Assessing Equity in Transit Pricing:
An Analysis of Triangle Transit

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Executive Summary

Triangle Transit seeks to answer two related questions:

- Are lower-income riders more likely than other riders to use a less efficient payment method that contributes to overpayment?

- What policies can Triangle Transit adopt to address potential inequities between payments by lower- and higher-income riders?

Findings

1. Triangle Transit's poorer riders are more likely to pay with a pass than with cash. Regression analysis that controls for other factors affecting payment type confirms this finding.

2. Overpayment is a persistent problem among Triangle Transit users, but particularly among cash users.

3. Though access to alternative transportation (cars) is important to employment prospects, it is not a statistically significant predictor of overpayment. However, employment status is closely linked to the likelihood a user pays with a pass or cash.

4. Descriptive statistics suggest that income, payment type, and transfers are predictors of overpayment. Lower income, cash use, and higher transfer rates are positive predictors of overpayment. Regression analysis also confirms that income and transfer are large and statistically significant predictors of overpayment.

Recommendations

1. Triangle Transit should increase visibility of 30-day passes at highly-travelled stops.
2. Triangle Transit should move to an electronic "Smart Card" system. As part of this transition, Triangle Transit should reduce transfer fees for customers paying with a "Smart Card."
3. Triangle Transit should ask a series of new questions in the next round of its rider survey, particularly related to payment decisions.
4. Reduce cash fares by 25 percent.

Introduction and Policy Question

An important aspect of Triangle Transit's payment system is that use of a pass that covers a certain time span (a week, ten days, a month, etc) provides a discount relative to paying each individual fare with cash, assuming that the rider reaches a threshold usage level that makes the pass a more efficient payment option than cash. It is unclear whether or not Triangle Transit's poorer riders currently pay a larger per ride price than its wealthier riders because of the different average payment types used for each ride by riders at different income levels. I will examine two related policy questions in order to assess the socioeconomic equity of the public service provided by Triangle Transit.

1. Are lower-income riders more likely than higher-income riders to use a less efficient payment method that contributes to overpayment?
2. What policies can Triangle Transit adopt to address any inequities that might arise?

In the remainder of this paper, I first provide background on who rides Triangle Transit and compare these statistics to ridership at the national level. Next, I present background on the importance of having sufficient access to public transportation and how price changes can affect ridership levels. Following this, I present findings and analysis on question 1 using ridership survey data. Finally, I answer question 2 by offering several recommendations for Triangle Transit's consideration.

Background: Putting Triangle Transit's Rider Demographics in the National Context

Triangle Transit's geographic structure differs from the typical geography covered by transit systems in the US, as Triangle Transit's routes cover both highly populated urban areas, moderately populated semi-urban areas, and less populated suburban areas. Triangle Transit's demographic makeup is similar to national statistics in terms of ethnicity, but differences emerge when measures of socioeconomic advantage are included. Locally, whites make up about 42 percent of riders, blacks about 37 percent, and Hispanics about 10 percent. Nationally, whites make up a plurality of public transit riders, with ridership shares hovering around 40 percent, with blacks and Hispanic/Latino riders making up an additional 33 percent and 14 percent, respectively. (APTA 2007, 22). White and black riders utilize roadway modes of public transportation in nearly equal shares at the national level, at about 40 percent and 36 percent of total ridership, respectively (APTA 2007, 22).

Table 1: Ethnicity of Triangle Transit Riders

Ethnicity	Percent
Black	37.5
Hispanic	10.3
Asian	6.0
White	42.0
Native American	0.9
Other	3.3

N: 2300

Nationally, the income distribution of public transit riders is skewed towards the poor. Looking specifically at riders who choose roadway modes of transportation, 75 percent earn less than $50,000 per year, and a full 43 percent earn less than $25,000 per year (APTA 2007, 24). As shown in Table 2, within the Triangle region, approximately 67 percent of all transit riders earn less than $50,000 per year, suggesting that Triangle Transit serves a relatively wealthier ridership than the national average, but still a population with a significant number of low-income members.

Table 2: Income Distribution of Triangle Transit Riders

Income	Percent
<$10,000 -$24,999	38.5
$25,000 - $49,999	28.1
>$50,000	33.4

N: 1974

Nationally, transit riders are also disadvantaged in terms of access to private automobiles within their households. Table 3 below summarizes automobile ownership among Triangle Transit riders. Choice riders, defined as those who have regular access to automobiles, tend to be wealthier than the "transit dependent," defined as those who have limited or no access to automobiles, and are more likely to be poor, urban, and minorities (Garrett and Taylor 2010). Similarly, "transit captives" tend to be the young, the elderly, the poor, and the handicapped, and those who do not have access to automobiles (Ircha and Gallagher 1985, 1-2). Though national statistics suggest that a significant majority of public transit riders are transit dependent (about 60 percent have no access to a car), Triangle Transit riders have relatively more access to automobiles, with only 35 percent lacking access to a car.

From a policy perspective, however, a relatively wealthy (defined here both by income and by access to automobiles) ridership has its drawbacks. "Choice" riders do not rely on Triangle Transit for transportation, and can substitute private transportation inputs for public transit in the event fares are increased beyond a level they are willing to pay.

Table 3: Vehicle Availabilty among Triangle Transit Riders

Cars	Percent
Zero	35.3
One	41.1
Two	19.3
Three or more	4.3

N: 2,268

In sum, the average Triangle Transit rider is somewhat wealthier than the national average, and has better access to automobiles. Income disparities among riders, and potential gaps between "choice" and "transit dependent" riders, prompt Triangle Transit's concerns about the degree to which different socio-economic groups pay a relatively equal fare (Litman 2010).

Transportation Accessibility and Affordability Directly Impacts Employment Prospects for Minorities and the Poor

Access to public transportation is frequently linked to the employment prospects of minorities and the poor. Locally, Triangle Transit users use its service to travel to and from work for nearly 65 percent of their trips. Nationally, this number is closer to 60 percent; both nationally and in the Triangle, transportation access and employment are very closely linked (APTA 2010a, 14). Table 4 below summarizes the distribution of reasons for choosing Triangle Transit.

Table 4: Primary Purose for Using Triangle Transit

Trip Purpose	Percent
To/from work	64.8
College/Voc School	6.2
To/from shopping	1.1
Social or Recreational	14.2
Medical	0.9
Airport	3.3
School*	5.2
Social Services	1.7
Other	2.7

*Middle or High School
N: 2,460

Spatial mismatch theory suggests a link between employment and public transportation. It states that as poor and minority populations continue to concentrate in urban areas, job opportunities are increasingly located in suburban areas, which in turn creates a mismatch between the location of employment positions and workers available to fill those positions (O'Reagan and Quigley 1999, 1). Because of this, poor and minority households tend to have higher unemployment rates, and longer, more expensive commutes (O'Reagan and Quigley 1999, 1). In addition to access, affordability is directly related to spatial mismatch; although a rider might have access to public transportation, if he or she cannot afford the fare, the option's availability has a negligible impact on employment prospects.

Maintaining Triangle Transit's accessibility and affordability is a central issue to its administrators, especially given that a large percentage of Triangle Transit riders rely on its service to get to or from work. Spatial mismatch would suggest that for Triangle Transit riders who are transit dependent, fare inequity could further decrease their employment opportunities. However, spatial mismatch generally focuses on areas with high concentrations of low-income and minority workers who rely on public transit to get them to jobs outside their urban setting. Triangle Transit's coverage area is much broader and less centralized than other urban transportation systems studied in the literature.

Fare Issues: The Price is Right?

Numerous researchers highlight using elasticity of demand to estimate how riders would respond to fare changes. In the 1960s, transit agencies relied on the Simpson-Curtin model to determine appropriate fare levels (Gallucci and Allen 2009). This model suggests that transit ridership will decrease by one percent for each 3 percent increase in fares (Litman 2007, 6). Litman (2007) concluded that price elasticities tend to be lower for riders dependent on transit than for riders who use transit by choice (Litman 2007, 14). Though transit agencies have traditionally followed an elasticity model for determining the impact of pricing changes, the necessary data are not available to do so for this study. Instead, alternative measures, such as "cost per week" and an "ideal payment" measures, are necessary.

Findings and Analysis

This section reports analysis based on the 2009 Triangle Transit Riders' Survey.

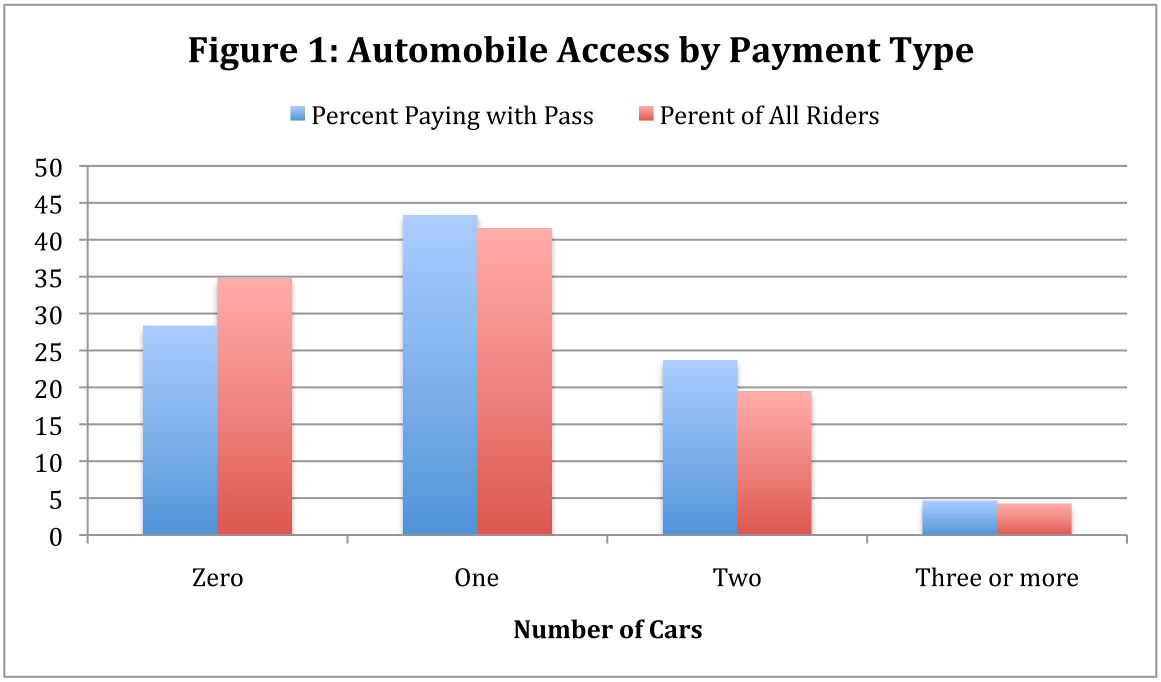
1. ***Poorer Riders are More Likely to Pay with Cash than a Pass***

Descriptive statistics, presented below in Table 5, indicate that, in general, Triangle Transit's low-income riders are more likely than higher-income riders to pay their fares with cash than with a pass. Additionally, across several measures of advantage, more disadvantaged riders are more likely to pay with cash than a discounted pass.

Table 5 Pass Use by Income Level

	Income Level			
Payment Type	<$10,000-$24,999	$25,000-$49,999	> $50,000	Total
Cash	285	144	82	511
(%)	39.5	26.4	12.6	26.6
Pass	437	402	569	1,408
(%)	60.5	73.6	87.4	73.4
Total	722	546	651	1,919
(%)	100	100	100	100

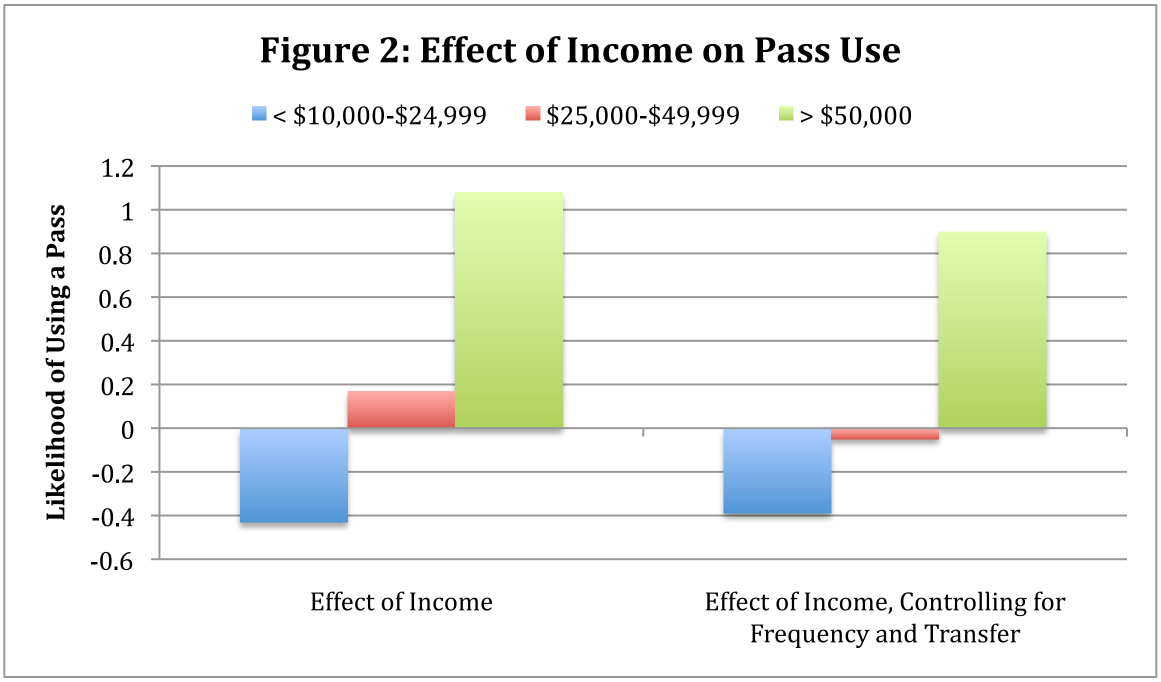
Car ownership is also an important correlate of pass use. Riders who have no access to a car represent a much lower share of pass usage than their overall share of the population.



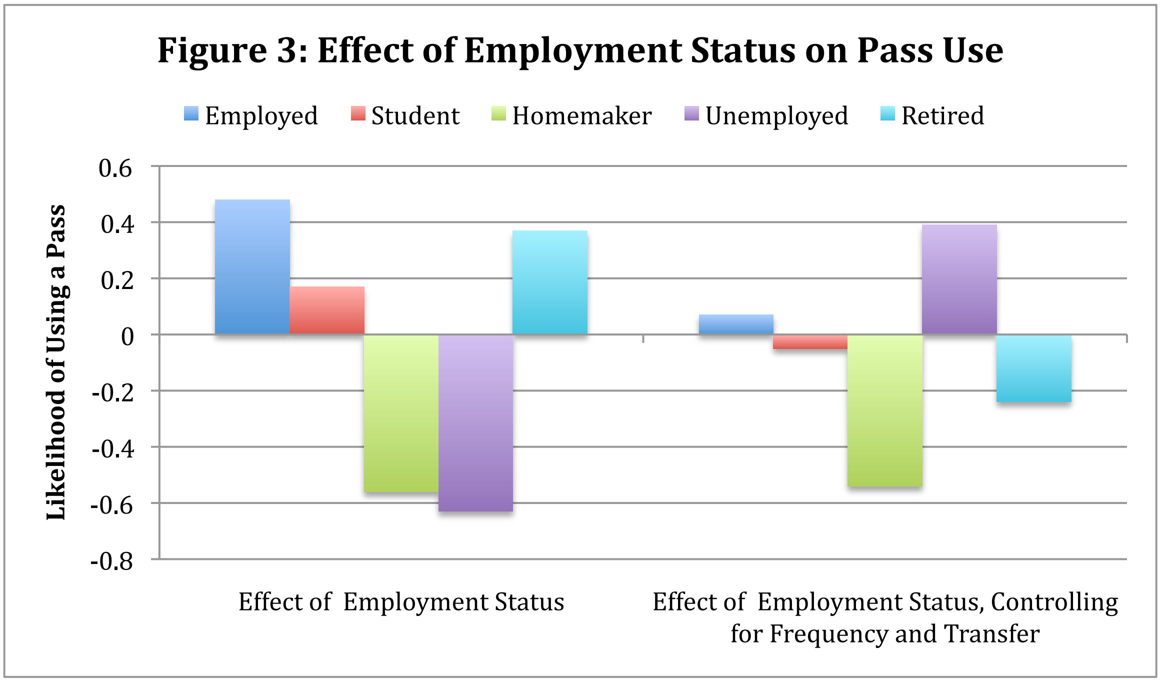
Two sets of explanatory variables contribute to pass usage: behavioral characteristics and socio-economic characteristics. Behavior characteristics include frequency of riding, the number of transfers, the number of systems used, and payment type. In particular, high frequency and high transfer riders might be more likely to overpay, particularly if they pay with cash. Socioeconomic factors include income, employment status, and ethnicity. In this analysis, regression is used to identify the relative impact of each of these factors on overpayment. Full coefficients and significance levels are presented in Appendix A; impacts are depicted in Figures 2, 3, and 4.

Regression analysis confirms that income is a persistent and statistically significant predictor of whether an individual will pay with cash or a pass. Coefficients suggest that as income level rises, so does the likelihood that an individual will pay for his or her fare with a pass. Controlling for frequency and transfers accounts for some of the effect of income, but low income and high income remain statistically significant predictors of pass use.

Figure 2 below presents the relative strength of income, and income controlling for frequency and transfer. Frequency is defined as the number of times a rider uses Triangle Transit per week, and transfer is defined as the number of times a rider stated he or she transfers in the course of the trip.



Employment status is another potential factor that contributes to pass use. Regression coefficients below suggest that varying employment statuses contribute to pass usage, including being employed and being a student. Homemakers, the unemployed, and the retired are more likely to pay with cash. This seems logical, as these riders are less likely to have developed ridership habits like students or employed workers. Controlling for transfer and frequency significantly reduces the effect of being employed, and to a lesser extent, the impact of every other work status. "Employed" includes individuals who described themselves as both working for pay inside the home and outside the home. Figure 3 below summarizes the relative impact of employment status on pass usage.



Finally, I investigated the effect of ethnicity on pass use. Controlling for income, regression analysis suggests that Hispanic, African American, and riders of other ethnicities are less likely to pay with a pass than white or Asian riders. Controlling for frequency and transfer accounts for some of the effect of ethnicity, but it remains strong for Hispanics, African American/Blacks, and "other ethnicity".

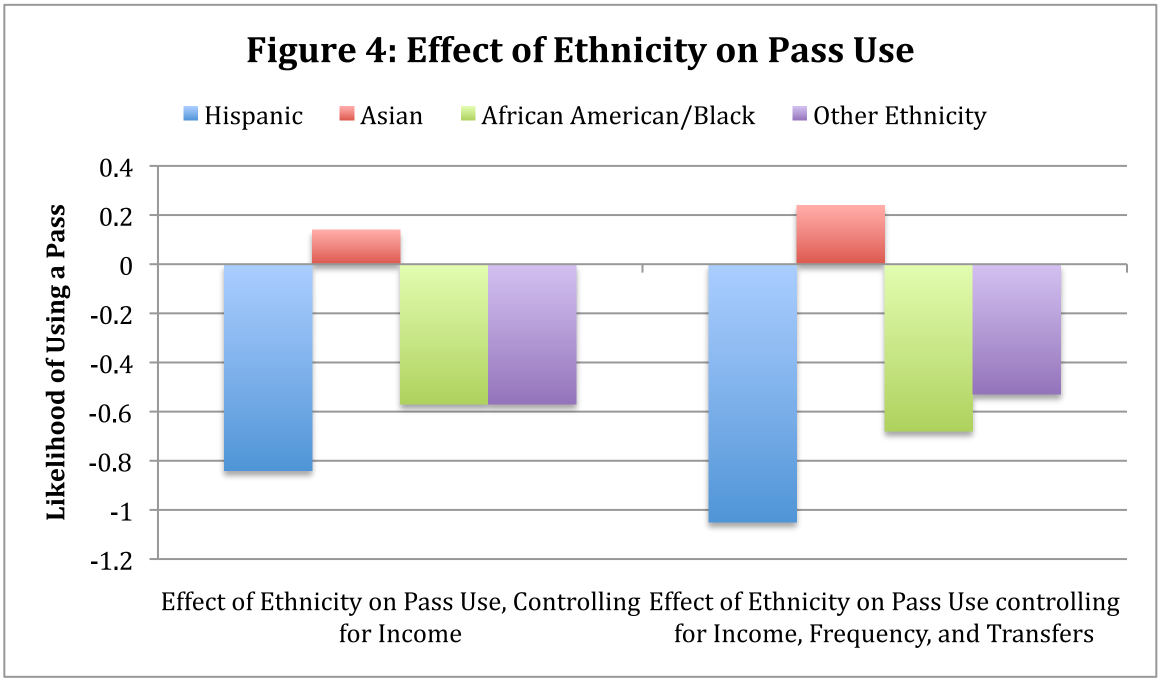


Figure 4: Effect of Ethnicity on Pass Use
Hispanic
Asian
African American/Black
Other Ethnicity
Likelihood of Using a Pass
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
Effect of Ethnicity on Pass Use, Controlling for Income
Effect of Ethnicity on Pass Use controlling for Income, Frequency, and Transfers

2. Overpayment is a Persistent Problem Among Triangle Transit Users, and Particularly Among Cash Users

Methodology

Overpay is a measure generated by determining what the *total weekly cost* would be for a rider based on the type of payment for the current trip and ridership frequency as reported by the rider, and comparing it to what their *ideal payment* would be, based on the lowest-cost payment the rider could have used given trip type and frequency. Total cost is a function of payment type, systems used during a given trip, and the number of transfers taken during the trip. A key assumption of this analysis is that riders are traveling roundtrip. Prices for payment types are calculated using 2009 prices.

The ideal payment measure is generated by calculating the cost per week of each different payment type that a rider *could* have used and selecting the minimum payment cost. A rider is overpaying if his or her total weekly costs cost exceeds their ideal payment.

Sample Rider

For example, if a Triangle Transit user transferred to a DATA bus and paid for the trip with cash, his or her total cost would be calculated by multiplying the Triangle Transit and DATA cash fares by 2 (to account for the roundtrip nature of the trip), and then summing the total. For a rider who used a 30-day pass, their total cost is calculated by taking the cost of the pass ($60) and dividing it by the of 4.3 (the average number of weeks per month) to get the effective cost per week. The weekly cost of a day pass is calculated by multiplying frequency by the cost of a pass. Finally, the 10-ride pass pack and the $25 value card are treated as discounted forms of cash, as they both reduce the effective cost per trip by 20 percent to $1.60.

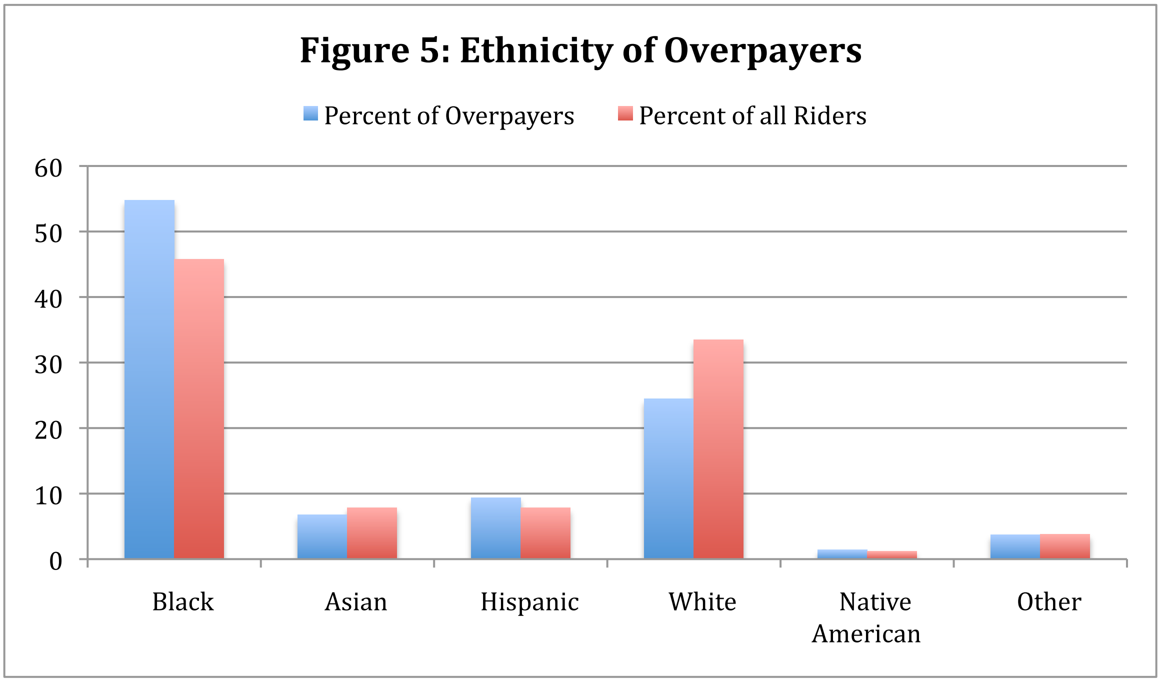
The remainder of this analysis will only include paying riders. Excluded are riders who used a GoPass, or selected "Other Payment Type" on the November 2009 survey. Subsequent references to "all riders" excludes these two payment types. Table 6 below summarizes overpayment by all riders, cash riders, and pass riders.

Table 6: Overpayment Summary

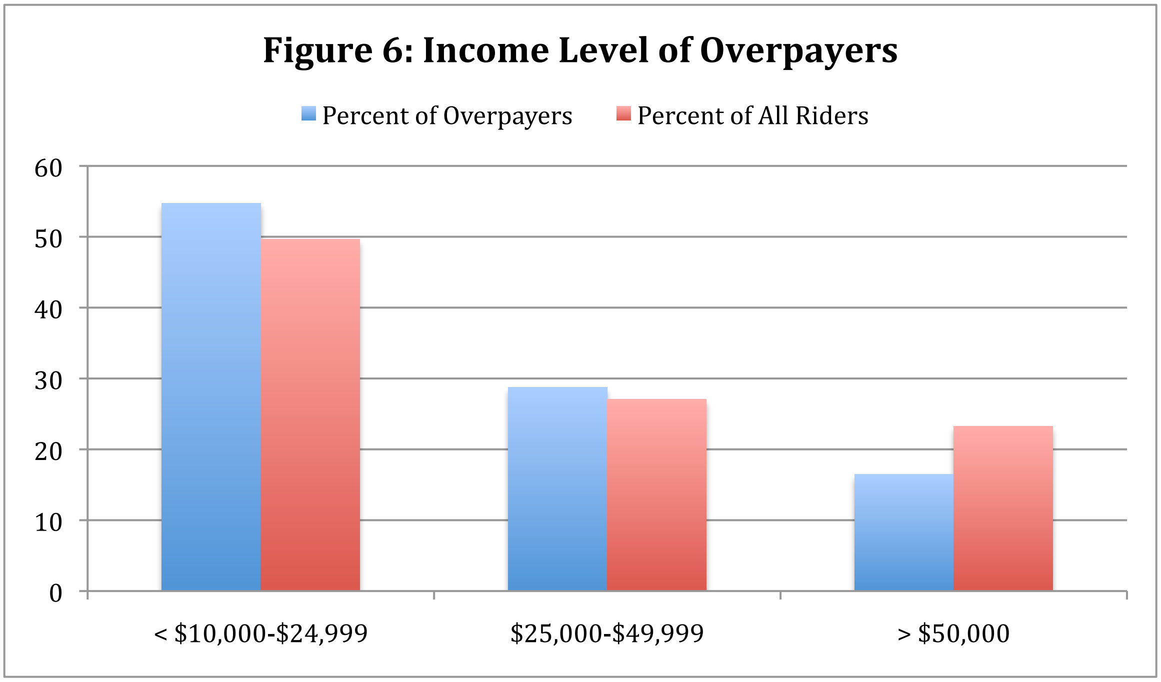
Overpay	No	Yes	Total (N)
All Riders	827	604	1431
% of all Riders	57.8	42.2	100
Cash Riders	257	389	646
% of Cash Riders	39.8	60.2	100
Pass Riders	465	215	680
% of Pass Riders	68.4	31.6	100

Overpay: All Riders

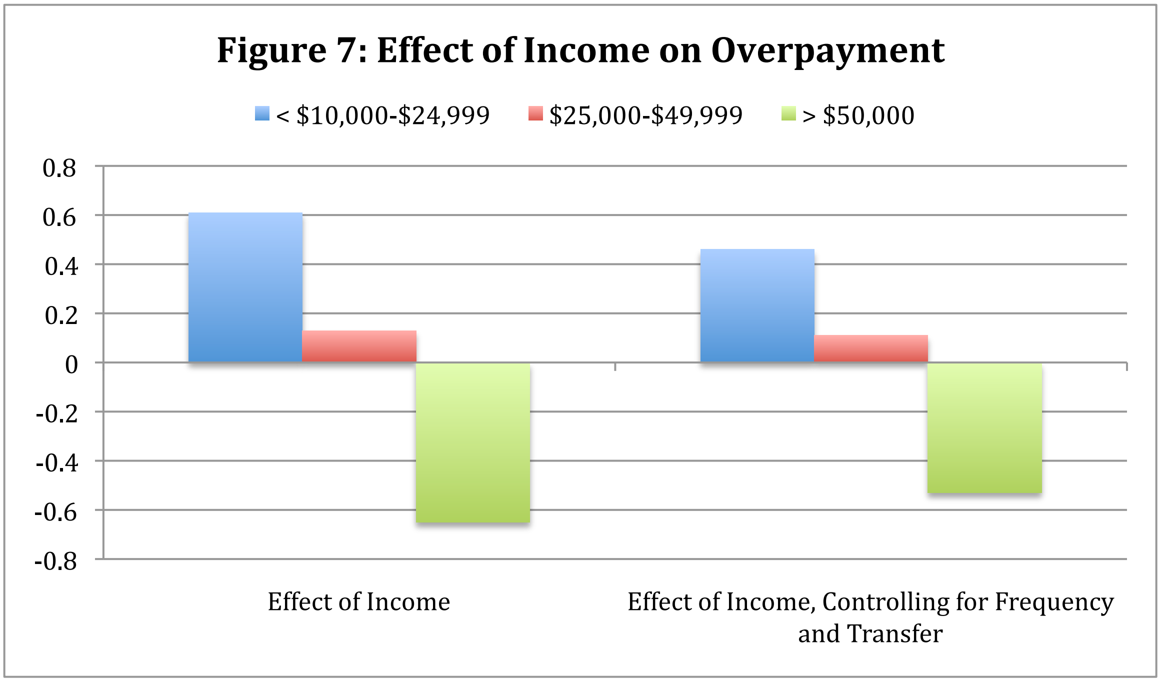
The rate of overpayment among all riders is just over 42 percent. African Americans make up a disproportionately large share of overpayers. Though they make up only 45.8 percent of all riders, they make comprise 54.8 percent of all overpayers. Hispanics also make up a larger share of overpayers than their total percentage of the population, where as Asian and white riders make up a smaller share of overpayers relative to their overall numbers within Triangle Transit's ridership. The average amount per week that a rider overpaid is nearly $8, which corresponds to an overall overpayment of about 72 percent, and an annual overpayment of over $400. The percent overpayment refers to the amount by which a person overpays divided by what their ideal weekly expenditure would be. Table 6 provides a breakdown of overpayment by payment type.



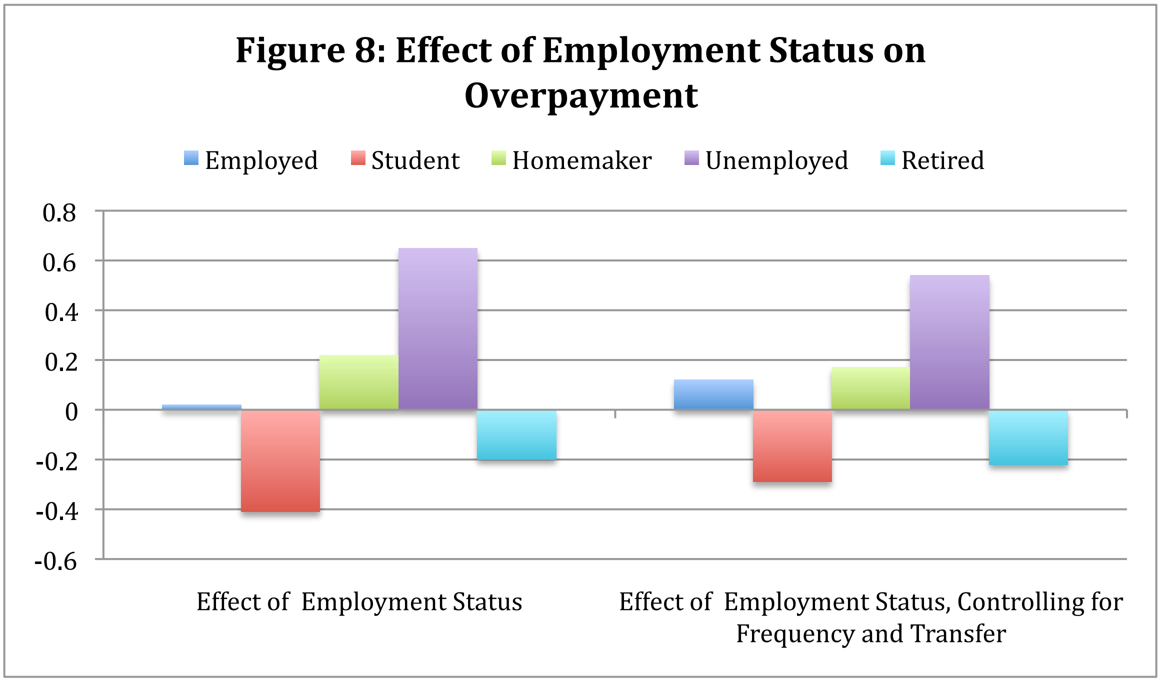
Descriptive statistics also suggest that poorer riders make up a disproportionately larger share of overpayers than do riders with higher incomes.



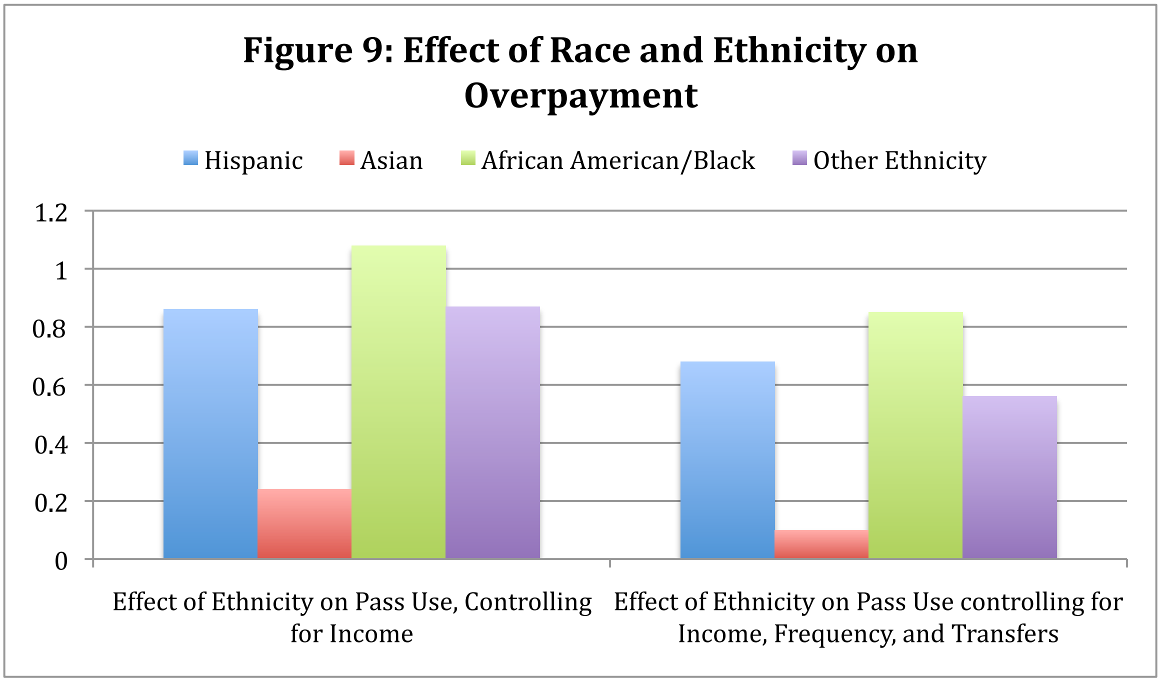
Similar regression techniques to those used to determine drivers of pass usage are used to determine whether rider behavior or socioeconomic characteristics have a stronger impact on the likelihood of overpayment. First, I examine the role of income in driving overpayment. Figure 7 below suggests that as income increases, the likelihood of overpaying decreases. Controlling for two rider behavior variables, frequency and transfer, account for some of the effect. However, relatively high income and relatively low income remain statistically significant predictors of overpayment.



Employment status, and particularly being a student or unemployed, is a strong predictor of whether a rider will overpay. Students tend to ride habitually and with consistent frequency, which could contribute to more optimal payment. Interestingly, the employed fall into this category as well, but its effect on overpayment is much smaller. The unemployed likely have erratic ridership habits, which makes them less likely to form consistent ridership patterns and optimal payment.



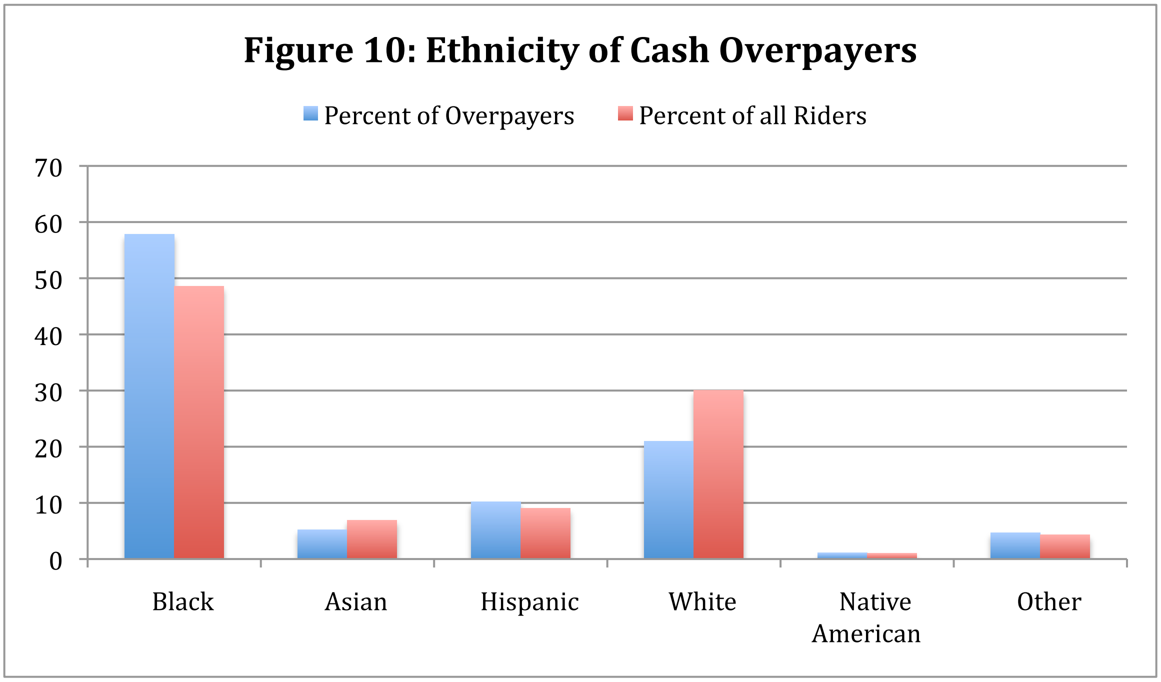
Finally, ethnicity is an important driver of overpayment. Figure 9 below suggests that compared to white riders, the likelihood of a rider overpaying increases significantly when the rider is Hispanic, or African American/Black. These patterns are confirmed in the next two sections, which utilize descriptive statistics to highlight overpayment patterns.



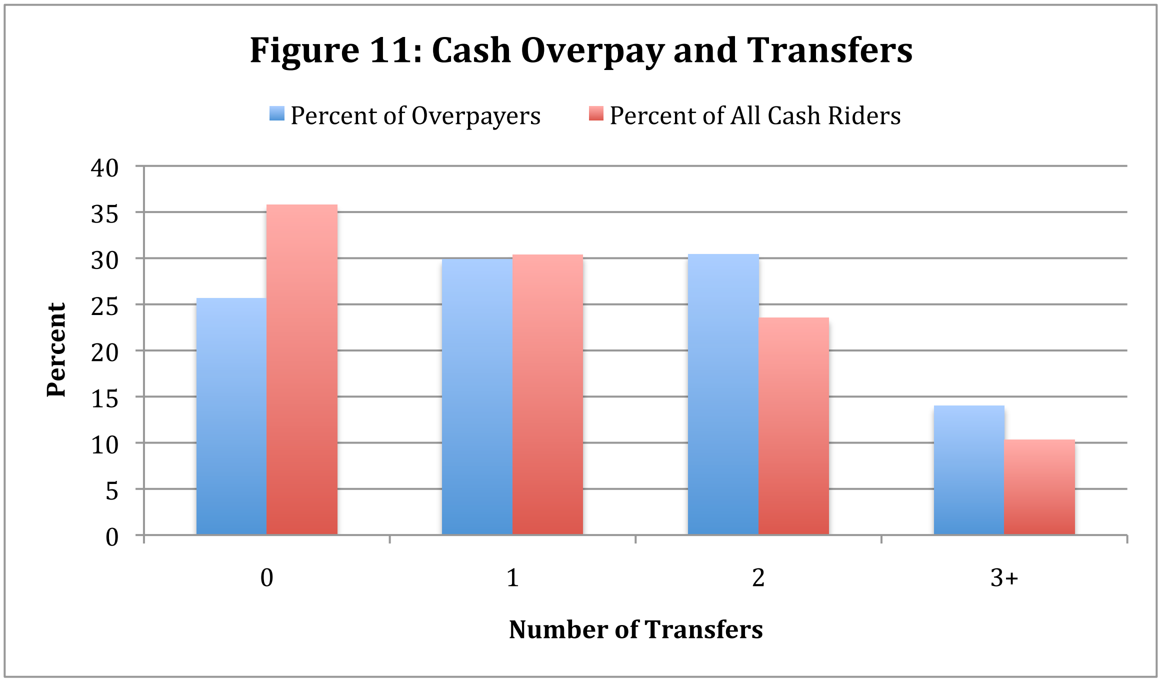
Overpay: Cash Riders

Cash riders make up about 48 percent of total ridership. Of those, 389, or just over 64 percent, overpaid. If riders who used the GoPass and the unknown payment type are included, cash users shrink to just over 27 percent of the population but again make up 64 percent of overpayers. An average cash rider overpays by almost $9 per week, which corresponds to an average overpayment rate of almost 80 percent.

The distribution of overpaying is skewed based on a rider's ethnicity. Though black riders make up 48.6 of all cash users, they make up over 57 percent of all cash overpayers.

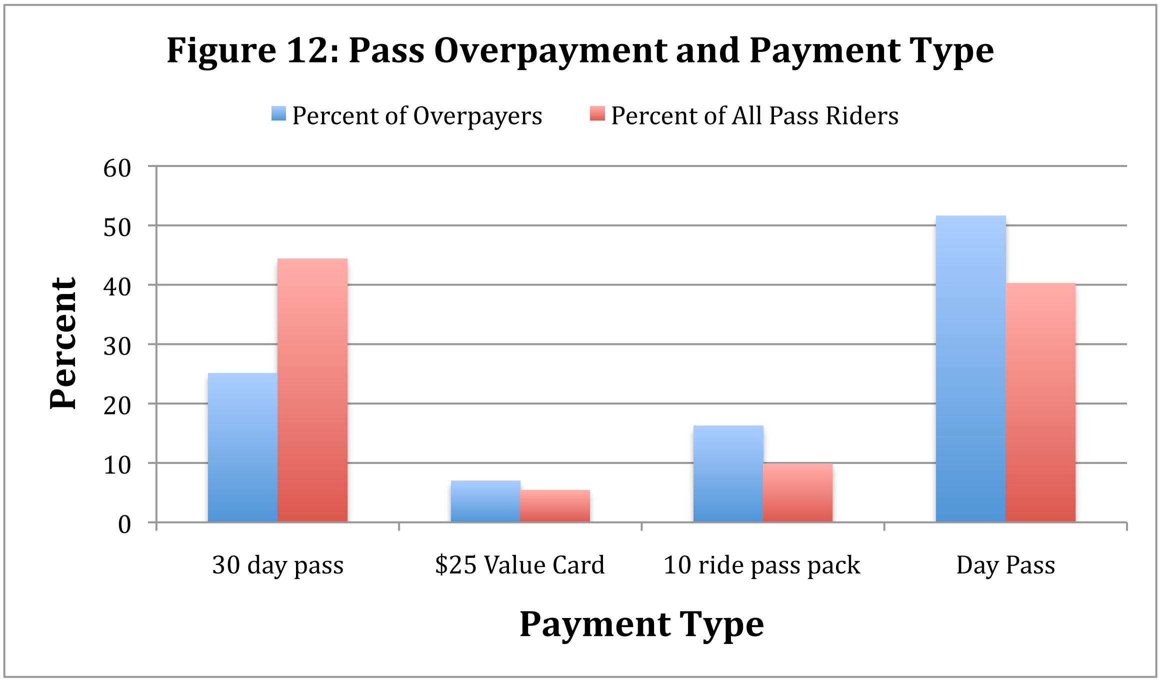


The number of time a person transferred is also a strong indicator of overpayment. Figure 11 below suggests that as the number of transfers increases, so does the likelihood of being an overpayer. Individuals who do not transfer at all are much more likely to overpay than individuals who transfer one, two, or three or more times.

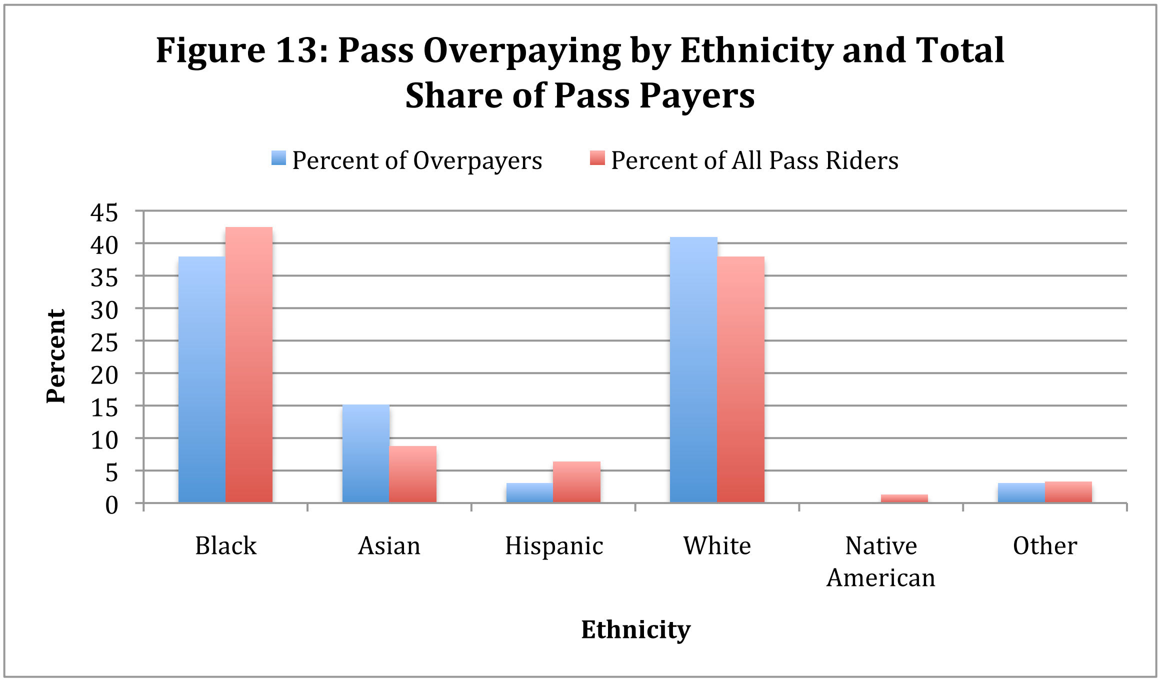


Overpay: Pass Riders

Pass overpayment is far less prevalent than cash overpayment. As shown in Table 12, pass users make up 51.28 percent of all riders, and of these riders, 215, or about 31.6 percent, overpaid. The average amount by which a pass user overpaid per week is $6.28, which corresponds to an average overpayment rate of 55 percent. Because of the relatively few number of pass overpayers, it is difficult to draw generalizations about these riders. As displayed in Figure 12 below, riders using the $25 value card and the 10 ride pack are more likely to overpay than users who paid with a 30 day pass or a day pass. In cases of high transfer rates and high frequency, there are other, more efficient payment options for riders who use a $25 value card or a 10-ride pass pack. Essentially, these two payment types are the equivalent of a discounted cash on Triangle Transit buses. However, they must pay full fare when they transfer to other systems, which in turn drives up their total cost. Additionally, high frequency riders who purchase a day pass are also susceptible to overpayment.



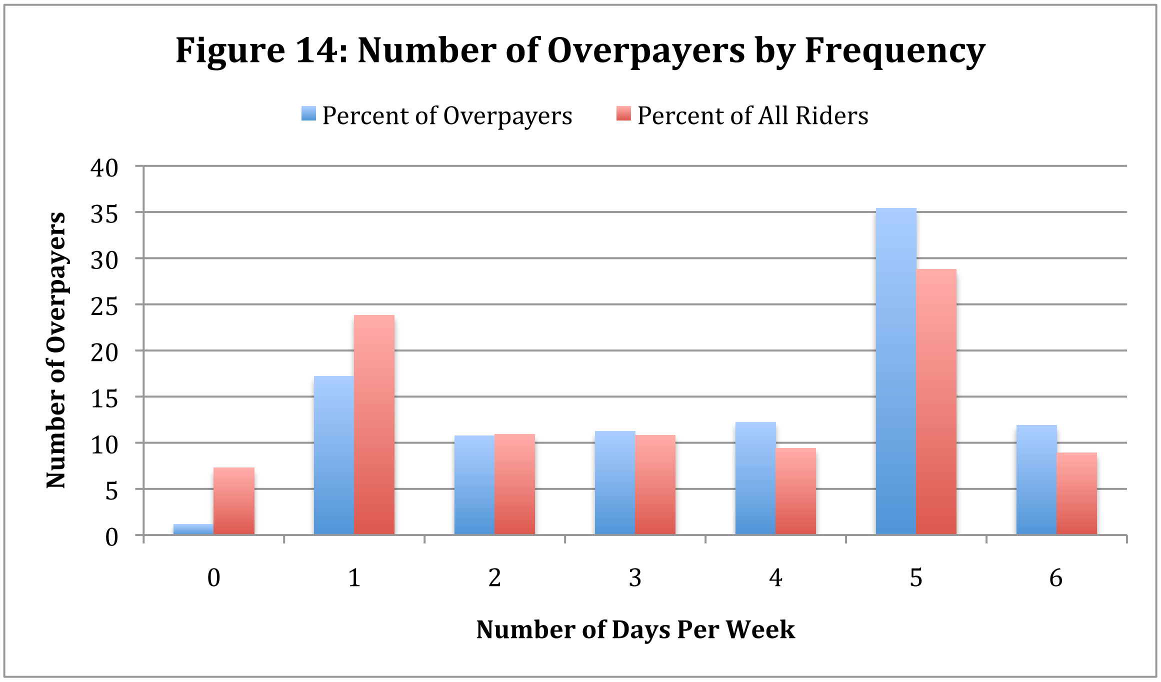
The demographics of pass overpayment are also different from cash overpayment. While black riders still represented the largest share of overpayers, the difference between their total ridership share and their overpayment share decreased from about 13 percent to about 7 percent. Figure 13 below provides the ethnic breakdown of pass overpayers.



High Frequency Riders also Overpay

High overpayment among one day per week riders seems reasonable; infrequent riders are less likely to be informed of optimal payment types. Somewhat curiously, however, there is a spike in the share of overpayers among riders who use Triangle Transit five times per week relative to their overall share in the population. Five day per week riders comprise 28.79 percent of all riders, but 35.43 percent of all overpayers.

The vast majority of five day per week riders who overpay are paying with cash. Among five day riders, 30.5 percent paid with cash, which is significantly lower than the overall cash rate of 48.7 percent. However, of those 30.5 percent, 75.3 percent overpaid for their trip.



The Effect of 2011 Prices on Overpayment

The survey data used for this study is from November 2009, and uses November 2009 prices. However, updating the analysis from 2009 to 2011 prices (assuming that rider behavior did not change in response to the price changes) does not significantly change the results. The raw number of overpayers remains exactly the same at 475. The only significant pricing change is the expansion of the 30-day pass to 31, and its increase in cost from $60 to $68. Table 7 below summarizes the difference in average overpayment and average percent overpayment for 2009 and 2011 prices.

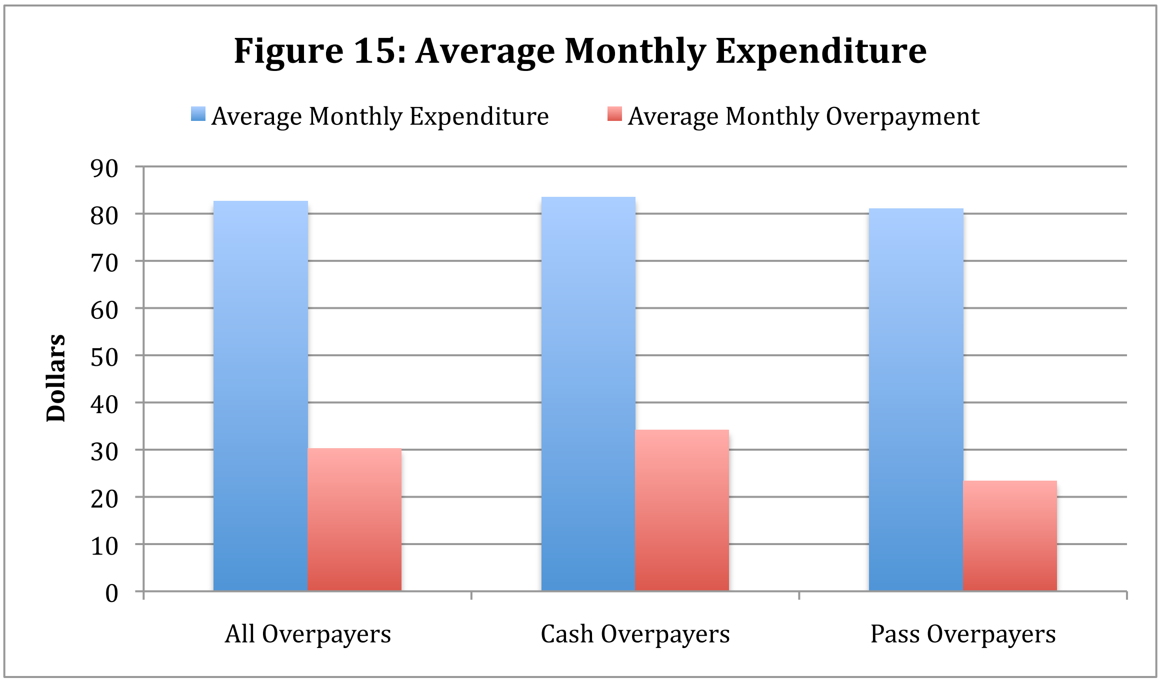
Table 7: Overpayment Levels at 2009 and 2011 Prices

	Average Overpayment	Average Percent Overpayment
2009 Prices		
All Riders	$7.96	76%
Cash Payers	$8.89	79%
Pass Payers	$6.28	55%
2011 Prices		
All Riders	$7.85	62%
Cash Payers	$7.91	68%
Pass Payers	$5.43	50%

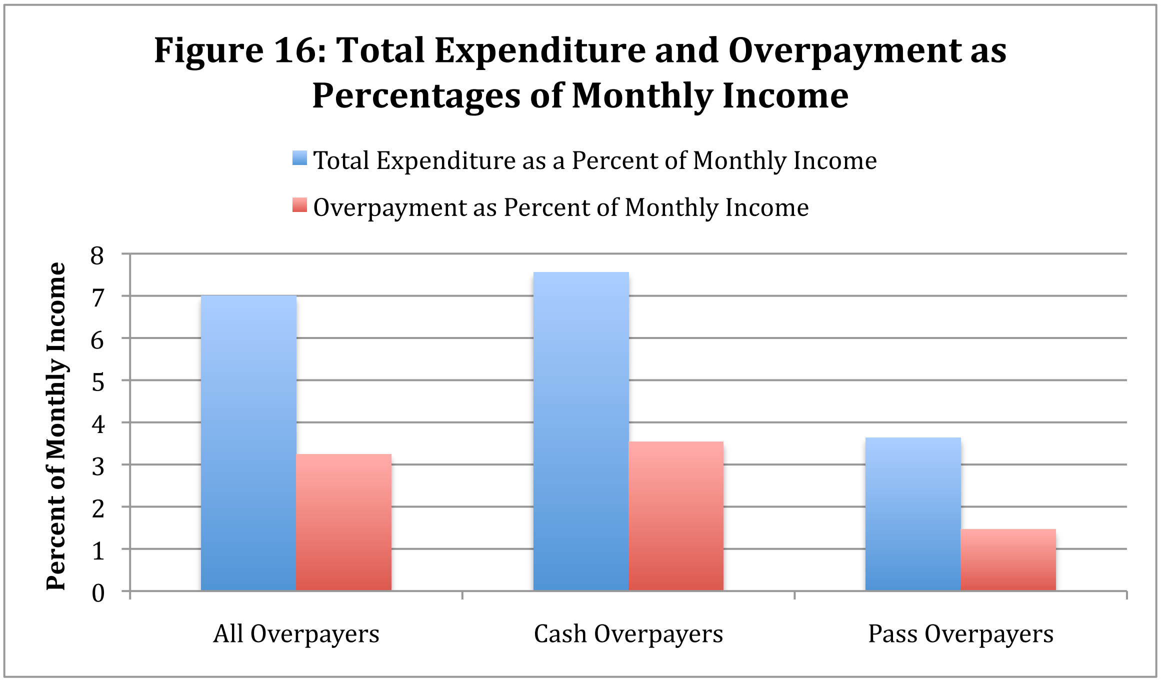
There are a few caveats, however. New payment types offered since November 2009, including the 5 day regional pass, could reduce the overall level among users who were overpaying with cash due to capital constraints. There is some evidence to suggest that Triangle Transit's riders have turned towards the five day passes. Based on data contained in the FY2010 pass sales report, the average number of one-way fares per month between July and December was 186. However, when the new pass type was introduced, the average, per month one-way fare totals decreased to 160. During the same time period, purchases of the five day pass averaged 66 passes per month. It's unclear whether these two events are linked, but exploring the issue in the next round of rider surveys could provide more insight.

Overpayment Constitutes a Significant Portion of Rider Income, Particularly Among Cash Riders

The average Triangle Transit rider spends almost $54 per month on Triangle Transit fares. This number jumps to $82 per month among overpayers. An average cash overpayer spends $38.20 on overpayment. Comparatively, pass overpayers spend about $23 per month on overpayment. As shown below in Figure 15, the amount overpaid by a rider constitutes a significant portion of their total monthly expenditures, particularly for cash overpayers.



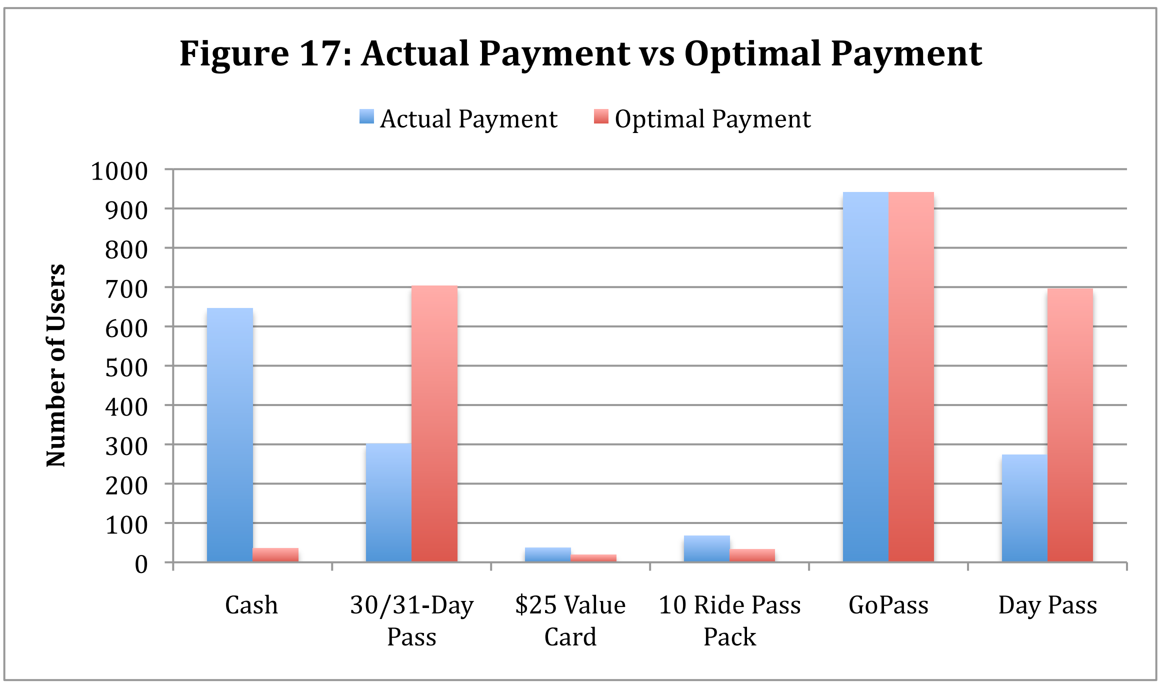
Among all overpayers, the average monthly overpayment corresponds to about 3.2 percent of a rider's monthly income. Among cash riders, the percentage increases to 3.54 percent and drops to 2.5 percent among pass users. Among Triangle Transit's poorest riders, those earning less than $25,000 per year, the percentage of income that is consumed by overpayment is almost 5 percent. (Monthly income is calculated by taking the average value of the income range reported by the rider. For example, if a rider says they earn between $5000 and $10,000 per month, the average monthly income would be $7500.)



Reducing overpayment can significantly reduce the share of income that a person spends on transit. Among cash overpayers, the share of their income spent on transit drops from more than 7 percent to just over 4 percent when the rider converts to his or her optimal payment type. Among all overpayers, the average monthly savings associated with switching to an optimal payment type is approximately $34. Among low-income cash users, however, this number jumps to $38, which on average constitutes nearly 5 percent of their income. In this sense, reducing the incidence of overpayment could have a very significant impact on the economic prospects of low-income riders.

Optimal Payment would significantly alter Triangle Transit's payment structure

Conversion to optimal payment would greatly reduce the percentage of riders that pay with cash and dramatically increase usage of 30 day regional passes (now 31 day regional passes). Figure 17 below shows how payment would shift if every Triangle Transit rider began paying optimally. Riders who paid with a GoPass were considered to be paying optimally already. For 318 riders, the weekly optimal payment amount is the same for day pass and cash payment. For these riders, I assumed that optimal payment would be a day pass. This allows for additional flexibility for the rider, and also increases system efficiency because riders will be able to transfer between buses more quickly. Finally, it makes riders' lives easier because they do not need to worry about having the required change at each stop; rather, they only need to make sure they have the necessary amount at their first boarding.



RECOMMENDATIONS

1. *Triangle Transit and Other Regional Transit Agencies Should Work to Revise Transfer Policies.*

High transfer rates and cash payment are two of the principal drivers of overpayment. Table 8 below suggests that as transfers rates increase, so does the rate of overpayment. Currently, none of the transit agencies within the Triangle (Triangle Transit, DATA, CAT, and C-Tran) accept free transfers from one system to the next. This dramatically drives up costs for cash users who must transfer several times in the course of a trip. Recently, several transit agencies eliminated cash transfers between systems, and there is evidence to suggest that these policies could *decrease* equity for Triangle Transit's riders. Issuing free transfers could, however, significantly hurt Triangle Transit's, as well as other transit operator's, revenue stream.

Table 8: Transfer Rates and Cash Overpayment

	Transfers				
Overpay	0	1	2	3	Total
No	128	78	33	12	251
	56.9	40.8	22.3	18.5	39.9
Yes	97	113	115	53	378
	43.1	59.2	77.7	81.5	60.1
Total	225	191	148	65	629
	100	100	100	100	100

Triangle Transit has expressed interest in moving to an electronic "Smart Card" system. If Triangle Transit does make this move, and this analysis recommends that it should, it should consider two actions. First, they should encourage other systems in the area to adopt a similar system. Second, Triangle Transit and other regional systems should consider offering discounted transfers to individuals who transfer from one bus to another using a "Smart Card." The following section will analyze the impact on overpayment and revenues that would occur if transfer costs were reduced by 50 percent.

Reducing transfer costs by 50 percent reduces the overall percent overpayment from about 42 percent to just over 30 percent. Among cash payers, the rate drops substantially, from about 60 percent to almost 35 percent. The average amount in monthly overpayment drops to about $26 for all rider types. It makes a significant difference in the average amount a rider overpays, as well as the percentage of that individual's income. Table 9 summarizes these projections.

Table 9: Overpayment Levels at 2009 and 2011 Prices

	Current Transfer Structure	Discounted Transfer Structure
All Riders		
Average Monthly Overpayment	$34.2	$26.1
Percent of Income	3.19	2.40
Cash Riders		
Average Monthly Overpayment	$38.2	$26.2
Percent of Income	3.54	2.32
Pass Riders		
Average Monthly Overpayment	$27.0	$26.0
Percent of Income	2.53	2.48

Riders who pay with a "Smart Card" are essentially paying with cash as they have to load the card with a certain amount prior to usage.. Granting these riders a discount when they transfer to another bus will help reduce the incidence of overpayment among cash riders who do not convert to their optimal payment type, which would likely be a pass.

Revenue losses associated with reduced transfer costs and conversion to optimal payment types can be made up by slightly increasing the price of monthly passes. There is some evidence to suggest that these riders would be willing to accept an upward fare adjustment. Among riders who use the 30-day pass, 34 percent and almost 36 percent said they chose to ride Triangle Transit because it was the only transportation available and for environmental concerns, respectively. No other response received more than 10 percent. The 34 percent of riders for whom Triangle Transit is the only transportation available have relatively inelastic demand, and would likely pay a small increase in fare. Likewise, the 36 percent who ride for environmental reasons would also likely absorb a small increase.

2. ***Triangle Transit, as well as Other Area Transit Agencies, Should Increase Visibility of Discounted Pass Types, Particularly the 31-Day Regional Pass and the Five-Day Regional Pass.***

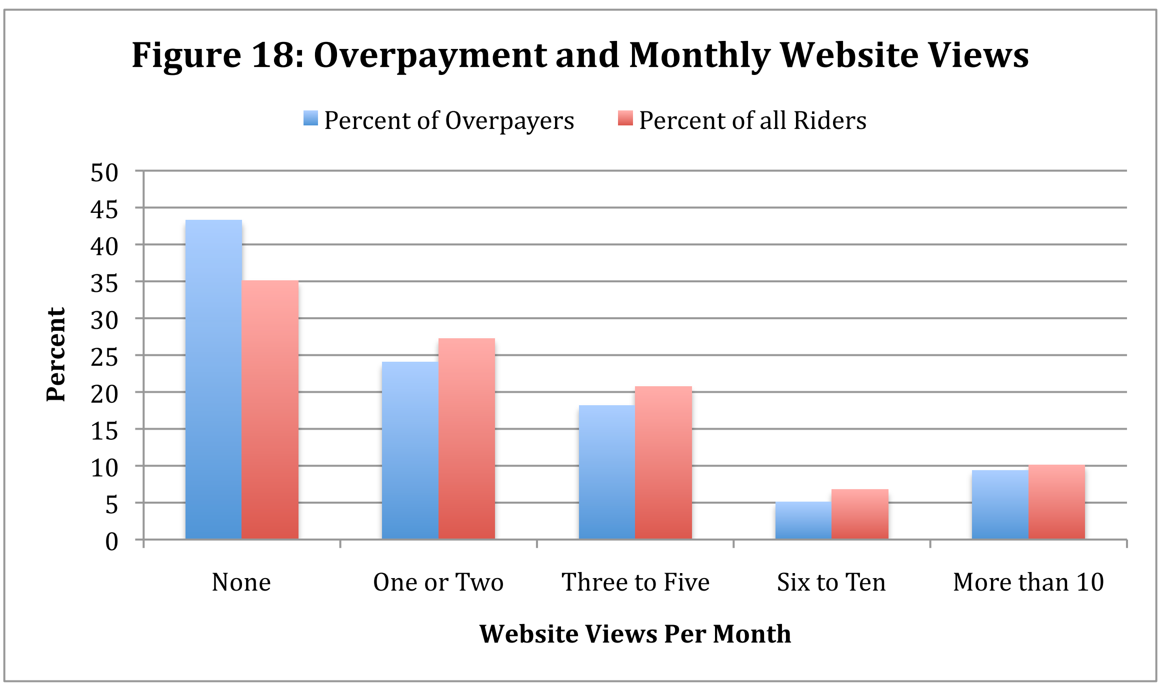
Among overpayers who ride five times per week, almost 50 percent paid with cash instead of a discounted pass. Moreover, most riders who overpay, ride five times per week, and pay with cash are transferring at least one time over the course of their trip. Their costs would be significantly diminished if they used a discounted pass. If these riders face credit constraints (i.e., they have difficulty affording the up-front funds to buy a 31-day pass) they could turn to the regional 5-day pass to reduce upfront costs. Given that this payment type was made available after this survey was administered, it is difficult to determine how much riders have started using it instead of cash.

Additionally, the DATA website states that the 31-Day Regional Pass is valid only on Triangle Transit, DATA, and CAT routes. However, the Triangle Transit website site states that it is valid on Triangle Transit, DATA, CAT, and C-Tran. A correction could rider awareness and pass usage.

Overpayers pass through Durham Station and the Regional Transportation Center at high rates, but this also reflects the fact that high percentages of riders in general pass through these two areas. Analysis of the starting location of overpayers reveals that there is little systematic evidence to suggest that these riders originate at a particular stop. However, many riders who do overpay either start or move through Durham Station and the Regional Transportation Center, both of which sell 31-Day Regional passes. Providing greater opportunities for riders to purchase passes while waiting for their next bus could help reduce overpayment and increase equity.

There are several other clusters of highly-trafficked stops where many overpayers can be found, including those at Durham Station, Franklin Street/Varsity Theater, Moore Square, South Road/Student Union, the RTC, and Wilmington/Martin. Increasing awareness at these stops could further reduce the incidence of overpayment. For example, Triangle Transit could generate a pamphlet explaining the most efficient payment types for a particular hypothetical rider, and distribute these pamphlets at high volume stops. Additionally, copies of the pamphlets could be placed on each bus route, with instructions given to bus drivers to encourage their distribution.

Insufficient internet access could also drive poor knowledge and related low visibility of Triangle Transit's passes. Figure 18 below suggests that either limited access to the internet, or a lack of knowledge of Triangle Transit's internet services are related to overpayment.



3. When Triangle Transit Administers Future Surveys, They Should Ask Additional Questions about Frequency of Travel.

Future surveys should include several questions to facilitate future analyses.

1. A significant percentage of riders who overpaid rode once per week. Triangle Transit should consider asking broader questions about ridership frequency beyond daily and weekly use.
2. Future surveys should also include a question about how often a rider purchases their particular payment method. This would help facilitate revenue analyses.
3. Triangle Transit should also consider including a question to measure the education level of its riders.
4. A question about whether or not a rider purchased their pass online could also help Triangle Transit determine how people access their services.
5. Triangle Transit should include a question about how confident riders are in their selection of payment type. If riders lack confidence that they are using their most optimal payment method, this suggests they could have imperfect information about their payment options.
6. A question about whether or not Triangle Transit riders have converted to a new payment type within a defined time period would help Triangle Transit understand whether new payment options have gained traction among their targeted riders.

4. Reduce Cash Fares

Reducing cash fares by varying amounts would reduce the level of overpayment by cash riders. A 25 percent reduction, for example, would reduce full fares to $1.50 and senior/disable fares to $.75. This would lower the rate of overpayment from just over 60 percent to 56 percent for cash riders. While this drop seems relatively modest, the monthly overpayment amount drops from just over $38 to $28. Moreover, the percentage of a rider's income devoted to overpayment will drop from 3.5 percent to just over 2.7 percent.

Reducing cash fares by 50 percent shows more significant reductions in the rate of overpayment. The overall rate of cash overpayment drops from 60 percent to 35 percent. However, those riders who still overpay are doing so at very high levels. The average monthly overpayment among those who still overpay is $34, which corresponds, on average, to 3.28 percent of monthly income.

Reducing cash fares by 25 or 50 percent would also result in corresponding losses of the same percentages to revenue from cash riders. These losses can be offset in part by the aforementioned increases in the cost of the 31-day passes.

Appendix A:

Logistic Regression Estimates of Behavorial and Socioeconomic Characteristics Impact on Pass Use

Explanatory Variable	Effect of Explanatory Variable on Overpayment	Effect of Explanatory Variable on Overpayment, Controlling for Transfer and Frequency
Income		
< $10,000-$24,999	-0.43***	-0.39**
$25,000-$49,999	0.17	-0.05
> $50,000	1.08***	0.90***
Number of Transfers		-0.11*
Frequency		0.36***
Occupational Status		
Employed	0.48**	0.07
Student	0.17	-0.05
Homemaker	-0.56	-0.54
Unemployed	-0.63**	-0.39
Retired	-0.37	-0.24
Number of Transfers		-0.22***
Frequency		0.36***
Ethnicity		
Hispanic	-0.84***	-1.05***
Asian	0.14	0.24
Black	-0.57***	-0.68***
Other Ethnicity	-0.57*	-0.53*
Number of Transfers		0
Frequency		0.39***
Income		
< $10,000-$24,999	-0.40**	-0.37*
$25,000-$49,999	0.11	-0.09
> $50,000	0.86***	0.72***

* p<0.05, ** p<0.01, *** p<0.001

Appendix B

Logistic Regression Estimates of Behavorial and Socioeconomic Characteristics Impact on Overpayment

Explanatory Variable	Effect of Explanatory Variable on Overpayment	Effect of Explanatory Variable on Overpayment, Controlling for Transfer and Frequency
Income		
< $10,000-$24,999	0.57***	0.36**
$25,000-$49,999	0.08	-0.02
> $50,000	-0.78***	-0.68***
Number of Transfers		0.51***
Frequency		0.15***
Occupational Status		
Employed	0.07	0.09
Student	-0.3	-0.18
Homemaker	0.05	-0.05
Unemployed	0.63**	0.56*
Retired	0.05	0.06
Number of Transfers		0.59***
Frequency		0.13***
Ethnicity		
Hispanic	1.10***	0.77***
Asian	-0.02	-0.12
Black	0.99***	0.69***
Other Ethnicity	0.76**	0.60*
Number of Transfers		0.43***
Frequency		0.13***
Income		
< $10,000-$24,999	0.45**	0.27
$25,000-$49,999	0.08	-0.05
> $50,000	-0.55**	-0.60**

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

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