MODELING TRANSIT RIDER PREFERENCES FOR CONTACTLESS BANKCARDS AS FARE MEDIA: TRANSPORT FOR LONDON AND THE CHICAGO TRANSIT AUTHORITY

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ABSTRACT

A number of transit agencies are considering accepting contactless credit and debit cards directly at turnstiles and bus fare boxes. By using the expertise and scale economies of the payments industry, agencies may reduce fare collection costs and improve regional interoperability and ease of use. Given these possible advantages, transit agencies want to understand rider demand for this new fare medium. This paper evaluates transit rider preferences for contactless bankcards at two major public transit agencies: Transport for London and the Chicago Transit Authority. Stated preference survey results from both transit agencies were analyzed, and discrete choice models for fare medium preference were used to assess factors influencing the demand for contactless bankcards. The results show that approximately 33% of riders in London and 36% of riders in Chicago prefer contactless bankcards over current fare media. While trends among ridership groups are not strong, a few key factors did emerge that influence the choice of fare medium. Riders at both transit agencies who currently have credit or debit cards had a tendency to prefer contactless bankcards; likewise, younger riders showed a preference for contactless bankcards in both London and Chicago. The results appear to align with sociology models for consumer adoption of new technologies.

INTRODUCTION

Over the past two decades, many large public transit agencies have introduced contactless smart card fare collection systems, such as Transport for London's Oyster card (*1*) and the Chicago Transit Authority's Chicago Card *(2).* A smart card is a small plastic card with an embedded integrated circuit or processor that is used to store value or data and perform simple fare logic. These smart card systems have been custom-designed solutions for each transit agency. They have delivered many benefits to transit agencies and transit riders, including reducing ticket fraud, enabling flexible fare policies, improving the customer experience, and expediting boarding of buses and passage through turnstiles in stations *(3, 4, 5, 6).* However, smart card systems are generally not interoperable between transit authorities, requiring users to carry and load multiple cards *(3).* Additionally, some transit smart card systems have come under criticism for weak data security standards *(7, 8, 9).* Last, the cost of fare collection can be as high as 15% of the revenue collected, and transit agencies are looking for increased efficiency in this function *(10).*

Financial institutions in the United States and United Kingdom have recently begun to issue new payment products in the form of contactless credit and debit cards (collectively referred to as contactless bankcards). These commercial products appear to meet many of the business needs of transit fare collection systems, including speedy boarding and rigorous data security standards. This has created an opportunity for convergence between transit fare collection systems and the payments industry *(3, 11).* Many transit agencies have recognized the potential benefits of capitalizing on the economies of scale and expertise of the payments industry *(12, 13).* Some organizations are actively moving towards implementation of contactless bankcard fare collection systems, in which contactless bankcards are accepted directly at the gates in rail stations and upon boarding buses.

OBJECTIVE

In light of transit agency interest in contactless bankcards, this research aims to assess the level of demand for these new payment products for fare collection using recent survey data from two public transit agencies: the Chicago Transit Authority (CTA) and Transport for London (TfL). Discrete choice modeling is used to identify trends in fare medium preference among rider groups. This analysis may help transit agencies plan contactless bankcard fare collection systems more effectively, by targeting marketing to specific rider groups, for example. Additionally, the results may help inform decision-makers at other transit agencies that are considering contactless bankcard acceptance but are unsure if there is sufficient demand among their riders.

BACKGROUND

Contactless Bankcards

A contactless bankcard is a smart card used by the financial industry. It is a credit or debit card that can be "waved" or "tapped" less than two to four inches from a point-of-sale terminal, as opposed to being "swiped" through a magnetic stripe terminal like a traditional credit or debit card. Transactions are processed through the standard financial payment network *(11).*

Many major financial institutions are increasing issuance of contactless bankcards in the United States and the United Kingdom. Contactless cards have been issued in the United States since 2004. As of June 2009, more than 90 million contactless bankcards had been issued in the

US under the brand names American Express, MasterCard, and Visa *(14).* As of the summer of 2010, approximately 9.6 million payment cards had been issued with contactless technology in the United Kingdom. Recent studies estimate that 7% of debit or credit cardholders in the United Kingdom have at least one contactless card, and this is expected to rise to 20% by the end of 2012 *(15).*

Contactless Bankcards in Transit Fare Collection Systems

In a contactless bankcard fare collection system, transit riders can walk up to the gates in rail stations and simply tap their contactless bankcard as they walk through; likewise, when they board buses, they can tap their cards on the fare box upon entering. In other words, transit riders are able to pay directly at rail gates and on buses, without having to purchase a ticket or load a transit-only smart card before entering. The costs of their trips are then billed to them via their debit or credit cards. Contactless bankcard users can also purchase period passes online or through other channels such as vending machines; they again tap their card upon entry and are allowed to travel on the fare product purchased.

Transit agencies in the United Kingdom and the United States are in different stages of assessing, planning, and implementing contactless bankcard fare collection systems. A leader in implementation is the Utah Transit Authority in Salt Lake City, which already accepts contactless bankcards system-wide *(16).* Additionally, the Metropolitan Transportation Authority is collaborating with the Port Authority of New York and New Jersey and New Jersey Transit to conduct a six month contactless bankcard pilot program *(17).* Some agencies have recently issued Requests for Proposals to begin procurement processes for contactless bankcard fare collection systems, including the Chicago Transit Authority *(13, 18, 19)*, while other agencies are investigating the pros and cons of implementing such a system.

Because most transit agencies in the United States and Europe do not yet accept contactless bankcards, there is limited information about transit rider attitudes toward bankcards for fare payment, and the degree to which transit riders will adopt contactless bankcards for fare payment has not been studied. Therefore, this study seeks to assess the level of ridership demand for this new fare payment product and investigate trends among different ridership groups.

MODELING FRAMEWORK

Stated preference survey data for contactless bankcards and other fare media was provided by two major public transportation agencies, namely Transport for London and the Chicago Transit Authority. Both TfL and the CTA currently utilize transit-only smart card systems for fare payment (the Oyster card and Chicago Card, respectively). More importantly, both agencies are currently designing contactless bankcard fare collection systems *(18, 19, 20).* Because of this commitment to contactless bankcards, TfL and the CTA have invested time and resources in the planning process, so quantitative data are available.

Discrete choice models are utilized for each of the two datasets to determine the probability that a respondent will select a given option from the set of fare medium alternatives. The coefficients of the parameters in the discrete choice model allow for interpretation of the extent to which different attributes of the alternatives and socioeconomic characteristics of the respondent relate to choice of fare medium. This is different from the discrete choice models commonly discussed in the transit fare policy literature, which are based primarily on fare price *(4, 21)*, and this modeling framework rests on the assumption that contactless bankcards are inherently different from existing forms of fare media (i.e. transit-only smart cards and magnetic

stripe tickets). Last, while the datasets from the two transit agencies include different variables, the intent was to make the discrete choice models as comparable as possible.

TRANSPORT FOR LONDON

TfL Data

TfL is the body responsible for managing London's buses and extensive underground railway (tube) network *(22)*. Currently, transit riders can pay fares using the Oyster card contactless smart card and magnetic stripe tickets. The Oyster card was originally introduced system-wide in 2003. Since then, there has been rapid increase in the utilization of Oyster cards, and over 80% of all bus and tube trips are made using Oyster (*23*).

In the spring of 2009, TfL commissioned a ridership survey specifically to assess customer attitudes towards future fare medium options. The survey was conducted via interviewer administered computer-aided interviewing at eleven test hall locations throughout London. A total of 460 interviews were completed, and the sample was weighted post-survey to be representative of all public transport system users utilizing three data sources: population data, the latest London Travel Report, and data prepared by TfL Fares and Ticketing. Survey questions pertained to ticket choices, travel behavior, socioeconomic information, and financial characteristics.

TfL Fare Medium Choice

TfL survey respondents were provided with fare medium information using demonstration cards and a short video. They were reminded how they can currently pay for travel in London, and they were given a description of contactless bankcard technology. Then, they were asked to select one of three future fare medium options in the following manner: "*Which do you most prefer?*

(1) TfL Card
(2) Bank Card
(3) Paper Ticket."

The description of each alternative provided to the respondents is shown in Table 1, and the preferences of the 460 respondents are shown in Figure 1. The majority (55%) stated that they preferred the TfL card, and 31% stated that they preferred to use contactless bankcards for transit payment.

TfL Discrete Choice Model for Fare Media

The raw survey data were provided by TfL to the authors to conduct the following discrete choice analysis. Because there were three distinct future fare medium choices (bankcard, TfL card, and paper ticket), multinomial logit was selected to identify the extent to which characteristics of the respondent relate to their fare medium choice. For estimation of this discrete choice model, weighting of the data was not necessary to obtain unbiased and consistent results because the sample was stratified based on exogenous variables *(24)*. The multinomial logit model was estimated with the BIOGEME software package *(25)*. The independent variables available for this analysis are defined in Table 1, and these include socioeconomic, transportation, and ticketing characteristics of the survey respondents. Most of the variables are categorical and were analyzed as binary variables, as is indicated in Table 2.

After assessing many specifications using these independent variables, which included testing for nested structures, the simple multinomial logit specification shown in Table 3 was selected as having the most explanatory power. Many of the independent variables from Table 2 were not statistically significant, and therefore, only parameters with t-statistics over 1.5 were included in the final model.

TfL Model Conclusions

The following conclusions can be drawn from the results of the TfL model. First, the overall goodness of fit of the model is low by a number of measures. A rho-squared of 0.187 suggests that the independent variables have a weak, but still statistically significant, relationship with fare medium choice.

The alternative specific constants for the bankcard and paper ticket alternatives were -1.59 and -1.73, respectively. The negative signs indicate that, all else being equal, the TfL card is the preferred alternative. Additionally, the relatively large magnitude of these two constants compared to the other coefficients indicates that there is a high level of unexplained preference between alternatives.

Gender was a statistically significant variable, and the positive coefficient of the male variable (0.674) in both the bankcard and TfL card equations indicates that men may have a higher preference for the two contactless alternatives than women.

Riders who already have credit, debit or prepaid cards from the payments industry had a positive preference for using bankcards for fare payment, as is indicated by the banked coefficient (0.648). It was not known if the respondent's card was contactless. Last, the t-statistic was only 1.55, and this variable does not have as great statistical significance as the other variables.

Riders age 18 to 24 showed a preference for contactless bankcards, as indicated by the positive age coefficient (0.634) for the bankcard alternative. Likewise, riders who already use debit cards to purchase tickets or reload Oyster cards also had a tendency to prefer bankcards, as is indicated by the debit coefficient of 0.734. Additionally, riders from Class A households showed a preference for bankcards, which is shown by the large, positive coefficient of 1.33.

The positive coefficient of 1.44 for paper tickets indicates that riders who currently use paper tickets exhibit a tendency to prefer paper tickets. Last, respondents who primarily use National Rail, which is the commuter rail service in greater London, exhibited a tendency to prefer paper tickets, as is shown by the positive coefficient of 0.664 in the paper ticket equation. It is noted that this survey was conducted in 2009, which was before the Oyster card was expanded to most National Rail services and paper tickets were the primary form of fare payment *(1).*

TfL Model Areas for Improvement

There are many potential areas for improvement of the TfL analysis. First, the literature on survey methods contains extensive discussion on the potential for biases when using stated preference data. It is well known that the format and context of the hypothetical setting can affect the respondent's answer (*26*). In this instance, contactless bankcard is the only new alternative, and respondents could have overstated their interest in this option because of an omission of situational constraints when choosing an alternative or a cognitive incongruity with actual behavior. Additionally, the paper ticket alternative was presented as "being more expensive" than the other two alternatives, which could have incentivized price-sensitive survey

respondents to choose the other two alternatives. A more thorough stated preference survey could have varied attributes of the alternatives to better assess consumer preferences and reduce the potential for such biases. Last, in the discrete choice analysis, there exists the possibility of multicollinearity between the independent variables, although cross-tabulation of significant variables suggests that these effects are not large.

THE CHICAGO TRANSIT AUTHORITY

CTA Data

The CTA operates the second largest public transportation agency in the United States *(27)*, including the elevated railway network and the bus system in the greater Chicago area. Currently, transit riders can pay fares using the Chicago Card contactless smart card, magnetic stripe pay-as-you-go or period passes, or directly with cash on buses *(2)*. Smart cards and magnetic stripe cards can be loaded or purchased in train stations, at a limited number of local retailers and grocery stores, and in currency exchanges *(28)*. The Chicago Card smart card was originally introduced system-wide in 2002, and as of the spring of 2009, approximately 32% of trips were made using the Chicago Card (*13*).

In the fall of 2008, the CTA conducted a comprehensive customer experience survey that included questions on ridership, general perceptions of the CTA, fare payment, service attributes, customer loyalty, technology use, and socioeconomic status. This survey was used by the agency to gather insight into changes in travel behavior and to address issues facing the CTA. Data were collected by telephone using Random Digit Dial (RDD) sampling as well as computer-assisted telephone interviewing (CATI) technology. The sample was stratified by geographic area of residence, which were downtown, north, northwest, south, southwest, west, and suburban Chicago, and by the respondent's primary mode, which were CTA bus or CTA operated trains (commonly referred to as the "L"). This data collection process yielded a total sample size of 2,439 interviews, which were weighted to be representative of residence location and primary mode. The resulting cell size allowed for statistically reliable results.

CTA Fare Medium Choice

CTA riders were asked how likely they would be to use contactless bankcards for transit payments in comparison to continuing to use the current fare media in the following manner: "*How likely would you be to use a system that allows you to pay your fare on buses and at train turnstiles by holding your credit or bank/debit card up to a secure reader instead of using cash or other CTA pass or card?*

1) *Very unlikely*
2) *Somewhat unlikely*
3) *Neither likely nor unlikely*
4) *Somewhat likely*
5) *Very likely*
6) *Don't know*
7) *Prefer not to answer."*

The specific fare policy associated with each alternative was not presented, nor was any additional description of the alternatives. The results are shown in Figure 2. 20% of riders were very likely to use a contactless bankcard, and another 17% were somewhat likely.

CTA Discrete Choice Model for Fare Media

The raw survey data were provided by the CTA to the authors to conduct the following discrete choice analysis. The choice set was defined to be bankcard and the existing fare medium, and binary logit was utilized. Respondents who stated that they were "very likely" or "somewhat likely" to choose contactless bankcards were assumed to have chosen the bankcard alternative. Likewise, those who were "very unlikely" or "somewhat unlikely" to use contactless bankcards were combined to select the existing fare medium. Respondents who were "neither likely nor unlikely" to use contactless bankcards were excluded from the choice model; they represented less than 1% of survey participants.

For estimation of this discrete choice model, weighting of the data was not necessary to obtain unbiased and consistent results because the sample was stratified based on exogenous variables *(24)*. The BIOGEME software package was again utilized *(25)*. The independent variables available for this analysis are defined in Table 4, and they include socioeconomic, travel, ticketing, and financial characteristics of the respondent.

After assessing many specifications using these independent variables, the binary logit specification shown in Table 5 was selected as having the most explanatory power. Many of the independent variables from Table 4 were not statistically significant, and again, only parameters with t-statistics over 1.5 were included in the final model.

CTA Model Conclusions

The following conclusions can be drawn from the results of the CTA model. First, the overall goodness of fit of the model is very low. A rho-squared of 0.070 suggests that the independent variables have very limited relationship with fare medium choice. Possible reasons for this are discussed in the next section.

The alternative specific constant for bankcard (-0.774) indicates that, all else being equal, the existing fare medium is the preferred alternative. Additionally, the relatively large magnitude of this constant compared to the other coefficients indicates that there is a high level of unexplained preference between alternatives.

Riders under 45 years of age showed a preference for contactless bankcards, as indicated by the positive coefficient of this variable (0.292). Riders over age 65 showed a preference for existing fare media, as indicated by a positive coefficient (0.516).

Household size was a statistically significant variable, and the positive coefficient (0.0863*)* suggests that respondents from larger households may prefer contactless bankcards. This coefficient is small in magnitude compared to the other coefficients, which can partially be attributed to the fact that household size is a continuous variable that is larger in magnitude than the other binary variables. Additionally, respondents who primarily use CTA operated trains exhibited a tendency to prefer contactless bankcards, as is noted by the positive train coefficient of 0.247.

An interaction term for riders who had heard of contactless bankcards and also had a credit card, debit card, or checking account is indicated by "banked * aware of contactless." The positive coefficient of 0.224 indicates that these riders have a positive preference for using bankcards for fare payment.

Riders who primarily use the CTA for work trips, which includes commuting to work or school or for business related trips, showed a preference for existing fare media, as is shown by the coefficient of 0.238. Last, riders who always use cash for retail payments were inclined to choose an existing fare medium, as is shown by the positive coefficient of 0.378.

CTA Model Areas for Improvement

As was noted in the previous section, the overall goodness of fit of the binary logit model was very low. As with the TfL model, there are many possible factors that could have caused biases in the stated preference dataset. Because contactless bankcard is the only new alternative, respondents could have overstated their interest in this option because of an omission of situational constraints when choosing an alternative or a cognitive incongruity with actual behavior.

Another possible factor that could have caused bias in the survey results is an incomplete description of alternatives. Telephoned survey participants were only offered a short description of contactless bankcard fare collection systems, which was described as "a system that allows you to pay your fare on buses and at train turnstiles by holding your credit or bank card up to a secure reader." This can be contrasted with the TfL survey, in which a short video was utilized to explain the fare medium alternatives to survey participants. A more thorough stated preference survey could have included additional information about contactless bankcards. Yet another factor that could have biased the results was an indifference of survey participants to the experimental task. The CTA Customer Experience survey had over seventy questions; although not all questions were asked to every participant, they were asked many questions and could have become indifferent to answering before the fare medium question was presented.

COMPARISON AND CONCLUSIONS

The results of the discrete choice models for the CTA and TfL can be compared to investigate overarching themes and trends of rider preferences for future fare media, as is shown in Table 6. Some general conclusions can be drawn from this analysis that may help to inform other transit agencies considering or implementing contactless bankcard fare collection systems. First, the overall preference for contactless bankcards is similar in percentage for both transit agencies. As can be seen in Table 6, 33% of TfL riders and 36% of CTA riders prefer contactless bankcards. Likewise, the majority of TfL riders (69%) preferred TfL cards or paper tickets, and most CTA riders (62%) prefer existing fare media. These statistics demonstrate that, particularly in the initial years of contactless bankcard fare collection systems, the majority of riders may prefer not to use contactless bankcards. Alternative forms of fare media will be necessary, such as contactless prepaid cards issued by the payments industry, perhaps branded for and issued on behalf of the transit agency.

The results of the discrete choice models were generally in alignment with models of consumer adoption of new technologies, but there were a few surprising results. First, in the TfL model, the gender variable indicated that males may be more inclined to utilize contactless fare media. One possible explanation is that males have historically had a greater tendency to travel for regular commuting trips, as opposed to women who have a comparatively greater percentage of shopping and personal business trips (*29*). The advantages of using contactless technology to expedite movement in crowded stations and on buses in the peak hours may cause commuting men to have greater preferences for these options. Similarly in the CTA model, household size resulted in an increased preference for contactless bankcards. This appears to go against conventional wisdom that larger household sizes often have lower income levels and would therefore be less likely to use financial instruments, but it is unclear why. Despite these two unexpected findings, most results were in alignment with general trends of consumer adoption, and the key factors that appear to influence the choice of fare media are age, payment characteristics, and travel mode.

Younger riders showed a preference for contactless bankcards at both agencies. In general, younger generations have demonstrated trends of increased adoption of credit and debit cards *(30, 31)*. Moreover, younger age groups may be more inclined to adopt new technologies *(32, 33)*. On the other hand, older riders showed a preference for existing fare media at the CTA. Because the CTA (and TfL) have concession schemes for older riders, it may have been unclear to survey respondents if contactless bankcards would or could be used for free travel. Even if these riders were paying full fares, older generations are generally less likely to adopt new technologies *(32, 33)*.

Riders at both transit agencies who currently have credit or debit cards had a tendency to prefer contactless bankcards. Therefore, they may be more inclined to use them for transit payments for reasons of convenience or familiarity. Moreover, at the CTA, those who were already aware of contactless bankcards had a tendency to prefer contactless bankcards.

Current payment choices in retail and transit influenced fare medium selection at both transit agencies. At the CTA, riders who stated that they always used cash for retail payments had a tendency to prefer existing fare media, which may indicate that they are hesitant to change from their current preferred payment choice. On the other hand, TfL riders who currently use debit cards to purchase transit tickets showed a preference for contactless bankcards, again indicating that riders may want to continue with their preferred payment instrument. Debit cards are more widely issued and used than credit cards in the United Kingdom (*34*), which may help to explain why debit but not credit cards were statistically significant in the discrete choice analysis.

Different modes exhibited transit agency-specific fare medium trends. CTA train riders had a tendency to prefer contactless bankcards. This may be because CTA train riders generally have higher income levels than bus riders, which was shown in the survey data. On the other hand, TfL National Rail riders had a preference for paper tickets. This may be because National Rail largely did not have contactless technology when the survey was administered, and customers were more familiar with paper tickets. These results could be different now that the Oyster card was expanded to commuter rail at the beginning of 2010 *(1)*.

The factors influencing fare medium choice at the CTA and TfL seem to be in alignment with standard sociology models for consumer adoption of new technologies *(32, 33)*. These models suggest that technologies are first adopted by a small percentage of innovative individuals who are often younger, more willing to take risks, from higher social classes, and well educated *(27)*. In this analysis, riders who preferred contactless bankcards were generally from younger age groups, and they tended to have access to credit and debit cards. Likewise, Class A riders in London preferred bankcards. On the other hand, those who preferred existing fare media were older in age, and they tended to favor current payment mechanisms (such as cash for retail payments), which may indicate that they approach new payment technologies with skepticism. This second group often follows the lead of the innovative, risk-taking group once a new technology has demonstrated benefits *(33)*. Therefore, while contactless bankcards may only be adopted by approximately one third of riders initially, other transit riders may choose to adopt contactless bankcards in the future.

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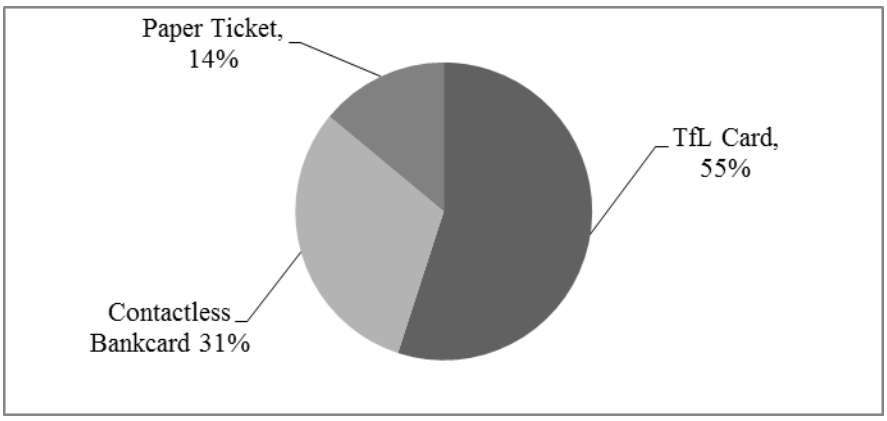

FIGURE 1 Future fare medium choices of TfL riders (N= 460).

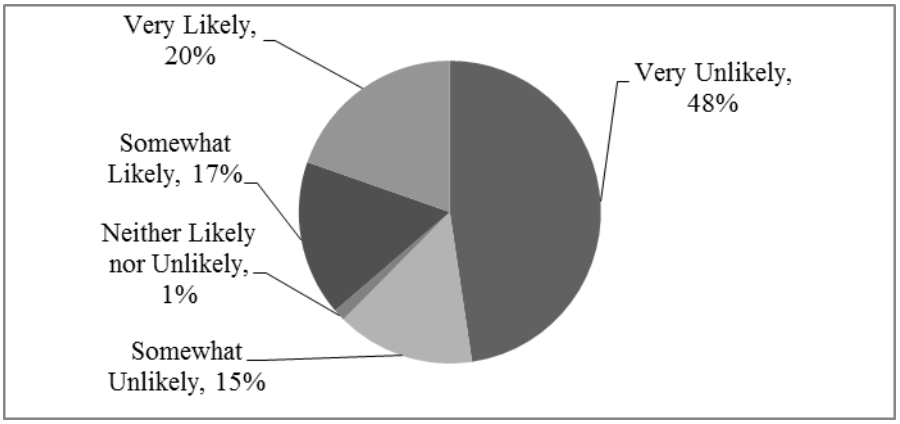

FIGURE 2 CTA rider likelihood of using contactless bankcards (N = 2,356).

TABLE 1 Description of TfL Future Fare Media Provided to Survey Participants

TRANSPORT FOR LONDON FUTURE TICKETING OPTIONS		
1. TfL Card, similar to an Oyster card	**2. Bank Debit or Credit Card**	**3. Paper Tickets**
How it's used *– the TfL card can only be used for travel on all public transport in London by 'touching-in' and 'touching-out' at the point of entry and exit*	***How it's used –*** *you can use your debit or credit card to pay for all public transport in London by 'touching-in' and 'touching-out' at the point of entry and exit. You can also use this card to pay for other everyday items under £10 without entering your PIN*	• *You can pay for paper tickets using cash or a bank card at Tube and London Overground ticket offices and ticket machines* • *They can also be purchased on buses, and at buses, DLR and tram stops* • *Paper tickets will be more expensive than using a TfL Card or Bank Card to travel*
Registration *– you will be able to register your card with TfL which will:* • *Let you use your card as a Travelcard or Bus & Tram Pass e.g. 7 day, monthly and annual, or flexibly allowing you to choose the Travelcard or Bus Pass period of between a month and a year* • *Protect you against loss or theft of card* • *Allow you to receive service messages about improvements and/or any disruption to your regular journey*	***Registration*** *– you will be able to register your card with TfL which will:* • *Let you use your card as a Travelcard or Bus & Tram Pass e.g. 7 day, monthly and annual, or flexibly allowing you to choose the Travelcard or Bus Pass period of between a month and a year* • *Let you transfer your Travelcard or Bus & Tram Pass to another card by accessing your TfL account on-line or by phone if you lose your credit or debit card* • *Allow you to receive service message about improvement and/or any disruption to your regular journey*	
Top-up *– you can top-up your TfL card with credit for pay as you go travel:* • *At a ticket office* • *Using your mobile phone* • *Over the internet using your mobile phone or computer*	***Top-up*** *– you do not need to top-up your card:* • *Pay As You Go: Your bank or credit card account would be charged automatically by TfL at the end of each day for any pay as you go trips you have made* • *Travelcard or Bus Pass: Your bank or credit card account would be charged automatically by TfL when you add a Travelcard or Bus Pass to your Bank Card*	

TABLE 2 Definitions of TfL Independent Variables

	Variable	Definition
Socioeconomic Characteristics	Male	A binary variable was defined to be one if the respondent was male.
	Age	Binary variables were used for respondent age categories, which were subdivided 18-24, 25-34, 35-44, 45-54, 55-59 and 60+.
	Location	A binary variable was defined to be one if the respondent lived within the city of London.
	Ethnicity	Binary variables for ethnicity categories were used for Caucasian and minorities respondents.
	Employment Status	Binary variables were used for employment categories: employed, student, unemployed, retired, homemaker, or other.
	Banked	A binary variable was defined to be one if the respondent had a credit, debit, or payments industry prepaid card. "Banked" implies that they have financial instruments available.
	Social Grade	Binary variables were used for social grade categories: A, B, C1, C2, D, and E. A is upper middle class, with a higher managerial, administrative or professional position; B is middle class with an intermediate managerial, administrative or professional job; C1 is lower middle class, with supervisory or clerical, junior managerial, administrative or professional jobs; D is working class, with semi or unskilled manual workers; and E is the lowest level of subsistence, with dependence on the state for payments or those with casual employment or without regular income.
	Income	Binary variables were used for annual income categories £10,000 & less, £10,000-50,000, and £50,000 & greater.
	Household Size	A continuous variable represented the total number of individuals in the household.
Travel Characteristics	Journey Purpose	Binary variables were used for journey purpose categories: Work/Education Commuting/Business, Leisure or Personal Business.
	Mode	Binary variables were used for primary mode categories: Bus, Underground, National Rail (i.e. commuter rail), Overground, Docklands Light Rail, and Tram.
Ticketing Characteristics	Ticket Type	Binary variables for current TfL ticket type were divided into the following categories: Paper Tickets, Oyster Pay-as-you-go, Weekly Passes on Oyster, and Season Tickets (monthly and longer).
	Ticket Purchase Location	Binary variables were used for the following categories where TfL tickets are currently purchased: Tube Ticket Offices, Overground Ticket Offices, National Rail Ticket Office, Bus stop/Onboard, Ticket Machines, Travel Information Centers, Oyster Ticket Stops, Online, Auto Top up and Other.
	Paying for Ticket	Binary variables were used for categories of how tickets are currently purchased: using a debit card, using a credit card, using cash, by an employer, or other.

TABLE 3 TfL Multinomial Logit Model Results

Bankcard Alternative Parameters	**Coefficient**	**T-statistic**
Male	0.674	2.20
Banked	0.648	1.55
Age 18 to 24	0.634	2.76
Debit	0.734	3.32
Class A	1.33	1.76
Constant	-1.59	-3.90
Paper Alternative Parameters	**Coefficient**	**T-statistic**
Paper Ticket	1.44	4.79
National Rail	0.664	1.90
Constant	-1.73	-7.66
TfL Card Alternative Parameters	**Coefficient**	**T-statistic**
Male	0.674	2.20
Overall Statistics	**Value**	
Number of observations	452	
Initial Log Likelihood	-494.739	
Final Log Likelihood	-402.024	
Likelihood Ratio Test	185.431	
Rho-squared	0.187	
Adjusted Rho-squared	0.169	

Male is equal to 1 for male respondents;
Banked is equal to 1 if the respondents has at least one credit, debit or prepaid card;
Age 18 to 24 is equal to 1 if the respondent is between the ages of 18 and 24;
Debit is equal to 1 if the respondent currently uses a debit card to buy or reload tickets;
Class A is equal to 1 if the respondent lives in a household in social grade ranking A, which is for higher managerial, administrative or professional positions;
Paper Ticket is equal to 1 if the respondent currently uses a paper ticket; and
National Rail is equal to 1 if the respondent's primary mode is National Rail.

TABLE 4 Definitions of CTA Independent Variables

	Variable	Definition
Socioeconomic Characteristics	Male	A binary variable was defined to be one if the respondent was male.
	Age	Binary variables were used for respondent age categories, which were subdivided into 16-17, 18-24, 25-34, 45-54, 55-64 and 65+.
	Location	Binary variables were used for regions where the respondents live in Chicago: North, Northwest, South, Southwest, West, Downtown and Suburbs.
	Ethnicity	Binary variables for ethnicity categories were used for Caucasian respondents and minorities.
	Employment Status	Binary variables were used for employment categories: employed, student, unemployed, retired, homemaker, or other.
	Income	Binary variables for annual income categories were: $20,000 & less, $20,000-55,000, $55,000-85,000, and $85,000 & greater.
	Household Size	A continuous variable represented the total number of individuals in the household.
Financial Characteristics	Banked	A binary variable was defined to be one if the respondent had a credit card, debit card or checking account.
	Frequency of Cash Payment	Binary variables were used for the frequency with which the respondent uses cash for retail payments: never, sometimes, most of the time, and all of the time.
	Awareness of Contactless Bankcards	A binary variable was defined to be one if the respondent had heard of contactless bankcards.
Travel Characteristics	Frequency of Travel	Binary variables were defined for the following categories: frequent riders (at least five rides per week), infrequent riders (at least one ride per week), and occasional riders (at least one ride per month).
	Journey Purpose	Binary variables were used for journey purpose categories: Work/Education Commuting/Business, Leisure/Personal Business/Medical/Airport, and Only Mode of Travel.
	Mode	Binary variables were used for the following primary mode categories: CTA bus, CTA operated train, or both.
Ticketing Characteristics	Ticket Type	Binary variables for current ticket type were divided into cash, transit card (magnetic stripe), Chicago card, Chicago card plus, period pass, and reduced/free fares.

TABLE 5 CTA Binary Logit Model Results

Bankcard Alternative Parameters	**Coefficient**	**T-statistic**
Age Under 45	0.292	2.88
Household Size	0.0863	2.98
Train	0.247	2.03
*Banked * Aware of Contactless*	0.224	2.36
Constant	-0.774	-5.92
Existing Fare Media Alternative Parameters	**Coefficient**	**T-statistic**
Age over 65	0.516	3.36
Work Trip	0.238	2.46
All Cash Payments	0.378	3.23
Overall Statistics	**Value**	
Number of observations	2,211	
Initial Log Likelihood	-1,539.648	
Final Log Likelihood	-1,432.250	
Likelihood Ratio Test	214.796	
Rho-squared	0.070	
Adjusted Rho-squared	0.065	

Age Under 45 is equal to 1 for respondents under age 45;
Household Size is the size of the respondent's household, ranging up to 14 people;
Train is equal to 1 if the respondent's primary mode is CTA operated train;
Banked is equal to 1 if the respondent has a credit card, debit card, or checking account;
Aware of Contactless is equal to 1 if the respondent has previously heard of contactless bankcards;
Age over 65 is equal to 1 if the respondent is over 65 years of age;
Work Trip is equal to 1 for respondents whose primary journey purpose is commuting to work or school or work-related trips; and
All Cash Payments is equal to 1 for respondents who stated that they always use cash to pay for things (like retail purchases).

TABLE 6 Comparison of TfL and CTA Rider Preferences for Contactless Bankcards

	Transport for London (2009 Survey Data)	**Chicago Transit Authority (2008 Survey Data)**
Rider Preference for Future Fare Media		
Overall Percentage	- 33% of riders prefer contactless bankcards; - 55% of riders prefer TfL cards; and - 14% of riders prefer paper tickets.	- 36% of riders prefer contactless bankcards; - 1% are neutral; and - 62% of riders prefer existing fare media.*
Influencing Factors		
Age	- Young riders (ages 18-24) prefer contactless bankcards.	- Younger riders (under 45 years) prefer contactless bankcards. - Older riders (65+) prefer existing fare media.
Household	- Riders from Class A households have a stronger tendency to choose contactless bankcards.	- Riders from larger households have a stronger tendency to choose contactless bankcards.
Banked	- Riders with credit, debit or prepaid cards tend to prefer contactless bankcards.	- Riders with credit, debit cards or checking accounts tend to prefer contactless bankcards.
Mode	- National Rail riders prefer paper tickets.	- CTA train users prefer contactless bankcards. - No commuter rail riders were surveyed.
Tickets & Payments	- Riders who currently use debit cards to purchase tickets have a tendency to choose contactless bankcards. - Paper ticket users have a tendency to continue to prefer paper tickets.	- Riders who are aware of contactless bankcards have a tendency to choose contactless bankcards. - Riders who always use cash for retail payments prefer existing fare media.
Other	- Male riders have a tendency to prefer either TfL or bankcards, in comparison to paper tickets.	- Riders who use the CTA for commuting and work-related trips prefer contactless bankcards.
Strength of Trends		
Goodness of Fit	- The overall goodness of fit suggests a weak but still statistically significant relationship.	- Little goodness of fit, which may indicate biases in the data, such as limited respondent understanding of alternatives.
**Rounded to the nearest whole percent*.		