Impact Study of COVID-19 on the Private and Social Insurance Sectors

- *Using Toronto/Ontario as an example*

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1. Introduction

1.1 Background

COVID-19 has imposed significant challenges on the global economy, all countries are joining the journey together to fight against the pandemic during this unprecedented period. Effective actions including implementing social distance, shutting down non-essential businesses have been taken to help slow down the spread and protect vulnerable and innocent lives. Amid the turbulence, insurance, as one of essential business with the special social responsibilities, is facing greater uncertainty across different line of businesses. The purpose of this paper is to study the impact of COVID-19 across major insurance lines including commercial line, personal auto, residential property and social insurance for both private and social sectors using Toronto or Ontario as an example. To help the industry understand the increasing insurance risks during the pandemic, navigate resources efficiently to the places where is mostly needed, and take proactive actions to eliminate potential losses.

1.2 Business Problem

Commercial line of business- Business Interruption

Commercial insurance is a complex and highly specialized product offered by experienced insurers. Generally, commercial insurance policies traditional business interruption policies do not cover losses due to pandemic such as COVID-19. Based on the latest updates from Insurance Bureau of Canada *"Some organizations may have purchased specialized contingent business interruption coverage, stand-alone business interruption coverage and supply chain disruption coverage which may be triggered as a result of the World Health Organization's declaration of a pandemic."* Thus more throughout study is required for each individual insurer to assess their exposures triggered by COVID-19.

Within this study, Using Toronto as an example, location data from Foursquare was used to identify the business sectors which are greatly affected by COVID-19(restaurants, bars, hotels, and gyms), and then Toronto boroughs was clustered into 3 clusters based on the related venue information. Cluster analysis would help the industry to identify similarity and differences among boroughs within Toronto. Given the tremendous amount of efforts required by commercial specialists to go through each individual commercial contract figuring out if the coverage is trigged and if so, how much the settlement is, I believe this study will help them to assess which boroughs require more attentions, so that they could prioritize their tasks accordingly.

Since the study is based on publicly available information through Foursquare API, the findings is for an average insurance company assuming it shares the commercial insurance market fairly among different boroughs in Toronto, each individual insurer should consult this study through the lens of understanding on their own commercial business profiles.

In the meanwhile, in order to adapt to the "new norm", more restaurants nowadays are collaborating with local food delivery companies to offer take-out services, this new business model could help the restaurant to get back to business sooner instead of filing claims for the business interruption coverage, the delivery service was not considered within this study, the impact could be material if more restaurants are trying to adapt to the 'new norm' over the long run.

Personal and Commercial Property – Residential Property

Starting from the middle of March this year, students at several colleges and universities were asked to vacate dorms over COVID-19 either compulsively or voluntarily (high encouraged) in Ontario, it imposed growing uncertainty for international students, most of them might end up with living in Airbnb with friends or classmates since normally less-than-one-year renting options would not be available in the market. Also, in general, international students are facing disadvantages when it comes to renting given their short credit histories, it might push them further to the less-maintained apartments. Combining with the fact that students are less experienced in cooking, it could trigger extra risks on residential properties due to the cookware malpractice during the lockdown from this angle. In the meanwhile, the latest reports showed that COVID-19 continues to ravage in senior homes, given the panic outbreaks and short of stuffs in long-term care facilities, it could inject even higher risks for residential properties.

Within this study, both location data from Foursquare and Open Database of Healthcare Facilities from Statistics Canada were leveraged to identify related residential information and conducted cluster analysis on boroughs in Toronto, the feature of this section is to apply condo and nursing houses as two key dimensions when reviewing the residential property risk due to the pandemic.

Personal Auto – Toronto Killed and Seriously Injured Claims

As a critical action taken by Ontario during the lockdown, almost all companies have carried on the contingency business plans with **Working From Home** policy since the March break. Having no need to commute from home to work during the lockdown, collision claim counts are expected to plummet to the significantly low level. At the same time, a number of Canadian insurers are reducing or rebating auto insurance premium to compensate customers for the change.

A trend analysis has been performed using Toronto Police Service Public Safety Data Portal to estimate the Q2 Killed and Seriously Injured (KSI) claims based on 2008-2018 data assuming there is no COVID-19.

In general, fatal and seriously injured claims are closely tracked and monitored by insurance companies and acting as a key driver for the reserving analysis results. The finding from this section serves as a great benchmark for the industry to understand the favourable impact on collision frequency due to COVID-19, and be able to assess the combined impact from both frequency decrease and premium rebate during this period.

Again, since the data used for this study is based on the publicly available information **From Toronto Police Service Public Safety Data Portal**, the finding applies to an average insurance company assuming it shares the personal auto insurance market fairly among all auto collision claims, each insurer should consult this study through a lens of understanding on their own personal auto business portfolios.

Social Insurance - Unemployment Insurance

Due to the lockdown across Canada, more workers lost their jobs recently, the government has announced that "*if you have stopped working because of COVID-19, The Canada Emergency Response Benefit may provide you with temporary income support*." For more details please refer to [Coronavirus disease (COVID-19) – Employment and Social Development Canada](). Given the surge of unemployment rate, more EI claims are expected to be submitted in the following months even weeks, the EI benefits claims information for March and April this year is currently not available due to both the surge of clams submitted and the slow-down in the application process as people are adapting to the new form of working-from-home lifestyle.

Given the data constrain, the study focused on Ontario instead of Toronto. Unemployment and EI claims information from Feb. 2010 to Feb./Mar. 2020 was downloaded from **Statistics Canada**. The monthly unemployment by type of work was used as a leading indication to estimate the expected EI benefits claims during the lockdown given the strong correlation between the unemployment and EI claims. One interesting finding has also been discussed under this section, I believe that the study will help the government to manage the work around upcoming EI claims efficiently, and shed some lights on the near-future claim trend.

2. Data Input and Cleaning

2.1 Data Sources

Data has been leveraged from different sources to fit in the various analysis within this study.

1) For commercial business interruption coverage and residential property insurance, the location data have been extracted from Foursquare APl through developer portal. Geospatial and borough information of Toronto is taken from Wikipedia page. Senior home information is downloaded from Statistics Canada (Open Database of Healthcare Facilities). The links for all resources are summarized below.

   - Foursquare: https://developer.foursquare.com/

   - List of postal codes of Canada: M:
     https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M

   - Open Database of Healthcare Facilities

     https://www.statcan.gc.ca/eng/lode/databases/odhf

2) For the trend analysis on personal auto KIS claims, the KIS claim information from 2008 to 2018 was downloaded from Toronto Police Service Public Safety Data Portal

   Toronto Police Service Public Safety Data Portal: http://data.torontopolice.on.ca/search?q=traffic

3) Unemployment from Feb.2010 to Mar.2020 and EI claims counts from Feb.2020 to Feb.2020 were downloaded from Statistics Canada

   - Employment insurance claims received by province and territory, monthly, seasonally adjusted https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1410000501#timeframe

   - Unemployment by type of work sought and search method, monthly, unadjusted for seasonality (x 1,000) https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410005801

2.2 Data Preparation and Cleaning

Similar to one of the most common journey taken by all data analysis projects, tremendous amount of time has been spent on data preparation stage. The data is extracted from different sources and merged for various types of analysis. In general, extra spaces and non-sense symbols have been removed from the working database during this stage using Python, also, necessary dimensions are merged with the major working database as it seems appropriate.

Commercial line of business- Business Interruption

Based on the Geospatial data of Toronto is pulled from the source, the mean latitude and mean longitude were calculated for each borough in Toronto for clustering as it is present below

	Borough	Latitude	Longitude
0	Central Toronto	43.701980	-79.398954
1	Downtown Toronto	43.654597	-79.383972
2	East Toronto	43.669436	-79.324654
3	East York	43.700303	-79.335851
4	Etobicoke	43.660043	-79.542074
5	Mississauga	43.636966	-79.615819
6	North York	43.750727	-79.429338
7	Scarborough	43.766229	-79.249085
8	West Toronto	43.652653	-79.449290
9	York	43.690797	-79.472633

After the location information was pulled from Foursquare, businesses which are significantly affected by COVID-19 were selected and grouped into three major types for further analysis as it's summarized below

Venue Category	Type
Restaurant	Dining in
Bar	Dining in
Nightclub	Dining in
Hotel	Checking in
Gym	Working out

Residential Property

Location information on residence (category Id: '4e67e38e036454776db1fb3a') was pulled from Foursquare, the subset of residential location data on Residential Building(Apartment/Condo) was selected and merged with Toronto geospatial data for borough cluster analysis. Since the senior home location data is neither complete nor available in Foursquare, additional nursing and residential care facilities data was downloaded from Statistics Canada. The types of nursing and residential care facilities covered in the study are **retirement home, long-term care, and long-term care home.**

Social Insurance - Employment Insurance

Two outliers have been identified in Unemployment benefits claims database for Jun. 2015 and July 2015 where it has the highest and lowest EI claim count while the Unemployment seems normal, without enough insights behind this observation, these two data points have been excluded in polynomial regression modeling. Several interesting features have been observed in the original database during the study, several adjustments have been made during the second round of modelling, for more detailed study, please refer to the next section.

3. COVID-19 Impact Study by Line of Business

3.1 Commercial Line- Business Interruption

Figure 3.1.1 visualizes the map of Toronto borough using library folium and geopy. The study clustered boroughs in Toronto into 3 clusters based on the mostly affected business types (Dining in, Checking in, and Working out). Figure3.1.2 visualizes the final clusters for boroughs in Toronto.
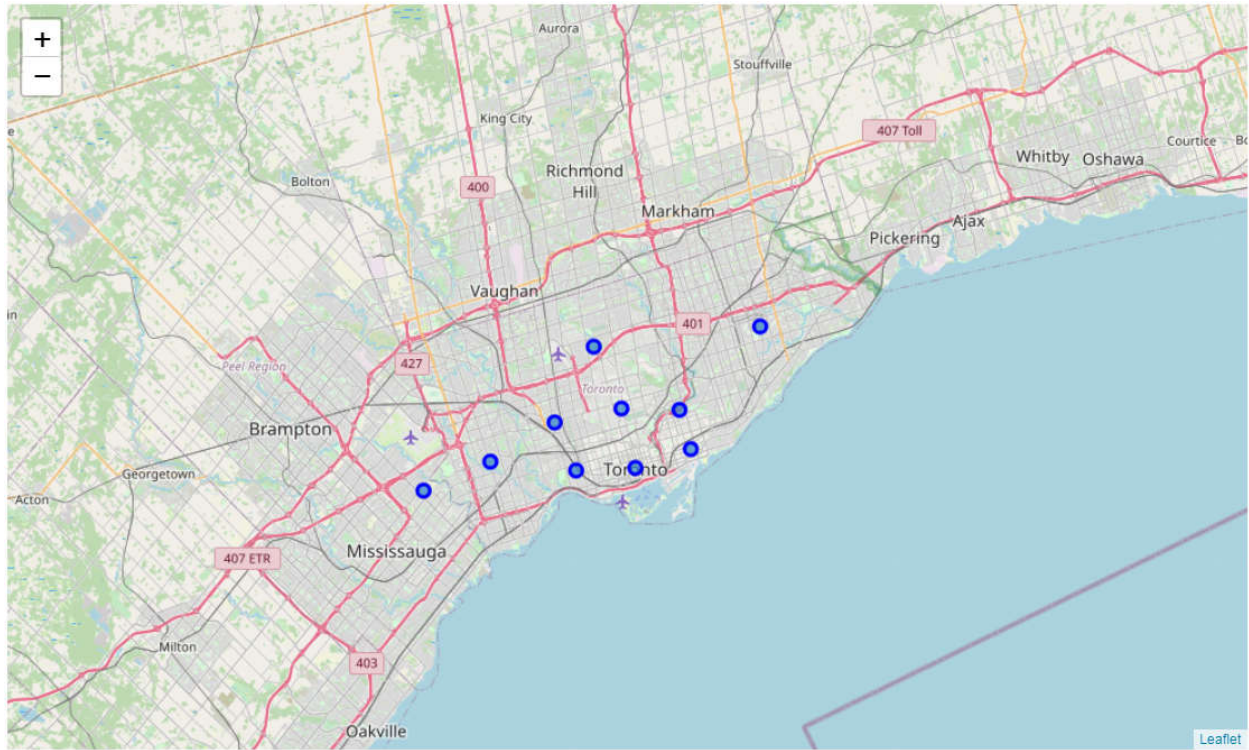
Figure 3.1.1
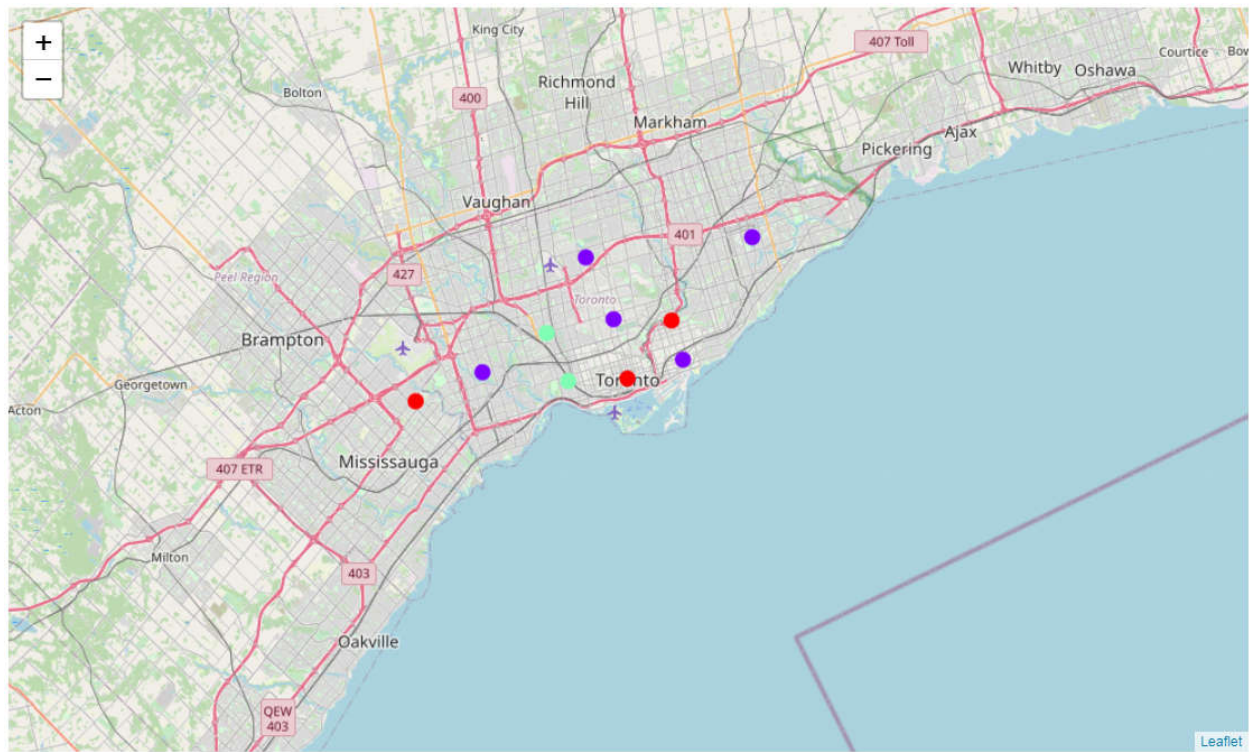
Figure3.1.2

The final clustering result is summarized below.

Cluster	Toronto Borough
1	Downtown Toronto, East York, Mississauga
2	Central Toronto, East Toronto, Etobicoke, North York, Scarborough
3	West Toronto, York

Commercial line specialists could use this clustering to prioritize their tasks based on their own business profiles. Similar information, thinking processes and actions should apply to the similar clients within the same cluster in order to achieve fairness and improve the work efficiency.

3.2 Residential Property

Figure3.2.1 visualizes the final clusters based on Residential Building (Apartment/Condo) and additional nursing and residential care facilities information. The clusters are summarized below

Cluster	Toronto Borough
1	East York, East Toronto, Mississauga, York
2	Central Toronto, Downtown Toronto, Etobicoke, West Toronto,
3	North York, Scarborough
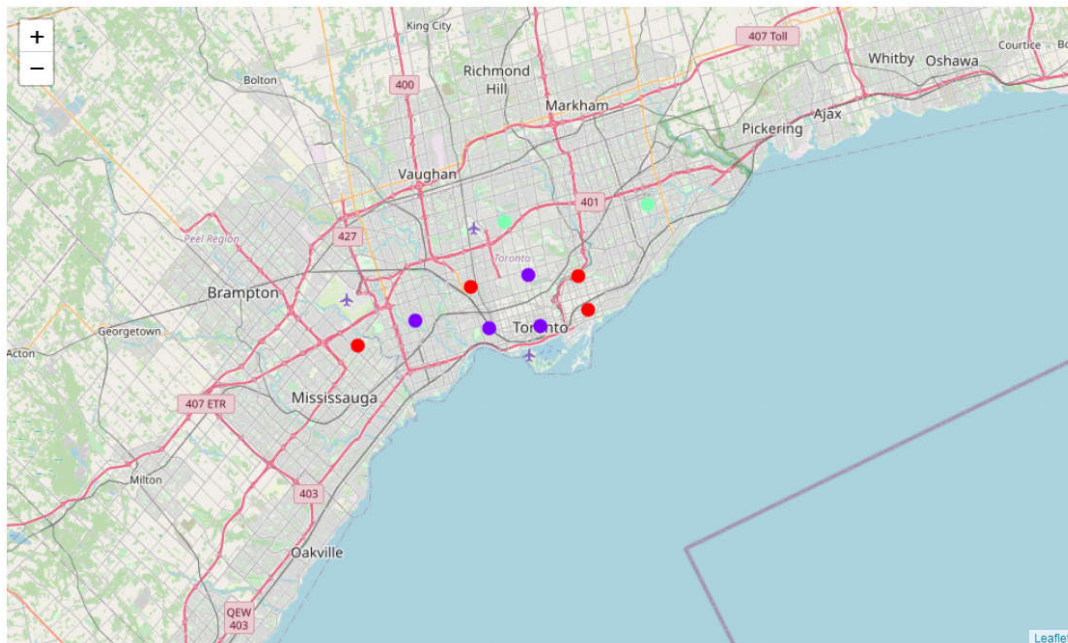
Figure3.2.1

Extra attention should be given to boroughs within cluster 3. North York and Scarborough are both relatively dominated by nursing and residential care facilities comparing with the rest of boroughs.

3.3 Personal Auto – Killed and Seriously Injured Claims (KSI Claims)

Since the lockdown started around the end of March this year, trend analysis on the KSI claim count was using reported KSI claim information for the second quarter of the past ten years since 2008. Figure 3.3.1 superimposed the location of the KSI claims onto the Toronto map.

Figure 3.3.1

Figure 3.3.2 grouped the markers into different clusters. Each cluster is represented by the number of claims in each neighborhood.

Figure 3.3.2

Performed Trend analysis on 2008-2018Q2 KSI claim counts using polynomial curve fitting with 2 degree of freedom. Predicted 2020Q2 KSI claims assuming no impact of COVID-19 is 253. Due to the scarcity and disparity of data as it's shown in the figure, the result is subjected to high error term. Insurance companies could use this figure as a benchmark to conduct high-level sense-check on the impact of COVID-19 while looking at their Q2 analysis results. Again, since the study is based on public data with great volatility, the results need to be considered with great caution.

'No. Fatal and Seriously Injured Claim Counts = 1 * Year + -2980'

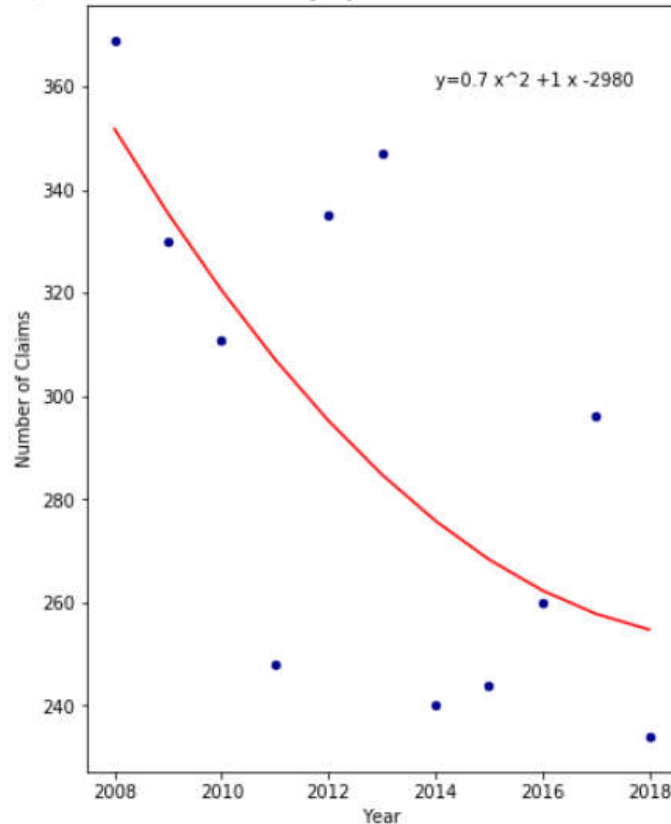Q2 Total Fatal and Seriously Injured Claim Counts from 2008 - 2018

$y=0.7 x^2 +1 x -2980$

Figure 3.3.3

```
In [33]: x=2020
         y_hat2020q2=fit[0] * x*x + fit[1]*x+fit[2]
         y_hat2020q2
Out[33]: 253.05454545561224
```

When considering premium reduction and rebates for policyholders, insurance companies need to understand that the favorable loss development, which is driven by the lockdown, could be mostly offset by the premium rebase, thus IBNR true-up and projections need to be carefully evaluated with the premium rebate action in mind.

3.4 Social Insurance – EI Claims

Figure3.4.1 shows the comparison of unemployment in Ontario by type between the simple historical average from 2010 to 2018 and March2020.Temporary layoff increased by 10 times compared with 10-year historical average, it indicates a spike on the unemployment right after the announcement of lockdown in Ontario at the end of March. The unemployment increase is significant in March this year and could serve as a leading factor to predict the surge of EI claims.
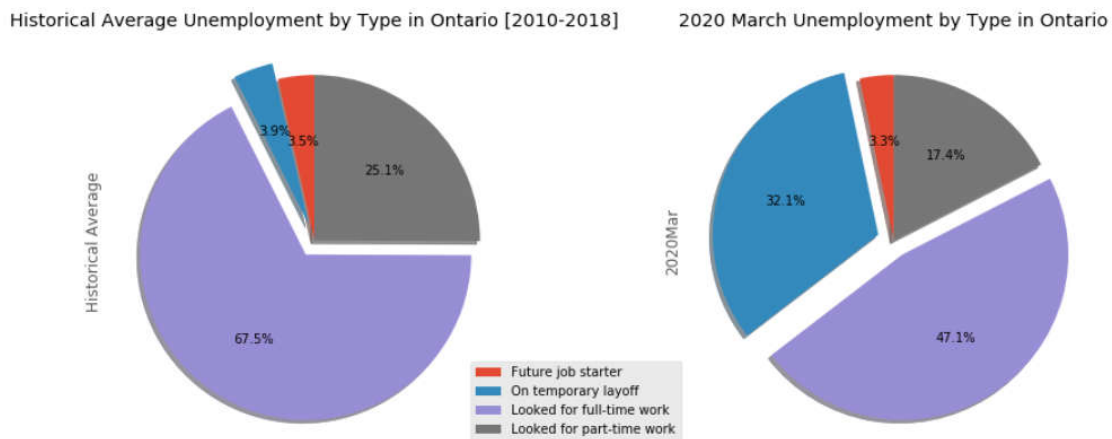

Figure3.4.1

Figure3.4.2 shows the plots of normalized unemployment and EI claim counts in Ontario from February 2020 to March2020. Although the unemployment shows more volatilities comparing with EI claim counts during the same periods, the two show the similar pattern over time. When the unemployment changes, the EI claim count are most likely to follow its path.
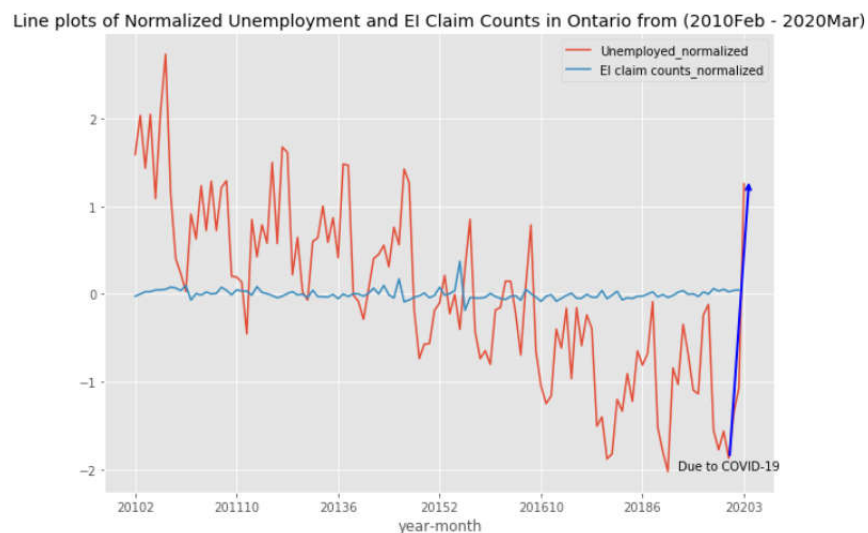

Figure3.4.2

Performed polynomial regression on EI claim counts based on total unemployment, the result is presented below.
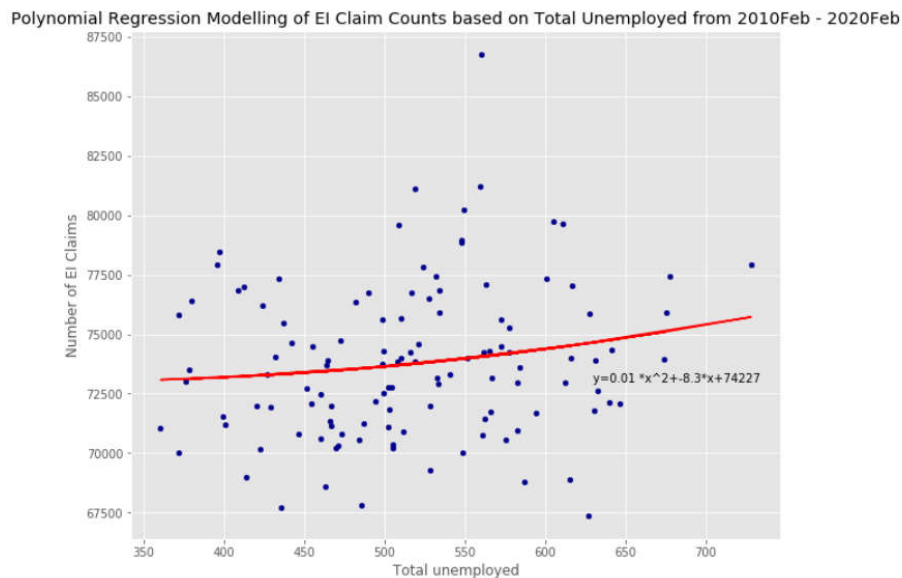

Figure3.4.3

Estimated EI claim counts for March 2020 is 74,487, the estimate is even lower than actual EI claim counts during January 2020 and February 2020, which seems counter-intuitive to some extent.

```
x=df.iloc[120,6]
EI_CC_Hat_2020Mar=fit[0] * x*x + fit[1]*x+fit[2]
EI_CC_Hat_2020Mar
print(x)
print(EI_CC_Hat_2020Mar)
```
```
614.0
74487.96840266735
```

Taking a second look at Figure3.4.2 line plots to check if the model needs to be revised.

Firstly, unemployed are at the quite different level before and after 2016, it makes more sense to only rely on more recent experience for modelling given the level of unemployed have been moved to a different mean level, thus data since 2017 was chosen to fit into the second round of modelling.

Secondly, a delay on EI employment claim counts has been observed in the database since it usually takes time to process EI claim payments especially when the unemployment spikes, that explains why the increase on EI claim count did not show up when the unemployment increased by 50% in March 2020 bases on the model. Having this mismatch in the dataset would distort the true correlation between unemployment and EI claim counts. Continuing modelling with the unadjusted database would lead to the wrong conclusion. In order to remove the impact on the timing delay, the EI claim counts have been shifted 2 month ahead to pair with the 'true unemployment level' during the second round of modelling. Graph3.3.4 shows the polynomial fit with matplotlib for EI claim counts – Total unemployed.
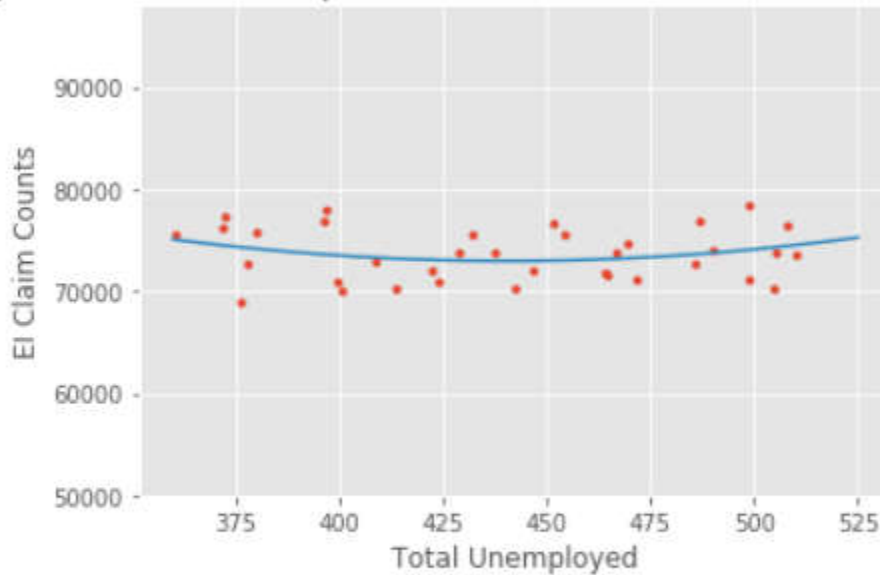
Figure3.4.4

After adjusting the model within the second round, the model indicates that EI claim counts will spike at 82,667 in May 2020 as a reflection on the COVID-19 impact, the claim counts will remain relativily low at 73,222 and 72,974 in March and April as it is shown in Figure3.4.4

```
Mar=df.iloc[120,6]
Feb=df.iloc[119,6]
Jan=df.iloc[118,6]

EI_CC_Hat_2020Mar_adj=p(Jan)
EI_CC_Hat_2020Apr_adj=p(Feb)
EI_CC_Hat_2020May_adj=p(Mar)
print(EI_CC_Hat_2020Mar_adj)
print(EI_CC_Hat_2020Apr_adj)
print(EI_CC_Hat_2020May_adj)
```

```
73222.52136192619
72974.88619918334
82667.52655657055
```

4. Conclusion

Thank for taking time reviewing my report. I would like to take this chance to thank the course for encouraging us to apply what we have learnt during the course into the real-life problem. Various analysis technics including Cluster Analysis, Data Visualization, Polynomial Regression, Trend Analysis, and Model Validation play a critical role within this study.

The study gives a well-rounded review on the increasing insurance risks for both private and social insurance imposed by COVID-19, and provides suggestions on proactive actions the industry could consider based on the analysis results. The study can not be completed without the knowledge obtained during the course.

- For business interruption coverage, specialists should prioritize their works based on cluster analysis results. Similar information, thinking process and actions should apply to the similar clients within the same cluster in order to achieve fairness and improve the work efficiency.

- For residential property coverage, extra attention should be given to boroughs where most of nursing and residential care facilities are located

- For personal auto line of business, trend analysis on Killed or Seriously Injured claims indicates that when considering premium reduction and rebates for policyholders during the lockdown, insurance companies need to understand that the favorable loss development, which is driven by the lockdown, could be mostly offset by the premium rebase, thus IBNR true-up and projections need to be carefully evaluated with the premium rebate action in mind.

- For unemployment benefit, the study shows that there is a delay on the EI claim counts following the spike of unemployment. The model was adjusted to correct the delay and reflect the true correlation between the two.

Reference

[1] http://www.ibc.ca/on/business/covid-19

[2] https://www.ctvnews.ca/health/coronavirus/students-at-several-colleges-and-universities-asked-to-vacate-dorms-over-covid-19-1.4858086

[3] https://www.theglobeandmail.com/canada/article-outbreaks-at-seniors-homes-linked-to-almost-half-of-covid-19-deaths/

[4] https://business.financialpost.com/news/fp-street/insurers-cutting-auto-premiums-amid-pandemic-as-less-driving-leads-to-fewer-claims

[5] https://business.financialpost.com/news/fp-street/insurers-cutting-auto-premiums-amid-pandemic-as-less-driving-leads-to-fewer-claims

[6] https://developer.foursquare.com/docs/