How Do You Pay?
The Role of Incentives at the
Point-of-Sale

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Introduction

- The Bank of Canada needs to anticipate changes in the demand for cash relative to alternative means of payment:
    - Where and how is cash used in the economy?
    - Shifts in how consumers pay?
- Empirical investigation on choice of cash, debit and credit card usage at the point-of-sale (POS).

IN GOD WE TRUST
All Others Pay Cash !

Payment Frequencies, Volume and Value

TV	Volume				Value			
	< 15	15-25	25-50	50+	< 15	15-25	25-50	50+
Cash	72.8	42.0	24.9	16.7	59.6	37.7	21.6	10.9
Debit	18.1	31.9	40.0	36.3	25.4	33.1	37.7	37.0
Credit	9.5	26.4	35.7	48.0	15.0	29.2	40.7	52.1

Note: Sample statistics are computed from the SQ-DSI dataset using 10,288 transactions.

Payment choice and transaction value:
Bounie & François (WP, 2006) and Klee (JME, 2009).

Summary of Results

1. Cash dominates at low transactions value (below $25) because of acceptance, ease of use/speed and cash on hand.

2. Above $25, debit and credit dominate. Credit cards rewards shift usage away from debit.

3. Other monetary incentives are significantly associated with different payment behaviour. Those with no debit transaction fees and revolvers (those who carry credit card debt) use more debit relative to credit.

2009 Method of Payments Survey

- Sampling frame was based on marketing access panels.
- Two-parts:
    1. Day 0: Survey Questionnaire (SQ).
       Consists of 52 questions with 6,868 respondents.
    2. Day 1-3: Three-day Diary Survey Instrument (DSI).
       3,465 respondents yielded about 17,000 usable transactions.
- Market research firm constructed sample weights:
    1. Sample weights based on the Canadian Internet Usage Survey.
    2. Random digital dialing (OMNIBUS) survey with payments section.

Survey Questionaire (SQ)

- Demographics:gender, age, income, education, employment, marital status, home ownership, family size, ethnicity and online/offline status.
- Payment Features:
    - Debit card features: monthly fees, free transactions.
    - Credit card features: rewards, revolver, interest rates.
- Payment Perceptions:
    - Ease of use, cost, risk/fraud, acceptance and record keeping.
- Cash holding.
- Cash inventory practices (ATM withdrawals).

Diary Survey Instrument (DSI)

- Cash holding at beginning of the diary.
- Transaction details:
    - Payment instrument choice,
    - Transaction value,
    - Type of good,
    - Payment instrument acceptance at the point-of-sale,
    - Top reasons for payment choice:
      Ease, avoid fraud, avoid fees, rewards, payment delay and cashback.
- End-of-day check: # of transactions and cash balance.

Survey payment diaries: Summary

Organization	OeNB	TP	RBA	DNB	DB	BoC	FRB
Country	.at	.fr	.au	.nl	.de	.ca	.us
Perceptions	NO	NO	NO	NO	NO	YES	YES
Incentives	NO	NO	YES	NO	NO	YES	YES
Number of:							
Days	7	8	14	1-7	7	3	3
Households	1,204	1,035	662	1,017	2,292	3,465	300
Transactions	14,075	11,945	17,000	4,368	25,500	17,000	1797
Year	2005	2005	2007	2007	2008	2009	2010-1

All surveys contain information about demographics and information about transactions at the point-of-sale. OeNB: Austrian National Bank; TP: Telecom Paris; RBA: Reserve Bank of Australia; DNB: De Nederlandsche Bank; DB: Deutsche Bundesbank; BoC: Bank of Canada; FRB: Federal Reserve Bank of Boston. Other central banks such as Norway and Portugal also have payment diaries.

Additive Random Utility Models I

A consumer has three payment instrument alternatives at the point of sale. The utility of payment instrument j is :

$$U_j = V_j + \epsilon_j, \quad j = \text{Cash, Debit and Credit.} \tag{2}$$

Let V_j be the observed utility of choice j and ϵ_j be the random choice variation. Payment j is chosen:

$$\begin{aligned} \text{Prob}[\text{PMT} = j] &= \text{Prob}(U_j \geq U_k), \forall j \neq k \\ &= \text{Prob}(V_j - V_k \geq \epsilon_k - \epsilon_j). \end{aligned}$$

If $F(\epsilon_j) = e^{\epsilon_j} \exp(-e^{\epsilon_j})$ and $V_j = \mathbf{x}_j' \beta_j$ then Multinomial Logit (MNL):

$$\text{Prob}[\text{PMT} = j] = \frac{\exp(\mathbf{x}_j' \beta_j)}{\sum_{l=1}^{m} \exp(\mathbf{x}_l' \beta_l)}. \tag{3}$$

Model specification

- Multinomial logit (and probit).
- Observables consumer demographics, perceptions, payment and transaction characteristics.
- Consumer's choices of cash, debit and credit at the point-of-sale from diaries.
- Consumers holding all three payment instruments: cash, credit and debit (80 percent) $\Rightarrow$ Avoid modeling the adoption decision.
- Condition on transactions taking place at store (83 percent) $\Rightarrow$ Only POS transactions and no mail, online or phone purchases.
- Transaction values less than 400 dollars.
- Final estimation sample 10,288 transactions.

Predicted Probabilities

- Visualization method to assess impact across characteristics.
- Probability of choice j conditional on a set of covariates $(\mathbf{x}_g)$ evaluated at profile g:

$$\widehat{P}_{gj} = \frac{\exp(\mathbf{x}'_g \hat{\beta}_j)}{\sum_{l=1}^m \exp(\mathbf{x}'_g \hat{\beta}_l)}. \tag{6}$$

$\widehat{P}_{gj}$, could be computed over a range of possibilities. For the remainder of the exercise, we consider the following demographic profile: urban, married, Canadian, male, employed, homeowner in Ontario, earning 30-50K/year, with average values for all other variables.

Ease of use/speed: Top reason for cash
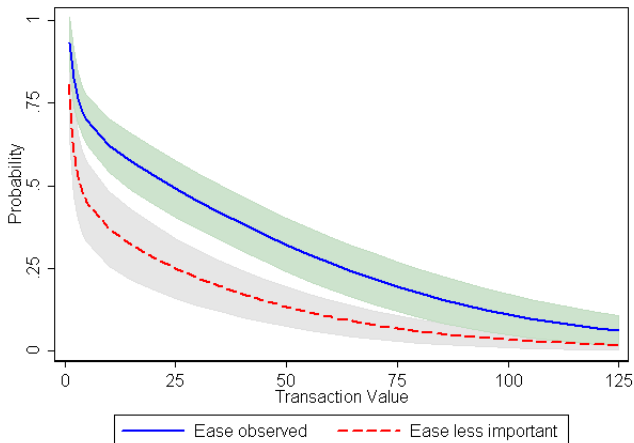
Note: The perception of *Ease of use/speed* is evaluated at the observed level versus credit card speed importance. Shaded areas represent 95 percent confidence intervals.

Debit Card Committed User
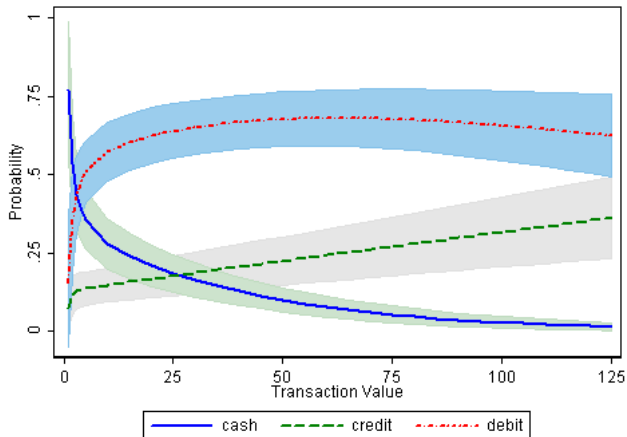
Note: **Debit Card User** with free DC transactions, pays debit monthly fee, earns average rewards, no CC annual fee, not CC revolving. Calculated for average demographic profile. Credit & debit accepted everywhere. Shaded areas represent 95 percent confidence intervals.

Credit Card Reward Packages

- 178 different credit card types among DSI respondents.
- Roughly 60% of credit card respondents have rewards.
- Convert reward points/miles to ad-valorem cash rewards using various sources (Banks, FCAC, etc.).
- Carbó & Linares-Zegarra (JBF, 2011) and Agarwal, Chakravorti, and Lunn (2010) use $RP = 1.00\%$.
- MOP, the average rewards is $\overline{RP} = 0.78\%$.
- Exploit this heterogeneity to measure the effect of rewards.

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Heterogeneity in Reward Schedules

Reward Points (RP)	None	(0,0.5)	[0.5, 1.0)	[1.0, 5.0)
Cash				
Value	38.5	35.1	29.5	30.3
Volume	51.2	48.4	43.3	44.8
Debit				
Value	42.2	31.2	27.0	20.9
Volume	35.3	27.4	24.8	19.4
Credit				
Value	19.3	33.7	43.4	48.8
Volume	13.5	24.2	31.8	35.8
Households	949	249	683	470

Note: Based on 2,351 individuals with access to a credit card in DSI. Value represents share of purchases by payment method in dollars. Volume represents share of purchases by payment method in frequencies. Shares do not add up to one due to other payment categories such as cheques and stored-value cards.
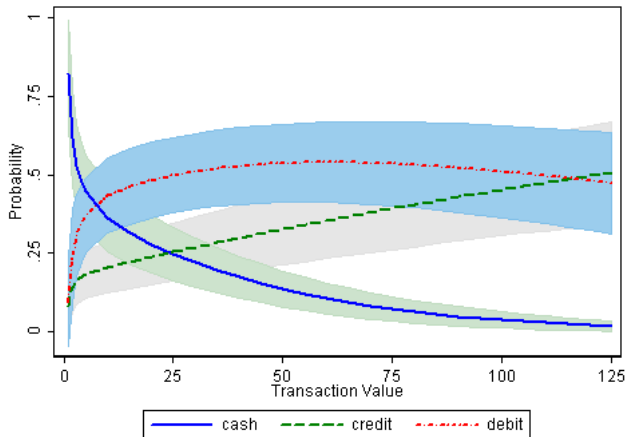
Credit Card Committed User
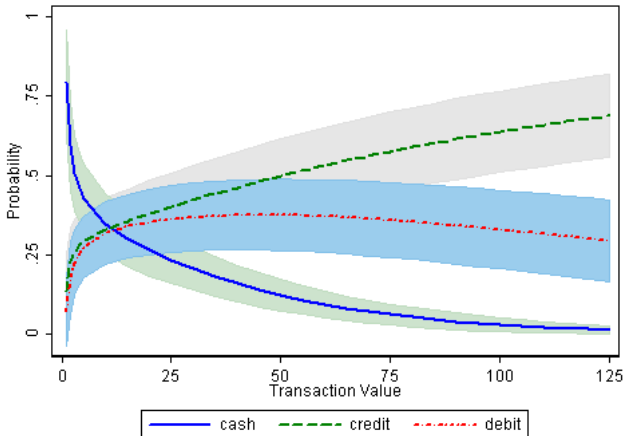
Note: **Credit card intensive user with average rewards**, no free DC transactions, no debit monthly fee, pays CC annual fee, not CC revolving. Calculated for average demographic profile. Credit & debit accepted everywhere. Shaded areas represent 95 percent confidence intervals.

Credit Card Committed User & Revolving

Note: Credit card intensive user with average rewards, no free DC transactions, no debit monthly fee, pays CC annual fee, and **CC revolving**. Calculated for average demographic profile. Credit & debit accepted everywhere. Shaded areas represent 95 percent confidence intervals.

Price Incentives: Credit Card Rewards

Rewards are specified in the following fashion:

$$\beta_1 RW_i + \beta_2 RW_i \times TV_i, \tag{7}$$

where $RW_i = I(RP_i > 0)RP_i \times TV_i$, RP_i is the ad-valorem amount of rewards points and TV_i is the transaction value.

- Extensive Margin or comparison of those with and without rewards:

$$EXT[RP, \bar{x}_g] = \widehat{P}_{gj}(RP = 0.78, \bar{x}_g) - \widehat{P}_{gj}(RP = 0, \bar{x}_g). \tag{10}$$

- Intensive Margin or elasticity of rewards on the probability of credit card (P_{CC}):

$$E_{P_{CC}, RW} = \frac{\partial P_{CC}}{\partial RW} \frac{RW}{P_{CC}} \bigg|_{TV}. \tag{11}$$

Rewards versus No Rewards: Extensive Margin

TV	Cash	DC	CC
5	-0.37	-0.21	0.58
25	-1.82	-1.78	3.61
50	-2.76	-5.12	7.87
100	-2.10	-10.71	12.81

Note: Difference in predicted probabilities for those with Rewards (evaluated at RP=0.78%) and those without rewards.

Rewards Elasticity

TV	RP = 0.5%	RP = 0.78%	RP = 1.0%	RP = 1.5%
5	0.03	0.04	0.06	0.08
	(0.006)	(0.010)	(0.012)	(0.018)
25	0.12	0.18	0.22	0.32
	(0.026)	(0.039)	(0.049)	(0.068)
50	0.17	0.26	0.32	0.43
	(0.041)	(0.058)	(0.069)	(0.085)
100	0.19	0.27	0.32	0.37
	(0.053)	(0.070)	(0.077)	(0.081)

Note: Elasticity of rewards evaluated at a range of reward points. Standard errors in parentheses.

Extension: A work-in-progress

Rewards are correlated with unobserved preferences for credit cards:

1. Respondent use credit cards more often due to rewards.
2. Rewards induce switching and learning about credit cards.
3. Card-issuers send pre-approvals to consumers who are credit-card intensive.

$$U_j^* = X_j\beta_j + f\left(RP_i^* \times TV_i\right) + \epsilon_j,$$
$$RP_i^* = X_j\beta_j + \delta Z + \nu_j.$$

Payment choice is a Multinomial Probit (MNP) while the reward points is a Tobit. Estimated via Simulated Maximum Likelihood.

Identification Strategy

1. Exclusion restriction (Z).
   Ching & Hayashi (JBF, 2010) suggests perceptions.
   Simon, Smith & West (JBF, 2010) suggest income dummies to proxy for annual fee and interest rates.

2. Functional forms: Joint normality or $\epsilon, \nu \sim N(0, \Sigma)$.

We have estimates based on: no exclusion restrictions, **annual fee**, interest rates and both annual fee and interest rates.

Accounting for Selection: Extensive Margin of Rewards

	MNP			MNP-S		
TV	Cash	DC	CC	Cash	DC	CC
5	-0.36	-0.22	0.58	-0.24	-0.22	0.46
25	-1.70	-1.69	3.40	-1.67	-1.58	3.25
50	-2.50	-4.43	6.92	-3.45	-3.77	7.21
100	-1.65	-8.94	10.59	-2.31	-4.44	6.74

Note: Difference in predicted probabilities evaluated at the average reward level (RP=0.78%) and those without rewards. Multinomial Probit (MNP) and Multinomial Probit with Selection: Annual Fee (MNP-S).

Accounting for Selection: Intensive Margin of Rewards

TV	MNL	MNP	MNP-S
5	0.044	0.043	0.055
25	0.177	0.160	0.187
50	0.259	0.222	0.212
100	0.270	0.231	0.102

Note: Elasticity of rewards evaluated at the average reward level (RP=0.78%). Multinomial Logit (MNL), Multinomial Probit (MNP) and Multinomial Probit with Selection: Annual Fee (MNP-S).

Conclusion

- Cash is used mostly in low value transactions (below $25).

  ⇒ Acceptance and Ease of Use.

- Increase debit and credit usage as transaction value increases.

  i.e. low value note denominations.

- Portfolio features play an important role in substitution patterns.
- Rewards: consumers shift towards credit at the expense of debit.
- Low and varying reward/fees elasticities imply the impact of price regulation on payment behaviour and potential efficiency of price discrimination is not clear cut.

  Later this afternoon: Chiu, Dong, & Shao "Societal Benefits of Credit as a Means of Payments."

Merci à tous!

Thanks for your time!