Consumer awareness and equilibrium in two-sided markets for payment methods

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# Introduction: overview

- Construct an equilibrium structural model of a two-sided market for payments at the point-of-sale (POS)
- Estimate parameters using consumer & merchant survey data
- Conduct counterfactual simulations to model
  - (1) information shock;
  - (2) what does it takes to drive cash out;
  - (3) merchant card fees, equilibrium and welfare.

# Why do we care?

- Two important observations about the payment industry
  - declining use of cash at the POS,
  - o emergence of private and central bank digital currencies.

raise lots of interesting questions about

- o potential transition to a cashless economy,
- o future of cash as a method of payment,
- o new technologies, platform intermediation, and social welfare.

# Why do we care?

- Two important observations about the payment industry
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  - raise lots of interesting questions about
    - o potential transition to a cashless economy,
    - o future of cash as a method of payment,
    - o new technologies, platform intermediation, and social welfare.
- Theory on multi-sided markets and platforms:
  - Rochet and Tirole (2002; 2003; 2011), Schmalensee (2002), Rochet (2003), Wright (2003; 2004), Belleflamme and Peitz (2019), Anderson and Peitz (2020), Jain and Townsend (2020), <u>Bedre-Defolie and Calvano (2013)</u>, Edelman and Wright (2015)
- Empirical models of payment choice:
  - Gowrisankaran and Stavins (2004), Rysman (2007; 2009), Loke (2007), Schuh and Stavins (2010), Jonker (2011), Carbó-Valverde et al. (2016), Bounie et al. (2016), Li et al. (2019), Koulayev et al. (2016)

# Model: outline

- Consumes want to complete a set of transactions.
  - Can always use cash.
  - Debit or credit cards can be used only if the merchant accepts them.
  - Consumers know merchant acceptance for some of their transactions.
- Merchants sell products.
  - Price-takers and maximize profits by choosing what to accept.
  - We abstract from modeling supply of real products.
- Trade depends on consumer awareness:
  - o informed consumers shop at merchants with known acceptance choice;
  - o uninformed consumers only know average merchant acceptance choices;
  - o consumers are endowed with both informed and uninformed transactions;
  - intuition: repeated vs one-time purchases.

# **Model: outline**

- Two-stage game representation:
  - 1) consumes/merchants choose what to adopt/accept,
  - 2) consumers choose what to use at the POS.



#### Stage 2: Usage at the POS

- $\circ$  Informed consumers: choose from their adoption set  $\mathcal{M}_b$
- Uninformed consumers: choose from an overlap  $\mathcal{M}_b \cap \mathcal{M}_s$

## **Model: consumers**

- Every consumer b is endowed with a set of transactions,  $\mathcal{J}_b$ .
- A transaction is defined by  $(p_{bj}, I_{bj}, T_{bj})$ :
  - *p<sub>bj</sub>* is transaction value,
  - I<sub>bj</sub> is transaction-specific information status,
  - $T_{bj}$  is transaction type (e.g., gas, groceries, parking, durable products).
- Consumer per-transaction utility at the POS

$$U_{bjm} = X_{bm}\beta + \alpha C_{bm}(p_{bj}) + \xi_m(D_b, T_{bj}) + \epsilon_{bjm},$$

#### where

- $m \in \{ca, dc, cc\}$  denotes payment instrument;
- X<sub>bm</sub> perceptions of ease-of-use, security, costs;
- $C_{bm}(p_{bj})$  transaction cost as a function of transaction value;
- $\xi_m(D_b, T_{bj})$  match value between consumer, transaction type and a payment instrument such that  $\xi_{ca,b,j} \equiv 0 \ \forall b, j$ ;
- $\epsilon_{\textit{bjm}}$  iid innovations at the POS;
- $(\alpha, \beta, \xi_{\textit{mbj}})$  are parameters to estimate.

#### Model: consumers

• Expected maximum utility in the second stage,

$$EU_b(\mathcal{M}_b) = \sum_{j \in \mathcal{J}_b} \mathbb{E}_{\epsilon} \left[ I_{bj} \max_{m \in \mathcal{M}_b} U_{bjm} + (1 - I_{bj}) \sum_{\mathcal{M}_s \in \mathcal{M}} \bar{P}_{\mathcal{M}_s} \max_{m \in \mathcal{M}_b \cap \mathcal{M}_s} U_{bjm} \right],$$

where

- $\mathcal{M}_b \in \{\{ca\}, \{ca, dc\}, \{ca, dc, cc\}\}$  is adoption combination;
- $\bar{P}_{\mathcal{M}_s}$  is a vector of probabilities of merchant acceptance choices;
- Adoption probability

$$P_{b,\mathcal{M}_b} = \Pr\left(\mathcal{M}_b = \operatorname*{arg\,max}_{\mathcal{M}'_b \in \mathcal{M}} \left\{ EU_b(\mathcal{M}'_b) - F_{b,\mathcal{M}'_b} 
ight\} 
ight),$$

where F<sub>b,Mb</sub> is combination-specific adoption cost to estimate and is a
 function of observable characteristics: demographics, credit score, and perceptions.

#### **Model: merchants**

Incur method-specific usage cost at the POS

$$C_{sm}(p_{bj})=c_{0sm}+c_{1sm}p_{bj},$$

where

- *p<sub>bj</sub>* is transaction value, and
- $(c_{0sm}, c_{1sm})$  are estimated from previous studies.
- Every merchant earns constant per-transaction profit margin

$$\gamma_{sbj} \equiv rac{p_{bj} - mc_{sbj}}{p_{bj}},$$

where

- $mc_{sbj}$  is marginal cost of product *j* offered to buyer *b* by merchant *s*,
- we assume  $\gamma_{sbj} = \gamma$  for all s, b, j.
- Acceptance probability

$$P_{s,\mathcal{M}_s} = \Pr\left(\mathcal{M}_s = \underset{\mathcal{M}'_s \in \mathcal{M}}{\arg\max}\left\{ \mathbb{E}\Pi_s(\mathcal{M}'_s) - F_{s,\mathcal{M}'_s} \right\}\right).$$

# Model: summary

#### Consumers

- o make adoption decisions in anticipation of the usage stage,
- o since adoption is costly have to consider
  - (1) expected merchant acceptance decisions, and
  - (2) own awareness about exact merchant choices.
- Merchants
  - o can attract informed consumers by accepting more methods;
  - o wider acceptance combinations do not minimize operating costs;
  - o due to the fixed acceptance costs have to consider
    - (1) expected consumer adoption, and
    - (2) consumer awareness about own acceptance choice.
- In equilibrium (SPNE):
  - each side solves a corresponding single-agent maximization problem;
  - o consumer expectations are consistent with realized merchant choice;
  - o merchant expectations are consistent with realized consumer choice.

#### **Caveats**

- Survey data from 2013 (consumer) and 2014 (merchant)
  - o credit cards are the most expensive option for merchants, and
  - for society (if price exceeds \$20) relative to other payment options.

#### Model assumptions:

- Universal acceptance of cash.
- Fixed demand for transactions.
- No strategic interactions between merchants.

#### **Results: consumer adoption costs and benefits**



### Results: determinants of consumer usage choice

- transaction costs, and
- ease-of-use at the POS; 
   U-stage
- older consumers don't like electronic payment instruments;
- rich and educated consumers tend to benefit more from credit cards;
- those who spend more prefer credit cards;
- consumers having better debit tend to have better credit cards;
- after controlling for demographics, credit score becomes irrelevant;
- on average, debit ≻ cash ≻ credit.

Ref to OLS results

#### **Results: merchant costs and profit margins**

- Merchant profit measures:
  - gross profit margin  $\hat{\gamma} = 5.2\%$ ;
  - after paying all banking fees the margin reduces to 3.4%;
  - after acceptance costs are paid it becomes 1.6%.
- Merchant acceptance costs vs terminal costs, CAD

revenue	total acceptance cost		costs of terminals		
	cash and debit	all methods	cash and debit	all methods	
50,000	3,712	2,709	311.76	336.18	
175,000	6,038	6,047	90.16	409.15	
375,000	8,168	9,104	459.36	549.61	
625,000	11,539	13,941	300.00	518.89	
875,000	13,704	17,047	618.21	751.59	
3,000,000	42,928	58,980	500.00	948.88	
7,500,000	103,707	146,192	-	1,318.67	
average	20,762	27,175	407.66	695.34	

# Counterfactuals

#### (1) Information shock •• graphs

- Consumer awareness is very important
  - o affects equilibrium adoption and use;
  - merchants response is very strong .;
  - $\Rightarrow$  may be more efficient to target policies towards consumer side.
- Under almost 95% awareness reveals preference for cash:
  - o most consumers know where to go with debit and credit cards;
  - $\circ~$  eliminating 5% uncertainty would affect mostly the merchants:
    - ▶ share of cash-only merchants  $\Downarrow$  from 0.24 to 0.16, while
    - share of merchants accepting all methods  $\Uparrow$  from 0.72 to 0.81.

## Counterfactuals

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#### (2) Cashless economy •• graphs

- Cashless society seems like a distant future:
  - $\,\circ\,$  for cash use to drop below 1% its cost of use must  $\Uparrow$  5.8 times;
  - e.g., a 5 minute trip to an ATM will become a half-hour journey.

# **Counterfactuals (cont.)**

#### (3) Merchant card fees and social welfare • graphs

- Credit card issuers have market power
  - o retain about 23% to 29% of the merchant fees;
  - o likely to over-subsidize consumers and over-tax merchants;
  - potential for excessive intermediation.
- Socially optimum merchant card fee is 0.8% lower than observed.
- Our findings empirically confirm theory predictions by:
  - Bedre-Defolie and Calvano (2013);
  - Edelman and Wright (2015).





# Thanks/Merci!



## Usage stage preferences

paramotor	no info	no info full info		observed info	
parameter	(1)	(2)	(3)	(4)	
transaction cost	-15.965	-5.296	-7.173	-7.302	
(s.e.)	(0.289)	(0.117)	(0.176)	(0.184)	
ease-of-use	8.907	6.766	7.097	6.406	
(s.e.)	(0.423)	(0.320)	(0.334)	(0.348)	
security	1.630	1.155	1.203	1.053	
(s.e.)	(0.214)	(0.162)	(0.168)	(0.171)	
affordability	2.939	2.223	2.326	2.203	
(s.e.)	(0.158)	(0.127)	(0.131)	(0.133)	



# OLS regression of debit and credit card match values

variable	debit fixed effect		credit fixed effect	
Variable	coef.	(s.e.)	coef.	(s.e.)
constant	3.859	(0.078)	-4.223	(0.078)
age	-0.011	(0.000)	-0.001	(0.000)
In(income)	-0.037	(0.005)	0.138	(0.005)
education	-0.125	(0.003)	0.151	(0.003)
male	-0.135	(0.007)	0.155	(0.007)
urban	0.000	(0.010)	-0.004	(0.010)
married	0.014	(0.008)	0.026	(0.008)
number of transactions	0.000	(0.001)	-0.010	(0.001)
value of transactions	-0.006	(0.003)	0.017	(0.003)
credit score	0.003	(0.008)	-0.007	(0.008)
credit FE, $\xi_{cc}$	0.601	(0.007)		
debit FE, $\xi_{dc}$			0.626	(0.007)
observations	12,029		12,029	
R-squared	0.561		0.575	

Table: Explaining consumer-transaction-method match values



OLS regression of debit and credit card match values

#### Elasticity with respect to consumer awareness



## Information shock



Notes: Red vertical line is at observed consumer awareness level.

## **Cashless economy**



Notes: Red vertical line denotes observed equilibrium. (\*\* back

#### Merchant card fees and social welfare



Notes: Red vertical line is at the original maximum total welfare with full pass-through. Green vertical line is at the total welfare maximum under optimal issuers' pass-through. Dashed lines are for the full pass-through case. Negative change implies transfer from consumers to merchants, while positive change implies transfer from merchants to consumers. Welfare is measured for our

sample only. >> back

#### OLS regression of debit and credit card match values

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