The Role of Convenience and Risk in Consumers' Means of Payment

by Carlos Arango and Varya Taylor

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Currency Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
carango@bankofcanada.ca
vtaylor@bankofcanada.ca

Acknowledgements

Abstract

Using data from a 2004 survey of the Canadian public, the authors study the role of convenience and risk in consumers' use of cash relative to debit and credit cards. The authors find that consumers who perceive debit cards and credit cards to be more convenient and less risky than cash use them more frequently. Even at low levels of perceived risk, consumers shift substantially away from cash and towards alternative payment methods. However, the authors' results reveal that there exists a lower bound for which cards can substitute for cash. Also, as other studies have shown, the relative use of cash is higher among older, less-educated, lower-income consumers.

JEL classification: E41, L2
Bank classification: Bank notes

Résumé

En se servant des données d'une enquête menée en 2004 auprès de la population canadienne, les auteurs étudient dans quelle mesure les perceptions de la commodité et du risque influent sur la décision des consommateurs de régler leurs achats comptant, par carte de débit ou par carte de crédit. Ils constatent que, lorsque les consommateurs croient que les cartes sont plus pratiques et présentent moins de risques que les espèces, ils utilisent plus souvent ce mode de paiement. La perception d'un risque, même faible, entraîne un net recul de l'utilisation de l'argent comptant au profit des cartes de paiement. Toutefois, d'après les résultats, il existe un seuil en deçà duquel celles-ci ne peuvent pas remplacer l'argent liquide. Par ailleurs, comme l'ont montré d'autres études, les consommateurs qui sont plus âgés, moins instruits et dont les revenus sont plus bas ont davantage recours à l'argent comptant pour payer leurs achats.

Classification JEL : E41, L2
Classification de la Banque : Billets de banque

1 Introduction

Using data from a public survey that was commissioned by the Bank of Canada in 2004, we study how perceptions of convenience and risk affect consumers' means of payment (MOP). We focus on these two factors, in addition to demographics, as they relate to the use of cash relative to debit and credit cards. Although the survey's main objective was to assess consumer confidence in bank notes, it also provides valuable data on the frequency of MOP use and perceptions of convenience and risk.

Insight into how convenience and risk can affect the demand for retail payments is of interest to the Bank of Canada, since it provides the public with bank notes. The Bank recognizes that, although bank notes are the most frequently used MOP, the demand for electronic payments is growing and consumers consider transaction speed, availability, acceptance, record keeping, costs, and rewards in addition to convenience and risk. Unfortunately, these other factors were not addressed by the 2004 survey, and thus our research is unable to capture them directly. We argue, however, that perceptions of convenience – which may encompass these other factors – and risk are of particular importance to the demand for payments as more payment options become available to consumers.[1] In fact, newer payment innovations, such as contactless or mobile phone payments, compete directly with existing payment methods mainly on the basis of convenience. While enhanced convenience may appeal to consumers, the potential risk of fraud or identity theft has been accentuated by advances in technology. Thus, there is an increasing need to conduct research in this area.

Our main contributions to the literature on retail payments are twofold. First, we show that, along with demographic factors, consumers will use alternative MOP more frequently than cash if they find it more convenient and less risky. In fact, we find that even at low levels of perceived risk, relative cash use is considerably impacted. Second, we find that there exists a lower bound on the extent to which consumers can substitute away from cash usage. This likely reflects the fact that cash is currently accepted in transactions with more certainty than debit and credit cards.

The rest of this paper is organized as follows. In the next section, we review some of the factors underlying MOP demand. In sections 3 and 4, we describe the survey data and the survey's caveats, limitations, and potential for research. Sections 5 to 7 present models of relative cash usage, adoption, and MOP frequency of use in absolute terms. Section 8 concludes.

2 Factors Affecting Consumers' MOP Decisions

In Canada, as in many other countries, consumers have access to a variety of payment methods such as cash, cheques, debit cards, and credit cards. In deciding which MOP to adopt, consumers

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[1]. Jonker (2005), Klee (2006), Schuh and Stavins (2009), Borzekowski, Kiser, and Shaista (2008), and Ching and Hayashi (2008), among others, have shown the significance of MOP factors such as speed, rewards, and fees in explaining MOP choices. However, the impact of risk perceptions has not been explored thoroughly.

compare the expected marginal benefits and costs of using a MOP with the fixed costs. For debit and credit cards, there may be set-up and monthly/annual fees associated with the account. In addition, access to credit cards may be limited by a consumer's creditworthiness, which usually depends on their credit history, income, and employment status. For certain consumers, learning a new payment technology and breaking old habits could also be costly.

In deciding how often to use their MOP, consumers may consider convenience, risk, and fees, which may vary across consumers, depending on their consumption patterns. Klee (2006) and Bounie and Francois (2006), for example, find significant evidence of the effect of transaction values and transaction characteristics such as the type and the number of items purchased on MOP choices. Similar results are found by Arango and Taylor (2008), who, in studying merchants, show significant evidence that MOP payment shares at the point of sale (POS) vary by transaction value and retail subsector.

In this paper, we are able to examine only broad perceptions of convenience and risk. However, underlying these two broad categories, there are many specific factors that influence consumers' MOP decisions. The following are some of the factors most commonly mentioned in the literature on payments adoption and usage.

Acceptance: Although debit and credit card acceptance is very high in Canada, cash still remains the most accepted payment method. Thus, as long as consumers expect that some merchants may not accept credit or debit cards, they will carry some cash.[2] Dutta and Weale (2001) empirically show that merchants' degree of acceptance of credit, together with the financial costs associated with it, determine consumers' decisions regarding money holdings and debt. Bolt, Humphrey, and Uittenbogaard (2005) also show that the availability of card payment terminals played a substantial role in the growth of electronic payment use in Norway and the Netherlands.

Speed: Recent studies (Borzekowski, Kiser, and Shaista 2008; Borzekowski and Kiser 2008) show that speed is a significant driver of consumers' MOP choices at the POS. Estimates of payment time at the checkout show that, on average, cash is the fastest payment method, followed by debit cards and credit cards (Working Group on Costs of POS Payment Products 2004). However, checkout times for cash payments may vary more than for cards, depending on the transaction value, the change involved, and other transaction characteristics.

Security: When using cash, consumers face the risk of theft, counterfeiting, or loss. However, as Kahn, McAndrews, and Roberds (2005) show, consumers may appreciate the anonymity of cash for privacy reasons, or because using debit or credit cards may increase their exposure to fraudulent activities, including the unauthorized use of a lost or stolen card. When such fraud occurs, consumers are usually protected by liability agreements. However, the effects of fraud

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2. See, for example Markose and Loke (2003) and Bolt and Chakravorti (2008), and the references therein, for theoretical studies of acceptance in consumers' and merchants' MOP decisions.

can be extensive and the resolution process can be time consuming, as in the case of identity theft, where bad credit and damaged reputation can have long-lasting effects. In the case of debit cards, there is also potential for the temporary loss of funds until the case is resolved, or permanent losses if cardholders are not diligent in notifying the authorities and financial institutions or if there is proven evidence of negligent handling of the card or the personal identification number.

Access to funds: In order to pay with cash, sufficient funds are physically required to finalize transactions. Debit and credit cards, on the other hand, provide consumers with secure and immediate access to funds at the POS. Credit cards also provide consumers with an interest-free loan period, thereby assisting those who may face liquidity constraints.

Fees and rewards: The use of cash involves a variety of costs that depend on transaction frequency and value, such as withdrawal fees, and the opportunity costs of time spent obtaining cash and interest forgone from carrying cash balances.[3] Consumers may face per-transaction costs from using debit cards as part of their bank account arrangements, or they may incur interest costs if credit card balances are not paid in full by the due date. To promote card usage, card networks often offer attractive reward programs, such as cash rebates or travel points.

Record keeping: Consumers may also value the record keeping function of debit and credit cards, especially as transaction values increase, since it helps keep track of expenses and, in the case of credit cards, build credit history. Cash, on the other hand, has a limited record keeping function, since it leaves no trace of payment.

Budgeting control: Some people may not carry credit cards and use cash or debit cards to avoid overspending. Fusaro (2008) finds evidence that, despite the fact that credit cards are more attractive than debit cards in terms of the interest-free loan period and rewards, people use debit cards to control their budget and avoid the financial burden associated with overspending.

3   Survey Data and Results

The data used in this paper are collected from a telephone survey, conducted in 2004, of over 2,000 adult Canadians.[4] The survey was commissioned by the Bank of Canada to assess

- the frequency of cash, debit card, and credit card use
- the value of bank note holdings
- confidence in bank note security

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3. Whitesell (1989) and Shy and Tarkka (2002), among other theoretical studies (see the references therein), base the decision to use cash on the opportunity cost of holding cash which increases with the value of the transaction and the costs of accessing alternative payment instruments.
4. See Taylor (2006) for further details.

- perceptions of the convenience and risk of cash, debit cards, and credit cards

The original intention of the survey was to analyze public confidence in bank notes during a time in which the level of counterfeit bank notes detected in circulation was extraordinarily high.[5]

To represent the adult population in Canada, the survey sample was selected at random, stratified by province, and distributed by income, age, education, and gender. Table 1 provides a break-down of the survey sample with, for comparison, the 2006 Census of Canada (Statistics Canada 2006). Compared to the census, the unweighted sample overrepresents adults aged 30–45 years and those with a university education and underrepresents those with an education less than high school. Given the sample size and distribution, the survey results have a margin of error of +/-2.2 per cent, 19 times out of 20.

3.1 Respondents' perceptions and frequency of MOP use

For each MOP, respondents were asked to report their perceptions of convenience, ranging from "not at all" to "very" convenient, and risk, ranging from "non-existent" to "high." (Risk was asked in terms of the likelihood of fraud or loss.) They were also asked to report how often they typically use each MOP – whether daily, weekly, once or twice a month, rarely, or never.

The survey results indicate that Canadians perceive debit cards to be the most convenient payment method: 70 per cent of respondents state that debit cards are very convenient, compared to 62 per cent for cash and 59 per cent for credit cards. Credit cards are seen as the most risky MOP: 36 per cent of respondents perceive credit cards to have high risk, compared to 21 per cent for cash and 19 per cent for debit cards.

The survey also suggests that cash is the most frequently used MOP: 73 per cent use cash at least once a week, compared to 64 per cent for debit cards and 36 per cent for credit cards. While all respondents use cash, 18 per cent of respondents say they never use debit cards and 24 per cent say they never use credit cards. These findings are discussed in section 5.

3.2 Perceptions across demographic groups

In this section, we use ordered probit models to examine how perceptions of convenience and risk vary across demographic groups.[6] We consider that consumers perceive MOP differently because of their own experiences, habits, shopping patterns, and attitudes. We use demographic variables to capture these differences. For instance, younger and more educated consumers may

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5. The Bank's main concern was that a lack of confidence could negatively affect the public's "willingness and propensity to use cash as a means of payment with freedom from uncertainty or embarrassment." To understand how confidence can affect the demand for bank notes, however, it is necessary to consider the payment alternatives that may serve as a substitute for cash. The survey therefore provides data on the public's use and perceptions of debit and credit cards, as well as cash.
6. Ordered probit models are used when modelling categorical responses such as perceptions of convenience and risk in this case, where linear regression is not suitable. See Appendix A for a technical review of ordered probits.

find debit and/or credit cards more convenient because they are more adept at technology. Richer consumers, who make higher-valued purchases, may also find card payments more convenient and less risky, because of the immediate and secure access to funds and the benefits of record keeping. The relationship of age and risk perceptions, however, is less straightforward. Older consumers may be more aware of the potential consequences of payment card fraud, and thus may value the anonymity of cash more than younger consumers. Alternatively, younger people may be more aware of the pervasiveness of card fraud because they are more familiar with the technology associated with it.

According to the ordered probit analysis shown in Table 2, consumers with higher education and income perceive significantly higher levels of convenience for debit and credit cards. Older consumers tend to find debit cards less convenient and credit cards more convenient. Men perceive cash to be more convenient than do women, and perceive debit and credit cards to be less convenient. As confirmed by a joint test of significance, there are no significant differences across demographic groups when it comes to the convenience of cash, aside from gender.[7]

The perceived risk of cash is much more heterogeneous (Table 3). As will be discussed in section 5, relatively young, low-income, and less-educated consumers are the most likely to perceive cash to be risky, probably reflecting the fact that they are more cash intensive and therefore could be more exposed to theft or loss. Perceptions of debit card risk appear invariant across demographic groups, although men are more likely to perceive debit cards to be less risky than women. Men are also more likely to perceive credit cards to be less risky, as do older consumers.

4   Survey Caveats, Limitations, and Potential for Research

4.1   Caveats

Before proceeding with further research, it is necessary to recognize some caveats regarding the survey. One important caveat is the measurement error associated with the results that rely on respondents' recollections. It may be difficult for respondents to accurately report the frequency of MOP use. In particular, respondents may underestimate the number of cash transactions, because cash is often associated with smaller and more menial purchases.

Another caveat is the respondents' interpretations of the survey questions. Perceptions of convenience and risk are broad categories that can be interpreted differently. To some respondents, MOP convenience may mean faster transaction times at the point of sale; ease of use; immediate access to funds; electronic record keeping; availability; or acceptance by merchants. Thus, the final results are based on respondents' notions of convenience, instead of specific aspects. Respondents may also interpret the question of risk as either an awareness of

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7.   The results reported are based on statistical tests of differences in the parameter estimates for the dummy categories.

how prevalent risk is (perhaps based on media reports) or as an expectation of monetary loss to an individual. For example, credit cards were ranked as the most risky MOP, yet credit cards usually have "zero liability" for consumers in case of fraudulent activity. This implies that more respondents considered the prevalence of credit card fraud instead of the risk of actual monetary loss.

A final caveat is that many respondents did not complete the survey questions entirely. To avoid a significant loss of data, and potential sample bias from excluding respondents who did not answer some of the questions used in the econometric analysis, we impute the missing values through an iterative multivariable regression technique.[8] In doing so, we assume that the missing responses are observed at random.

4.2   Limitations

In addition to the caveats, the survey has its limitations for further research. Ideally, we would like to estimate a structural model of MOP demand.[9] However, the survey does not provide all the data required for such a model. Most critically, the survey does not report the marginal costs and benefits associated with each MOP. Data on ATM fees for cash withdrawals, debit card transaction fees, and credit card interest rates, spending limits, and reward programs would significantly vary by respondent and impact MOP use.

Furthermore, the survey does not explicitly capture the respondents' shopping patterns, which would also influence the frequency of MOP use. We therefore do not know the POS characteristics that tend to determine the choice of payment, such as the store location, type of good, or value of purchase.

Another drawback of the survey is the lack of information on MOP adoption. It is not clear if respondents who say they "never use" a MOP have adopted the MOP and never use it, or have not adopted the MOP in the first place.

Finally, the survey omits other demographic factors that could also influence MOP use, such as information on respondents' employment status, job classification, wealth, and outstanding debt.

4.3   Potential for research

Given the survey's caveats and limitations, the development of a structural MOP demand model is rather restricted. However, at the very least, the survey data can offer insight into how perceptions of convenience and risk can vary by consumer (as shown in section 3.2), and how these perceptions can influence MOP use.

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8.   We use the imputation by chained equations (ICE) program in STATA to impute the missing values.
9.   A structural model, as opposed to a reduced-form model, would account for the interactions between the decisions to adopt, and the frequency of use of, each MOP. It would also seek to represent the substitution effects among MOP generally, allowing for asymmetric substitution effects among MOP pairs.

We therefore proceed with a reduced-form model that examines the use of cash relative to debit and credit cards. We argue that, despite not having direct measures of costs and benefits, convenience is an important perception that encompasses many of the benefits of using a MOP. We also argue that risk is a perceived potential cost that reflects the degree of confidence in a MOP, and that confidence is essential to any MOP, since goods and services are exchanged only with the expectation that all payments will be honoured by their legitimate value. Furthermore, the lack of data on transaction characteristics may not be a serious problem, since we are not explaining the choice at the POS, but rather, the frequency of use. Also, the demographic data that we do have can partly reflect shopping patterns.

As for the missing information on adoption, we classify consumers who use a MOP with some frequency as "active adopters," as opposed to those who "never use" it.[10] In doing so, we show in section 6 that MOP adoption may be important to MOP demand.

5 Relative Cash Usage (RCU)

5.1 RCU as a reduced-form model

We calculate an index of relative cash usage (RCU) for each respondent based on the reported frequency of use of cash, debit, and credit cards. With a choice of answers such as "daily" or "rarely" or "never," respondents were asked how frequently they use each MOP. The responses allow us to construct measures of MOP usage.[11] The RCU_i is defined as the ratio of cash frequency to the sum of cash, debit card, and credit card frequencies for respondent i, and it varies between zero and one:

$$RCU_i = \frac{\text{cash frequency}_i}{\text{cash frequency}_i + \text{debit frequency}_i + \text{credit frequency}_i}. \tag{1}$$

We model RCU_i for respondent i as a function of demographic variables and perceptions:

$$RCU_i = \alpha + \sum_{j=1}^{A} \beta_j a_{ij} + \sum_{j=1}^{I} \delta_j i_{ij} + \sum_{j=1}^{E} \phi_j e_{ij} + \lambda G_i + \eta C_i + \pi R_i + \varepsilon_i, \tag{2}$$

where a_{ij} are dummy variables for age, i_{ij} are dummy variables for income, e_{ij} are dummy variables for education, and G_i is a dummy variable for gender that equals 1 for male respondents. C_i is a variable for relative cash convenience and R_i is a variable for relative cash risk. C_i is defined, in a way similar to the RCU, as follows:

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10. Snyder and Zinman (2008) discuss the implications of passive and active adoption for the degree of competition in payment networks.
11. We converted the categorical responses to numbers as follows: "daily" equal to 7 as a proxy for performing at least seven transactions per week; "every two or three days" equal to 3; "weekly" equal to 1; "once or twice a month" or "rarely" equal to 0.5; and "never" equal to 0.

$$C_i = \frac{\text{cash convenience}_i}{\text{cash convenience}_i + \text{debit convenience}_i + \text{credit convenience}_i} . \tag{3}$$

We expect C_i to have a positive effect on RCU_i, since higher values of C_i mean that cash is perceived to be relatively more convenient than cards and therefore should induce higher cash usage compared to cards.

Similarly, R_i is defined as follows:

$$R_i = \frac{\text{cash risk}_i}{\text{cash risk}_i + \text{debit risk}_i + \text{credit risk}_i} . \tag{4}$$

We expect R_i to have a negative effect on RCU_i, since higher values of R_i mean that cash is perceived to be relatively riskier than cards and therefore should induce lower cash usage compared to cards.

We expect an inverse relationship between income and RCU. It is plausible that the total volume and value of transactions increase with income, making cash less convenient than cards. Also, consumers with higher income may have greater opportunity costs of time and find it more costly and inconvenient to withdraw cash in advance of a purchase.

Education, age, and gender capture other sources of heterogeneity. We expect a negative relationship between education and RCU, since education signals knowledge and aptitude, as well as employment stature and wealth. Thus, consumers who are more educated may be inclined to use more sophisticated card payments, rather than cash, for higher-valued purchases. Also, less-educated consumers are more likely to receive their income in cash or cashable cheques and therefore may be more cash intensive. Age may represent habits, experience, and different shopping patterns. Older consumers, who are more accustomed to cash and set in their ways, may be more cash intensive than younger consumers. If older consumers are more set in their ways, they may also have higher adjustment costs from learning a different MOP. Experience, on the other hand, may drive older consumers towards card payments, especially in the case of credit cards, where credit history is important. Finally, gender may also reflect different shopping patterns, such as purchase location and transaction values.

5.2   RCU results

The results of equation (2) are shown in the first column of Table 4. As expected, the RCU index is significantly higher for those older than 45 years, less educated, and of lower income. In addition, men are more cash intensive than women. Note that all higher education levels significantly reduce RCU, but high school education seems to be the most important, since there is no significant difference between college and university education. Higher income levels are

also associated with a significant reduction in relative cash usage; however, there is not much difference for those with an annual income above $40,000.

Tests performed on the different dummies for education and income indicate a lower bound on how much consumers can reduce their relative cash usage.[12] This lower bound is interesting because it suggests that all consumers use some minimum amount of cash on a regular basis. This probably reflects the fact that consumers are compelled to use cash because it is more widely accepted in transactions than debit and credit cards.

It is not surprising that those who perceive cash to be relatively more convenient than cards have significantly higher RCU. The coefficient associated with convenience is particularly high, and underscores its importance to the use of cash. Risk perceptions, however, are not significant to RCU, even though the coefficient is negative, as was expected.

The insignificance of risk deserves further attention, since we previously argued that confidence underlies demand for any MOP. We address this insignificance as a possible misspecification error and disaggregate relative risk into dummy variables that represent very low/non-existent, low, medium, and high relative risk perceptions.[13] As shown in the second column of Table 4, we find that risk is indeed significant (also confirmed by joint tests) and that relative cash usage drops substantially, even starting at low levels of risk. Chart 1 illustrates that consumers who have medium to high perceptions of cash risk use cash 20 per cent less frequently than those who do not perceive cash to be risky.[14]

It should be noted that relative risk perceptions may be an endogenous variable, since higher R_i may itself be caused by higher RCU_i levels. In other words, those who use cash more intensively may be more exposed to theft or loss, and therefore have higher perceived risk. In this case, our results would underestimate the risk effect. Unfortunately, we do not have instrumental variables available to address this bias.[15]

6   Indicators of Adoption

In this section we assess the importance of adoption, which is not accounted for in the RCU model. The RCU specification treats respondents who use only cash and debit cards, or cash and credit cards, in the same manner as those who use cash, debit cards, and credit cards all together.

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12. The tests show that the differences in the dummy coefficients are significantly different from zero at lower ranges of income and education, but not at the higher ranges. This implies a non-linear relationship.
13. The dummy variables were selected and categorized at our discretion, after examining the distribution of risk perception responses.
14. Different statistical procedures were used to check the impact of outliers in the results. We estimate alternative models with interactions between demographics and perceptions of risk and convenience, and estimate Box-Cox transformations to test non-linearities. The results do not change significantly.
15. Potential instrumental variables could include the respondent's postal code, combined with statistics on crime, or the respondent's risk awareness.

As discussed in section 4, although the respondents were not asked what payment methods they have actually adopted, they were given the option to state that they "never use" a MOP. This response category is a likely indicator of "non-adoption." We find that 5 per cent of respondents use cash exclusively, 19 per cent of respondents use cash and debit cards exclusively, and 12 per cent use cash and credit cards exclusively. While 64 per cent of respondents use all three MOP combined, 24 per cent never use credit cards and 18 per cent never use debit cards. These findings suggest that the adoption decision is important in understanding the demand for MOP in Canada.

Table 5 reports the results of a multinomial logit model of MOP adoption, based on perceptions and demographics.[16] These adoption indicators are defined as "cash only," "cash and debit card only," "cash and credit card only," and "cash, debit, and credit card combined." We find that those who use only cash, as opposed to all three MOP, are affected by their perceived convenience of each MOP (in the expected direction), but not by perceived risk. However, those who think credit cards are risky and less convenient are more likely to use cash and debit. The opposite is observed for those who perceive debit cards to be more risky and less convenient.

Interestingly, the convenience of cash is significant in all cases, and the largest convenience effect occurs for those who use only cash. This also indicates that those who find cash less convenient are more likely to use all three MOP combined. This again suggests that, despite a lower regard for its convenience, cash is still used because it is more often accepted in transactions.

As for demographics, those in the oldest age category and those in the lowest income category are more likely to use only cash. Older age has a positive effect on the likelihood of using only cash and credit cards, and higher income reduces the likelihood of using only cash and debit cards. Finally, the results suggest that men are more likely than women to use payment methods other than debit cards.

The adoption results have some general implications. First, perceptions of convenience and risk may induce people to reject a particular MOP all together. Second, age (representing experience) and income may be important in the decision to adopt a MOP. Third, age may also represent persistence of habit through a cohort effect, which is observed for those in the oldest age category who use only cash.

Finally, the results suggest that adoption decisions may impact relative use of MOP in at least two ways: (i) directly by not using a particular MOP in the first place, and (ii) by limiting consumer choices.

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16. See Appendix A for a technical review of the multinomial logit model. Hausman tests of independence from irrelevant alternatives (IIA) did not reject the null hypothesis of independence, which validates the multinomial logit model approach.

7   Frequency of MOP Use in Absolute Terms

A weakness of the RCU model is that it does not distinguish the substitution effects between cash and debit cards, and cash and credit cards. For example, the reduction in RCU for higher income ranges, described in section 5, reflects higher demand for card payments but not whether higher-income consumers substitute cash for debit cards or credit cards. In this section, we therefore show the direction in which the factors influencing RCU may affect cash, debit, and credit cards individually. We do this by estimating separate ordered probit models of the frequency of each MOP, based on demographics and MOP perceptions.

Table 6 shows a positive income effect for all three MOP. The RCU model, in comparison, shows that higher income actually decreases the use of cash in relative terms.

Holding everything else constant, consumers older than 60 years use cash less frequently, in absolute terms, than those younger than 30 years. Also, older consumers generally use debit cards less frequently. However, we find no age effect for credit cards. The age effect found in the RCU model might therefore be driven by those consumers who use only cash (an adoption effect) and by the strong age effect away from debit cards. While education may have a negative effect on the relative use of cash in the RCU model, our results indicate that higher education has a positive effect on credit card use and little effect on debit card use. This may suggest that higher education causes substitution away from cash and towards credit cards.

Although men have a higher RCU index than women, the individual ordered probit models show that this result is probably caused by men being more cash intensive than women, since there is no significant gender effect for debit and credit cards.

Perceptions of convenience and risk have asymmetric effects on MOP usage. Those who perceive cash to be more convenient use it more frequently, and debit and credit cards less frequently, although the negative effect on debit cards is stronger. Perceptions of debit and credit card convenience seem to be closely interlinked. Those who perceive debit cards to be highly convenient use them more frequently than credit cards, with no apparent effect on cash. Finally, the more convenient credit cards are perceived to be, the more they are used, with negative but insignificant effects on cash and debit cards.

Perceptions of cash risk have a very significant and positive effect on the use of debit cards. The perception of debit card risk barely has a significant (negative) effect on debit card use and a negative effect on cash use. Credit card risk has a negative effect on credit card use and a positive effect on cash use.

To summarize, the ordered probit models illustrate which MOP are closer substitutes for one another in terms of risk and convenience. However, these models give rise to some further questions. It is not clear, for example, why cash usage does not decrease with perceptions of cash

risk. Nor is it clear why higher perceptions of credit card risk increase cash but not debit card use. Collinearity across risk and convenience responses may be part of the answer.

Nonetheless, many of the results reported in this section are in line with the reduced-form RCU model. They also highlight the value of developing structural models to better encompass both adoption choices, as discussed earlier, and substitution effects for different MOP.

8   Conclusion

In this paper, we explore how perceptions of convenience and risk can affect the MOP used by consumers. Our analysis suggests that convenience is significant to all MOP and is particularly important to the use of cash. Risk, even at a moderate level, also has a significant impact on cash use. We find that, because of perceived risk, the shift away from cash towards the use of debit and credit cards is substantial. These findings suggest that the risk perceived by the public can significantly affect the use of a MOP. Therefore, MOP providers, such as central banks or card companies, must be diligent in combatting fraud or any other security threat.

As for demographic traits, we find that young, well-educated, high-income consumers are more inclined to use card payment instruments. However, our results suggest that, despite the variety of payment options in Canada, there remains a lower bound for which cards can substitute for cash. This likely reflects the fact that cash is currently accepted in transactions with more certainty than debit and credit cards.

Our study focuses mainly on the use of MOP, but it shows that adoption decisions may have a significant effect on MOP demand. Future research should focus on modelling the simultaneous relation between adoption and frequency of MOP use. In addition, the notions of convenience and risk, as captured by our data, are too broad. The next step would be to identify the specific factors that impact the demand for MOP and how they relate to the transaction characteristics at the POS. Surveys that explicitly address these factors and structural models are needed to address these gaps.

References

Arango, C. and V. Taylor. 2008. "Merchant Acceptance, Costs, and Perceptions of Retail Payments: A Canadian Survey." Bank of Canada Discussion Paper No. 2008-12.

Bolt, W. and S. Chakravorti. 2008. "Consumer Choice and Merchant Acceptance of Payment Media." Federal Reserve Bank of Chicago Working Paper No. 2008-11.

Bolt, W., D. Humphrey, and R. Uittenbogaard. 2005. "The Effect of Transaction Pricing on the Adoption of Electronic Payments: A Cross-Country Comparison." Federal Reserve Bank of Philadelphia Working Paper No. 05-28.

Borzekowski, R. and E. Kiser. 2008. "The Choice at the Checkout: Quantifying Demand Across Payment Instruments." *International Journal of Industrial Organization* 26 (4): 889–902.

Borzekowski, R., E. Kiser, and A. Shaista. 2008. "Consumers' Use of Debit Cards: Patterns, Preferences, and Price Response." *Journal of Money, Credit and Banking* 40 (1): 149–72.

Bounie, D. and A. Francois. 2006. "Cash, Check or Bank Card? The Effects of Transaction Characteristics on the Use of Payment Instruments." Telecom Paris Economics and Social Sciences Working Paper No. ESS-06-05.

Ching, A. and F. Hayashi. 2008. "Payment Card Rewards Programs and Consumer Payment Choice." Munich Personal RePec Archive No. 8458. Available at <http://mpra.ub.uni-muenchen.de/8458>.

Dutta, J. and M. Weale. 2001. "Consumption and the Means of Payment: An Empirical Analysis for the United Kingdom." *Economica* 68 (271): 293–316.

Fusaro, M. 2008. "Debit vs Credit: A Model of Self-Control with Evidence From Checking Accounts." Available at <http://personal.ecu.edu/fusarom/fusarodebitvcredit.pdf>.

Greene, W. 2000. *Econometric Analysis*, 4th edition. New Jersey: Prentice-Hall.

Jonker, N. 2005. "Payment Instruments as Perceived by Consumers—A Public Survey." De Nederlandsche Bank Working Paper No. 53.

Kahn, C., J. McAndrews, and W. Roberds. 2005. "Money Is Privacy." *International Economic Review* 46 (2): 377–99.

Klee, E. 2006. "Paper or Plastic? The Effect of Time on the Use of Check and Debit Cards at Grocery Stores." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series No. 2006-02.

Markose, S. M. and Y. J. Loke. 2003. "Network Effects on Cash-Card Substitution in Transactions and Low Interest Rate Regimes." *Economic Journal* 113 (487): 456–76.

Schuh, S. and J. Stavins. 2009. "Why Are (Some) Consumers (Finally) Writing Fewer Checks? The Role of Payment Characteristics." Federal Reserve Bank of Boston Working Paper No. 09-1.

Shy, O. and J. Tarkka. 2002. "The Market for Electronic Cash Cards." *Journal of Money, Credit and Banking* 34 (2): 299–314.

Snyder, C. and J. Zinman. 2008. "Consumer Homing on Payment Cards: From Theory to Measurement." Available at <http://www.frbatlanta.org/news/CONFEREN/08payments/08payments_SnyderZinman.pdf>.

Statistics Canada. 2006. "2006 Census: Highlight tables." Available at <http://www12.statcan.ca/census-recensement/2006/dp-pd/hlt/index-eng.cfm>.

Taylor, V. 2006. "Trends in Retail Payments and Insights from Public Survey Results." *Bank of Canada Review* (Spring): 25–36.

Whitesell, W. 1989. "The Demand for Currency versus Debitable Accounts: A Note." *Journal of Money, Credit and Banking* 21 (2): 246–57.

Working Group on Costs of POS Payment Products. 2004. "The Costs of Payments: Survey on the Costs Involved in POS Payment Products." National Forum on the Payments System, De Nederlandsche Bank. Available at <http://epso.intrasoft.lu/papers/DNB-cost-of-payments.pdf>.

Table 1

Sample Composition

	Unweighted sample (%)	Census 2006 (%)
Age[1]		
18 - 29 years old	16	21
30 - 45	37	28
46 - 60	30	28
Older than 60	17	23
Household income		
Under 20K	11	15
20K - 30K	12	10
30K - 40K	15	11
40K - 60K	22	19
60K - 80K	16	15
80K - 100K	10	10
100K +	15	19
Education[2]		
Less than high shool	12	24
Completed high school	21	26
Some college/university	32	33
Completed university/post-graduate	35	18
Gender		
Male	48	49
Female	52	51

Notes: [1]Census percentages based on the population 18 and over. [2]Census percentages based on the population age 17 and over.

Table 2

Perceptions of Convenience (Ordered Probits)

	Cash convenience	Debit card convenience	Credit card convenience
Age 30 - 45	-0.060	0.040	0.280 ***
	(0.08)	(0.1)	(0.09)
Age 45 - 60	-0.170 **	-0.320 ***	0.240 ***
	(0.09)	(0.1)	(0.08)
Age 60+	-0.040	-0.610 ***	0.500 ***
	(0.1)	(0.11)	(0.1)
Completed high school	-0.150	0.250	0.550 **
	(0.22)	(0.21)	(0.25)
Some college/university	-0.140	0.450 **	0.770 ***
	(0.22)	(0.22)	(0.24)
Completed university/post-graduate	-0.080	0.250	0.980 ***
	(0.22)	(0.23)	(0.25)
Income 20K - 40K	0.050	0.250 **	0.120
	(0.11)	(0.11)	(0.11)
Income 40K - 60K	-0.120	0.400 ***	0.320 ***
	(0.11)	(0.12)	(0.12)
Income 60K - 80K	-0.060	0.390 ***	0.450 ***
	(0.12)	(0.14)	(0.13)
Income 80K +	-0.060	0.530 ***	0.650 ***
	(0.13)	(0.13)	(0.12)
Gender (M = 1)	0.200 ***	-0.250 ***	-0.030
	(0.06)	(0.07)	(0.06)
Observations	2,009	2,009	2,009
LR chi	50.9	230.2	236.2
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.009	0.053	0.053

Notes: ***, **, * Statistically significant at 1%, 5%, and 10% level, respectively. Regression with robust standard errors. The left-out groups for the different sets of dummies are: for age, individuals younger than 30; for education, individuals up to elementary or some but not completed high school; and for income, individuals with annual earnings below 20K.

Table 3

Perceptions of Risk (Ordered Probits)

	Cash risk	Debit card risk	Credit card risk
Age 30 - 45	-0.180 **	0.030	-0.230 ***
	(0.08)	(0.07)	(0.08)
Age 45 - 60	-0.280 ***	0.020	-0.320 ***
	(0.08)	(0.07)	(0.08)
Age 60+	-0.600 ***	-0.140	-0.650 ***
	(0.09)	(0.09)	(0.09)
Completed high school	-0.540 **	-0.260	0.130
	(0.22)	(0.22)	(0.2)
Some college/university	-0.660 ***	-0.290	0.040
	(0.22)	(0.22)	(0.2)
Completed university/post-graduate	-0.720 ***	-0.240	0.040
	(0.22)	(0.22)	(0.2)
Income 20K - 40K	-0.080	0.120	0.060
	(0.09)	(0.1)	(0.11)
Income 40K - 60K	-0.110	0.200 **	0.070
	(0.1)	(0.1)	(0.12)
Income 60K - 80K	-0.260 **	0.080	-0.030
	(0.11)	(0.12)	(0.14)
Income 80K +	-0.330 ***	0.000	-0.080
	(0.1)	(0.11)	(0.13)
Gender (M = 1)	-0.280 ***	-0.200 ***	-0.330 ***
	(0.05)	(0.05)	(0.05)
Observations	2,009	2,009	2,009
LR chi	175.9	50.5	180.9
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.024	0.007	0.027

Notes: ***, **, * Statistically significant at 1%, 5%, and 10% level, respectively. Regression with robust standard errors. The left-out groups for the different sets of dummies are: for age, individuals younger than 30; for education, individuals up to elementary or some but not completed high school; and for income, individuals with annual earnings below 20K.

Table 4

Relative Cash Usage (Generalized Least Squares)

	Relative cash usage (RCU)	
Constant	0.220 ***	0.290 ***
	(0.07)	(0.07)
Age 30 - 45	0.020	0.020
	(0.01)	(0.01)
Age 45 - 60	0.050 ***	0.050 ***
	(0.01)	(0.01)
Age 60+	0.070 ***	0.070 ***
	(0.02)	(0.02)
Completed high school	-0.130 **	-0.130 **
	(0.05)	(0.05)
Some college/university	-0.160 ***	-0.160 ***
	(0.05)	(0.05)
Completed university/post-graduate	-0.150 ***	-0.150 ***
	(0.05)	(0.05)
Income 20K - 40K	-0.050 **	-0.050 **
	(0.03)	(0.02)
Income 40K - 60K	-0.080 ***	-0.080 ***
	(0.03)	(0.03)
Income 60K - 80K	-0.070 ***	-0.070 ***
	(0.03)	(0.02)
Income 80K+	-0.070 ***	-0.070 ***
	(0.03)	(0.03)
Gender (M = 1)	0.040 ***	0.040 ***
	(0.01)	(0.01)
Relative convenience	0.950 ***	0.950 ***
	(0.08)	(0.08)
Relative risk	-0.040	
	(0.07)	
Low *relative* risk		-0.070 **
		(0.03)
Medium *relative* risk		-0.080 **
		(0.03)
High *relative* risk		-0.080 **
Observation	1,999	1,999
R-squared	0.132	0.183

Notes: ***, **, * Statistically significant at 1%, 5%, and 10% level, respectively. Regression with robust standard errors. The left-out groups for the different sets of dummies are: for age, individuals younger than 30; for education, individuals up to elementary or some but not completed high school; for income, individuals with annual earnings below 20K; and for relative risk, individuals with "very low" to "non-existent" relative risk perceptions.

Table 5

MOP Adoption Indicators (Multinomial Logit)

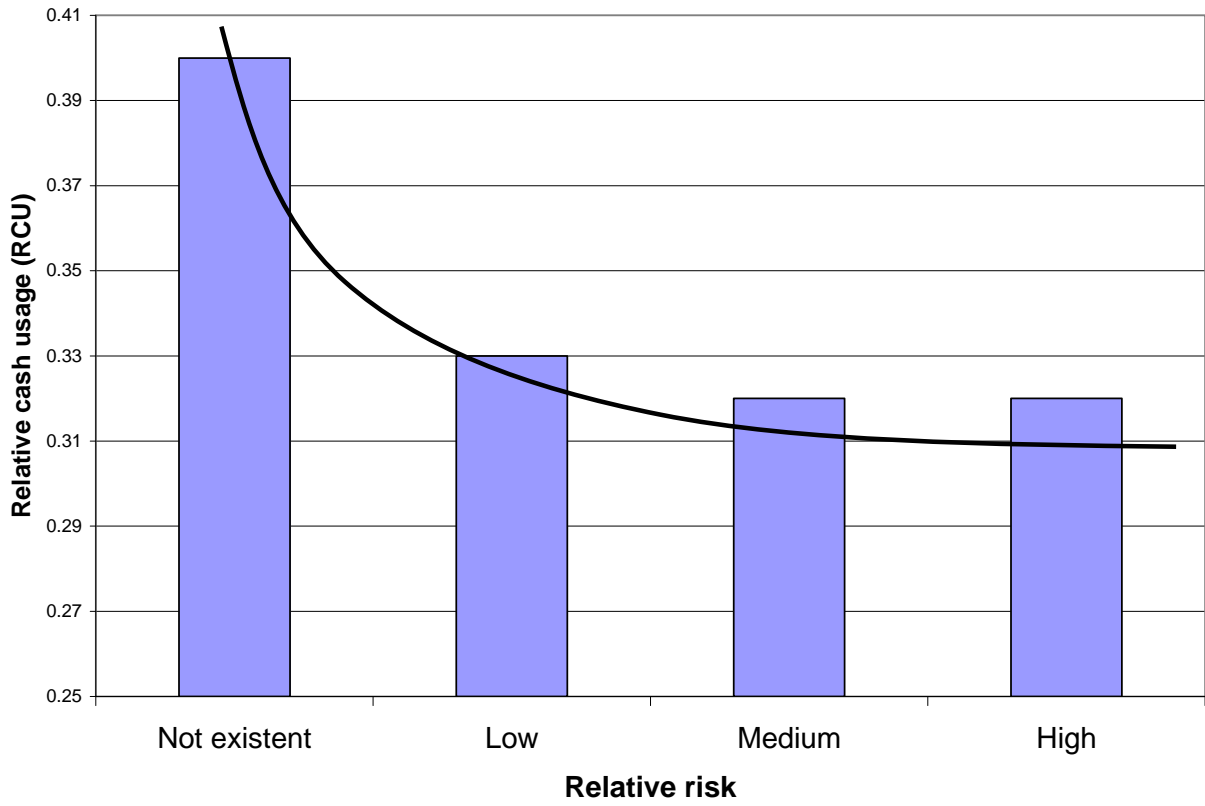|	Cash only	Cash & debit card	Cash & credit card
Constant	0.939	-1.012	-2.936 ***
	(1.21)	(0.93)	(1.06)
Age 30 - 45	0.162	-0.326	1.159 **
	(0.4)	(0.2)	(0.46)
Age 45 - 60	0.726 *	-0.206	1.826 ***
	(0.39)	(0.21)	(0.45)
Age 60+	1.184 ***	-0.388	2.911 ***
	(0.42)	(0.28)	(0.47)
Completed high school	-0.766	0.151	-0.073
	(0.61)	(0.52)	(0.57)
Some college/university	-1.157 *	-0.371	-0.652
	(0.62)	(0.53)	(0.59)
Completed university/post-graduate	-1.494 **	-0.707	-0.076
	(0.7)	(0.56)	(0.58)
Income 20K - 40K	-1.040 ***	-0.413 *	0.294
	(0.36)	(0.23)	(0.31)
Income 40K - 60K	-1.782 ***	-0.835 ***	-0.052
	(0.52)	(0.26)	(0.34)
Income 60K - 80K	-1.350 ***	-0.708 **	-0.010
	(0.47)	(0.31)	(0.37)
Income 80K+	-1.892 ***	-1.215 ***	0.056
	(0.62)	(0.3)	(0.34)
Gender (M = 1)	0.644 ***	0.173	0.338 **
	(0.24)	(0.15)	(0.17)
Cash risk	-0.041	0.013	-0.153
	(0.15)	(0.09)	(0.1)
Debit card risk	0.210	-0.090	0.400 ***
	(0.18)	(0.09)	(0.16)
Credit card risk	-0.023	0.236 **	-0.095
	(0.19)	(0.12)	(0.13)
Cash convenience	0.488 **	0.270 ***	0.375 ***
	(0.19)	(0.1)	(0.13)
Debit card convenience	-0.640 ***	0.187	-1.011 ***
	(0.13)	(0.14)	(0.1)
Credit card convenience	-0.660 ***	-0.530 ***	0.332 **
	(0.13)	(0.09)	(0.14)
Observation	1,977		
Wald chi2(51)	517.6		
Prob > chi2	0.000		
Pseudo R2	0.170		

Notes: Multinomial logistic regression. ***, **, * Statistically significant at 1%, 5%, and 10% level, respectively. Regression with robust standard errors. The portfolio of reference is "Cash, debit and credit card combined." The left-out groups for the different sets of dummies are: for age, individuals younger than 30; for education, individuals up to elementary or some but not completed high school; and for income, individuals with annual earnings below 20K.

Table 6

Frequency of MOP Use in Absolute Terms (Ordered Probits)

	Cash frequency	Debit card frequency	Credit card frequency
Age 30 - 45	-0.080	-0.210 ***	-0.030
	(0.08)	(0.07)	(0.08)
Age 45 - 60	-0.110	-0.580 ***	-0.040
	(0.08)	(0.07)	(0.08)
Age 60+	-0.340 ***	-1.070 ***	-0.070
	(0.09)	(0.09)	(0.09)
Completed high school	-0.160	0.250	0.320
	(0.21)	(0.22)	(0.2)
Some college/university	-0.100	0.390 *	0.510 ***
	(0.21)	(0.23)	(0.2)
Completed university/post-graduate	-0.050	0.250	0.590 ***
	(0.21)	(0.23)	(0.2)
Income 20K - 40K	0.330 ***	0.280 ***	0.290 ***
	(0.11)	(0.09)	(0.11)
Income 40K - 60K	0.350 ***	0.450 ***	0.470 ***
	(0.13)	(0.09)	(0.11)
Income 60K - 80K	0.420 ***	0.470 ***	0.410 ***
	(0.11)	(0.1)	(0.12)
Income 80K+	0.630 ***	0.540 ***	0.640 ***
	(0.12)	(0.11)	(0.12)
Gender (M = 1)	0.310 ***	-0.080	0.020
	(0.05)	(0.05)	(0.05)
Cash risk	-0.020	0.090 ***	-0.030
	(0.03)	(0.03)	(0.03)
Debit card risk	-0.080 **	-0.070 *	0.050
	(0.04)	(0.04)	(0.03)
Credit card risk	0.080 **	0.060	-0.090 **
	(0.04)	(0.04)	(0.04)
Cash convenience	0.380 ***	-0.170 ***	-0.100 ***
	(0.04)	(0.04)	(0.03)
Debit card convenience	0.030	0.650 ***	-0.020
	(0.04)	(0.04)	(0.03)
Credit card convenience	-0.020	-0.030	0.270 ***
	(0.03)	(0.03)	(0.04)
Observations	2,009	2,009	2,009
LR chi	336.7	914.5	320.4
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.060	0.120	0.040

Notes: Ordered probit models. ***, **, * Statistically significant at 1%, 5%, and 10% level, respectively. Regression with robust standard errors. The left-out groups for the different sets of dummies are: for age, individuals younger than 30; for education, individuals up to elementary or some but not completed high school; and for income, individuals with annual earnings below 20K.

Chart 1
Relative Risk Perceptions and Relative Cash Usage

Appendix A

Review of the Ordered Probit Model

We use ordered probit models to study MOP perceptions of risk and convenience and MOP frequency of use. As described in the main text, these variables are based on categorical responses that are ordered from low to high levels of the respective variable. The ordered probit model is based on the assumption that there is a latent factor y_i^*, which is considered by respondent i in their categorical response. For example, consumers might have measures of the benefits and costs of using an alternative MOP, or may have some notion of the number of transactions they make with a MOP. However, due to time constraints, or accuracy or confidentiality issues, the researcher has to rely on an ordered categorical response $g \in \{1,2,...,G\}$, where higher values of g reflect higher values of the latent factor y_i^*.

In general, letting y_i^* be a linear function of a set of explanatory variables, x_i:

$$y_i^* = \beta' x_i + \varepsilon_i,$$

and, assuming that the error term ε_i follows a normal distribution, the probability that a consumer would choose a particular categorical response g is:

$$P_{ig} = P(\mu_{g-1} < y_i^* \leq \mu_g) = \Psi_g(\beta' x_i),$$

where μ_i are thresholds to be estimated. In other words, under the assumptions of the model, the categorical responses provide information about the value ranges of the latent factor y_i^* that each category g represents. Ψ_g is a functional form that varies with category g and derives from the normality assumption of ε_i. The ordered probit model allows us to estimate the parameter vector β by maximum-likelihood methods (Greene 2000).

Review of the Multinomial Logit (ML) Model

We use a multinomial logit model to study MOP adoption decisions. The ML model assumes that there is a latent variable that measures the level of utility or benefit, U_{ij}, that a respondent i perceives from choosing j out of the $J > 2$ possible alternatives.

Letting

$$U_{ij} = \beta'_j x_{ij} + \varepsilon_{ij},$$

where x_{ij} are individual and choice-specific characteristics. Then, the probability that choice j is made P_{ij} is equal to:

$$P(U_{ij} > U_{ik}) \text{ for all } k \neq j.$$

In other words, P_{ij} is the probability that choice j provides the highest utility or benefit among all available choices. Assuming that the J disturbances ε_{ij} are independent and identically distributed with Weibull distribution leads to the ML. The ML model allows us to estimate the parameter vector β_j by maximum-likelihood methods. β_j, as reported in Table 5, represents the marginal effects of changes in x_{ij} on the odds ratio, $\ln(P_{ij}/P_{i0})$, where P_{i0} is the choice of reference.

One important feature of the ML model is the property of the independence of irrelevant alternatives (IIA), which states that the odds ratio P_{ij}/P_{i0} does not depend on the other choices. The IIA is a convenient property for estimation, but a strong assumption on consumer's behaviour. Therefore, we use Hausman's specification tests to evaluate whether IIA holds (see Greene 2000 for further details).