House	2	NA	NA
12	500202	Mangonui East	Far North District	Northland	House	3	NA	NA
13	500202	Mangonui East	Far North District	Northland	House	4	NA	NA
14	500202	Mangonui East	Far North District	Northland	House	Bedrooms Total	NA	NA

3. The missing data rows are selected to be removed from the raw data by different criteria for different purposes of analysis. For example, if the analysis only concerns about the most recent rental market, all the month columns except for Jun 2018 and the "NA" rows are removed.

4. .arff files are built from the data in .csv files by adding the @relation, @attribute and @data, etc.

```
@relation National_Rental

@attribute Suburb string
@attribute City {Far_North,Whangarei,Kaipara,Rodney,North_Shore,Waitakere,Auckland,Franklin,Papakura,Manukau,Waikato,Hamilton,Waipa,Otorohanga,Waitomo,Ruapehu,Thames-Coromandel,Hauraki,Western_Bay_Of_Plenty,Matamata-Piako,South_Waikato,Tauranga,Rotorua,Taupo,Whakatane,Kawerau,Opotiki,Gisborne,Wairoa,Hastings,Napier,Central_HawkeS_Bay,Tararua,New_Plymouth,Stratford,South_Taranaki,Wanganui,Rangitikei,Manawatu,Horowhenua,Palmerston_North,Kapiti_Coast,Upper_Hutt,Lower_Hutt,Porirua,Wellington,Masterton,Carterton,South_Wairarapa,Marlborough,Kaikoura,Tasman,Nelson,Buller,Grey,Westland,Hurunui,Waimakariri,Selwyn,Christchurch,Ashburton,Timaru,Mackenzie,Waimate,Waitaki,Dunedin,Clutha,Central_Otago,Queenstown-Lakes,Invercargill,Gore,Southland}
@attribute Region {Northland,Auckland,Waikato,Manawatu-Wanganui,Bay_of_Plenty,Gisborne,Hawkes_Bay,Taranaki,Wellington,Marlborough,Canterbury,Tasman,Nelson,West_Coast,Otago,Southland}
@attribute Property_Type {Room_or_Boarding_House,Flat_or_Apartment,House}
@attribute Bedrooms numeric
@attribute Jun2018RentAve numeric

@data

Mangonui_East,Far_North,Northland,House,3,312
Taipa_Bay-Mangonui,Far_North,Northland,Flat_or_Apartment,2,275
Taipa_Bay-Mangonui,Far_North,Northland,House,3,318
Kaitaia_West,Far_North,Northland,Flat_or_Apartment,2,264
Kaitaia_West,Far_North,Northland,House,3,317
Kaitaia_East,Far_North,Northland,House,3,296
Kerikeri,Far_North,Northland,Flat_or_Apartment,1,279
Kerikeri,Far_North,Northland,House,1,275
Kerikeri,Far_North,Northland,House,2,381
```

```
@relation Wellington_Rental

@attribute Suburb {Tawa_South,Central_Tawa,Linden,Thorndon-Tinakori_Road,Lambton,Willis_Street-Cambridge_Terrace,Aro_Street-Nairn_Street,Mt_Cook-Wallace_Street,Mt_Victoria_West,Churton,Johnsonville_North,Johnsonville_South,Johnsonville_East,Newlands_North,Newlands_South,Raroa,Khandallah_Park,Te_Kainga,Rangoon_Heights,Awarua,Ngaio,Wadestown,Wilton-Otari,Karori_Park,Karori_East,Wright_Hill,Northland,Kelburn,Taitville,Brooklyn,Vogeltown,Kingston,Brooklyn_South,Island_Bay_West,Island_Bay_East,Melrose,Berhampore,Newtown_West,Newtown_East,Adelaide,Oriental_Bay,Roseneath,Hataitai,Kilbirnie_East,Kilbirnie_West,Lyall_Bay,Strathmore_Park,Miramar_South,Miramar_North,Seatoun}
@attribute City {Wellington_City}
@attribute Region {Wellington}
@attribute Property_Type {Room_or_Boarding_House,Flat_or_Apartment,House}
@attribute Bedrooms integer
%@attribute Bedrooms {1,2,3,4}
@attribute Jun2018RentAve integer

@data

Tawa_South,Wellington_City,Wellington,House,3,549
Central_Tawa,Wellington_City,Wellington,Flat_or_Apartment,2,385
Central_Tawa,Wellington_City,Wellington,House,3,500
Linden,Wellington_City,Wellington,House,2,416
Linden,Wellington_City,Wellington,House,3,496
Thorndon-Tinakori_Road,Wellington_City,Wellington,Flat_or_Apartment,1,394
Thorndon-Tinakori_Road,Wellington_City,Wellington,Flat_or_Apartment,2,525
Thorndon-Tinakori_Road,Wellington_City,Wellington,Flat_or_Apartment,3,575
Thorndon-Tinakori_Road,Wellington_City,Wellington,House,2,591
Thorndon-Tinakori_Road,Wellington_City,Wellington,House,3,762
Thorndon-Tinakori_Road,Wellington_City,Wellington,Room_or_Boarding_House,1,301
Lambton,Wellington_City,Wellington,Flat_or_Apartment,1,406
```

5. The .arff files are imported into Weka for modelling.

Feature Selection/Manipulation

7 important aspects of the data are selected to create the ML models. The location, type, number of rooms of a property are suspected to relate to the rent strongly. The newly lodged number of rental record can be used to analyse the supply and demand relationship. The rent cost is the predictive attribute in this case.

Attribute	Description	Data Type
Town/Suburb	The location of property.	Nominal and String *
City/District		
Region		
Property Type	House, Flat, Apartment or Room.	Nominal {1, 2, 3, 4}
No. of Rooms	Room number of the property type in each property type with certain room number.	Integer
Lodged No.	The newly lodged number of rental record.	Integer
Rent	The predictive attribute.	Integer

*: The selection between nominal and string for data type of location depends on whether the analysis focus is on inter-city or inter-suburb in a city.

Part 2: Feature importance to rental costs in Wellington

In this part, features that may determine the rental costs in Wellington are investigated.

1. **Attributes** that are **NOT strongly correlated** to the rental costs in Wellington:
   - GDP of New Zealand
   - Number of students at universities in Wellington

a. GDP of New Zealand vs. Wellington Average Rental Cost

New Zealand gross domestic product (GDP) raw data is downloaded from Stats NZ website. New Zealand rents related data is downloaded from MBIE website. Initially the rents data is recorded by month. To make the two variables comparable, the quarterly and annual growth by percentage are calculated from Wellington monthly absolute rent values (showed in Table 1).

Table 1. New Zealand GDP and Wellington average rent growth

Quarter	*NZ GDP * Quarterly Growth*	*WLG Rent ^ Quarterly Growth*	*NZ GDP * Annual Growth*	*WLG Rent ^ Annual Growth*
Mar-12	0.90%	4.11%	2.30%	0.57%
Jun-12	0.30%	-6.76%	2.70%	1.22%
Sep-12	0.10%	-1.51%	2.70%	-1.81%
Dec-12	1.50%	4.91%	2.60%	0.29%
Mar-13	-0.10%	6.14%	2.20%	2.25%
Jun-13	0.90%	-4.68%	2.20%	4.53%
Sep-13	0.70%	-2.02%	2.50%	3.99%
Dec-13	0.20%	2.06%	2.20%	1.17%
Mar-14	1.40%	8.09%	2.60%	3.03%
Jun-14	0.50%	-5.35%	2.70%	2.31%
Sep-14	1.30%	-1.69%	2.80%	2.65%
Dec-14	1.50%	5.75%	3.60%	6.36%
Mar-15	0.30%	5.98%	3.70%	4.28%
Jun-15	0.70%	-4.87%	3.90%	4.80%
Sep-15	1%	-6.74%	4%	-0.57%
Dec-15	1%	6.94%	3.50%	0.54%
Mar-16	1.20%	7.84%	3.60%	2.31%
Jun-16	1.10%	-5.51%	3.80%	1.62%
Sep-16	0.70%	-3.71%	3.90%	4.91%
Dec-16	0.40%	11.57%	4%	9.46%
Mar-17	0.80%	2.96%	3.70%	4.51%
Jun-17	0.90%	-4.32%	3.30%	5.84%
Sep-17	0.60%	-0.50%	3%	9.37%
Dec-17	0.60%	8.56%	2.80%	6.42%
Mar-18	0.50%	4.41%	2.70%	7.91%

***** NZ GDP data is collected from https://www.stats.govt.nz/topics/gross-domestic-product
^ Wellington average rental cost data is collected from http://www.mbie.govt.nz/info-services/housing-property/sector-information-and-statistics/rental-bond-data

The data above is plotted in below figures:

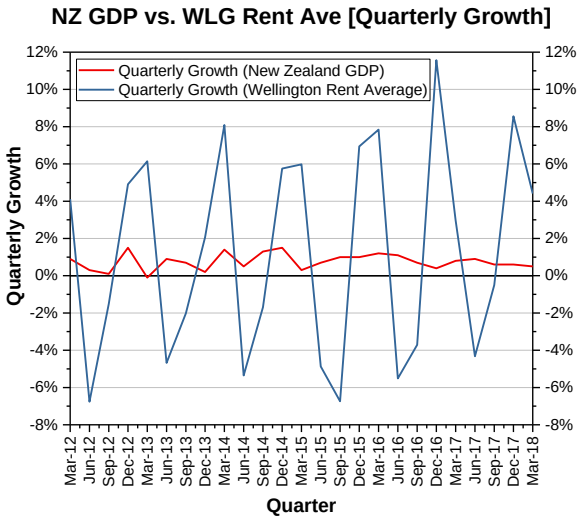

Fig.1 Quarterly Growth of NZ GDP & Wellington Rent Average

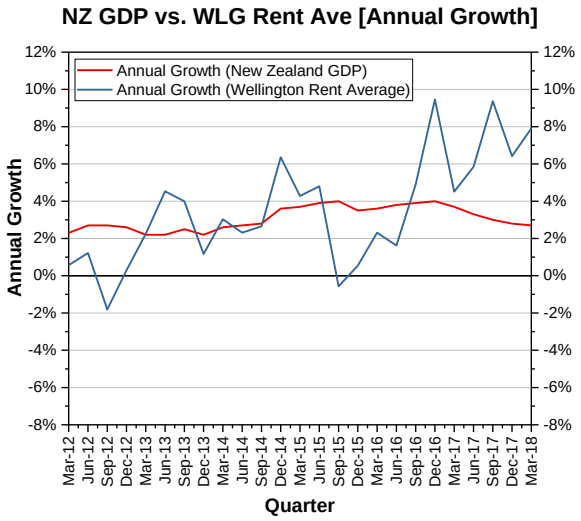

Fig.2 Annual Growth of NZ GDP & Wellington Rent Average

The correlation ρ is calculated for the data in above two charts and recorded in below table. And the correlation between them are not strong.

Table 2. Correlation (ρ) between New Zealand GDP and Wellington average rent

	Correlation (ρ)	Remarks
NZ GDP vs. WLG Rent Quarterly Growth	0.06	Not related
NZ GDP vs. WLG Rent Annual Growth	0.23	Weakly related

b. <u>Wellington student number in universities</u> vs. <u>Wellington Average Rental Cost</u>

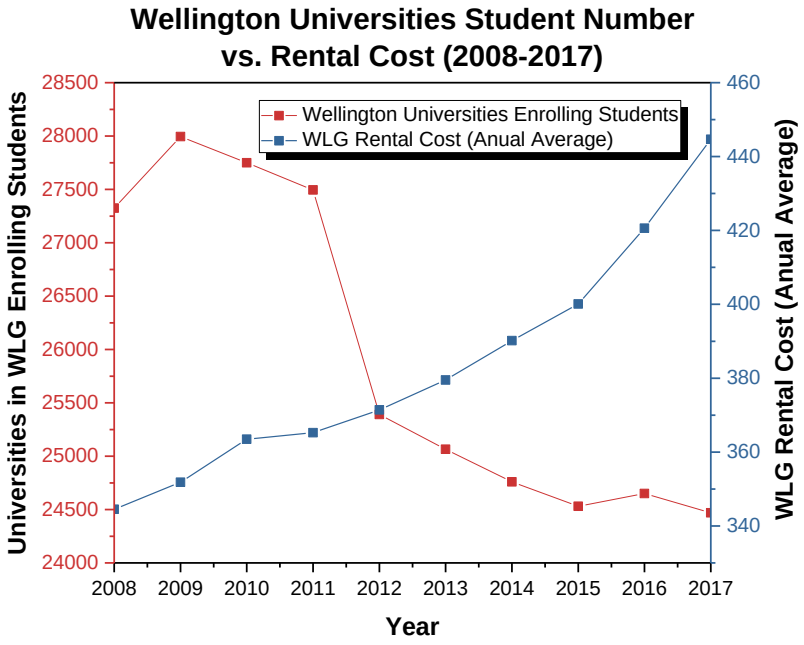

Fig.3 Wellington Student number in universities & Wellington Average Rental Cost

New Zealand territory education participation related raw data is downloaded from Education Counts* website. New Zealand rents related data is downloaded from MBIE website. Initially the rents data is recorded by month. To make the two variables comparable, annually average rent data of each year was calculated.

* Wellington Student number in universities data is collected from https://www.educationcounts.govt.nz/statistics/tertiary-education/participation

The correlation ρ is calculated for the data in above two charts and recorded in below table. Even though the absolute value of ρ between them are relatively high, the two data are not quite related to each other. Because normally, in supply-demand and price relationship, the high the demand the higher the price. **<u>There must be other reason, stronger demand other than students in Wellington universities.</u>**

Table 3. Correlation (ρ) between Wellington student number in universities and Wellington Average Rental Cost

	Correlation (ρ)
WLG Universities Student Number vs. WLG Average Rental Cost	-0.81

2. **Attributes** that are **correlated** to rental costs in Wellington:
   - Month of the year
   - Year
   - Property type
   - Bedrooms number
   - Suburb

a. Month of the Year vs. Wellington Average Rental Cost

The monthly average rental cost data in Wellington area is plotted in **Figure.4** according to the month of a year. The data includes all property types, bedrooms number, location in Wellington, from 1993 to 2018. The y-axis - difference - is calculated by subtracting the average rents over a year from 1993 to 2018 from the average rents over a certain month of a year in 1993-2018. For example, the data points in first error bar is calculated by

repeats from the **year** 1993 to 2018 {
    average over Jan of the **year** – average over the **year**;
}

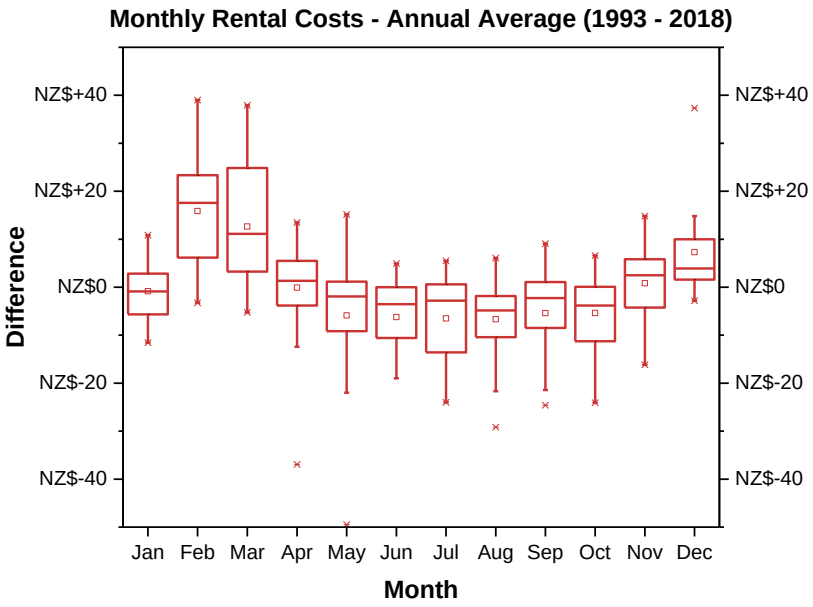

Fig.4 Difference between monthly rental costs and the annual average by month

From the data, we can see that, **in a year, the highest rent months are February and March**. The rent drops down in the autumn and keeps in a relatively low level in winter and starts to increase in the spring. **In February and March, the average rental costs are NZ$20 per week higher than the average of the year.** For some of the years, it is even NZ$40 higher in the two months.

b. New Zealand Cities (with a university) Average Rental Cost over the past 25 Years

The eight universities in New Zealand are located in Auckland, Christchurch, Dunedin, Hamilton, Palmerston North, Selwyn District and Wellington, respectively. The 3 suburbs near around the universities were also considered: North Shore, Manukau and Lower Hutt. From Figure.5, we can see the monthly average rent for all the regions keep rising in the past 25 years, especially in the recent 10 years.

The rent in Auckland area is the highest in New Zealand (including North Shore and Manukau), which reach NZ$550 in average (including all types of property and rooms number). **The rent in Wellington city is slightly lower, which is also over NZ$500 in average.** The rent in Auckland, Wellington city and Hamilton are higher than the national average (NZ$450). **The average rent in Palmerston North keeps low in all these cities and area, which is only around NZ$330 in 2018.**

Another finding in the figure is that, **the rents in Wellington city and Dunedin fluctuate periodically in a year**, more obviously than other cities. The reason why rental price is higher in summer but lower in winter in Wellington city might be because of the wind the rainfall in winter. The rental price also drops after summer every year and rises after winter in Dunedin. This may because of the low temperature in winter in Dunedin.

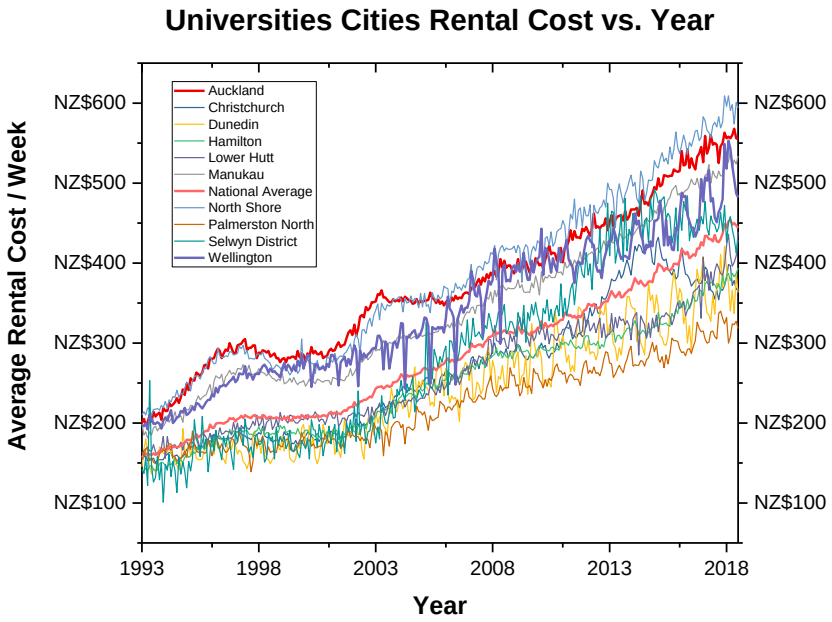

Fig.5 Average rental costs in New Zealand cities and areas with universities (1993-2018)

c. Comparison of average rental costs among New Zealand, Singapore and Hong Kong

The average rental costs in New Zealand rise over the year from 1993 to 2018 for all types of property and with different bedrooms number (plotted in Figure.6). For example, a 3-bedroom house in 2018 costs NZ$470 per week in average over all regions in New Zealand. A single room costs NZ$230.

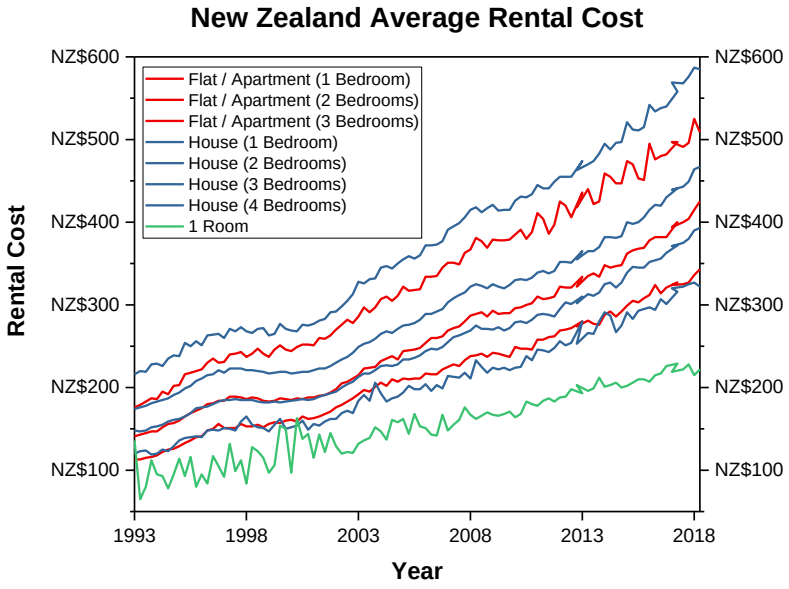

Fig.6 New Zealand average rental costs by property type and bedrooms number (1993-2018)

Comparing to New Zealand rental market, the rental costs of Singapore and Hong Kong are also showed below.

Data sources and remarks:

- Singapore

  https://data.gov.sg/dataset/median-rent-by-town-and-flat-type

  There is only median rent data of Singapore available online. There must be some error between median and average value, we assume the difference is not large.

  The original Singapore data was recorded in Singapore dollar, the data plotted in this report has been converted to New Zealand dollar according to the updated currency exchange rate. As we know, the currency exchange rate also varies over these years, but to make things easy, we assure the rate keeps the same.

- Hong Kong

  https://data.gov.hk/en-data/dataset/hk-rvd-tsinfo_rvd-property-market-statistics/resource/db56ece6-cd94-459c-9118-5b8d49aa0d0b

  The average rent data in Hong Kong area is recorded in per square meter, due to the space shortage and special rental market in Hong Kong. And because there are 5 classes of properties classified by the living area of the property, there are 5 figures below in this report show the price variation for each of them in the past 20 years.

  The original Hong Kong data was recorded in Hong Kong dollar, the data plotted in this report has been converted to New Zealand dollar according to the updated currency exchange rate. As we know, the currency exchange rate also varies over these years, but to make things easy, we assure the rate keeps the same.

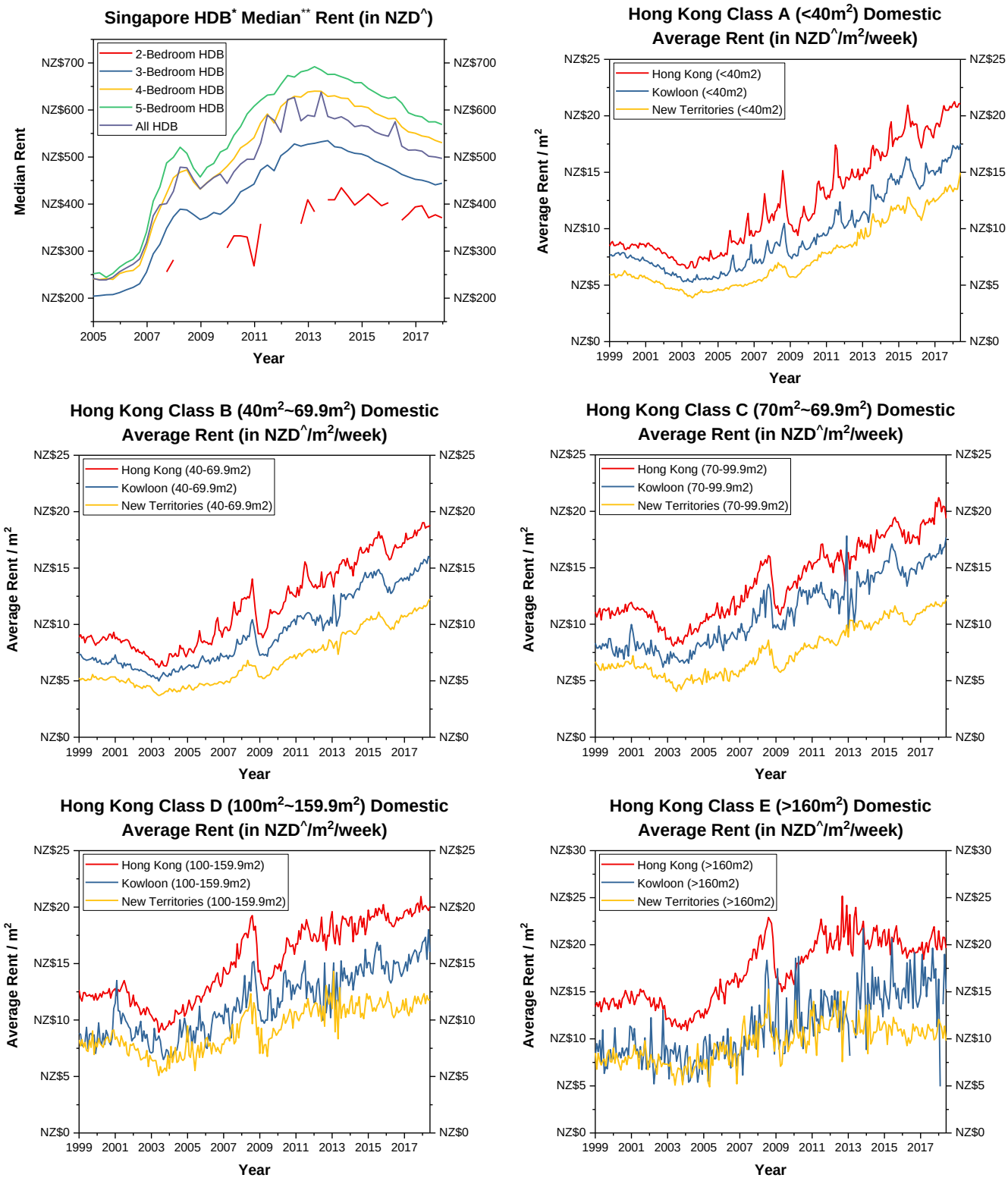

Fig.6 Singapore median (2005-2018) and Hong Kong average (1999-2018) rental costs by property size and area

* HDB: A type of property shares 75% of total dwelling units in Singapore.
** Median: The only available statistic online.
^ Updated Currency Exchange Rates: 1 SGD ≈ 1.10356 NZD, 1 HKD ≈ 0.193416NZD

From the data, we can see that:

1. Both the rental market in Singapore and Hong Kong were affected by 2009 financial crisis. New Zealand was not affected too much.
2. Except for the months around 2009, the average rents in New Zealand and Hong Kong keep rising. However, for Singapore, the price drops since 2013. This is because of the tightening of immigration policy.
3. To compare the price in a better way, take a property of $100m^2$ in each country/area in Jun 2018 as an example:

	Property	Estimated Rental per week
New Zealand	3-bedroom Apartment ($100m^2$)	520NZD/week
	2-bedroom House ($100m^2$)	390NZD/week
Singapore	3-bedroom HDB ($100m^2$)	450NZD/week
Hong Kong	Private Domestic ($100m^2$)	1700NZD/week

d. Comparison of average rental costs between Auckland and Wellington

The average rental costs between Auckland and Wellington are compared by different property type and room number.

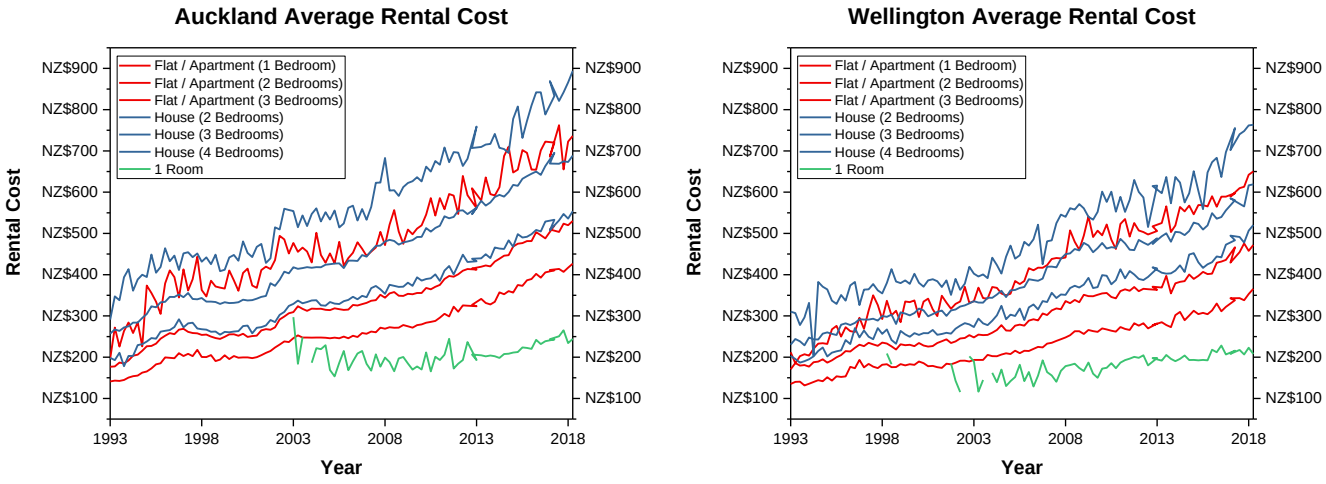

Fig.7 Auckland and Wellington average rental cost comparison

The data can be summarised into below table (data points are selected in Jun 2018):

Estimated Average Rental Cost	Auckland	Wellington	Auckland - Wellington
1-bedroom Flat/Apartment	430 NZD/week	360 NZD/week	+70 NZD/week
2-bedroom Flat/Apartment	530 NZD/week	460 NZD/week	+70 NZD/week
3-bedroom Flat/Apartment	740 NZD/week	650 NZD/week	+90 NZD/week
2-bedroom House	550 NZD/week	520 NZD/week	+30 NZD/week
3-bedroom House	690 NZD/week	620 NZD/week	+70 NZD/week
4-bedroom House	880 NZD/week	760 NZD/week	+120 NZD/week
1 Room	250 NZD/week	220 NZD/week	+30 NZD/week

From the example, we can see:

1. For each type and size of the property, the rental cost in Auckland is higher than the one in Wellington.
2. The larger the property, the larger the rental cost difference between Auckland and Wellington.

e. Comparison of average rental costs among major regions of Auckland and Wellington

The average rental costs among major regions of Auckland and Wellington for different type and size of the property are compare.

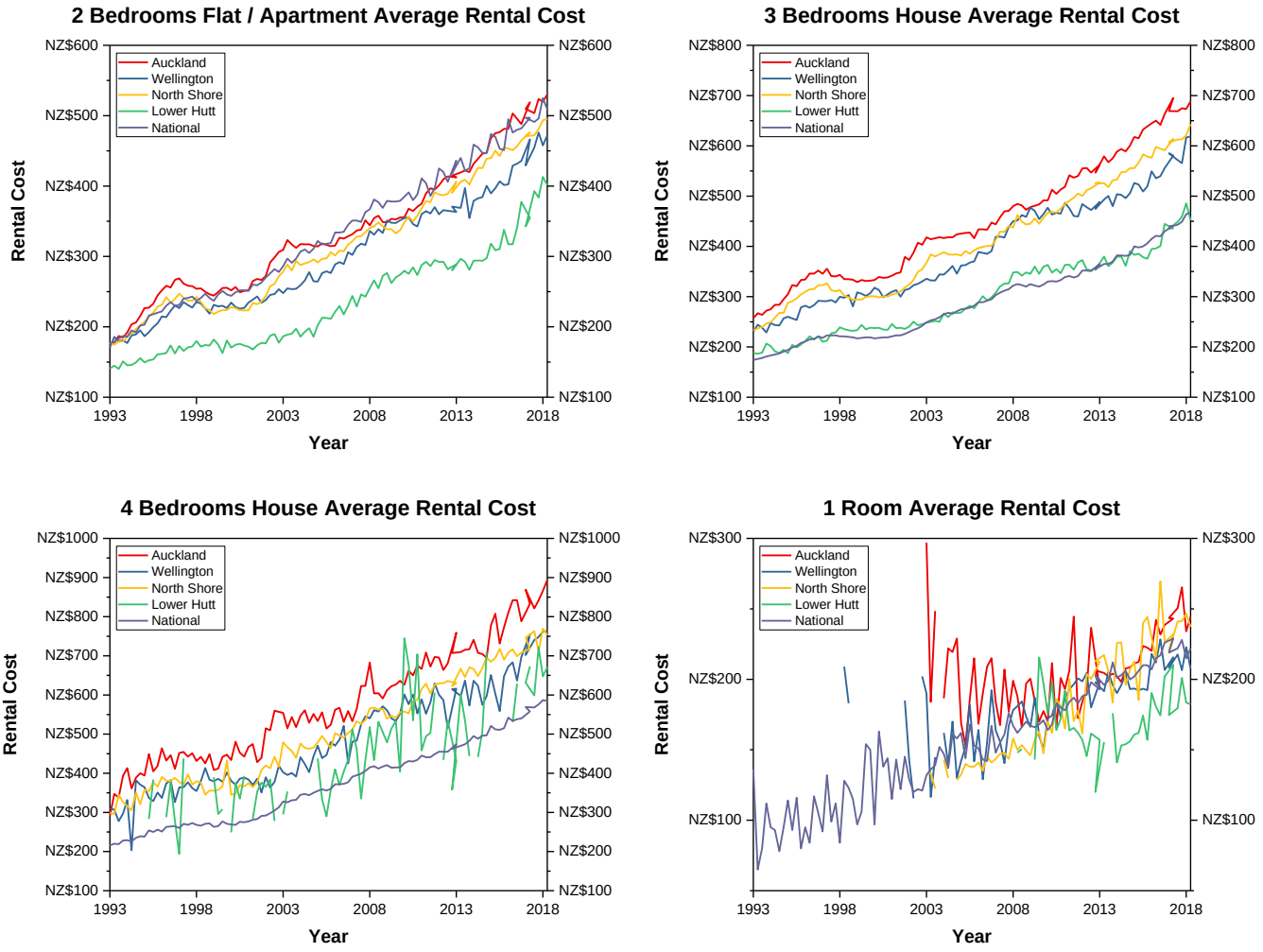

Fig.8 Auckland and Wellington average rental cost comparison

From the data, we can conclude:

1. The average rental cost in Lower Hutt area for each type and size of the property is the lowest among the selected areas. Auckland city is the highest.
2. The average rental cost in Wellington city is normally lower than Auckland city and North Shore.
3. For relatively larger house or apartment, the average rental cost in all the regions selected are higher than the national average; for smaller ones, like 1 room and 2-bedroom apartment, the average rental cost in selected regions are lower than national average, respectively.

f. Hypothesis of average rental costs for each suburb in Wellington city

The hypothesis equation below was generated by linear regression model in Weka, which considers the location, type and bedroom number of the property. **The correlation coefficient reaches 92.9%.**

```
Average Rent (Jun 2018) = NZ$ 32.9 +
                          NZ$208.9 (if Property_Type is House) +
                          NZ$154.3 (if Property_Type is Flat/Apartment) +
                          NZ$  0.0 (if Property_Type is Single_Room) +
                          NZ$121.9 * Bedrooms +
                          Rent Plus by Suburb
```

The rental plus variable can be looked up in below table for each suburb:

Suburb	Rent Plus
Roseneath	166.7
Oriental_Bay	160.3
Willis_Street-Cambridge_Terrace	136.8
Mt_Victoria_West	130.3
Kelburn	125.9
Thorndon-Tinakori_Road	100.9
Lambton	100.9
Seatoun	68.2
Rangoon_Heights	68.2
Miramar_South	68.2
Mt_Cook-Wallace_Street	59.6
Hataitai	59.0
Wadestown	59.0
Adelaide	57.6
Taitville	57.6
Te_Kainga	55.2
Melrose	53.1
Aro_Street-Nairn_Street	52.5
Vogeltown	46.9
Kilbirnie_West	44.6
Newtown_West	34.3
Brooklyn	34.3
Kilbirnie_East	28.5
Newtown_East	28.5
Island_Bay_East	20.7
Kingston	20.7
Northland	17.8
Lyall_Bay	17.8
Miramar_North	12.9
Brooklyn_South	11.4

Island_Bay_West	9.0
Wilton-Otari	-9.6
Wright_Hill	-10.4
Churton	-19.0
Ngaio	-33.0
Karori_Park	-36.8
Karori_East	-37.7
Newlands_North	-37.7
Johnsonville_East	-40.6
Strathmore_Park	-40.6
Johnsonville_South	-45.4
Raroa	-48.1
Awarua	-57.6
Tawa_South	-58.6
Newlands_South	-63.5
Johnsonville_North	-74.1
Khandallah_Park	-74.1
Central_Tawa	-76.9
Linden	-90.6

```
=== Cross-validation ===
=== Summary ===

Correlation coefficient                  0.9291
Kendall's tau                            0.7607
Mean absolute logarithmic error          0.1039
Mean absolute percentage error           0.1039
Root mean square logarithmic error       0.1557
Root mean square percentage error        0.146
Spearman's rho                           0.9167
Mean absolute error                     48.0271
Root mean squared error                 62.1647
Relative absolute error                 36.3692 %
Root relative squared error             37.6596 %
Total Number of Instances              158
```

3. **Other findings from dataset**:

For the past 25 years in New Zealand property rental market, both average rental price and volume keep rising. This means:

<u>Demand is always higher than supply in New Zealand rental market, even if the rental price keeps rising.</u>

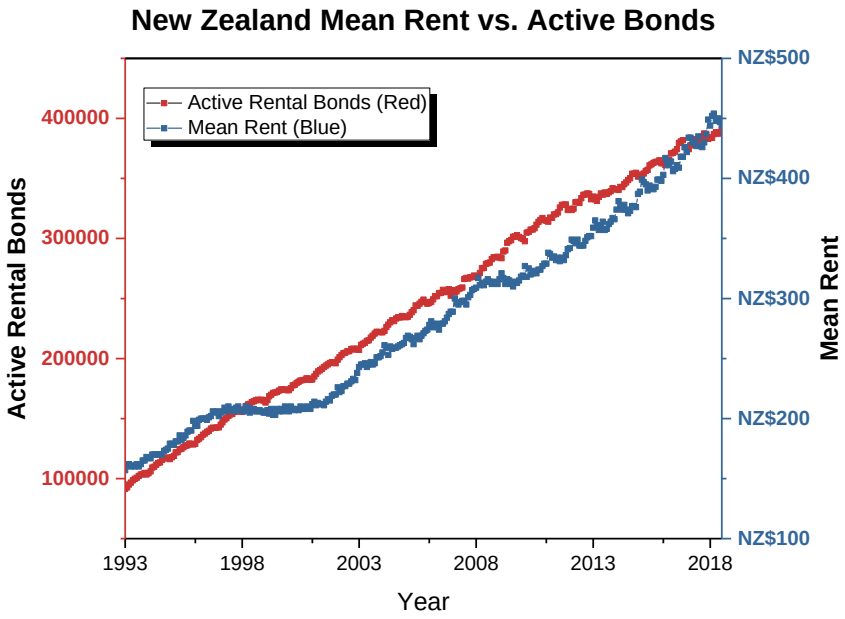

Fig.9 New Zealand rental market price vs volume (1993-2018)

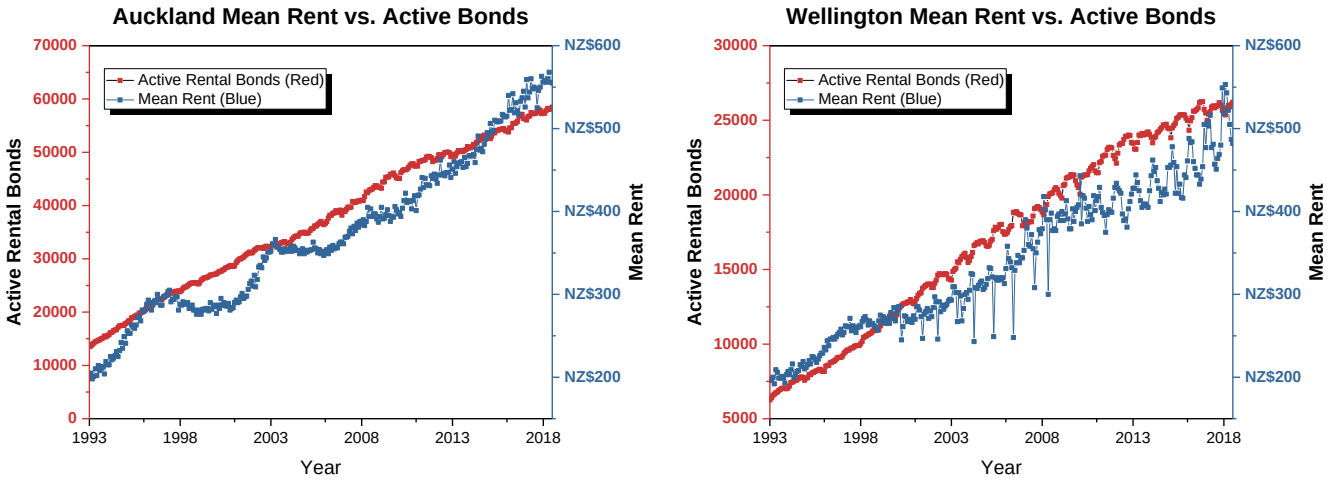

Fig.10 Auckland and Wellington rental markets prices vs volumes (1993-2018)

Part 3: Visualisation of results

The poster is attached separately in .ppt and .pdf formats.

Part 4: Consider the consequences and ethics of reporting your findings

There are some reports on public media this year about the rental cost in Wellington:
"Wellington's skyrocketing rental prices are not an issue in some of the provinces 10:51, Jan 25 2018 Stuff"
"Wellington rental prices match Auckland as property listings plummet 21:44, Feb 26 2018 Stuff"
"Wellington's rental prices cool, national rent stays at record high 08:02, Mar 26 2018 Stuff"
"Rents rise around the country as cost crunch goes on landlords 14:07, Apr 16 2018 Stuff"

From the data and investigation above in this study, the rental price in Wellington area keeps increasing, but is still lower than Auckland and its nearby regions, such as North Shore and Manukau. The rental cost for larger properties (with more than 2 bedrooms) in Wellington area is higher than national average.

If focus on the data within Wellington area, the rental cost for properties with view (especially sea view) and the properties in city centre are much higher than average. The rental cost in north Wellington are lower than average. So, it is cost-saving if students can rent in areas like Johnsonville, Churton Park and take train to universities which normally are located in city centre. This suggestion is only suitable to students who can share the cost for a 3 or 4 bedrooms property with other students or friends. Otherwise, a single room in city near the universities is more cost-saving and time-saving than traveling from and to north suburbs.

Hypothesis between **population in Wellington** and **average rent in Wellington**

Population in Wellington keeps increasing for the past at least 20 years (showed in Fig.11). **Wellington annual population growth rate** is calculated and plotted in Fig.12 with **Wellington rent growth rate**. There is an obvious lagging-behind relationship between them.

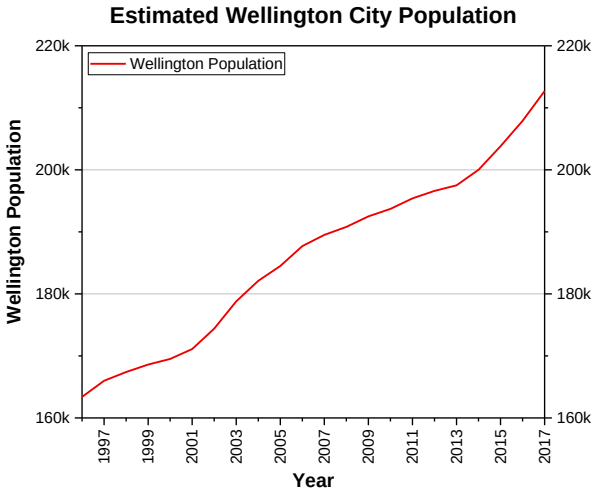

Fig.11 Estimated Wellington Population* vs. Year

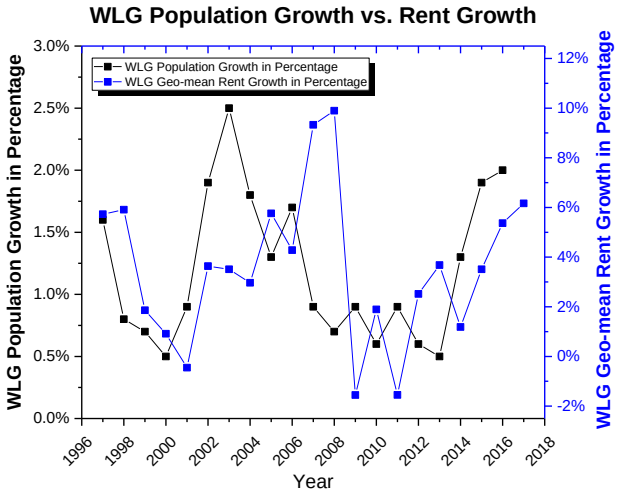

Fig.12 Wellington Population Growth* vs. Wellington Rent Growth Rates

*Wellington population and its growth rate are calculated from raw data published on https://profile.idnz.co.nz/wellington/population-estimate

From 1996 to 2000, population increment rate drops, then, from 1998 to 2001, the average rent growth rate drops.

From 2000 to 2004, Wellington population increases dramatically, then, the average rent increment rate follows the trend, and reaches its highest in 2008.

After the financial crisis, Wellington population increment rate increases again from 2013, the average rent increment also follows behind.

Therefore, **if the population in Wellington keeps increasing as the trend in Fig.11, Wellington average rental cost will increase accordingly**. And this increment is not contributed by universities students, because in the past 10 years, universities student number in Wellington keeps decreasing.

The **consequence** of publishing these hypothesis might be the **further reducing of student number in Wellington**. The proportion of rental cost in living expenses for students in Auckland and Wellington have already relatively high. The historical data and hypothesis of future trend published may affect the decision of students and their families in choosing between two or more offers from universities, especially one of them not come from Auckland or Wellington.