

The Effect of COVID-19 on New Zealand Spending

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1 Executive Summary

The aim of this project is to estimate the effect of COVID-19 and its resulting lock-downs on New Zealand spending. The project involved looking into specific industries, and how severely each was affected. The data used to answer this question is New Zealand card transactions sourced from StatsNZ and other government organisations.

The expected spending for the months of March to May was found by forecasting using the data prior to COVID-19. By comparing the expected spending for the months of March to May of 2020 to the actual spending I found that COVID-19 and its resulting lock-downs decreased spending over the months of March-May significantly. Spending was estimated to be between \$5.8 to \$6.5 billion less than expected over the three month period. This is the loss of total spending over the three industries retail, services and non-retail.

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2 Background

New Zealand spending is a crucial part of the New Zealand economy. When we buy things it creates a demand, which is important to keep our businesses running. If could not spend money, businesses would close and many Kiwi's would lose their jobs. Over lock-down this was the reality for many people. During lock-down, jobs in small business dropped by 4% (approximately 24,000 employees) [1]. Many New Zealand businesses are still struggling.

The aim of this project is to estimate the effect of COVID-19 on New Zealand spending. By predicting how much kiwis would have spent based on the data prior to lock-down, we can estimate how much less kiwis were spending. The project will involved looking into specific industries, and how severely each was affected.

3 Data Description

The data used to answer this question is New Zealand card transactions sourced from StatsNZ and other government organisations. Below is a summary of the types of data in the dataset(s).

NAME	TYPE
class	Categorical
category	Categorical
indicator-name	Categorical
series-name	Categorical
sub-series-name	Categorical
parameter	Categorical (Date)
value	Numerical (Discrete)
units	Categorical
date-last-updated	Categorical (Date)

The columns class, category, indicator-name, series-name, sub-series-name, unit, and date-last-updated were redundant as they all had only one unique variable. This is because the dataset was a subset of a much larger dataset and these columns were used to differentiate between the subsets.

The dataset is a time series. There are no missing values in the dataset. The variables used are parameter and value. The parameter is the date in question, which is monthly. Value is the amount spent that month.

4 Ethics, Privacy and Security

4.1 Ethical Considerations

It is important to be careful about making inferences or conclusions about all of New Zealand when using this data. Especially when using these metrics as an indicator of something greater such as economic activity.

The data being used to answer a question on spending is made up exclusively of card-based spending (eftpos, debit, etc). This means it excludes some groups of Kiwi's, such as members of certain religious groups who choose not to use this technology. It may also exclude the elderly or particularly privacy conscious people that may not make many card based payments

4.2 Privacy Concerns/ Confidentiality

Having peoples card transactions become public could be incredibly dangerous and could potentially lead to things like stalking and identity theft. The data used in this report is made up of totals of the whole population. As there is no way to link the data being used to any individuals, privacy is not a major concern.

4.3 Security

Security is an important topic when working with data that contains personal information. People can be very private about their spending and would not want that data to be at risk. Fortunately, the datasets we have been working with from StatsNZ have totals of the whole population, and the data cannot be

linked to an individual. Obviously for this data to exist, the data of individuals had to be collected and combined. This is not an issue for us however, as we are not working with the original data of individuals.

5 Exploratory Data Analysis

Card spending is broken into three industries. These are retail, services and non-retail. Non-retail includes things like gambling and travel.

The break down of industry spending between March and May (the months where New Zealand was in level 3 or higher in 2020) is visualized in figure 1. Comparing the break down of industry spending in 2020 (the focus year) with 2019 and 2018 (two examples of a 'normal' year), we can see a slight difference. In 2020, during lock-down, non-retail spending was a larger portion of New Zealand spending than it was in previous years. Retail and services were both smaller portions of New Zealand spending compared to previous years.

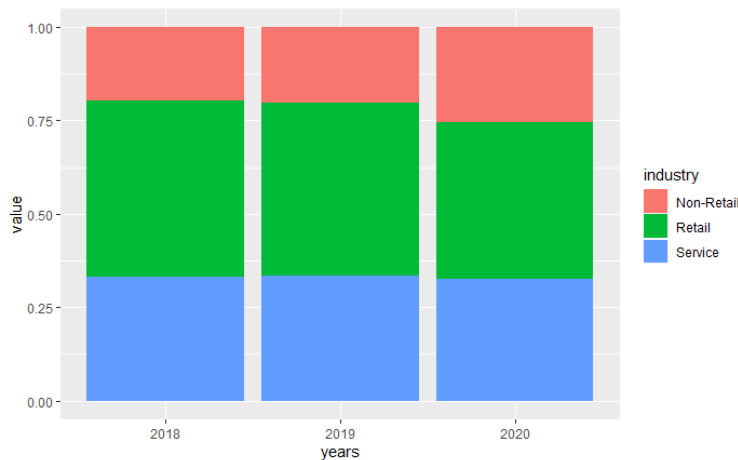


Figure 1: Industry Breakdown 2018-2020 (March-May)

5.1 Retail

Retail spending (by card), as shown in figure 2, was around 5.5 billion per month in 2019, peaking in December at 7 billion due to the holiday season. The red lines indicate the months New Zealand was at level 3 or higher. We can see a large drop in retail spending around March of 2020 which lines up with New Zealand's lock-down. In April spending was less than 3 billion. We can see that retail spending has still not recovered and is lower than it was prior to lock-down.

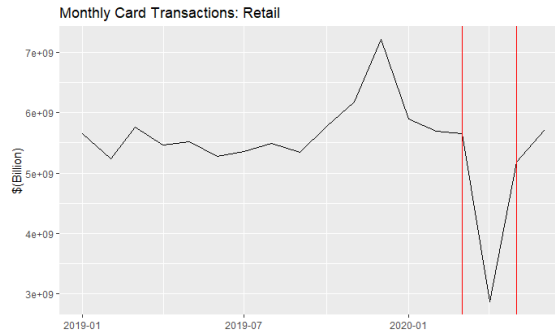


Figure 2: Monthly Retail Spending

5.2 Services

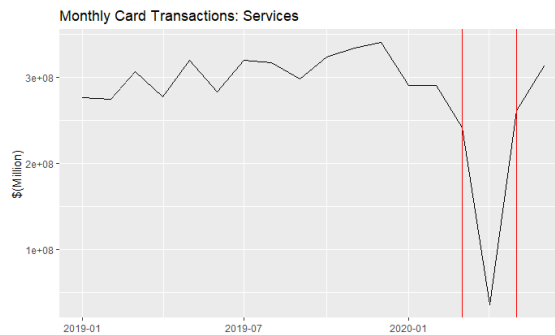


Figure 3: Monthly Services Spending

Services spending (by card), as shown in figure 3, was around 300 million per month in 2019. The red lines indicate the months New Zealand was at level 3 or higher. We can see a large drop in services spending around March of 2020, which lines up with New Zealand's lock-down. In April services spending was less than 100 million. We can see that services spending has more or less recovered and is similar to what it was prior to lock-down.

5.3 Non-Retail

Non-retail spending (by card), as shown in figure 4, was around 1.75 billion per month in 2019. The red lines indicate the months New Zealand was at level 3 or higher. We can see a large drop in non-retail spending around March of 2020, which lines up with New Zealand's lock-down. In April non-retail spending was less than \$750 million. We can see that non-retail spending has still not recovered and is lower than it was prior to lock-down.

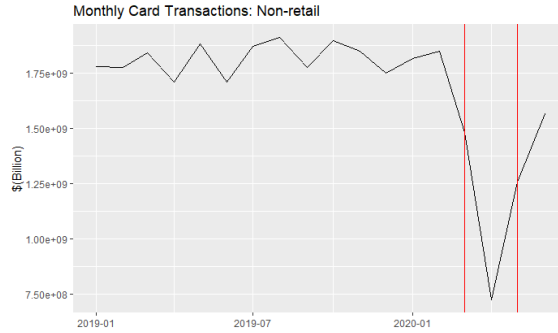


Figure 4: Monthly Non-Retail Spending

6 Detailed Analysis Results

Using data prior to March 2020 we can use ARIMA models and forecasting techniques to get the expected spending for the months of lock-down for each industry. This will be done with the seasonally adjusted data for each industry. Seasonally adjusted data is used because forecasting, and many other time series methods, have the assumption that the data is stationary. For a more in-depth look at the assumptions of the models used, see the appendix.

6.1 Retail

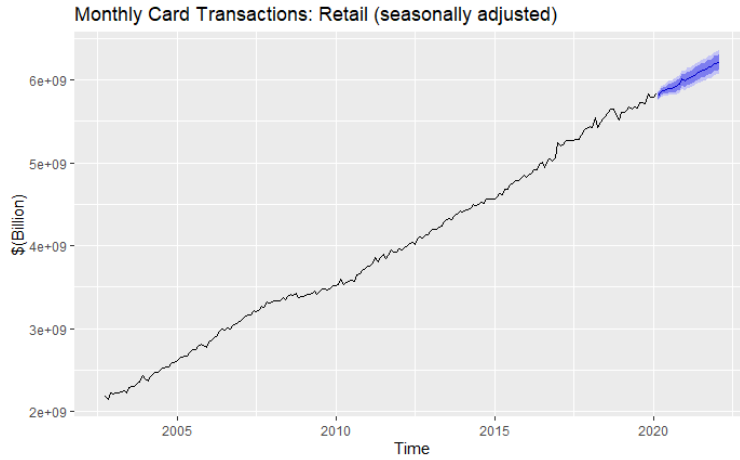


Figure 5: Retail Forecasting

Figure 5 is a time series plot of New Zealand retail card transactions by month, with the expected values for the months affected by lock-down. The

data is seasonally adjusted, as the data needs to be stationary to meet the forecasting assumptions.

The following table breaks down retail spending between March and May of 2020, comparing the actual retail spending and the expected retail spending. The expected spending has an upper and lower bound with 95% confidence. A more in depth table of the expected values from the forecast can be found in the appendix.

Retail Spending Lost, 2020			
Date	Actual Spending	Expected Spending	Lost Spending
Mar	\$5,651,500,000	\$5,744,714,399 - \$5,858,592,635	\$93,214,399 - \$207,092,635
Apr	\$2,870,600,000	\$5,790,671,439 - \$5,916,437,921	\$2,920,071,439 - \$3,045,837,921
May	\$5,188,200,000	\$5,799,439,416 - \$5,938,420,277	\$611,239,416 - \$750,220,277

The lost spending was found by getting the difference between the actual spending with and the expected spending boundaries. In total, the estimated lost spending for retail is between \$3,624,525,254 and \$4,003,150,833.

6.2 Services

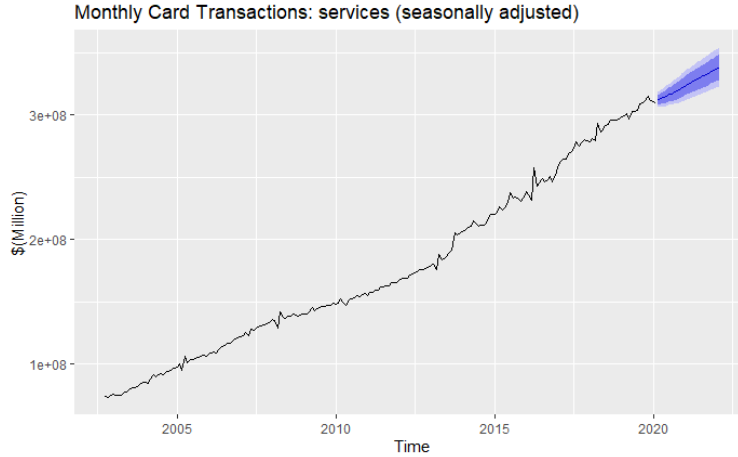


Figure 6: Services Forecasting

Figure 6 is a time series plot of New Zealand services card transactions by month, with the expected values for the months affected by lock-down. The data is seasonally adjusted, as the data needs to be stationary to meet the forecasting assumptions.

The following table breaks down services spending between March and May of 2020, comparing the actual services spending and the expected services spending. The expected spending has an upper and lower bound with 95% confidence. A more in depth table of the expected values from the forecast can be found in the appendix.

Services Spending Lost, 2020			
Date	Actual Spending	Expected Spending	Lost Spending
Mar	\$240,700,000	\$306,487,217 - \$318,468,182	\$65,787,217 - \$77,768,182
Apr	\$35,600,000	\$307,094,001 - \$320,029,239	\$271,494,001 - \$284,429,239
May	\$260,900,000	\$306,877,779 - \$321,187,100	\$45,977,779 - \$60,287,100

The lost spending was found by getting the difference between the actual spending with and the expected spending boundaries. In total, the estimated lost spending for services is between \$383,258,997 and \$422,484,521

6.3 Non-Retail

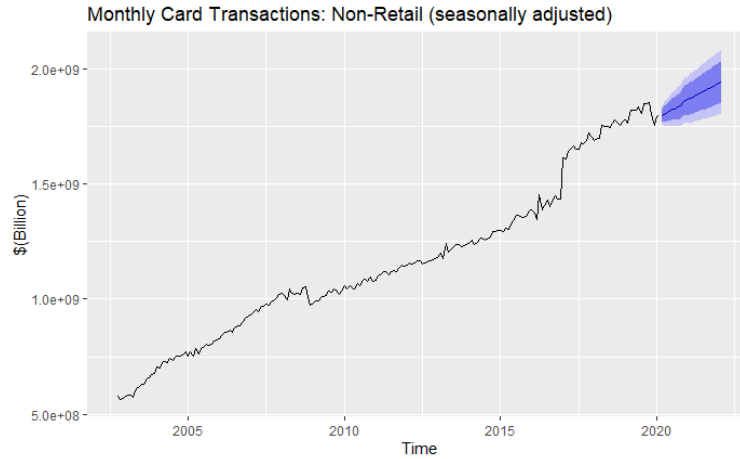


Figure 7: Non-Retail Forecasting

Figure 7 is a time series plot of New Zealand non-retail card transactions by month, with the expected values for the months affected by lock-down. The data is seasonally adjusted, as the data needs to be stationary to meet the forecasting assumptions.

The following table breaks down non-retail spending between March and May of 2020, comparing the actual non-retail spending and the expected non-retail spending. Non-retail spending includes things such as travel and gambling. The expected spending has an upper and lower bound with 95% confidence. A more in depth table of the expected values from the forecast can be found in the appendix.

Non-Retail Spending Lost, 2020			
Date	Actual Spending	Expected Spending	Lost Spending
Mar	\$1,480,700,000	\$1,756,373,293 - \$1,839,207,066	\$275,673,293 - \$358,507,066
Apr	\$725,400,000	\$1,752,733,615 - \$1,854,406,415	\$1,027,333,615 - \$1,129,006,415
May	\$1,255,800,000	\$1,751,353,880 - \$1,868,883,803	\$495,553,880 - \$613,083,803

The lost spending was found by getting the difference between the actual spending with and the expected spending boundaries. In total, the estimated lost spending for retail is between \$1,798,560,788 and \$2,100,597,284.

6.4 Total Spending

Estimates Lost Spending by Industry		
Industry	Lower Estimate	Upper Estimate
Retail	\$3,624,525,254	\$4,003,150,833
Services	\$383,258,997	\$422,484,521
Non-Retail	\$1,798,560,788	\$2,100,597,284
Total	\$5,806,345,039	\$6,526,232,638

As shown in the table, it is estimated that Kiwis spent \$5.8 to \$6.5 billion less than expected in a three month period.

7 Conclusions and Recommendations

Kiwis spent \$5.8 to \$6.5 billion less than expected in a three month period. With such a large drop in spending, what happened to the New Zealand economy. New Zealand small businesses experienced a 10% drop in revenue on average in March of 2020 followed by a drop of 34% drop in April[1]. Jobs in small business dropped by 4% (approximately 24,000 employees)[1]. Many small businesses are still struggling to recover from the large drop in revenue.

So what can Kiwis do now that lock-down restrictions have lifted? Where possible, the average Kiwi can help the economy by buying locally and support their local small businesses.

An obvious limitation of these results is that the model did have some concerning features in the residual diagnostics, which can be found in the appendix. Due to each model having at least one significant spike in the ACF plot, there is reason to doubt the expected values of these models.

Better models that with clear residual diagnostics should be found and new predictions should be made.

References

- [1] Xero. Xero data reveals covid-19's initial impact on nz small business sector.

A Checking Residuals

A.1 Retail

We can check the assumptions of our ARIMA models using the `checkresiduals()` function in R. The output of this is shown in figure 8.

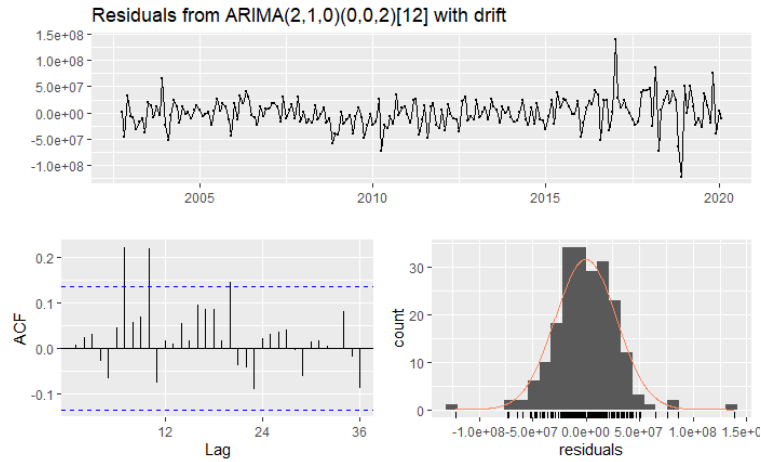


Figure 8: Retail Residuals

The ACF shows significant spikes on lag 7 and 10, which can be an indication that additional terms (non-seasonal) need to be added to the model. Looking at the count of residuals plot, it is centered around 0 and seems to be close to a normal distribution.

A.2 Services

We can check the assumptions of our ARIMA models using the `checkresiduals()` function in R. The output of this is shown in figure 9.

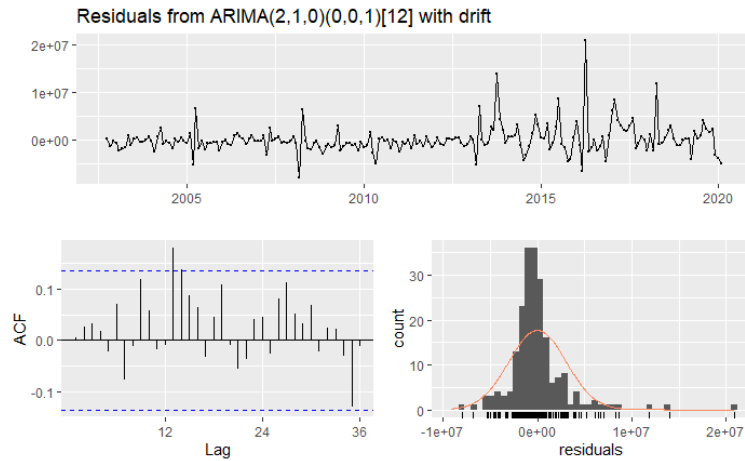


Figure 9: Services Residuals

The ACF shows significant spikes on lag 13, which can be an indication that additionally terms (non-seasonal) need to be added to the model. Looking at the count of residuals plot, it is centered around 0 and seems to be close to a normal distribution, with the exception of an outlier on the far right.

A.3 Non-Retail

We can check the assumptions of our ARIMA models using the `checkresiduals()` function in R. The output of this is shown in figure 10.

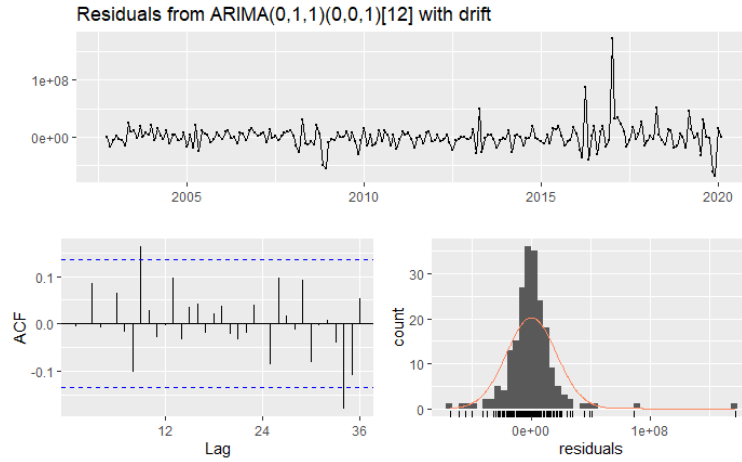


Figure 10: Non-Retail Residuals

The ACF shows a significant spike on lag 7, which can be an indication that an additionally term (non-seasonal) needs to be added to the model. There is also a significant spike on another lag in the opposite direction. This can be an indication that an additionally term (seasonal) needs to be added to the model. Looking at the count of residuals plot, it is centered around 0 and seems to be close to a normal distribution, with the exception of an outlier on the far right.

B Detailed Expected Values

B.1 Retail

Date	Point Forecast	Expected Retail Spending			
		Lo 85	Hi 85	Lo 95	Hi 95
Mar 2020	5801653517	5764423029	5838884005	5744714399	5858592635
Apr 2020	5853554680	5812437539	5894671822	5790671439	5916437921
May 2020	5868929846	5823492496	5914367196	5799439416	5938420277

B.2 Services

Expected Services Spending					
Date	Point Forecast	Lo 85	Hi 85	Lo 95	Hi 95
Mar 2020	312477699	308560733	316394666	306487217	318468182
Apr 2020	313561620	309332671	317790569	307094001	320029239
May 2020	314032440	309354258	318710621	306877779	321187100

B.3 Non-Retail

Expected Non-Retail Spending					
Date	Point Forecast	Lo 85	Hi 85	Lo 95	Hi 95
Mar 2020	1797790180	1770709133	1824871226	1756373293	1839207066
Apr 2020	1803570015	1770329879	1836810150	1752733615	1854406415
May 2020	1810118842	1771694498	1848543185	1751353880	1868883803