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A Strategic Look at Friday Exceptions in Weekday Schedules for Urban Transit

Alex Lu and *Alla Reddy*

Operations Planning
New York City Transit Authority

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Why Weekday Exceptions?

Monday through Friday except Holidays, Effective May 16 - September 11, 2011

Eastbound

To The Hamptons & Montauk

Weekdays

For explanation, see "Reference Notes."		See Note			See Note	See Note	See Note		Note 5	Peak PM	See Note	Note 2	Peak PM	Peak PM	Peak PM	See Note	Peak PM		
	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
PENN STATION	1:05	J 1:45	J 2:39	3:21	J 3:58	J 3:58	J 4:01	4:04	J 4:24	J 4:40	5:09	5:09	5:36	J 5:51	6:27	J 7:11	7:30	J 8:30	10:28
Woodside	1:16	J 1:46	J 2:50	3:32	J 4:06	J 4:06	J 4:06	4:15	J 4:26	J 4:43	J 5:12	J 5:12	.....	J 5:58	6:38	J 7:16	J 7:33	J 8:19	10:40
Forest Hills	J 12:46	J 1:46	J 2:43	J 3:19	J 4:02	J 4:02	J 4:02	4:20	J 4:20	J 4:20	J 5:18	J 5:18	.....	J 6:05	J 6:30	J 7:26	J 7:26	J 8:24	J 10:22
Kew Gardens	J 12:48	J 1:48	J 2:45	J 3:21	J 4:04	J 4:04	J 4:04	4:22	J 4:22	J 4:22	J 5:20	J 5:20	.....	J 6:07	J 6:32	J 7:28	J 7:28	J 8:26	J 10:24
HUNTERSPOINT AVE.	.....	1:49	.....	.....	4:06	4:06	4:06	J 3:40	4:30	4:44	J 4:59	J 4:59	.....	J 5:47	J 6:30	J 6:41	.....	.....	.....
ATLANTIC TERMINAL	J 1:05	J 1:35	J 2:35	J 3:23	J 3:56	J 3:56	J 3:56	J 3:56	J 4:20	J 4:31	J 5:11	J 5:11	T 5:23	J 5:49	J 6:27	J 7:06	J 7:23	J 8:30	J 10:08
Nostrand Avenue	J 1:12	J 1:42	J 2:42	J 3:29	J 4:02	J 4:02	J 4:02	J 4:02	J 4:22	J 4:37	J 5:17	J 5:17	T 5:29	J 5:55	J 6:33	J 7:12	J 7:29	J 8:36	J 10:16
East New York	J 1:17	J 1:47	J 2:47	J 3:34	J 4:07	J 4:07	J 4:07	J 4:07	J 4:31	J 4:42	J 5:22	J 5:22	T 5:34	J 6:00	J 6:38	J 7:17	J 7:34	J 8:42	J 10:21
JAMAICA (Arrive)	1:26	2:06	2:59	3:42	4:22	4:22	4:22	4:27	4:45	5:01	5:30	5:30	.....	6:13	6:47	7:33	7:48	8:49	10:49
JAMAICA (Leave)	1:28	2:09	3:03	3:44	4:25	4:25	4:25	4:28	4:49	5:03	5:32	5:32	T 5:44	6:17	6:49	7:38	7:50	8:53	10:50
Mineola (Note)	.....	.....	3:16	.....	.....	.....	.....	.....	.....	5:18	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hicksville	.....	.....	.....	.....	.....	.....	.....	.....	.....	5:27	.....	.....	.....	.....	.....	.....	.....	.....	.....
BABYLON (Arrive)	2:16	Train runs	.....	4:24	Train runs	Train runs	Train runs	5:05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
(Note) (Leave)	T 2:21	Fridays	3:40	T 4:28	Thursdays	Fridays	Friday	T 5:10	.....	5:44	6:13	.....	.....	.....	.....	.....	.....	.....	.....
Bay Shore	T 2:27	ONLY	3:46	T 4:34	ONLY	ONLY	May 20	T 5:16	5:36	5:50	6:19	.....	.....	.....	.....	.....	.....	.....	.....
Islip	T 2:32	May 27 -	3:51	T 4:39	May 26 -	May 27 -	Only.	T 5:21	.....	5:55	6:24	.....	.....	.....	.....	.....	.....	.....	.....
Great River	T 2:35	Sept. 9.	3:54	T 4:42	Sept. 8.	Sept. 9.	.....	T 5:24	.....	5:58	6:27	.....	.....	.....	.....	.....	.....	.....	.....
Oakdale	T 2:39	.....	3:58	T 4:46	.....	.....	.....	T 5:28	.....	6:02	6:31	.....	.....	.....	.....	.....	.....	.....	.....
Sayville	T 2:44	.....	4:03	T 4:51	.....	.....	.....	T 5:33	5:47	6:07	6:36	.....	.....	.....	.....	.....	.....	.....	.....
PATCHOGUE	T 2:51	.....	4:10	T 4:58	.....	.....	.....	T 5:41	5:55	6:14	6:44	.....	.....	.....	.....	.....	.....	.....	.....
Bellport	.....	.....	.....	.....	.....	.....	.....	T 5:47	6:01	.....	6:50	.....	.....	.....	.....	.....	.....	.....	.....
Mastic-Shirley	.....	.....	.....	.....	.....	.....	.....	T 5:54	6:08	.....	6:57	.....	.....	.....	.....	.....	.....	.....	.....
SPEONK	.....	.....	.....	.....	.....	.....	.....	T 6:10	6:24	.....	7:13	.....	.....	.....	.....	.....	.....	.....	.....
Westhampton	.....	3:39	.....	.....	5:39	5:41	5:39	.....	6:31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hampton Bays	.....	3:50	.....	.....	5:49	5:51	5:49	.....	6:41	.....	Train will	.....	.....	.....	.....	.....	.....	.....	.....
Southampton		4:02			6:01	6:05	6:01	.....	6:51	.....	NOT run	.....	.....	.....	.....	.....	.....	.....	.....
								.....	7:00	.....	Fridays	.....	.....	.....	.....	.....	.....	.....	.....
								.....	7:10	.....	May 27 -	.....	.....	.....	.....	.....	.....	.....	.....
								.....	7:15	.....	Sept. 9.	.....	.....	.....	.....	.....	.....	.....	.....
								.....	7:35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
								PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
								2732	2712	2778	2734	2							

From WALL STREET	A	S	A	S	A	A	S
MONDAY - THURSDAY	PM	PM	PM	PM	PM	PM	PM
New York - Wall Street	4:15	4:40	5:00	5:15	5:35	5:55	6:15
South Brunswick - 8A Park & Ride	5:20	5:45	6:05	6:20	6:40	7:00	7:20
Monroe Twp - Rossmor	5:25	5:50	6:10	6:25	6:45	7:05	7:25
Park & Ride	5:29	5:54	6:14	6:29	6:49	7:09	7:29
Clearbrook	5:30	5:55	6:15	6:30	6:50	7:10	7:30
The Ponds		6:00					
Greenbriar at Whittingham		6:05					
Twin Rivers - Abbington Drive	5:40	6:20	6:25	6:40	7:00	7:20	7:40
Hightstown - Franklin & Broad St.				6:48			7:48
Rogers & Mercer				6:49			7:49
East Windsor - Rts 130 & 571				6:55			7:55

From WALL STREET	A	S	A	S	A	S
FRIDAY	PM	PM	PM	PM	PM	PM
New York - Battery Park	4:15	4:40	5:05	5:25	5:45	6:15
South Brunswick - 8A Park & Ride	5:20	5:45	6:10	6:30	6:50	7:20
Monroe Twp - Rossmor	5:25	5:50	6:15	6:35	6:55	7:25
Park & Ride	5:29	5:54	6:19	6:39	6:59	7:26
Clearbrook	5:30	5:55	6:20	6:40	7:00	7:30
The Ponds		6:00				
Greenbriar at Whittingham		6:05				
Twin Rivers - Abbington Drive	5:40	6:20	6:30	6:50	7:10	7:45
Hightstown - Franklin & Broad St.				6:58		7:53
Rogers & Mercer				6:59		7:54
East Windsor - Rts 130 & 571				7:05		8:00

From WALL STREET	S	S	A	A
ADJUSTED WEEKDAYS	PM	PM	PM	PM
New York - Wall Street	3:45	4:30	5:15	6:00
South Brunswick - 8A Park & Ride	4:50	5:35	6:30	7:05
Monroe Twp - Rossmor	4:55	5:40	6:25	7:10
Park & Ride	4:59	5:44	6:29	7:14
Clearbrook	5:00	5:45	6:30	7:15
The Ponds		5:50		
Greenbriar at Whittingham		5:55		
Twin Rivers - Abbington Drive	5:15		6:45	7:30
Hightstown - Franklin & Broad St.	5:23		6:53	7:38
Rogers & Mercer	5:24		6:54	7:39
East Windsor - Rts 130 & 571	5:30		7:00	7:45

For Schedule and other Information
SUBURBAN TRANSIT
750 Somerset Street
New Brunswick, NJ 08901
(732) 249-1100
www.suburbantransit.com

ACADEMY BUS
2042 Burlington Mt Holly Road
West Hampton, NJ 08080
(609) 265-2400
www.academybus.com

WEEK-DAYS

LEAVE	1189 ★B P M	2189 B P M	105 B P M	1191 ★B P M	2191 ★B P M	193 ★B P M	1195 ★B P M	2195 B P M	109 B P M	197 ★B P M	113 P M
Boston	5.02	5.07	5.15	5.22	5.25	5.26	5.40	5.50	6.00	6.05	6.25
Trinity Place	5.06	5.11	5.19	.....	.....	5.31	5.44	5.54	6.04	6.09	6.29
Cottage Farm	Does not run Saturdays	....	.....	Does not run Saturdays	.....	5.37	Does not run Saturdays	5.59	.....	....	.....
Allston		5.17	.....		.....	5.40		6.03	.....	6.15	6.35
Brighton		....	.....		.....	5.43		6.06	.....	6.17	6.38
Faneuil		5.21	.....		5.38	5.46		6.09	.....	6.20	6.41
Newton		5.25	.....	.....	5.42	5.49	5.54	6.12	.....	6.23	6.44
Newtonville	5.18	5.28	.....	5.39	5.45	5.52	5.58	6.16	.....	6.26	6.47
West Newton	5.22	.....	5.35	5.43	5.48	5.56	6.02	6.19	.....	6.29	6.50
Auburndale	....	5.33	5.39	5.47	5.52	5.59	6.05	6.22	.....	6.32	6.53
Riverside... Ar.	5.27	5.36	5.41	5 49	5.58	6.02	6.08	6.25	6.19	6.35	6.56
Ar. N. L. Falls	....	h6.00	6.00	6.00	.....	.....	6.25	.....	h6.25	....	.....
	P M	P M	P M	P M	P M	P M	P M	P M	P M	P M	P M

B No baggage carried on this train.
h No service to N. L. Falls on Sundays or holidays.
k Runs Saturdays only.
u Stops holidays only.
★ Does not run on holidays.
Feb. 22 and April 19, 1933.

Collection of John G. Allen

Industry Friday Exceptions

Carrier	Differential Scheduling Practice
New York City Transit	Supplemental Schedules and G.O.
New York City Bus	Picked “School Closed” Schedules
Long Island Rail Road	Th/Fr Cannonball, Hamptons Reserve service
Massachusetts Bay Transportation Authority	Friday “Night Owl” service 2001-2005
North County Transit District Breeze	Rt. 395: Mo-Th off-peak, Fr-Su peak
Amtrak	Cardinal (M,W,F); Newport News Fr ext., etc.
Academy	Mo-Th capacity relief short trips
Lucky Star	Unadvertised extras Fri & Sun, 2pm-5pm
United	Day-of-week scheduling industry norm
British Rail	ThFO, FO, FSX trips in public timetable
Union Pacific	Mon pm-Fri am transcontinental “super-exp.”

Fridays in New York City

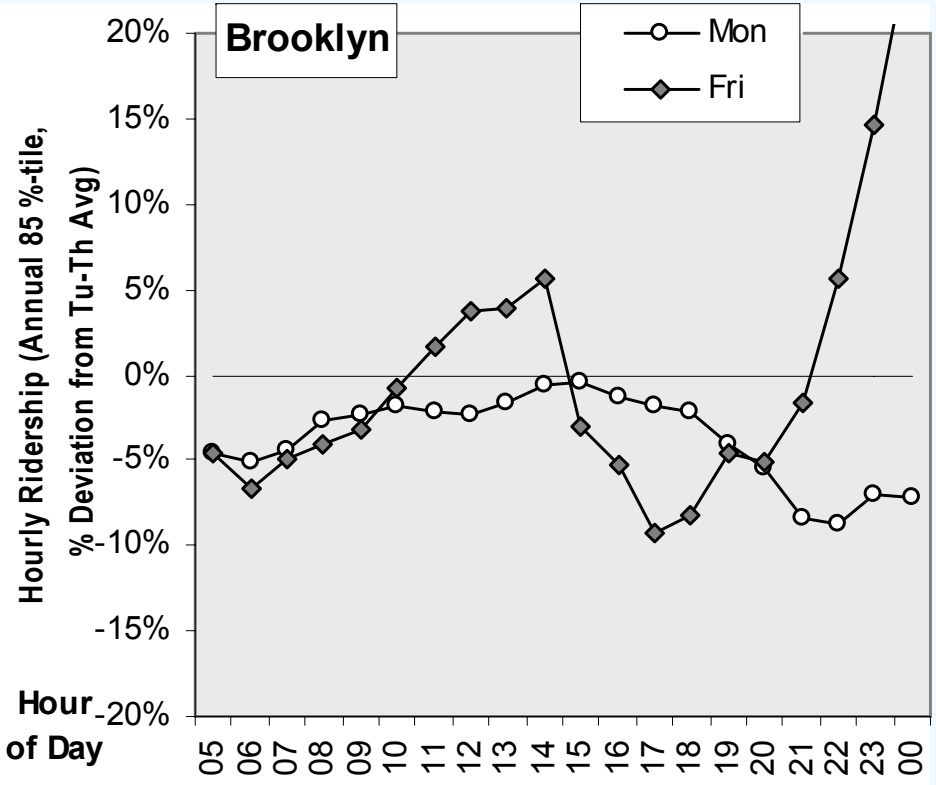
Analytical Methods

- **Ridership Analysis**
  - Cluster Analysis by Day-of-Week
  - Time-of-Day and Day-of-Week Ridership Profiles by Borough
  - Farecard-level Longitudinal Analysis by Day-of-Week
  - Ridership Profiles by Route
- **Cost Analysis**
  - Differential Service Frequency Determination
  - Vehicle-Miles-based Cost Model
  - Crew Regular Day-Off (RDO) Assignment Model

Bus Ridership Cluster Analysis

Time Period	Fri Diff (000)	% Fri Diff	Compressed Dendrogram
07:00~07:59	**-13.6**	**-6%**	(7-6)-**((5-(1-4))**-(3-2))
08:00~08:59	**-8.9**	-4%	(7-6)-**(5-(1-**((2-4)-3)))
09:00~09:59	-3.8	-3%	(7-6)-(**(5-1)**-((2-4)-3))
10:00~10:59	-0.9	-1%	(7-6)-**(1-(5-**((4-2)-3)))
11:00~11:59	0.4	0%	7-(6-(1-(4-((2-5)-3))))
12:00~12:59	2.4	2%	7-(6-(1-((4-2)-(3-5))))
13:00~13:59	3.2	3%	7-(6-((1-(2-4))-(3-5)))
14:00~14:59	6.2	4%	(7-6)-(((2-4)-1)-(3-5))
15:00~15:59	-4.7	-3%	(7-6)-**(5-**((3-4)-(1-2)))
16:00~16:59	**-9.5**	**-5%**	(7-6)-**(5-((4-1)**-(3-2)))
17:00~17:59	**-15.1**	**-8%**	(7-6)-**(5-((1-4)**-(3-2)))
18:00~18:59	**-11.4**	**-8%**	(7-6)-**(5-((1-4)**-(2-3)))
19:00~19:59	-5.7	**-5%**	(7-6)-(**(5-1)**-(2-(3-4)))

Brooklyn Mon/Fri Ridership Difference from Midweek



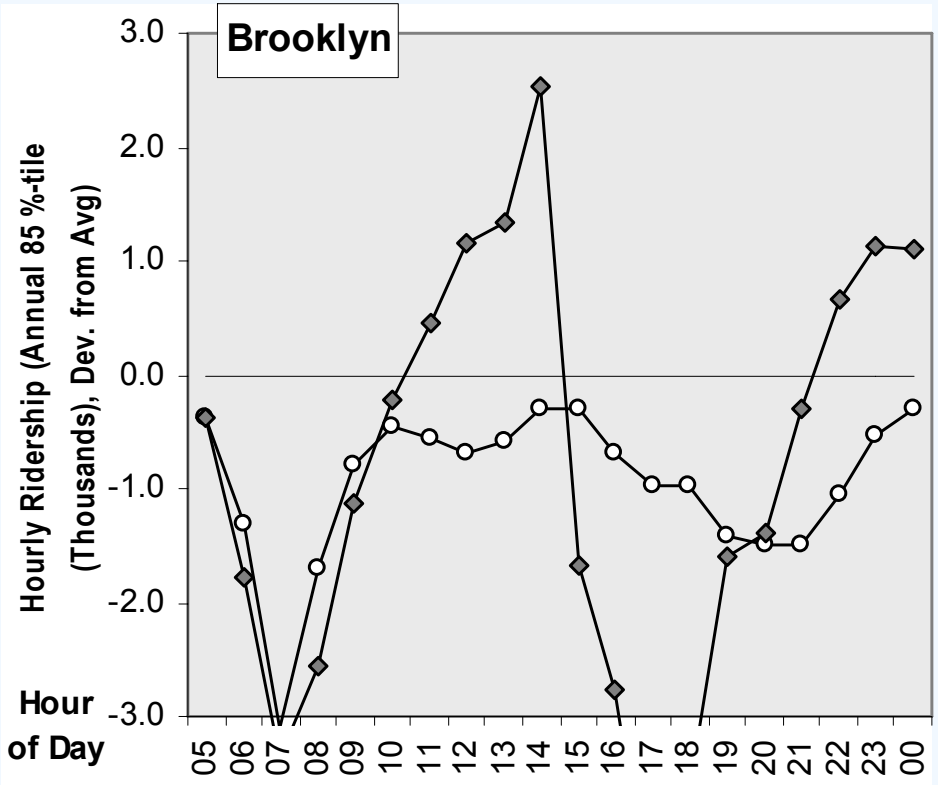
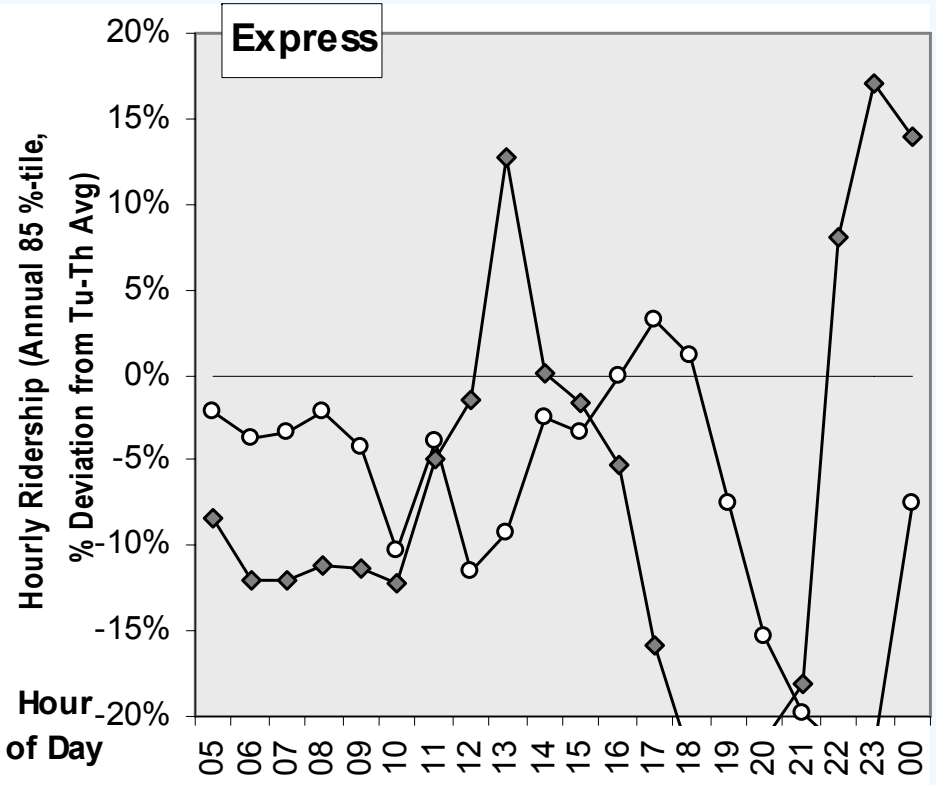
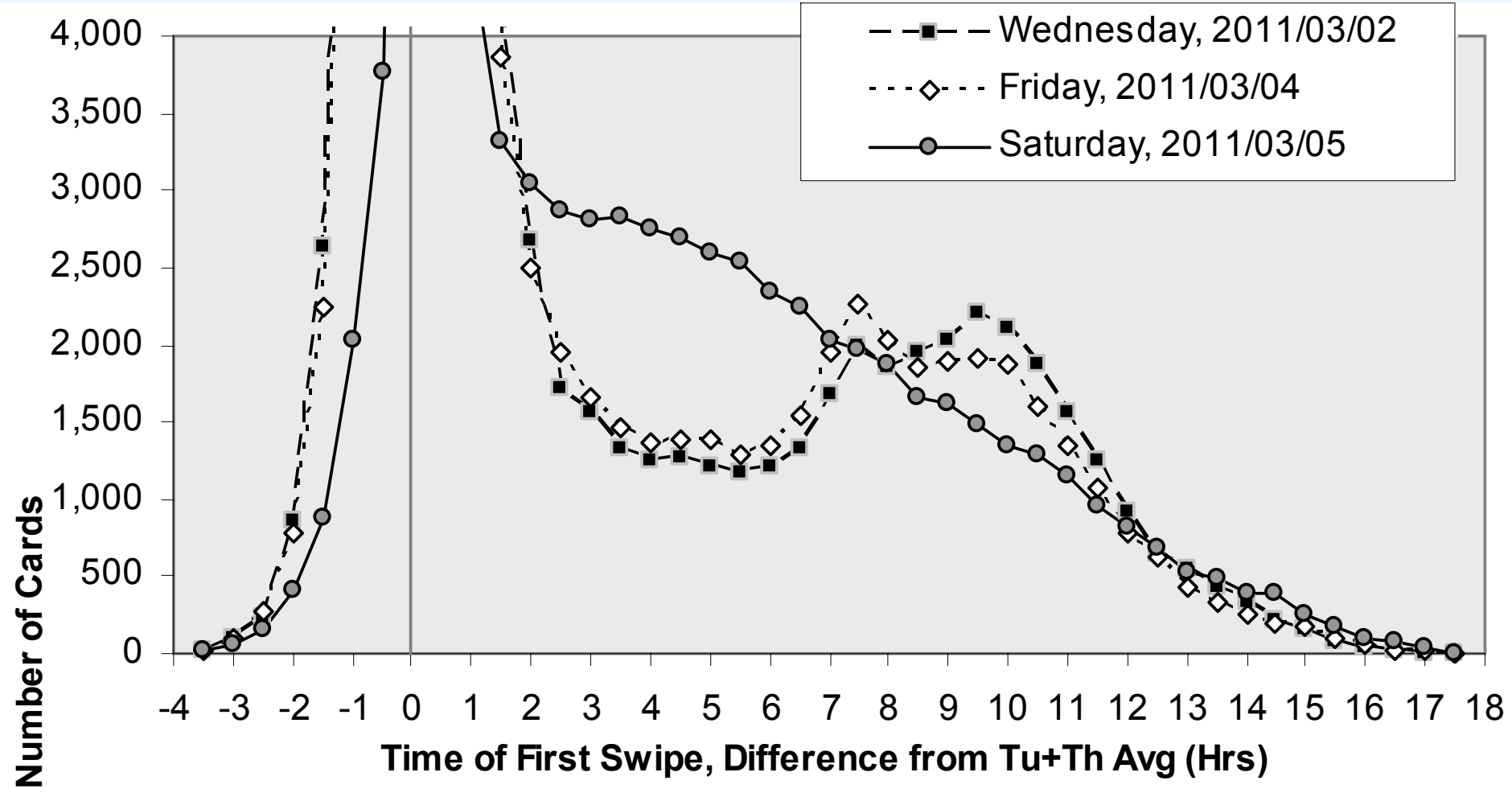


Photo: Adam E. Moreira/Wikimedia Commons

Express Bus Mon/Fri Ridership Difference from Midweek

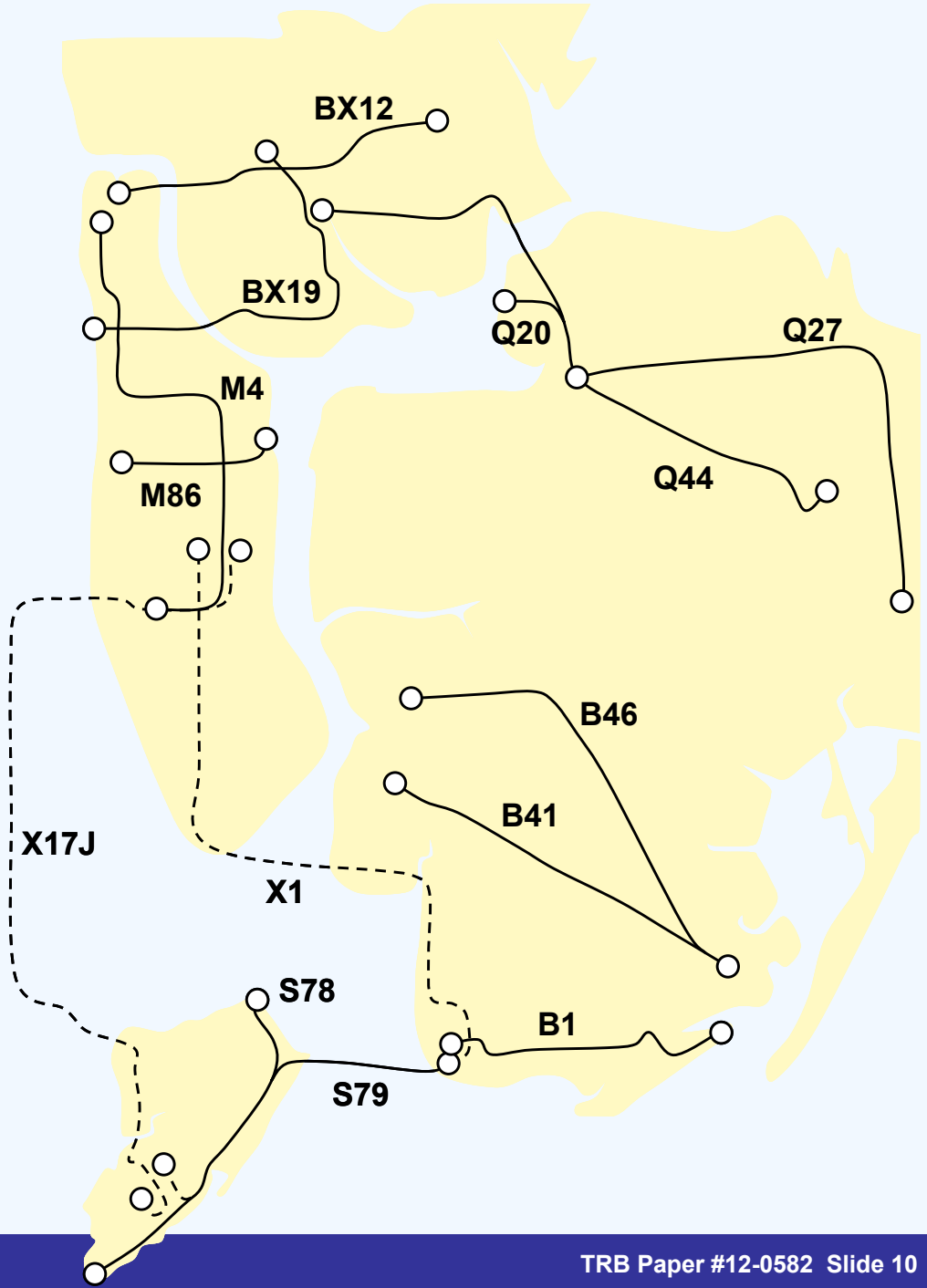


Longitudinal Analysis: First-Swipe-Time Differences

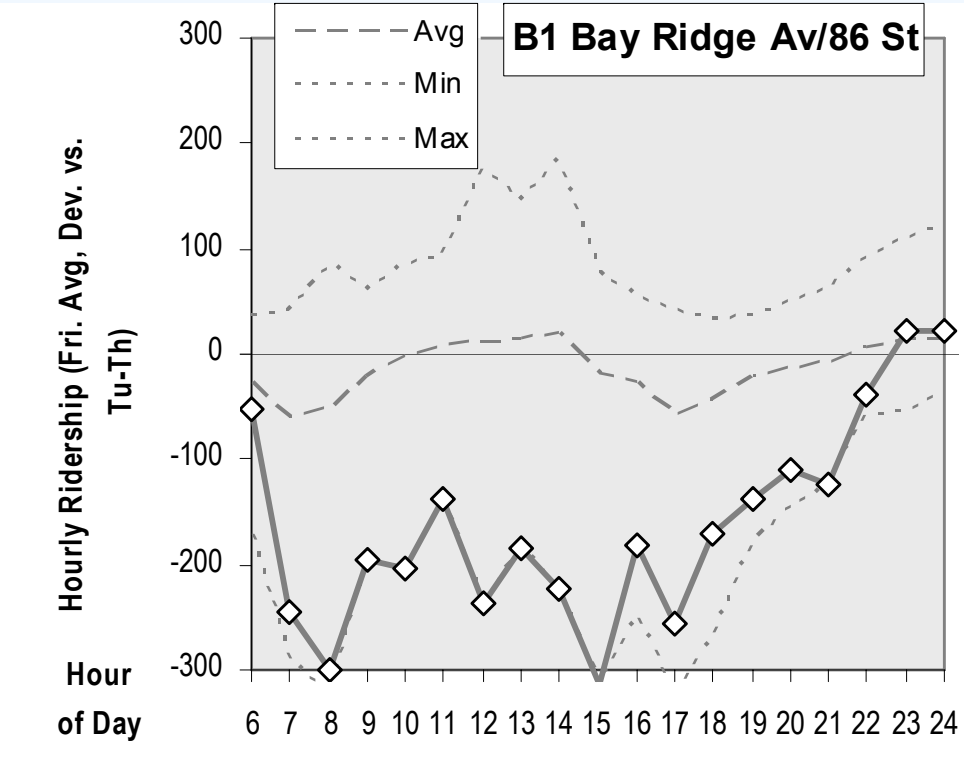


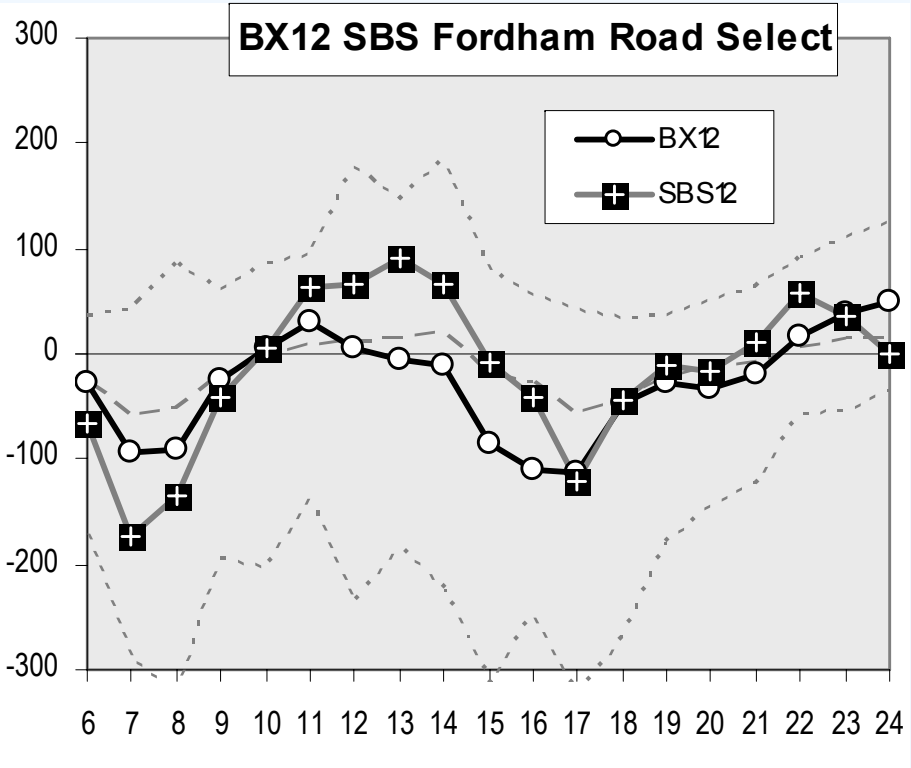
Route Level Exploration

- Analysis of fourteen representative routes
- Radial/Urban Trunk
  - **M4, B41**
- Urban Crosstown
  - **M86, BX19, B46, BX12**
- Medium Density Circumferential
  - **B1, Q27, Q44/20**
- Low Density Arterial
  - **S78/S79**
- Commuter Express
  - **X1, X17**



Mon/Fri Ridership Difference from Midweek: Crosstown Routes

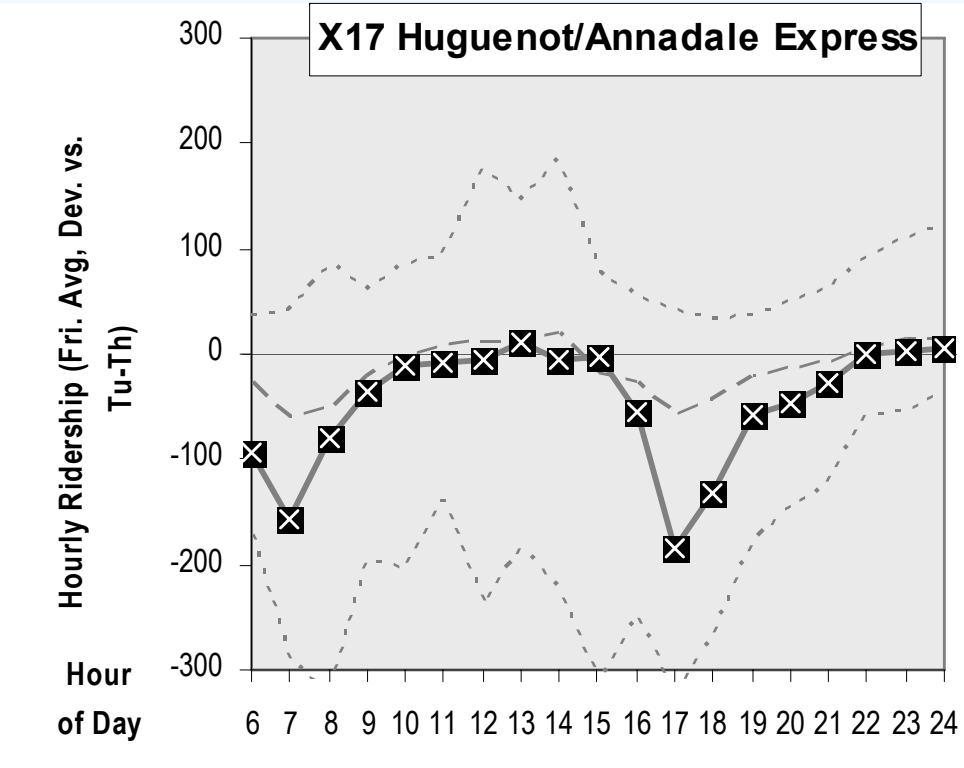


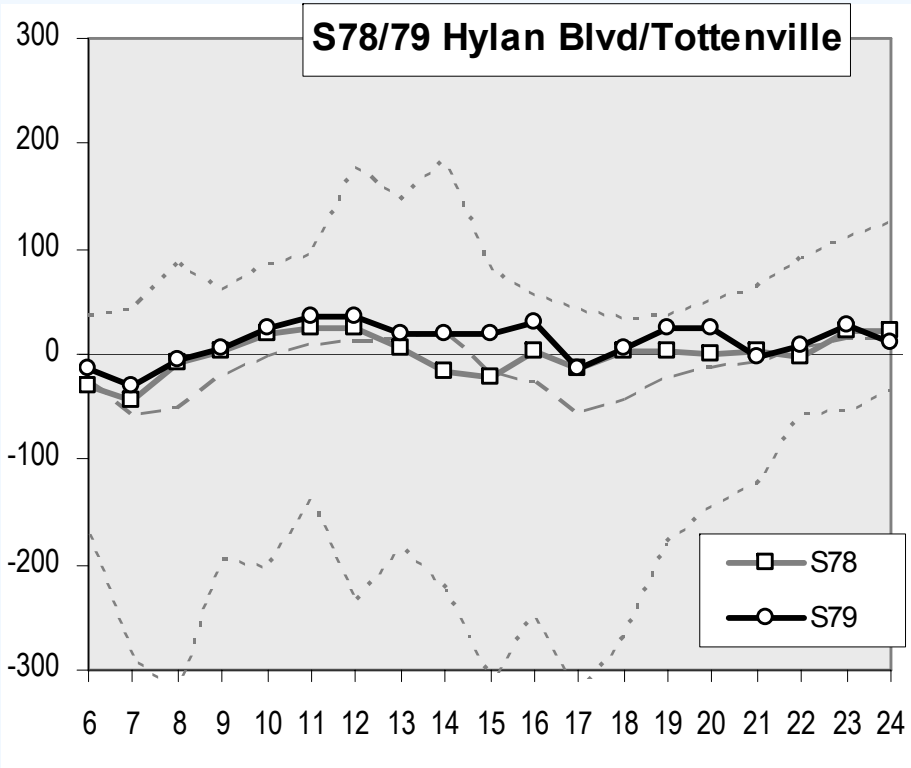


B1 Medium Density Crosstown Commuter School Route

BX12 Urban Crosstown

Mon/Fri Ridership Difference from Midweek: Express, Arterial





X17 Commuter Express

S78/S79 Low Density Arterial

Differential Frequency Determination: AM Peak

Route	Hour with Maximum Riders	Avg. Hrly Ridership Difference	Buses per Hour (bph)	Vehicle Cycle (Hrs)	Capacity Utilizat'n Ratio	bph Change	Estimated Veh-hr Change
B1	08	-301	7.5	2.0	2.7	-1	-10.0
BX12 Local	08	-90	6.0	2.0	1.7	0	—
BX12 Select	07	-173	10.0	1.7	2.6	-1	-8.4
S78	07	-43	4.0	2.8	1.5	0	—
S79	07	-31	7.5	2.5	1.0	0	—
X17	07	-158	20	4.5	0.8	-2	-44.7

Photo: Adam E. Moreira/Wikimedia Commons

Planning-Level Cost Model

Route	B1	BX12 Local	BX12 Select	S78	S79	X17A / X17J	System‡
Friday Veh-hr Chg (Cycle basis)	-29.7	-9.9	-18.5	—	—	-113.5	**-3,012**
Friday Veh-hr Chg (Sch'd basis)	-45.4	-9.8	-21.7	—	—	-63.9	**-3,437**

Day Type	2010 Vehicle Hrs (mil)	2009 Vehicle Hrs (mil)	Vehicle Hours Chg (mil)	Vehicle Hours % Change	Total Cost Chg (millions)	Cost Reduct'n /Veh-hr*	NTD Cost /Veh-hr†
Weekday	12.05	12.68	-0.63	-5.3%	-$38.8	$61.27	—
Weekend	2.84	3.06	-0.22	-7.8%	-$12.5	$56.47	—
Overall	**14.89**	**15.74**	**-0.85**	**-5.7%**	**-$51.3**	**$60.03**	**$99.31**

* **Source:** *2010 NYC Transit Service Reductions – Revised. New York, N.Y., March 19, 2010.*

† **Source:** *FTA National Transit Database (NTD), NYCT Motor Bus Operating Cost per Veh-hr (2009).*

‡ Factored up (15.4% veh-hr basis) to systemwide from 14 representative exploratory analysis routes.

Cost Model Results

- 7.4% reduction in Friday vehicle-hours
- 1.2% reduction in annual vehicle-hours
- $13 million in annual operating budget available for reinvestment (service add-backs or new service)
- Equivalent to 1.5% increase in Monday-Thursday service

Cost Estimation Method	#1	#2	#3	#4	Average
Avail. Reinvestment	$9.6m	$11.0m	$16.9m	$15.6m	**$13m**

Method #1: Est. Friday Veh-hr Chg (cycle basis) multiplied by count of Fridays and Weekday Cost Factor per Veh-hr ($61.27). **Method #2:** Est. Friday Veh-hr Chg (schedule basis) multiplied by count of Fridays and Weekday Cost Factor per Veh-hr. **Method #3:** NTD 2010 Actual Motor Bus Operating Expense ($2.211 billion) multipled by Variable Cost Fraction (64.7%, *MTA Financial Plan* 2010 Actual), then multiplied by %Chg in Annual Veh-hr. **Method #4:** Est. Friday Veh-hr Chg (cycle basis) multiplied by count of Fridays and NTD Operating Cost per Veh-hr ($99.31).

Regular Day Off (RDO) Impacts

	Service Level (% of Base Weekday)					Jobs' Regular Days Off (Brackets = Diff. from Base)			
Scenario	Wkd	Fri	Sat	Sun	Total Jobs	Sa-Su	Fr-Sa/ Su-Mo	Mid-week	Exc-ess
NYCT Base	**100%**	**100%**	**64%**	**52%**	**7,185**	**3,095**	**1,362**	**2,728**	**0**
NYCT Modified	101%	94%	65%	52%	7,185 (0)	2,922 (-173)	1,707 (+345)	2,556 (-172)	0
Typ. (+5%)	105%	105%	50%	50%	486 (+6)	248 (+8)	66 (-14)	172 (+12)	0
Typical*	**100%**	**100%**	**50%**	**50%**	**480**	**240**	**80**	**160**	**0**
Typ. (-5%)	95%	95%	50%	50%	474 (-6)	232 (-8)	94 (14)	148 (-12)	0
Typ. (-10%)	90%	90%	50%	50%	468 (-12)	224 (-16)	108 (28)	136 (-24)	0
Typ. (-15%)	85%	85%	50%	50%	467 (-13)	207 (-33)	127 (47)	133 (-27)	5

* Prototypical results for medium-sized transit agencies with 400 weekday runs (or, for large agencies, a single garage/depot).

Conclusions

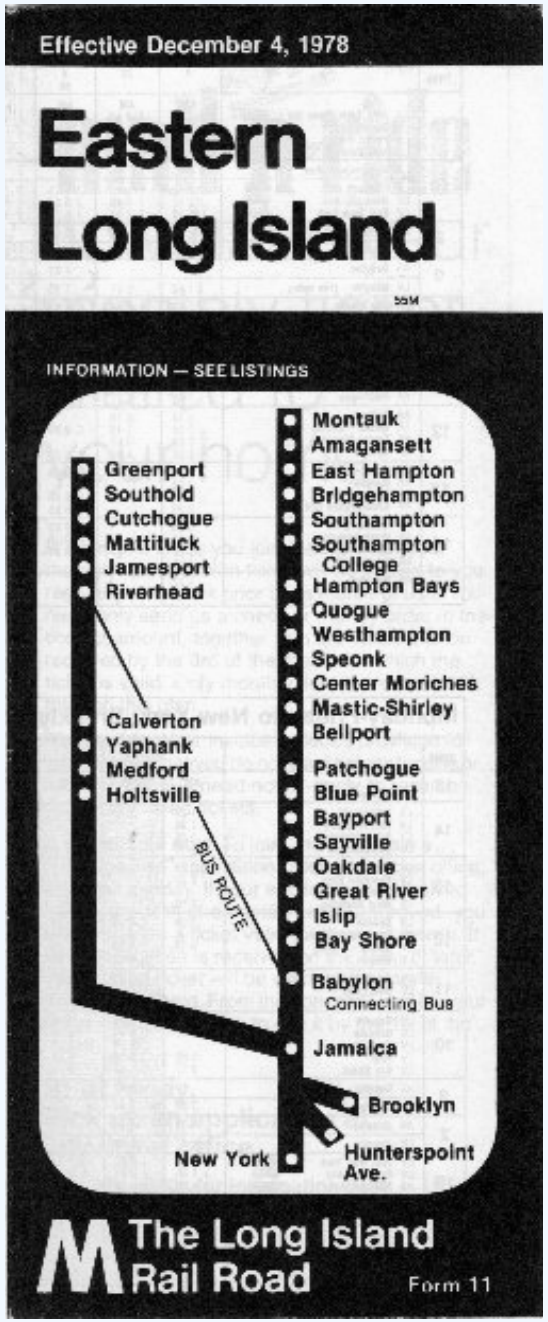
- Labor agreements are necessary prerequisites
- Computerized run-cutting is critical
- Weekday exceptions are normal
- Friday exceptions should be published
- Exception schedules match demand to supply
- Multiple factors cause Friday ridership changes
- Productivity improvements vary by route
- Minor frequency changes result in redeployable resources despite whole-bus adjustments
- Reducing Friday coverage can results in crew regular day-off benefits
- Opportunity for service reinvestment
- Multi-day AFC analytical infrastructure needed

Implementation Issues

- Network impacts?
- Mitigating customer confusion?

  "Next train on Platform 8 will be the Fridays-only Hamptons Reserve service to Montauk, stopping at Westhampton, Hampton Bays… This train will not stop at local stations Babylon to Speonk."
- Scheduling workload? Staff up!
- Validating crew impacts: run-cutting
- Support infrastructure: payroll, paddles, trip planner, reports, etc.

- Anything else you can think of? Please submit a TRR "Discussion" or, better yet, a full paper for TRB 2013!



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Peter Cafiero
Mohammed Maula
Victor Bashmakov
Santosh Kumar
Melissa Chow
Employees of the Long Island Rail Road
TRB's AP010 Transit Management and Performance Committee

Alla V. Reddy
Senior Director, System Data Research,
Division of Operations Planning,
New York City Transit Authority
2 Broadway, Office A17.92
New York, N.Y. 11751-0406
(646) 252-5662
alreddynyct@gmail.com

Alex Lu
Principal Transportation Planner,
New York City Transit Authority
P.O. Box 406,
Islip, N.Y. 11751-0406
(646) 252-5664
lexcie@gmail.com
http://lexciestuff.net/

All photos by the author unless otherwise stated.

A Strategic Look at Friday Exceptions in Weekday Schedules for Urban Transit: Improving Service, Capturing Leisure Markets, and Achieving Cost Savings by Mining Automated Fare Collection Ridership Data—Speaker's Notes

Alex Lu and *Alla Reddy*

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(Slide 2)

- **Basic reason is to accommodate recurring special ridership patterns**
  - Academy Bus from Wall St
  - Monday to Thursday 7 trips, Friday 6 trips, Holidays 4 trips
- **Long Island Rail Road's Montauk Branch—"Beach" Trains**
  - Additional trains on Summer Fridays (and Thursdays)
  - Monday to Wednesday 20 outbound trips, Thursday 21 trips, Friday 24 trips plus one regular train extended to Montauk
  - No bikes on Friday afternoon trains
  - One extra late-morning inbound train on Mondays in peak Summer season
- **Commuter railroad practice in the pre-War era**
  - Example is from Boston & Albany (New York Central System)
  - Work week was Monday to Saturday, with half-day on Saturdays
  - Saturday afternoons have a lunch-time rush-hour
  - "Week Days" schedule with trains shown "Saturdays Excepted"

(Slide 3)

- **Boston MBTA**—Tried Night Owl service 2001-05 on Friday and Saturday nights using bus drivers hired on overtime, to serve students and prevent drunk driving.
- **North County San Diego (Breeze Bus)**—Route 395 serves Camp Pendleton and other military installations. Mon-Thu: 5 trips, Fri-Sun: 14-18 trips.
- **Amtrak**—Trains like the Cardinal runs three times per week. "Beach" trains on Fridays extended to Newport News, Boston, etc. similar to LIRR.
- **Academy Bus**—Buses are full before all pickups are made Monday-Thursday, extra short-trips in timetable to provide capacity relief.
- **Lucky Star**—Unadvertised half-hourly service on Friday and Sunday afternoons, sometimes using rented buses to provide extra capacity, shorten waiting times.
- **Continental**—Like all other airlines, practices day-of-week scheduling.
- **British Rail**—Like other commuter and intercity railroads, have exceptions on Thursday and Fridays for reasons similar to LIRR.
- **Union Pacific**—Three-business-day transit time usually includes two weekend "catch up" days (e.g. Tuesday pm departure doesn't arrive until Monday am). Exception needed once a week because Monday pm departure has no cushion.
- **Plenty of Other Examples**—Metro North, CTA, Boston University Shuttle, New York Waterways, Taiwan Railway, etc.

(Slide 4)

- **Transit in New York City**
  - 5½ million Daily Subway Passengers
  - 3 million Daily Bus Passengers
  - Complex subway and bus routes, multiple bus operators

- **Service Reduction in 2010**
    - Needed financial assistance from State
- **Fridays**
    - Noticeably different ridership patterns
    - Fewer riders
    - Summer Fridays—day-off, half-day
    - Winter Fridays—Jewish must keep sabbath
    - Lots of shopping traffic
    - Payroll timing impact
    - Consideration of 60-75-90 "Holiday Adjusted" schedule for subways

(Slide 5)
Analytical methods used in this paper are standard AFC data analysis and scheduling methods. You have probably all seen this before, so we won't dwell on that too much. Essentially, we start with AFC ridership data. Then we drill down to see if we have a business case for exception scheduling at New York City Transit.

(Slide 6)
Researchers call this "cluster analysis". It asks: which days-of-the-week has ridership closest to each other? It is a systematic way to decide which days should be grouped together for scheduling.

In the peak hours, days 7 & 6 (Sundays and Saturdays) are grouped together for their lower ridership relative to weekdays. Of course, we already knew this; many commuter railroads publish a "weekend" schedule identical for Saturday and Sunday. For the TA, Saturday and Sunday schedules are also not dramatically different.

In the afternoon peak, day 5 (Fridays) has lowest ridership than all other weekdays, followed by days 1 & 4 (Mondays and Thursdays). Days 2 & 3 (Tuesdays and Wednesdays) are peak travel days. Ridership on Friday afternoons is 5%~8% less than midweek average.

Remember that Sesame Street episode, "which one is not like the others?" I would say "F for Fridays" is clearly not like the others, and could use a different schedule. We already knew that, too—private commuter buses and airlines have been using different Fridays schedules for decades. By the way, this lovely "F" Train bear will be yours if you ask the first question about this paper in the Q&A.

(Slide 7)
The graphs here show the times-of-the-day having largest ridership deviations from "midweek" average. On a percentage-basis, Friday middays in Brooklyn are up to 5% busier. Afternoon rush are 10% quieter. Apparently Brooklynites are true party animals because their Friday night ridership is off the charts, more than 20% busier and probably requires extra service.

On the right, the absolute magnitude of ridership change is on the order of several thousands of riders per hour. Scheduling Fridays differently allows us to match service supply to ridership demand much more closely. By the way, we didn't just pick on Brooklyn; in the full paper, charts show the same characteristic "W" shape for every borough except Staten Island.

(Slide 8)
Our express buses serve a different kind of market, daily commuters to and from Manhattan with typically higher income levels. You know, more like Kermit the Frog than Rizzo the Rat.

Most TA express buses originate from Staten Island. They also run with lower average load factors and higher peak-to-base ratios, making it highly leveraged in precisely matching supply to demand.

Friday afternoon ridership is more than 20% lower than midweek. It's probably because commuters take Fridays off, work half-days on Fridays, or hang out in Manhattan on Friday nights. This makes express buses less competitive compared to the Subway or the Staten Island Ferry. Although absolute change is not quite as dramatic, reductions of almost 1,000 passengers per hour could mean operating 20 fewer buses on Fridays.

(Slide 9)
Longitudinal analysis tracks the same farecards over one typical week in March 2011. It tells us that most ridership differences we saw on Fridays came from commuters taking the day off, or leaving work early.

(Slide 10)
The results are encouraging. Differences between Friday and midweek ridership is solid across service groups and boroughs. However, scheduling is ultimately done at the route level. We conducted a Friday ridership differential analysis on 14 representative routes. These routes include all boroughs, route types, and characteristics, covering 14% of system ridership. We will look at four examples. The remainder is discussed in the full paper.

(Slide 11)
The B1 is a crosstown route serving the lower-density multi-family residential part of Brooklyn. It starts from Bay Ridge, runs through Coney Island, and terminates at Kingsborough Community College. Fridays are particularly quiet at all times except late night, reflecting its predominantly feeder ridership, and college class schedules.

The Bronx 12 is also a crosstown feeder connecting Pelham Bay Park with Inwood, but it serves Fordham Road, a heavily travelled urban corridor. Showing the classic "W" shape, Friday lunchtimes are busy with shoppers, whereas rush hours are quieter.

(Slide 12)
These trends are not so significant on Staten Island local routes. Staten Island routes are more community-based and less commuter-centric. They are also low-volume and lower frequency (every 15 minutes). This makes it harder to adjust service frequency.

Overall, Fridays have different ridership on many routes at various time periods. Day-of-week characteristics also differ by route group. The driving factors behind these differences remain inconclusive and are the subject of further research.

(Slide 13)
We wanted to estimate how many buses to add in midday and evenings—top part of the "W"; conversely, how many buses we don't have to run during peak periods—trough of the "W".

We adjusted scheduled service frequencies for each time period based on ridership changes, rounded to the nearest whole bus. This table shows a few routes in the morning peak as example. Some routes showed a net reduction, whereas others did not. In the midday period many showed a net increase.

We converted service frequency changes into vehicle-hours by using standard vehicle cycle calculations. We can't know for sure how many buses we need without actually doing a run-cut, we relied on a planning-level model that allowed us to get ballpark numbers on expected service impacts.

(Slide 14)
We summed Friday vehicle-hours for the 14 routes, and factored it up to the systemwide level. We used two different ways but obtained similar results. Then we used data from the 2010 Service Reductions to estimate our marginal cost of service, and the National Transit Database to estimate our average cost per vehicle-hour. These unit costs were used to determine budget impact of anticipated Friday service adjustments. This amount is equivalent to the total annual operating budget of a small town transit agency—like the Merrimack Valley Regional Transportation Authority in my hometown of Haverhill, Massachusetts.

(Slide 15)
Although we added service midday and evenings, and reduced peak service, the overall impact was a net vehicle-mile reduction of 7.4% on Fridays. This is equivalent to a 1.2% reduction annually, or a 1.5% operating budget increase for Monday through Thursday.

Using unit costs, we estimated budget impacts using four different methods. The methods were in general agreement, yielding $10 to $17 million dollars in operating budget impacts.

This "free money", if you'd like to call it that, could be reinvested in service addbacks for 2010 Service Reductions, or developing new markets where transit assets could be deployed productively. For example, midday express buses to Kingston, Albany, Binghamton, or Ithaca, could be good investments and represent responsible stewardship of operating dollars.

(Slide 16)
Adjusting service levels by day-of-week would necessarily impact operators regular day-offs. We broke out each day and assumed a collective bargaining agreement allowing us to assign a different work program on Fridays, similar to what we do now for Saturday and Sundays. Then we ran an RDO assignment model that covered the work by changing rosters without using day-off reliefs, similar to the LIRR. We made sure that everyone has two consecutive days off in a week.

Fridays would have 7.4% less service, so more Friday-Saturday off jobs became available. Because of how other assignments work out, there would also be more Sunday-Monday off jobs. 340 more jobs would be created with one weekend day off, whereas shifts that operators dislike, with two consecutive weekdays off, would be reduced.

We also ran the model for a typical agency with 480 jobs, equivalent to about a single TA garage. For this sensitivity analysis, we changed levels of Friday scheduled service to see how weekend-inclusive RDOs varied. Reductions in midweek RDOs eventually plateaued at somewheres between 10% and 15%, but there was usually some scope for moving days off in a desirable direction.

This result is potentially important in negotiating a CBA, because it offers something that may improve operators' quality of life by allowing more operators to have one weekend day off.

(Slide 17)
What have we learned? Obviously, an appropriate agreement allowing a distinct Friday schedule type in bidding and picking is a huge part of making this happen. It will allow us to capture the "free money" released by reducing capacity on Fridays where it's not needed.

However, true to its name, a CBA is an agreement that must be bargained for. The management might be expected to offer something in return. More jobs with one weekend day-off might be an incentive. For properties currently operating Friday exceptions using extra board crews, more regular assignments might be positive or negative.

Regardless of how you do it, adding capacity to relieve crowding is good for the customers, and not running near-empty trains when it's not busy is good for the environment. As Kermit the Frog says, and we all know, "it ain't easy being green." It therefore behooves responsible stewards of the service and our environment to get together and hash out operating plans and work rules that are mutually acceptable. Anyway, isn't a CBA just "a mutually agreed upon set of rules by which to assign work?"

Giving more crews time-off on the weekends means they can be with family, rather than working Fridays when the capacity isn't needed anyway. Reducing extra board needed to cover Friday exceptions will improve schedule predictability and work-life balance. The key is to get the issues on the table and talk about it, while making sure that everyone comes away with something and they can live with.

(Slide 18)
There are a bunch of other conclusions, too. Obviously none of this can work without a computerized run-cutting system. We need an analytical system that can deal with multi-day AFC ridership data. Weekday exceptions are actually a pretty normal thing, based on our review of industry practices. Friday exceptions should be publicized so that customers can plan their trips accordingly.

Many factors drive Friday ridership changes; productivity improvements therefore vary substantially by route. Despite concerns about whole-bus adjustments, minor Friday frequency reductions can actually offer sufficient margin for adding service elsewhere. As already discussed, there are RDO benefits relating to crewing.

(Slide 19)
What are some of the implementation issues? There might be network impacts on low frequency systems relying on timed-connections or pulsed schedules; for us, that was Staten Island. The private sector has already figured out how to thin out frequencies without breaking too many timed departures. Let's have a conversation about that with Academy, Suburban, Trans-Bridge, Martz, Peter Pan, or any hub-and-spoke airline. If there are any of you in the audience we'd like to hear from you in the Q&A.

Other than that, we've heard that customer confusion might be an issue. So, what's the industry solution? Make announcements, like this:

"Train on Platform 8 is the 4:25 Fridays only, Fridays only, Hamptons Reserve service to Montauk, stopping at Westhampton, Hampton Bays, Southampton, Bridgehampton, East Hampton, Amagansett, and Montauk. First car only for Amagansett. First stop Westhampton, no local stops. This train will

not stop at local stations Babylon to Speonk. If you're travelling to those stations, please wait for the following train also on Platform 8, the Fridays only 4:28 Babylon-Speonk."

Another issue is scheduling workload and computational capacity. Back when I was a schedule manager for the Glasgow Blue Trains, we used to re-make run cuts, by hand, for engineering works every weekend. A next step would be to actually mock this up for a specific depot so we can validate workload and crewing impacts.

Once the concept is proven, actual deployment would require modification to system support infrastructure, like payroll, paddles, trip planner, etc., etc.

Are there any other issues you can think of? We have a lot of industry experts in this room and we'd like to hear from you. You can submit a "Discussion" to the TRR if we're selected for publication, or better yet, you could submit a full paper for TRB 2013. We'll work with the Committees to make this topic a Call for Papers.

(Slide 20)

Thanks for listening. I'd just like to take a moment to thank all the folks who have helped to make this research not only possible but interesting. In particular I want to thank John Allen of the Chicago RTA for helping me dig up various interesting facts about old schedules, and of course TRB's AP010 Committee whose reviewers' inputs was invaluable. Thank you.