Effectiveness of Social Distancing Policies - A Comparative Study of Canadian Provinces

By:
Anusha Arif 1004519639
Derron Yu 1004149352
Nour El Mazny 1005400816
William Wang 1004278818

Policy Paper for ECO 446
Prof. Micheal Smart

Abstract:
In this paper, we make four broad contributions. First, we provide an introduction and literature review regarding prior economic and social science research on mobility patterns, Non-Pharmaceutical Interventions, and policy responses during the first phase of the pandemic. Next, we introduce a discussion of the data sets and policies to be included in our paper that may be useful in examining the effectiveness of NPIs on human mobility patterns. In addition, we analyze a number of data visualizations that graphically demonstrate the impact of social distancing policies on mobility. Lastly, we utilize our difference-in-difference regression equation to analyze policies during both closing and reopening regressions, in both the first and second wave. Our results indicated that the policies for restaurants, schools and recreation did have a significant impact on the decline in mobility, with an emphasis on mobility in the first wave.

Introduction

The Coronavirus pandemic has impacted millions of people globally. Countries worldwide have introduced measures such as social distancing to combat the spread of coronavirus and minimize its severe social and economic consequences. In Canada, different provinces chose to implement various mandates related to addressing COVID-19. These include (but are not limited to) declaration of emergency, the closure of schools and restaurants, introduction of fines for not following public COVID-19 protocols, and international travel restrictions. Almost all provinces declared a state of emergency in various forms, but at different times and with a different number of initial cases. Some provinces, such as Quebec, immediately imposed a state of emergency, going as far as also imposing a formal intra-provincial travel restriction (Breton, 2020). COVID-19 social distancing practices began in March, relaxed in May and June (as the number of cases decreased), but saw a tightening in October and November. Having said that, there was a noticeable pattern in the timeline of the implementation of social distancing mandates throughout Canada, as different provinces implemented policies at different periods.

At the onset of the pandemic, provinces adopted policies through a case of trial and error, as they were influenced by their health departments and the mandates of other countries. Using data from the first and the second waves of COVID-19, we can now understand and adopt appropriate policies to revive the national economy and lessen the impact of a potential third wave, or any future COVID-19 waves. This data will help us in answering one of our research questions, which is whether updated statistics and further regression analysis help provide a clearer picture of the effectiveness of social distancing protocols on various parts of Canada. We analyze the various vectors of spread within different provinces to answer whether aggressive lockdown policies are more effective in tackling the spread of COVID-19, as opposed to more lenient policies. More importantly, the goal is to find how rapidly various social distancing policies were implemented by different provinces in Canada, and how successful they were in curbing the spread of COVID-19. Lastly, we aim to update existing literature on the effectiveness of social distancing mandates in North America, with more recent Canadian data. We will examine human mobility responses to the pandemic and the procedures with social distancing measures to address these objectives. By doing so, we hope to better understand and control the spread of the virus using government policy, and identify potential areas of focus or variables of spread to stop it before it happens.

The following research paper is divided into four parts. In the first part, we discuss the previous literature written on social distancing and physical mobility in the context of the COVID-19 pandemic. Our second section describes the data sources utilized in our research, the methodology of the paper, as well as our difference-in-difference regression techniques. In the third part, we provide a descriptive analysis and detailed visualizations, drawing from the aforementioned data sources. Finally, our fourth section details the empirical results (which includes our regression). In this section, we provide quantitative findings on the relationship

between policies implemented by federal/provincial governments and human mobility patterns from both the first and second wave of the pandemic.

Literature Review

It was during the first half of 2020 when COVID-19 had severely disrupted social and economic lives globally. Scientists worldwide have been working nonstop to study the virus and the effects it has had on the planet.

One of the largest areas of study is the prevention and control of the virus. Many epidemiologists proclaim that implementing social distancing mandates and other nonpharmaceutical interventions (NPIs) are the key strategies to combat the spread of the virus. Even though the pandemic is less than a year old, economists, epidemiologists, and other social scientists have generated considerable research about the pandemic. Many of the papers produced talk about the changes in mobility patterns as a consequence of the social distancing mandates (Gupta et al., 2020) (Armstrong et al., 2020). Another field of research tends to consider other control measures that contribute to the reduction of human mobility (Kraemer et al., 2020) . Other papers focus mainly on estimating the effectiveness of NPIs in curbing the spread of COVID-19 (Karaivanov et al., 2020). Looking into what previous research has to say about the directives implemented to curb the virus's spread will help us find the gap that has not been tackled so far about the effectiveness of these mandates. More specifically, our research aims to fill the gap in the literature related to Canadian public policy in regard to the COVID-19 pandemic. By doing so, we hope to understand better and control the spread of the virus using government policy and identify potential areas of focus or variables of spread to stop it before it happens.

Mobility

In the guiding paper, Gupta et al. (2020) look at the effects of social distancing mandates in the US to understand the best targeted social distancing policies to control the spread of virus and minimize economic damage. They detect an overall pattern for human mobility during the first wave of the pandemic. Namely that it fell around March, recovered around June, and dropped again in October. Through their analyses, the authors find that there was indeed a reduction in human mobility in the states that had implemented a stay-at-home order even before the issuance of the mandate. Meanwhile, there were large increases in mobility in the states that adopted closure policies and measures later than other states. These findings illustrate key differences between voluntary versus policy induced changes in mobility. It is likely that people are not as strict in voluntarily taking care of protecting themselves against the virus during the second wave. This could be due to the fact that the fear of the pandemic was great during the first wave. Since our data extends till the second wave, we can shed further light to these findings, specifically in the Canadian context. These results of this paper are crucial to our research project, because they give us insight on what to expect. We believe that the situation in the

United States serves as a good approximation about the spread of COVID-19 in Canada, because both countries share similar physical, geographic and cultural elements. Unlike Gupta et. al, we will conduct a difference-in-difference model rather than an event study regression method to measure the causal effect of social distancing mandates on mobility and to assess the effectiveness of these policies.We will use the same sources of mobility data, that is the Google and Apple mobility reports, though, we will only consider the Canadian portion of these reports in our research.

Armstrong et al. paper (2020) is another interesting paper that assesses the impact of social distancing policies on mobility patterns. It is a comparative study on major US and Canadian cities that measures the aggressiveness of different social distancing policies and estimates the effect of such policies on mobility trends. The paper shows that on average the policy aggressiveness was similar in both countries but the level of mobility was less in Canada. This is due to the increased rapidness of policy interventions in Canada compared to the US. The paper utilized municipal, provincial/state level policy decisions that impacted the cities whereas we will only focus on Canadian provincial measures in our research. The paper adds to the Canadian literature of urban politics and public policy studies. It also provides rare evidence that there were nearly immediate policy responses to identical policies across both countries. This paper estimates how local residents responded to the overall mix of social distancing policies, something our paper closely aims to measure. The paper suggests that the implementation of social distancing policies had significant effects on driving. It found that in the long run an increase in the number of COVID-19 cases leads to an increase in driving possibly displacing the use of public transit. The paper also shows that transit mobility declines with policy aggressiveness. Our paper will extend and test whether this holds true for the second wave as well.

Other control measures contributing to the reduction of human mobility

Unlike Gupta et al.'s (2020) research, which focuses on existing social distancing mandates, Kraemer et al.'s (2020) paper analyzes the effectiveness of immediately imposed travel restrictions, improved rates of diagnostic testing, clinical management, rapid isolation of suspected cases, confirmed cases, and contacts, and, most notably, restrictions on mobility. Put differently, Kraemer et al. (2020) discusses precisely what measures are required to contain the spread of SARS-CoV-2, which causes the coronavirus disease. From this standpoint, Kraemer et al.'s (2020) work is similar to more traditional epidemiological research papers on public outbreaks, rather than a policy analysis perspective such as Gupta et al. (2020).

Kraemer et al. (2020) paper concluded that the drastic control measures implemented in China substantially mitigated the spread of COVID-19 and that mobility statistics offered a precise record of the spread of SARS-CoV-2 among China's cities at the start of 2020. However, once the virus had escaped Wuhan, strict local control measures such as social isolation and hygiene, rather than long-distance travel restrictions played the largest part in controlling the

SARS-CoV-2 spread. Finally, the frequency of introductions from Wuhan was predictive of the epidemic's size sparked in other provinces.

From this paper, it is clear that mobility data and human mobility patterns are a clear indicator that can predict the spread and size of epidemics in China and any country. As such, our paper can also draw from mobility data in widely available, accessible online databases such as Google and Apple to investigate the correlation between the implementation of various social distancing policies against comparative trends in mobility data. This correlation is but one way to investigate the effectiveness of such social distancing mandates.

Effect of NPIs on the spread of COVID-19 in Canada

Similar to Gupta et al.'s (2020) research that focuses more on the effect of existing policies and information-based events on the spread of COVID-19 and Kraemer et al.'s (2020) analysis on the effectiveness of travel restrictions and other immediately implemented mandates, Karaivanov et al's (2020) paper measures the effectiveness of masking policies and other NPIs in curbing the spread of COVID-19 in Canada. Based on their study, the authors conclude that there is a significantly negative correlation between mask mandates and COVID-19 case growth. Thus, indicating that masks help slow the spread of the virus significantly. In addition to these findings, the authors found that relaxed restrictions on businesses and social gatherings were positively associated with subsequent COVID-19 case growth. Moreover, they suggest that past knowledge about COVID-19 outcomes had effects on subsequent COVID-19 outcomes, with favourable information about the pandemic outcomes resulting in riskier behaviour following. This would limit the effectiveness of any NPI policies including masking and social distancing. In their paper, the authors took advantage of within-province and cross-province geographic and temporal variations to explore the impact of the timings of NPI policies.

The findings of this paper are of great importance to our work as it provides us with a basis of how certain mandates can interact with each other and influence the behaviour of a population. Since our research shares the same subject area as the one of Karaivanov et al. (2020), we expect to generate similar results as Karaivanov et al. (2020) for the first wave of the pandemic. Though our research will include more up-to-date data and will incorporate the multiple waves of the pandemic. Karaivanov et al (2020) also used Canadian data from Google mobility reports, which we will also be incorporating in our own project, however, we will also be using the Apple mobility report as well in our analysis. Finally, the work done in this paper also gives us insight on the within-province and cross-province effects that we may need to take into account for the timing of certain policies.

All of the above mentioned literature are important to our research, as they lay the groundwork for our paper. By looking at similar aspects of policy and similar variables all the while using newer data and conducting an additional difference-in-difference analysis, we hope to update the existing findings of some of these pieces of literature with data and regression from more recent sources and potentially add to it. Our study is a comparative study of determinants

between provinces that used more aggressive social distancing policies versus provinces that used less aggressive social distancing policies. Our paper will contribute to the longstanding Canadian literature for policymaking primarily related to pandemics.

Discussion of Data Sources and Policies studied

This research analyzes data from 1st March 2020 to 19th February 2021. Information about the social distancing mandates implemented by each jurisdiction are collected from the website "Reopening after Covid" (2020). This website presents unique quantitative data on trends in social distancing in Canada including re-opening indicators in different countries and provinces. The unit of observation is provinces with weekly implementation of reopening policy. In this dataset level 1 indicates complete lockdown, level 2 indicates greatly reduced access, level 3 indicates reduced access, level 4 indicates a new norm and level 5 indicates unrestricted access.

Policy intervention start-dates are obtained from datasets by Charles Breton, the executive director of the Centre of Excellence of the Canadian Federation at the Institute of Research and Public Policy (Breton 2020). The "Breton" dataset captures the level of policy restrictions across Canada. Overall, there were twelve different measures taken in the dataset enacted by provincial and territorial governments such as gathering sizes, facial coverings, school closures, and travel restrictions. For our research purposes, we mainly focus on cultural services and venues, restaurant, non-essential and retail businesses, schools and border restrictions (including inter-and intra- provincial travel restrictions). For these policies, the level of strictness in the Breton dataset increases from 0 to a maximum of 3. In particular, for cultural services, venues, restaurants, non-essential and retail businesses, 0 indicates no restriction, 1 indicates partial closure or limited capacity and 2 indicates full closure with the exception of take-out and delivery services. For borders, 0 indicates no restriction and 1 indicates ban on travelling. Lastly, for schools 0 indicates no restriction, 1 indicates physical school buildings are open but with altered methods of learning such as more dedicated classes, 2 indicates some school buildings are closed with altered methods of learning including more dedicated classes and remote learning and 3 indicates all physical school buildings are closed with only remote learning. The unit of observation is provinces with daily implementation of policies.

Mobility data is extracted from both Apple and Google databases. Both public reports provide information on how human mobility has changed since the beginning of the coronavirus. The Apple data is based on location insights of Apple's services in 3 dimensions – driving, walking and transit, aiming to help mitigate the spread of COVID-19 and provide governments, research institutions and health authorities with valuable information on human mobility. The Apple graphs have a baseline of 100, with the baseline being January 13th, 2020 (Apple 2020). For driving, the dataset includes data for all provinces except for Nunavut. For transit, it does not include data for Nunavut, Northwest Territories, New Brunswick, Newfoundland and Labrador,

Prince Edward Island, and Yukon. It also seems to be missing data for Nunavut, Northwest Territories, Prince Edward Island and Yukon in the walking dimension.

The Google dataset charts movement trends across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations and residential places. By using Google data, we provide a rationale to identify the timing and severity of the social distancing measure actualization in these provinces. These reports show how visits and length of stay at different places change compared to a baseline. The baseline for Google mobility datasets is the median value for the corresponding day of the week during the five-week period from January 3rd, 2020 to Feb 6, 2020. (Canada Google Mobility Changes 2021). It includes data for all provinces except Nunavut, Northwest Territories and Yukon during 15th August to 11th September for workplace mobility. For retail and recreation, it does not include any data for Nunavut and has missing data for Northwest Territories and Yukon during 6th April to 14th May. Prince Edward Island is missing data for retail and recreation as well as grocery and pharmacy during 17th August to 10th September. For parks, there is no data for Nunavut, Northwest Territories, Yukon and Prince Edward Island. It also seems to be missing data for Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia and Saskatchewan during 16th August to 10th September.

Descriptive Analysis

On March 11th 2020, the World Health Organization (WHO) officially announced COVID-19 as a world pandemic. Just like countries around the world, Canada started taking its social distancing measures to curb the spread of the virus. As Canada is a decentralized country, within Canada, 13 provinces took 13 different approaches to fighting the virus. This motivates our research question further in understanding what these provinces did, how strict or lenient they were in the polices and what impact it had on different types of mobility. Some of the key social distancing policies include, restaurant restrictions and bans, school closures, non-essential business closure, restrictions on gatherings in weddings, funerals, museums etc. and inter and intra provincial travel restrictions.

The start dates for these policies in the first wave are summarized in Figure 1 below. The key takeaways are that most policies were implemented within one week of the WHO announcement. The state of emergency was declared around 17th and 18th March 2020 in most provinces including Ontario, the Prairies and the North. Quebec was the first province to implement a state of emergency on 14th March and Nova Scotia was the last province to do so around 22nd March. Newfoundland and Labrador seemed to officially implement very few policies followed by Saskatchewan, New Brunswick, Manitoba, and Northwest Territories. Quebec seemed to be the fastest province to implement any social distancing policy and also the only province to implement an intra-provincial travel ban. Most provinces started with a ban on visits to long term healthcare homes, school closure or non-essential business closure. Moreover,

some provinces like Quebec first implemented some restaurant gathering restrictions and then fully banned restaurant visits with only take-out permitted. While some provinces like Ontario, directly implemented bans on restaurants.

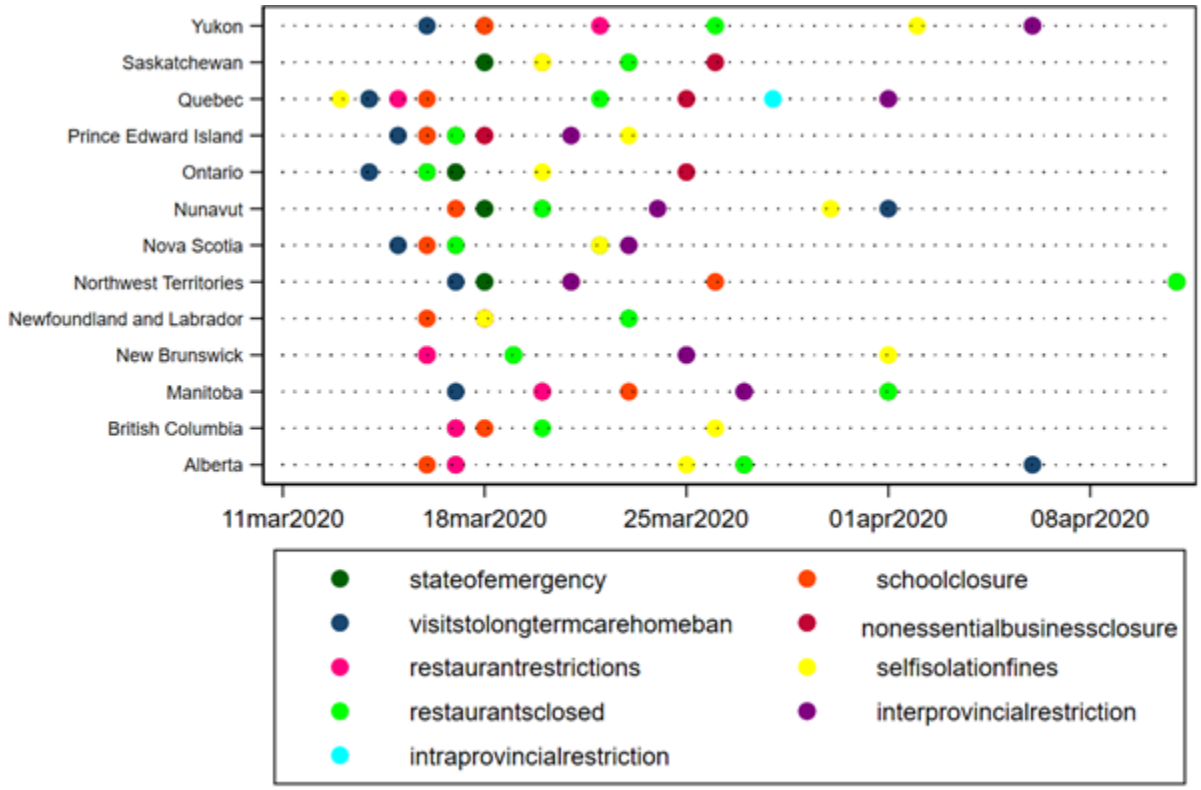
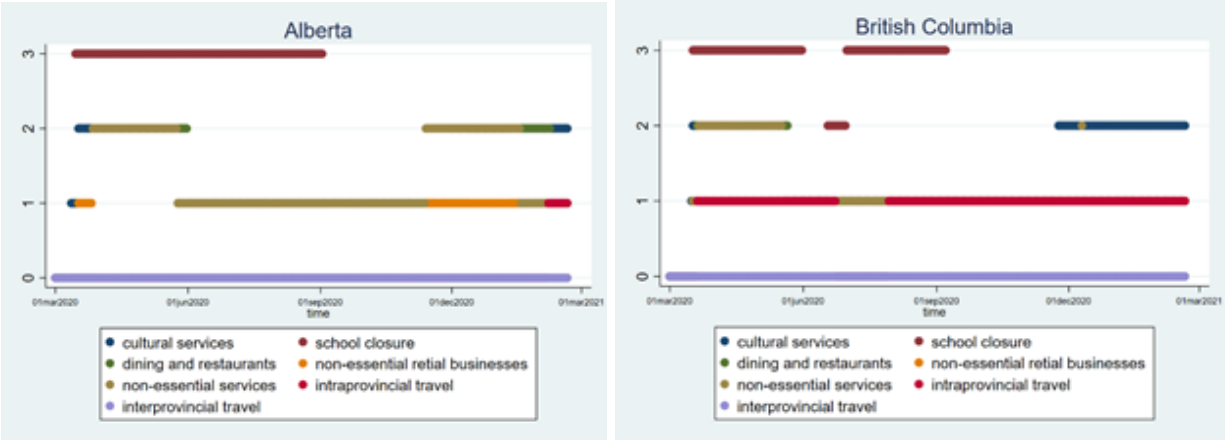


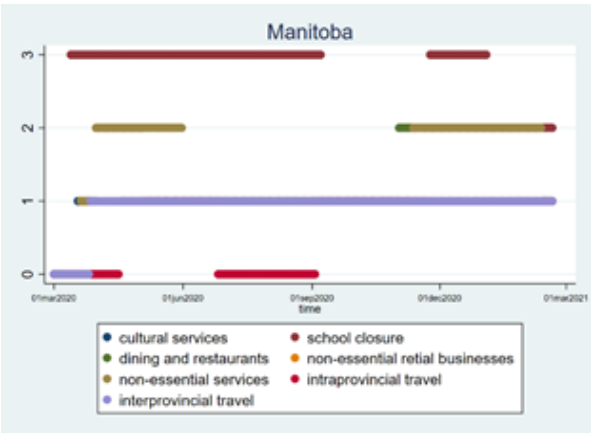
FIGURE 1: POLICY INTERVENTION START DATES
SOURCE: BRETON

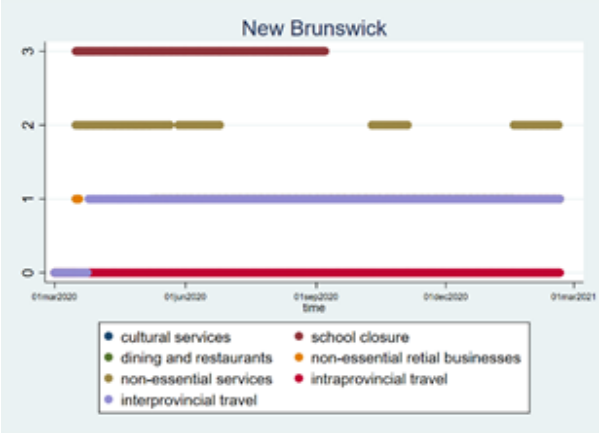
The policies were implemented throughout the first and second wave. However, during the reopening phase in June many policies, especially cultural gathering requirements, restaurant and store restrictions were eased but not completely removed. In the second wave during October, strictness in the policies began to pick-up but were not as severe. It was not until mid-September that doctors and epidemiologists started to warn of a second wave in Canada (Re-opening After Covid, 2020). As the number of cases grew exponentially, federal and provincial governments started to implement stricter measures to mitigate the severity and the adverse effects of the virus. Quebec and Ontario, in particular, started implementing more rigorous measures during the first weeks of October. On October 9th, the Ontario government enforced a gathering limit of 10 people indoors and 25 people outdoors (Re-opening After Covid, 2020). The government also issued the closure of places that offered indoor dining for at least 28 days. On November 20th, the premier announced that Toronto and Peel Region were

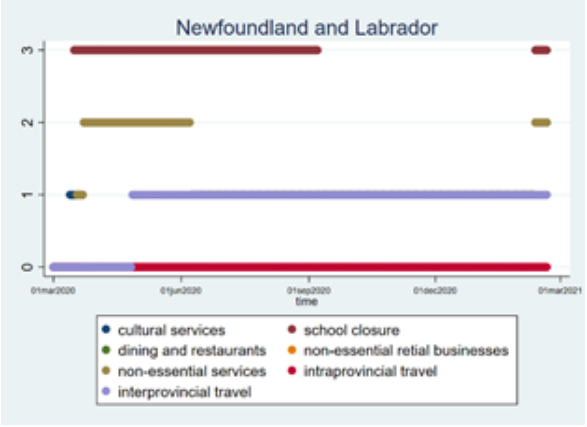
moving into "lockdown". On October 5th, red zones (which had to stay red for a minimum of 28 days) were declared in the Greater Montreal Area, Quebec City, and the city of Montreal itself was put on red alert on October 13th (Re-opening After Covid, 2020).

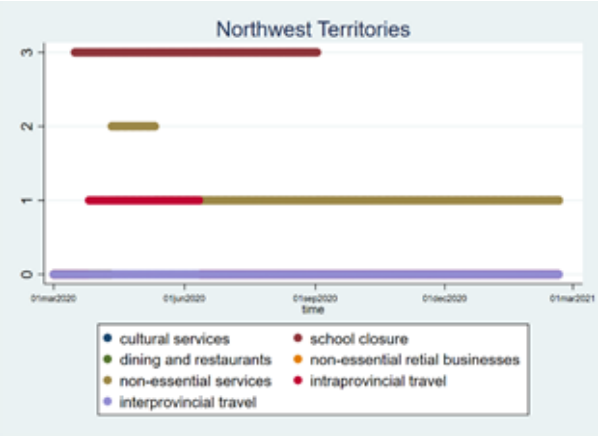
Figure 2 goes further to show the severity of the implementation of each policy in each province included in the Breton dataset. Some key takeaways are that Alberta, British Columbia, Saskatchewan, Ontario, Quebec, Prince Edward Island and Nunavut had cultural services completely closed for most part of the first and second wave. While Manitoba and Newfoundland and Labrador had limited capacity restrictions. Almost all provinces had complete school closure with all learning moved to remote delivery. It is important to note that during the second wave Saskatchewan implemented an altered student schedule-based learning program with only some learning services moved to remote conditions. Almost all provinces had restaurant dining completely closed with only delivery, drive-thru and curbside pick-up allowed in either the first, second or both waves. During the first and second wave non-essential services were completely closed. Having said that, it is important to note that there was some leniency granted to non-essential retail businesses, as they were allowed to operate at a limited capacity. Almost all provinces had some sort of inter-provincial travel ban except for Alberta, British Columbia, Northwest Territories and Ontario. Quebec was the first province to implement intra-provincial travel restrictions later in the first wave, with British Columbia, Nunavut and Northwest territories following this policy. Ontario only implemented intra-provincial travel restrictions in the second wave.

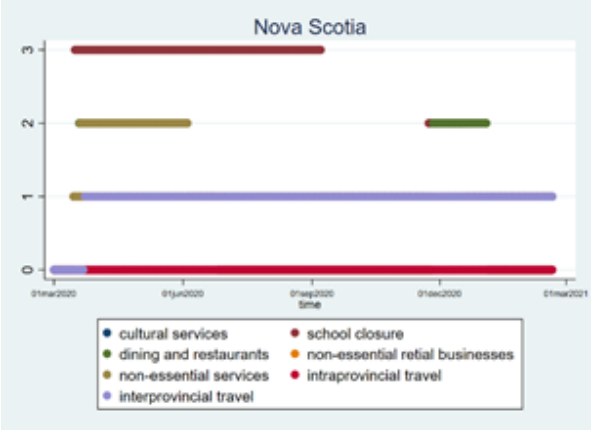


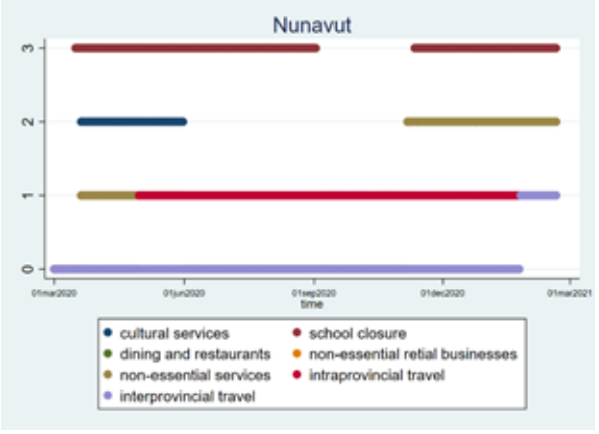

Manitoba
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel


New Brunswick
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel


Newfoundland and Labrador
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel


Northwest Territories
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel


Nova Scotia
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel


Nunavut
0
1
2
3
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time
cultural services
dining and restaurants
non-essential services
interprovincial travel
school closure
non-essential retial businesses
intraprovincial travel

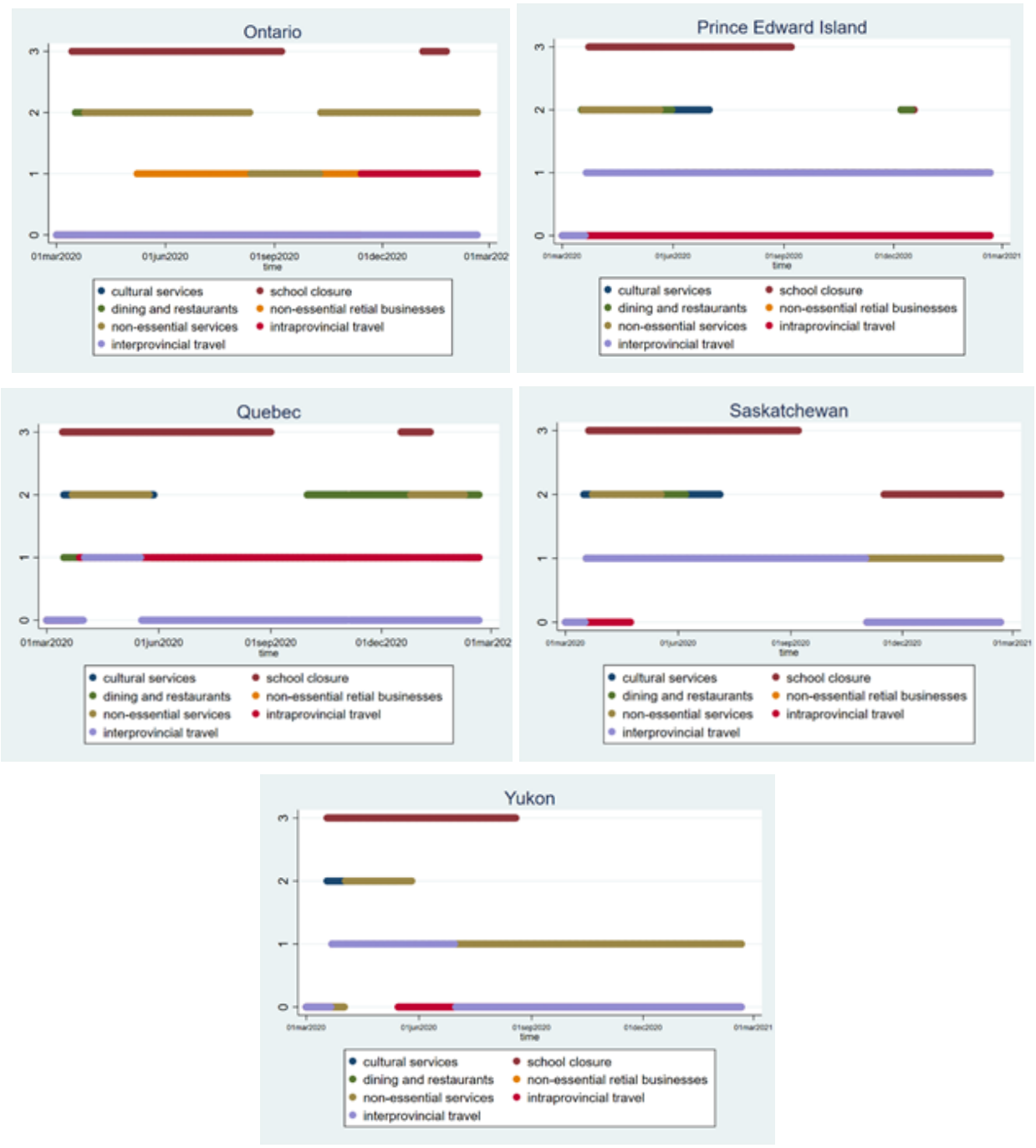
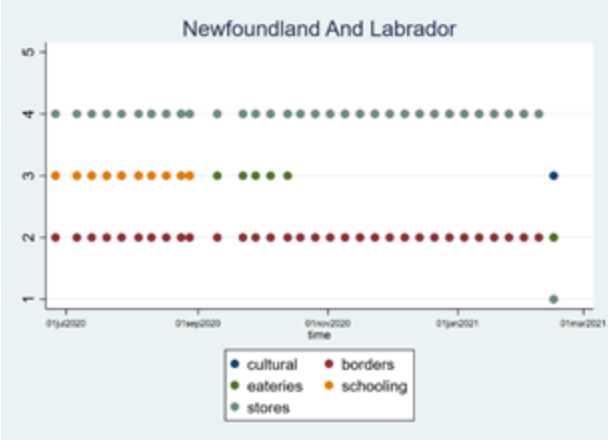
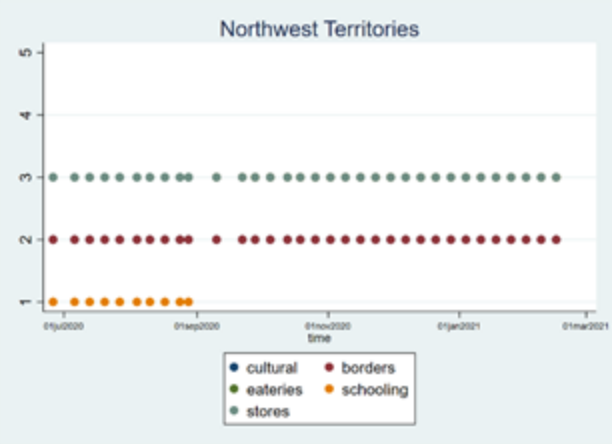


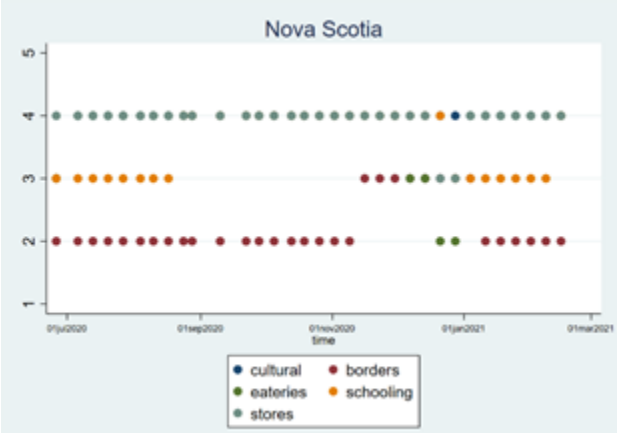
FIGURE 2
SOURCE: BRETON

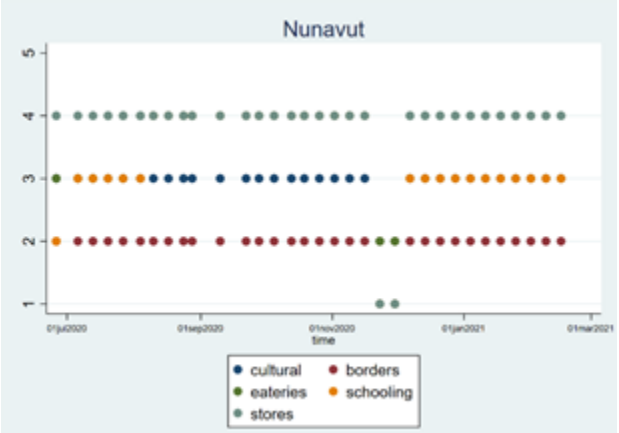
Figure 3 shows the reopening phase of each province starting in the last week of May 2020 until mid-February of 2021. It is important to note that during the reopening phase in June, restaurants and other "dining" places were allowed to operate but with safety measures in place. This was implemented for all provinces except Ontario, Quebec, and Prince Edward Island where there were still limitations on capacity. All provinces operated stores with limited capacity

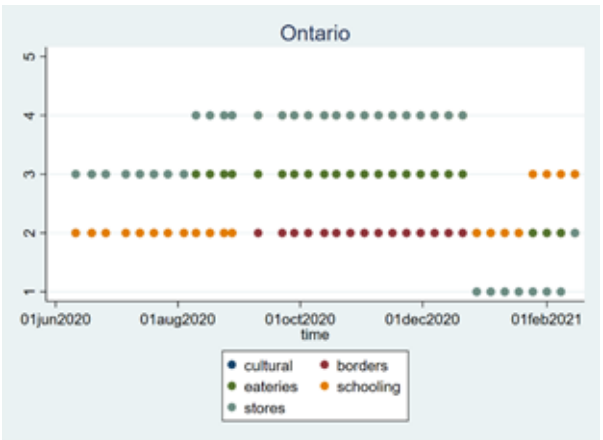
and maintained rules of physical distance, except for Yukon where only small-medium sized stores were allowed to open. During October, most provinces did not go back to the extremely strict bans implemented in the first wave for restrictions on store visits. However, Ontario, Nunavut and Manitoba completely closed stores during the second wave for a few weeks. For restaurants, Ontario, Quebec and Prince Edward Island transitioned to exclusively curb-side pickups and drive-thru services for restaurants. The Prairies, Atlantic regions and the North mostly allowed small outdoor cultural institutions to reopen with capacity limitations in early June and July but after October Alberta, Manitoba especially closed all cultural institutions. Throughout the course of the pandemic, borders were open only for citizens, permanent residents, and long-term residents such as students and professionals but Nova Scotia and New Brunswick also opened them for foreigners based on certain restrictions (for instance, if some countries were banned from entering). Schools experienced the most aggressive policy measures for all provinces where only selected levels of education opened with restrictions regarding attendance and outdoor classes were encouraged. Alberta attempted to reopen schools and youth activities at full capacity around August, yet reverted to a limited capacity and online delivery setting by the start of September. Recently, Quebec and Prince Edward Island also opened in-person schools and youth activities with strict measures and online options for students.


Newfoundland And Labrador
1
2
3
4
5
01jul2020
01sep2020
01nov2020
01jan2021
01mar2021
time
cultural
borders
eateries
schooling
stores


Northwest Territories
1
2
3
4
5
01jul2020
01sep2020
01nov2020
01jan2021
01mar2021
time
cultural
borders
eateries
schooling
stores


Nova Scotia
1
2
3
4
5
01jul2020
01sep2020
01nov2020
01jan2021
01mar2021
time
cultural
borders
eateries
schooling
stores


Nunavut
1
2
3
4
5
01jul2020
01sep2020
01nov2020
01jan2021
01mar2021
time
cultural
borders
eateries
schooling
stores


Ontario
1
2
3
4
5
01jun2020
01aug2020
01oct2020
01dec2020
01feb2021
time
cultural
borders
eateries
schooling
stores

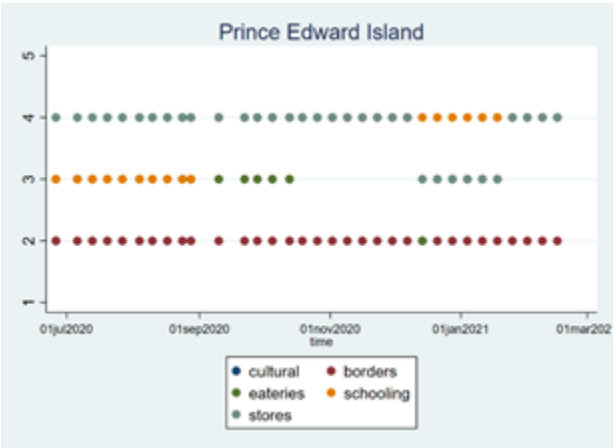
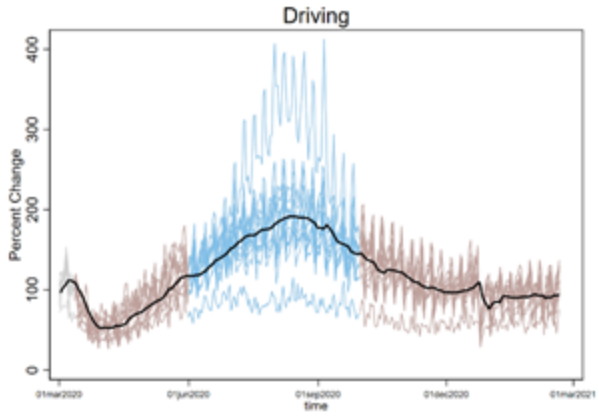
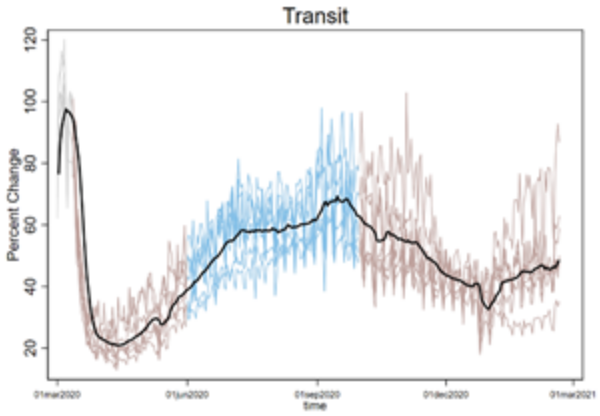
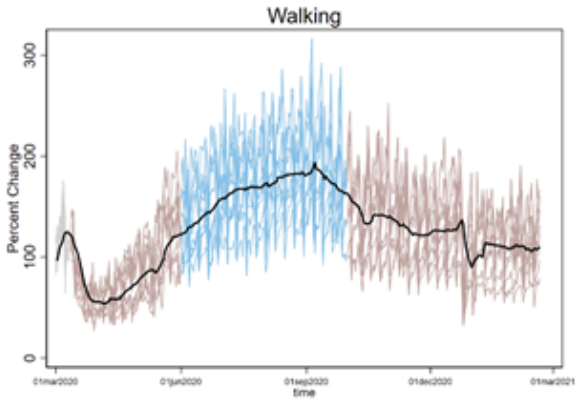

Prince Edward Island
1
2
3
4
5
01jul2020
01sep2020
01nov2020
01jan2021
time
cultural
borders
eateries
schooling
stores

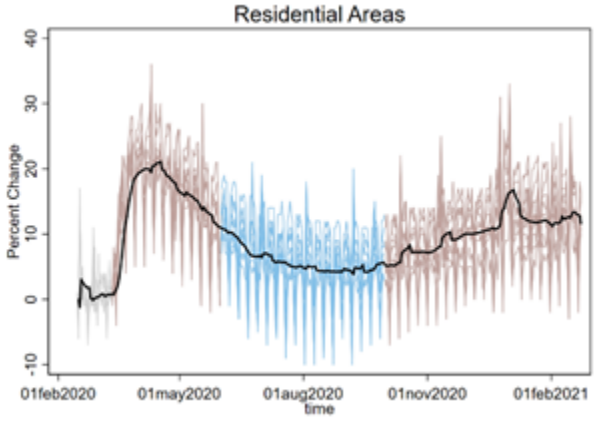
FIGURE 3
SOURCE: REOPENING AFTER COVID

Due to implementation of social distancing policies, there was a significant decline in mobility within various areas. The mobility patterns are summarized in Figure 4 below. The key takeaways are that mobility fell drastically for driving, transit, walking, retail and recreation and workplace in the first wave between March 1st – June 1st signalling the implementation of social distancing policies. On the other hand, the mobility for residential areas peaked as more people self-isolated, quarantined or just stayed at and near home to avoid the spread of the virus. Then in the reopening phase from June 1st – October 1st mobility recovered mostly except in transit as most people still avoided crowded areas and preferred modes and places where there were less people. We see that driving shows a huge increase for one province which is Prince Edward Island.


Driving
Percent Change
0
100
200
300
400
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time


Transit
Percent Change
20
40
60
80
100
120
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time


Walking
Percent Change
0
100
200
300
01mar2020
01jun2020
01sep2020
01dec2020
01mar2021
time


Residential Areas
Percent Change
-10
0
10
20
30
40
01feb2020
01may2020
01aug2020
01nov2020
01feb2021
time

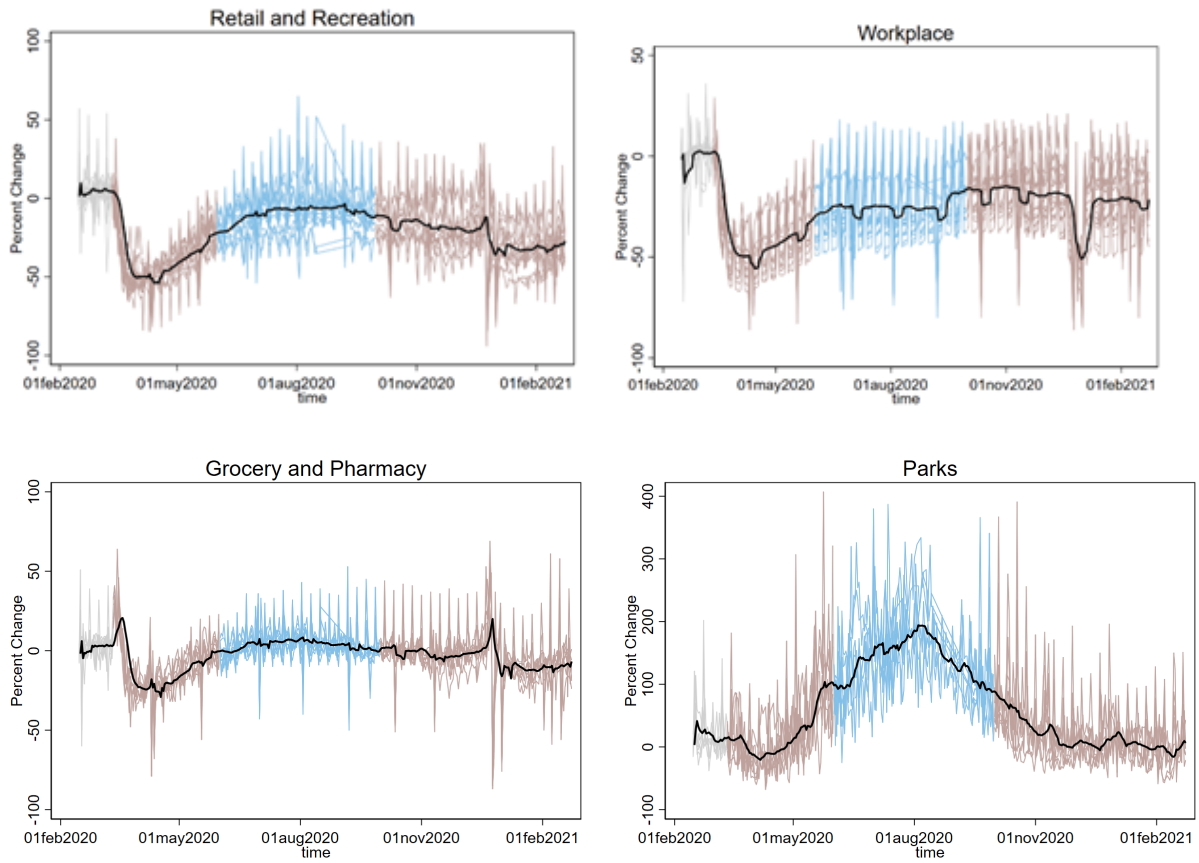


FIGURE 4: The first grey portion refers to the first wave, and the second grey portion refers to the second wave and blue portion is the reopening phase. The black line is the "smoothed" seven-day moving average of the provinces.
SOURCE: GOOGLE AND APPLE MOBILITY REPORTS

In Figure 5, the mobility trends for each province were plotted for only the months of March and October of 2020. This is to distinguish between the start dates for the first and the second waves of the pandemic. We can observe an immediate drastic decline in the mobility for retail and recreation in the week of March 11th. This is when most provinces had declared a state of emergency and implemented other social distancing mandates as well. The pattern is similar across most provinces except for Nova Scotia, New Brunswick and Prince Edward Island which see a slight peak right before the decline. The changes in mobility for the second wave were not as rapid as they were for the first wave. The graph clearly shows that the response is almost two weeks after Justin Trudeau's announcement of a second wave in the last week of September as opposed to the first wave where the response was visible within the same week of announcement. If we look closely, we can see there is a slight decline in the second week of October. More importantly, not all provinces follow the same pattern such as Prince Edward

Island and Nova Scotia have huge peaks in mobility compared to other provinces during this period.

Similar pattern is observed in workplace mobility. For mobility in grocery and pharmaceuticals, there was a huge spike in the week of March 11th. This spike was soon followed by a huge decline. This could be due to the fact that people quickly tried to get all essentials in bulk as soon as they heard about the lockdown. In the second wave, we see a stable pattern but huge downward spikes in the second week of October for Ontario, Manitoba and New Brunswick. For Nova Scotia there was a huge spike before a decline followed by weekly spikes, signalling the pattern that people were timing their visits for grocery.

Residential areas saw a drastic increase during the start of the first wave for all provinces. This is largely due to the behaviour of quarantine, self-isolation and the stay at home order. Nonetheless, the mobility pattern did not see a drastic increase in the second wave, just small spikes around the second week of October. Ontario and Quebec seemed to have the highest residential area percent change in mobility signalling to the lockdowns announced in October. Parks do not see a consistent pattern in the first wave, with very small decline for some provinces like Alberta, Manitoba, Quebec, Ontario and Saskatchewan. Interestingly, we can see an increase in mobility for Nova Scotia and New Brunswick. In the second wave, mobility increased for all provinces slightly and drastically for New Brunswick and Nova Scotia.

Driving, transit and walking saw a drastic decline in mobility in the first almost immediately after the announcement of lockdown. Although, walking saw some weekly increase in New Brunswick, Newfoundland and Labrador, Nova Scotia and Saskatchewan. In the second wave almost all provinces saw weekly increases in mobility for walking but Quebec and Ontario saw relatively lower increase in percent change. Transit had not really recovered in the second wave so the mobility was relatively low even before the announcement but declined even more for Quebec and Ontario. Driving also saw weekly downward and upward peaks in the second wave.

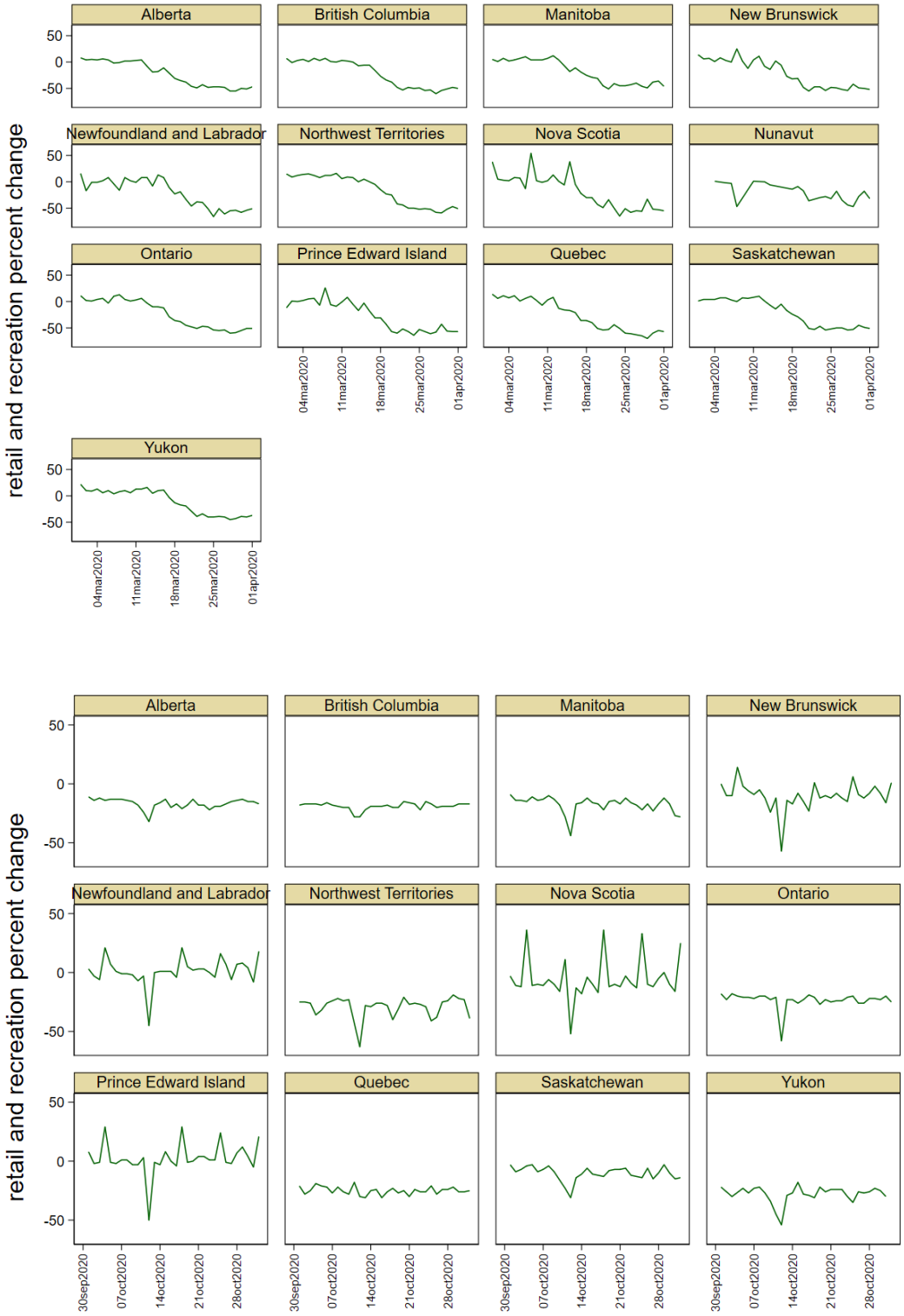


FIGURE 5: Only recreation and retail is included in the paper, refer to the appendix A for other mobility trends

SOURCE: GOOGLE AND APPLE

Key Results:

Empirical Methods:

The empirical data collection, visualization, regression and analysis sections serve as an essential factor towards the productivity of our research. With the data collected, the difference-in-difference model was implemented as the regression strategy. Using the Apple and Google mobility data as the dependent variables and the Breton and Reopening policy indicators as the independent variables, we are able to determine overall changes to mobility as due to certain policies over the course of the pandemic. Specifically, in this part we focused on mobility patterns of workplaces, residential areas, retail and recreation, driving, transit and walking. Other regression results for remaining mobility patterns can be found in the appendix B but will not be elaborated upon in this section as similar results were observed. For policies, we focus on five areas: restaurants, non-essential and retail businesses, schools, cultural gatherings and venues and borders.

We utilize a difference-in-difference, quasi-experimental approach to estimate the effect of Non-pharmaceutical Interventions (NPIs) in reducing the mobility trends of people across different provinces in Canada. To assess the impact of NPIs and behavioral responses on COVID-19 in Canada from March 2020 to February 2021, we estimate the following variables on outcome Y_{it} , which corresponds to the change in mobility trends:

$$Y_{it} = \beta_0 + \beta_1(post_t) + \beta_2(treat_i) + \beta_3(post_t \times treat_i) + \beta_4(prov) + \epsilon_{it}$$

β_0 refers to the constant for each mobility regression, while β_1(post) refers to the time, specifically when policies are implemented. In addition, $\beta_2(treat_i)$ refers to specific provinces that implemented policies (i.e. whether or not provinces implemented policies or not), and $\beta_3(post_t * treatment_i)$ refers to the interaction term between the post and treatment variable. Our analysis draws upon the interaction term as the primary result for the regression. Finally, β_4(prov) refers to the province-specific fixed effects, and ε_{it} is the error term.

Empirical Results:

Before conducting the analysis of the regression results, it should be noted that for all tables each heading is a different regression. The regression is split into several columns for different levels of policies to keep the tables succinct since each policy can have up to 5 levels.

Table 1:

	COVID-19 NPI Effects on Mobility Overall (Apple)					
	Driving		Walking		Transit	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	-4.1652	-9.9133***	-5.3606*	-6.9556**	3.2957***	-1.6069
	(2.7938)	(3.1331)	(2.7836)	(3.1825)	(1.0438)	(1.2005)
Nonessential Services	4.9647	3.8379	9.4909**	6.2643	6.1079***	3.0619**
	(4.3191)	(4.264)	(4.3274)	(4.3189)	(1.6188)	(1.6195)
Cultural Services and Venues	-12.1466***	-10.0594**	-1.2756	-2.8815	0.6475	1.5679
	(4.1753)	(4.1060)	(5.6658)	(5.7138)	(2.1762)	(2.1874)
Schools	12.7135**	13.0462***	11.5844**	12.1152**	-6.5262***	-5.8059***
	(5.1494)	(4.6769)	(5.735)	(5.4063)	(2.0256)	(1.9149)
Inter-Provincial Travel		7.4126***		18.348***		1.1628*
		(1.4537)		(1.5818)		(0.6804)
Intra-Provincial Travel		7.6726***		-2.7886**		-0.9197**
		(1.0967)		(1.1624)		(0.4192)
Dining and Restaurants	-13.3577***	-19.3264***	-21.7397***	-29.6454***	-13.6373***	-16.9893***
	(2.1027)	(2.1644)	(1.892)	(1.9563)	(0.6472)	(0.6774)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	4247	4247	3203	3203	2491	2491

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1 represents the Apple mobility data regressed on a subset of the Breton policies. The policies were chosen based on how much we think the type of policy could feasibly have an impact on mobility. For example, a mask policy will likely not have an effect on mobility while closure of certain businesses may. In Table 1, driving was heavily affected by these closure policies, both partial and complete, as there were many statistically significant estimates for the effect of policies on driving mobility. In particular, the policies that led to the most significant decreases in driving mobility are the complete closure of non-essential retail businesses, closure of cultural services and the closure of restaurants. This is further reflected in the changes to walking and transit mobility as we see similar trends for the same policies, like non essential retail and dining, and hence this suggests that mobility of all kinds followed the same general patterns during the pandemic. We find that when there are complete restrictions, there is a decline in nonessential retail businesses for walking and driving but not too much for transit. Moreover, we also see a subsequent increase in both the driving and walking mobility once the school policies were implemented. This can be seen with the statistically significant increases for driving of 12.71 percentage points and 13.05 percentage points for the partial and complete closures, respectively, and a 11.58 percentage points and 12.12 percentage points increase for the walking mobility. In contrast, we find a decrease in the transit, with decreases of 6.53 percentage points and 5.81 percentage points for partial and complete closure, respectively. This suggests that there was a shift towards mobility types that see students interacting with less people overall, since driving and walking is usually done in smaller numbers when compared to transit methods like the bus. In terms of the other policies, we see that driving went down as a result of the

cultural closures, by roughly 10-12 percentage points, and that dining closures saw the greatest decreases across all three mobility types.

Table 2:

	COVID-19 NPI Effects on Mobility Overall (Google)					
	Workplace		Retail and Recreation		Residential	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	2.1826**	-0.2431	-0.5375	-8.6256***	-1.4493***	0.1184
	(0.9657)	(1.0894)	(1.2654)	(1.4503)	(0.3306)	(0.3782)
Nonessential Services	-3.6006**	-5.040***	0.1184	-3.7315**	-0.3690	0.5915
	(1.4178)	(1.4195)	(1.9758)	(1.9697)	(0.5161)	(0.5149)
Cultural Services and Venues	0.3447	-0.8529	-1.9492	-2.0705	0.0857	0.3267
	(1.2356)	(1.2201)	(1.8803)	(1.8487)	(0.6578)	(0.6627)
Schools	1.3334	0.6772	3.3211	0.1982	-1.379**	-0.6972
	(1.792)	(1.6224)	(2.3092)	(2.0772)	(0.6017)	(0.5544)
Inter-Provincial Travel		1.9127***		4.8473***		-0.6606***
		(0.4821)		(0.6713)		(0.1884)
Intra-Provincial Travel		-1.7415***		0.474		0.1749
		(0.3726)		(0.5287)		(0.1387)
Dining and Restaurants	-1.0990*	-3.1156***	-4.2078***	-8.8326***	1.4146***	1.884***
	(0.658)	(0.6948)	(0.9379)	(0.9773)	(0.227)	(0.2347)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	4425	4425	4098	4098	3412	3412

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 2, we regress the Google mobility data on the same subset of the Breton policies used in Table 1. This leads to very similar results as Table 1. For most of the areas, mobility decreases as a result of dining policies except for the residential category. This makes sense because we can expect people to stay home more. Thus, increasing the mobility in and around their homes. Moreover, nonessential services saw a decrease to workplace mobility as well as retail and recreational mobility, which would make sense considering most jobs are nonessential and hence would not require travel to. Additional areas of the Google data set can also be found in the Appendix.

In addition to using the Breton closing policy indicators, an additional regression was conducted using the reopening policy indicators. We regressed both the Apple and Google mobility data with reopening policy indicators. This dataset from the Reopening After Covid dashboard presented some limitations because it only provides weekly observations. Hence, giving us a smaller sample size to work with. That's why, some results from this regression may change given a bigger sample (most likely the ones with coefficients close to their standard errors). With most reopening policies occurring simultaneously, it makes it hard to determine the exact individual effects. Nonetheless conducting the regression is still helpful as it still shows the impact of society reopening as a whole.

Table 3:

	COVID-19 Reopening Effects on Mobility Overall (Apple)											
	Driving				Walking				Transit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Stores	-12.3691	-9.1001	-2.8219		-12.3807*	-13.8409**	-11.4342		2.2099	6.338*	10.1986***	
	(7.6627)	(10.2497)	(10.5044)		(7.0145)	(9.9603)	(10.1202)		(2.5152)	(3.504)	(3.6429)	
Schooling	21.5576***	36.1269***	33.6312***	16.1988***	39.0991**	50.8656***	55.7563***	61.1599***		-3.1389**	-1.1807	-1.2416
	(7.4142)	(5.548)	(7.7748)	(9.9072)	(18.4157)	(18.0559)	(18.2206)	(19.287)		(1.7707)	(1.806)	(2.6919)
Borders		4.1676				10.3551**				-0.7502		
		(5.8105)				(5.1364)				(2.4607)		
Eateries		-2.9296	-17.2651***			-8.2097	-5.2099			-1.0233	4.3928**	
		(5.7402)	(5.9117)			(5.2873)	(5.482)			(1.939)	(2.1046)	
Cultural Services	-1.6891	-6.4629	5.8247		2.0016	9.6938	6.473		-1.7707	0.05082	0.4112	
	(7.2401)	(8.0995)	(8.8451)		(6.6738)	(8.1215)	(8.685)		(2.3099)	(2.8322)	(3.1376)	
Gatherings	-2.6974	-9.1079	-4.2216		-3.0577	-8.1723	-15.6858**		-3.2546	-4.1726	-6.3001	
	(6.7574)	(7.6069)	(8.858)		(6.0346)	(6.8983)	(8.1253)		(2.1854)	(2.5864)	(3.0637)	
Policy Type	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access
Number of Observations	406	406	406	406	307	307	307	307	239	239	239	239

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 shows the effects of reopening on general mobility types using 6 different reopening indicators. The most prominent result from this regression is the overall increases to mobility due to the reopening of schools. We see that for both driving and walking, there was an increase in mobility at all levels of reopening. This reiterates the results of Table 1 in terms of increases in these mobility types as a result of the policies. It should be noted that this reopening period took place during the time students started returning to school in August and September. So, this increase could partially be the result of students needing to return to school to retrieve supplies or technology. We also see that transit mobility had the least number of statistically significant results. This suggests that transit travel did not recover as much as the other mobility types during the reopening phase, which aligns with our mobility graphs. The last result from this data is that mobility saw a decrease overall for eateries. This indicates that even when reopening, many dining and restaurant locations are still affected by decreased traffic. This is reflected by the statistically significant decreases in driving and potentially significant results in walking.

Table 4:

	COVID-19 Reopening Effects on Mobility Overall (Google)											
	Workplace				Retail and Recreation				Residential			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Stores	4.0117	5.9681	7.3674*		-1.0314	7.5605*	8.8321**		0.0725*	-1.2165	-1.8967	
	(2.8792)	(3.9398)	(3.9838)		(3.0058)	(4.021)	(4.1237)		(0.9399)	(1.3087)	(1.3382)	
Schooling	10.8209***	9.7641***	11.0230***	10.191**	7.1061**	10.1656***	10.8273***	6.0594	4.5827**	4.5046**	3.3636	3.4785
	(2.8869)	(2.2879)	(3.0337)	(3.9715)	(3.1577)	(2.4687)	(3.3286)	(4.091)	(2.4718)	(2.4329)	(2.4543)	(2.5936)
Borders		4.1204*				5.0505				-1.1936*		
		(2.2657)				(2.2713)				(0.6837)		
Eateries		-1.5106	0.6184			2.3928	4.4433			-0.3314	-0.8734	
		(2.2528)	(2.2939)			(2.242)	(2.318)			(0.6847)	(0.7026)	
Cultural Services	0.02476	1.7572	0.4857		-5.7144**	3.8858	-1.836		1.6034	0.5186	0.715	
	(2.8423)	(3.1686)	(3.4549)		(2.8337)	(3.1634)	(3.4664)		(0.8928)	(8.1215)	(1.1372)	
Gatherings	-0.4620	0.1307	1.145		-1.6441	-3.3383	-3.7715		0.1457	0.7528	1.4605	
	(2.6539)	(2.9791)	(3.47)		(2.6452)	(2.9848)	(3.4791)		(0.8077)	(0.9178)	(1.0798)	
Policy Type	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access
Number of Observations	427	427	427	427	393	393	393	393	340	340	340	340

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Looking at the Google mobility data in Table 4, we see the same kinds of policy effects as before. We can see that schooling saw the greatest overall increases compared to the other policies, with statistically significant increases to workplace mobility by roughly 10 percentage points, 7-11 percentage points in retail and recreational mobility during all levels of reopening except unrestricted access, and roughly 4.5 percentage points increases for both reduced accesses in residential, all of which are significant to at least 5 percent statistical significance.

Table 7:

	COVID-19 NPI Effects on Mobility First Wave (Apple)					
	Driving		Walking		Transit	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	-6.8048**	-10.6753***	-6.6433	-3.9024	-1.053	-4.9538
	(2.8622)	(3.1568)	(4.7701)	(5.2807)	(2.1041)	(2.3232)
Nonessential Services	7.5553***	5.9942**	4.1552	3.1848	7.8393***	3.7908**
	(2.9234)	(2.8947)	(4.728)	(4.6649)	(1.9002)	(1.8929)
Cultural Services and Venues	-6.3089**	2.9788	-3.9752	-9.7293*	-5.2374***	-2.152
	(2.5484)	(2.7683)	(5.0513)	(5.6937)	(1.9157)	(2.0742)
Schools	-2.3052	2.3547	-21.6493**	-0.654**	-6.6245	-6.9884***
	(9.7691)	(2.3118)	(15.1097)	(4.7495)	(4.9326)	(1.6226)
Inter-Provincial Travel		5.3423***		8.3416***		1.8103**
		(1.0652)		(1.7585)		(0.7056)
Intra-Provincial Travel		-2.5558**		-0.8814**		3.8826***
		(1.1132)		(1.9013)		(0.6678)
Dining and Restaurants	-8.0699***	-12.3379***	15.2415**	11.9179*	-2.0914	-0.4692
	(3.0109)	(3.2551)	(6.418)	(6.948)	(2.2711)	(2.3852)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	1,092	1,092	837	837	651	651

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 highlights the effects of reopening on general mobility types from the first wave, using 7 different reopening indicators and drawing upon databases provided by Apple. The most prominent result from this regression is the overall increases in mobility as a result of policies allowing nonessential services to re-open, as noted by increased mobility trends for both driving (~7 percentage points increase in driving mobility) , walking (~4 percentage points increase in walking mobility) and transit (~7 percentage points increase in transit mobility). Similarly to Table 3, transit mobility experienced the least number of statistically significant results, suggesting that transit travel did not recover as much as the other mobility types. The last result from this data is that mobility saw a decrease overall for eateries. This indicates that even when reopening, many dining and restaurant locations were affected by decreased traffic.

Table 8:

	COVID-19 NPI Effects on Mobility First Wave (Google)					
	Workplace		Retail and Recreation		Residential	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	-5.3861***	-6.7437***	-5.0745**	-8.8789***	0.9173	1.3673*
	(1.565)	(1.7149)	(2.4959)	(2.7429)	(0.6811)	(0.7462)
Nonessential Services	6.1968***	3.2063**	6.0409**	1.9078	-1.0831	-0.4682
	(1.5585)	(1.5765)	(2.545)	(2.5798)	(0.6668)	(0.6693)
Cultural Services and Venues	1.2954	6.0329***	-0.2494	6.1029	-0.1412	-0.0706
	(1.3524)	(1.4132)	(2.2602)	(2.4205)	(0.7001)	(0.7767)
Schools	-0.3666	0.3679	-3.7272	-1.0645	-0.7185	-0.5076
	(5.3201)	(1.2623)	(8.5159)	(1.9948)	(2.1458)	(0.5718)
Inter-Provincial Travel		1.1812**		2.0702**		-0.7441***
		(0.5746)		(0.947)		(0.2483)
Intra-Provincial Travel		-1.6243***		-1.8546*		0.22
		(0.5546)		(0.9653)		(0.2678)
Dining and Restaurants	-5.9537***	-11.323***	-4.5139*	-6.7556**	0.3605	0.14
	(1.5852)	(1.7048)	(2.6509)	(2.8513)	(0.8903)	(0.9505)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	1,177	1,177	1,054	1,054	902	902

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

When looking at mobility data provided by Google for COVID-19 NPI Effects on Mobility related to the first wave, we observe that workplace and retail and recreation experienced the greatest increases stemming from policies related to non-essential services (~6 percentage points). On the other hand, policies related to non-essential retail businesses led to a significant decrease in mobility in both workplace and retail/recreation industries (~5 percentage points for workplace mobility and ~5 percentage points for retail and recreation). As can be noted by the statistics on the dining and restaurants, Table 8 demonstrates similar trends from previous tables in that eateries suffered a negative shift in mobility stemming from policies that forced restaurants to close in-person dining experiences (~5 percentage points for workplace mobility as a result of dining/restaurant policies and ~5 percentage points for retail and recreation mobility as a result of dining/restaurant policies). Similar to Table 4, Table 8 experiences the lowest number of observations for residential mobility, which point towards less statistically significant results.

Table 9:

	COVID-19 NPI Effects on Mobility Second Wave (Apple)					
	Driving		Walking		Transit	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	-3.6924**	-7.6403***	-1.2214	2.0033	4.952***	0.3209
	(1.7112)	(2.5374)	(2.1713)	(3.2243)	(0.809)	(1.3025)
Nonessential Services		1.9087		2.4257		0.2717
		(1.2745)		(1.6458)		(0.7364)
Cultural Services and Venues		1.948		-1.4741		0.6215
		(1.414)		(1.7951)		(0.6136)
Schools	5.0893***	-1.2278	3.9924***	-3.3549*	-0.0587	0.05701
	(1.0947)	(1.5732)	(1.4421)	(2.0294)	(0.5022)	(0.7324)
Inter-Provincial Travel		12.4187***		14.005***		-0.7945
		(2.7985)		(3.5916)		(1.2457)
Intra-Provincial Travel		1.6352		-0.9078		-1.6618*
		(1.8585)		(2.3807)		(0.8493)
Dining and Restaurants	-12.2961***	-21.196***	-20.5986***	-28.4468***	-14.4088***	-19.4173***
	(2.4952)	(2.3009)	(3.2808)	(2.9314)	(1.1505)	(1.0032)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	1,691	1,691	1,268	1,268	986	986

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9 examined the effect of various policies implemented on mobility outcomes for the second wave in Canada, and was taken from databases provided by Apple. Overall, compared to the first wave, there were different magnitudes of changes in various sectors for different policies. As demonstrated by the prior tables in the first wave, mobility regarding schooling saw a noticeable change after policies were implemented. Schooling underwent the greatest overall increases in mobility (~5 percentage points for driving mobility and ~4 percentage points for walking mobility), whilst dining and restaurants suffered from the greatest overall decreases in mobility (~12 percentage points for driving mobility and ~23 percentage points for walking mobility). These trends can be further highlighted by the various, stricter policies surrounding the restaurant industry that prohibited individuals from eating in-person at restaurants. We saw greater decreases in dining/restaurant mobility for the second wave than during the first wave. These trends can be partially explained by heavily weighted sample size policies in provinces such as Ontario and Quebec, where restrictions were more severe than other provinces. In addition, it was easier for people to adapt to updated policies, given that the second wave was 5-6 months after the initial start date. Exact changes regarding policies can be further referred to in the Appendix.

Echoing the previous tables demonstrating mobility patterns from the first wave, we can see that policies on the Transit mobility patterns are the least statistically significant, which coincides with the least number of observations. Unlike the first wave, governments and public transportation systems received a greater amount of time to prepare and develop social distancing policies that would limit the number of COVID-19 cases.

Table 10:

	COVID-19 NPI Effects on Mobility Second Wave (Google)					
	Workplace		Retail and Recreation		Residential	
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business	-7.5648***	-12.2361***	-1.2164	-10.7764***	0.9317***	2.5651***
	(2.7501)	(3.0012)	(1.2813)	(1.8998)	(0.3189)	(0.4729)
Nonessential Services	6.2545*	5.8931*		-1.591*		0.1012
	(3.2924)	(3.4621)		(0.9543)		(0.2376)
Cultural Services and Venues	0.1927			-0.0307		-0.0068
	(0.9269)			(1.0588)		(0.2639)
Schools	-0.6051	-3.6696***	1.8539**	-2.759**	-0.2595	1.2492***
	(0.7162)	(1.0052)	(0.8197)	(1.1785)	(0.2064)	(0.2968)
Inter-Provincial Travel		13.4175***		9.8615***		-3.3313***
		(1.8022)		(2.0959)		(0.5255)
Intra-Provincial Travel		-1.8976		-1.7855		0.3388
		(1.2187)		(1.3918)		(0.3487)
Dining and Restaurants	1.8526	-2.2615	0.5377	-7.0342***	-0.8086*	1.0999**
	(1.6348)	(1.5073)	(1.8688)	(1.7232)	(0.467)	(0.4295)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	1,780	1,780	1,677	1,677	1,409	1,409

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

For Table 10, we examined the effect of various policies implemented on mobility outcomes for the second wave in Canada, which was taken from Google dataset. The Google results indicate that nonessential services foresaw the greatest overall increases in mobility (specifically in the workplace of ~6 percentage points). Similarly, mobility regarding nonessential retail businesses experienced a negative change in mobility (for instance, ~7 percentage points for workplace mobility) after policies were implemented from federal and provincial governments. It is important to note that the number of observations for both tables 9 and 10 (regarding the second wave) exceeds that of mobility patterns from the first wave. Overall, the increased number of observations strengthens the regressions by demonstrating more consistent mobility trends in various industries.

Conclusion

In terms of variation of policies, our research found significant variations across the provinces on people's response to both the lockdown and social distancing mandates. Whilst some provinces followed suit, other provinces experienced delays before announcing any NPIs. For instance, Quebec and Ontario implemented the most rigorous policies, specifically in the second wave. In terms of policy implications, our research indicated that various industries experienced greater changes in mobility than others. Our regressions identified the biggest decrease across all mobility types (such as walking, transit, driving etc) for eateries and the restaurant industry, which underwent a significant change as federal and provincial governments imposed drastic limits for in-person dining experiences. When comparing the first and second waves of the pandemic, we can see a difference in mobility trends across both waves. Physical mobility dramatically fell in the first wave compared to the second wave as shown in Figure 4. Our findings suggest that people may prefer modes in which they are alone, or with family and friends (such as driving and walking) as opposed to strangers or in large groups (such as transit). Our mobility data supports these findings, as the transit mobility from both the first and second wave was unable to return to its initial mobility patterns from before the pandemic, whereas driving and walking mobility both saw an uptick during the second wave. Next, our findings reinforced the theory that mobility patterns experienced a very high degree of similarity for most sectors. For instance, in the residential sector, an increase in mobility patterns during the first and second waves was observed across both the Google and Apple mobility datasets.

Taking all this into account, our research has added to the works of our predecessors and filled in any potential gaps in existing literature by updating previous analyses on the topic with exclusively Canadian data in a difference and difference model, focusing specifically on both the first and second wave data, since many of the prior literature was written only using the first wave data and very early on. Overall, our work does assist us in concluding that these non-pharmaceutical interventions were helpful in reducing mobility trends throughout different provinces in Canada. Through the reduction in mobility trends, our work has also led us to conclude that NPIs aid in reducing the spread of COVID-19, by encouraging an increase in social distancing behaviour.

However, there are still some unanswered questions. Even though we conducted an extensive analysis and regression on the effect of various NPIs on mobility patterns and saw a correlation, there may be omitted variable bias present. This could be in the form of other factors that are more influential in leading individuals to stay at home. These variables could be the influence of the media in relaying scientific information regarding COVID-19, word-of-mouth leading to fears about contracting the disease (and therefore, an increased desire to stay home and follow policies). Unfortunately, these factors are difficult to not only identify, but measure utilizing statistical methods within the scope of our course. In addition, the study cannot account for the effect of Non-pharmaceutical interventions stemming from the recently proclaimed "third wave" of COVID-19, that began in April 2021. Given the varying mobility trends examined

from both the first and second wave of COVID-19, it is interesting to identify whether new variants of COVID-19, and the lasting impacts of the policies implemented from prior waves would have a definitive impact on the mobility trends from the upcoming third wave. Finally, with the gradual adoption of various vaccines that are intended to protect Canadian citizens from infectious disease, it would be interesting to identify if these NPIs would still remain as effective with an increasing number of vaccinated people.

References

Apple. (2021). "Apple Maps Mobility Trends Reports". https://covid19.apple.com/mobility

Armstrong II, D. A., Lebo, M. J., & Lucas, J. (2020). Do COVID-19 Policies Affect Mobility Behaviour? Evidence from 75 Canadian and American Cities. Canadian Public Policy, S127-S144. https://www.utpjournals.press/doi/pdf/10.3138/cpp.2020-062.

Breton, C. (2020). “How the Provinces Compare in Their COVID-19 Responses” Policy Options.https://policyoptions.irpp.org/magazines/april-2020/how-the-provinces-compare-in-their-covid-19-responses/.

Google LLC. (2021). “Canada Google Mobility Changes, April 2021”. https://www.gstatic.com/covid19/mobility/2021-04-04_CA_Mobility_Report_en.pdf

Google LLC. (2021). "Google COVID-19 Community Mobility Reports". https://www.google.com/covid19/mobility/

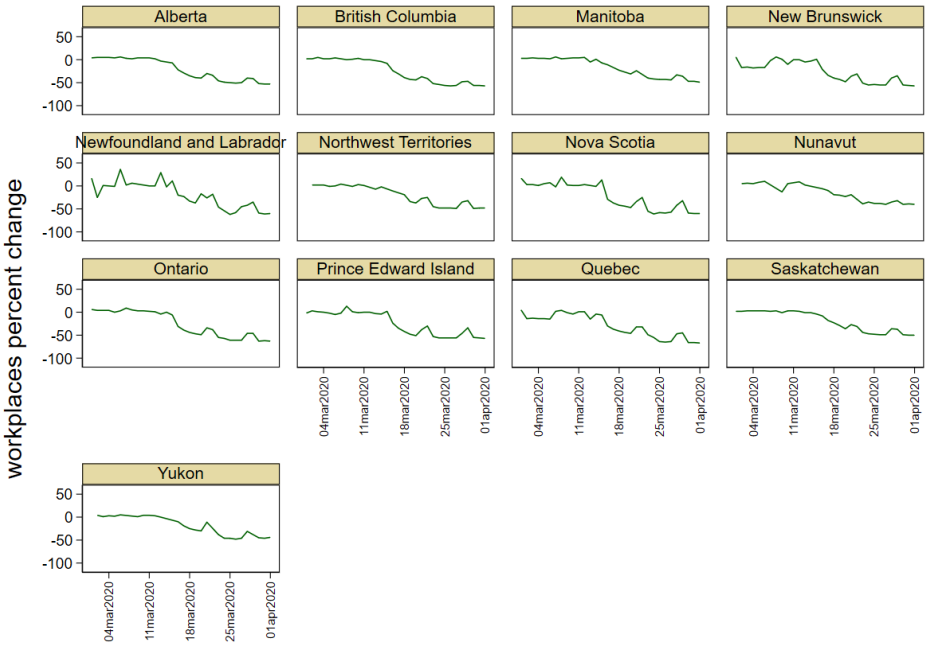
Gupta, S., Simon, K. I., & Wing, C. (2020). Mandated and Voluntary Social Distancing During The COVID-19 Epidemic: A Review. National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w28139/w28139.pdf

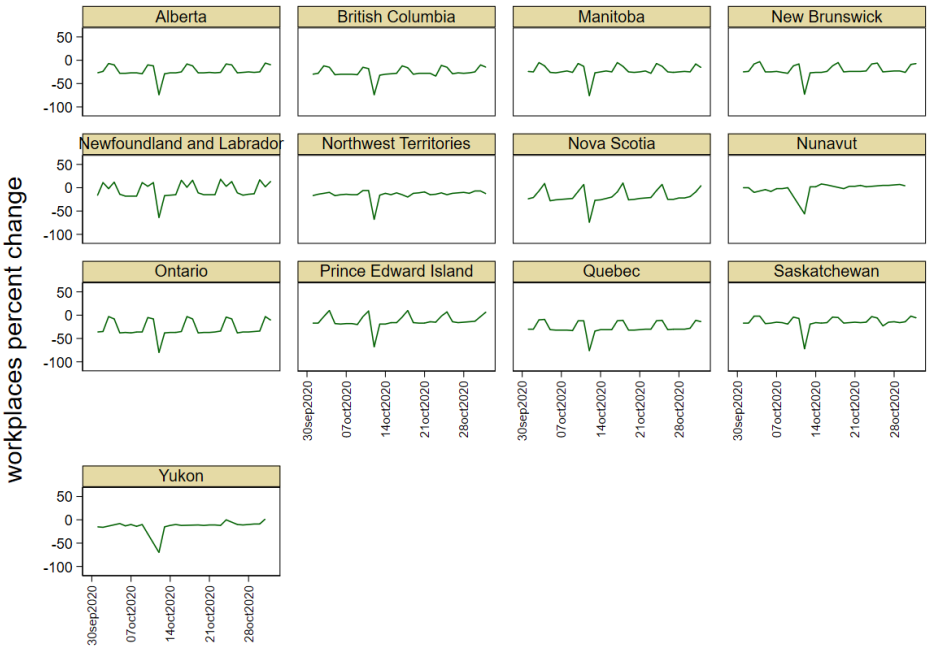
Karaivanov, A., Lu, S. E., Shigeoka, H., Chen, C., & Pamplona, S. (2020). Face masks, Public Policies and Slowing the Spread of COVID-19: Evidence from Canada. National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w27891/w27891.pdf

Kraemer, M U.G, Yang, C-H, Gutierrez, B, Wu, C-H, Klein, B and Pigott, D.M. 2020. Mobility and Control Measures on the COVID-19 Epidemic in China, https://science.sciencemag.org/content/368/6490/493

Loewon, P, Merkley, E, Bridgman, A, McAndrews, J. (2021). Re-opening After COVID-19; Munk School of Global Affairs. https://www.reopeningaftercovid.com/

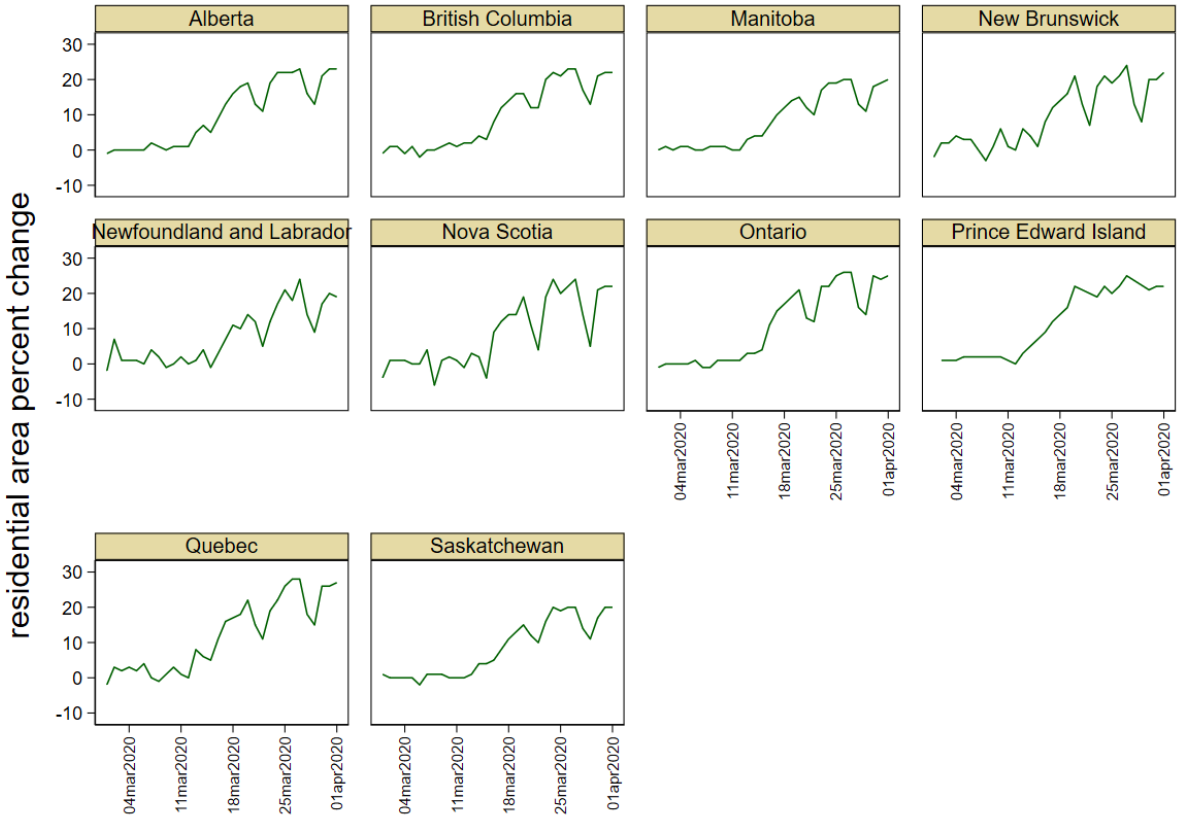
Appendix A

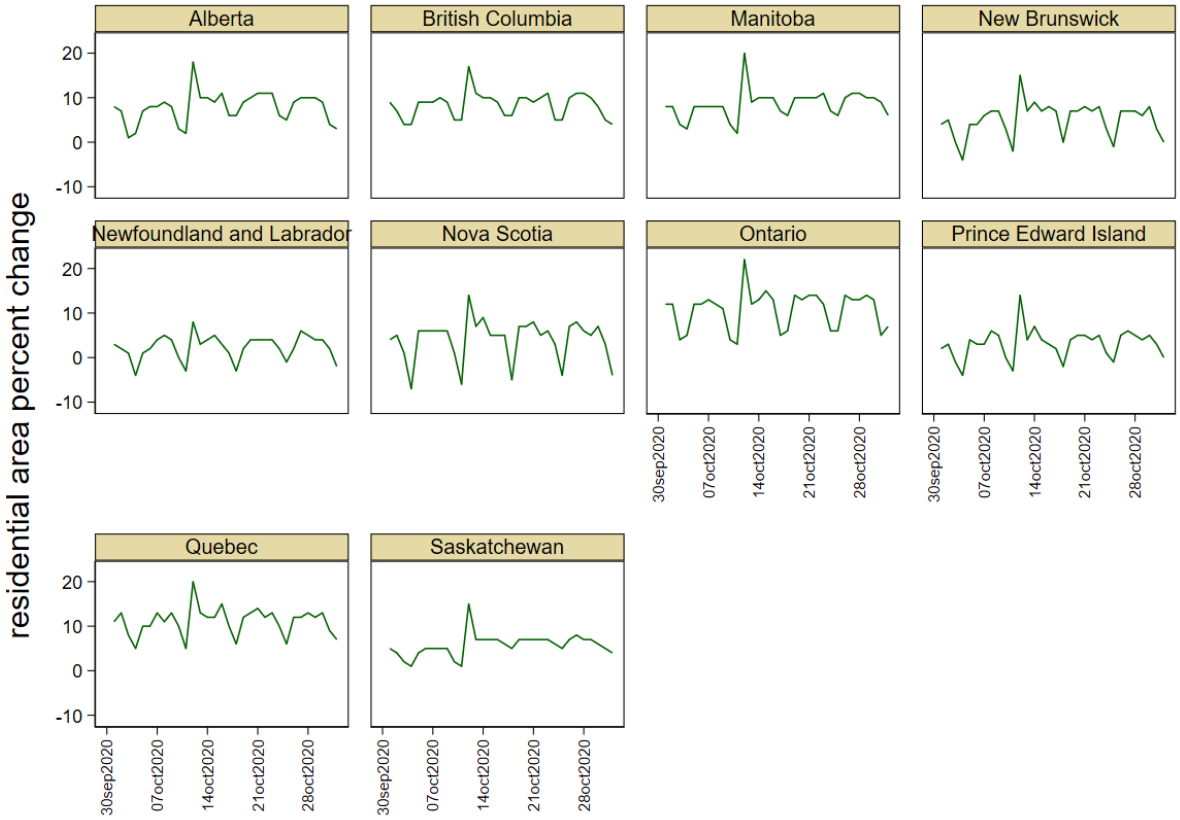

workplaces percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Nunavut
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon
50
0
-50
-100
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020

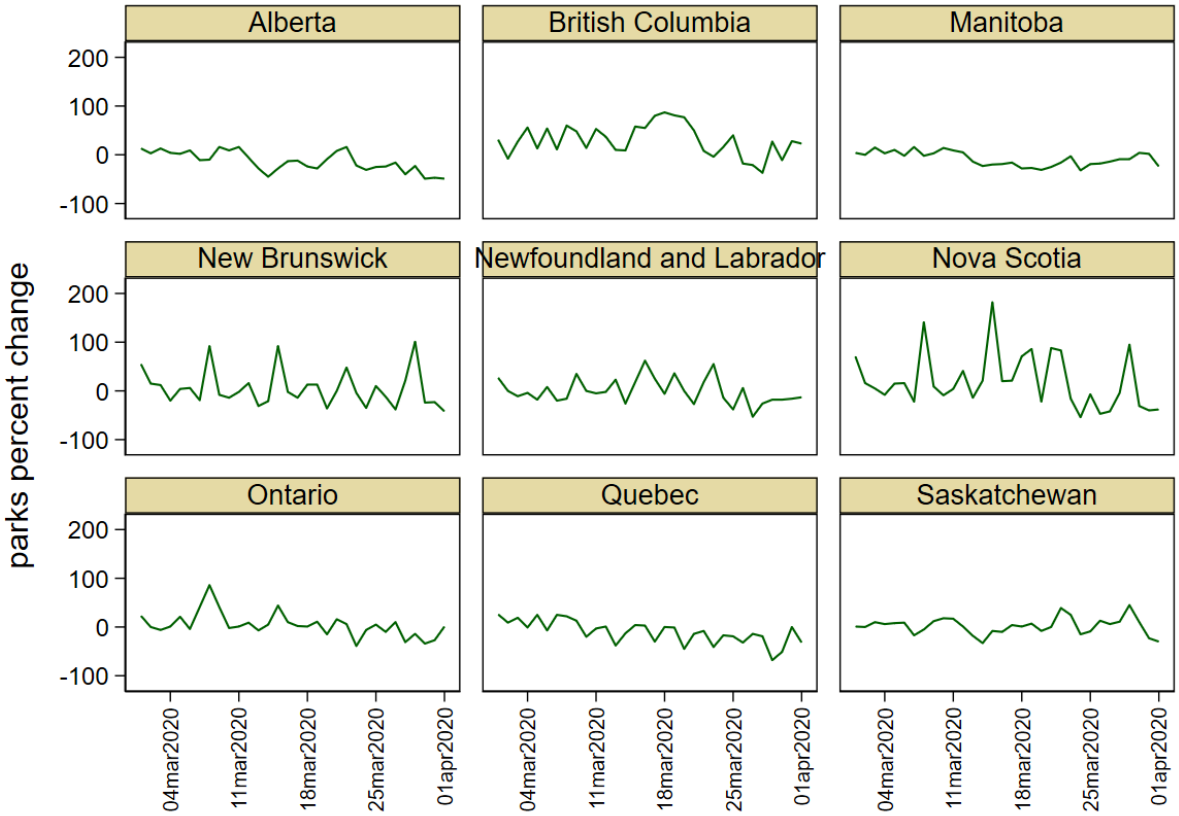

workplaces percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Nunavut
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon
50
0
-50
-100
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020

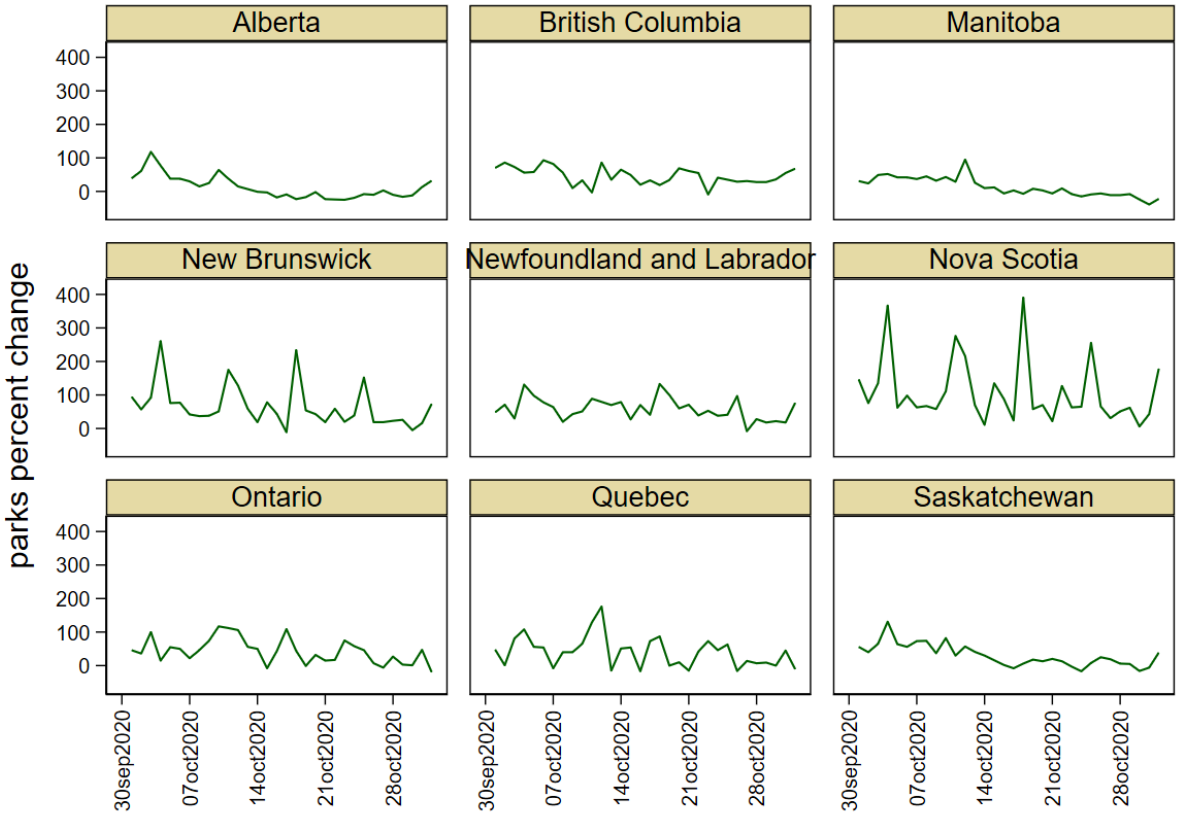

grocery and pharmacy percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon
100
50
0
-50
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020


grocery and pharmacy percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
50
0
-50
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020

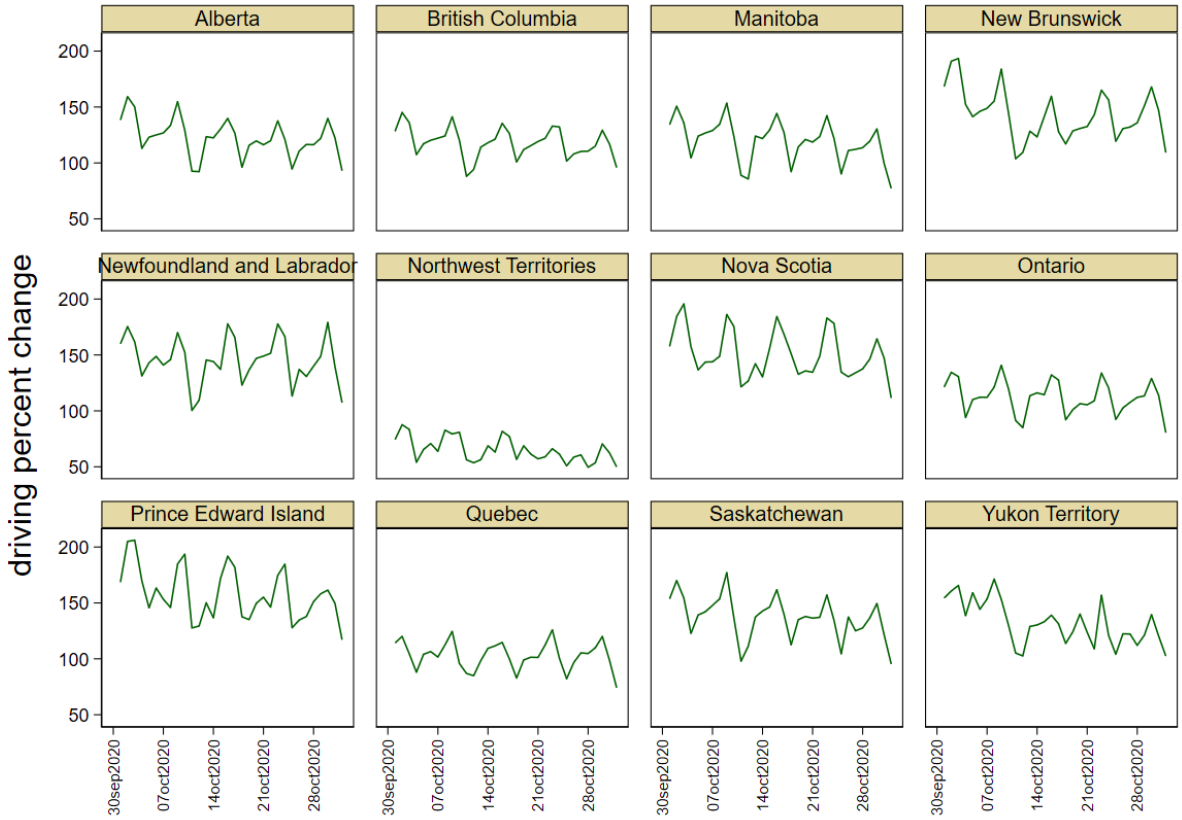

residential area percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
30
20
10
0
-10
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020

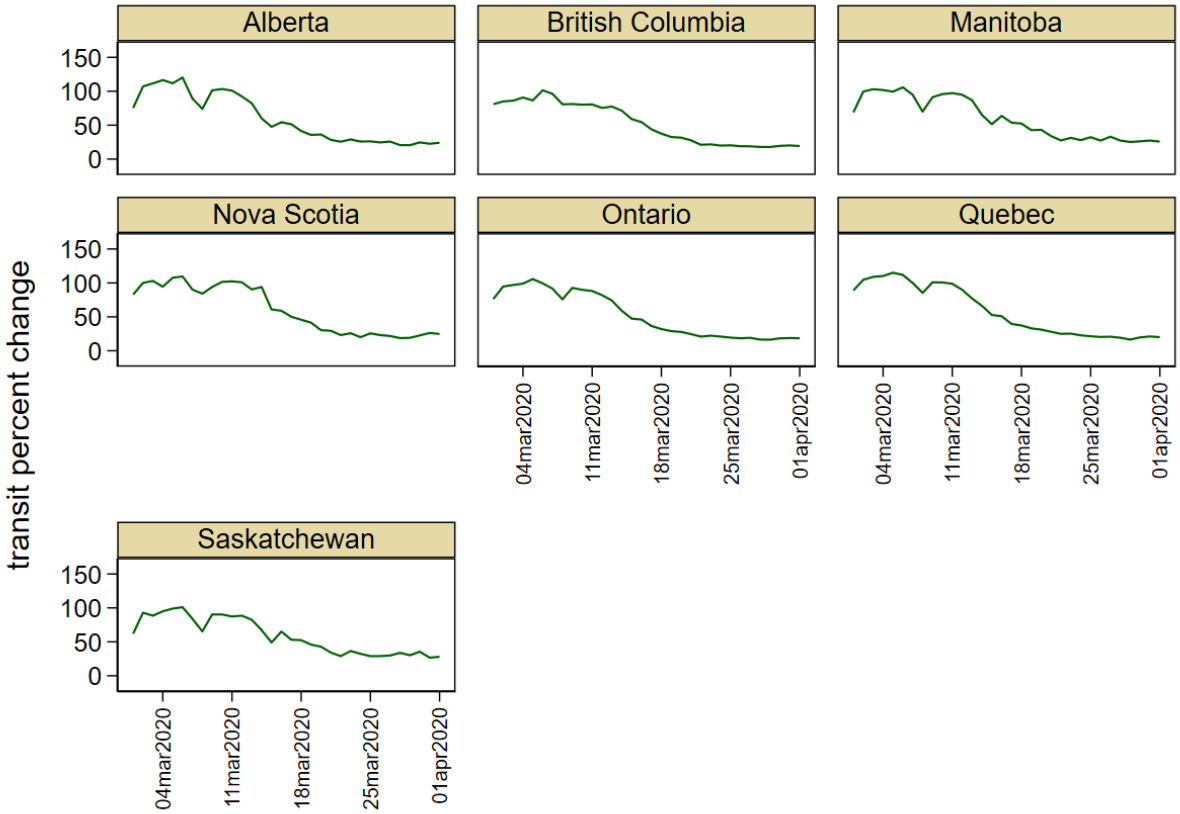

residential area percent change
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
20
10
0
-10
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020

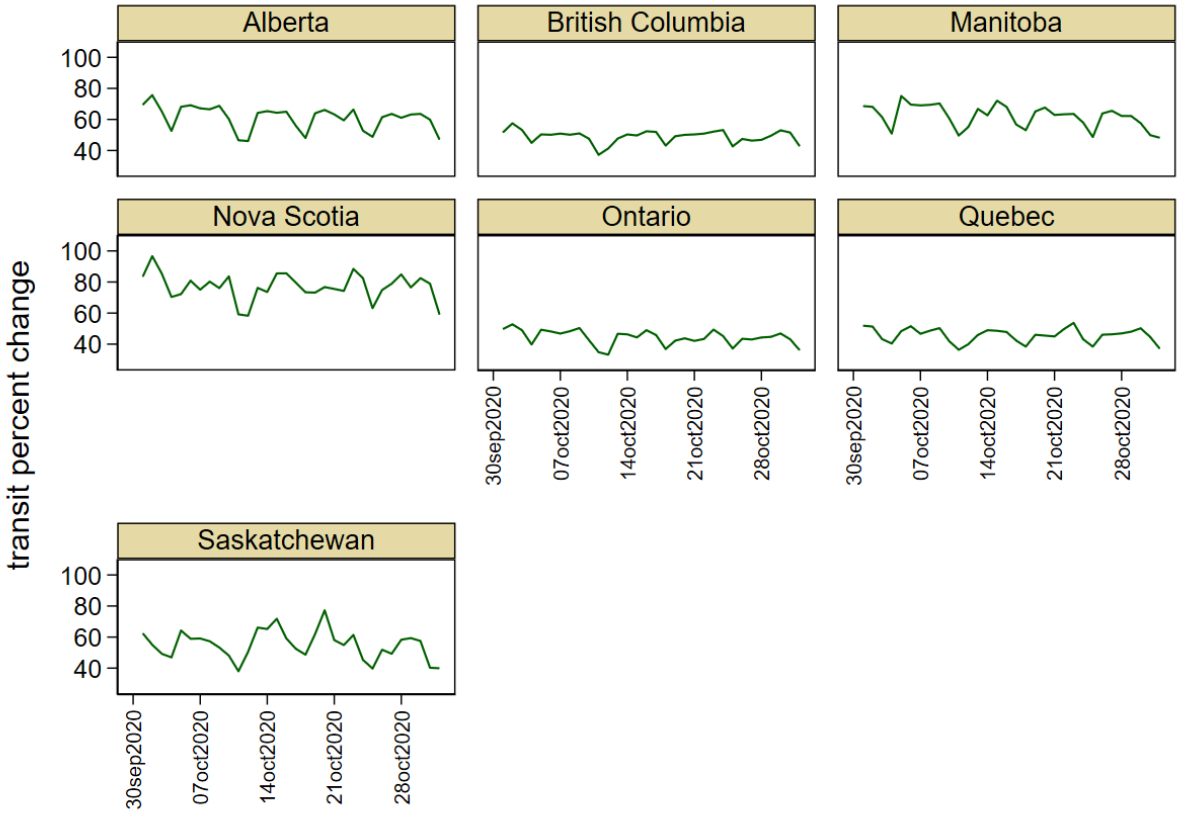

Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Quebec
Saskatchewan
parks percent change
200
100
0
-100
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020

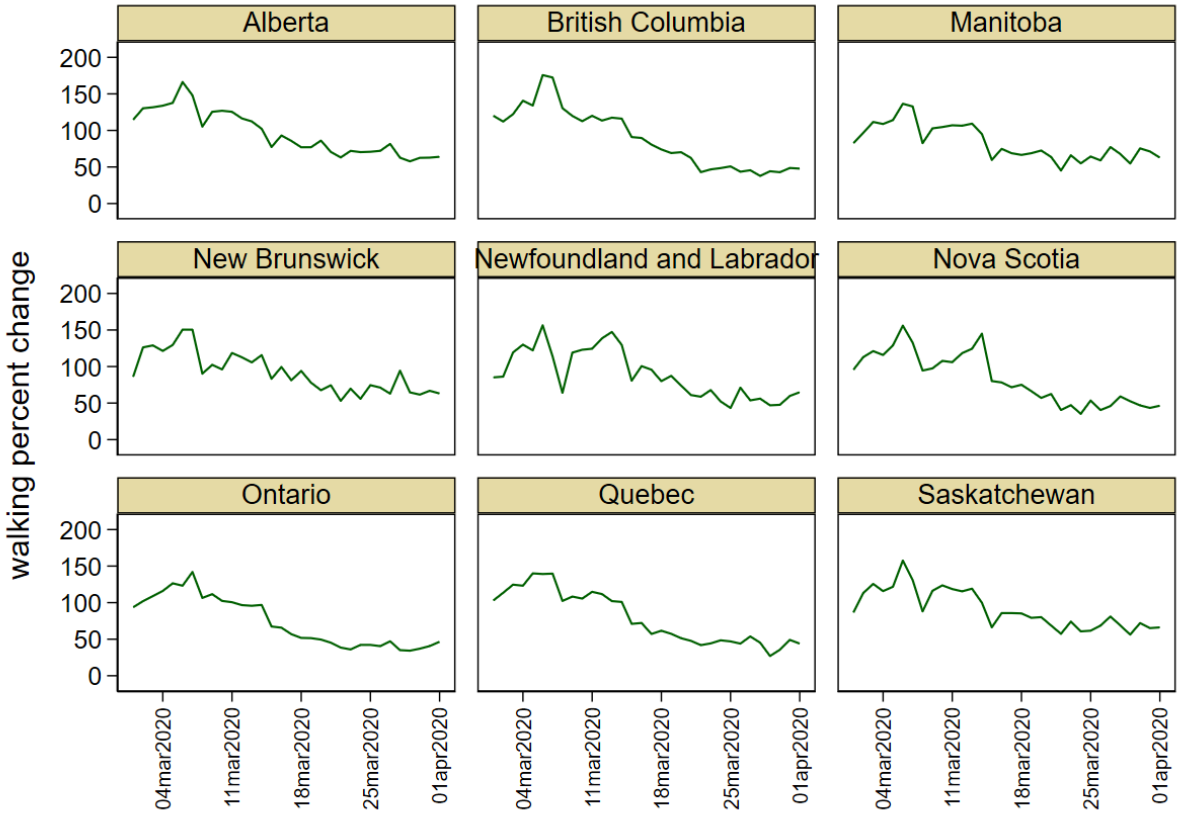

Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Quebec
Saskatchewan
parks percent change
400
300
200
100
0
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020

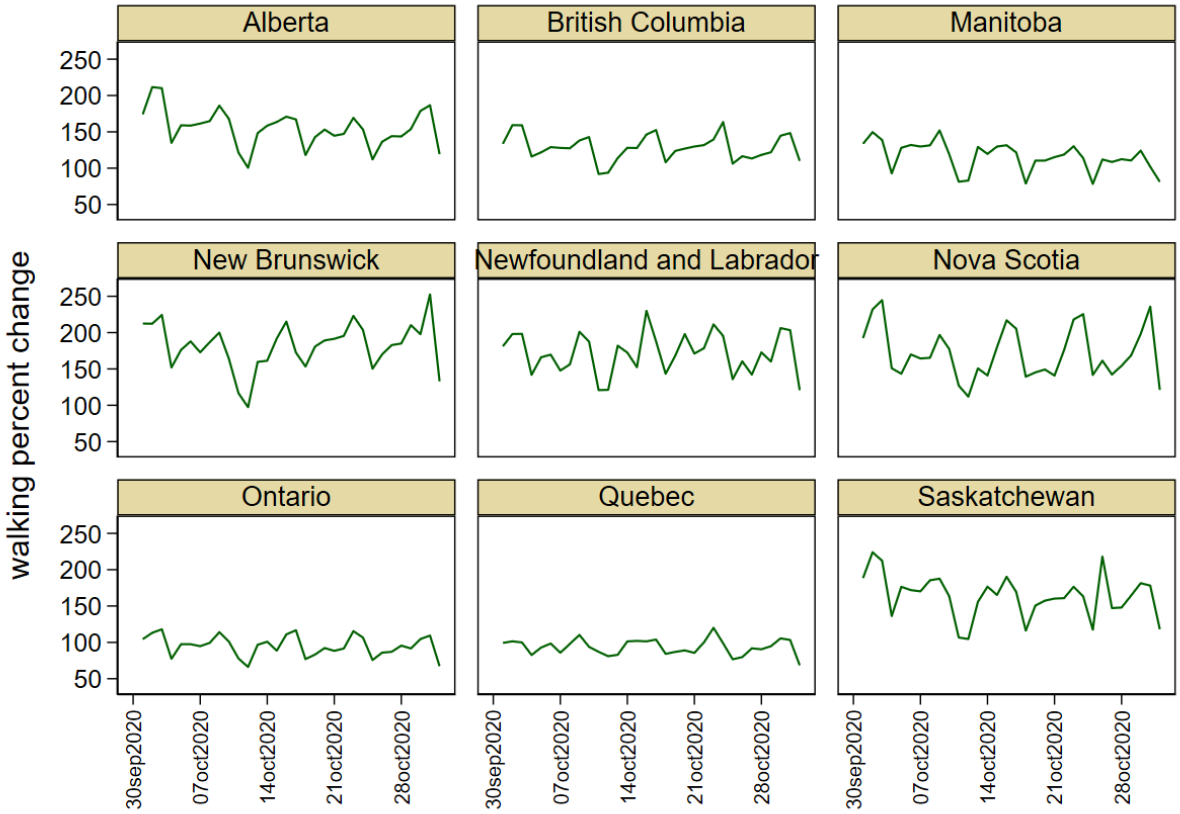

Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon Territory
driving percent change
150
100
50
0
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020


Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon Territory
driving percent change
200
150
100
50
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020


Alberta
British Columbia
Manitoba
Nova Scotia
Ontario
Quebec
Saskatchewan
transit percent change
150
100
50
0
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020


Alberta
British Columbia
Manitoba
Nova Scotia
Ontario
Quebec
Saskatchewan
transit percent change
100
80
60
40
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020


Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Quebec
Saskatchewan
walking percent change
200
150
100
50
0
04mar2020
11mar2020
18mar2020
25mar2020
01apr2020


Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Nova Scotia
Ontario
Quebec
Saskatchewan
walking percent change
250
200
150
100
50
30sep2020
07oct2020
14oct2020
21oct2020
28oct2020

Appendix B

Table 5:

	COVID-19 NPI Effects on Mobility Overall (Google)					
	Parks			Grocery and Pharmacy		
	(1)	(2)	(3)	(4)	(5)	(6)
Nonessential Retail Business		22.2109**	11.2408		4.1267***	1.1542
		(6.6975)	(7.6737)		(1.3504)	(1.5463)
Nonessential Services		-0.7998	3.3969		2.0381	-1.3652
		(10.3193)	(10.2979)		(2.01628)	(2.0093)
Cultural Services and Venues		5.2183	14.3427		4.4321**	4.8257**
		(13.4736)	(13.5965)		(2.0096)	(1.9984)
Schools	-3.1192	3.0413	9.6072	4.4544*	4.1416*	1.9193
	(13.5341)	(13.6508)	(12.8559)	(2.2827)	(2.312)	(2.0822)
Inter-Provincial Travel			4.0301			0.2132
			(3.7915)			(0.7744)
Intra-Provincial Travel			8.4519***			-1.3175**
			(2.8481)			(.5599)
Dining and Restaurants		-20.44***	-27.2424***		-3.622***	-4.4852***
		(4.7151)	(4.8687)		(0.9395)	(0.9791)
Policy Type	Altered Lifestyle	Partial Restriction	Complete Restriction	Altered Lifestyle	Partial Restriction	Complete Restriction
Number of Observations	2,989	2,989	2,989	3,613	3,613	3,613

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6:

	COVID-19 Reopening Effects on Mobility Overall (Google)							
	Parks				Grocery and Pharmacy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Stores	-20.3607	-33.9819	-16.0617		-2.7973	3.0335	3.3633	
	(15.0097)	(21.1153)	(21.5527)		(3.0499)	(4.2436)	(4.3396)	
Schooling	36.2834	53.2673	65.9218*	47.0339	-12.2131	-10.2203	-7.4558	-11.1428
	(39.411)	(39.0036)	(39.2241)	(41.1128)	(8.0215)	(7.9072)	(7.9637)	(8.4109)
Borders		-7.6731				2.6243		
		(11.2238)				(2.2174)		
Eateries		-11.5698	-18.1948			2.981	3.9575*	
		(11.2437)	(11.8084)			(2.2203)	(2.2913)	
Cultural Services	3.8497	8.4798	16.6084		-3.6654	-2.9162	-3.21	
	(14.2332)	(17.1302)	(18.5103)		(2.8941)	(3.4887)	(3.6916)	
Gatherings	10.774	-6.4397	-15.6014		-1.3537	-3.578	-7.4616**	
	(12.8527)	(15.2381)	(17.6871)		(2.6189)	(2.9854)	(3.5044)	
Policy Type	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access
Number of Observations	274	274	274	274	334	334	334	334

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11:

	COVID-19 NPI Effects on Mobility First Wave (Google)			
	Parks		Grocery and Pharmacy	
	(1)	(2)	(3)	(4)
Nonessential Retail Business	4.4444	3.3393	-1.4483	-1.5933
	(13.2968)	(14.7252)	(2.7378)	(3.0355)
Nonessential Services	-2.0763	7.5668	5.824**	1.5127
	(13.1921)	(13.009)	(2.8372)	(2.843)
Cultural Services and Venues	0.8719	5.1814	4.0089	5.0911*
	(14.0785)	(15.8686)	(2.531)	(2.7655)
Schools	-13.0012	3.1866	0.1317	1.4265
	(42.3836)	(13.2353)	(9.3049)	(2.1837)
Inter-Provincial Travel		7.7114		0.3086
		(4.9385)		(1.0485)
Intra-Provincial Travel		7.5467		0.003
		(5.3126)		(1.1034)
Dining and Restaurants	16.7576	15.6111	-1.3098	-1.6344
	(17.8915)	(19.3714)	(2.9188)	(3.1697)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	831	831	1,004	1,004

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12:

	COVID-19 NPI Effects on Mobility Second Wave (Google)			
	Parks		Grocery and Pharmacy	
	(1)	(2)	(3)	(4)
Nonessential Retail Business	-12.5281***	-15.5487**	-0.2794	-4.5318**
	(4.7749)	(7.0902)	(1.3684)	(2.0296)
Nonessential Services		11.3797***		-0.2545
		(3.6192)		(1.0195)
Cultural Services and Venues		9.4195**		0.0219
		(3.9474)		(1.1326)
Schools	5.9091*	1.7169	1.0872	-2.9691**
	(3.1712)	(4.4633)	(0.8858)	(1.2728)
Inter-Provincial Travel		18.9278**		5.822***
		(7.9002)		(2.2536)
Intra-Provincial Travel		-8.8118*		-2.4655*
		(5.2362)		(1.4959)
Dining and Restaurants	-6.54	-13.4675**	0.7118	-1.7567
	(7.2148)	(6.4471)	(2.0035)	(1.843)
Policy Type	Partial Restriction	Complete Restriction	Partial Restriction	Complete Restriction
Number of Observations	1,270	1,270	1,430	1,430

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13:

	COVID-19 Reopening Effects on Mobility Reopening Period (Apple)									
	Driving				Walking			Transit		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stores		-15.4573	-29.4844*			12.2027			4.2418	
		(12.3198)	(15.2288)			(9.4687)			(4.4458)	
Schooling	-20.8728	11.5897	1.4447	-7.1401	7.4168	16.6457*	9.3035	-5.511	-3.0354	-3.9153
	(16.4435)	(9.5891)	(14.0469)	(14.2179)	(10.9235)	(10.0555)	(12.6693)	(4.1817)	(3.5705)	(4.5688)
Eateries		-34.7052*	-40.3751**		-23.1184	-1.4992		0.895	2.3529	
		(20.9993)	(18.5975)		(18.1411)	(15.6002)		(6.4423)	(6.0635)	
Cultural Services		-0.1889	11.1464		-11.6859	-19.2442		-6.494	-5.2741	
		(9.3897)	(11.3388)		(12.2099)	(13.5181)		(4.4701)	(4.8568)	
Gatherings		-2.3349	-1.9791		-4.6497	-13.5957*		0.3605	-3.8012	
		(5.7479)	(8.8569)		(5.2721)	(7.5406)		(2.4729)	(2.9007)	
Policy Type	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Reduced Access	New Norm	Unrestricted Access	Reduced Access	New Norm	Unrestricted Access
Number of Observations	166	166	166	166	127	127	127	239	239	239

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14:

	COVID-19 Reopening Effects on Mobility Overall Reopening Period (Google)										
	Workplace				Retail and Recreation				Residential		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Stores		-14.6529***	-16.24***			7.5318**	10.6628***			-1.4674*	
		(2.3321)	(2.6952)			(3.2987)	(3.8177)			(0.7853)	
Schooling	-1.9092	-0.4456	-3.7972	-1.0721	6.1527	9.3048***	9.3474**	7.636**	0.5741	0.1811	-0.0607
	(2.5972)	(1.9651)	(2.5883)	(2.5868)	(4.201)	(2.8137)	(3.8296)	(3.6938)	(0.8921)	(0.849)	(1.0661)
Eateries		-6.0779**	-4.8073*			6.1781	5.6192		0.3184	-0.3188	
		(3.0465)	(2.8194)			(4.618)	(4.0953)		(1.4929)	(1.3015)	
Cultural Services		0.9624	1.0298			1.036	3.7537		0.1958	-0.0221	
		(1.4572)	(1.6967)			(2.0863)	(2.5172)		(0.8531)	(0.9287)	
Gatherings		2.672***	3.8468***			-1.1507	-1.2064		0.8196*	0.6914	
		(0.8489)	(1.376)			(1.2878)	(1.9489)		(0.4423)	(0.6323)	
Policy Type	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Greatly Reduced Access	Reduced Access	New Norm	Unrestricted Access	Reduced Access	New Norm	Unrestricted Access
Number of Observations	167	167	167	167	153	153	153	153	140	140	140

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15:

Province Regression Fixed Effects Overall								
Province	Driving	Walking	Transit	Workplace	Retail and Recreation	Grocery and Pharmacy	Residential	Parks
British Columbia	-11.8116***	-29.1289***	-9.9652***	-0.7073	-4.1473***	0.3915	0.2894	21.4082***
	(1.7245)	(1.6094)	(0.5575)	(0.5939)	(0.7939)	(0.8073)	(0.193)	(3.8611)
Manitoba	-5.2884**	-41.0025***	4.2224***	2.8449***	-1.045	-0.251	-0.5551**	4.721
	(2.1014)	(2.1088)	(0.7998)	(0.7061)	(0.9572)	(1.0437)	(0.2529)	(5.1276)
New Brunswick	16.0839***	3.6445*		0.9984	3.722***	-4.3431***	-2.3512***	40.1094***
	(1.9952)	(1.938)		(0.675)	(0.9043)	(0.9703)	(0.2324)	(4.698)
Newfoundland and Labrador	14.8948***	-10.2984***		10.4802***	10.0103***	-1.603*	-4.6437***	35.2426***
	(1.9428)	(1.8581)		(0.6594)	(0.8772)	(0.9359)	(0.2227)	(4.4734)
Northwest Territories	-50.4606***			7.8468***	-9.9534***	-5.7947***		
	(1.5032)			(0.5317)	(0.7208)	(1.3674)		
Nova Scotia	-0.1371	-43.8705***	-3.7627***	-0.0443	-0.0865	-3.8915***	-1.0653***	52.375***
	(2.4379)	(2.3629)	(0.8966)	(0.7952)	(1.1076)	(1.1805)	(0.2825)	(5.6374)
Nunavut				23.2874***	5.796***			
				(0.6958)	(1.9059)			
Ontario	-11.3825***	-49.8126***	-9.0716***	-2.4775***	-2.5197***	-3.8663***	1.6016***	12.126***
	(1.5711)	(1.3747)	(0.4742)	(0.5382)	(0.6996)	(0.7002)	(0.1651)	(3.2748)
Prince Edward Island	40.5494***			6.7764***	10.1706***	-0.5316	-3.5408***	-12.4962
	(2.029)			(0.6916)	(0.9279)	(0.9923)	(0.2407)	(17.0568)
Quebec	-17.8717***	-46.1338***	-1.5882***	-0.3323	-4.7119***	-7.5412***	1.1175***	20.4626***
	(1.7379)	(1.6364)	(0.567)	(0.5975)	(0.7961)	(0.817)	(0.1963)	(3.9432)
Saskatchewan	0.8212	-13.3733***	-2.3374***	6.6002***	0.1113	3.4169***	-2.2462***	37.8366***
	(2.2068)	(2.2757)	(0.8643)	(0.759)	(1.0198)	(1.116)	(0.2726)	(5.5116)
Yukon Territory	8.7171			11.3367***	-11.2051***	4.6906***		
	(1.5171)			(0.5662)	(0.7169)	(1.7542)		
Constant	128.862***	156.429***	62.3318***	-29.9098***	-14.9062***	-9.1806***	11.8078***	15.4347
	(5.8911)	(8.7452)	(3.2401)	(1.8647)	(2.6896)	(2.8186)	(0.954)	(20.7493)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16:

Province Regression Fixed Effects First Wave

Province	Driving	Walking	Transit	Workplace	Retail and Recreation	Grocery and Pharmacy	Residential	Parks
British Columbia	-7.1305***	-25.3877***	-12.9902***	-2.6791***	-3.1343**	-3.5219**	-0.1533	39.0594***
	(1.7404)	(2.8543)	(0.9919)	(0.9406)	(1.5607)	(1.7196)	(0.4051)	(7.9629)
Manitoba	3.5373**	-23.9815***	0.6457	3.0926***	4.0235***	0.515	-1.0646***	4.0315
	(1.7133)	(2.6718)	(0.9205)	(0.9253)	(1.5008)	(1.6433)	(0.3839)	(7.449)
New Brunswick	7.495***	-7.8485***		-1.8843**	4.4906***	-8.0426***	-1.2801***	24.1997***
	(1.6102)	(2.4825)		(0.8727)	(1.4036)	(1.5386)	(0.3573)	(6.9547)
Newfoundland and Labrador	-0.0624	-15.4014***		0.8779	1.9418	-7.7544***	-2.6244***	18.8044***
	(1.4697)	(2.2023)		(0.7953)	(1.2666)	(1.3807)	(0.3175)	(6.1685)
Northwest Territories	-30.1648***			0.9631	-0.4932	-8.0149***		
	(1.7598)			(0.9621)	(1.8522)	(2.2577)		
Nova Scotia	-0.9437	-41.7058***	-5.6612***	-0.4874	2.3109	-6.7433***	-0.1664	28.3834***
	(1.9208)	(3.1698)	(1.0578)	(1.0229)	(1.7161)	(1.9109)	(0.4525)	(8.8466)
Nunavut				10.4973***	5.8203***			
				(1.0603)	(2.158)			
Ontario	-16.646***	-41.7503***	-9.8938***	-7.1147***	-8.4275***	-7.8684***	2.7287***	1.7313
	(1.4129)	(2.1251)	(0.6996)	(0.7661)	(1.2209)	(1.3316)	(0.3063)	(5.9219)
Prince Edward Island	9.6564***			0.4292	-2.0979	-5.5012***	-1.3873***	-29.5784
	(1.6548)			(0.8969)	(1.443)	(1.5799)	(0.3911)	(28.3578)
Quebec	-21.2721***	41.4425***	-5.3639***	-10.1343***	-10.5298***	-13.8834***	2.8359***	-3.1513
	(1.7931)	(2.9779)	(1.0353)	(0.9777)	(1.6119)	(1.7684)	(0.4267)	(8.3037)
Saskatchewan	3.0937	-7.6923***	-3.3083***	2.0066*	-0.7416	1.453	-1.9125***	24.1393***
	(1.9276)	(3.239)	(1.1147)	(1.0515)	(1.756)	(1.9352)	(0.4571)	(9.0351)
Yukon Territory	7.7205***			4.1055***	0.4818	1.0949		
	(1.912)			(1.0881)	(1.7168)	(2.1256)		
Constant	92.6472***	103.79***	49.2234***	-30.7519***	-25.7588***	-8.4799***	14.3226***	-24.5099
	(2.8764)	(6.9952)	(2.5212)	(1.5745)	(2.594)	(2.9227)	(0.9423)	(19.454)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17:

Province Regression Fixed Effects Second Wave

Province	Driving	Walking	Transit	Workplace	Retail and Recreation	Grocery and Pharmacy	Residential	Parks
British Columbia	-4.8955**	-21.0005***	-7.0118***	1.0372	0.7459	5.1214***	-0.6059	37.4902***
	(2.112)	(2.6816)	(0.9201)	(1.385)	(1.5813)	(1.6904)	(0.3939)	(5.8973)
Manitoba	-7.4293***	-39.3729***	7.408**	-5.4308**	-3.5052**	-5.6121***	1.7603***	-12.0832*
	(2.3332)	(2.9588)	(1.0184)	(2.3157)	(1.7468)	(1.8624)	(0.4338)	(6.5067)
New Brunswick	1.6841	14.9647***		-10.2817***	-2.0267	-9.0121***	0.1761	10.1871
	(2.9176)	(3.7728)		(2.0056)	(2.1854)	(2.3589)	(0.5503)	(8.2994)
Newfoundland and Labrador	5.9409**	-0.1663		5.7985***	9.5055***	-4.3861*	-3.3505***	24.3318***
	(2.9517)	(3.8204)		(2.0333)	(2.2111)	(2.3879)	(0.5571)	(8.4139)
Northwest Territories	-42.0607***			14.2802***	-5.1644***	-3.658*		
	(1.4545)			(0.9551)	(1.0959)	(2.1378)		
Nova Scotia	-5.3752	-19.9002***	4.0791**	-5.2634**	1.6542	-1.359	-1.7851***	44.8157***
	(3.532)	(4.5897)	(1.6885)	(2.4248)	(2.6456)	(2.8481)	(0.6641)	(10.0953)
Nunavut				29.8757***				
				(1.6796)				
Ontario	-3.7982**	-46.5163***	-8.2679***	1.204	3.8579***	0.3118	-0.0482	17.0531***
	(1.8374)	(2.3555)	(0.8543)	(1.205)	(1.3762)	(1.4767)	(0.3443)	(5.1803)
Prince Edward Island	10.0469***			-1.5899	9.4358***	-4.0733*	-1.4777***	-28.2419
	(2.9432)			(2.0311)	(2.2047)	(2.381)	(0.5555)	(17.6543)
Quebec	-7.8685***	-39.6141***	-1.9695**	4.4818***	1.6295	-2.6631	-0.5553	30.5998***
	(2.2467)	(2.9187)	(1.0042)	(1.4744)	(1.6827)	(1.8092)	(0.4219)	(6.4197)
Saskatchewan				-0.9347				
				(2.5878)				
Yukon Territory	3.5035**			16.1075***	-9.5821***			
	(1.454)			(0.9999)	(1.107)			
Constant	116.6525***	154.7236***	60.2382***	-29.4182***	-23.4116***	-4.0454*	11.6091***	2.3532
	(2.7836)	(3.6136)	(1.2712)	(2.6724)	(2.0848)	(2.2416)	(0.5226)	(7.9476)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$