Impact Analysis of the 2007 MBTA Fare Increase and Restructuring

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EXECUTIVE SUMMARY

Some of the technical terms that are used in this summary without explanation are explained in the course of the discussions in the main body of this report.

In January 2007, the MBTA raised fares to meet a projected budget deficit and raise approximately $70 million in additional annual revenue. A Pre-Fare Increase Impacts Analysis model was developed to project the ridership and revenue implications of any fare change. Also included in the model were functions to estimate the effects of certain changes to the fare structure. The Pre-Fare Increase Impacts Analysis estimated that the combined effect of the proposed fare increases and structural changes would be a 5.0 percent decline in annual unlinked trips and a 21.2 percent increase in annual revenue.

The Post-Fare Increase Impacts Analysis was intended, in part, to test these projections. Assisting with the analysis was the full implementation of automated fare-collection (AFC) technology throughout the MBTA's core local bus and rapid transit system. Although the data from AFC still needed some adjustments to account for in-station transfers, flash pass activity, and fare evasion, the extent of the data, and the ability to disaggregate it by mode, fare type (single-ride or pass), and fare media (CharlieCard, CharlieTicket, or cash onboard), provided a significant improvement over the old revenue-based ridership estimation methodology.

When ridership and revenue from all the various categories were summed for calendar year 2007, total unlinked trips were estimated to have decreased by 9.5 percent. Annual revenue was estimated to have increased by 23.0 percent. While the model appears to have slightly underestimated the negative and positive effects on ridership and revenue, respectively, this was not consistent across all modes and fare types. Generally within the core system, the model underestimated the loss in pass ridership more than the loss in single-ride ridership. This was particularly the case for surface Green Line ridership. Outside the core system, on commuter rail and ferry services, the situation was reversed, with the model underestimating the negative ridership impact on single-ride trips.

At the heart of the underestimation of the ridership loss were elasticities that, upon analysis of the actual responses to the fare increase, appear to be too inelastic. Whereas the model in the Pre-Fare Increase Impacts Analysis generally assumed elasticities between -0.20 and -0.30 for single-ride trips and between -0.15 and -0.25 for pass trips, the demonstrated elasticities were much less concentrated. The surface Green Line and commuter rail single-ride elasticities were much more elastic than what the model assumed, thus leading to ridership losses greater than the model's projections. Similarly, demonstrated pass elasticities in the core system were all much more elastic than those used in the model. In addition to elasticity inputs, ridership diversion factors were used in the Pre-Fare Increase Impacts Analysis to project ridership changes. These factors estimate the shift in trips between ridership categories, for example from single-ride to pass or from local bus to rapid transit. While it is not possible to directly estimate these factors for the Post-Fare Increase Impacts Analysis, we have made certain assumptions and noted the relative ridership changes in the single-ride versus pass categories, and it seems likely that the actual scale of diversion is greater than what was modeled.

AFC technology dramatically facilitates the analysis of various ridership characteristics. For example, it is now possible to chart total ridership, or ridership broken down by any category such as mode or fare type, over time. In 2007, ridership appears to have dropped in the first two months but then risen (though not to pre-increase levels) and stayed relatively constant throughout the remainder of the year. Over this time, pass ridership had greater variability than single-ride ridership. Sales of the LinkPass in particular reflect this variability; sales of the other major passes stayed constant or increased at a constant rate. The penetration of CharlieCards increased throughout 2007, as the proportion of trips made using a CharlieCard grew from 56 percent in January 2007 to 67 percent in December 2007. Single-ride and pass unlinked trips can also be broken down. For single-ride trips, adult fares composed the majority of trips for all modes, but short fares and transfers together accounted for 30 percent on bus. For pass trips, more trips were taken on LinkPasses than any other pass. Even on buses, the LinkPass was responsible for 48 percent of trips, compared to 20 percent for the Local Bus Pass. On surface rapid transit, 77 percent of pass trips were taken using a LinkPass. Surface rapid transit also had the highest percentage of CharlieCard trips. Analyses such as these using AFC data can be conducted down to the station or route level as well.

The adoption of AFC technology along with significant changes to the fare structure heralded an entirely new way for many customers not only to pay their fare but also to think about how to take their trip. With lower per-ride fares for trips taken with a CharlieCard, the introduction of the LinkPass, and transfer discounts for CharlieCard holders, the MBTA is encouraging customers to consider the entire system when deciding on their trip. AFC technology is also enhancing planning at the MBTA. Through the detailed transaction data that AFC equipment provides by route, station, fare type, or fare media, the MBTA can better understand rider characteristics and use this understanding in its planning efforts. Indeed, this Post-Fare Increase Impacts Analysis is likely to be one of many reports to come that draw heavily on AFC data.

INTRODUCTION

This study, herein referred to as the "Post-Fare Increase Impacts Analysis," has several purposes. The first is to estimate the ridership and revenue impacts of the January 2007 MBTA fare increase and restructuring. A second purpose is to compare these impacts to those projected by a 2006 study (documented in the technical report entitled *Impact Analysis of a Potential MBTA Fare Increase and Restructuring in 2007*) herein referred to as the "Pre-Fare Increase Impacts Analysis." This comparison concerns not only the aggregate ridership and revenue impacts of the fare increase and restructuring, but also some of the inputs traditionally used to estimate those impacts in advance. Specifically, elasticity, ridership diversion factors, and pass-ride values were used in the Pre-Fare Increase Impacts Analysis to estimate the effect of individual and relative price changes for different fare types. The Post-Fare Increase Impacts Analysis will derive these factors based on actual ridership changes and compare them to those used to make the projections.

This report is also intended to assist the MBTA in its determination of the preferable method for estimating ridership, whether for reporting annual modal ridership to the National Transit Database (NTD) or for internal understanding of ridership trends. Before automated fare collection (AFC), the MBTA relied on a revenue-based ridership estimation methodology. In addition to collecting AFC data for 2007, therefore, CTPS also continued to conduct the surveys used in the revenue-based methodology and produced estimates of 2007 ridership using that methodology. In this report, those estimates will be compared to the data from AFC. The MBTA will undoubtedly make greater use of AFC technology and reports in the future; however, a comparison of the ridership estimates of the two approaches may assist the MBTA in better understanding its past ridership estimates in light of the current technology.

Finally, AFC offers a wealth of data on the choices that MBTA riders make on a daily basis. This data extends into where and at what time riders generally travel, as well as the method of payment that they choose to use for these trips. The final section of the Post-Fare Increase Impacts Analysis will therefore summarize and report on various ridership trends and characteristics in 2007 as indicated by AFC. In this report, "2007" refers to calendar year 2007, unless stated otherwise.

SUMMARY OF THE PRE-FARE INCREASE IMPACTS ANALYSIS

CTPS conducted a Pre-Fare Increase Impacts Analysis to assist MBTA staff and the MBTA Board of Directors in estimating the impacts of the proposed 2007 fare increase and restructuring on ridership and revenue. This section of the Post-Fare Increase Impacts Analysis revisits the rationale for changing the fare structure. It also describes the methodologies used to project ridership and revenue changes and the inputs used in those methodologies. These ridership and revenue projections will be compared to the actual 2007 ridership and revenue figures, which are presented later in this report.

Description of and Rationale for the Fare Restructuring

The Rider Oversight Committee was established in response to the previous MBTA fare increase in 2004 to better incorporate the public and advocacy voices into the planning process. At its inception, the committee was specifically charged with reviewing the existing fare structure and, should it have any suggestions for change, discussing those suggestions with the MBTA. Many of the features implemented in the new fare structure are the result of this process.

The principal characteristics of the proposed fare structure are as follows:

- Flat fares by mode for all local bus and rapid transit trips and a reduction of express bus fare zones to two
- A “step-up” transfer privilege between local bus, rapid transit, and express bus whereby the transfer price equals the “step-up,” or difference, in price from a lower-priced mode to a higher-priced mode, such that the customer never pays any more than the fare of the higher-priced mode for the entire linked trip
- The merging of the Subway and Combo Pass categories
- Single-ride fare surcharges on trips not made with the new CharlieCard technology

There are several reasons why the Rider Oversight Committee and the MBTA decided on these changes to the fare structure. The new flat fare by mode with simple “step-up” transfer privileges between local bus, rapid transit, and express bus responds to the MBTA’s enabling legislation, which requires the Authority to adopt a fare policy that provides for free or substantially reduced-rate bus-rail transfers on the system.[1] Indeed, by instituting the “step-up” transfer, the MBTA can ensure that basic transit mobility is priced the same for those who live within walking distance of a rapid transit line and those who must take a bus to access that line. Whereas previously a local bus–rapid transit transfer trip would generally cost $2.15 (and even more if the trip was made on a zoned-local bus or through an extra-fare station on the rapid transit system), the new maximum fare actually decreased to $1.70. This logic also applies to the merging of the Subway and Combo Pass categories. Whereas the Combo Pass price was $71.00, the new merged LinkPass price is $59.00.

[1] MGL Chapter 161A, Section 5(r).

There was also a compelling business interest in implementing this major fare restructuring requested by the Rider Oversight Committee at the same time as the institution of the AFC system. The restructuring eliminated more than a dozen anomalies in the fare structure that were the product of various political and operating considerations over the years – many of which had little ongoing justification. It was expected that these changes would attract potential customers who were unfamiliar with the transit system and intimidated by the complicated fare structure. The installation of AFC equipment also permitted the adoption of the "step-up" transfer privilege. This was intended to lower the cost of bus-rapid transit transfer trips and thus encourage more customers to make better use of the entire MBTA system. Finally, in the interest of encouraging customers to use the CharlieCard, which is the most efficient mode of payment using AFC, the MBTA assessed a surcharge on all single-ride trips that are not made using this fare-payment media. In addition, the step-up transfer privilege was only offered to CharlieCard customers.

Estimation Methods Used

Two separate approaches were used by CTPS in attempting to project the impact on MBTA ridership and revenue. The first approach consisted of applying the regional travel demand model of the Boston Region Metropolitan Planning Organization (MPO) to forecast demand for each MBTA mode with the previous and increased fare levels. The second approach used a set of spreadsheets originally created by CTPS and the MBTA to project impacts. In the past, CTPS had used solely a spreadsheet-based approach to compute ridership and revenue impacts. The regional travel demand model was employed in this fare impacts analysis to complement the spreadsheet model, with the two models together providing some indication of the potential range of impacts that could be expected. The Pre-Fare Increase Impacts Analysis presents a detailed description of the two separate approaches.

While aggregate modal results from the Post-Fare Increase Impacts Analysis will be compared against figures from both the spreadsheet model and travel demand model, more detailed data, in terms of more specific modal categories as well as specific fare media (CharlieCard, CharlieTicket, or cash onboard) and fare type (single-ride fare or pass type) categories, is only available with the spreadsheet approach. Therefore, for purposes of more detailed comparisons between the Pre- and Post-Fare Increase Impacts Analyses, the spreadsheet model approach will be used.

One additional reason for using the spreadsheet model as the basis for comparison lies with that model's use of price elasticity and diversion factors in its projection of ridership changes. These factors are also subject to comparison in this analysis. With data on the actual ridership and price changes for various modal and fare categories, CTPS can estimate the actual price elasticities and assume the extent of ridership diversion that occurred due to the fare increase. A detailed description of price elasticity and ridership diversion is presented in the Pre-Fare Increase Impacts Analysis; however, a basic explanation of the factors is given below. As described in the Pre-Fare Increase Impacts Analysis, these factors were taken from studies of the experiences of peer agencies.

Price elasticity is the measure of the rate of change in demand relative to a change in price if all other factors remain constant. Price elasticities are generally expected to be negative, meaning that a positive price increase will lead to a decrease in demand (with a price decrease having the opposite effect). As the absolute value of the price elasticity increases, the projected impact on demand also grows. Larger (or more negative) price elasticities are said to be relatively “elastic,” while smaller negative values closer to zero are said to be relatively “inelastic.” Thus, if the price elasticity of the demand for transit is assumed to be elastic, a given fare increase would cause a greater loss of ridership than if demand were assumed to be inelastic.

The price elasticities used to project ridership changes in the spreadsheet model are presented in Table 1. As shown in the table, the bus mode was generally assumed to be the most elastic or responsive to price changes. Rapid transit was assumed to be slightly less elastic, with commuter rail and water transportation assumed to be even less elastic. Pass elasticities were assumed to be slightly more inelastic than cash elasticities, and ridership was expected to respond more dramatically to price decreases than price increases.

TABLE 1
Price Elasticities Used in Spreadsheet Model

	Price Increase	Price Decrease
Cash Elasticities		
Bus	-0.30	-0.40
Subway	-0.25	-0.35
Combo	-0.25	-0.35
Commuter Rail	-0.20	-0.30
Water	-0.20	-0.30
The RIDE	-0.05	-0.05
Pass Elasticities		
Bus	-0.25	-0.35
Subway	-0.20	-0.30
Combo	-0.20	-0.20
Commuter Rail	-0.15	-0.25
Water	-0.15	-0.25

Diversion factors reflect estimates of the likelihood of a switch in demand for one good to another that is related to the change in the relative prices of those goods. These factors are always given as pairs, with the direction of the diversion and thus the diversion factor values depending on the categories’ respective price changes. The category with the greater respective price decrease (or the smaller respective price increase) would gain riders from the diversion while the category with the smaller respective price decrease (or the greater respective price increase) would lose riders from the diversion. The diversion factors essentially work to redistribute demand between the two categories after the respective price elasticities have been applied. The factor itself represents the ratio of the estimated actual diversions to the estimated potential diversions. Actual diversions equal the difference between the total ridership change and the change in ridership caused solely by price elasticity. Potential diversions equal the percentage change in the relative price ratio multiplied by the ridership caused solely by price elasticity. In other words, the ridership diversion factor can be explained as the percent of potential diversions that actually do switch from one good to another.

The diversion factors that were used in the Pre-Fare Increase Impacts Analysis to estimate the diversion of ridership from one modal or fare type category to another due to the relative price changes in the two categories are presented in Table 2. As shown in the table, the subway single-ride mode was modeled to lose a slightly higher rate of riders to the bus single-ride mode than vice-versa, given the relative price changes. Diversion between various pass types was assumed to be much lower. The largest diversion factors were assumed to occur from single-ride customers switching to passes.

TABLE 2
Diversion Factors Used in Spreadsheet Model

	To Bus	*To* Subway	*To* Combo
Modal Diversion			
SR*			
From Bus	-	0.019	0.017
From Subway	0.022	-	0.003
From Combo	0.017	0.003	-
Pass			
From Bus	-	<0.001	0.005
From Subway	<0.001	-	0.001
From Combo	0.005	0.001	-
Fare Type Diversion	*To* Bus Pass	*To* Subway Pass	*To* Combo Pass
From Bus SR*	0.050	-	-
From Subway SR*	-	0.050	-
From Combo SR*	-	-	0.050

**SR: Single-Ride*

Projections of Revenue and Unlinked Trips

The Pre-Fare Increase Impacts Analysis projected the absolute and percentage changes in annual ridership and revenue by mode. The projections made by the spreadsheet model are presented in Tables 3 and 4. The impacts of the fare increase and restructuring on revenue and unlinked trips[2] in the core system,[3] as shown in Table 3, were generally modeled to be greater for single-ride compared to pass customers. The surcharge placed on non-CharlieCard fares, the elimination of free outbound fares on all surface rapid

[2] Linked trips represent the number of riders, while unlinked trips represent the number of trips on individual transit vehicles. For example, a trip involving a transfer from bus to rapid transit or between rapid transit lines is one linked trip, but two unlinked trips.
[3] The core system is composed of the following modal categories: rapid transit and Central Subway (Blue, Orange, and Red Lines and subway Green Line), surface Green Line, and bus and trackless trolley. The non-core system is composed of express bus, commuter rail, ferry services, and The RIDE.

transit lines, a smaller overall percentage increase in pass prices, and the larger elasticities of single-ride versus pass customers were expected to be some of the major causes of the greater impact on core single-ride trips.

TABLE 3
Core System Revenue and Ridership:
Projected Percent Changes

	% Change Revenue		% Change Ridership	
Mode	Single-Ride	Pass	Single-Ride	Pass
Rapid Transit and Central Subway	+26.8%	+14.2%	-6.9%	-2.4%
Surface Green Line	+47.7%	+47.0%	-16.0%	-8.4%
Bus and Trackless Trolley	+34.1%	+4.2%	-7.8%	-2.3%
Total	**+30.5%**	**+13.5%**	**-8.4%**	**-2.9%**

Projected changes in revenue and unlinked trips outside of the core system (express bus, commuter rail, ferry services, and The RIDE) from the proposed fare increase and restructuring are shown in Table 4. As was the case with the core system, the impacts on single-ride customers were generally expected to be greater than for pass customers. Unlike the core system, however, where surcharges resulted in a significant increase in price for customers paying with cash onboard vehicles or using CharlieTickets, the difference in impacts for express buses, commuter rail, and boats is due mainly to the relative increase in cash and pass prices. This is because the installation of AFC technology has not occurred on these modes with the exception of express buses. In the case of both single-ride fares and pass prices, the percent increase was greater for the core compared to the non-core, and, in some cases, such as with the effective lowering of pass prices for some express bus customers and Inner Harbor ferry customers, projected revenue actually declined and ridership increased for certain non-core categories.

TABLE 4
Non-Core System Revenue and Ridership:
Projected Percent Changes

	% Change Revenue		% Change Ridership	
Mode	Single-Ride	Pass	Single-Ride	Pass
Express Bus	+2.9%	-12.8%	+0.8%	+11.9%
Commuter Rail	+22.8%	+20.9%	-3.6%	-2.4%
Ferry Services	+0.6%	-1.1%	-0.9%	+3.2%
The RIDE	+10.0%		-0.7%	
Total	**+19.5%**	**+20.1%**	**-2.7%**	**-1.8%**

The estimated changes in systemwide combined single-ride fare and pass revenue and unlinked trips from the fare increase and restructuring, as projected using the travel demand model, are shown in Table 5. Note that the travel demand model does not estimate revenue on a modal basis; thus only the systemwide revenue total is presented.

Aside from commuter rail, the change in unlinked trips projected by the travel demand model for all modes was quite modest. Trips on bus and trackless trolley were actually projected to increase under the fare increase and restructuring scenario. Revenue was projected to increase by 18.4 percent systemwide.

TABLE 5
Systemwide Combined Revenue and Ridership:
Projected Percent Changes

	% Change	
Mode	Revenue	Ridership
Rapid Transit		-1.9%
Bus and Trackless Trolley		+3.1%
Commuter Rail		-16.1%
Express Bus		+0.7%
Ferry		-8.6%
Total	**+18.4%**	**-1.7%**

Table 6 presents the percent changes projected by the travel demand model and the spreadsheet model for unlinked trips, revenue, and revenue per unlinked trip. What differences there are between the two models' percentages can be explained in large part by certain assumptions used for each model with regard to elasticities, trip conservation,[4] and transfer activity. However, the difference between the two models' projections represents a range of estimates. In summary, therefore, the Pre-Fare Increase Impacts Analysis estimated a decrease in unlinked trips of between 1.7 percent and 5.0 percent, and an increase in revenue of between 18.4 percent and 21.2 percent. Henceforth, for purposes of comparison with the results of the Post-Fare Increase Impacts Analysis, the projections of the spreadsheet model will be used.

TABLE 6
Comparison of System Revenue and Ridership:
Projected Percent Changes

	Projected Change	
	Travel Demand Model	Spreadsheet Model
Unlinked Trips	-1.7%	-5.0%
Revenue	+18.4%	+21.2%
Revenue per Unlinked Trip	+20.5%	+27.6%

[4] The travel demand model starts with a set number of trips and then distributes these trips to various modes, such as driving or transit, based on the relative costs, thus conserving the total number of trips in the region.

RESULTS OF THE POST-FARE INCREASE IMPACTS ANALYSIS

On January 1, 2007, the MBTA implemented a fare increase, the major purpose of which was to raise approximately $70 million in revenue. At the same time, several new fare structure elements were implemented along with the full adoption of AFC technology on local bus, express bus, and rapid transit. Specifically, the step-up transfer, differential pricing by fare media, and the replacement of the Subway Pass with the LinkPass were entirely new concepts to MBTA riders. The restructuring also included the elimination of pricing inconsistencies, such as free outbound travel on surface Green Line vehicles and the higher-priced fare zones on the Green Line D branch and the Red Line South Shore branch. The combination of the restructuring and the systemwide use of new AFC faregates and fareboxes along with CharlieCards represented perhaps the greatest change to the way MBTA riders paid their fares since the implementation of exit fares in the days of “Charlie on the MTA.” There is therefore much interest in learning how MBTA riders responded not only to the fare increase but also to these significant changes in the fare structure.

As the Post-Fare Increase Impacts Analysis represents one of the first comprehensive uses of AFC data for reporting purposes, a learning curve with respect to the ability to organize and analyze the data was to be expected. The establishment of a data warehouse, separate from the live AFC database that is continually updated with every individual transaction, vastly improved the ease with which reports could be run and data downloaded. Several queries for analyzing the database had been developed in advance of its release. These queries summarized transactions in various ways, such as by product type, station location, or date. However, it was not until CTPS began to actively use that data for this study that limitations to the pre-existing queries could be determined, ideas for new queries suggested, and refinements made. At all times, the AFC department at the MBTA was exceptionally responsive to the needs and concerns of CTPS.

One of the greatest concerns that CTPS has with the existing AFC structure is the time limit that is placed on data storage. Currently, data from every sale or transaction is stored in the data warehouse for 14 months. Data more than 14 months old is deleted upon daily update of the database. This caused a problem in the present study when certain queries to retrieve and summarize data from the data warehouse needed to be refined. Specifically, the data for the months of January and February 2007 had been collected via a query that had two minor problems. First, the query did not account for the delay in downloading data from some fareboxes, particularly on surface Green Line routes. Second, a coding modification was needed to avoid the query’s double-counting of transactions on the first day of every month. Rectification was impossible, because the data was more than 14 months old by the time the query was corrected. However, taken together, the two problems with the query largely offset each other, and the estimated effect on ridership and revenue totals is negligible; however, the fact remains that this study uses data for the months of January and February 2007 that it would not have used if the 14-month window for these two months had not passed.

The AFC department at the MBTA has since put into place a mechanism for indefinitely storing a summarized version of the data warehouse that uses less memory. This data summary is of sufficient detail to permit the type of analysis presented in the present study to occur on a regular basis. However, data at the level of detail of an individual transaction is still being purged after 14 months. It will therefore be impossible, for example, to compare a certain day's ridership from one year to the next if the first date is more than 14 months in the past. Such a limitation will require greater foresight when planning for the performance of various analyses. Perhaps more importantly, as the MBTA and CTPS continually learn how to better use AFC data, this time window of data availability prevents the application of these improved processes to older information.

Ridership Estimation

Methodology

With the adoption of AFC technology in the core transit system, ridership data on all AFC transactions is now available for local buses, express buses, light rail, and heavy rail. This data is divided between fareboxes on all buses and light rail vehicles operating on the surface, validators[5] at light rail stops on the surface, and faregates at all subway stations and surface stations with pre-payment fare zones.[6] Farebox data can be organized by sign code (the route designation), while validator and faregate data is collected by station. In this way, AFC data can be segregated and summarized according to the desired modal category.

While AFC provides a 100 percent count of all passengers who interact with the equipment, any trips that either do not pass through an AFC payment zone or are not recorded will not be counted. In the case of the former, children aged 11 and under, who are not required to pay, and passengers transferring between rapid transit lines within the pre-payment zone are examples. Fare evaders as well as those customers who have bought a pass but board a vehicle by simply "flashing" it are examples of the latter. Therefore, CTPS has developed factors for estimating the extent to which in-station transfers and farebox or faregate non-interaction are occurring. These factors vary according to the mode or AFC equipment type and must be estimated separately for each. Table 7 presents the factors that were applied to AFC transactions to estimate ridership for the core transit system in the Post-Fare Increase Impacts Analysis.

Outside of the core transit system, various data sources were used to estimate ridership. For commuter rail, ticket sales of single-ride zonal fares were used as a proxy for the number of riders in these ridership categories except for onboard and special fares, for which conductor counts were used. For pass trips on commuter rail, the number of pass sales by pass type was multiplied by the pass-ride value, or the number of trips made per

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[5] Validators essentially act as fareboxes, with the added function that they "validate" each transaction by providing a validation slip that indicates that the passenger has paid his or her fare. This allows the passenger to board a bus or Green Line vehicle through a rear door without having to interact with the farebox at the front door. Validators are located at certain Green Line surface stops and other high-volume boarding areas.

[6] Any transit boarding area where entry is restricted to customers who have already paid their fare is referred to as a pre-payment fare zone. Faregates are the exclusive means for granting entry to these zones.

month per pass type for passes that were estimated to have been used on commuter rail. These pass-ride values were calculated from a commuter rail pass-users survey.

TABLE 7
In-Station Transfer and Non-Interaction Factors

In-Station Transfer Factors	
HR Transfers per HR Trip	0.21
LR Transfers per HR Trip	0.18
LR Transfers per LR Trip	0.02
HR Transfers per LR Trip	0.22
HR Transfers per SSTA HR Boardings	0.185
SL Transfers per SSTA SL Boardings	2.6
Non-Interaction Factors	
Bus Fareboxes	0.195
Faregates	0.022
LR Fareboxes	0.298

HR: Heavy Rail; LR: Light Rail; SL: Silver Line; SSTA: South Station

TABLE 8
Monthly Commuter Rail (CR) and Commuter Boat Pass-Ride Values
(Trips per Month)

	Monthly Pass-Ride Value	
Pass Type	On Commuter Rail	On Commuter Boat
CR Zone 1a	31.5	9.0
CR Zone 1	34.4	2.2
CR Zone 2	40.5	0.1
CR Zone 3	40.2	1.2
CR Zone 4	40.3	0.4
CR Zone 5	40.1	2.8
CR Zone 6	39.6	3.3
CR Zone 7	39.3	0.4
CR Zone 8	40.5	4.4
Commuter Boat	33.0	38.1
InterZone (all)	34.0	0.0
Student	35.0	8.3
7-Day LinkPass*	4.4	1.3

**Weekly Pass-Ride Value*

Commuter boat and Inner Harbor ferry single-ride and pass trips were reported by boat operators and were separated by fare type. However, pass use was not broken down into the various pass types, so pass-ride values for boat travel using the commuter rail and commuter boat passes were taken from the commuter rail pass-users survey and multiplied by pass sales for the respective pass type for passes that were estimated to have been used on water transportation. The pass-ride values calculated from the commuter rail pass-users survey are presented in Table 8.

Finally, the Office for Transportation Access at the MBTA directly reported the number of trips by month on The RIDE.

2007 Estimated Ridership

The total number of unlinked trips in 2007 is estimated at 351 million (see Table 9). Of this total, more than 91 percent, or 321.7 million, are taken on the core transit system, where AFC equipment is in place. Within the core system, 70 percent of the trips are taken on rapid transit, encompassing all subway stations, in-station transfers, both branches of the Silver Line, and surface light rail, with the remaining trips split between the bus modes of local buses, crosstown buses, and the inner and outer express buses. The remaining 29.3 million trips, of which almost 90 percent are on commuter rail, are taken on the non-core system, where AFC is not in usage. Boat services account for 4.7 percent of trips, with trips on The RIDE making up the remaining 5.6 percent of trips in this category.

Within the bus category, local bus service carries 96 percent of trips, followed by inner express bus service with 2.3 percent, crosstown bus service with 1.1 percent, and outer express bus service with less than 1 percent of trips. Within the rapid transit category, riders using subway stations make up the majority of trips, at 62 percent, with transfer trips between rapid transit lines constituting an additional 26 percent. Taken together, these trips made on the Red, Orange, and Blue lines and the subway portions of the Green and Silver lines are nearly 89 percent of trips made on rapid transit. Surface light rail, including the B, C, D, and E surface branches of the Green Line as well as the Mattapan High-Speed Line, accounts for almost all of the remaining rapid transit ridership, with 9.1 percent of the total. The Silver Line along Washington Street and the Silver Line Waterfront surface service represent the final 2.2 percent of rapid transit trips.

The highest ridership on the commuter rail system is estimated to occur in Zone 3 with 16.1 percent of trips, followed by Zone 2 with 15.9 percent, Zone 4 with 15.2 percent, and Zone 6 with 14.9 percent. Zone 8 has the next highest percentage of trips, at 10.1 percent, followed by Zones 1, 5, and 7, each with about 8 percent of trips. Zone 1a has the smallest percentage of trips, at 3.4 percent. Of the commuter boat routes, route F1 carries slightly more than half of all boat trips, and F2 and F4 both carry approximately 23 percent of these trips.

Revenue Estimation

Methodology

Revenue can be reported by the new AFC system for the core transit system in two different ways. First, sales revenue is compiled from all sales at AFC fare vending machines (FVMs), retail sales terminals (RSTs), bus fareboxes, and other sales sources such as station ticket windows, private agents, the MBTA website, and the Corporate

Pass Program. Sales revenue therefore equals the sum of all revenue collected at the point of sale of various fare and pass products.

TABLE 9
2007 Total Unlinked Trips by Modal Category

Mode	Unlinked Trips
Bus	95,179,710
Local	91,357,245
Crosstown	1,086,621
Inner Express	2,235,797
Outer Express	500,047
Rapid Transit	226,487,126
Red, Orange, Blue, Green, Silver Line Waterfront Subway	141,430,954
In-Station Transfer	59,535,381
Silver Line Washington Street	3,717,045
Silver Line Waterfront Surface	1,252,987
Light Rail Surface (Green Line and Mattapan High-Speed Line)	20,550,759
Total Core AFC System	**321,666,836**
Commuter Rail	26,226,769
Zone	23,481,737
Zone 1a	792,394
Zone 1	1,712,504
Zone 2	3,728,952
Zone 3	3,790,055
Zone 4	3,574,174
Zone 5	2,027,534
Zone 6	3,489,613
Zone 7	1,988,155
Zone 8	2,378,357
InterZone (all zones)	101,231
Onboard (all zones)	2,643,801
Commuter Boat	1,378,946
F1: Hingham-Boston	749,449
F2: Quincy-Hull-Boston-Logan Airport	319,483
F4: Boston-Charlestown	310,014
The RIDE	1,648,941
Total Non-Core, Non-AFC System	**29,254,656**
Total System	**350,921,492**

Transaction revenue, the other method by which revenue is estimated, totals and distributes revenue collected at the point of use. In the case of single-ride transactions, it equals each transaction type multiplied by its price summed for all transactions. In the case of passes, total revenue per pass type is calculated by multiplying the pass price by the number of passes sold. Revenue is then distributed among the various modal categories equal to the distribution of transactions.

In theory, total sales and transaction revenue should sum to the same amount. However, there are a few slight differences in the way in which the two revenue totals are collected. One example would be in the calculation of revenue from short fares, or fares deposited in bus and light rail fareboxes that are less than the correct fare. Whereas sales revenue would equal the sum of all short fares, the calculation for transaction revenue necessitates estimating an average short fare and then applying this average to all short fare transactions. The two methods therefore result in different total revenue estimates for this type of fare transaction. Another example occurs with the use of stored value. Sales revenue would simply equal the sum of all stored value added to CharlieCards or CharlieTickets. Transaction revenue, on the other hand, would equal the sum of all the transactions that use this stored value if and when they use it. For example, stored value that is lost or discarded would be counted as sales revenue but not as transaction revenue because it was never actually used. Similarly, stored value that was loaded before the study time period would not count as sales revenue but would be counted as transaction revenue. Considering these differences between the two methodologies, transaction revenue is used to estimate revenue in this Post-Fare Increase Impacts Analysis because it can more closely relate revenue to ridership.

2007 Estimated Revenue

Table 10 presents the estimates of 2007 revenue by modal category. Total systemwide revenue is estimated at $424.2 million. Due to the higher average fares and pass prices of non-core modes, the core system accounts for a relatively smaller percentage of total revenue than it did for ridership. However, core revenue still makes up 74 percent of systemwide revenue. Within the core, similarly due to its lower average fares and pass prices, the bus category now accounts for 24 percent of core revenue – less than its ridership percentage – with rapid transit constituting the other 76 percent. Individual bus modal revenue distributions largely mirror those of ridership, with a slightly smaller percentage of revenue going to the local bus category due to the higher fares and pass prices for inner and outer express buses. While a lower percentage of revenue is allocated to in-station transfers, owing to the free in-station transfer for single-ride trips, revenue for pass trips in this category is distributed according to estimated flash pass trips, so this modal category still receives some of the pass revenue. The combined subway categories still account for 90 percent of rapid transit revenue, followed by surface light rail at 8.5 percent, and the two surface Silver Line categories at 1.7 percent.

For the non-core, non-AFC system, commuter rail contributes by far the largest portion of revenue at 91 percent, with commuter boat and The RIDE contributing 5.6 and 3.0 percent, respectively. Among the commuter rail zones, Zone 6 accounts for the largest portion of revenue at 17.5 percent. Owing to their higher fares and pass prices, the zonal categories 5 and above make up a greater percentage of the commuter rail revenue total than of the ridership total, whereas the opposite is true for zonal categories 4 and below. Among the commuter boat categories, while the F4 Inner Harbor ferry service contributes 23 percent of total commuter boat ridership, it makes up only 5.3 percent of revenue, due to its lower fares compared to those of other boat services. The F1 and F2 services account for 63 percent and 32 percent, respectively, of commuter boat revenue.

TABLE 10
2007 Total Revenue by Modal Category

Mode	Revenue
Bus	$74,079,491
Local	$67,677,183
Crosstown	$878,215
Inner Express	$4,203,321
Outer Express	$1,320,772
Rapid Transit	$238,746,027
Red, Orange, Blue, Green, Silver Line Waterfront Subway	$177,672,061
In-Station Transfer	$36,710,658
Silver Line Washington Street	$2,566,146
Silver Line Waterfront Surface	$1,521,242
Light Rail Surface (Green Line and Mattapan High-Speed Line)	$20,275,920
Total Core AFC System	**$312,825,518**
Commuter Rail	$101,856,083
Zone	$82,675,818
Zone 1a	$1,033,484
Zone 1	$4,587,109
Zone 2	$10,426,206
Zone 3	$12,148,803
Zone 4	$12,245,406
Zone 5	$7,820,010
Zone 6	$14,476,898
Zone 7	$8,801,540
Zone 8	$11,136,362
InterZone (all zones)	$310,294
Onboard (all zones)	$18,869,972
Commuter Boat	$6,248,346
F1: Hingham-Boston	$3,939,383
F2: Quincy-Hull-Boston-Logan Airport	$1,979,443
F4: Boston-Charlestown	$329,520
The RIDE	$3,297,882
Total Non-Core, Non-AFC System	**$111,402,311**
Total System	**$424,227,829**

COMPARISON OF THE POST- AND PRE-FARE INCREASE IMPACTS ANALYSES

This section will show the percent changes in ridership and revenue due to the 2007 fare increase and restructuring and compare these percentages to those projected by the Pre-Fare Increase Impacts Analysis. It will then show the calculated price elasticities and possible ridership diversion factors, and compare them to those that were used to make the projections. Finally, the pass-ride values determined for each pass type (the number of uses per month per modal category) will be presented and compared to those used in the Pre-Fare Increase Impacts Analysis.

Ridership

Percent Changes

In estimating the percent change in unlinked trips for various modal categories, it is possible to split the ridership totals between single-ride and pass trips to better understand the impact depending on the rider category. In general, the data from AFC makes this split relatively easy, as each trip is matched with a specific transaction type that can be coded as either single-ride or pass. One issue arises, however, with the designation of trips estimated using the farebox or faregate non-interaction factors. Because these trips, by definition, do not interact with any AFC equipment, it is impossible to know how each should be classified. If they are children or fare evaders, then they should be classified as single-ride trips. If they are pass holders who flash their pass to gain entry, however, then they should be classified as pass trips. As part of the surface Green Line fare-mix study and passenger count, the number of flash pass trips and the number of other non-interaction trips were counted. Flash pass trips were found to make up 40.8 percent. This ratio was assumed to be the flash pass percentage for all farebox non-interaction trips (all faregate non-interaction trips were assumed to be single-ride). This assumption has a significant effect on the relative ridership estimates for single-ride versus pass trips.

Ridership declines are generally witnessed throughout the system. Total bus ridership for 2007 was estimated at 95.2 million, as shown in Table 9. This represents a 7.9 percent decrease compared to the annual bus ridership total before the fare increase and restructuring. When breaking out total bus ridership between single-ride and pass trips, single-ride trips show a decrease of 6.8 percent, while pass trips decrease by 8.9 percent. Whereas pass trips seem to have responded to the fare increase more dramatically than single-ride trips for bus, this was not the case for rapid transit categories. All subway stations (including in-station transfers) along the Red, Orange, Blue, Green, and Silver Waterfront lines constitute 202 million annual unlinked trips. This represents a 6.6 percent decrease compared to the annual total before the fare increase and restructuring. Single-ride and pass ridership both declined by 6.6 percent. Total unlinked trips on the surface Green Line decreased by 31.3 percent, and single-ride trips declined by more than pass trips, 34.2 percent versus 27.8 percent, respectively.

Outside of the core transit systems, commuter rail appears to have witnessed a 12 percent decline in unlinked trips. Unlike bus and even more so than with rapid transit, the majority of this decline seems to have occurred in single-ride trips, with a 33.9 percent decline in this category. Pass trips, on the other hand, decreased by only 1.1 percent. Within the commuter rail zones, the higher-priced zones on average saw larger percentage decreases in single-ride trips. Some passes actually appear to have higher ridership now than before the fare increase, though on average the impact on total pass ridership was slightly negative. Ridership on commuter boat increased by 9.2 percent; this was driven by a doubling of pass ridership, as there was a decrease of 11.2 percent in single-ride trips. Despite the increase in pass trips on commuter boat, they still amount to only about half the number of single-ride trips on this mode. Finally, The RIDE also witnessed an increase in ridership during 2007, as the number of trips on this service jumped by 23.5 percent.

The above figures are presented in Tables 11 through 12. Note that only modes with ridership totals at or near one million trips are presented in the tables, although ridership on these modes is included in the modal subtotals. Table 13 presents the ridership for the entire core system, which declined by 9.7 percent for single-ride trips and 9.3 percent for pass trips, for a total percent decrease across all fare categories in core trips of 9.5 percent. Total non-core ridership declined by 25.7 percent for single-ride trips and actually increased by 0.1 percent for pass trips. The total percent decrease in non-core trips was 9.7 percent. Taken together, core and non-core single-ride trips fell by 10.9 percent in 2007, while pass trips fell by 8.5 percent, for a total annual systemwide decrease in unlinked trips of 9.5 percent.

TABLE 11
Percent Change in Single-Ride Unlinked Trips

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	45,831,007	49,196,675	-6.8%
Rapid Transit	98,740,648	110,942,693	-11.0%
Subway & Silver Line Waterfront	86,212,749	92,297,998	-6.6%
Silver Line Washington St	1,929,477	1,696,267	+13.7%
Surface Green Line	10,597,337	16,116,380	-34.2%
Total Core AFC System	**144,571,655**	**160,139,373**	**-9.7%**
Commuter Rail	6,510,593	9,852,581	-33.9%
Zone 1a	90,600	94,311	-3.9%
Zone 1	450,129	590,642	-23.8%
Zone 2	1,034,362	1,376,781	-24.9%
Zone 3	1,069,749	1,434,471	-25.4%
Zone 4	828,582	1,191,295	-30.4%
Zone 5	628,680	965,394	-34.9%
Zone 6	1,004,307	1,507,041	-33.4%
Zone 7	533,234	895,147	-40.4%
Zone 8	853,555	1,244,886	-31.4%
Commuter Boat	930,154	1,047,328	-11.2%
The RIDE	1,648,941	1,335,692	+23.5%
Total Non-Core Non-AFC System	**9,089,688**	**12,235,601**	**-25.7%**
Total System	**153,661,343**	**172,374,974**	**-10.9%**

TABLE 12
Percent Change in Pass Unlinked Trips

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	49,348,703	54,185,294	-8.9%
Rapid Transit	127,746,478	141,166,836	-9.5%
Subway & Silver Line Waterfront	116,006,574	124,185,828	-6.6%
Silver Line Washington St	1,787,568	2,166,207	-17.5%
Surface Green Line	9,951,131	13,779,393	-27.8%
Total Core AFC System	**177,095,181**	**195,352,130**	**-9.3%**
Commuter Rail	19,716,176	19,939,361	-1.1%
Zone 1a	701,794	605,218	+16.0%
Zone 1	1,447,333	1,869,170	-22.6%
Zone 2	3,122,456	2,904,100	+7.5%
Zone 3	3,161,112	3,379,722	-6.5%
Zone 4	3,083,363	2,939,254	+4.9%
Zone 5	1,658,310	1,674,514	-1.0%
Zone 6	2,901,888	2,836,154	+2.3%
Zone 7	1,674,596	1,747,182	-4.2%
Zone 8	1,874,363	1,941,051	-3.4%
Commuter Boat	448,792	215,373	+108.4%
Total Non-Core Non-AFC System	**20,164,968**	**20,154,734**	**+0.1%**
Total System	**172,374,968**	**215,506,864**	**-8.5%**

TABLE 13
Percent Change in All Unlinked Trips

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	95,179,710	103,381,969	-7.9%
Rapid Transit	226,487,126	252,109,534	-10.2%
Subway & Silver Line Waterfront	202,219,322	216,483,832	-6.6%
Silver Line Washington St	3,717,045	3,862,475	-3.8%
Surface Green Line	20,548,468	29,895,773	-31.3%
Total Core AFC System	**321,666,836**	**355,491,503**	**-9.5%**
Commuter Rail	26,226,769	29,791,942	-12.0%
Zone 1a	792,394	699,529	+13.3%
Zone 1	1,897,463	2,459,812	-22.9%
Zone 2	4,156,818	4,280,881	-2.9%
Zone 3	4,230,860	4,814,193	-12.1%
Zone 4	3,911,945	4,130,549	-5.3%
Zone 5	2,286,990	2,639,908	-13.4%
Zone 6	3,906,194	4,343,196	-10.1%
Zone 7	2,207,830	2,642,330	-16.4%
Zone 8	2,727,918	3,185,937	-14.4%
Commuter Boat	1,378,946	1,262,702	+9.2%
The RIDE	1,648,941	1,335,692	+23.5%
Total Non-Core Non-AFC System	**29,254,656**	**32,390,335**	**-9.7%**
Total System	**350,921,492**	**387,881,838**	**-9.5%**

Comparison to Projections

The ridership declines were not unexpected. Indeed, the spreadsheet model projected a decrease in rapid transit and Central Subway unlinked single-ride trips of 6.6 percent, an estimate very close to the actual decrease of 7.4 percent. However, the actual percent decrease in pass trips was greater than the model's projection, 6.6 percent versus 2.4 percent. As a result, the total rapid transit and Central Subway percent decrease in unlinked trips of 6.6 percent was greater than the model's projected decrease of 4.2 percent. This under-prediction of actual ridership decreases for pass trips appears to be relatively consistent for most modes. While the model's forecast of bus unlinked single-ride trips was also close to the actual numbers (a 7.8 percent projected decrease versus an actual 6.8 percent decrease), the actual decline in pass trips of 8.9 percent was greater than the model projection of a 2.3 percent decline. The percent decrease in total bus unlinked trips was therefore 7.9 percent, compared to a projected 4.8 percent decrease. The percent decreases in surface Green Line ridership were greater than the model projections for both single-ride and pass trips. Total surface Green Line ridership declined by 31.3 percent, compared to a projected 12.2 percent decrease.

In terms of commuter rail ridership, the spreadsheet model similarly predicted that the fare increase would have a much smaller impact on trips than it did. The model was fairly close in regards to the projection of pass trips, but it dramatically undercounted the loss in commuter rail single-ride trips. Its projection for total commuter rail ridership was a 2.7 percent decrease, whereas the actual change was a 12.0 percent decrease. The model predicted no overall change in water transportation trips, while it appears that water ridership actually increased in 2007. Finally, the model predicted that trips on The RIDE would fall slightly, while ridership in fact increased substantially.

TABLE 14
Projected vs. Actual Percent Changes in Unlinked Trips:
Single-Ride, Pass, and Total

	Projected % Change			Actual % Change		
Mode	Single-Ride	Pass	Total	Single-Ride	Pass	Total
Rapid Transit and Central Subway	-6.9%	-2.4%	-4.2%	-6.6%	-6.6%	-6.6%
Surface Green Line	-16.0%	-8.4%	-12.2%	-34.2%	-27.8%	-31.3%
Bus and Trackless Trolley	-7.8%	-2.3%	-4.8%	-6.8%	-8.9%	-7.9%
Commuter Rail	-3.6%	-2.4%	-2.7%	-33.9%	-1.1%	-12.0%
Ferry Services	-0.9%	+3.2%	0.0%	-11.2%	+108.4%	+9.2%
The RIDE	-0.7%		-0.7%	+23.5%		+23.5%
Systemwide	**-8.8%**	**-3.4%**	**-5.0%**	**-10.9%**	**-8.5%**	**-9.5%**

Table 14 shows these comparisons between projected and actual percent changes in unlinked trips. Systemwide, the model appears to have under-predicted the percent decrease in both single-ride and pass trips compared to the actual change, though the single-ride forecasts are closer than the pass forecasts. Despite these differences, the proportion of actual changes in single-ride to pass trips is at least relatively consistent with what the model projected, in that single-ride trips were projected to decrease at a greater percentage than pass trips. Regardless of how unlinked trips are split between single-ride and pass trips, however, the model underestimated the decrease in ridership in 2007.

Revenue

Percent Changes

As with ridership, revenue is split between single-ride and pass categories. As mentioned above, single-ride revenue equals the fare per transaction summed for all transactions. Pass revenue is determined at the systemwide level by multiplying the pass price by the number of passes sold for each pass type. Pass revenue is then distributed across modal categories proportional to the number of unlinked trips in each category.

The reason for the fare increase was the necessity of raising approximately $70 million in revenue. While ridership declines in certain modal and fare categories were enough to lead to revenue decreases in these categories, overall the effect of the fare increase was to increase revenue. The actual revenue totals before and after the fare increase and the percent changes are presented by mode in Tables 15 through 17 for, respectively, single-ride, pass, and all trips. Note that, as with ridership, only those modal categories with total revenue collected of at least $1 million are listed, though the revenue from modes with less than $1 million is included in the modal subtotals.

As shown in Table 17, the fare increase raised revenue by $79.4 million, or 23.0 percent. Most of this increase – $68.0 million or 85.6 percent – was attributable to pass revenue, while single-ride trips contributed an $11.4 million increase in revenue.

Within the single-ride category, the core AFC system was responsible for the increase. In the core, bus single-ride revenue increased by 4.0 percent, and while the rapid transit subtotal of single-ride revenue increased by 11.4 percent overall, surface Green Line revenue in this category actually fell by 20.9 percent, somewhat mitigating the 18.6 percent increase in subway revenue. Non-core single-ride service revenue also declined, led by a 4.1 percent decrease in commuter rail single-ride revenue. The higher zones led these commuter rail revenue losses. Single-ride revenue from commuter boats and The RIDE increased by 8.8 percent and 36.8 percent, respectively.

Pass revenue increased in virtually all categories. The only exceptions were an 11.5 percent decrease in bus revenue and a 10.9 percent decrease in commuter rail Zone 1 pass revenue. The rapid transit category overall increased its pass revenue by 75.3 percent. Commuter rail pass revenue also increased overall, by 24.9 percent, with the upper-zone passes recording some of the highest revenue increases. Pass revenue from commuter boats increased by 36.8 percent.

TABLE 15
Percent Change in Single-Ride Revenue

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	$31,867,528	$30,652,410	+4.0%
Rapid Transit	$104,082,845	$93,471,345	+11.4%
Subway & Silver Line Waterfront	$90,040,902	$75,912,015	+18.6%
Silver Line Washington St	$1,230,477	$1,316,083	-6.5%
Surface Green Line	$12,810,464	$16,185,340	-20.9%
Total Core AFC System	**$135,950,374**	**$124,123,755**	**+9.5%**
Commuter Rail	$40,527,644	$42,242,687	-4.1%
Zone 1a	$276,231	$160,488	+72.1%
Zone 1	$2,001,668	$1,823,310	+9.8%
Zone 2	$5,159,146	$4,611,997	+11.9%
Zone 3	$5,885,482	$5,106,652	+15.3%
Zone 4	$4,964,721	$5,045,013	-1.6%
Zone 5	$4,121,168	$4,557,898	-9.6%
Zone 6	$7,129,321	$7,454,985	-4.4%
Zone 7	$4,051,109	$4,696,203	-13.7%
Zone 8	$6,910,432	$7,011,683	-1.4%
Commuter Boat	$5,071,587	$4,660,756	+8.8%
The RIDE	$3,297,882	$2,410,405	+36.8%
Total Non-Core Non-AFC System	**$48,897,113**	**$49,313,848**	**-0.8%**
Total System	**$184,847,486**	**$173,437,603**	**+6.6%**

TABLE 16
Percent Change in Pass Revenue

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	$42,211,962	$44,600,482	-5.4%
Rapid Transit	$134,663,182	$76,803,130	+75.3%
Subway & Silver Line Waterfront	$125,863,060	$67,940,336	+85.3%
Silver Line Washington St	$1,335,668	$936,280	+42.7%
Surface Green Line	$7,463,589	$7,460,517	0.0%
Total Core AFC System	**$176,875,144**	**$121,403,613**	**+45.7%**
Commuter Rail	$61,328,439	$49,092,018	+24.9%
Zone 1a	$990,571	$634,038	+56.2%
Zone 1	$3,484,199	$3,909,594	-10.9%
Zone 2	$7,604,910	$5,569,168	+36.6%
Zone 3	$9,006,558	$7,163,528	+25.7%
Zone 4	$9,582,908	$8,985,438	+6.6%
Zone 5	$5,621,048	$4,913,202	+14.4%
Zone 6	$10,680,771	$8,320,930	+28.4%
Zone 7	$6,638,317	$3,812,959	+74.1%
Zone 8	$7,437,230	$5,654,594	+31.5%
Commuter Boat	$1,176,759	$860,450	+36.8%
Total Non-Core Non-AFC System	**$62,505,198**	**$49,952,468**	**+25.1%**
Total System	**$239,380,342**	**$171,356,081**	**39.7%**

TABLE 17
Percent Change in All Revenue

Mode	Post-Fare Increase	Pre-Fare Increase	% Change
Bus	$74,079,491	$75,252,892	-1.6%
Rapid Transit	$238,746,027	$170,274,475	+40.2%
Subway & Silver Line Waterfront	$215,903,961	$143,852,351	+50.1%
Silver Line Washington St	$2,566,146	$2,252,362	+13.9%
Surface Green Line	$20,274,053	$23,645,856	-14.3%
Total Core AFC System	**$312,825,518**	**$245,527,368**	**+27.4%**
Commuter Rail	$101,856,083	$91,334,705	+11.5%
Zone 1a	$1,266,802	$794,526	+59.4%
Zone 1	$5,485,867	$5,732,904	-4.3%
Zone 2	$12,764,056	$10,181,165	+25.4%
Zone 3	$14,892,039	$12,270,181	+21.4%
Zone 4	$14,547,629	$14,030,451	+3.7%
Zone 5	$9,742,216	$9,471,100	+2.9%
Zone 6	$17,810,092	$15,775,914	+12.9%
Zone 7	$10,689,427	$8,509,161	+25.6%
Zone 8	$14,347,661	$12,666,277	+13.3%
Commuter Boat	$6,248,346	$5,521,199	+13.2%
The RIDE	$3,297,882	$2,410,405	+36.8%
Total Non-Core Non-AFC System	**$111,402,311**	**$99,266,309**	**+12.2%**
Total System	**$424,227,829**	**$344,793,684**	**+23.0%**

Comparison to Projections

As shown in Table 18, total revenue projections were only slightly less than the actual revenue increase from the fare increase and restructuring. Significant differences exist, however, between the projections and actual results in the modal categories and in terms of single-ride versus pass revenue. As with ridership, the model underestimated the increases in pass revenue. This appears to particularly be the case in the rapid transit and Central Subway category. In this category, revenue was projected to increase by 14.2 percent, whereas it in fact increased by 85.3 percent. Actual surface Green Line revenue also differs between single-ride and pass in a way that the model did not predict. Bus revenue, while significantly lower than the amounts forecast, did seem to reflect a large difference between the single-ride and pass categories – something that was predicted by the model.

While the model projected that the surface Green Line would contribute a large portion of the revenue increase, in fact revenue from this mode appears to have fallen. The model also did not anticipate the decrease in commuter rail single-ride revenue, which led overall commuter rail revenue to be lower than what was projected, despite greater-than-expected pass revenue. These revenue losses were more than compensated, however, by the increase in rapid transit and Central Subway revenue, specifically in pass revenue.

TABLE 18
Projected versus Actual Percent Changes in Revenue:
Single-Ride, Pass, and Total

	Projected % Change			Actual % Change		
Mode	Single-Ride	Pass	Total	Single-Ride	Pass	Total
Rapid Transit and Central Subway	+26.8%	+14.2%	+20.6%	+18.6%	+85.3%	+50.1%
Surface Green Line	+47.7%	+47.0%	+46.9%	-20.9%	0.0%	-14.3%
Bus and Trackless Trolley	+34.1%	+4.2%	+17.2%	+4.0%	-5.4%	-1.6%
Commuter Rail	+22.8%	+20.9%	+21.6%	-4.1%	+24.9%	+11.5%
Ferry Services	+0.6%	-1.1%	0.0%	+8.8%	+36.8%	+13.2%
The RIDE	+10.0%		+12.5%	+36.8%		
Systemwide	**+27.2%**	**+16.2%**	**+21.2%**	**+6.6%**	**+39.7%**	**+23.0%**

Elasticity

Demonstrated Elasticities

Elasticity in the context of this report measures the responsiveness of demand (measured by unlinked trips) to changes in price (measured by single-ride fares and pass prices). Specifically, it is calculated by taking the ratio of the percent change in unlinked trips to the percent change in prices. Elasticity can be determined for any modal category in which the two parts of this ratio exist; however, the smaller the demand of the category under scrutiny, the more likely the elasticity calculation is to give unrealistic results. The reason for this lies with the assumption in the elasticity calculation that all other factors that could potentially affect demand are constant. If these outside factors do indeed have an impact on demand, even a small one, the effect will be greater, on a percentage basis (the basis by which elasticity is calculated), in the case of targeted modal categories with smaller ridership totals than in the case of more generalized categories with larger ridership totals.

There were undoubtedly outside factors with the potential to affect MBTA ridership in 2007. Characteristics of the economy, including the strength of the housing sector, the number of jobs, and the price inflation of key goods such as fuel, are assumed to have an effect on the demand for public transportation, though the extent of that effect has not been conclusively determined. The important question, however, is not whether these outside factors were affecting MBTA ridership in 2007, but whether the effect they had on ridership in 2007 was significantly different from their effect on ridership the previous year. If these larger economic influences were relatively consistent between 2006 and 2007, such that the only major impact on MBTA ridership over that time period was the fare increase, then, while it is a simplification, measuring the price elasticity could be said to isolate the effect of the fare increase.

Table 19 presents the calculated price elasticities of the Post-Fare Increase Impacts Analysis. As shown in the table, elasticities for the various modal categories range from negative numbers below -1 (defined as unit elasticity, where the demand for a good decreases in exact or greater proportion to the change in price) to positive numbers (highly inelastic, such that demand actually increases in response to a price increase). Again, note how these instances of what would generally be considered unreasonable elasticities tend to occur with the more specific modal categories. When the elasticity calculation is made for a modal subtotal or for combined single-ride and pass trips, the elasticity generally falls within reasonable bounds.

There are several interesting comparisons to be found in Table 19. First, when comparing single-ride trips to pass trips, the latter appear to be more elastic in the core system, but more inelastic in the non-core system. The total core system's single-ride elasticity averages -0.19, compared to -0.40 for pass trips. However, in the commuter rail system, the largest service in the non-core system, single-ride elasticity is actually unit elastic, while pass elasticity is highly inelastic at -0.04. A second characteristic of note is that total non-core ridership appears more elastic than core ridership. Within the core, the most elastic service is the surface Green Line, with an elasticity of -0.47, while the entire core system has an elasticity of -0.27. Outside of the core, several commuter rail zones and the commuter boat service appear to have elasticities of -0.50 or less, while the total non-core elasticity is -0.42. Finally, within the modal subtotals, it is interesting to note that the surface Green Line had by far the greatest demonstrated elasticity of any rapid

TABLE 19
Calculated Price Elasticities
(Post-Fare Increase Impacts Analysis)

Mode	Single-Ride Trips	Pass Trips	Total Trips
Bus	-0.12	-0.51	-0.21
Rapid Transit	-0.23	-0.38	-0.29
Subway & Silver Line Waterfront	-0.14	-0.31	-0.21
Silver Line Washington St	+0.68	-0.33	-0.10
Surface Green Line	-0.49	-0.43	-0.47
Total Core AFC System	**-0.19**	**-0.40**	**-0.27**
Commuter Rail	-1.00	-0.04	-0.44
Zone 1a	+0.86	+0.48	+0.46
Zone 1	-0.71	-0.88	-0.83
Zone 2	-0.65	+0.29	-0.10
Zone 3	-0.59	-0.23	-0.38
Zone 4	-0.98	+0.20	-0.20
Zone 5	-1.21	-0.04	-0.54
Zone 6	-1.01	+0.10	-0.39
Zone 7	-1.18	-0.18	-0.64
Zone 8	-0.94	-0.13	-0.51
Commuter Boat	+8.77	-3.18	-0.77
The RIDE	+2.17		+2.17
Total Non-Core Non-AFC System	**-1.16**	**0.00**	**-0.42**
Total System	**-0.27**	**-0.33**	**-0.30**

transit service and that, within the various commuter rail zones, the single-ride elasticities of the upper zones (4 through 8) appear to drive the unit elasticity of the entire commuter rail single-ride category.

Comparison to the Model's Elasticity Inputs

The extent to which the model over- or under-predicted the percent change in ridership and the actual change in unlinked trips can generally be traced back to the price elasticity assumptions that were used in the model and how they differ from the demonstrated elasticities. For example, as shown in Table 20, the demonstrated elasticities for the surface Green Line were much more elastic than what the model assumed, leading to an under-prediction of the percent loss in ridership in this modal category. The situation is similar for bus pass elasticities and commuter rail single-ride elasticities. In both of these cases, the demonstrated elasticity was much more elastic than the model input, leading to much greater ridership declines than what the model predicted. The situation is reversed for The RIDE. While the model predicted an elastic relationship, the actual elasticity was highly inelastic. For ferry services, where the average fare actually decreased in 2007, the positive calculated elasticity for single-ride trips results from the ridership decline in this category. The model did not predict this or the large ridership gains in the pass category.

TABLE 20
Model Input Elasticities versus Demonstrated Elasticities

	Model Elasticities		Demonstrated Elasticities	
Mode	Single-Ride	Pass	Single-Ride	Pass
Rapid Transit and Central Subway	-0.25	-0.20	-0.14	-0.31
Surface Green Line	-0.25	-0.20	-0.49	-0.43
Bus and Trackless Trolley	-0.30	-0.25	-0.12	-0.51
Commuter Rail	-0.20	-0.15	-1.00	-0.04
Ferry Services	-0.30	-0.25	+8.77	-3.18
The RIDE	-0.05		+2.17	

Ridership Diversion

Possible Diversion Factors

As mentioned above, a diversion factor is an estimate of the likelihood of a switch in demand from one good to another that is related to the change in the relative prices of those goods. The difficulty in estimating diversion lies in separating the effects of diversion from the effects of elasticity. Indeed, diversion is itself a type of measure of cross elasticity, or the measurement of how a price change in one good affects the demand for the other. While elasticity is estimated from ridership and price inputs, the estimate of diversion must depend on assumptions regarding this elasticity figure.

Unlike the calculation for elasticity, diversion factors cannot be definitively measured from ridership and price changes alone. As a result, most studies of diversion attempt to derive the factor through surveys. This study estimates diversion factors using an assumption that may reasonably be made about elasticity.

When the percent increase in single-ride fares is greater than in pass prices, it is likely that some number of single-ride customers, when faced with the improved price of passes relative to single-ride fares, will choose to purchase a pass. The trips associated with these customers were therefore diverted from the single-ride to the pass category. To determine this number of trips, however, an assumption must be made as to the "real" elasticity, as opposed to the observed elasticity. The observed single-ride elasticity includes the loss of all riders in that fare category, regardless of whether they have diverted to the pass category or have left the MBTA system altogether. The real elasticity takes into consideration the fact that some of the riders lost from the single-ride category merely shifted to the pass category. Thus the real elasticity is somewhat less elastic; that is, the fare increase actually had less impact on ridership demand than what the observed elasticity measured. So, in order to estimate diversion, an elasticity adjustment must be applied.

Table 21 presents the assumed annual diverted trips by mode and the resultant diversion factors when different assumptions are made regarding the elasticity adjustment. In all cases, the direction of the diversion is estimated to occur from single-ride to pass trips, due to a smaller percent increase in pass prices relative to the percent increase in single-ride fares. Therefore, the real single-ride price elasticity is assumed to be less elastic (as has been explained) and the real pass elasticity is assumed to be more elastic (since some of the loss of pass riders was masked by the diversion of riders to pass from single-ride) than the respective observed elasticities for these two categories.

When a 15 percent adjustment is applied to the observed elasticities to make the single-ride elasticity less elastic (which means, numerically, decreasing the absolute value of the elasticity number) and to make the pass elasticity more elastic (increasing the absolute value), this results in an estimated 912,787 trips being diverted in the rapid transit and Central Subway category from single-ride to pass trips. The resultant diversion factor is 0.051. When the assumed elasticity adjustment is increased, making the single-ride elasticity even less elastic and the pass elasticity even more elastic, more trips are assumed to divert from the single-ride to the pass category.

The greatest number of diversions as a percent of ridership, regardless of the elasticity adjustment factor used, occurs on the surface Green Line. It appears that the relative change in prices was so great for this modal category that the number of diversions totaled more than 100 percent of the potential diversions that were expected due to the change in relative prices. Systemwide, between 2.8 and 4.7 million single-ride trips are assumed to have diverted to pass trips, assuming that the real single-ride price elasticities are 15-25 percent less elastic and pass price elasticities are 15-25 percent more elastic than their observed levels.

TABLE 21
Diversion Assumptions and Diversion Factors:
Single-Ride to Pass Trips

	Assumed Diversions		Diversion Factors	
	Elasticity Adjustment		Elasticity Adjustment	
Mode	15%	25%	15%	25%
Rapid Transit and Central Subway	912,787	1,521,312	0.051	0.085
Surface Green Line	827,856	1,379,761	2.153	3.424
Bus and Trackless Trolley	504,850	841,417	0.031	0.051
Commuter Rail	501,298	835,497	0.988	1.572
Ferry Services	17,576	29,293	0.037	0.061
Systemwide	**2,807,044**	**4,678,406**	**0.153**	**0.253**

An additional diversion that was modeled in the Pre-Fare Increase Impacts Analysis was from bus trips to rapid transit trips, due to the greater percent increase in bus prices than rapid transit prices. As shown in Table 22, with elasticity adjustments between 12 and 15 percent making the bus real elasticity less elastic and the pass real elasticity more elastic, the estimated number of diversions is assumed to be between 1.0 and 1.2 million annual trips. The resultant diversion factor based on this assumption therefore ranges between 0.041 and 0.051.

TABLE 22
Diversion Assumptions and Diversion Factors:
Bus to Rapid Transit Trips

	Elasticity Adjustment	
	12%	15%
Assumed Diversions	984,271	1,230,339
Diversion Factor	0.041	0.051

Comparison to the Model's Diversion Inputs

Diversion from single-ride to pass trips was assumed by the model to have a 0.050 diversion factor. As shown in Table 21, with the given elasticity adjustments, the diversion factors are generally much greater, with only a few exceptions. An elasticity adjustment of approximately 5 percent, however, would lead to a systemwide diversion factor of 0.052. In terms of diversion from bus to rapid transit trips, the model used in the Pre-Fare Increase Impacts Analysis assumed factors between 0.019 and 0.017 for subway and combo trips, respectively. Table 22, on the other hand, shows diversion factors between 0.041 and 0.051, depending on the elasticity adjustment. An elasticity adjustment of approximately 5 percent would result in a diversion factor of 0.017 between bus and rapid transit.

Pass-Ride Values

The pass-ride value for each pass type equals the number of trips taken per pass sold per the modal category per the time period of the pass type. It is determined by dividing the total number of pass sales by the total number of uses by modal category. In this way, the systemwide pass-ride value for a given pass type equals the sum of its modal pass-ride values. Note that the estimated pass-ride values will be depressed by the extent of flash pass use, as there is no way to know which pass was used and where. It is therefore likely that modes with higher flash pass activity, such as local bus, express bus, and surface Green Line, have actual pass-ride values that are higher than the estimated ones.

Table 23 presents each of the pass types' pass-ride values for the various modal categories and the system. The highest relative values are those of the monthly LinkPass, commuter rail zonal passes, and Senior/TAP Pass. In each of these cases, the high pass-ride value is attributable to trips on multiple modes, likely because of transferring. Indeed, the commuter rail modal pass-ride value for commuter rail zonal passes is 35.84, approximately the rate that would be expected for regular commuting travel. But an additional 20.29 trips per month are taken on subway rapid transit, many of which likely involve transferring from and to commuter rail.

TABLE 23
Pass-Ride Values
(Post-Fare Increase Impacts Analysis)

	Modal Category								
Pass Type	Local Bus	Inner Express	Outer Express	Subway Rapid Transit	Surface Light Rail	Surface Silver Line	Comm. Rail	Comm. Boat	System
Local Bus	36.13	0.19	0.01	N/A	N/A	1.63	N/A	N/A	37.96
Inner Express	8.33	12.05	<0.01	15.17	0.46	0.15	N/A	N/A	36.17
Outer Express	3.81	0.86	20.92	12.07	0.57	0.10	N/A	N/A	38.32
Monthly LinkPass	12.79	0.03	<0.01	47.38	4.12	0.63	N/A	0.16	65.11
1-Day LinkPass	0.15	<0.01	<0.01	4.39	0.11	0.03	N/A	N/A	4.68
7-Day LinkPass	5.39	0.02	<0.01	13.11	0.50	0.18	0.02	<0.01	19.22
Comm. Rail Zone	1.84	0.11	0.17	20.29	0.42	0.15	35.84	0.05	58.86
InterZone	1.44	0.22	<0.01	N/A	N/A	<0.01	34.03	N/A	35.70
Comm. Boat	0.27	0.03	0.01	9.02	0.09	0.04	12.91	13.77	36.14
Senior/ TAP	27.89	0.10	<0.01	34.99	3.70	2.25	N/A	N/A	68.93
Student	3.87	0.06	<0.01	15.68	0.24	0.05	0.50	N/A	20.40

In the Pre-Fare Increase Impacts Analysis, only total pass-ride values were used: that is, the values were not broken down into modal and sub-modal categories. Those values are presented in Table 24 and compared to the estimated actual pass-ride value of the relevant existing pass type. As shown in the table, the model appears to have underestimated pass use on most pass types. The Local Bus Pass is a pass type for which the model overestimated pass use; however, much of the difference between the model's estimate and the estimated actual level of use is likely accounted for by flash pass activity.

TABLE 24
Comparison of Pass-Ride Values
Pre-Fare Increase Impacts Analysis versus Post-Fare Increase Impacts Analysis

	Pass Type							
	Local Bus	Subway	Combo Weekly	Combo Monthly	1-Day Pass	7-Day Pass	Commuter Rail Pass	Water Pass
"Pre-" Analysis	64.20	58.30	10.10	43.90	4.00	20.00	42.00	47.50
"Post-" Analysis	37.96	65.11	19.22	65.11	4.68	19.22	58.86	36.14

Summary of Analysis Results and Comparisons

The figures presented in the Post-Fare Increase Impacts Analysis provide useful information on how ridership and revenue were affected in calendar year 2007 by the fare increase and changes to the fare structure. The comparison of these results to the impacts projected by the Pre-Fare Increase Impacts Analysis should assist the MBTA in better estimating the ridership and revenue effects of any fare increases or restructuring in the future. In general, the model appeared to slightly under-predict both the ridership loss and revenue gain. Price elasticities used by the model were generally less elastic than those evidenced by the results of the analysis. This would explain the underestimation of the ridership declines associated with fare increases. The slight underestimation of the revenue gain is likely due mainly to the switching of riders between certain fare and modal categories, such as the diversion of riders from the Local Bus Pass to the LinkPass.

With future price changes or restructurings that alter the relative prices of fare or modal categories, therefore, the elasticities, diversion factors, and pass-ride values developed in this analysis should be used to estimate the impacts on ridership and revenue. Undoubtedly, some adjustments will need to be made. Elasticities often tend to increase in absolute terms along with the percent change in the price. The large surface Green Line elasticity, for example, may have been an accurate representation of the ridership change in response to the elimination of free outbound boardings, but future fare increases will likely be much smaller in percentage terms, and it may make more sense to apply a lower elasticity when estimating ridership for this modal category. Moreover, with the availability of a constant stream of AFC data now and into the future, it will become much easier to more quickly observe changes in ridership and revenue. In this way, the MBTA will constantly enhance its understanding of how the fare structure impacts the daily ridership choices of its customers.

REVENUE-BASED RIDERSHIP ESTIMATION RESULTS AND COMPARISON TO AFC FIGURES

Background

Before the MBTA began to implement AFC technology throughout the bus and rapid transit systems, ridership was estimated using a revenue-based methodology. In this methodology, a sample of fares paid onboard buses or surface light rail vehicles or at subway station faregates was collected; an average farebox deposit was calculated for each trip and an average faregate deposit was calculated for each survey time period; and a modal average farebox and faregate deposit was estimated with the appropriate statistical confidence. This average deposit was then divided into total non-pass revenue to obtain an estimate of total boardings, or linked trips. In the case of light rail and heavy rail, in-station transfer factors were then applied to obtain unlinked trips.

As this ridership information was required for the National Transit Database (NTD), the MBTA estimated ridership in the core system for four general modes: directly operated motorbus (including all express buses, Silver Line Washington Street, and Silver Line Waterfront), trackless trolley, light rail, and heavy rail. Furthermore, in order to estimate light rail ridership, the mode was broken into two categories: surface and subway. For surface light rail, an average farebox deposit was estimated. For subway light rail, an average faregate deposit was estimated. Revenue was reported by modal category or subcategory and linked trips were estimated for each by dividing revenue by the respective average farebox/faregate deposit.

In state fiscal year (SFY) 2008, the MBTA intends to report all ridership figures using AFC. Factors for in-station transfers or farebox/faregate non-interaction will still be applied to adjust the AFC numbers, but the revenue-based ridership estimation methodology will no longer be used. In SFY 2007, due to the partial availability of AFC data, AFC was used to report ridership on heavy rail and subway light rail; however, the revenue-based methodology was still used to estimate ridership for motorbus, trackless trolley, and surface light rail. While the MBTA will use AFC to report ridership totals to the NTD for this year and into the foreseeable future, this section of the Post-Fare Increase Impact Analysis will compare ridership estimates of the revenue-based methodology against those reported by AFC for the core transit system. This comparison may provide some indication of the accuracy of the revenue-based methodology used in previous years.

Comparison

Motorbus

For the revenue-based ridership estimation, the combination of the ridechecks of directly operated motorbus trips in the four quarters of calendar year (CY) 2007 provides the necessary sample size to estimate an average farebox deposit for this mode. A total of 283 trips were ultimately used to estimate an average farebox deposit of $0.3401. The precision of this estimate equaled 7.72 percent, indicating that any value lying within this percentage of $0.3401 would be considered to meet the 95 percent confidence threshold that the National Transit Database mandates by specifying that the precision of the estimate not exceed 10 percent. By dividing this average farebox deposit into the total non-pass transaction revenue calculated for directly operated motorbus, an estimate of 101,698,048 total boardings is achieved. This figure is slightly higher than SFY 2007's estimate of motorbus ridership and slightly greater than SFY 2006's estimate. Like the previous two fiscal years, this CY 2007 estimate lies well below those of SFYs 2003-2005.

AFC data can be split into the various NTD modal categories, as it was for the modal categories specified by the Post-Fare Increase Impacts Analysis. According to AFC data from all non-trackless-trolley local buses, the Silver Line Washington Street, and the Silver Line Waterfront, total directly operated motorbus ridership in CY 2007 totaled 99,797,400. The revenue-based methodology therefore appears to accurately estimate directly operated motorbus ridership in CY 2007, differing by only 1.9 percent from the AFC figure. This AFC ridership total falls well within the 7.72 precision range of the revenue-based estimate.

Trackless Trolley

In the revenue-based ridership estimation, the trackless trolley average fare is determined through conducting a full ridecheck, as the total number of trips is small enough that a full ridecheck is possible. This ridecheck was done for all trackless trolley routes in the summer quarter of 2007. According to that ridecheck, the average farebox deposit was calculated as $0.3973, with a precision of 4.89 percent, well below the required level. Dividing this average farebox deposit into total trackless trolley non-pass transaction revenue results in a ridership estimate for this mode of 2,692,670. Such an estimate would be the lowest estimate of trackless trolley ridership over the past five fiscal years. A slightly higher average farebox deposit ($0.344 in SFY 2007) is the likely reason for this supposed decline in trackless trolley ridership.

AFC ridership figures for the trackless trolley routes total to 3,180,202. Therefore, in the case of trackless trolley, it appears that the revenue-based ridership methodology underestimates boardings by 15.3 percent. Even when the precision percentage is applied to the revenue-based methodology's estimate, the value does not reach the AFC's reported total.

Light Rail

In revenue-based ridership estimation, as mentioned above, light rail is split between surface and subway. The two numbers are then combined when reporting total light rail ridership to the NTD. For surface light rail, the same surveying process by which the farebox non-interaction factor was determined was also used to collect a sample of farebox deposits per trip and calculate an average deposit of $0.503. Dividing this deposit into total surface light rail non-pass revenue results in an estimate of 25,650,065 boardings in CY 2007. Ridership on subway light rail was determined using the average faregate deposit from the SFY 2007 NTD report of $0.791. The calculation for this ridership equals 29,548,881.

The combination of surface and subway light rail results in an estimate of total light rail boardings of 55,198,946. When the in-station transfer factors are applied to account for heavy rail passengers transferring to light rail and light rail passengers transferring from one light rail line to another, the estimate of total unlinked light rail trips equals 74,415,716 with an associated precision of 5.87 percent. This estimate lies well within the range of light rail ridership estimates for the past five fiscal years.

Total AFC-reported light rail boardings in CY 2007 equal 51,502,695, and total unlinked trips equal 73,797,805. The revenue-based ridership estimate is thus only 0.8 percent greater than the AFC figure, which lies well within the 5.87 percent precision range of the revenue-based estimate.

Heavy Rail

For revenue-based ridership estimation, the average heavy rail faregate deposit equals $0.704; this was calculated for the SFY 2007 NTD report, though it was not used, as AFC data was available for the heavy rail figure for the 2007 portion of the fiscal year. After dividing this deposit figure into heavy rail non-pass revenue, total heavy rail boardings are estimated at 92,864,866 and total heavy rail unlinked trips are estimated at 125,000,451 with a precision of 8.46 percent. This figure lies well below the range of estimates that were made using the revenue-based methodology over the past five fiscal years.

Total AFC-reported heavy rail boardings equal 109,001,452, and total unlinked trips sum to 144,891,429. Therefore, the revenue-based methodology results in an estimate of unlinked trips that is 13.7 percent lower than what was reported by AFC. Even when applying the precision range to the number, the revenue-based methodology appears to underestimate heavy rail unlinked trips. This discrepancy is likely due to a larger average faregate deposit figure than is appropriate. As indicated by the AFC ridership figures, it appears that many riders likely diverted from single-ride to pass trips over the course of CY 2007. Such behavior would have lowered the average faregate deposit. Indeed, when total single-ride revenue is divided by total heavy rail ridership, the average faregate deposit is calculated at $0.60 – more than $0.10 lower than the SFY 2007 NTD figure. Moreover, as one would expect, using this lower average farebox deposit in revenue-based ridership estimation results in an estimate of heavy rail unlinked trips virtually identical to that reported by AFC.

Summary

Table 25 summarizes these comparisons. As shown in the table, the revenue-based methodology appears to have accurately estimated directly operated motorbus and light rail ridership while significantly underestimating trackless trolley and heavy rail ridership. The difference between the revenue-based methodology and the AFC data for the core system is -5.6 percent. However, if the lower average faregate deposit for heavy rail is used, resulting in a ridership estimate much closer to the AFC figure, the systemwide difference drops to just 0.5 percent. If these differences are indicative of past estimates of MBTA ridership using the revenue-based methodology, it would suggest that this methodology has been and can be quite accurate. However, these estimates are sensitive to the sampled farebox/faregate deposit figure.

TABLE 25
Comparison of CY 2007 Estimates of Total Unlinked Trips
Revenue-Based Estimation Methodology versus AFC

Mode	Revenue-Based Methodology	AFC	% Difference
Directly Operated Motorbus	101,698,048	99,797,400	+1.9%
Trackless Trolley	2,692,670	3,180,202	-15.3%
Light Rail	74,415,716	73,797,805	+0.8%
Heavy Rail	125,000,451	144,891,429	-13.7%
Total Core System	**303,806,885**	**321,666,836**	**-5.6%**

To help assess the extent that the inaccuracies of the revenue-based ridership estimation just examined may have been systematic over the years, Table 26 compares the AFC CY 2007 figures to a five-year average of NTD modal estimates. When considering that the AFC numbers include the effect of the 2007 fare increase and thus should be, on average, 9.5 percent less than pre-fare increase figures (see Table 13), the figures are not so dissimilar. While it appears, for example, that the revenue-based methodology may have overestimated directly operated motorbus and trackless trolley ridership, it also seems likely that the methodology underestimated light rail and only slightly overestimated heavy rail unlinked trips. Given that these latter two modes make up two-thirds of total core system ridership, it appears that the revenue-based methodology may have resulted in only a slight underestimation of total core system ridership.

TABLE 26
Comparison of Estimates of Total Unlinked Trips:
Revenue-Based Estimation for SFYs 2003-2007* versus AFC for CY 2007

Mode	5-Year NTD Average*	AFC	% Difference
Directly Operated Motorbus	102,212,079	99,797,400	+2.4%
Trackless Trolley	3,384,456	3,180,202	+6.4%
Light Rail	66,498,196	73,797,805	-9.9%
Heavy Rail	134,669,322	144,891,429	-7.1%
Total Core System	**306,764,054**	**321,666,836**	**-4.6%**

** Five-year NTD average factored down by 9.5 percent to account for ridership decline due to the CY 2007 fare increase.*

RIDERSHIP CHARACTERISTICS OF THE CORE SYSTEM (AFC DATA)

This final section of the Post-Fare Increase Impacts Analysis will take a closer look at various aspects of the AFC data collected over 2007. Note that the information presented in this section pertains only to the core AFC system. The analysis does not include ridership on modes not covered by AFC, such as commuter rail, commuter boat, or The RIDE, nor does it include assumptions and factors related to in-station transfers or farebox/faregate non-interaction. The tables and graphs represent only the transactions that occurred at fareboxes, faregates, and validators. Accordingly, “ridership” in this section refers exclusively to unlinked trips.

This section will begin by charting various ridership characteristics over the 12 months of calendar year (CY) 2007. It will then turn to a breakdown of usage by mode, fare type (single-ride or pass), and fare media (CharlieCard, CharlieTicket, or cash onboard). Subsequent to the concluding remarks that follow upon the present section, the appendix will present the percentages of transactions by fare type and fare media for every surface bus route (all bus routes except for the subway stations of the Silver Line Waterfront service), subway rapid transit station, and surface Green Line route.

Monthly AFC Transactions in 2007

Following a fare increase such as the one instituted in January 2007, the traditional expectation is that demand will immediately drop by some percentage, only to slowly return to some consistent, lower overall level of demand. Figure 1 appears to generally bear out this theory of responsiveness to price. As shown in the figure, the two months with the lowest ridership in 2007 are January and February, the months immediately following the fare increase. In March, ridership climbed above 20 million monthly transactions and remained at this relative level throughout most of the rest of the year.

FIGURE 1

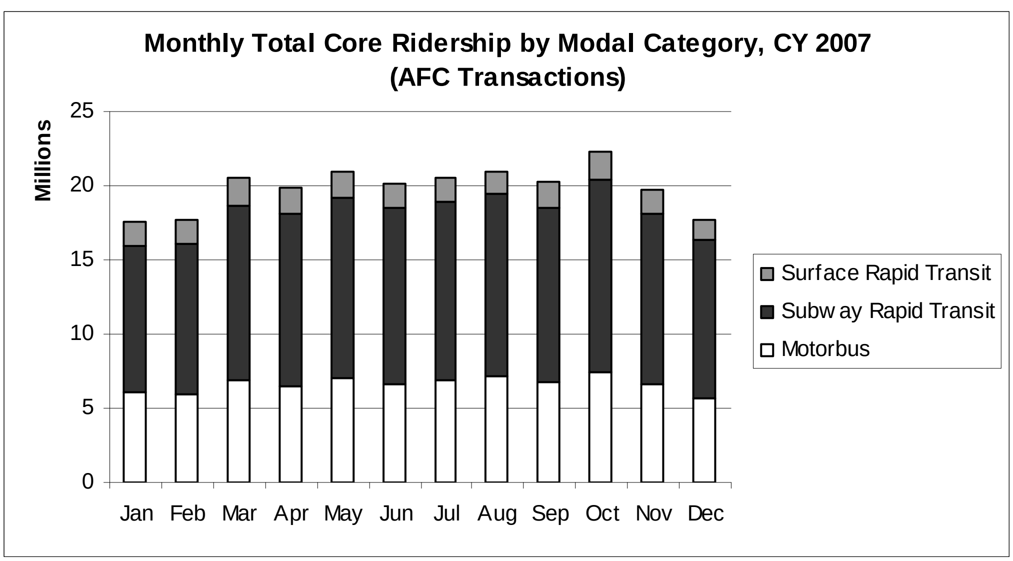


Figure 2 breaks down monthly total core ridership by fare type – i.e. single-ride (including all adult, senior, and student single-ride fares as well as free, transfer, and short transactions) and pass. As mentioned above, non-AFC transactions, such as in-station transfers, fare evasion, or flash pass uses are not included. As shown in the figure, while both single-ride and pass transactions do appear to respond to the fare increase in the same way – with lower transaction totals in January and February compared to most other months – there seems to be greater variability in the pass transactions. While the difference between the minimum and maximum month of single-ride trips is 2.0 million, or 26 percent, the corresponding difference for pass trips is 3.4 million, or 37 percent.

FIGURE 2

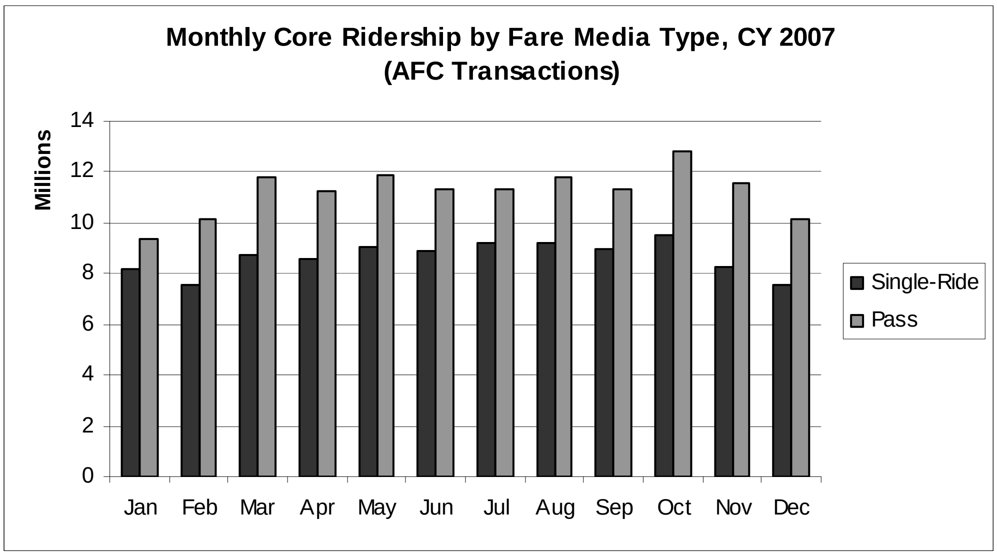


Figure 3 shows the pass sales totals for the major pass types over twelve months. Sales of the pass type with the largest sales volume, the monthly LinkPass, likely drive much of the variability in pass ridership. Monthly LinkPass sales jumped dramatically from March to April and then averaged approximately 150,000 per month for the rest of the year, varying between a high of 168,159 in October and a low of 134,224 in June. Sales of the 7-Day LinkPass steadily increased between February and August. There is very little variability in the monthly sales of commuter rail zonal passes, the Local Bus Pass, and the 1-Day LinkPass.

As the MBTA introduced a new means of paying fares in 2007 with the CharlieCard and encouraged its use by imposing surcharges on CharlieTicket and cash onboard single-ride adult fares and by limiting the step-up transfer discount to CharlieCard users, it is also interesting to chart the penetration of the CharlieCard over the course of 2007. Several factors limit this penetration. For example, the availability of AFC technology only in the core system means that all passes available for use on commuter rail or the commuter boat must be loaded on CharlieTicket stock, so as to be of use both in and outside the core. This list of passes includes all commuter boat and commuter rail passes, as well as the express bus passes and the 7- and 1-Day LinkPasses. However, as shown in Figure 4, CharlieCard usage has increased throughout 2007. Correspondingly, CharlieTicket usage and onboard payments with cash have declined throughout the year.

FIGURE 3

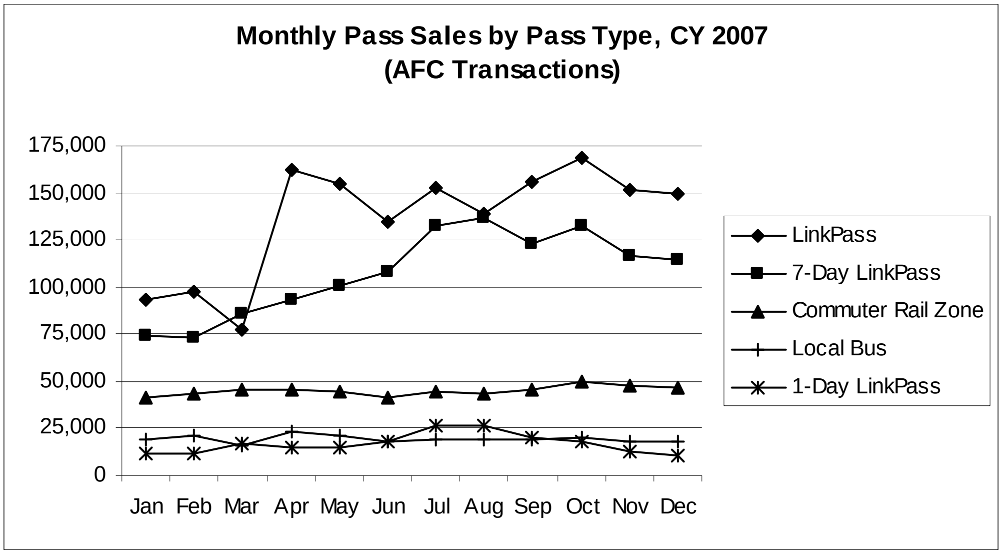
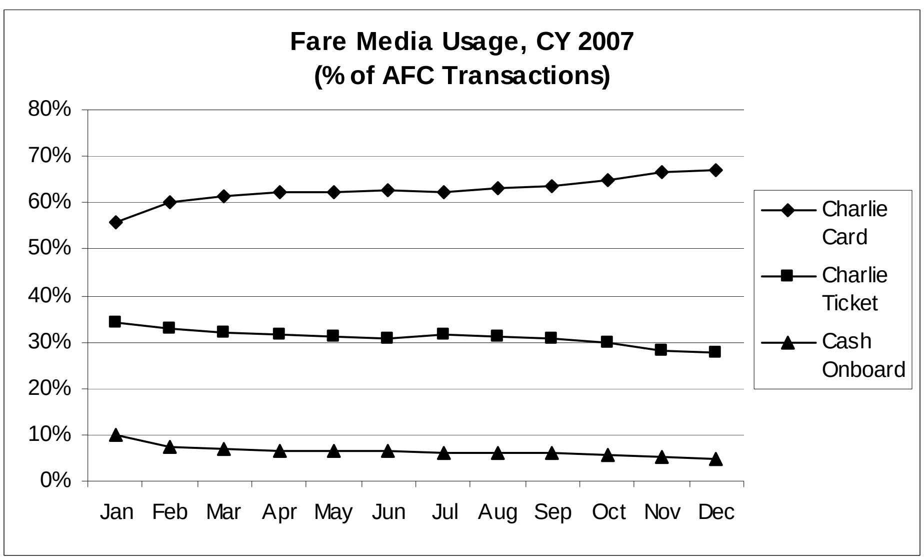


FIGURE 4



AFC Transactions by Fare Type

The charts in Figure 5 break down single-ride and pass transactions into the various fare types for the three modal categories of bus, subway rapid transit, and surface rapid transit. Bus includes local and crosstown routes as well as inner and outer express bus routes. Subway rapid transit consists of all stations with gated pre-payment boarding areas. This includes all Silver Line and Green Line subway stations. Surface rapid transit contains surface Green Line routes as well as the Mattapan High-Speed Line, the Silver Line Washington Street, and the surface portion of the Silver Line Waterfront.

As shown in the charts, the majority of single-ride fares on all modes are adult full fares. However, this fare type constitutes a much greater percentage of transactions on both subway and surface light rail compared to bus. Seniors and students both make up a greater percentage of bus trips than of rapid transit trips. There is also a much greater percentage of transfer fares paid on bus (either bus-to-bus or rapid transit-to-bus transfers) than on either subway or surface rapid transit. Short fares also represent a sizable portion of bus transactions. The existence of short fares on surface rapid transit is the only noticeable difference between this category and subway rapid transit; the percentage of trips taken using other fare types is similar for both modes.

As shown in the second half of Figure 5, there is a greater diversity of options for pass users than for single-ride customers. Still, by far the most used pass on all modes is the monthly LinkPass. Indeed, the LinkPass is used for more than twice as many trips as the Local Bus Pass in the bus category. Following the Local Bus Pass in this mode, the 7-Day LinkPass contributes the next highest percentage of trips. As with the single-ride category, a greater portion of trips is taken with the Senior Pass on bus than on either rapid transit mode. Subway rapid transit has a higher percentage of trips taken with a commuter rail zonal pass than either surface rapid transit or bus. Other passes, such as InterZone or commuter boat passes, are used very little on any part of the local bus, subway rapid transit, or surface rapid transit systems.

FIGURE 5

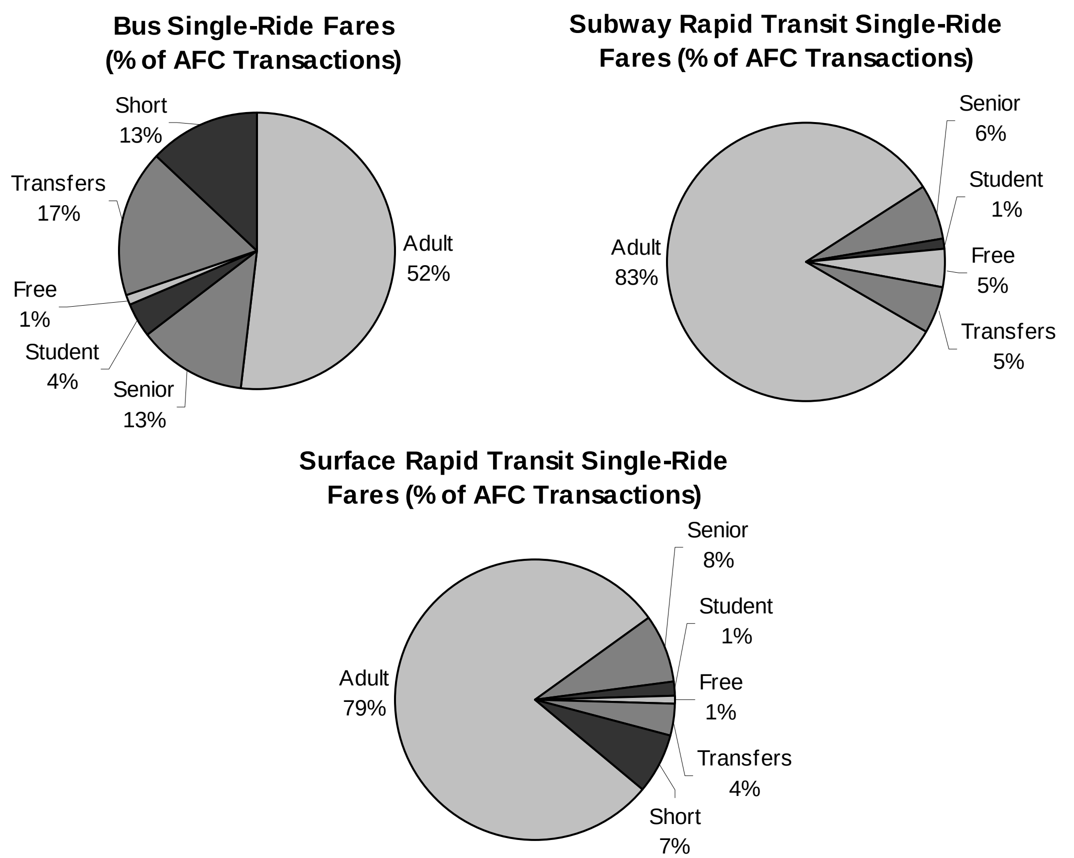


FIGURE 5 – cont.

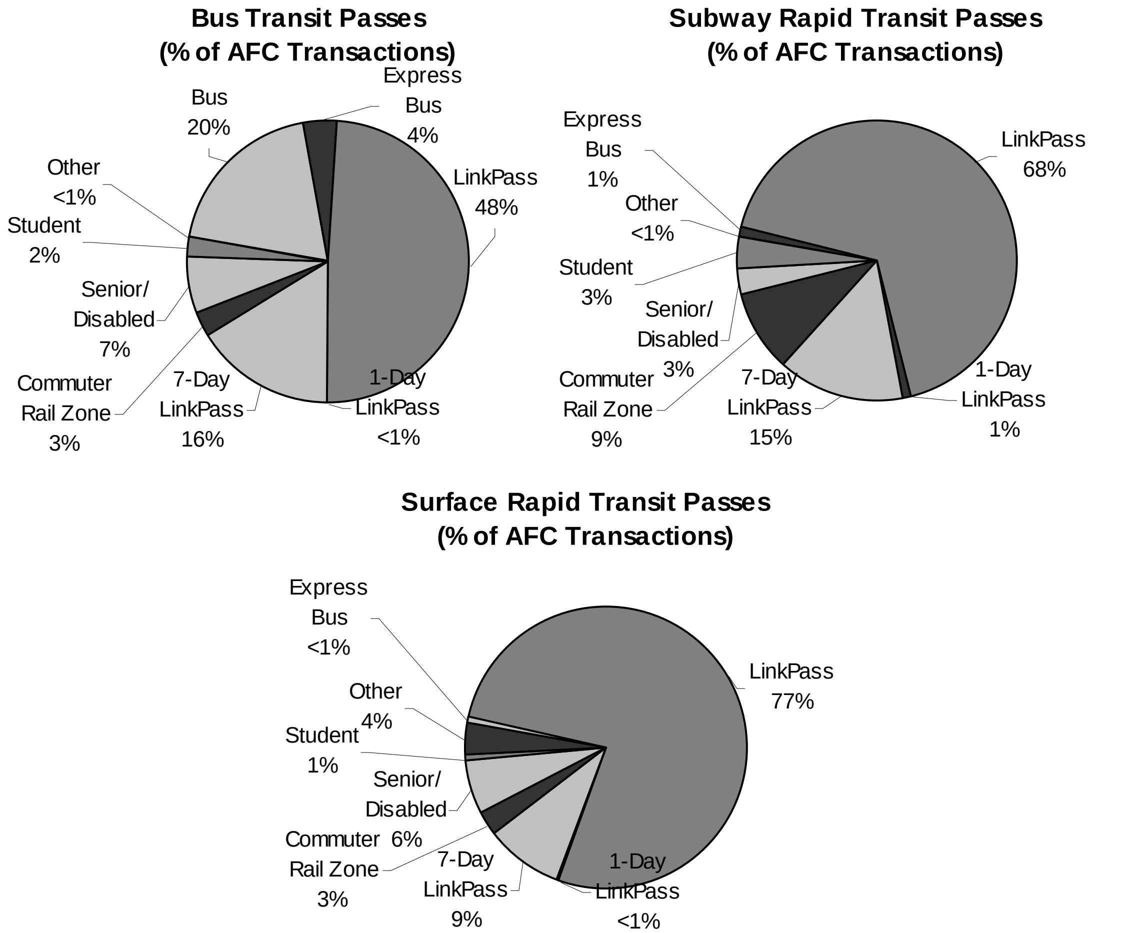
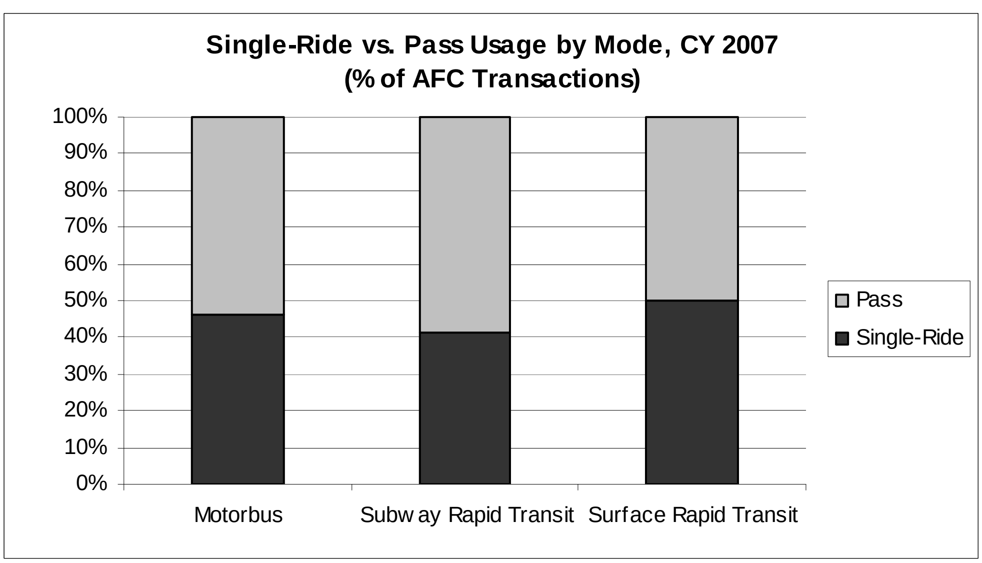


Figure 6 gives the percentages of single-ride and pass transactions by mode. Subway rapid transit has the greatest percentage of pass trips, followed by bus and then surface rapid transit. Surface rapid transit trips were almost evenly split between single-ride and pass trips in 2007.

FIGURE 6



AFC Transactions by Fare Media

As mentioned above, the extent to which MBTA customers enter the system via CharlieCard, CharlieTicket, or cash onboard is a matter of significant interest. Greater CharlieCard penetration, for example, not only provides more customers with a lower fare for single-ride transactions and transfers but also greater ease of use in terms of interacting with AFC equipment. For the MBTA, the CharlieCard offers the most efficient way to collect revenue in terms of operations, particularly at fareboxes onboard buses and light rail vehicles. While CharlieCards are currently unavailable for use on non-core modes, thus discouraging non-core riders from using CharlieCards even when accessing core modes, it is interesting to note the breakdown of fare media usage between CharlieCard, CharlieTicket, and cash onboard on certain fare and modal categories.

Figure 7 shows the percentage of transactions by fare media for the three major modal categories. Surface rapid transit has the highest CharlieCard penetration, followed by subway rapid transit and then bus. Surface rapid transit also has the smallest share of CharlieTicket transactions.

FIGURE 7

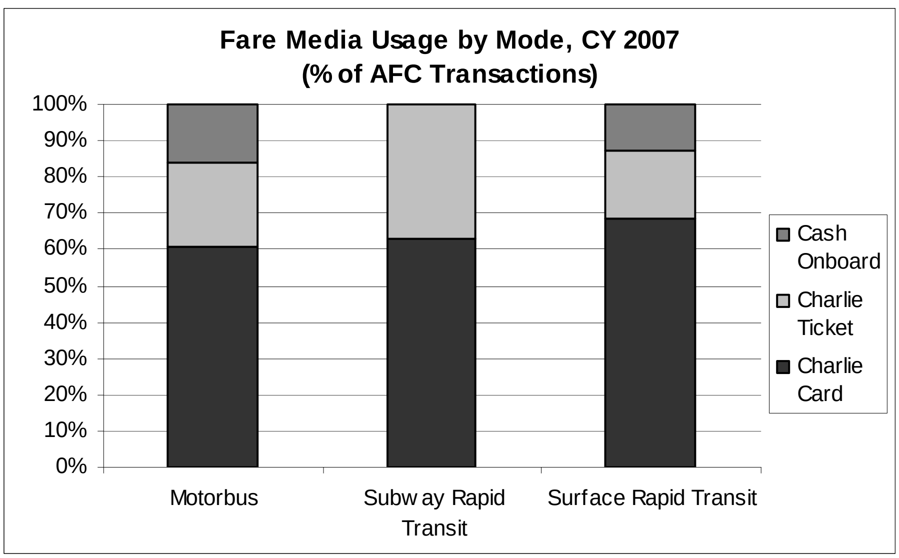


Figure 8 breaks down the modal categories in Figure 7 by fare type. While the CharlieCard penetration rate is almost the same between single-ride and pass trips for the bus mode, there are significant differences in the fare media usage on the two rapid transit modes between single-ride and pass trips. On surface rapid transit, for example, while approximately 60 percent of single-ride transactions are made with a CharlieCard, this percentage climbs to nearly 80 percent for pass transactions. On subway rapid transit, the situation is reversed. Nearly 9 percent fewer pass trips use the CharlieCard than single-ride trips.

FIGURE 8

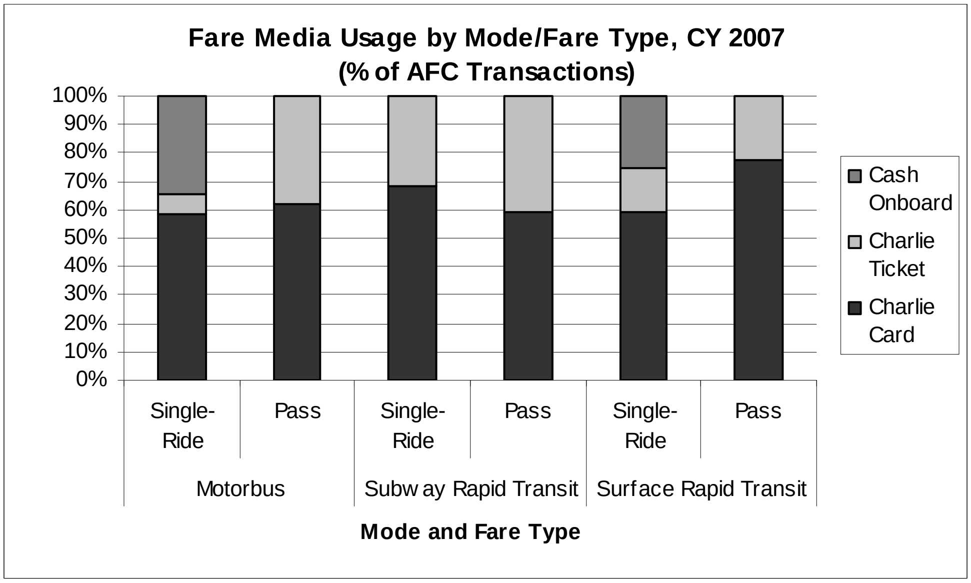


Figure 9 further breaks down one of the categories in Figure 8, examining single-ride adult fares. It is with these fares that perhaps the greatest cost difference between CharlieCard and other fare-payment media exists, as CharlieTicket and cash onboard fares are $0.25 greater on bus and $0.30 greater on rapid transit. As demonstrated by the figure, in 2007 approximately 40 percent of transactions for all modes incurred the single-ride adult fare surcharge imposed on CharlieTicket and cash onboard customers.

FIGURE 9

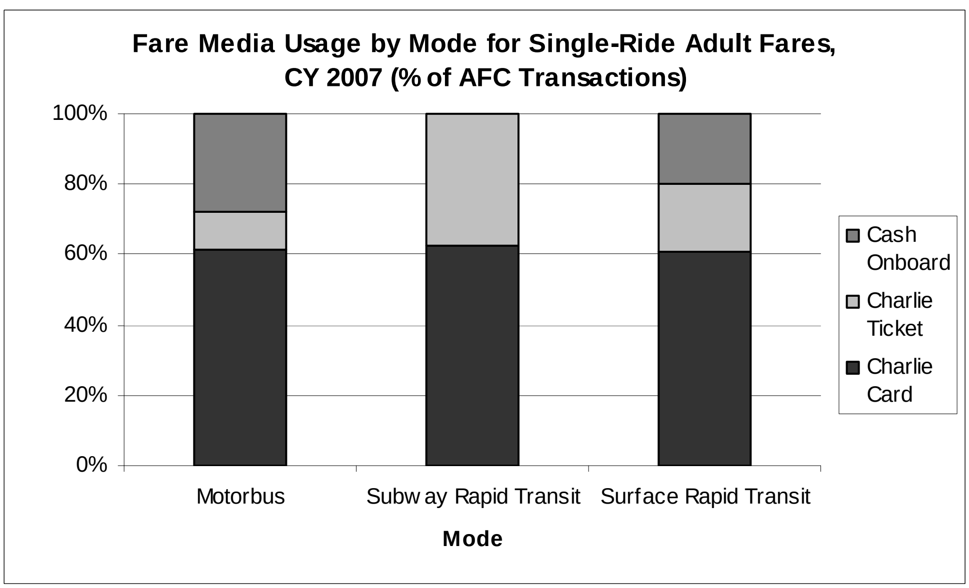
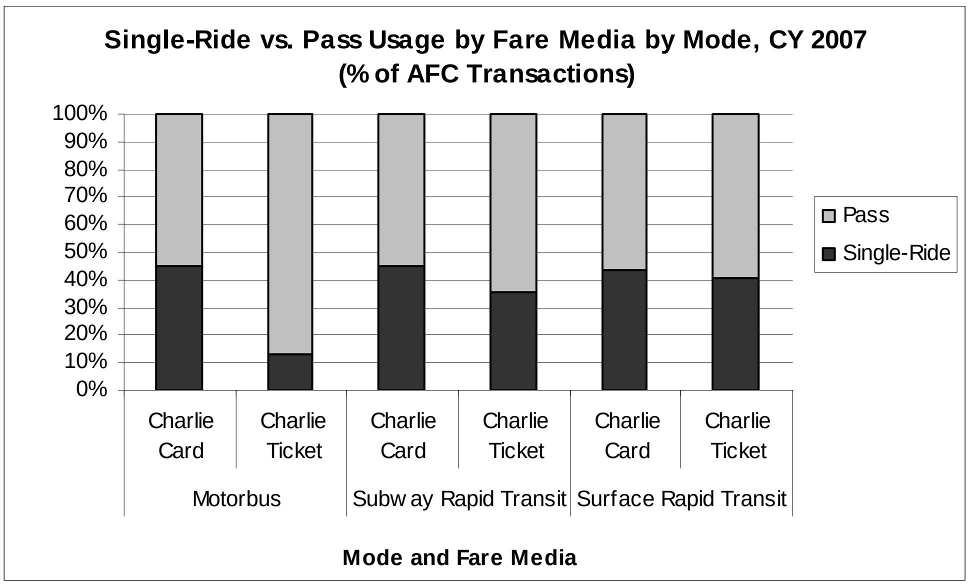


Figure 10 presents one final way of understanding the interaction of fare media and fare type by mode. This figure breaks down modal CharlieCard and CharlieTicket uses by whether they were a single-ride or pass trip. It is interesting to note, for example, that nearly 90 percent of bus CharlieTicket transactions were pass trips while only 55 percent of CharlieCard transactions on this mode were pass trips. A greater percentage of CharlieTicket transactions were pass trips compared to CharlieCard transactions on the two rapid transit modes as well, though the differences were much smaller. The percentage splits of CharlieCard trips between single-ride and pass trips are practically the same across all three modes.

FIGURE 10



CONCLUSION

The fare increase and restructuring of 2007 marked one of the most significant changes in how the MBTA charges and collects fares since the days of exit fares. A symbol of this change, “Charlie on the MBTA,” has become more and more familiar, and embodies for MBTA customers their feelings about the service they use.

While there was undoubtedly ridership loss at the outset of 2007 immediately following the fare increase, many of the new elements of the fare structure likely helped to moderate that loss and perhaps attracted new riders as well. Many customers certainly appear to have responded to the incentives of the new fare structure. A majority of single-ride trips on all modal categories are made using the CharlieCard, and thus receive the lower fare per trip. The percentage of riders using the CharlieCard also increased throughout the year. The LinkPass, which replaced the Combo and Combo+ Passes as well as the Subway Pass, is by far the pass with the highest use in the system and across all core modes, indicating that the intent of the pass to encourage multi-modal travel is being realized.

The analysis of ridership responsiveness to price increases in 2007 will assist the MBTA in better projecting the impacts of future changes in prices or structure. In general, the ridership price elasticities used to project demand in the Pre-Fare Increase Impacts Analysis model do not appear to have been elastic enough. Pass ridership in particular declined in the core system at levels greater than the model predicted, while on commuter rail, single-ride trips appeared much more responsive to price than expected.

The elasticities developed from these ridership changes will be of much use when forecasting ridership in the future. Furthermore, as single-ride fares increased relatively more than pass prices, it was anticipated that some amount of diversion between the fare types would occur. While the level of diversion cannot be exactly measured, it is possible by comparing the relative elasticities of single-ride versus pass categories for various modes to make some assumptions regarding the number of trips that the changing prices could have encouraged to switch from single-ride to pass.

One of the advantages provided by the implementation of AFC technology is the potential for a much greater understanding of customer choices as demonstrated by their ridership patterns. No longer is a revenue-based ridership estimation methodology, in which trips are estimated at the modal level, the only means by which the MBTA can chart ridership trends. Now, while certain limitations to AFC data do exist in terms of estimating in-station transfers, flash pass use, and fare evasion, the extent of information provided can assist in multiple comparisons of use by route, station, fare type, and fare media. Going forward, as a history of use for each of these categories is collected and both the depth of the data and the ability to understand it are improved, the MBTA will be able to use this data more and more effectively in planning for the valuable service it provides.

APPENDIX: AFC TRANSACTIONS BY ROUTE AND STATION

The presentation of AFC data in the body of this report has necessitated some level of aggregation. Every transaction on a farebox, faregate, or validator, however, is collected for, and therefore can be associated with, a specific route or station. Tables A-1 through A-3 contain information for MBTA surface bus routes, subway rapid transit stations, and surface Green Line branches, respectively. The tables provide the total transactions and the breakdowns by fare type and fare media for each individual route, station, and branch. Included in the fare types in these tables are transfers, as it may be interesting to note the routes or stations with a high degree of transfer activity.

Preceding the tables, Figures A-1 through A-6 present this data in graphical format. The figures show, for CY 2007, the percentage of transactions by fare type (single-ride, transfer, and pass) and by fare media (CharlieCard, CharlieTicket, and cash onboard) for surface bus routes, subway rapid transit stations, and surface Green Line branches, respectively, sorted by total annual transactions. For example, in Figure A-1, all surface bus routes are ordered on the x-axis by total ridership. The y-axis shows each route’s percentages of single-ride, transfer, and pass transactions. For instance, the route located rightmost on the x-axis is the Silver Line Washington Street, as the count of its CY 2007 transactions was well over 3 million. The markers locating it there are the three rightmost symbols in the figure, which represent the percentages for that route of single-ride, transfer, and pass transactions (just over 40 percent, just below 10 percent, and approximately 50 percent, respectively). As has been mentioned, the exact percentages for each bus route can be found in Table A-1.

FIGURE A-1

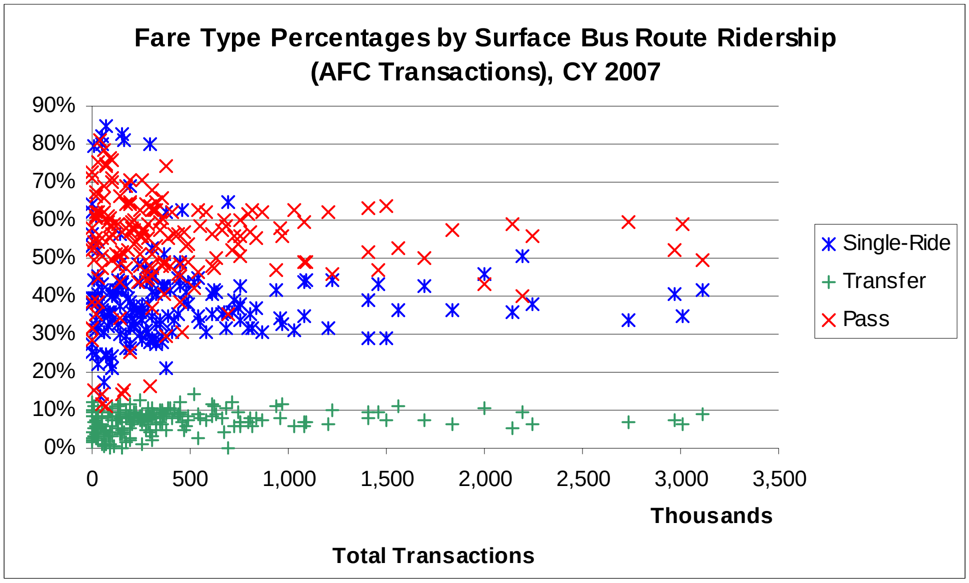


FIGURE A-2

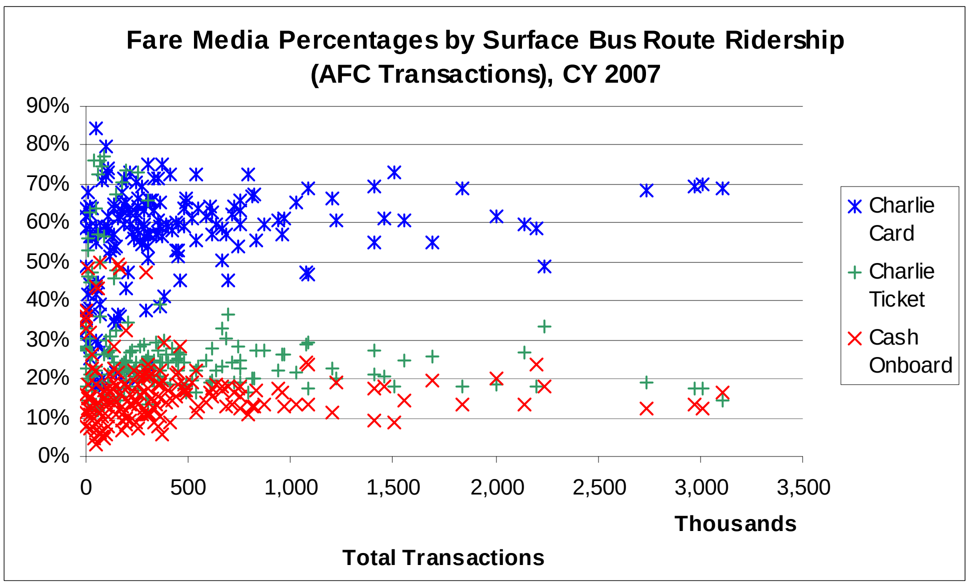


FIGURE A-3

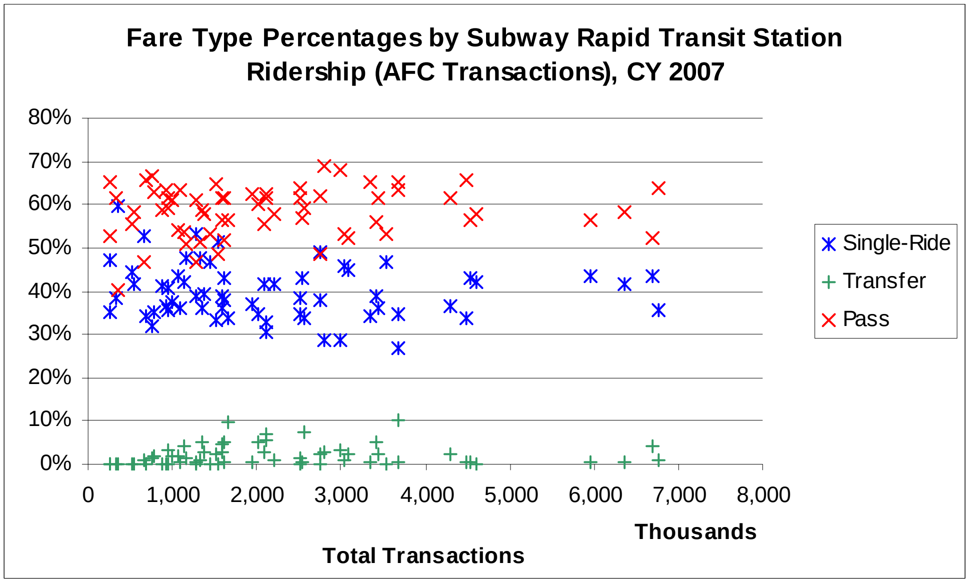


FIGURE A-4

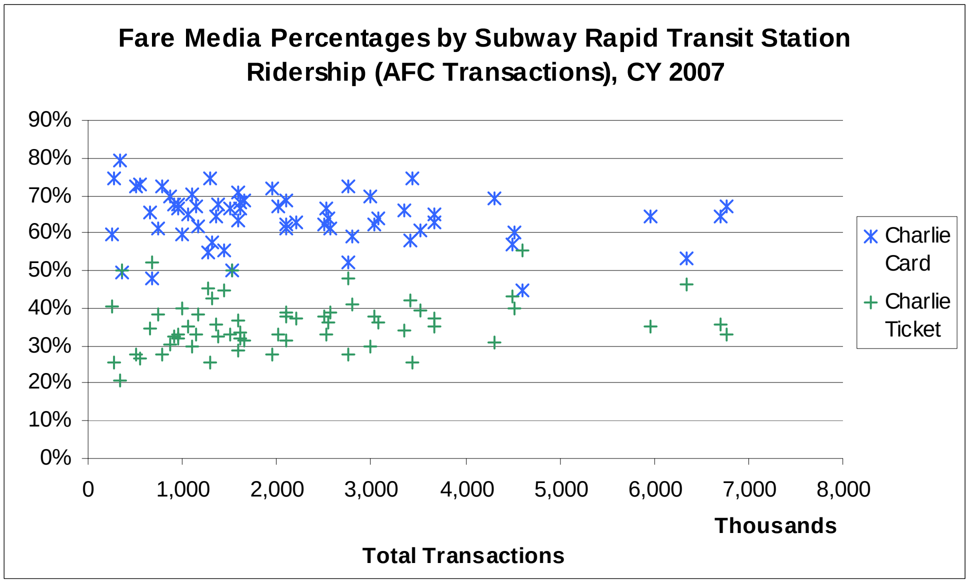


FIGURE A-5

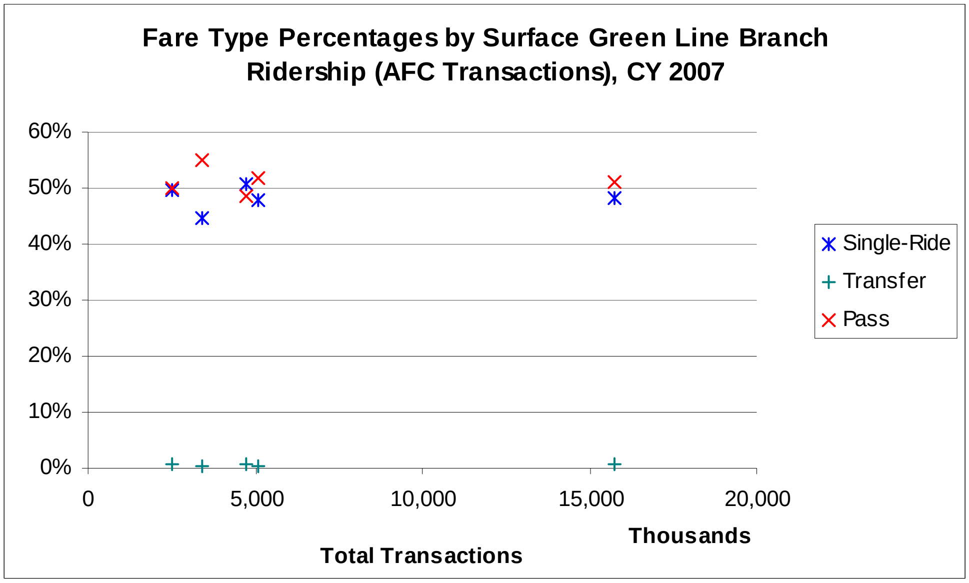


FIGURE A-6

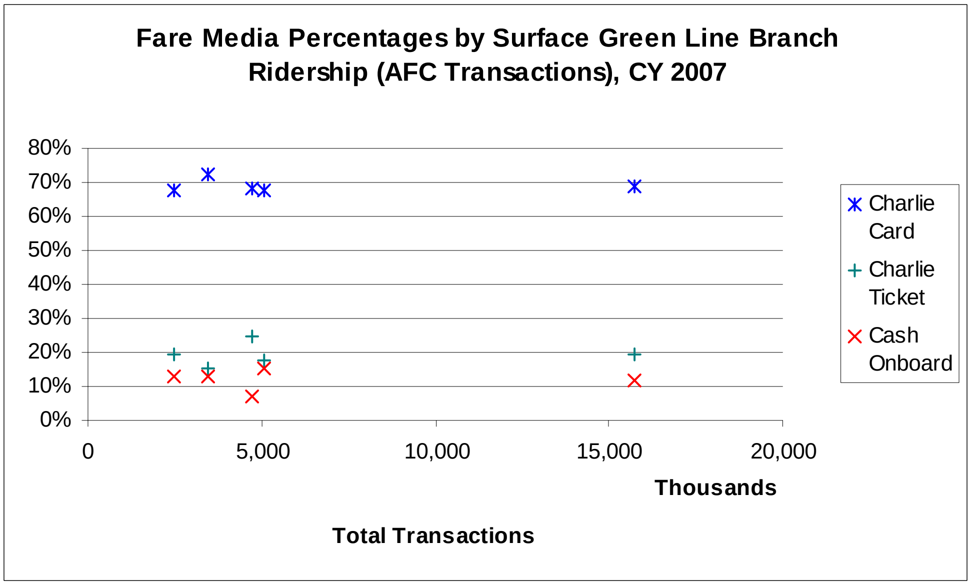


TABLE A-1
Fare Type and Fare Media Percentages by Surface Bus Route
CY 2007

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
1	Harvard/Holyoke Gate - Dudley Station via Mass Ave	2,974,054	41%	7%	52%	69%	17%	13%
4	North Station - World Trade Center via Congress Street	65,731	30%	4%	66%	39%	50%	11%
5	City Point - McCormack Housing	33,840	52%	10%	38%	57%	17%	26%
6	Boston Marine Industrial Park - South Station/Haymarket	29,607	41%	5%	54%	64%	26%	10%
7	City Pt. - Franklin & Devonshire Sts via Northern Avenue	541,141	35%	3%	63%	73%	16%	11%
8	Harbor Point/UMass - Kenmore Station	809,920	35%	8%	57%	67%	20%	13%
9	City Point - Copley Square via Broadway Station	1,085,963	35%	6%	59%	69%	17%	14%
10	City Point - Copley Square via Andrew Station	755,005	42%	7%	50%	59%	23%	18%
11	City Point - Downtown via Bayview	722,583	39%	6%	56%	64%	19%	17%
14	Roslindale Square - Dudley Station	282,735	46%	9%	45%	60%	20%	20%
15	Kane Square or Fields Corner - Ruggles Station	1,221,112	44%	10%	46%	61%	20%	19%
16	Forest Hills Station - Andrew Station or U. Mass.	934,634	42%	11%	47%	61%	22%	17%
17	Fields Corner Station - Andrew Station	635,179	41%	9%	50%	60%	22%	18%
18	Ashmont Station - Andrew Station via Dorchester Ave.	139,549	56%	10%	34%	57%	15%	28%
19	Fields Corner Station - Ruggles Station via Grove Hall & Dudley	489,687	38%	8%	54%	65%	19%	16%
21	Ashmont Station - Forest Hills Station	715,193	36%	12%	52%	62%	24%	14%
22	Ashmont Station - Ruggles Station via Talbot Ave	1,456,792	43%	10%	47%	61%	21%	18%
23	Ashmont Station - Ruggles Station via Washington Street	2,004,459	46%	11%	43%	62%	19%	20%
24	Wakefield Ave. & Truman Pkwy - Mattapan or Ashmont Station	275,354	47%	9%	44%	55%	24%	21%
25	Franklin Park - Ruggles Station via Dudley	23,774	39%	5%	55%	64%	21%	15%
26	Ashmont Station - Norfolk & Morton Belt Line	245,526	36%	13%	51%	63%	23%	14%
27	Mattapan Station - Ashmont Station via River Street	139,327	38%	12%	51%	64%	22%	14%
28	Mattapan Station - Ruggles Station via Dudley Station	2,198,130	50%	9%	40%	59%	18%	23%
29	Mattapan Station- Jackson Square Station via Seaver Street	368,148	43%	9%	48%	57%	24%	19%
30	Mattapan Station - Roslindale Square or Forest Hills	386,333	35%	10%	55%	60%	26%	14%
31	Mattapan Station - Forest Hills Station via Morton Street	966,357	33%	12%	56%	61%	26%	13%
32	Wolcott Square - Forest Hills Station via Hyde Park Avenue	1,558,156	36%	11%	53%	61%	25%	15%
33	Dedham Line - Mattapan Station via River Street	139,669	48%	8%	44%	54%	24%	22%
34	Walpole Center - Forest Hills Station via Washington Street	1,403,203	39%	10%	52%	55%	27%	17%
35	Dedham Mall/Stimson Street - Forest Hills Station	422,371	34%	10%	56%	58%	28%	14%
36	Charles River Loop, V.A. Hospital or Rivermoore - Forest Hills	684,151	31%	10%	58%	57%	30%	13%

CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
37	Baker & Vermont Streets - Forest Hills Station	286,276	31%	11%	59%	59%	29%	12%
38	Wren Street - Forest Hills Station	189,485	32%	11%	57%	65%	24%	11%
39	Forest Hills Station - Back Bay Station	3,014,309	35%	6%	59%	70%	18%	13%
40	Georgetowne - Forest Hills Station	227,222	37%	9%	54%	58%	27%	15%
41	Center & Eliot Streets - Dudley Station	446,544	45%	9%	45%	60%	22%	19%
42	Forest Hills Station - Ruggles Station via Washington Street	520,754	44%	14%	42%	61%	20%	19%
43	Ruggles - Park & Tremont Streets	486,009	44%	7%	49%	67%	16%	17%
44	Jackson Square Station - Ruggles Station via Seaver Street	608,258	41%	11%	48%	64%	19%	17%
45	Franklin Park Zoo - Ruggles Station	619,336	42%	11%	47%	63%	20%	18%
47	Central Square, Cambridge - Albany Street via Longwood Area	792,280	31%	7%	62%	73%	17%	11%
48	Center & Eliot Street - Jamaica Plain Loop	25,832	45%	10%	45%	56%	21%	23%
50	Cleary Square - Forest Hills Station	216,007	33%	9%	57%	60%	27%	13%
51	Reservoir (Cleveland Circle) - Forest Hills Station	358,733	29%	10%	61%	66%	24%	10%
52	Dedham Mall or Charles River Loop - Watertown Square	120,021	42%	7%	51%	52%	27%	21%
55	Jersey & Queensberry Streets - Copley Square or Park Street	190,224	38%	3%	59%	71%	17%	11%
57	Watertown Square - Kenmore Station via Commonwealth Ave.	2,142,094	36%	5%	59%	60%	27%	14%
59	Needham Junction - Watertown Square	262,144	36%	7%	57%	56%	28%	16%
60	Chestnut Hill - Kenmore Station via Cypress Street	270,822	31%	5%	64%	69%	20%	11%
62	Bedford V.A. Hospital - Alewife Station	251,315	34%	9%	57%	66%	20%	13%
64	Oak Square - Central Square, Cambridge or Kendall/M.I.T.	330,592	33%	5%	63%	63%	25%	12%
65	Brighton Center - Kenmore Station via Brookline Ave.	307,812	29%	3%	68%	75%	14%	12%
66	Harvard Square - Dudley Station via Harvard Street	2,734,688	34%	7%	59%	68%	19%	13%
67	Turkey Hill - Alewife Station	105,245	24%	6%	70%	74%	16%	10%
68	Harvard Square, Holyoke Gate - Kendall/MIT via Broadway	94,160	35%	4%	60%	72%	14%	14%
69	Harvard/Holyoke Gate - Lechmere Station via Cambridge Street	753,990	38%	7%	56%	66%	19%	15%
70	Cedarwood or Watertown Square - Central Square, Cambridge	1,693,844	43%	7%	50%	55%	25%	19%
71	Watertown Square - Harvard Station via Mount Auburn Street	1,410,937	29%	8%	63%	70%	21%	9%
72	Huron Avenue - Harvard Station via Concord Avenue	217,700	32%	8%	60%	73%	18%	9%
73	Waverly Square - Harvard Station via Trapelo Road	1,502,842	29%	7%	63%	73%	18%	9%
74	Belmont Center - Harvard Station via Concord Ave.	248,328	30%	8%	62%	71%	20%	9%
75	Belmont Center - Bennett St. Alley via Huron Towers	81,601	32%	8%	60%	71%	19%	10%
76	Hanscom Air Base - Alewife Station via Mass. Ave.	195,044	26%	9%	65%	71%	20%	10%
77	Arlington Heights - Harvard Station via Mass. Ave.	1,833,913	36%	6%	57%	69%	18%	13%
78	Arlmont Village - Harvard Station	330,366	27%	8%	65%	72%	19%	9%

CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
79	Arlington Heights - Alewife Station via Mass. Ave.	258,227	37%	7%	56%	64%	17%	19%
80	Arlington Center - Lechmere Station	474,229	39%	5%	57%	59%	24%	17%
83	Rindge Avenue - Central Square, Cambridge	475,393	41%	6%	53%	64%	17%	19%
84	Arlmont Village - Alewife Station	44,295	14%	5%	81%	84%	12%	3%
85	Spring Hill - Kendall/M.I.T. Station	98,423	21%	3%	76%	80%	14%	6%
86	Sullivan Square Station - Reservoir (Cleveland Circle) via Harvard	1,201,502	32%	6%	62%	66%	23%	11%
87	Arlington Center or Clarendon Hill - Lechmere Station	819,452	32%	6%	62%	67%	20%	13%
88	Clarendon Hill - Lechmere Station via Highland Ave.	1,028,203	31%	6%	63%	65%	22%	13%
89	Clarendon Hill - Sullivan Square Station via Broadway	867,412	30%	7%	62%	60%	27%	13%
90	Davis Square - Wellington Station	242,014	36%	8%	56%	61%	24%	15%
91	Sullivan Square Station - Central Square, Cambridge	442,446	35%	8%	56%	60%	24%	15%
92	Assembly Square Mall - Downtown via Main Street	323,206	41%	6%	53%	66%	19%	15%
93	Sullivan Square Station - Downtown via Bunker Hill Street	752,447	34%	6%	60%	63%	24%	12%
94	Medford Square - Davis Square Station	313,901	28%	9%	63%	66%	23%	11%
95	West Medford - Sullivan Square Station	344,361	32%	10%	57%	57%	29%	14%
96	Medford Square - Harvard Station via George Street	409,345	30%	8%	62%	73%	19%	9%
97	Malden Center Station - Wellington Station	174,442	34%	8%	58%	63%	24%	13%
99	Upper Highlands - Wellington	292,779	28%	8%	64%	65%	25%	11%
100	Elm Street - Wellington Station via Fellsway	191,324	27%	9%	64%	65%	25%	10%
101	Malden Center Station - Sullivan Square Station	956,875	34%	8%	58%	57%	26%	16%
104	Malden Center Station - Sullivan Square Station via Ferry Street	834,343	37%	8%	55%	56%	27%	17%
105	Malden Center Station - Sullivan Square Station via Main Street	203,059	36%	7%	58%	63%	22%	15%
106	Lebanon Street, Malden - Wellington Station	583,981	30%	7%	62%	62%	24%	14%
108	Linden Square - Wellington Station	666,500	35%	8%	57%	59%	23%	18%
109	Linden Square - Sullivan Square Station	743,535	37%	9%	54%	54%	28%	17%
110	Wonderland or Park Avenue & Broadway - Wellington Station	612,840	35%	8%	56%	57%	28%	15%
111	Woodlawn - Haymarket Station via Mystic River/Tobin Bridge	2,240,867	38%	6%	56%	49%	34%	18%
112	Wellington Station - Maverick Station via Mystic Mall	305,748	46%	9%	46%	54%	23%	22%
114	Bellingham Sq. - Maverick Station	207,686	34%	6%	60%	48%	35%	18%
116	Wonderland Station - Maverick Station via Revere Street	1,076,702	44%	7%	49%	47%	29%	24%
117	Wonderland Station - Maverick Station via Beach Street	1,089,008	44%	7%	49%	47%	30%	24%
119	Northgate - Beachmont Station	234,021	48%	8%	44%	56%	22%	22%
120	Orient Heights - Maverick Station via Bennington Street	668,822	36%	4%	60%	50%	33%	17%
121	Wood Island Station - Maverick Station via Lexington Street	65,534	17%	4%	78%	58%	36%	6%
CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard								

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
131	Melrose Highlands - Malden Center Station	105,348	21%	7%	71%	73%	19%	8%
132	Redstone Shopping Center - Malden Center Station	135,092	33%	8%	59%	65%	22%	13%
134	North Woburn - Wellington Station via Woburn Square	446,856	42%	9%	49%	53%	25%	22%
136	Reading Depot - Malden Station	284,026	38%	6%	55%	63%	20%	17%
137	Reading Depot - Malden Center Station via North Avenue	213,191	37%	9%	54%	63%	22%	16%
170	Burlington Industrial Park - Dudley Station via Riverside (AM)	8,924	40%	11%	49%	41%	46%	12%
171	Airport - Dudley via Andrew	1,733	25%	2%	73%	59%	30%	11%
191	Mattapan - Haymarket via Ashmont	5,016	40%	2%	58%	68%	20%	12%
192	Cleary Sq - Haymarket via Forest Hills	21,157	25%	8%	67%	62%	30%	7%
193	Watertown Yard - Haymarket	17,115	31%	3%	66%	57%	30%	13%
194	Clarendon Hill - Haymarket via Sullivan Station	3,315	28%	2%	71%	64%	28%	8%
195	Shattuck Hospital - Park & Tremont Sts	734	38%	10%	52%	62%	22%	16%
201	Fields Corner Loop via Neponset Ave	103,958	34%	10%	56%	59%	27%	14%
202	Fields Corner Loop via Adams St	88,823	36%	9%	55%	59%	26%	15%
210	Quincy Center Station - North Quincy or Fields Corner	169,203	43%	10%	47%	62%	22%	16%
211	Quincy Center Station - Squantum via Montclair and N Quincy	158,137	41%	7%	52%	61%	17%	21%
212	Quincy Center Station - North Quincy Station via Billings Road	52,954	41%	8%	51%	55%	23%	22%
214	Quincy Center Station - Germantown via Sea Street	301,103	41%	8%	51%	57%	26%	18%
215	Quincy Center Station - Ashmont Station via West Quincy	399,749	41%	11%	48%	59%	24%	17%
216	Quincy Center - Houghs Neck via Sea Street	298,342	44%	8%	48%	57%	23%	21%
217	Wollaston Beach - Ashmont Station via Beale Street	52,122	43%	10%	47%	59%	22%	19%
220	Quincy Center Station - Hingham	364,654	42%	9%	49%	59%	22%	18%
221	Quincy Center Station - Fort Point	18,160	31%	7%	62%	59%	25%	15%
222	Quincy Center Station - East Weymouth	353,477	42%	9%	48%	61%	21%	19%
225	Quincy Center Station - Weymouth Landing via Quincy Ave.	551,424	33%	8%	59%	64%	23%	13%
230	Quincy Center Station - Brockton Line via Holbrook	308,388	45%	8%	47%	57%	22%	21%
236	Quincy Center Station - South Shore Plaza	130,048	41%	11%	48%	57%	26%	18%
238	Quincy Center Station or Crawford Sq, Randolph - Ashmont	437,584	45%	9%	46%	53%	26%	21%
240	Avon Line or Crawford Square, Randolph - Ashmont Station	539,946	45%	9%	46%	56%	22%	22%
245	Quincy Center - Mattapan Station via Pleasant Street	103,988	40%	10%	49%	62%	21%	17%
275	Albany Street - Long Island Hospital	1,118	56%	12%	32%	49%	18%	33%
276	BU Medical Area - Long Island Hospital	1,471	62%	9%	28%	35%	27%	37%
277	Lemuel Shattuck Hospital - Downtown Boston	47	53%	9%	38%	36%	28%	36%
325	Elm St, Medford - Haymarket Station via I-93	67,180	24%	1%	75%	18%	76%	6%

CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
326	West Medford - Haymarket Station via I-93	90,700	23%	1%	76%	18%	77%	5%
350	North Burlington - Alewife Station via Burlington Mall	351,779	33%	7%	59%	57%	27%	15%
351	Oak Park - Alewife Station Express	23,902	32%	7%	61%	25%	63%	12%
352	Burlington - Boston Express Bus via Route 128 & I-93	74,867	25%	1%	74%	20%	75%	5%
354	Woburn Line - Boston via I-93	147,428	30%	4%	66%	22%	68%	11%
355	Mishawum Station - State Street via Cummings Park	6,576	39%	7%	54%	29%	56%	15%
411	Malden Center Station - Revere/Jack Satter House via Northgate	187,158	39%	9%	52%	60%	22%	18%
424	Eastern Ave & Essex St -Haymarket	49,036	36%	9%	55%	42%	45%	13%
426	Central Sq. - Wonderland or Haymarket	365,866	51%	9%	40%	39%	39%	22%
428	Oaklandvale - Haymarket via Granada Highlands	35,546	22%	2%	75%	19%	76%	4%
429	Central Square, Lynn - Linden Square	296,541	80%	4%	16%	38%	15%	47%
430	Appleton Street, Saugus - Malden Center Station	249,372	44%	8%	48%	58%	20%	21%
431	Neptune Towers-Central Sq. Lynn	9,809	79%	5%	15%	37%	14%	48%
434	Peabody Sq - Haymarket	11,469	44%	3%	53%	29%	53%	18%
435	Lynn - Danvers via North Shore Mall & Liberty Tree Mall	154,432	83%	3%	14%	37%	14%	49%
436	Central Square, Lynn - Goodwins Circle	162,321	81%	4%	15%	36%	16%	48%
439	Central Square, Lynn - Bass Point, Nahant	16,281	61%	3%	35%	38%	30%	32%
441	Marblehead - Haymarket via Paradise Road; Central Square, Lynn	306,622	53%	11%	37%	51%	25%	24%
442	Marblehead - Haymarket via Humphrey Street	447,707	49%	12%	39%	52%	27%	21%
448	Marblehead - Downtown Crossing via Paradise Road	22,130	34%	6%	60%	44%	45%	11%
449	Marblehead - Downtown Crossing via Humphrey Street	27,068	32%	6%	62%	44%	47%	9%
450	Salem Depot - Boston via Highland & Western Ave.	377,188	62%	9%	29%	41%	30%	29%
451	North Beverly - Salem Depot via Cabot Street or Sohier Road	56,043	82%	6%	12%	45%	12%	43%
455	Salem Depot - Haymarket via Loring Ave. & Central Square, Lynn	458,831	63%	7%	30%	45%	26%	28%
456	Salem Depot - Cent. Sq. Lynn. via Highland/Eastern	48,450	80%	6%	14%	43%	13%	44%
459	Salem Depot - Downtown Crossing	191,098	69%	5%	25%	43%	24%	33%
465	Liberty Tree Mall - Salem Depot via Danvers Sq	71,379	84%	5%	11%	37%	13%	50%
468	Salem Center - Essex Agricultural School via Liberty Tree Mall	2,704	64%	4%	31%	32%	33%	35%
500	Express Bus Riverside - Downtown Boston via Mass Pike	50,113	37%	1%	62%	30%	64%	7%
501	Express Bus Brighton Center - Downtown Boston via Mass Pike	253,002	29%	1%	70%	20%	73%	7%
502	Express Bus Watertown Square - Copley Square via Mass Pike	192,643	27%	2%	70%	19%	73%	8%
503	Brighton - Copley Square	59,055	30%	1%	69%	19%	73%	9%
504	Express Bus Watertown Square - Downtown Boston via Mass Pike	302,542	35%	2%	63%	23%	66%	11%
505	Express Bus Central Square, Waltham - Downtown Boston	175,254	29%	2%	69%	23%	70%	7%

CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard

Route #	Route Name	Total Transactions	Fare Type			Fare Media		
			Single-Ride	Transfer	Pass	CC	CT	OB
553	Roberts - Downtown Boston via Newton Corner & Mass Pike	150,230	44%	5%	52%	34%	48%	18%
554	Waverly Square - Downtown Boston via Mass Pike	132,577	44%	5%	50%	35%	46%	19%
556	Waltham Highlands - Downtown Boston via Mass Pike	86,414	36%	3%	61%	27%	57%	17%
558	Auburndale - Downtown Boston via Newton Corner & Mass Pike	59,644	35%	3%	62%	29%	57%	14%
701	CT1 Central Sq. (Cambridge) - Boston Medical Center via M.I.T.	356,734	28%	6%	66%	72%	21%	8%
708	CT3 Beth Israel Hosp. - Andrew Sta. via Boston Medical Center	178,468	27%	9%	64%	68%	23%	9%
741	Airport - South Station	689,522	65%	0%	35%	45%	37%	18%
742	BMIPK - South Station (Weekday PM)	93,406	41%	0%	59%	57%	30%	13%
743	City Point - South Station	115,189	40%	0%	59%	53%	31%	16%
746	Silver Line Phase 2	150,635	43%	0%	57%	54%	32%	14%
747	CT2 Sullivan Sta. - Ruggles Station via Longwood and Kendall Sta.	374,301	21%	5%	74%	75%	19%	6%
749	Dudley - Downtown (Silver Line)	3,111,171	41%	9%	50%	69%	15%	16%
	All Surface Motorbus Routes	82,336,918	39%	8%	54%	61%	23%	16%

CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard

TABLE A-2
Fare Type and Fare Media Percentages by Subway Rapid Transit Station
CY 2007

Station	Line	Total Transactions	Fare Type			Fare Media	
			Single-Ride	Transfer	Pass	CC	CT
Airport	Blue	1,537,659	51%	0%	49%	50%	50%
Alewife	Red	3,085,033	45%	3%	52%	64%	36%
Andrew	Red	1,584,123	39%	4%	57%	63%	37%
Aquarium	Blue	1,442,202	47%	0%	53%	55%	45%
Arlington	Green	2,512,725	39%	0%	61%	62%	38%
Ashmont	Red	1,665,778	34%	10%	56%	68%	32%
Back Bay	Orange	4,491,560	34%	0%	66%	57%	43%
Beachmont	Blue	786,568	35%	2%	63%	72%	28%
Bowdoin	Blue	335,681	38%	0%	62%	79%	21%
Boylston	Green	2,544,844	43%	0%	57%	64%	36%
Braintree	Red	1,173,206	48%	2%	51%	62%	38%
Broadway	Red	1,144,690	42%	4%	54%	67%	33%
Central	Red	4,301,821	36%	2%	61%	69%	31%
Charles/MGH	Red	2,749,876	38%	0%	62%	72%	28%
Chinatown	Orange	1,602,657	38%	1%	61%	68%	32%
Comm. College	Orange	955,878	41%	0%	59%	67%	33%
Copley	Green	4,523,770	43%	1%	57%	60%	40%
Courthouse	Silver	254,366	35%	0%	65%	60%	40%
Davis Square	Red	3,433,052	36%	3%	62%	74%	26%
Downtown Xing	Red/Orange	6,762,701	35%	1%	64%	67%	33%
Fields Corner	Red	1,063,088	44%	2%	54%	65%	35%
Forest Hills	Orange	3,673,511	27%	10%	63%	63%	37%
Government Ctr.	Blue/Green	3,528,689	47%	0%	53%	61%	39%
Green Street	Orange	920,721	36%	0%	63%	68%	32%
Harvard	Red	6,701,491	43%	4%	52%	64%	36%
Haymarket	Green/Orange	3,407,286	39%	5%	56%	58%	42%
Hynes	Green	3,032,195	46%	1%	53%	62%	38%
Jackson Square	Orange	1,349,317	36%	5%	59%	64%	36%
JFK/UMass	Red	2,200,949	42%	1%	58%	63%	37%
Kendall	Red	3,680,492	35%	0%	65%	65%	35%
Kenmore	Green	2,763,209	49%	2%	49%	52%	48%
Lechmere	Green	2,097,220	41%	3%	56%	62%	38%
Malden	Orange	2,985,321	29%	3%	68%	70%	30%
Mass Ave	Orange	1,384,827	39%	3%	58%	68%	32%
Maverick	Blue	2,797,862	29%	3%	69%	59%	41%
N.E. Medical Ctr.	Orange	1,513,570	33%	2%	65%	67%	33%
North Quincy	Red	1,948,523	37%	0%	62%	72%	28%
North Station	Green/Orange	4,605,398	42%	0%	58%	45%	55%
Oak Grove	Orange	1,582,191	36%	3%	61%	71%	29%
Orient Heights	Blue	1,102,727	36%	0%	63%	70%	30%
Park Street	Red/Green	5,959,258	43%	0%	56%	65%	35%
Porter	Red	2,522,252	35%	1%	64%	67%	33%
Prudential	Green	1,277,049	53%	0%	47%	55%	45%
Quincy Adams	Red	1,325,664	48%	1%	51%	58%	42%
Quincy Center	Red	2,108,787	33%	6%	61%	69%	31%
Revere Beach	Blue	955,116	36%	3%	61%	68%	32%
Roxbury Crossing	Orange	997,010	37%	2%	61%	60%	40%
Ruggles	Orange	2,108,241	31%	7%	62%	61%	39%

CC: CharlieCard; CT: CharlieTicket

Station	Line	Total Transactions	Fare Type			Fare Media	
			Single-Ride	Transfer	Pass	CC	CT
Savin Hill	Red	519,361	44%	0%	56%	72%	28%
Science Park	Green	367,054	60%	0%	40%	50%	50%
Shawmut	Red	555,225	41%	0%	58%	73%	27%
South Station	Red/Silver	6,350,602	41%	0%	58%	53%	47%
State	Blue/Orange	3,351,996	34%	0%	65%	66%	34%
Stony Brook	Orange	872,359	41%	0%	59%	70%	30%
Suffolk Downs	Blue	266,537	47%	0%	53%	75%	25%
Sullivan Square	Orange	2,574,933	34%	7%	59%	61%	39%
Symphony	Green	660,613	53%	1%	47%	65%	35%
Wellington	Orange	2,017,931	35%	5%	60%	67%	33%
Wollaston	Red	1,284,451	39%	0%	61%	74%	26%
Wonderland	Blue	1,619,492	43%	5%	52%	66%	34%
Wood Island	Blue	751,108	32%	1%	66%	61%	39%
World Trade Ctr.	Silver	683,015	34%	0%	66%	48%	52%
All Subway Stations		138,354,831	39%	2%	59%	63%	37%
CC: CharlieCard; CT: CharlieTicket							

TABLE A-3
Fare Type and Fare Media Percentages by Surface Green Line Branch
CY 2007

Line	Total Transactions	Fare Type			Fare Media		
		Single-Ride	Transfer	Pass	CC	CT	OB
Surface B Branch	5,082,899	48%	0%	52%	67%	17%	15%
Surface C Branch	3,441,133	44%	0%	55%	72%	15%	13%
Surface D Branch	4,749,996	51%	1%	49%	68%	25%	7%
Surface E Branch	2,487,215	49%	1%	50%	68%	19%	13%
All Surface Green	15,761,243	48%	1%	51%	69%	19%	12%
CC: CharlieCard; CT: CharlieTicket; OB: Cash Onboard							