Mobility and Proximity in Canada During the COVID-19 Pandemic
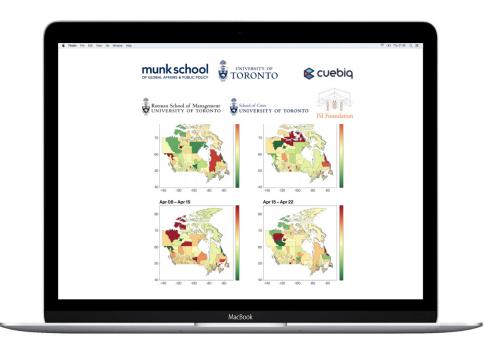
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Executive Summary

The COVID-19 pandemic caused severe disruptions on movement across Canada but, for many policymakers and members of the public, it was unclear how severe, dispersed, and lasting these disruptions were. To fill this information gap, researchers at the University of Toronto formed a data collaborative with Cuebiq (a co-author of this report[1]) and the ISI Foundation in which Cuebiq provided data on the geolocation of smartphone devices across Canada while the ISI Foundation provided code that the research team adapted to a Canada-specific context. The research team used these inputs to calculate the proximity and mobility of devices. The subsequent analysis revealed that, while mobility in Canada increased in the months after lockdowns took effect, proximity between individuals remained low.

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1. This case study was developed and written by NYU GovLab, with review by Cuebiq.

Problem at Hand

Canada, like many countries, began to feel the effects of COVID-19 in early 2020. Through January and February, the country reported its first cases as government leaders began discouraging non-essential travel.[2] Through March, infections continued to rise, with Sophie Gregorie Trudeau, spouse of Prime Minister Justin Trudeau, testing COVID-19 positive and entering quarantine with her husband.[3] On March 16, the government announced its intention to implement immediate restrictions on travel into Canada and requested that all Canadians abroad return.[4] The United States–Canada border shut down to all non-essential travel shortly thereafter.[5]

These events, coupled with recommendations from leaders to practice social distancing, caused serious disruptions to daily life across Canada. However, for researchers at the University of Toronto, an important set of questions arose about how severe, dispersed, and lasting these changes were. As the crisis persisted, researchers began looking at ways they could study the crisis to produce insights useful for policymakers and the public as both sought to better control disease spread. Through March, a research team led by Anita McGahan, Professor at the University of Toronto's Munk School of Global Affairs & Public Policy and Rotman School of Management, began developing a research proposal to address this knowledge gap.[6]

Project

As first envisioned, researchers at the University of Toronto planned to study whether there was a relationship between economic activity and the social distancing measures and mobility restrictions necessitated by the COVID-19 pandemic in the United States, Canada, and Italy.[7] In this initial design, researchers planned to seek out publicly available economic statistics on productivity, stock prices, and other items along with smartphone data from a tech company present in all three countries.[8] In crafting the research design, the research team at the University of Toronto developed a partnership with Cuebiq, a company with information on the locations of Canadians based on smartphone data.

However, technical limitations and resource restrictions caused by the pandemic (see Lessons Learned below) forced the researchers to narrow their scope. Through the framework of what The GovLab considers a research and analysis data collaborative, the University of Toronto delayed the economic analysis component of their work.[9] They also

2. Cecco, Leyland. "Hundreds of Canadians Await Evacuation Flight from Wuhan." The Guardian. February 3, 020, sec. World news. http://www.theguardian.com/world/2020/feb/03/hundreds-canadians-await-evacuation-flight-wuhan-coronavirus-outbreak.

3. CNN, Faith Karimi and Patrick Cornell. "Sophie Trudeau, Wife of Canadian Prime Minister, Tests Positive for Coronavirus." CNN, March 13, 2020. https://www.cnn.com/2020/03/12/americas/sophie-gregoire-trudeau-coronavirus/index.html.

4. Trudeau, Justin. "Prime Minister Announces New Actions under Canada's COVID-19 Response." Office of the Prime Minister of Canada, January 1, 1970. https://pm.gc.ca/en/news/news-releases/2020/03/16/prime-minister-announces-new-actions-under-canadas-covid-19-response.

5. U.S. Customs and Border protection. "Notification of Temporary Travel Restrictions Applicable to Land Ports of Entry and Ferries Service Between the United States and Canada." Federal Register, March 24, 2020. https://www.federalregister.gov/documents/2020/03/24/2020-06217/notification-of-temporary-travel-restrictions-applicable-to-land-ports-of-entry-and-ferries-service.

6. McGahan, Anita. "Organizational and Economic Impact of COVID19 Social Distancing: Executive Summary of Research Proposal Preliminary," March 31, 2020.

7. McGahan, Anita. Interview re: Mobility and Proximity in Canada. Zoom, December 8, 2020; McGahan, Anita. "Organizational and Economic Impact of COVID19 Social Distancing: Executive Summary of Research Proposal Preliminary, supra note 5.

8. McGahan, Anita. "Organizational and Economic Impact of COVID19 Social Distancing: Executive Summary of Research Proposal Preliminary, supra note 5.

9. A research and analysis partnership refers to companies who engage directly with public-sector or research partners by sharing certain proprietary data assets to generate new knowledge with public value. See: Verhulst, Stefaan, Andrew Young, Michelle Winowatan, and Andrew J. Zahuranec. "Leveraging Private Data for Public Good: A Descriptive Analysis and Typology of Existing Practices." Brooklyn, New York: The GovLab, October 2019. http://datacollaboratives.org/existing-practices.html.

began by studying Canada rather than all three countries. As such, the team's research questions asked:

- "How did Canadians react to the restrictions on mobility that were implemented in March, 2020, and subsequently to contain [the] spread of COVID? How did Canadians respond to the lifting of restrictions? Has mobility recovered to pre-pandemic levels?"

- "How did the proximity of Canadians to one another change with restrictions on mobility? Has contact recovered to pre-pandemic levels with the lifting of restrictions?"

- "What evidence do we have of changes in air travel?"[10]

Data Assets

After reviewing their options, the researchers collaborated with Cuebiq, a location-intelligence company that specializes in analyzing consumer behaviors for companies and marketers through apps that rely on its software development kit.[11] Unlike other companies that use apps to collect data, Cuebiq collects data directly from smartphone users who have agreed to share their locations ("opting in") with these apps. Per its website, the company's proprietary software development kit lets Cuebiq "know exactly where the data is coming from and can ensure users are providing consent to data collection."[12] It does not rely on the collection practices of third-party app developers.

The GovLab at New York University (an author on this report) introduced the researchers at the University of Toronto to Cuebiq. After several introductory conversations, the researchers secured a data donation through Cuebiq's Data for Good program. The purposes of this program are to "drive innovation and enhance the quality of life across the globe" by supporting academic research and humanitarian response.[13] Cuebiq expressed an interest in working with the research team and applying mobility data to economic analysis, as the initial scope included.[14] The two parties discussed what would be included in a subsequent data sharing agreement.

Through a legal operative appointed by the University of Toronto, the research team negotiated with Cuebiq on the detail, scope, and quality of the data it would provide to the researchers as well as the physical conditions under which it could be stored and analyzed. To facilitate these negotiations, Cuebiq provided researchers with a "test dataset" containing entries of fake inputs that could demonstrate the types of information Cuebiq could provide. They also put the research team in contact with the ISI Foundation, a Turin, Italy-based private foundation known for its research on complex systems, which had previously used Cuebiq's data to analyze the effect of COVID-19 restrictions in Italy and could provide support to the Toronto-based research team. This support included not just advice on how to conduct analysis but the (Python) code that the ISI Foundation used for its own research in Italy, code which became the backbone of the research team's efforts after being modified to fit the Canadian context. Between late March and May, simultaneous to these conversations, the researchers and legal operative used these assets to draft a legal agreement with Cuebiq outlining data storage, encryption, data audit, and access.

Ultimately, the two parties came to an agreement in which Cuebiq would provide fully de-identified and anonymized data with differential privacy for 40 consecutive weeks—from January 1, 2020 to October 6, 2020. This dataset included the locations of iOS and Android devices that used any of the over 100 smartphone applications using Cuebiq's software development kit, with location aggregated by census division. The dataset (narrowed from Italy, the United States, and Canada to Canada alone) reflected 700,000 devices, a number which increased to 870,000 by

10. Cavalli, Gabriel, Brennan Lake, Anita McGahan, and Emanuele Pepe. "Mobility and Proximity in Canada During the COVID-19 Pandemic." Policy Report. Toronto, Canada: Innovation Policy Lab, Munk School of Global Affairs & Public Policy, University of Toronto, October 27, 2020. https://munkschool.utoronto.ca/wp-content/uploads/2020/10/2020-10-27-Mobility-and-Proximity-of-Canadians-during-COVID-19-1.pdf.
11. Chan, Lawrence, and Cuebiq Marketing Team. "Cuebiq on Location Data Advancements and How Privacy Plays a Role." Cuebiq, March 22, 2019. https://www.cuebiq.com/resource-center/resources/cuebiq-on-location-data-advancements-and-how-privacy-plays-a-role/.
12. Ibid.
13. Cuebiq. "Data for Good." Accessed December 18, 2020. https://www.cuebiq.com/about/data-for-good/.
14. McGahan, Anita. Interview re: Mobility and Proximity in Canada, supra note 7.

mid-March from additional app downloads.[15]

Design

In addition to anonymizing the data, Cuebiq also applied differential privacy measures to remove home locations, work locations and sensitive points of interest from the dataset. The research team agreed it would not try to re-identify or disambiguate any of the information received. It also agreed to only access the information from the University of Toronto's facilities using official hardware to prevent unauthorized use of Cuebiq data. As Cuebiq's dataset was collected from individuals who had opted in to data sharing, the University of Toronto's Research Ethics Board in Social Sciences approved this agreement and the overall research approach.[16]

Analysis & Insights

The data-sharing agreement between Cuebiq and the university meant the researchers had permission to use and access the data, but logistics proved more complicated. The very lockdowns the research team intended to study meant that the research team could not physically access the University of Toronto's campus. The team had to develop a workaround. As described by Anita McGahan, team lead:

> "[There was a] kludge we put together in a backroom. I had purchased an extra workstation computer right before the university had shut down and it was sitting in my office at the university on a broadband connection. We got special permission [from the university] for an analyst in our computing group to go into my office and set up a mapping on that computer to [send the data to] a doctoral student's computer so that we could download [and perform analysis on] the data every day to a qualified computer at the university that met encryption standards that were required by our agreement."[17]

As the team sorted through this logistical challenge, additional difficulties emerged. The team received notice it had not received a grant to fund its research, which meant it would not be able to secure the resources needed to analyze US data, an asset requiring roughly one hundred times the computational power of the Canadian dataset. Further, the team noticed there were already extensive analyses being conducted on mobility and proximity in the United States and Italy while no such analysis had been conducted in Canada. Instead of seeking to identify a relationship between economics and mobility, the research would look solely at changes in mobility and proximity. Instead of looking at three countries (the United States, Italy, and Canada), the team would focus on Canada alone.

With this modification, the team spent summer 2020 cleaning the data, preparing it for analysis, and performing the actual mobility and proximity analysis. This work, according to the research team, included "getting rid of outliers, making sure [the team] was actually looking at smartphones [and] dealing with [the differences between] Android versus iPhone data."[18] It also included resolving technical questions about how to measure mobility, proximity and other issues relevant to the research questions. Cuebiq and the ISI Foundation both provided tips on the technical aspects of the project based on their experiences conducting similar projects in other contexts. The research team credited this support with making the analysis possible.

Based on these recommendations, University of Toronto researchers used the same methodology the ISI Foundation had applied to study mobility and proximity in Italy.[19] For proximity, the team measured "the co-location of users in public spaces within a radial circle of 50 meters sustained over a 1 hour period. [They] aggregated over users by

15. Cavalli, et al. supra note 9
16. McGahan, Anita. Interview re: Mobility and Proximity in Canada, supra note 7.
17. Cavalli, et al. supra note 9
18. McGahan, Anita. Interview re: Mobility and Proximity in Canada, supra note 7.
19. Cavalli, et al. supra note 9

assessing the proportion of users with proximity within a specific place."[20] In simpler terms, the analysis measured how many other devices the median cell phone connected to per hour, averaged daily. For mobility, the researchers measured the changes in the distance covered daily (in kilometers) by the median smartphone in each Canadian census division and the changes in the traffic flows between the 30 most important Canadian cities and their neighboring census divisions.

This methodology led to several key insights to the researchers. The analysis revealed that both mobility and proximity declined sharply across Canada after the institution of restrictions in March. Though the amount of mobility recovered somewhat by mid-July across many locations, proximity did not. As one of the research leads described it, "[Canadians'] proximity had dropped and stayed low. [...] What was happening was that Canadians were maintaining social distancing [...] even as they started to move around more."[21]

Outputs and Intended Outcomes

The research team compiled these findings in a policy report available on the website of the Innovation Policy Lab at the Munk School of Global Affairs & Public Policy at the University of Toronto.[22] Though the project had contracted in scope after its initial conception, the researchers expressed hope the piece would make an impact on the policymakers, scholars, and the public for whom the effects of restrictions in Canada were unclear.[23]

Following publication, the report received press coverage. The research team's findings were reported on coverage on television[24] and radio.[25] The team lead, Anita McGahan, published an op-ed in the Toronto Star, Canada's highest circulation newspaper.[26] It also received attention from organizations based in major Canadian cities, stemming from the report's inclusion of estimates of mobility and proximity across Canada's 30 largest cities. Anita McGahan participated in several public policy seminars hosted by the University of Toronto's Munk School that led her to present her research to members of city government in Ontario and Quebec.[27] In total, the team estimated subsequent attention necessitated three weeks of intensive media work.[28]

Though the published report led to interactions with media personalities, former national leaders, academics, and city leaders, the team argued that their report's greatest impact was on the Canadian public. All of this activity around the report allowed the findings to be disseminated broadly and helped demonstrate the importance and effectiveness of social distancing measures.[29] Though the team plans to expand on its work and is seeking an additional grant that will allow them to proceed with the original work plan, it considers this result a success.

Lessons Learned

The research team believed its work on the *Mobility and Proximity in Canada During the COVID-19 Pandemic* report had

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20. Ibid.
21.   McGahan, Anita. Interview re: Mobility and Proximity in Canada, supra note 7.
22. Cavalli, et al. supra note 9
23. Ibid.
24. "It's Been Months since the COVID-19 Pandemic Started. How Have Our Behaviours Changed?" Global News Morning Toronto. Global News, November 5, 2020. https://globalnews.ca/video/7444297/its-been-months-since-the-covid-19-pandemic-started-how-have-our-behaviours-changed/.
25. Cutrara, Kelly. "Training Judges Could Have Downfalls, How's Our Distancing? & Form Toy Making to the First Recyclable Masks." Omny.fm. Kelly Cutrara. 640 Toronto, October 28, 2020. https://omny.fm/shows/kelly-cutrara/training-judges-could-have-downfalls-hows-our-dist.
26. McGahan, Anita. "In the Battle against COVID, Canadians Have Accomplished a Lot — and We Need to Do More." Thestar.Com, November 7, 2020, sec. Opinion. https://www.thestar.com/opinion/contributors/2020/11/07/in-the-battle-against-covid-canadians-have-accomplished-a-lot-and-we-need-to-do-more.html.
27. McGahan, Anita. Interview re: Mobility and Proximity in Canada, supra note 7.
28. Ibid.
29. Ibid.

several implications for researchers.

Enabling Conditions

- **Cross-Sector Collaboration:** The researchers spoke highly about the value of multi-institution and multi-sector collaboration. Though researchers often have fears about frictions and conflicts of interest emerging in research conducted with the private sector, the project team found no such issues.[30] There were negotiations but, as Anita McGahan described it, "It was a very constructive and positive process." Moreover, the research team emphasized the value of their relationship with the ISI Foundation and considered the organization's support critical in completing the project.

Challenges

- **Pressure to Publish:** The team encountered difficulties balancing the need to publish analysis quickly with the need to adhere to the ethical guidelines agreed to in the initial research design. At the project's inception, the research team claimed it would only work with a data supplier that let users explicitly "opt-in" to data collection to preserve user privacy as well as transparency and accountability. To this effect, the research team worked with Cuebiq, whose practices it considered in line its standards, and began a negotiation process through the university to draft a data-sharing agreement making its expectations explicit. During these negotiations, however, academics at other universities began publishing analyses of similar research questions. These reports, in contrast with University of Toronto's work, relied on datasets collected by organizations without "opt-in" data collection. These publications put pressure for the researchers to begin analysis as soon possible to avoid their work being overtaken by others. The research team subsequently argued that researchers would benefit from a robust framework supported by academic institutions and government, to better standardize and rationalize practices meant to protect data subjects and the integrity of data processes. Such practices, they suggested, would reduce pressure to move quickly.

- **Logistics:** Though the research team started out a broad scope, the realities of the crisis turned out to be deeply constraining. The team was on a tight deadline and budget after a grant proposal rejection. Staff was unavailable. Essential facilities and computational power could not be easily accessed due to lockdown measures. In other words: The pandemic itself made it difficult to conduct large-scale empirical analysis on the pandemic.[31] Other research teams might seek to identify, in advance, how the pandemic affects the availability and accessibility of resources.

Conclusion / Next Steps

In terms of final recommendations for other teams, Anita McGahan suggested that organizations needed to do better to standardize frameworks for collaboration. Though collaboration can be effective, the time and resources needed to begin sharing between academia and the private sector can be significant. By streamlining the process, researchers can start work earlier and private-sector companies can eliminate friction between themselves and academics.

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30. Ibid.
31. Ibid.