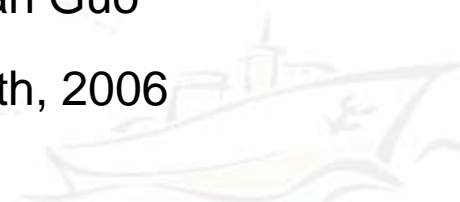


Assessing the Transfer Penalty from Commuter Rail to Subway in Downtown Boston

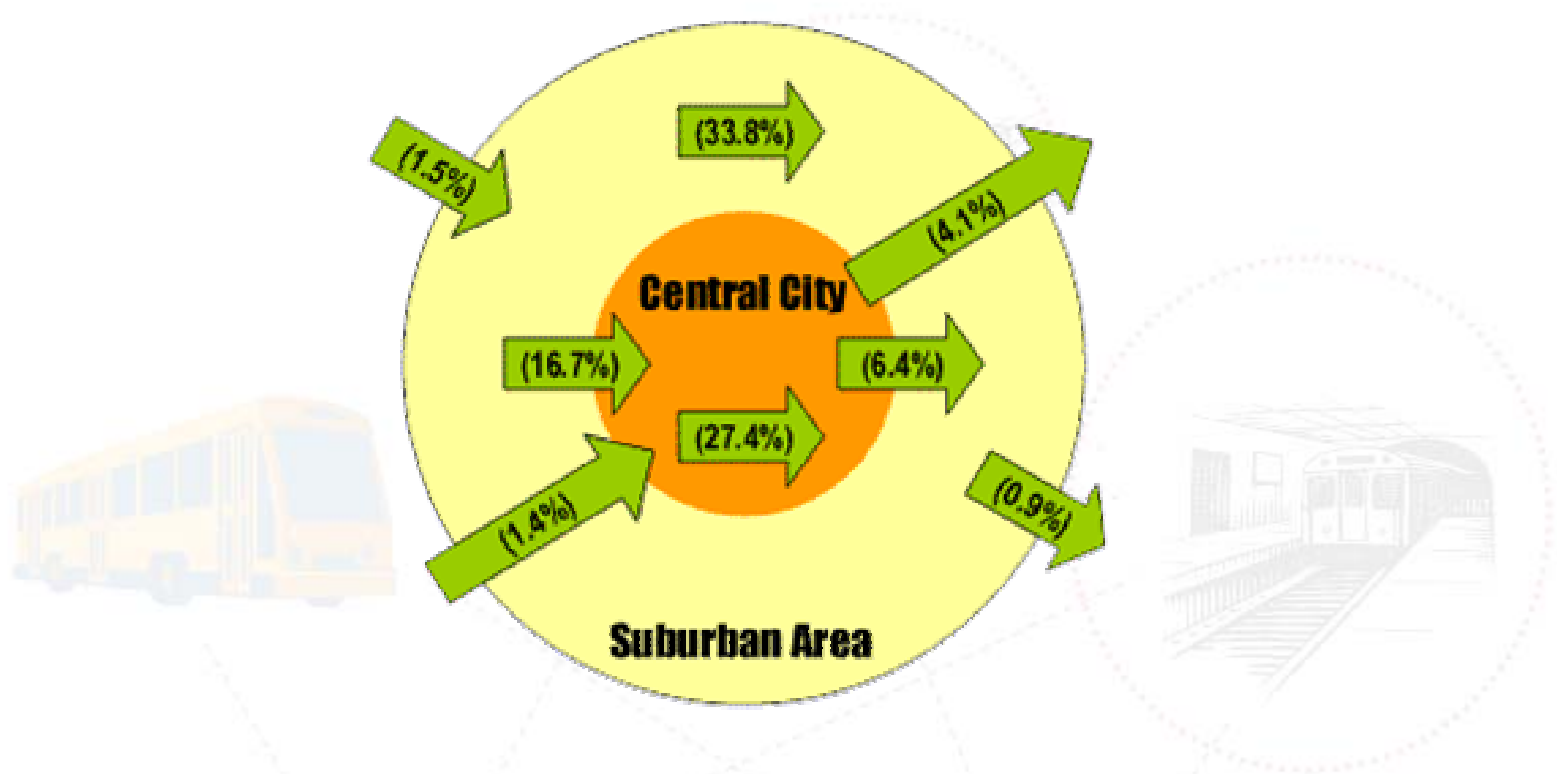


by Zhan Guo

Feb. 10th, 2006

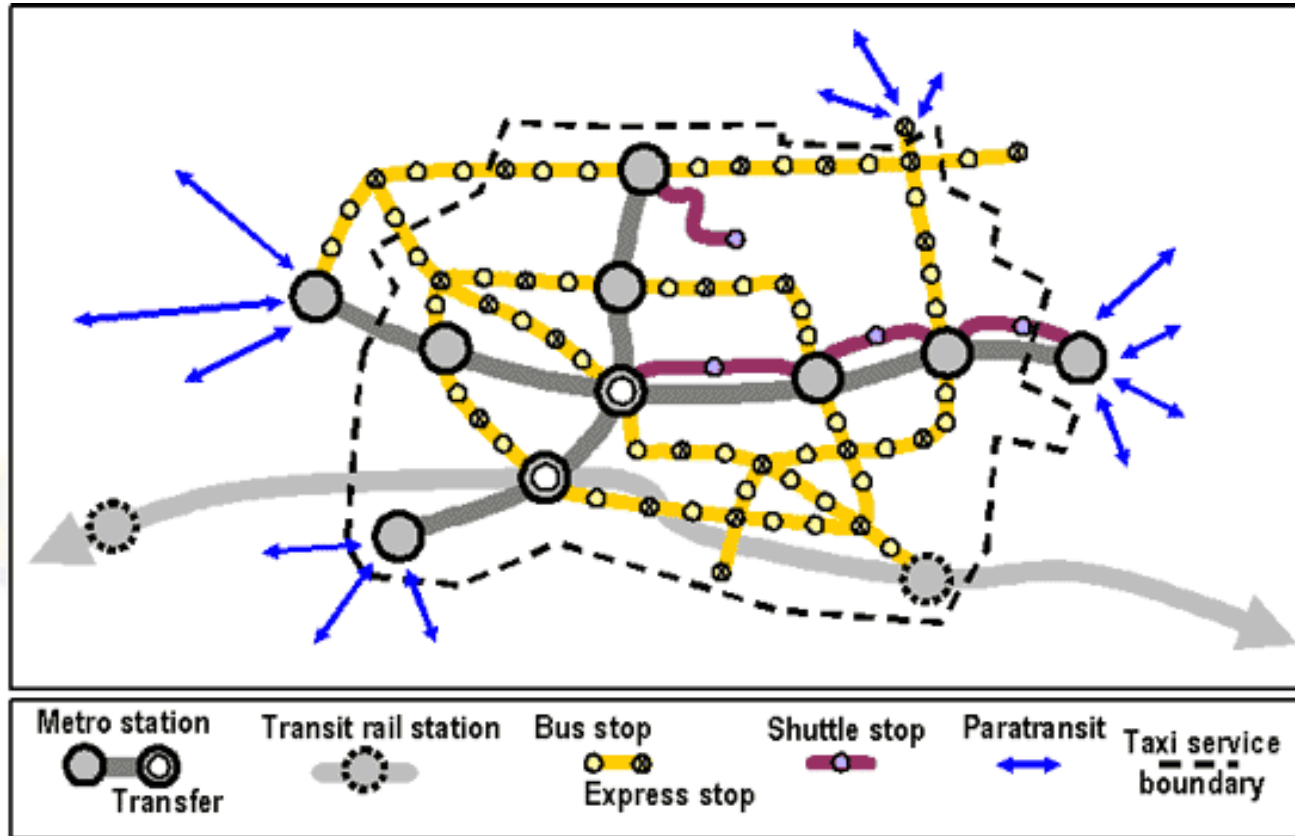


Background: Diverse Travel Demand



- Diverse development patterns in decentralization: edge city, suburban center, office park, growth corridors, industry districts, etc.
- Diverse travel demands: reverse travel, suburban-to-suburban travel, exurban travel, etc.

Background: Diverse Transit Services



- Diverse transit services in metropolitan areas: express bus, dail-a-bus, light rail, paratransit, etc.

Background: Increasing Frequency and Importance of Transfers in Transit Systems

- Increasing rate of transfers in transit systems from **35%** in 1990 to **50%** in 1995 (NPTS 1990, 1995 Surveys).
- Convenient transferring is the top concern of auto drivers to switch to transit (Wardman and Hine, 2000).

| Reason | Commuters | Visitors |
|-------------------------|-----------|----------|
| Convenient Connection | 18 % | 15 % |
| Frequency | 11% | 8 % |
| Car-Use Cost | 9 % | 9 % |
| Transit Fare | 5 % | 9 % |
| Car Availability | 5 % | 6 % |
| Location | 5 % | 5 % |
| Better public transport | 4 % | 2 % |
| Other | 13 % | 13 % |
| Would never switch | 30 % | 33 % |
| Total | 100% | 100% |

← What Would Make Motorists Switch to Transit?

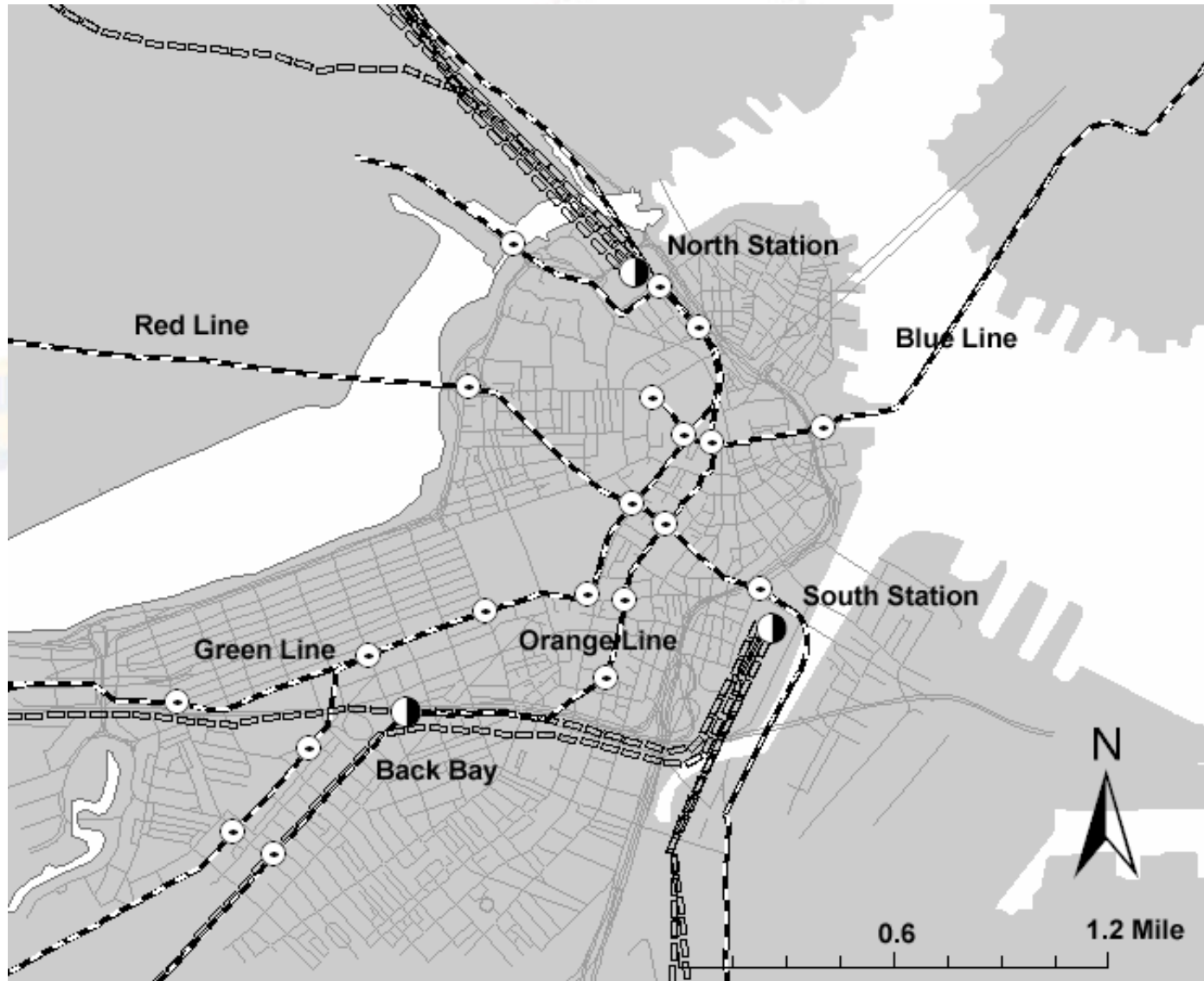
Top Features Most Concern Auto Drivers

| Concerns | Percentage |
|----------------------|------------|
| Service Reliability | 97% |
| Service Frequency | 87% |
| Convenient Transfers | 81% |
| Information | 75%. |

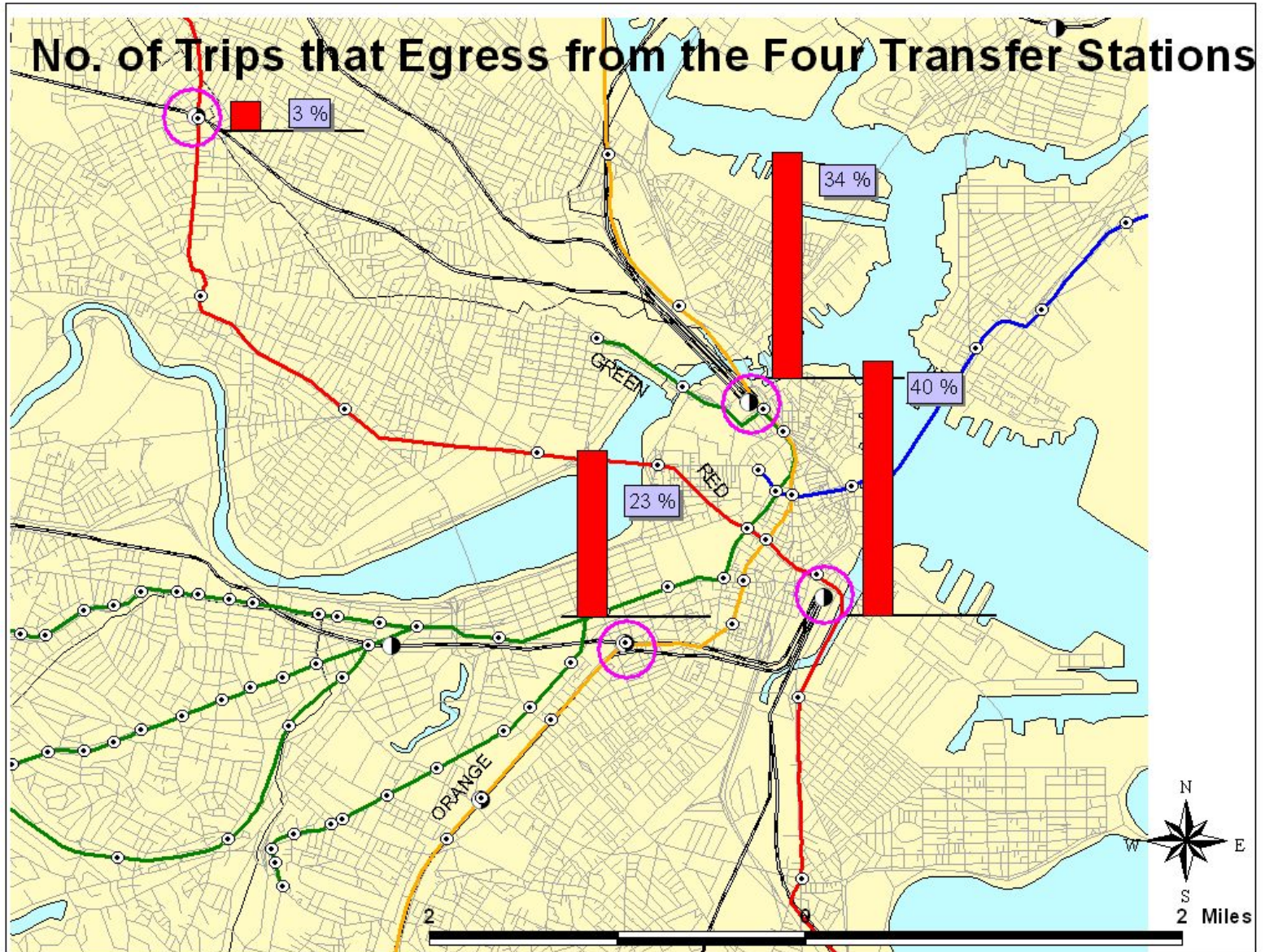
Transfers: Commuter Rail & Subway

- Two major transit services (70% transit ridership in Boston).
- Frequent transfers between the two systems:
33% commuter rail passengers transfer to subway after egress at downtown stations, representing 17% of subway trips ending in downtown (CPTS, 1993)
- The trend might increase as commuter rail has been gaining ridership in the past.
- From 1996-2003, commuter rail in Boston:
ridership share: 8.6% to 10.4%;
PMT share: 36.8% to 42.3%. (APTA, 2005)

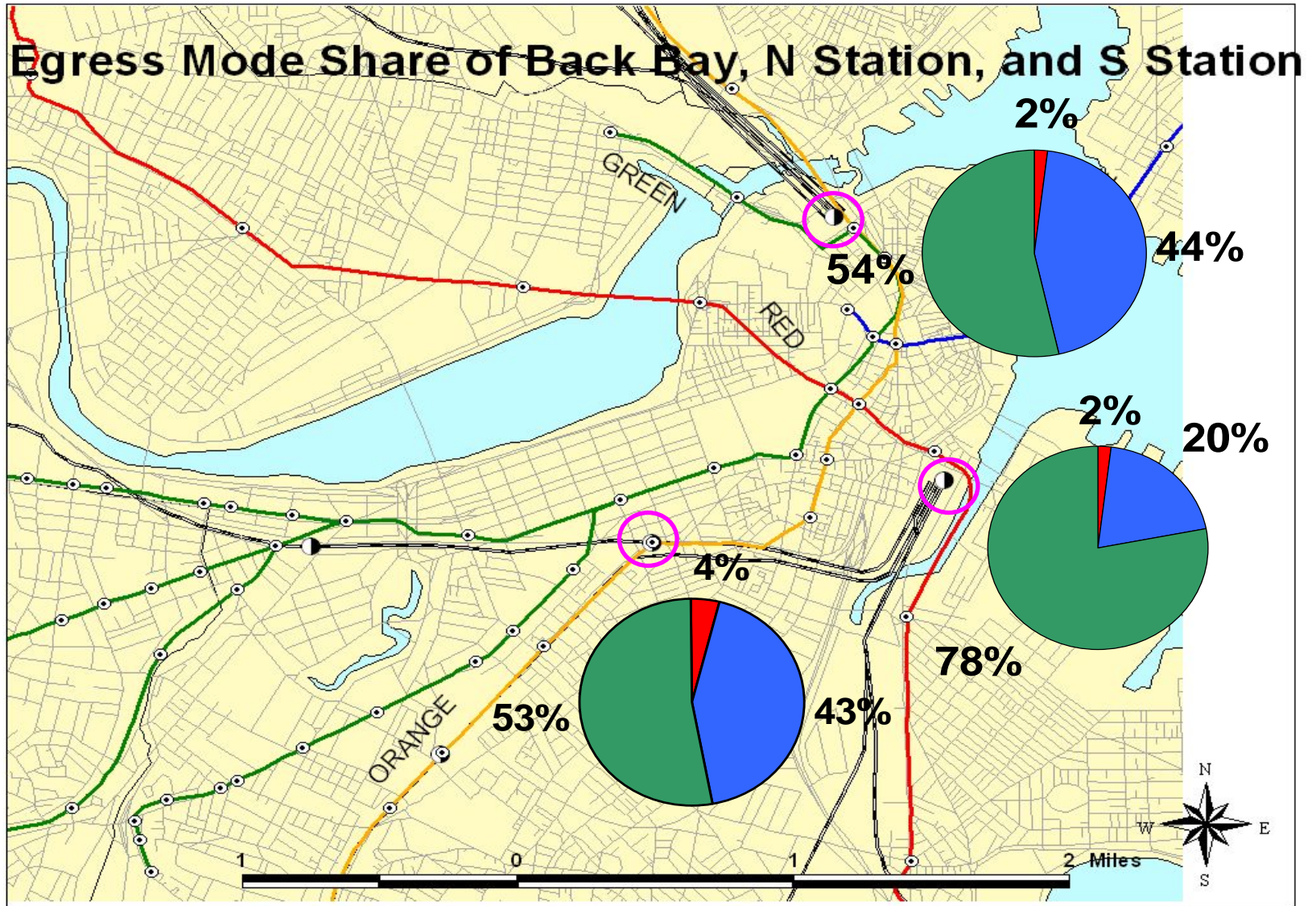
Commuter Rail & Subway Systems



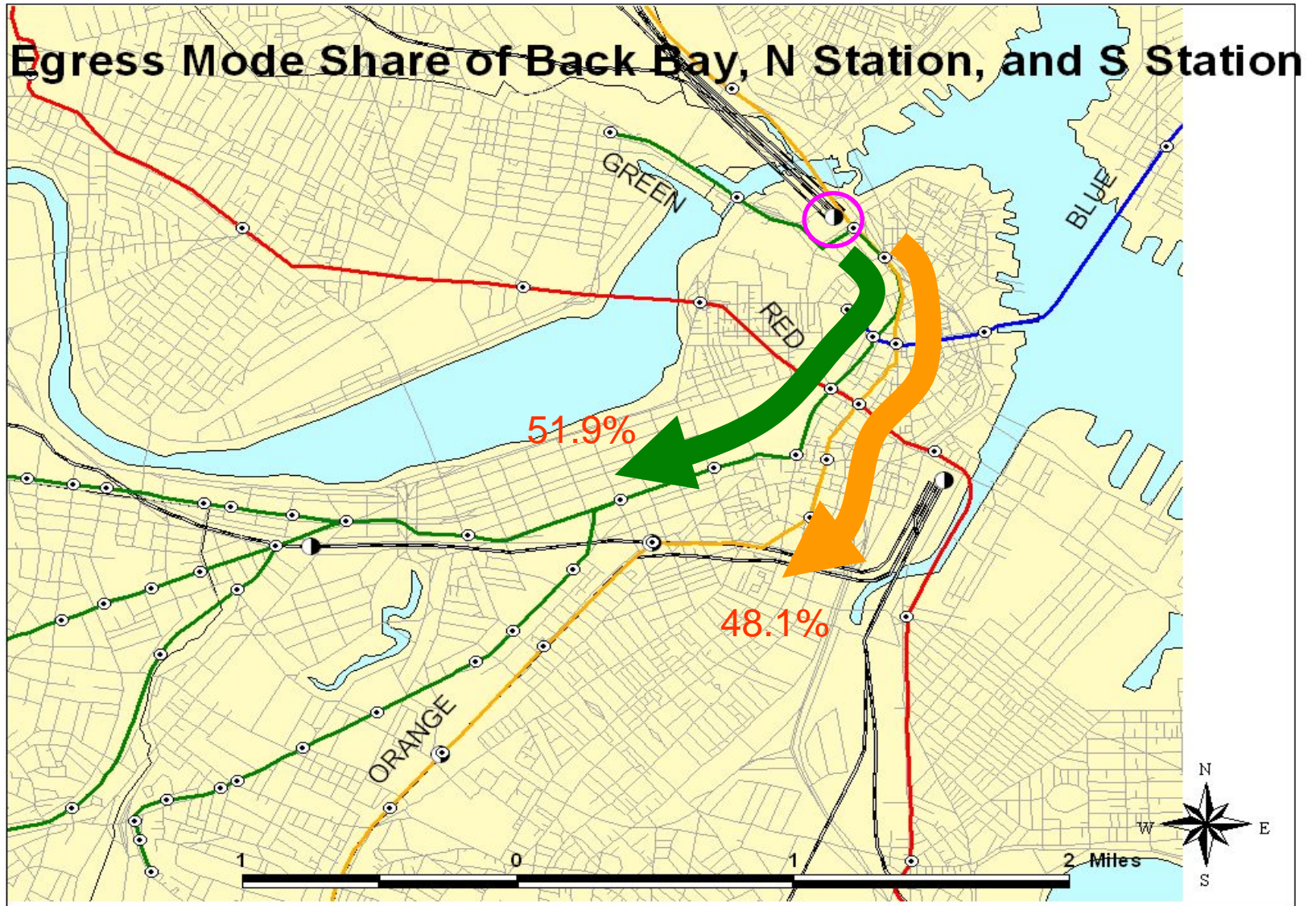
Four Commuter Rail Stations



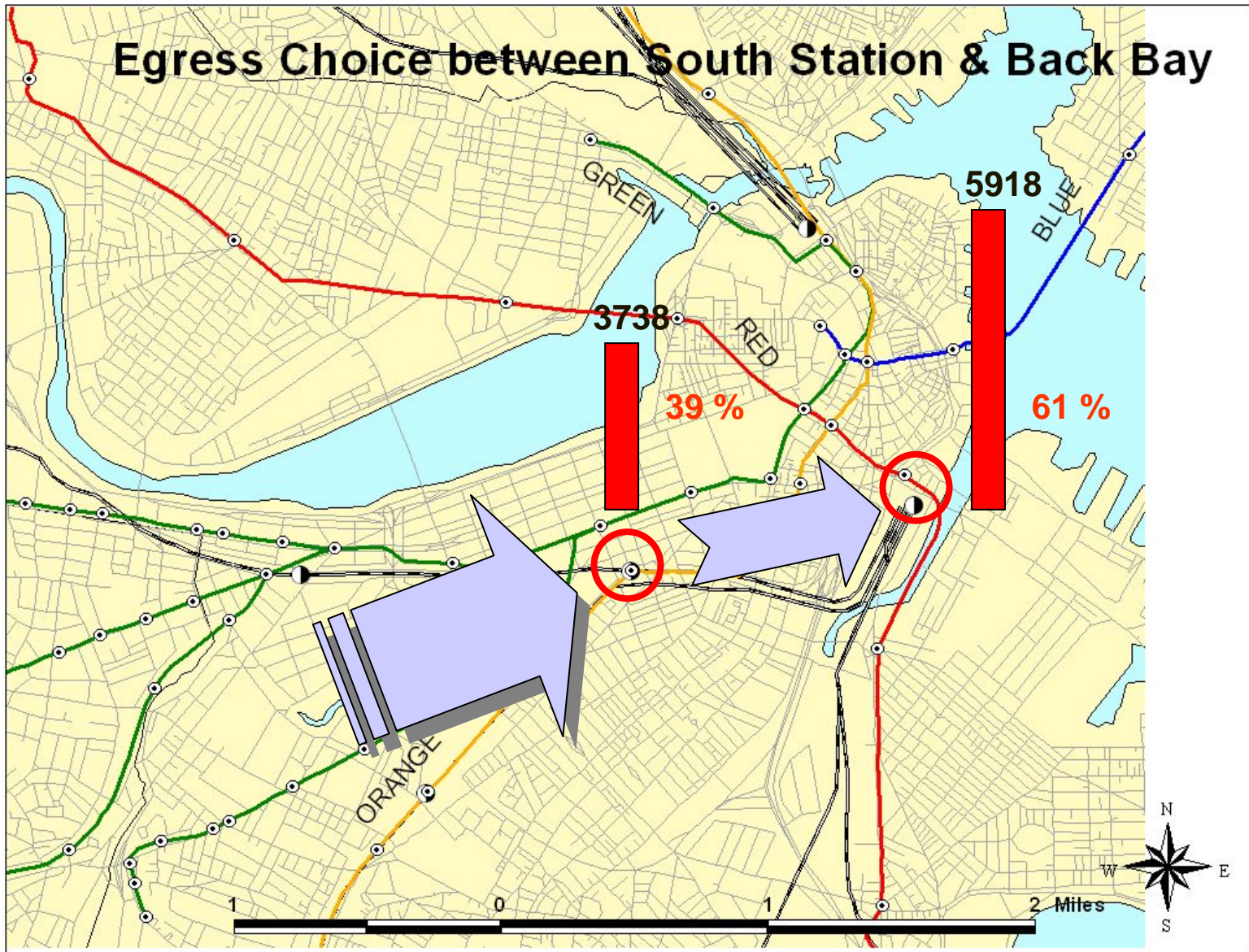
Egress Modes in Three Stations



Path and Transfer Choices From North



Station and Transfer Choices From South

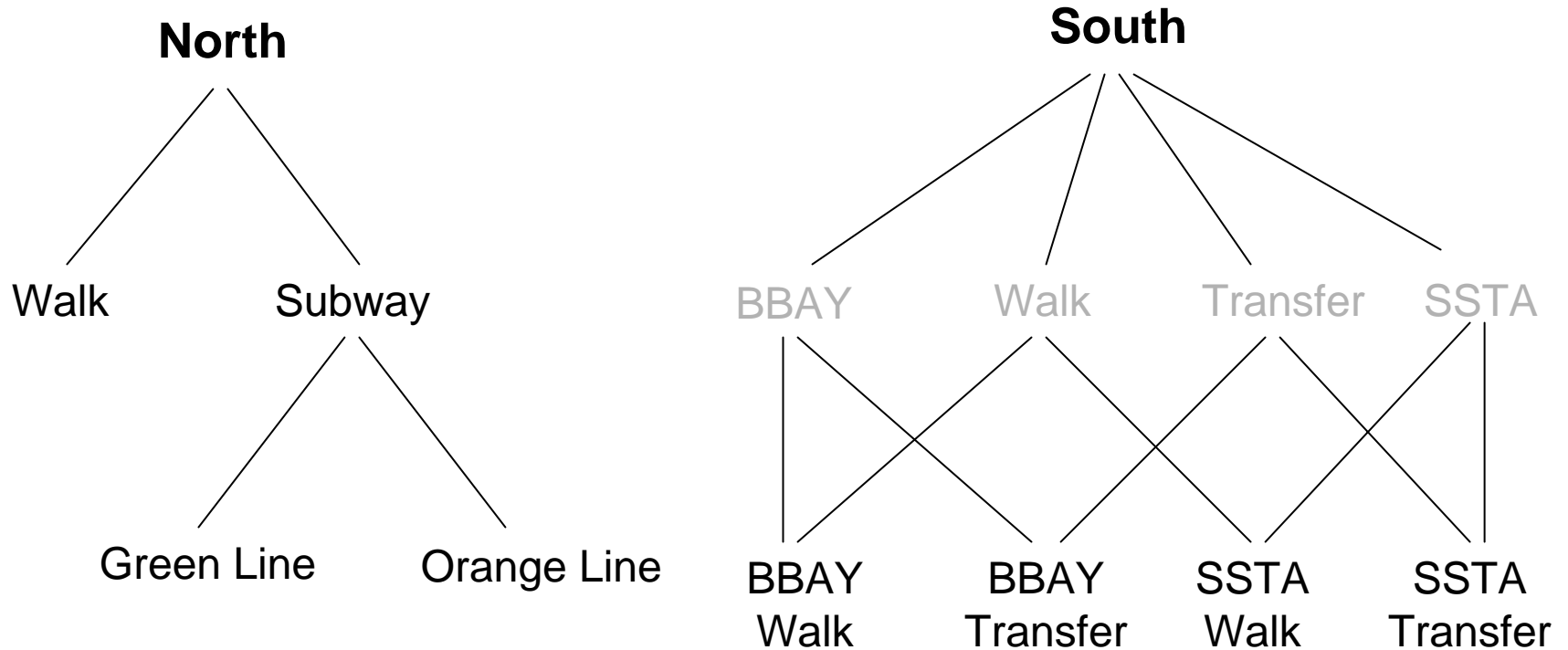


Assessing the Transfer Penalty

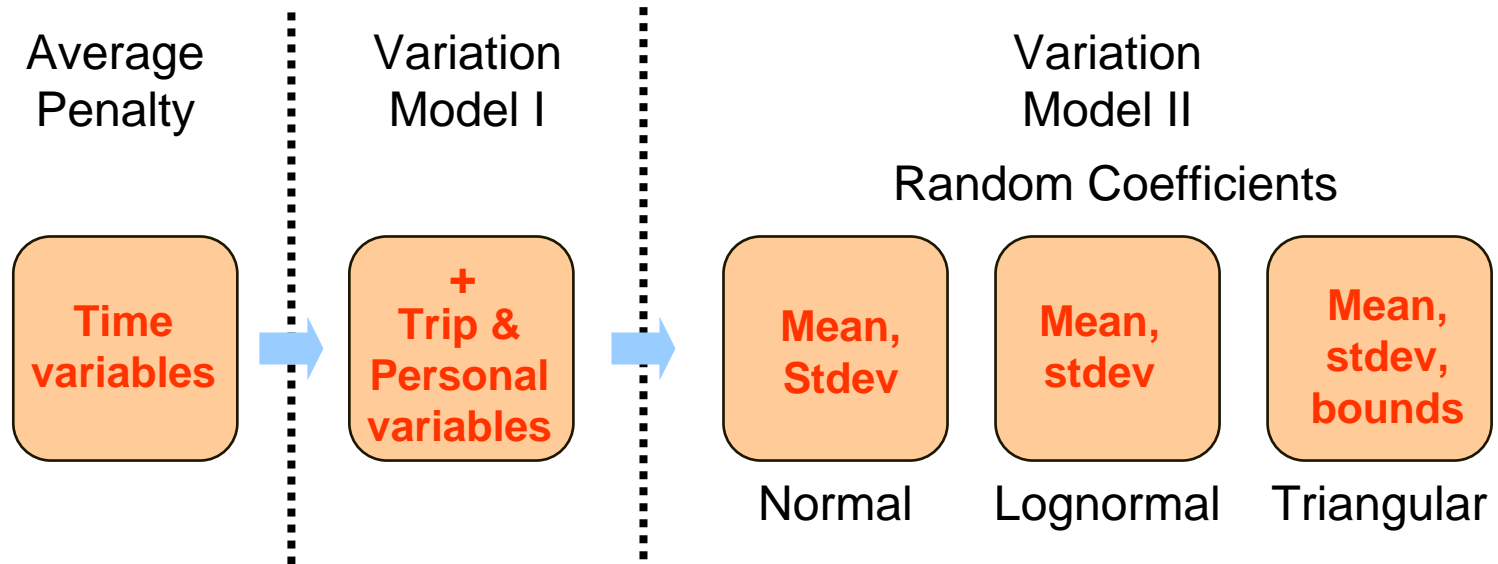
- Average value of the transfer penalty
- Variation of the transfer penalty
Observable sources: station design, service quality, etc.
Unobservable sources: attitudes, preferences, perceptions
- Random coefficients: different distribution assumptions

$$\frac{\beta_{Transfer}}{\beta_{Time/ Cost}} \longrightarrow \frac{f(\mu_{Transfer}, \sigma_{Transfer})}{\beta_{Time/ Cost}}$$
$$\beta_{Transfer} \sim f(\mu, \sigma)$$

Egress Choice Model Structure



Sequence of Model Development



Results: North Commuter Rail

| Variables | | MNL | | MMNL | | |
|---|------------------------------|-----------|-----------|-------------------|----------------------|-----------------------|
| | | Model A | Model B | Model C Normal | Model D Lognormal | Model E Triangular |
| Intercept | | | | | | |
| Green Line | | | | | | |
| Mean: | | -3.45 *** | -4.86 *** | -5.91 *** | -7.00 *** | -5.16 *** |
| Standard Deviation: | | | | 2.41 *** | 3.82 *** | 0.63 *** |
| Orange Line | | -3.36 *** | -4.72 *** | -5.01 *** | -5.00 *** | -4.88 *** |
| Travel Time Attributes (Minutes) | | | | | | |
| Walk Time | | -0.20 *** | -0.21 *** | -0.22 *** | -0.21 *** | -0.20*** |
| In-vehicle Time | | -0.08 *** | -0.07 * | -0.05 | -0.017 | -0.022 |
| Trip & Personal Attributes | | | | | | |
| (specific to walk option) | | | | | | |
| Fare Type: Monthly Pass | | | -0.81 *** | -0.86 *** | -0.86 *** | -0.81 *** |
| Frequent Rider (>=3 days/week) | | | -0.56 * | -0.57 * | -0.60 * | -0.62 *** |
| Reliability Negative (rating=1) | | | -1.08 *** | -1.10 *** | -1.10 * | -1.1 *** |
| Reliability Positive (rating=5) | | | -0.23* | -0.22 * | -0.24 * | -0.23 * |
| Scale | | | | 34.4 | | 3.26 *** |
| Transfer Penalty (minutes of walk) | To Green Line | | | | | |
| | Mean | 17.25 | 23.14 | 26.9 | 33.3 | 25.8 |
| | Standard Deviation | | | 11.0 | 18.2 | 3.15 |
| | Lower Bound | | | -∞ | 0 | 18.1 |
| | Upper Bound | | | +∞ | +∞ | 33.5 |
| | To Orange Line (mean) | 16.80 | 22.48 | 22.8 | 23.8 | 24.4 |
| Adjusted ρ^2 | | 0.299 | 0.321 | 0.328 | 0.327 | 0.321 |

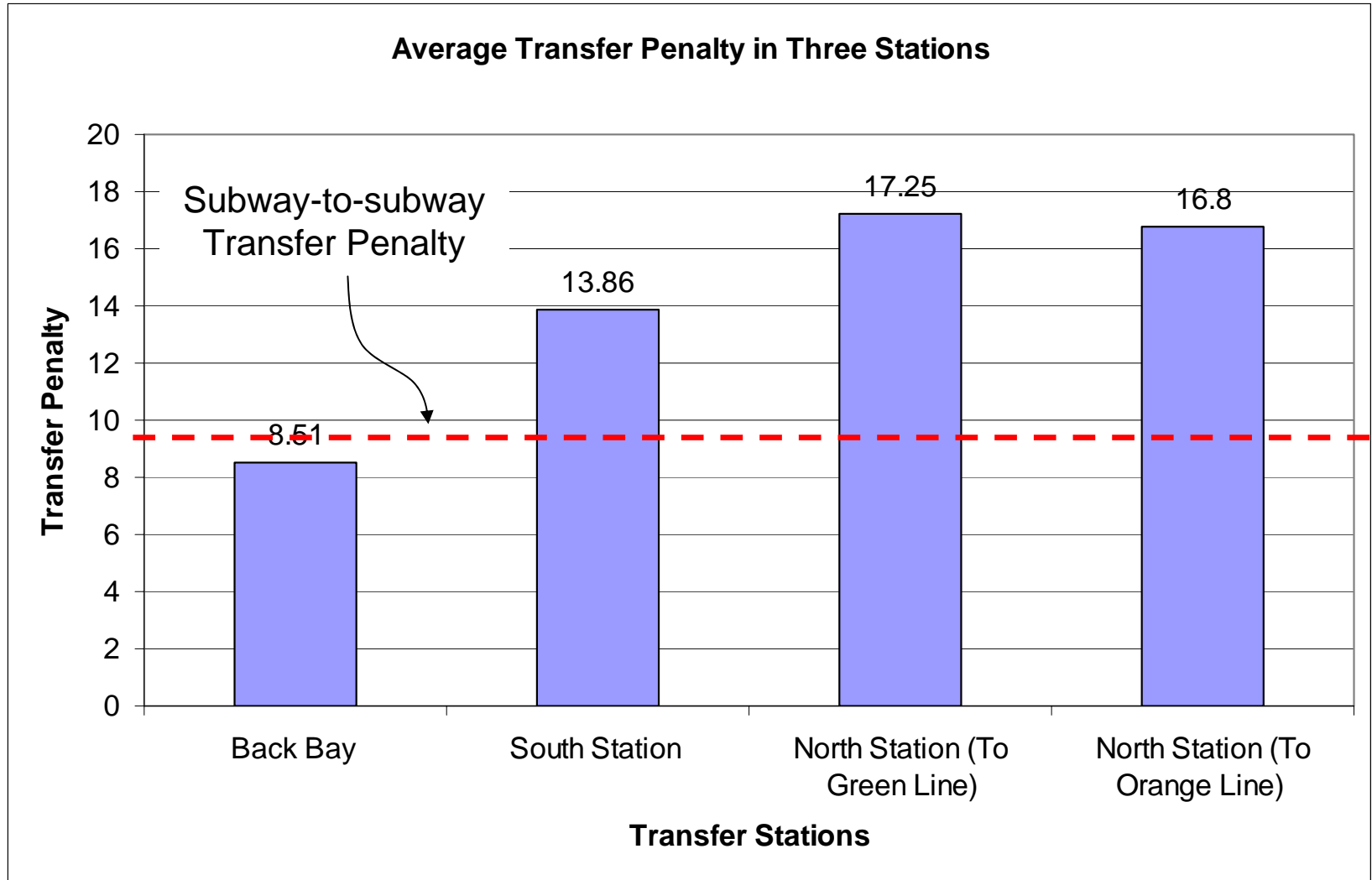
Note. 1. ***: P < 0.001; **: P < 0.05; *: P < 0.1. 2. N=1725

Results: South Commuter Rail

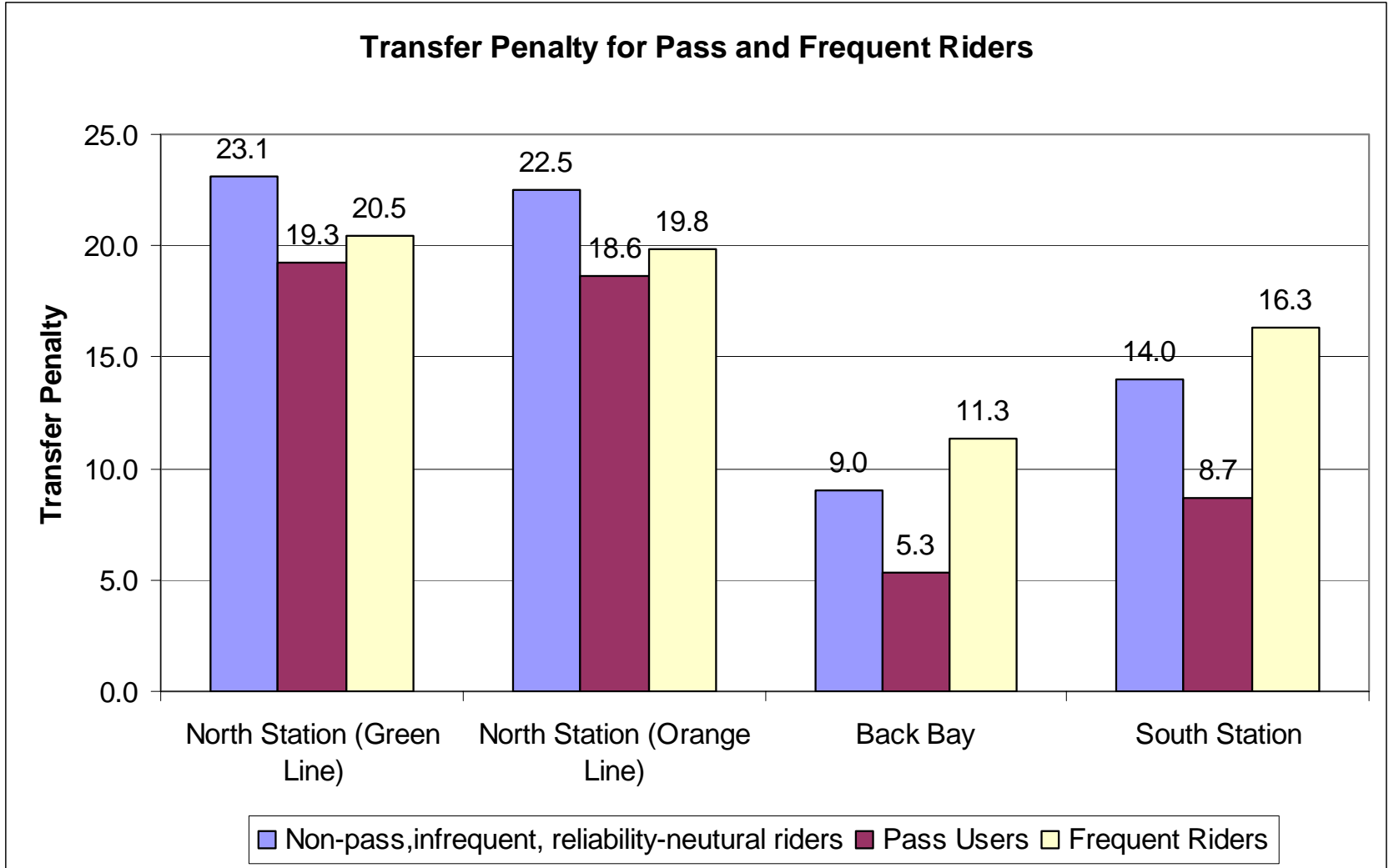
| Variables | | MNL | | MMNL | | |
|--|--------------------|-----------|-----------|-------------------|----------------------|-----------------------|
| | | Model A | Model B | Model C Normal | Model D Lognormal | Model E Triangular |
| Intercept | | | | | | |
| Transfer from Back Bay | | | | | | |
| | Mean | -2.83 *** | -3.01 *** | -3.08*** | -5.23*** | -3.52*** |
| | Standard Deviation | | | -1.46 *** | -4.15*** | -0.685*** |
| Walk from South Station | | | | | | |
| | Mean | -1.05 *** | -1.04 *** | -1.14 *** | -1.24 *** | -1.18 *** |
| Transfer from South Station | | | | | | |
| | Mean | -4.49 *** | -4.69 *** | -4.89 *** | -5.02 *** | -4.96 *** |
| | Standard Deviation | | | -0.002 | 1.005 | 0.016 |
| Travel Time Attributes (Minutes) | | | | | | |
| Walk Time | | | | | | |
| | Mean | -0.33 *** | -0.33 *** | -0.35 *** | -0.36 *** | -0.35 *** |
| Subway In-vehicle Travel Time | | | | | | |
| | Mean | -0.28 *** | 0.29 *** | -0.28 *** | -0.24*** | -0.27*** |
| Trip & Personal Attributes (two walk options) | | | | | | |
| Fare Type: Monthly Pass | | | | | | |
| | Mean | | -1.21 *** | -1.28 *** | -1.33 *** | -1.31 *** |
| Frequent Rider (>=3 days/week) | | | | | | |
| | Mean | | 0.76 ** | 0.82 *** | 1.00 *** | 0.85 *** |
| Reliability Negative (rating=1) | | | | | | |
| | Mean | | -0.51 | -0.53 | -0.52 | -0.54 |
| Reliability Positive (rating=5) | | | | | | |
| | Mean | | 0.04 | 0.05 | 0.06 | 0.05 |
| Implied Transfer Penalty (minutes of walk) | Back Bay Mean | 8.51 | 9.0 | 8.8 | 14.5 | 10.1 |
| | Standard Deviation | | | 4.2 | 11.5 | 1.96 |
| | Lower Bound | | | -∞ | 0 | 5.3 |
| | Upper Bound | | | +∞ | +∞ | 14.8 |
| | South Station Mean | 13.86 | 14.0 | 14.0 | 13.9 | 14.2 |
| | Standard Deviation | | | 0.0 | 0.0 | 0.016 |
| | Lower Bound | | | -∞ | 0 | 14.1 |
| | Upper Bound | | | +∞ | +∞ | 14.3 |
| Adjusted ρ^2 | | 0.498 | 0.511 | 0.512 | 0.513 | 0.512 |

Note.1. ***: P < 0.001; **: P < 0.05; *: P < 0.1. 2. N=1560

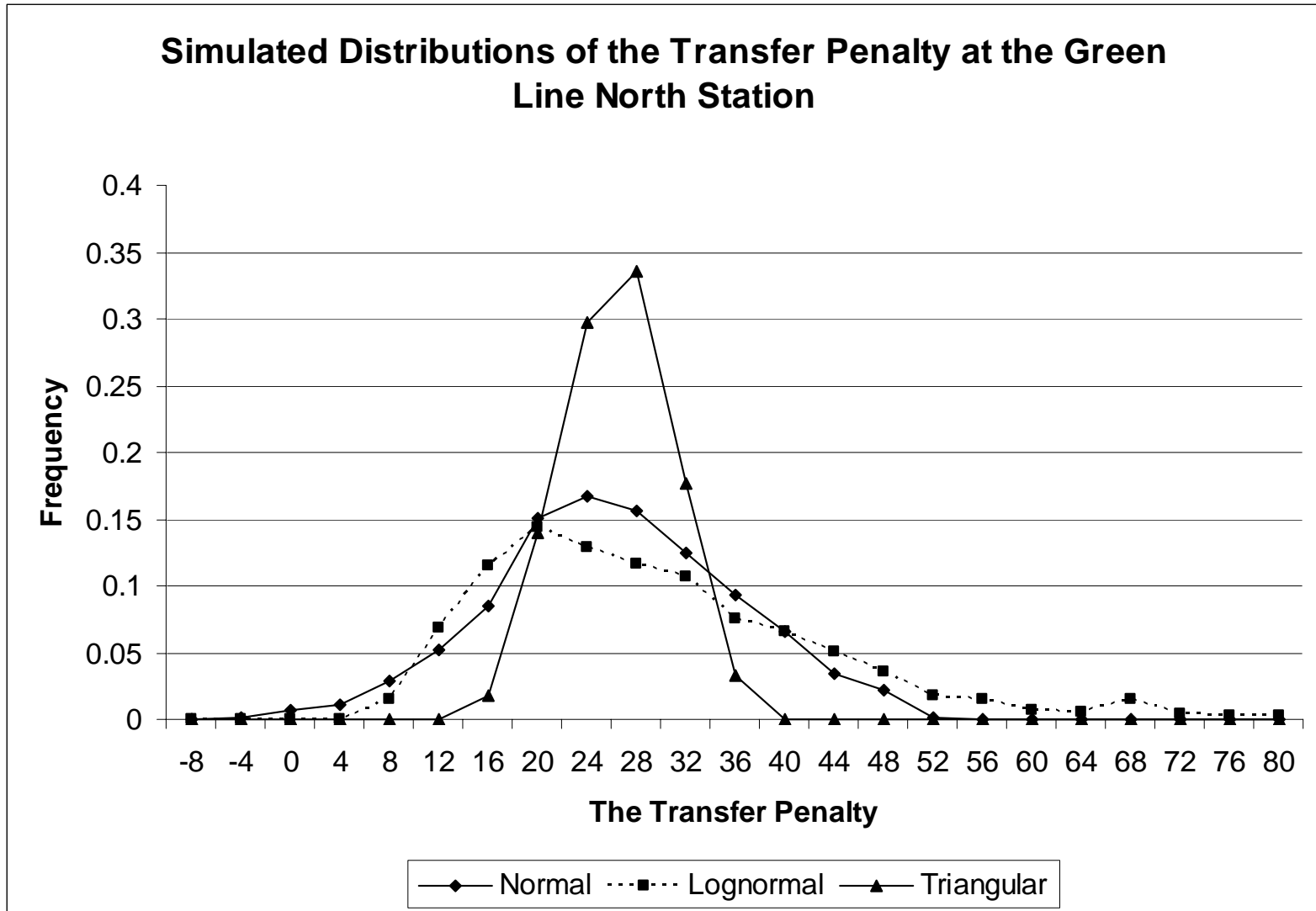
Transfer Penalties Across Stations



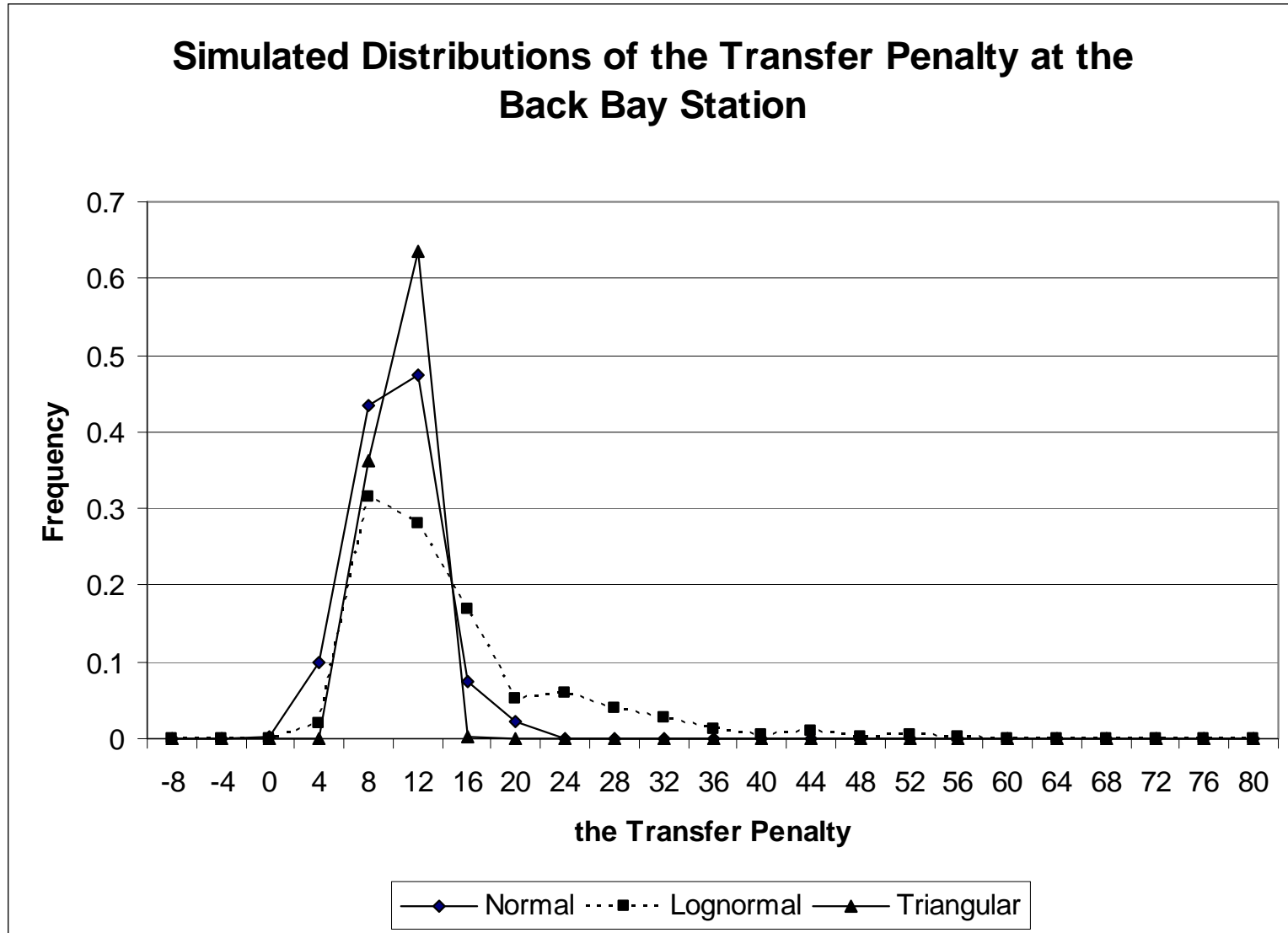
Transfer Penalties Across Rider Groups



Transfer Penalties Across Individuals I



Transfer Penalties Across Individuals II



Conclusion on the Variation of the Transfer Penalty

- The distribution of the transfer penalty is not widely spread
- The standard deviations of the transfer penalty are much smaller than the differences of the average transfer penalties among different transfer stations and demographic groups
- The variation of the transfer penalty originates more from the observable factors such as service quality, station design, and demographic characteristics, less from the unobservable attitudes, preferences, and perceptions of passengers

Thank You!

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