The Impact of Real-Time Information on Bus Ridership in New York City

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Outline

- Motivation for Real-Time Information
- Brief Review of Prior Research
- Timeline of Bus Time Roll-out
- Methodology: Panel Regression
- Conclusions and Limitations

Motivation

- Public transit can be unreliable.
- Improving reliability can be expensive.
- Providing real-time transit information to riders via personal devices can help.

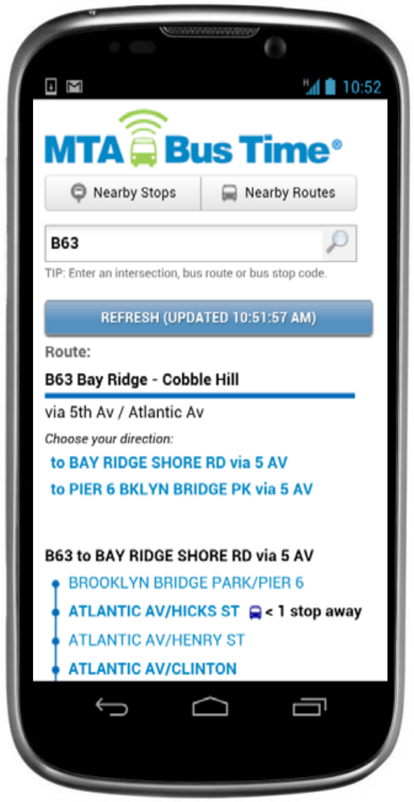


Image: Bus Time Mobile Website

Noteworthy Prior Studies on the Impacts of Real-Time Bus Information

Decreased Wait Times

- Watkins et al. (2011)
- Location: Seattle, King County Metro
- Conclusion: Both actual wait times and perceived wait times of real-time bus information users were less than non-users

could lead to

Increased Satisfaction

- Zhang, Shen, Clifton (2008)
- Location: University of Maryland
- Conclusion: Overall satisfaction with transit service increased due to real-time shuttle bus information

could lead to

Increased Ridership

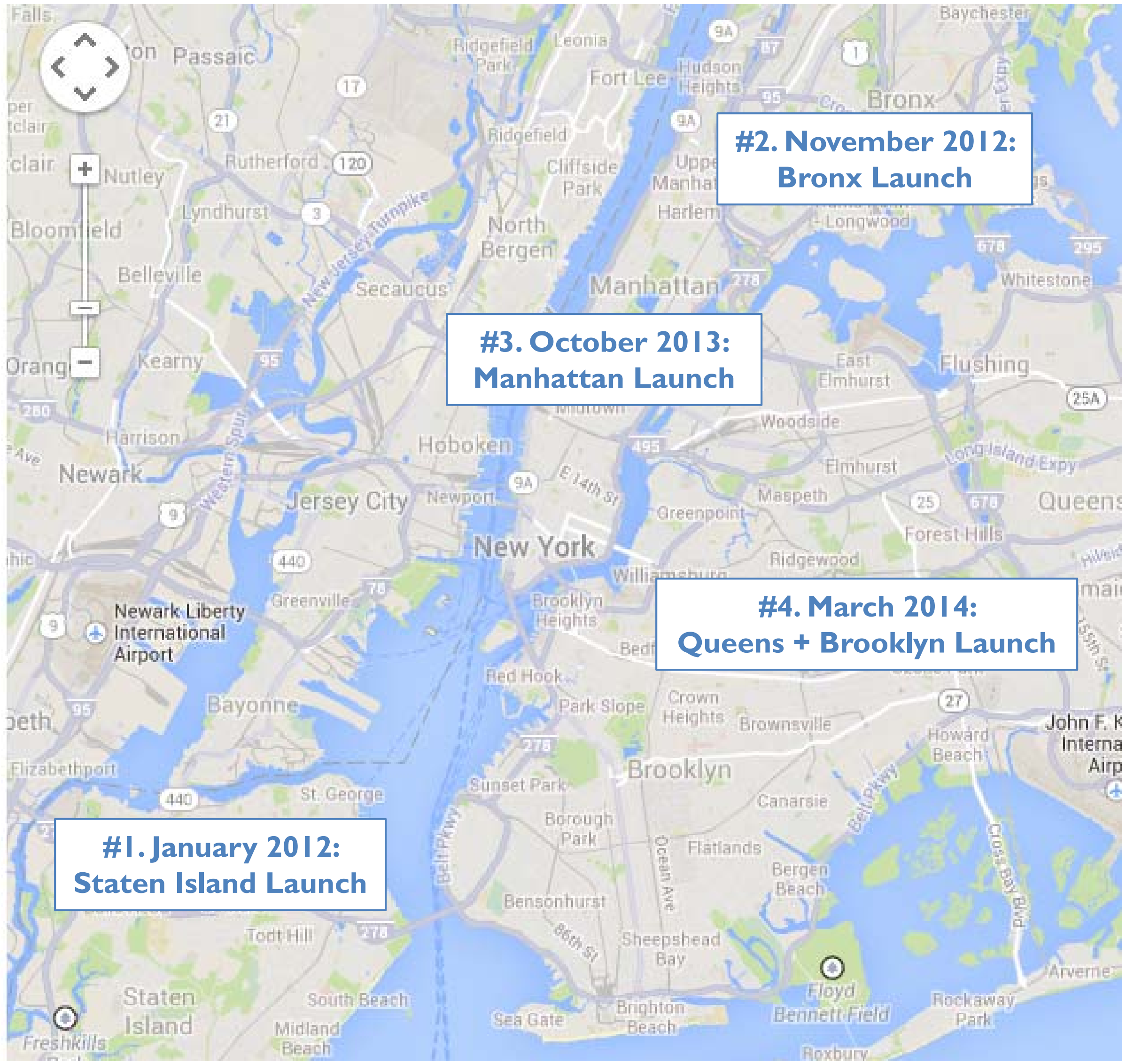
- Tang & Thakuriah (2012)
- Location: CTA, Chicago
- Conclusion: Modest increase in ridership (126 trips/route on average weekday) attributable to real-time bus information

1. Watkins, K. E., Ferris, B., Borning, A., Rutherford, G. S., & Layton, D. (2011). Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders. Transportation Research Part A: Policy and Practice, 45(8), 839–848.
2. Zhang, F., Shen, Q., & Clifton, K. J. (2008). Examination of Traveler Responses to Real-Time Information About Bus Arrivals Using Panel Data. Transportation Research Record: Journal of the Transportation Research Board, 2082, 107–115.
3. Tang, L., & Thakuriah, P. (Vonu). (2012). Ridership effects of real-time bus information system: A case study in the City of Chicago. Transportation Research Part C: Emerging Technologies, 22, 146–161.

Roll-out of Bus Time in New York City

Bus Time modeled with the following dates:

- Feb 2011: B63
- Jan 2012: All Staten Island Routes
- Apr 2012: M34
- Jul 2012: B61
- Nov 2012: All Bronx Routes; M100
- Oct 2013: All Manhattan Routes



Staten Island Bus Time On-Board Survey

High levels of technology adoption by riders coupled with strategic marketing of Bus Time quickly resulted in utilization of real-time information. This makes New York City an excellent test case to use econometric models to evaluate ridership impacts.

TECH ADOPTION

- 52% of bus riders use smartphones
- 62% use SMS[a]

+

MARKETING

- 73% of bus riders are aware of Bus Time[b]

Image Source: Liz Paul, MTA

→

REAL-TIME UTILIZATION

- 44% of bus riders have used Bus Time[c]

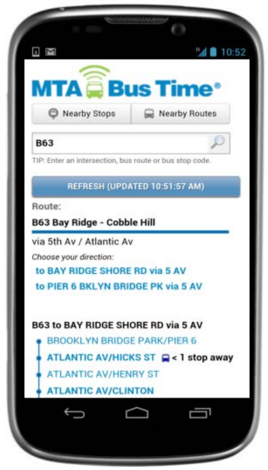


Image: Bus Time Mobile Website

[a] On-board survey conducted in December 2011; n=1,304
[b] On-board survey conducted in May/June 2012; n=1,404 (excludes No Answer)
[c] On-board survey conducted in May/June 2012; n=1,496 (includes No Answer)
Survey information provided by Peter Harris, MTA

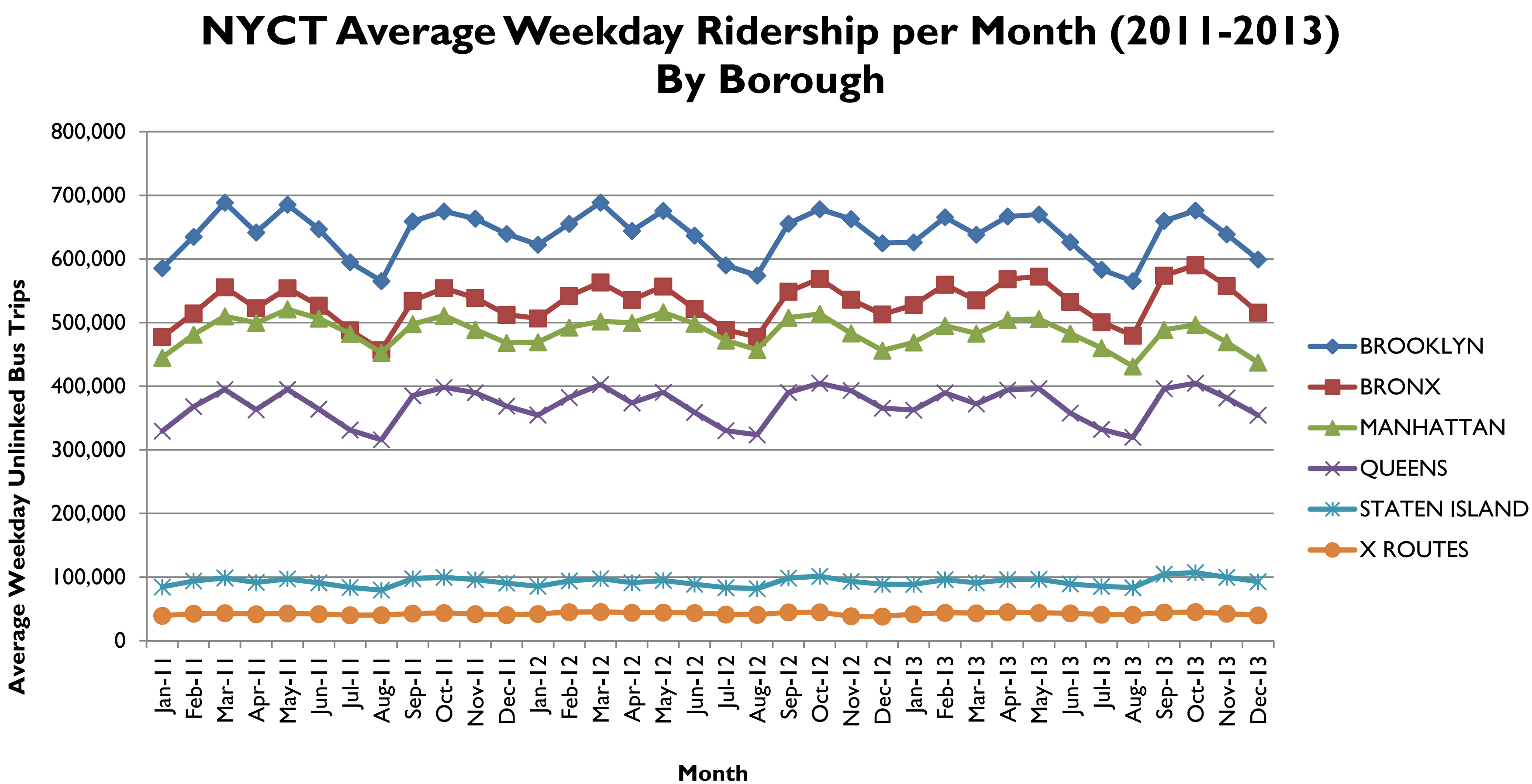
Data Sources & Variables

Many factors affect transit ridership, including transit-related variables (e.g., fares) and external factors (e.g., weather). The following variables were considered in the analysis.

	Variable Description (Units)	Geographic Unit	Variable Type	Data Source
Dependent Variable	Average Weekday Unlinked Bus Trips	Route-level	Continuous	New York City Transit
Explanatory Variables (Transit-related)	Bus Time Real-Time Information Available	Route-level	Binary	MTA Press Releases
	Bus Average Weekday Scheduled Revenue Miles	Route-level	Continuous	New York City Transit
	Bus and Rail Base Fare ($)	City-wide	Continuous	MTA Press Releases
	Rail Actual Vehicle Revenue Miles	City-wide	Continuous	New York City Transit
	Rail Scheduled Vehicles Operating in Maximum Service	City-wide	Continuous	New York City Transit
Explanatory Variables (External Factors)	Bike-sharing	Borough-level	Binary	Citibike
	Population (only annual estimates available; linear interpolation per month)	Borough-level	Continuous	US Census Bureau
	Gas Price ($/gallon)	City-wide	Continuous	US Energy Information Administration
	Unemployment Rate (percent)	City-wide	Continuous	US Bureau of Labor Statistics
	Weather (Average temperature, snowfall, precipitation; measurement at Central Park)	City-wide	Binary (Temperature); Continuous (Snow/rain)	National Oceanic & Atmospheric Administration
	Hurricane Sandy	City-wide	Binary	NYU Rudin Center Report

Route-level Ridership

The dependent variable of interest is monthly route-level ridership over a 3 year panel (t=36 months). All NYCT operated routes were included in the analysis (i=185* routes).



* Ridership statistics for a small number of NYCT routes were combined due to joint scheduling/counts (e.g. M101/2/3, BX40/42, etc.)

Methodology: Panel Regression

- OLS* regression is insufficient: $y_{it} = \alpha + \beta x_{it} + \varepsilon_{it}$

  where

  y = ridership

  i = bus route

  t = month

  x = explanatory variables

  $\varepsilon_{it} \rightarrow u_i + \varepsilon_{it}$

- Two types of panel regression were evaluated
  - Random Effects: $y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it}$
  - Fixed Effects: $y_{it} - \overline{y}_i = \beta(x_{it} - \overline{x}_i) + \varepsilon_{it}$

- Fixed Effects panel regression was selected

*Ordinary least squares

Model 1: Fixed Effects Regression Single Bus Time Variable

Variable	Estimate	Robust Standard Error
Bus Service by Borough (Revenue Miles)		
Brooklyn	5.381	(0.693)***
Bronx	5.073	(0.935)***
Manhattan	3.051	(1.227)**
Queens	2.765	(1.275)**
Staten Island	0.212	(0.301)
Other Transit-Related Variables		
Select Bus Service	-262.039	(461.757)
Fare ($)	-862.884	(121.641)***
Rail Revenue Miles (thousands)	0.072	(0.008)***
Rail Vehicles in Max. Service	-2.566	(0.398)***
Other External Factors		
Citi Bike in Manhattan	-556.237	(143.921)***
Citi Bike in Brooklyn	-375.308	(96.701)***
Unemployment Rate	-243.379	(40.208)***
Cold Month	-249.223	(30.778)***
Hot Month	-246.906	(35.622)***
Total Monthly Snowfall (mm)	-0.819	(0.070)***
Total Monthly Precipitation (mm)	-0.366	(0.060)***
Hurricane Sandy	206.319	(51.793)***
Real-Time Information	**118.278**	**(52.695)****
Monthly Dummy Variables (see paper)		
R^2		0.47

Significance codes: p<0.1; ** p<0.05; *** p<0.01
Balanced Panel: routes=185; time periods=36; N=6660
Huber-White Robust SE

Interpretation

- Bus service increases → bus ridership increases
- Availability of bike-sharing → bus ridership decreased
- Hurricane Sandy → bus ridership increased
- **Bus Time real-time information → increased route-level ridership ~118 rides per route per weekday (median of 1.7%),**

Model 2: Fixed Effects Regression with Real-Time Information by Route Size

Variable	Estimate	Robust Standard Error
Bus Service by Borough (Revenue Miles)		
Brooklyn	5.376	(0.693)***
Bronx	5.017	(0.945)***
Manhattan	3.153	(1.229)**
Queens	2.762	(1.274)**
Staten Island	0.03	(0.329)
Other Transit-Related Variables		
Select Bus Service	-326.825	(458.593)
Fare ($)	-868.031	(123.463)***
Rail Revenue Miles (thousands)	0.073	(0.008)***
Rail Vehicles in Maximum Service	-2.564	(0.393)***
Other External Factors		
Citi Bike in Manhattan	-535.102	(152.800)***
Citi Bike in Brooklyn	-375.586	(96.759)***
Unemployment Rate	-244.935	(40.397)***
Cold Month	-247.74	(30.635)***
Hot Month	-245.322	(35.529)***
Total Monthly Snowfall (mm)	-0.82	(0.070)***
Total Monthly Precipitation (mm)	-0.366	(0.061)***
Hurricane Sandy	204.454	(51.790)***
Real-Time Information		
Small Routes (Q1)	**16.256**	**(62.551)**
Smaller Medium Routes (Q2)	**147.101**	**(106.412)**
Larger Medium Routes (Q3)	**-35.114**	**(106.778)**
Large Routes (Q4)	**340.466**	**(124.803)*** **
Monthly Dummy Variables (see paper)		
R^2	0.47	

Significance codes: p<0.1; ** p<0.05; *** p<0.01
Balanced Panel: routes=185; time periods=36; N=6660
Huber-White Robust SE

Interpretation

- Bus service increases → bus ridership increases
- Availability of bike-sharing → bus ridership decreased
- Hurricane Sandy → bus ridership increased
- **Bus Time on Large Routes → increased ridership by ~340 rides per weekday on the largest quartile of routes (median of 2.3%)**

Conclusions & Limitations

- **Conclusions**
  - Model 1: Average increase of ~118 trips per route per weekday (median of 1.7%), which is similar to Chicago
  - Model 2: Average increase of ~340 trips per weekday on the largest quartile of routes (median of 2.3%)
- **Limitations**
  - Short Timescale: Study period had only 3 months of Bus Time in Manhattan and was prior to the Brooklyn and Queens launch
  - Unit of Analysis: Only considered weekday trips (not weekend)

THANK YOU.

Question? Email cbrakewood@ccny.cuny.edu