Measuring the Impact of COVID-19 Pandemic on Public Transit Demand in US

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1. Introduction

A novel coronavirus disease (COVID-19) has evolved into a global outbreak for its high contagiousness, high fatality rate, and lack of known treatments.

1. Background
2. Analysis

In this section, we first introduce our data sources of the transit demand and COVID-19 daily cases statistics. Then, we introduce our theory about the dynamics of transit demand and the linkage between the two curves.

* 1. **Data sources**

**Transit demand change.** We collected the transit demand change data via the web interface maintained by Transit app (Transit app, 2020). Transit is a popular mobile app providing real-time public transit data and trip planning. The app covers over 200 metropolitan areas around the world with more than 5 million download on Android platform. Therefore, although the actual ridership data is still largely unknown and inaccessible, the usage of the app can be regarded as a rough measure for the transit demand of these app users (Transit app, 2020). Surely, the difference between the behaviors of apps users and other users, the accurate ratio of apps users among all transit users, and other factors affecting the representativeness of the usage statistics are still largely unknown. However, we can still use it as a rough but reasonable proxy to capture the changes of transit demand and ridership caused by the COVID-19 pandemic due to the large user group and popularity of real-time transit apps.

As COVID-19 hit the world and the transit demand decreased consequently, the app website kept updating on the changes of transit demand on an everyday basis. The change values are a set of percentage, calculated by comparing actual usage of the app to projected use of the app based on last year’s numbers. The projected numbers are also adjusted for annual growth (Transit app, 2020). In this way, the values represent the difference between expected and the actual transit demand.

The data includes 182 public transit systems across the United States, Canada, Australia, New Zealand, and France. We select all 121 transit systems in 71 metro areas, 55 counties, and 30 states across the United States and conduct analyses based on these areas.

**COVID-19 case numbers.** We collected the daily case numbers from the COVID-19 Surveillance Dashboard produced by University of Virginia (Biocomplexity Institute, 2020). The data includes all counties in the US for every day. To find the linkage between the case numbers and the demand decrease, we geocoded each transit system to the corresponding county or multiple counties if cross-counties systems.

* 1. **Logistic model of transit demand change**

We first plot the curve of each system as shown in Figure 1. For all systems at the start, the demand generally oscillate around the base line. As the epidemic and quarantines progressed, the demand gradually decreased, until reached a very low level and then stabilized.

The shape of the curves can be easily connected with logistic function; therefore, to generalize the change of transit demand, we will use logistic function to fit the data. A logistic or sigmoid function can be expressed into the following form:

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

Where: is the curves’ minimum value, k is the logistic growth rate or steepness of the curve, is the x value when the function reaches the midpoint. We will fit each transit system’s demand data using logistic model individually and calculate these three parameters. In the next section, we discussed the trend of three parameters for each system.

**L – Base value.** L represents the limit of the logistic curve. In the practical sense, it represents the ratio of public transit users in this system that still will not or cannot stop using it regardless of the pandemic. For different systems, the L value is vastly different.

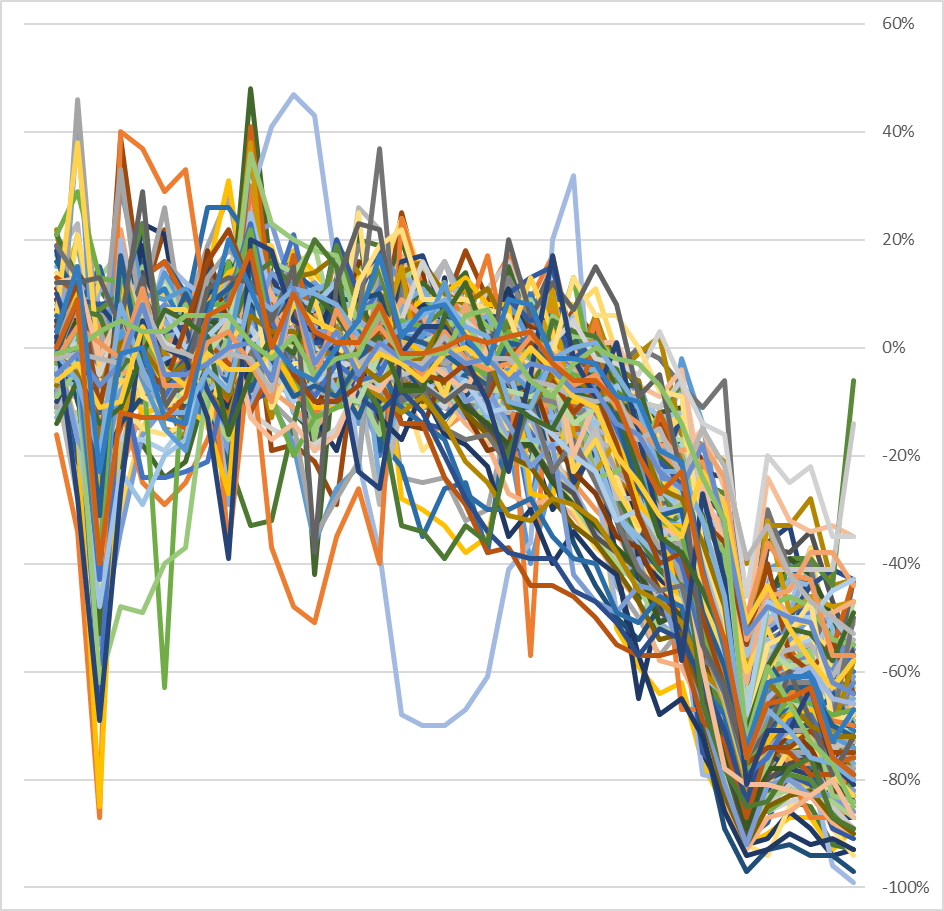


Figure 1: the cluster of demand change for all systems

The curveTransit demand change