# INVEST IN THE RIDE: *A longitudinal analysis of the determinants of public transport ridership in 25 North American cities*


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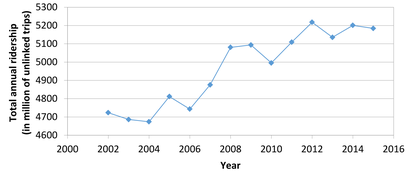
## CONTEXT

Public transport ridership has been steadily increasing since the early 2000s in many cities across North America.

However, many cities have more recently seen their **transit ridership plateau, if not decrease**.




**Ridership per year**

Note that data from the MTA in New York City is not included in this graph. New York is as an outlier in the distribution of ridership and was thus removed to avoid skewing the graph.

This trend in ridership has produced a lot of discussion on which factors contribute to changes in ridership. While no recent study has been conducted on this matter, understanding the **levers** that can be used to **increase ridership** is essential.

## RESEARCH AIM

The aim of this study is to explore the **determinants of public transport ridership** from **2002 to 2015** for **25 transit agencies in Canada and the United States** using a longitudinal multilevel mixed-effect regression approach.


## METHODOLOGY

### Inclusion Criteria of Transit Agencies

- Located in metropolitan areas with a population over 1.5 million in 2015
- Operates at least two modes (bus, streetcar, light rail and/or heavy rail).

### Summary Statistics and Data Sources

| | Source | Variable definition and construction | Unit | | | | |
|---|---|---|---|---|---|---|---|
| **Continuous variables** | | | | **Mean** | **Std dev.** | **Min.** | **Max.** |
| **Ridership** | NTD<br>CUTA | Number of unlinked passenger trips* | Trips (million) | 325 | 611 | 24 | 3510 |
| **Vehicle revenue kilometers** | NTD, ACS<br>CUTA, StatCan | Number of kilometers travelled by vehicle in revenue service* | Kilometer (million) | 102 | 135 | 12 | 728 |
| **Fare** | NTD<br>CUTA | Total fare revenue* †/ Number of unlinked passenger trips * | 2015 USD/ trip | 0.98 | 0.24 | 0.40 | 1.92 |
| **Population** | ACS,<br>US Census Bureau<br>StatCan | CMA population‡ | Person (million) | 4.96 | 3.82 | 1.73 | 20.2 |
| **Area** | ACS, US Census Bureau<br>StatCan | CMA geographic area‡ | Squared kilometers | 13169 | 6080 | 2883 | 22854 |
| **Percent of households without a car** | ACS<br>StatCan | Number of households without a car/total number of households | % of households | 0.11 | 0.06 | 0.05 | 0.32 |
| **Unemployment rate** | Bureau of Labour Statistics<br>StatCan | Number of unemployed/ Total labour force (seasonally adjusted) | % of labour force | 6.5 | 1.9 | 2.9 | 12.3 |
| **GDP per capita** | Bureau of Economic Analysis, US Department of Commerce<br>StatCan | Per capita real GDP by metropolitan area† | 2015 USD/ capita | 65456 | 14161 | 27119 | 112851 |
| **Gas price** | US Energy Information Administration<br>StatCan | Average retail prices for gasoline† | USD/liter | 0.84 | 0.20 | 0.46 | 1.42 |
| **Highway mileage** | Open Street Maps | Measured total length of highways within CMA through GIS | Kilometer | 2455 | 1506 | 221 | 6997 |
| **Dummy variables** | | | | **Proportion** | | | |
| **Presence of private bus operator** | NTD | Presence of purchased transportation for bus services, only for US agencies | 1=present, 0=not present | 0.33 | | | |
| **Presence of Uber** | Various newspapers and websites | Presence of Uber in the metropolitan area | 1=present, 0=not present | 0.24 | | | |
| **Presence of bicycle sharing system** | Bicycle sharing system websites | Presence of a bicycle sharing system in the metropolitan area | 1=present, 0=not present | 0.17 | | | |

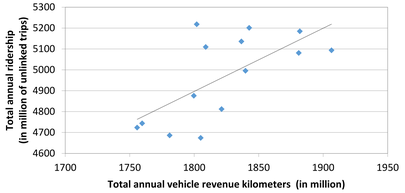
*Data collected by mode from the US National Transit Agency.
†All monetary variables were collected in CAD for Canadian agencies and converted to USD as per the conversion rate of the US Federal Reserve Bank.
‡ CMA is the census metropolitan area for Canadian cities, equivalent to MSA (metropolitan statistical area) in the United States.

NTD: National Transit Database
CUTA: Canadian Urban Transit Association
ACS: American Community Survey
StatCan: Statistics Canada

## RESULTS

### Correlation Analysis

The figure below presents the relationship between annual ridership and annual vehicle revenue kilometers for all agencies, each point representing one year. It suggests the following trend: **in years where vehicle revenue kilometers were higher, ridership was also higher.**




**Ridership and vehicle revenue kilometers per year (total of all transit agencies)**

Note that data from the MTA in New York City is not included in this graph. New York is as an outlier in the distribution of ridership and was thus removed to avoid skewing the graph.

### Regression Modelling

**Longitudinal multilevel mixed-effect regression model of public transport ridership (number of unlinked passenger trips) (log-transformed)**

| Variable | Coeff. | Sig. | Conf. interval† | |
|---|---|---|---|---|
| **Internal variables** | | | | |
| Revenue vehicle kilometers (ln) | 0.810 | *** | 0.726 | 0.894 |
| Average fare (ln) | -0.214 | *** | -0.286 | -0.142 |
| **External transport-related variables** | | | | |
| Presence of private bus operator | 0.115 | *** | 0.081 | 0.150 |
| Presence of Uber | 0.023 | | -0.004 | 0.051 |
| Presence of bicycle sharing system | 0.005 | | -0.028 | 0.038 |
| Proportion of carless households (ln) | 0.440 | *** | 0.268 | 0.613 |
| **Other external variables** | | | | |
| Population (ln) | 0.358 | *** | 0.189 | 0.526 |
| Area (ln) | -0.292 | ** | -0.487 | -0.097 |
| Gas price (ln) | 0.067 | ** | 0.022 | 0.111 |
| Constant | 2.491 | * | 0.096 | 4.886 |
| AIC | -630 | | | |
| BIC | -584 | | | |
| ICC | 0.90 | | | |
| Log-likelihood | 327 | | | |
| Observations | 348 | | | |
| Number of groups | 25 | | | |

* 95% significance level | ** 99% significance level | *** 99.9% significance level
† 95% confidence interval

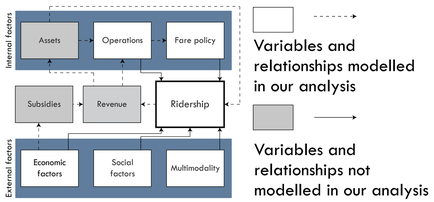
### Main Findings

- The **largest determinant** of ridership is the number of **vehicle revenue kilometers**: a 10% increase in vehicle revenue kilometers is associated with an 8.1% increase in ridership.
- Fare is statistically significant and associated with a decrease in ridership, where a 10% **increase** is linked with a 2.1% **decrease in ridership**.
- The presence of **Uber and bicycle sharing** systems in a city, although not statistically significant, is positively associated with ridership.

## DISCUSSION

### Ridership, Expenses and Revenues

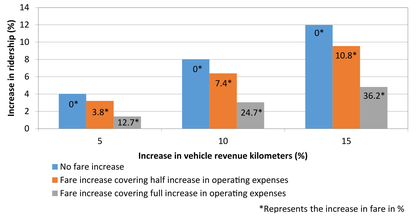
**Operations and fare policy** contribute to changes in ridership, in addition to economic factors, social factors and multimodality. Investments in operations are largely contingent on the **agency's revenue**, which is in turn influenced by subsidies and fare policy, through ridership.




**Determinants of ridership**

### Scenario Analysis

**Increases in ridership** associated with increases in vehicle revenue kilometers are **offset by losses in ridership from fare increases** that could be used to partially or fully recover the additional operation costs.




**Increase in ridership as a function of increase in vehicle revenue kilometers and fare.**

## CONCLUSION

Transit agencies and municipalities wishing to increase their ridership should consider improving their service through **investments in operations, while trying to limit fare increases.**

To ensure increases in ridership, transit agencies need to find **additional sources of revenue.**

## ACKNOWLEDMENTS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