Payment Systems and Financial Inclusion

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Why do payment systems matter?

New payment systems are rapidly changing the way that households shop, save, borrow, and make other financial decisions

Payment systems can benefit both sides of the market

- Consumers benefit from lower transaction costs
  - Costs of sending remittances (Jack Suri 2014)
  - Costs of traveling to a bank (Bachas Gertler Higgins Seira 2018, 2021)
  - Crime risks of carrying cash (Economides Jeziorski 2017)
- Retail firms
  - Reduce risk of cash theft (Rogoff 2014; Bachas Higgins Jensen 2025)
  - Attract consumers who prefer not to use cash (Higgins 2024)


ACEPTAMOS TODAS LAS TARJETAS DE CRÉDITO...
RECUPERA TU ENERGÍA
Coca-Cola

Why else do payment systems matter?

Two-sided payment markets generate **indirect network externalities**

- Can lead to multiple adoption equilibria
- Moving to the Pareto-dominating equilibrium requires coordination (Katz Shapiro 1986; Gowrisankaran Stavins 2004)

Thus, **coordination failures** can constrain financial technology adoption

- And spillovers of financial technology adoption might be large

Digital payment histories increasingly used to **evaluate creditworthiness** (Alok Ghosh Kulkarni Puri 2025; Ouyang 2023)

- For both consumers (Chioda Gertler Higgins Medina 2025)
- and firms (Ghosh Vallée Zeng forth.)

Today's talk

Based on Higgins, 2024, "Financial Technology Adoption: Network Externalities of Cashless Payments in Mexico," *American Economic Review*

- And will briefly talk about newer work in fast payments at the end, with a focuson emerging markets

Debit cards rolled out to 1 million cash transfer recipients

- Already paid in bank accounts, but had to travel to nearest bank branch
- With debit card, can access money at any bank's ATM
- . . . or use at stores with point-of-sale (POS) terminal to accept cards

Debit cards and POS terminals are an older payments technology, but:

- Two-sided payment markets (consumers adopt cards; businesses adopt POS terminals) relevant for new fast payment systems

Key results

Debit card rollout caused:

1. Increased financial technology adoption by small retailers (corner stores)
   - No effect among supermarkets, which already had high adoption
2. Spillovers to other consumers not directly affected by shock:
   - Other consumers adopt cards (21% ↑)
   - Richer shift 13% of supermarket consumption to corner stores
3. Corner store sales ↑ 6% and supermarket sales ↓ 12%
4. Consumer gains from spillovers exceed costs of debit card rollout by 37x

Spillovers of payments adoption difficult to study

1. Technology adoption is typically endogenous
   - Exploit plausibly exogenous variation in consumers' adoption of payments technology from rollout of cards by government
2. May need large local shock to induce response by supply side
   - Shock is large: 18 pp ↑ in households with cards (on base of 36%)
3. To isolate demand-side spillovers, need shock to subset of consumers
   - Cost of adoption only reduced for cash transfer beneficiaries
4. Data on firm technology adoption; outcomes for firms and other consumers
   - Combine nine data sets, both administrative and survey

Administrative data

1. Administrative data on debit card rollout
   - Number of beneficiaries and payment method $\times$ locality $\times$ month
     - Provided by Prospera (cash transfer program)
   - All card transactions by cash transfer recipients who receive card
     - Provided by Bansefi (government bank administering accounts)

2. Financial technology adoption and use by retail firms
   - Universe of point-of-sale (POS) terminal adoptions
   - Universe of card transactions by all cardholders (5 billion transactions)
     - Accessed on-site at Mexico's Central Bank

3. Consumer card adoption
   - Quarterly number of debit cards $\times$ issuing bank $\times$ municipality
     - Provided by National Banking and Securities Commission

Survey data

1. Income–expenditure survey: nationally representative household sample
   - All consumption including cash
   - Includes type of store at which each item purchased
     - Census tract identifiers accessed on-site at National Statistical Institute

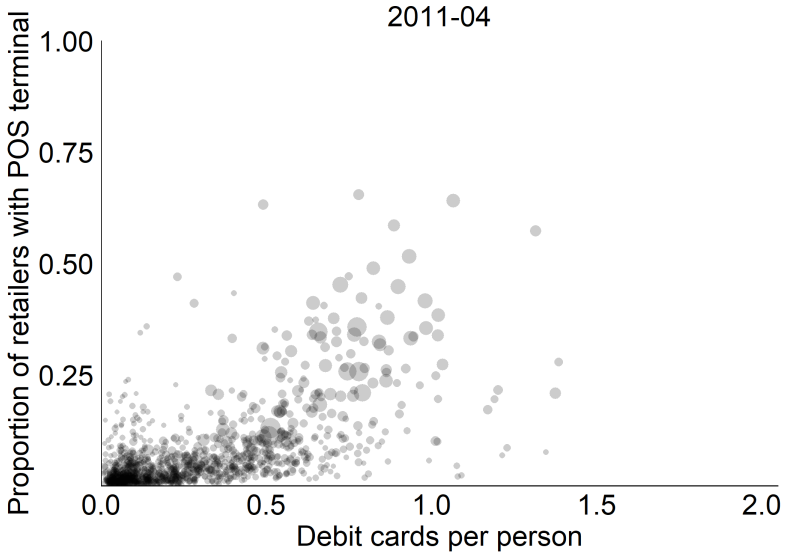
2. Economic census: panel on sales and costs of universe of retailers
   - All sales including cash
     - Accessed on-site at National Statistical Institute

3. Quarterly labor force survey
   - Wages for 20 million worker by quarter observations

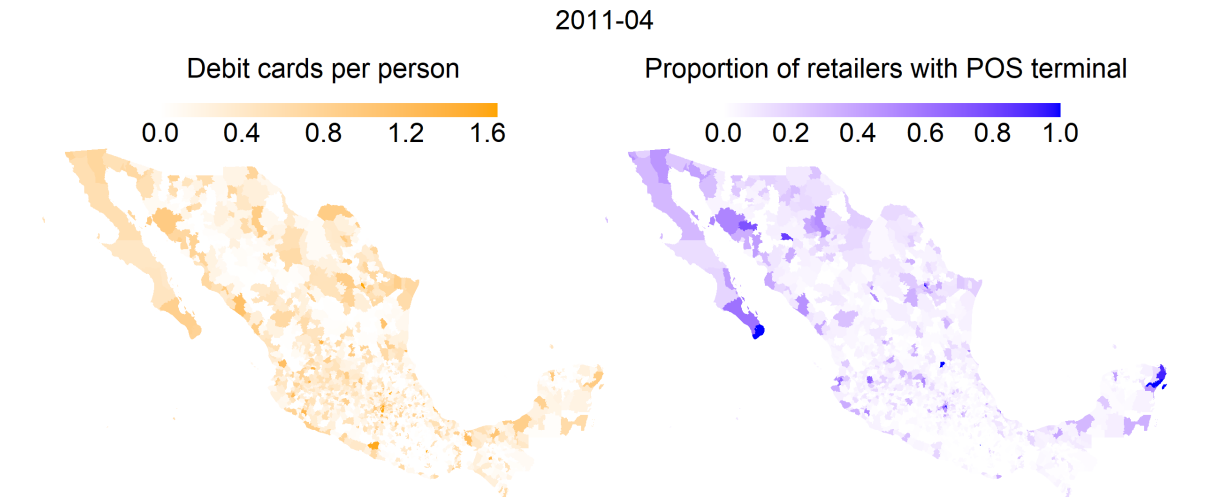
4. High-frequency price data
   - 10 million price quotes at barcode-level product $\times$ store $\times$ week level
     - Accessed on-site at National Statistical Institute

Context and identification

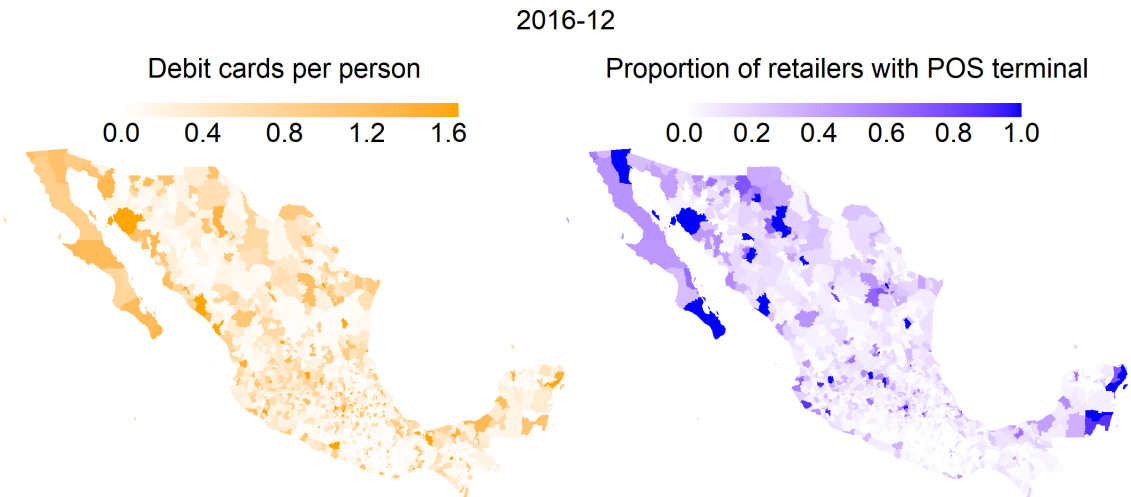
Debit cards and point-of-sale terminals over time



Debit cards and POS over time and space



Debit cards and POS over time and space



Measuring the impact of payments adoption

Exploit gradual rollout of debit cards over time by government

Over 2009–2012, Mexico's conditional cash transfer program Prospera distributed about 1 million debit cards

- In urban localities (population $>$ 15,000)

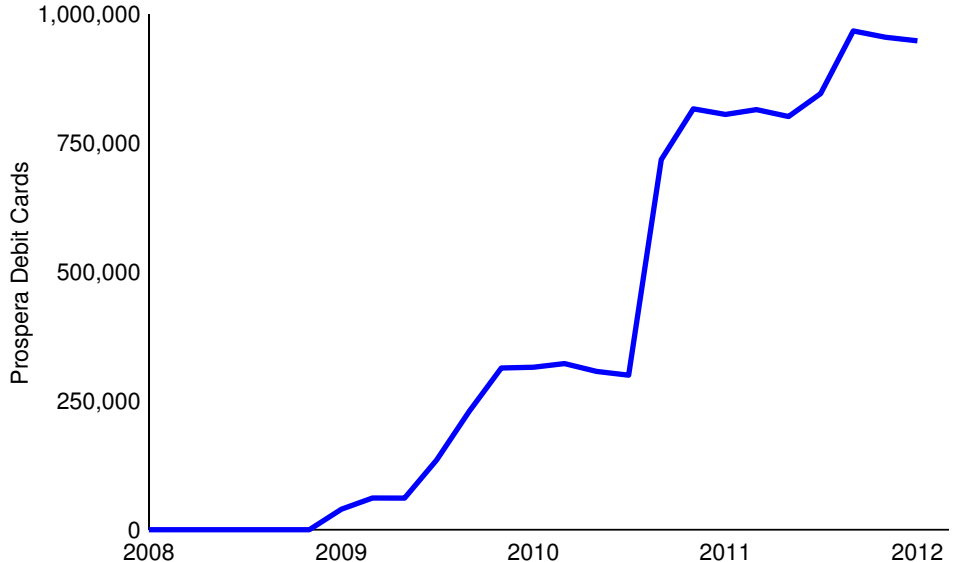
Pre-intervention: Urban recipients of government cash transfer program

- Receive transfers in a Bansefi bank account
- Paid every two months ($150 average)

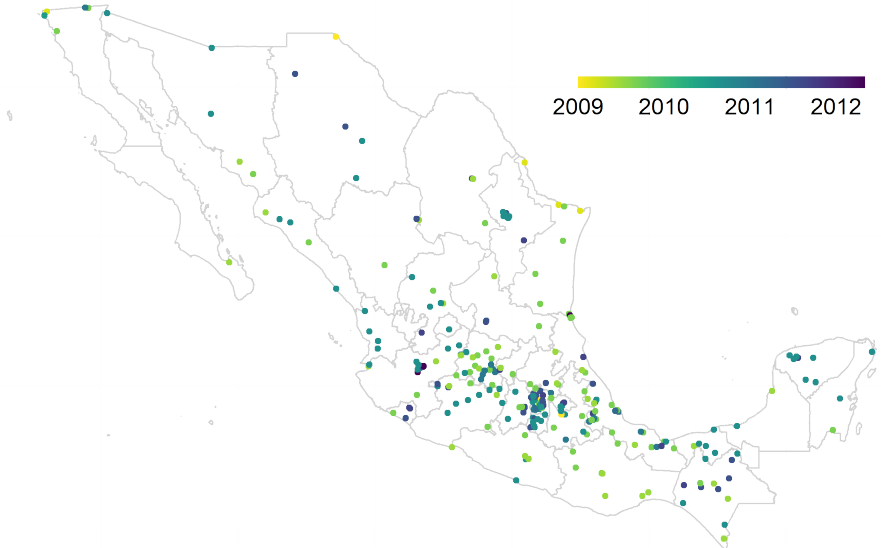
Intervention: Visa debit cards attached to accounts

- Can withdraw funds from any bank's ATM
- Use as debit cards at stores accepting Visa

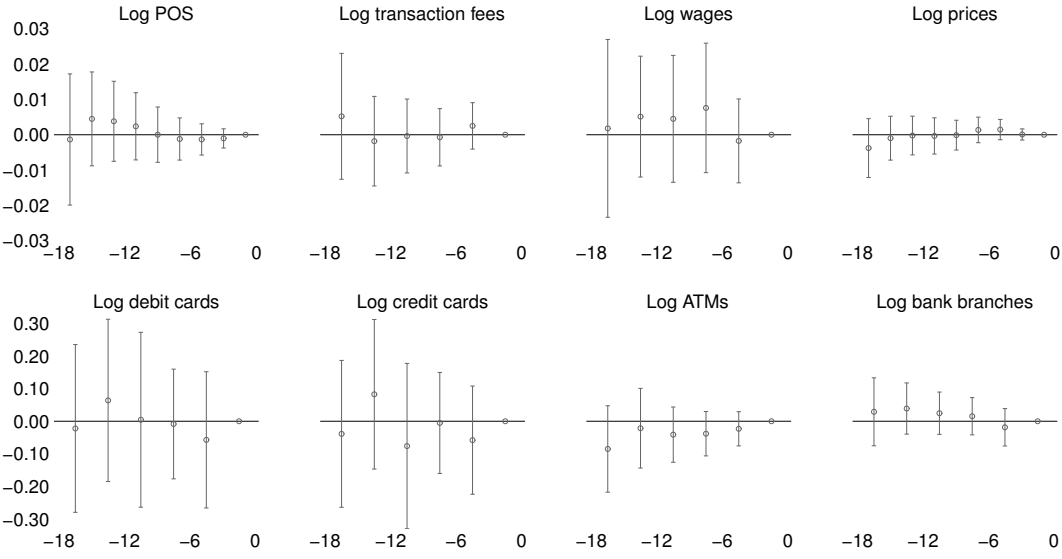
Debit card rollout over time



Debit card rollout over time and space



Balanced pre-trends in financial and other variables

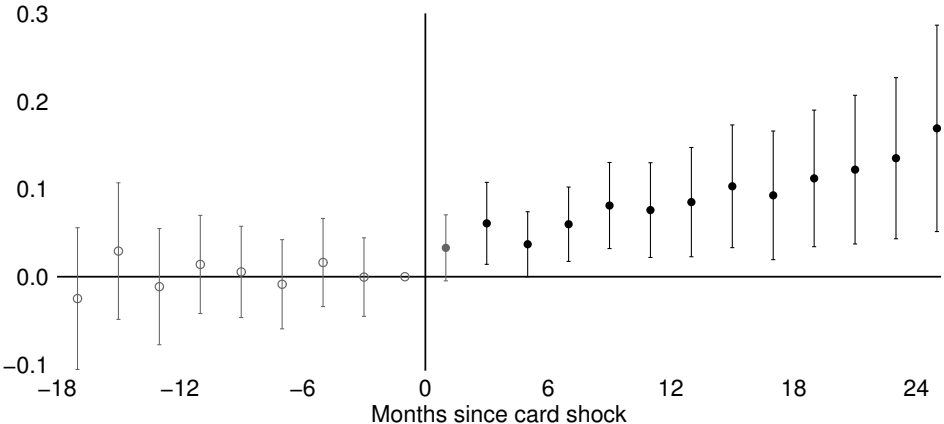


1) Corner stores increase adoption of POS

Corner stores increase adoption of POS

Data: Universe of point-of-sale terminal "contract changes" (adoptions, cancellations, etc.), 2006–2017

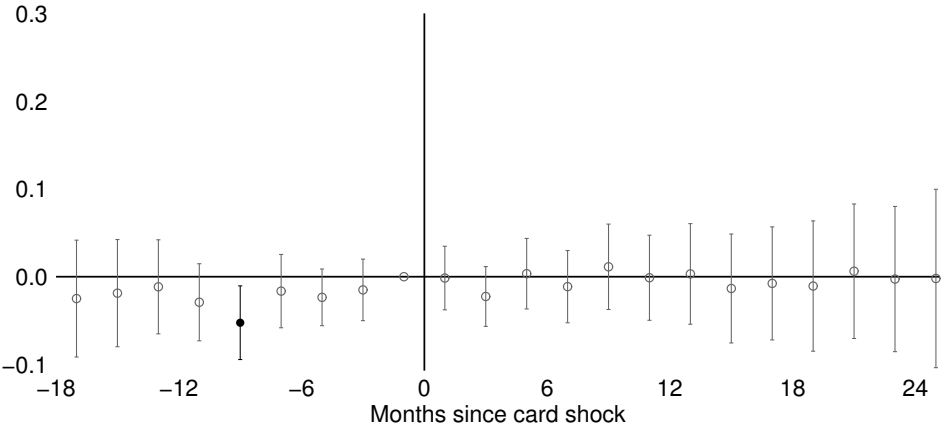
$$\log \textit{Number of corner store POS}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$



Supermarkets do not change adoption of POS

Data: Universe of point-of-sale terminal "contract changes" (adoptions, cancellations, etc.), 2006–2017

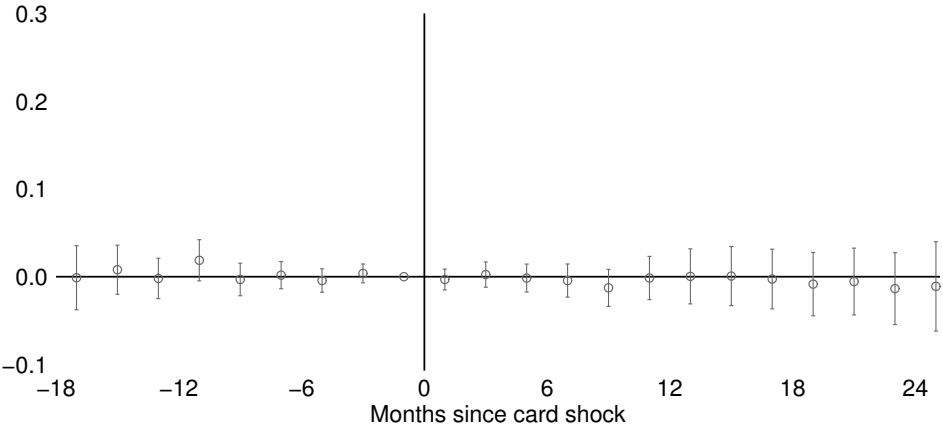
$$\log \textit{Number of supermarket POS}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$



Other retailers do not change adoption of POS

Data: Universe of point-of-sale terminal "contract changes" (adoptions, cancellations, etc.), 2006–2017

$$\log \textit{Number of other POS}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$

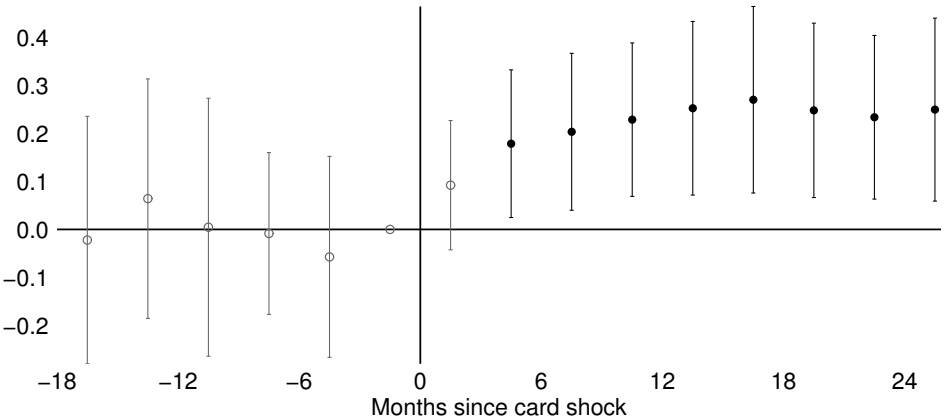


2) Spillovers to other consumers

Spillovers to other consumers' card adoption

Data: Total debit cards by bank by municipality by quarter, 2008–2014

$$\log \textit{Number of Non-Bansefi Debit Cards}_{jt} = \lambda_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$

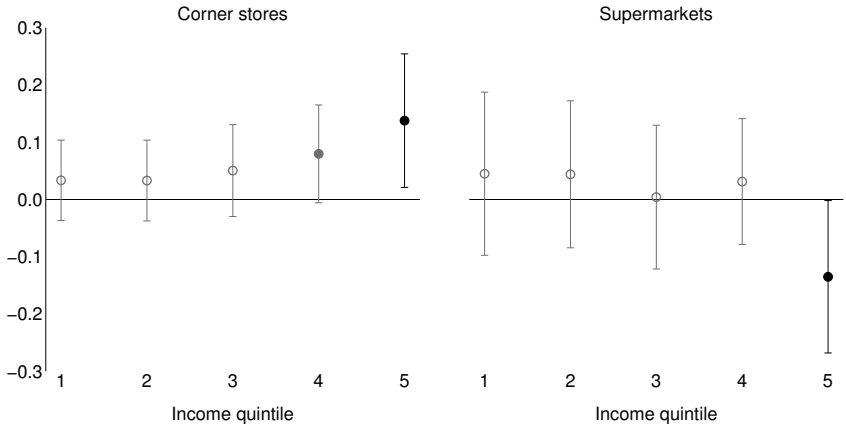


▸ Credit + debit ▸ Balanced panel ▸ By POS response ▸ By social connectedness ▸ By ATM density ▸ By where shop ▸ Bank response

Increased consumption at corner stores

Data: Consumption module of repeated cross-section survey, 2006–2014

$$\log Spending^{s}_{it} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(quintile = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$

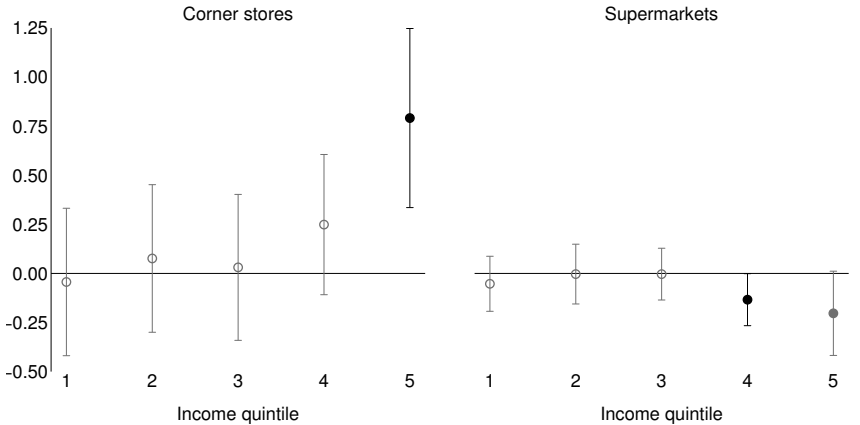


▸ Simple diff-in-diff ▸ Quantities ▸ Prices ▸ By category ▸ Minimum payments ▸ Consumption shares ▸ Google searches

Driven partly by changing number of trips

Data: Consumption module of repeated cross-section survey, 2006–2014

$$\textit{Weekly trips}^{s}_{it} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(\textit{quintile} = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$



▸ Simple diff-in-diff ▸ Quantities ▸ Prices ▸ By category ▸ Minimum payments ▸ Consumption shares ▸ Google searches

3) Corner store sales and profits increase

Retail sales and profits

Data: Mexico's Economic Census (panel)

- Revenues and costs by category for universe of firms
- Includes all sales (including cash)
- Caveat: only two points in time (2008 and 2013)
  - These bracket rollout; exploit variation in how long since shock

Corner store sales and profits increase

$$y_{it} = \gamma_i + \delta_t + \sum_k \gamma_k \mathbb{I}(\text{received cards at } k)_{j(i)} \times D_{j(i)t} + \varepsilon_{it}$$

	(1) Log Sales	(2) Log Inventory Costs	(3) Log Wage Costs	(4) Log Number Workers	(5) Log Rent Costs	(6) Log Capital	(7) Log Electricity Costs	(8) asinh Profits	(9) Charged VAT or Paid Social Security
Panel A: Corner stores ($N = 172{,}441$)									
Shock 3–4.5 years ago	0.081**	0.059*	−0.022	0.000	−0.028	0.047	−0.029	0.212**	0.014
	(0.036)	(0.034)	(0.020)	(0.005)	(0.025)	(0.083)	(0.034)	(0.099)	(0.009)
Shock 1.5–3 years ago	0.045	0.022	−0.022	0.000	0.022	0.024	0.005	0.143	0.031**
	(0.037)	(0.035)	(0.019)	(0.004)	(0.023)	(0.089)	(0.034)	(0.104)	(0.012)
Pooled coefficient									
Shock 1.5–4.5 years ago	0.061*	0.039	−0.022	0.000	−0.002	0.035	−0.011	0.175*	0.023***
	(0.034)	(0.032)	(0.017)	(0.004)	(0.022)	(0.082)	(0.032)	(0.096)	(0.008)
Panel B: Supermarkets ($N = 13{,}782$)									
Shock 3–4.5 years ago	−0.143**	−0.155**	−0.151	−0.014	0.314	−0.064	0.180	−0.228	−0.054
	(0.063)	(0.062)	(0.316)	(0.019)	(0.300)	(0.085)	(0.254)	(2.353)	(0.082)
Shock 1.5–3 years ago	−0.119*	−0.124**	−0.346	−0.022	0.135	0.144	0.153	0.149	−0.013
	(0.062)	(0.062)	(0.348)	(0.019)	(0.256)	(0.116)	(0.259)	(2.341)	(0.081)
Pooled coefficient									
Shock 1.5–4.5 years ago	−0.131**	−0.140**	−0.246	−0.018	0.227	0.037	0.167	−0.045	−0.034
	(0.058)	(0.057)	(0.308)	(0.019)	(0.242)	(0.086)	(0.253)	(2.326)	(0.080)
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

▸ Prices ▸ Wages ▸ Transaction fees ▸ Consumption ▸ Size ▸ Owners ▸ Churning ▸ Survey

Corner store formality increases

Debit card shock and ↑ POS terminal adoption ⇒ ↑ formality (Higgins 2024)

- 2.3 pp more likely to collect any VAT from customers
- 13% ↑ in VAT payments
- 0.3 pp ↑ in VAT/sales

Consistent with evidence from India that demonetization ⇒ ↑ use of digital payments ⇒ ↑ tax compliance (Das Gadenne Nandi Warwick 2023)

But informality and tax compliance still key constraints to small firm adoption of payment systems (Gertler Higgins Malmendier Ojeda 2025)

What does optimal regulation (of interchange fees, surcharging) look like in a context with high informality? (Higgins Wang ongoing)

- where an added benefit of ↑ payments adoption is ↑ tax compliance

Benefits and costs of newer fast payment systems (with a focus on emerging markets)

Benefits of new fast payment systems

Lenders can use payments transactions to evaluate creditworthiness

- AliPay in China (Ouyang 2023)
- UPI in India (Ghosh Vallée Zeng forth.; Alok Ghosh Kulkarni Puri 2025)
- Pix in Brazil (Mariani Ornelas Ricca 2025)
- Works well even for borrowers with no credit history (Chioda Gertler Higgins Seira 2024)

Lead to ↑ bank account ownership and complementarities with other payment technologies (Pix: Sampaio Ornelas 2025)

Lower bank market power and higher deposit interest rates paid to depositors (Pix: Liang Sampaio Sarkisyan 2025)

Costs of new fast payment systems

Convenience of instant payments for users $\Rightarrow$

- $\downarrow$ ability of banks to delay and net payment flows
- $\uparrow$ liquid assets held by banks
- $\uparrow$ risk-taking ($\uparrow$ subprime and defaulting loans) among banks' illiquid assets
- Pix: Ding Gonzalez Ma Zeng (2025)

Costs of new fast payment systems

Many fast payment systems require bank accounts (e.g., Pix, UPI)

Will remote, rural areas without access to banks get left behind?

And are payment systems built on a central bank digital currency (CBDC) with cash in/out agents a solution?

- Peru: Breza Higgins Medina Valdivia (ongoing)
- Or will CBDCs lead to disintermediation of banks? (Duffie 2019; Whited Wu Xiao 2022)
- Are CBDCs more useful in rural areas in developing countries as people lack access to payment systems and financial intermediation is low?

Benefits and costs of interoperability

Interoperability increases adoption of digital payments especially in fragmented markets (UPI: Copestake Kirti Martinez-Peria Zeng 2025)

But it can be costly for banks

- Brazil, India force banks to not charge for off-net P2P transactions
- Banks can charge merchants, but merchant payments use is very elastic to magnitude of fees (Gertler Higgins Malmendier Ojeda 2025)

Mobile money interoperability in Africa $\Rightarrow$

- $\downarrow$ mobile money fees
- But also $\downarrow$ investment in mobile towers and coverage (Brunnermeier Limodio Spadavecchia 2023)

Benefits and costs of interoperability

In Philippines, banks often charge high off-net transfer fees (and 0 on-net)

Given private incentives of banks, is this an equilibrium?

Can regulation equating on- and off-net pricing move us to a Pareto-dominating equilibrium?

- Potentially with banks switching to a subscription model, as telcos have (Armstrong 1998; Laffont Rey Tirole 1998)
- Central Bank released a draft circular proposing this regulation
- And Governor has floated banks switching to subscription model

Gonzales Higgins Toth Tsai Wang (ongoing) combine a structural model and a pricing RCT to explore these questions

Conclusion

Conclusion

Coordination failures around indirect network externalities in two-sided markets constrain adoption of payments technologies

Large spillovers of an adoption subsidy targeted to a subset of consumers

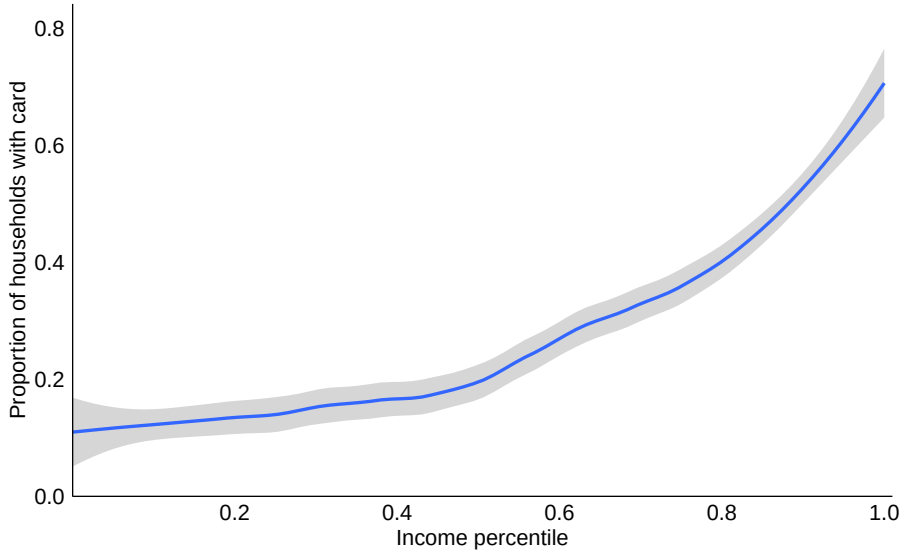
- Over half of consumer gains from ↑ merchant payment adoption accrue to other consumers who did not receive cards from gov. ▸ Details
- Consumer gains from spillovers exceed debit card rollout costs by 37x

Relevant for newer fast payment systems that can get stuck in a low-adoption equilibrium due to coordination failures

- Policy to subsidize adoption may be politically popular even among richer tax payers due to spillovers

Appendix

Proportion of households with debit or credit cards



▸ Rollout details

Background on Prospera

Large program: 24% of Mexican households receive benefits

One of first conditional cash transfer programs

- Targeted to poorest households with children 0–18 or pregnant women
- Conditional on school attendance and health check-ups/vaccinations

Started in rural localities in 1997 as Progresa

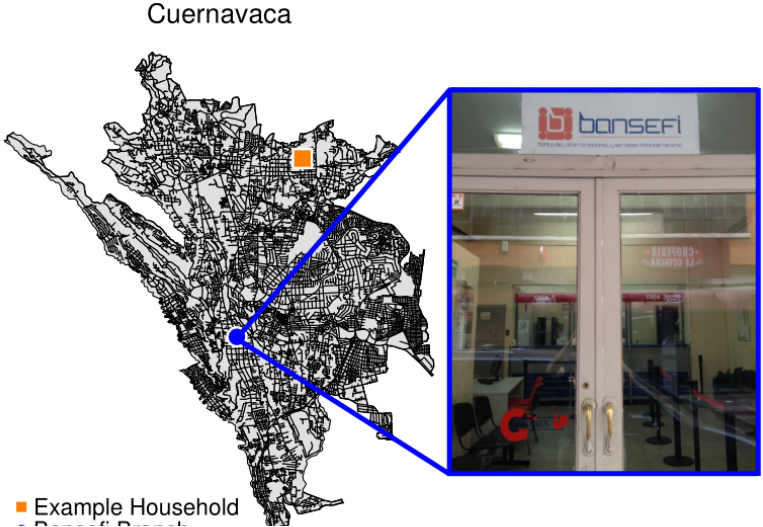
Expanded to urban areas in 2002–2003 as Oportunidades

Urban beneficiaries given Bansefi bank account in 2005

- But no debit card until 2009–2012 debit card rollout

▸ Rollout details

Debit cards reduce travel distance



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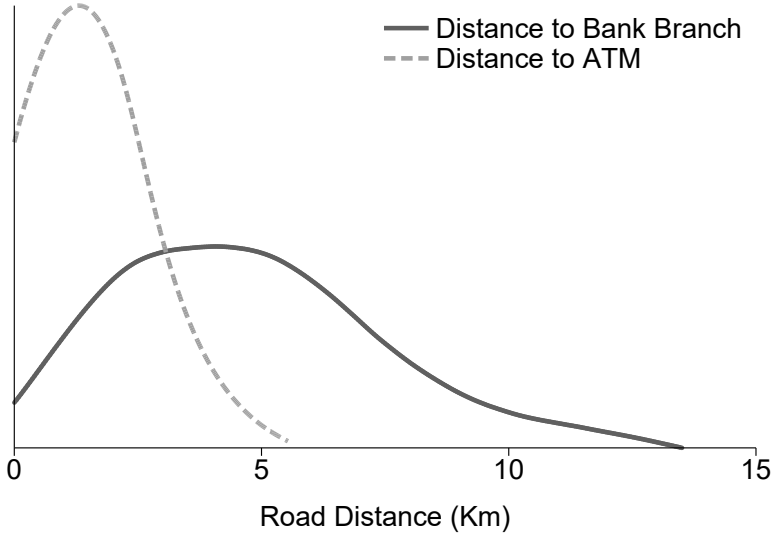
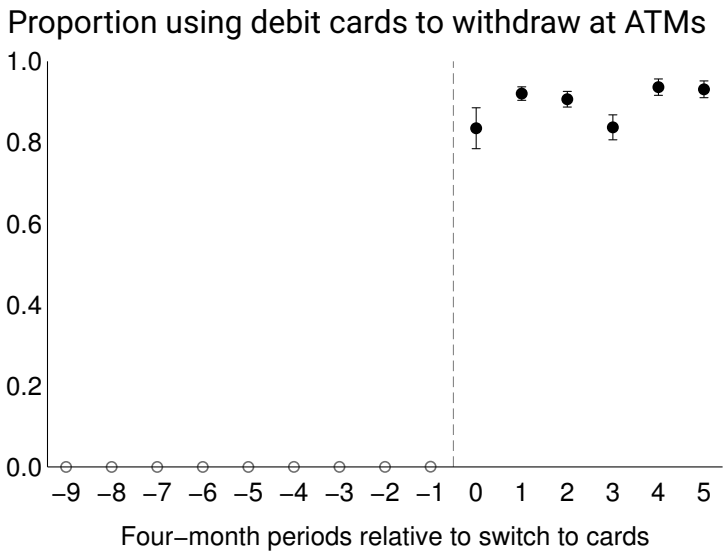


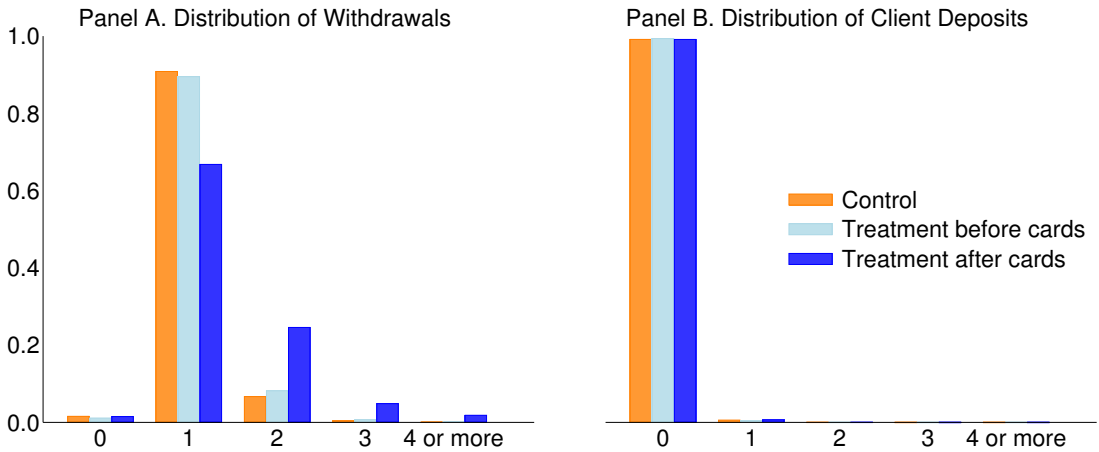
▸ Rollout details

Recipients use their cards at ATMs



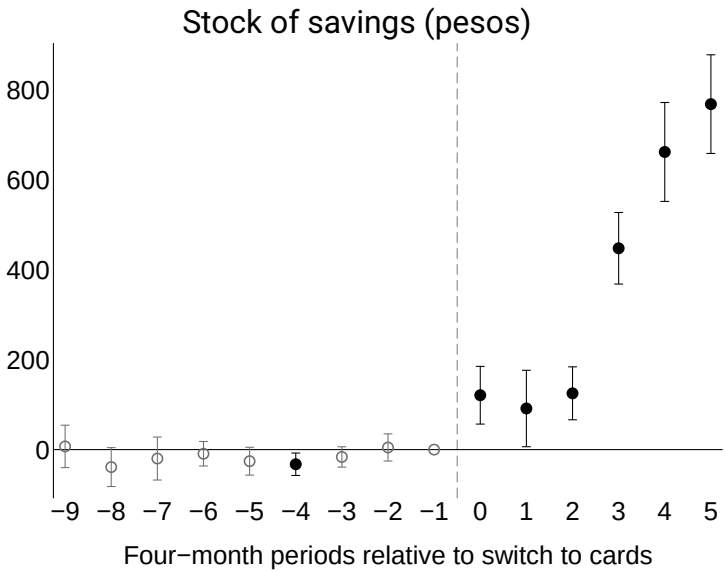
▸ Rollout details

Recipients make more withdrawals



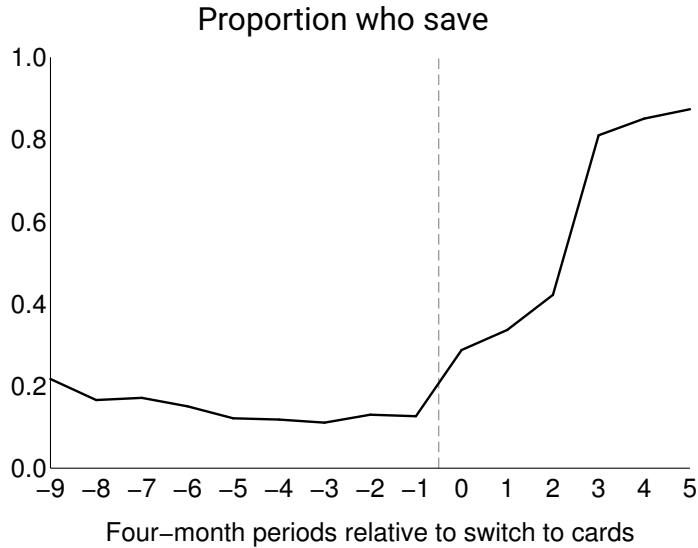
▸ Rollout details

Debit cards lead to more savings



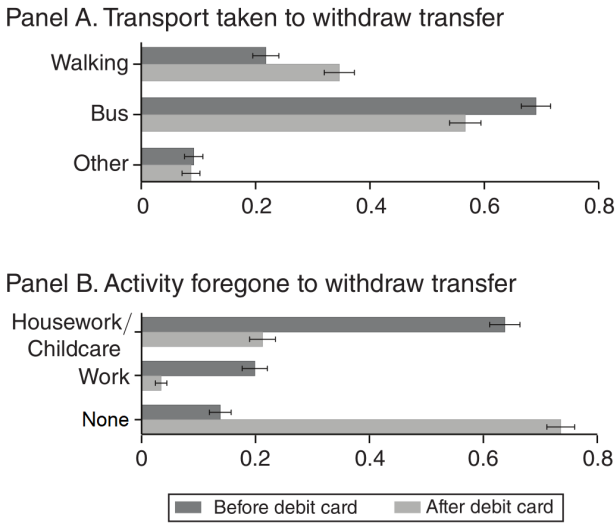
▸ Rollout details

Some start saving right away; others after delay



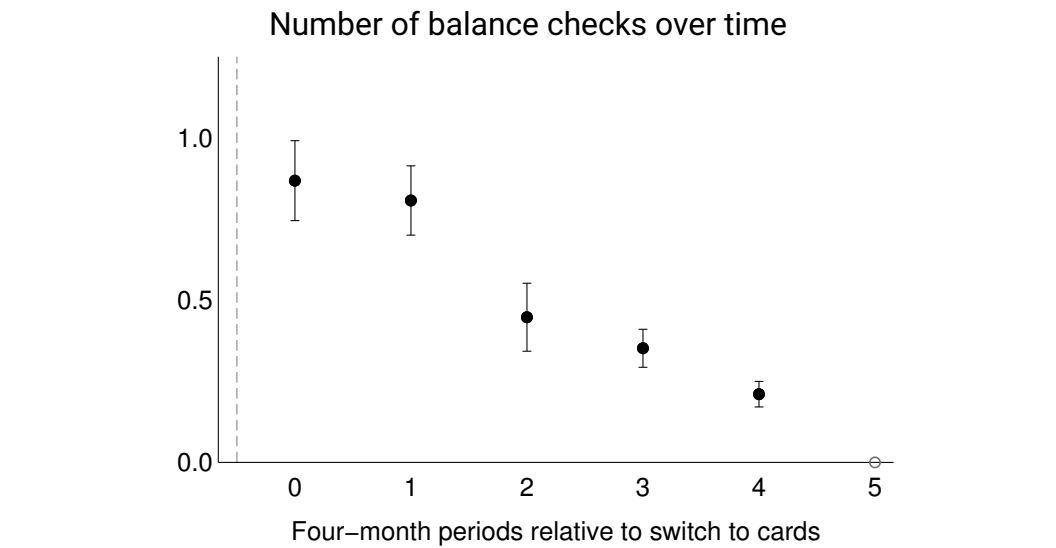
▸ Rollout details

Mechanism 1: Travel costs to access money

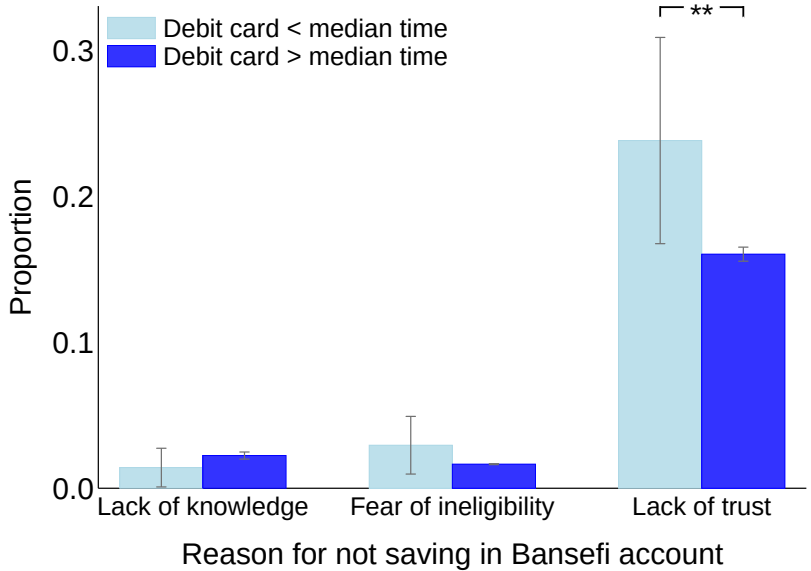


▸ Rollout details

Mechanism 2: Checking balance to monitor bank, build trust



Mechanism 2: Checking balance to monitor bank, build trust



▸ Rollout details

Increase in overall savings or substitution?

	(1)	(2)	(3)	(4)
Consumption	−175.36**	−150.51**	−136.52**	−155.11**
	(81.31)	(70.43)	(61.75)	(62.07)
	[−353.11, −1.52]	[−306.24, −2.30]	[−276.37, −4.75]	[−288.02, −33.10]
Income	98.16	106.01	75.50	38.11
	(170.03)	(150.31)	(127.77)	(106.12)
	[−290.77, 486.11]	[−230.64, 468.97]	[−219.75, 376.72]	[−175.00, 251.64]
Asset index	0.06	0.06	0.07	0.03
	(0.08)	(0.08)	(0.07)	(0.08)
	[−0.12, 0.24]	[−0.12, 0.24]	[−0.08, 0.23]	[−0.20, 0.24]
p-value consumption vs. income	[0.047]	[0.041]	[0.056]	[0.057]
Number of observations	9,246	9,246	9,246	7,754
Number of households	2,868	2,868	2,868	2,200
Time fixed effects	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Household characteristics × time	No	No	No	Yes
Winsorized	No	1%	5%	5%

▸ Rollout details

Why was it hard to save informally?

Money might be “hot” in hand or when being saved at home (Ashraf 2009)

May be easier for other household members to access the money when saved at home (Anderson and Baland 2002; Jakiela & Ozier 2016; Schaner 2015)

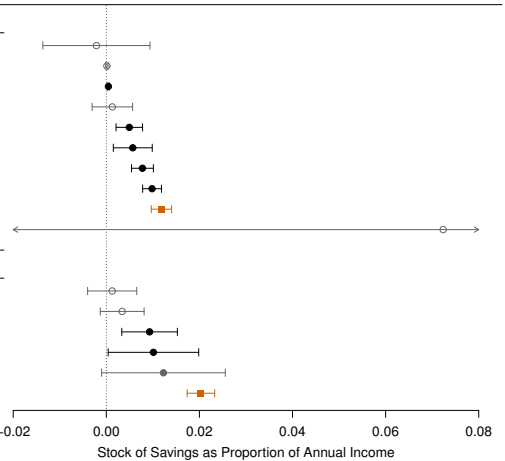
We find evidence consistent with this:

- Spending on temptation goods (alcohol, tobacco, sugar, etc.) falls by 14%, compared to 5% fall in overall consumption
- Effect of debit cards on savings concentrated among women with low baseline bargaining power

▸ Rollout details

Comparing effect sizes across studies

Study	Intervention	Country	Months
Panel A. Studies with Approximately One–Year Duration			
Drexler, Fischer, and Schoar (2014)	Financial education	Dominican Republic	12
Karlan and Zinman (2018)	Interest rate	Philippines	12
Kast, Meier, and Pomeranz (2018)	Savings group	Chile	12
Karlan et al. (2016)	Reminders	Philippines	9–12
Kast and Pomeranz (2014)	Account	Chile	12
Somville and Vandewalle (2018)	Payment default	India	8
Dupas and Robinson (2013)	Account or lockbox	Kenya	12
Prina (2015)	Account	Nepal	13
This paper (1 year)	Debit card	Mexico	12–15
Seshan and Yang (2014)	Financial education	India (migrants to Qatar)	13–17
Panel B. Studies with Longer Duration			
Ashraf, Karlan, and Yin (2006)	Deposit collection	Philippines	32
Dupas et al. (2018)	Account	Malawi	24
Karlan et al. (2017)	Savings group	Ghana, Malawi, Uganda	22–30
Dupas et al. (2018)	Account	Uganda	24
Schaner (2018)	Interest rate	Kenya	36
This paper (2 years)	Debit card	Mexico	20–23



▸ Rollout details

Calendar of transfer dates

Oportunidades

Calendario Fijo de Retiro de Apoyos Monetarios

GOBIERNO FEDERAL
SEDESOL

Entidad: **15 MEXICO**

Zona de Atención: **150303**

Municipio: **33 ECATEPEC DE MORELOS**

Localidad: **1 ECATEPEC DE MORELOS**

AGEB: [redacted]

Código Postal: **55450**

Domicilio: [redacted]

Folio Titular: [redacted]

Nombre Titular: [redacted]

Identificador de Familia: [redacted]

Fase de Incorporación: **35**

Esquema de Apoyos: **Urbano 1**

Colonia: [redacted]

Estimada Titular:

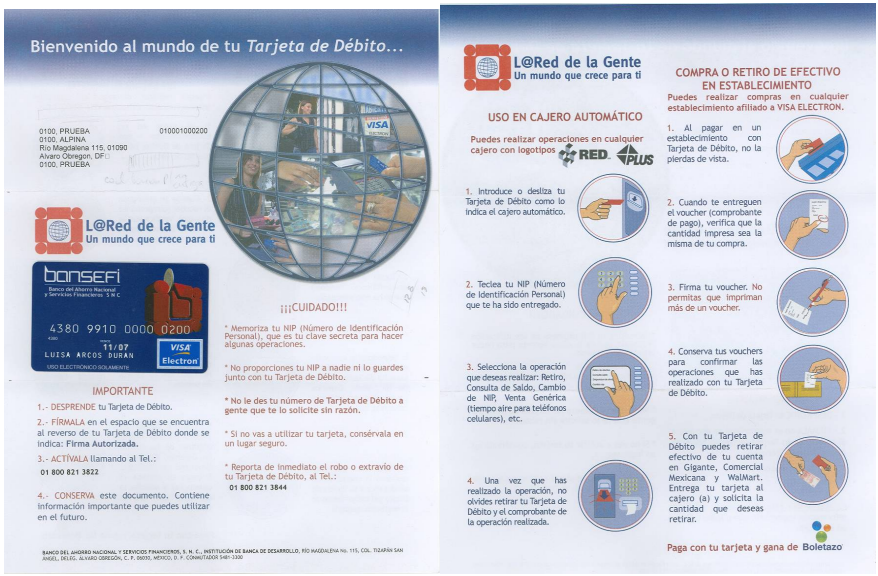
Los apoyos del bimestre de corresponsabilidad	los puede retirar a partir del
Noviembre - Diciembre del 2008	Lunes 20 de Abril del 2009
Enero - Febrero del 2009	Lunes 1 de Junio del 2009
Marzo - Abril del 2009	Lunes 13 de Julio del 2009
Mayo - Junio del 2009	Lunes 14 de Septiembre del 2009
Julio - Agosto del 2009	Lunes 16 de Noviembre del 2009
Septiembre - Octubre del 2009	Lunes 11 de Enero del 2010

Bimestre de Generación de Calendario: **Corresponsabilidad Noviembre - Diciembre del 2008**

Titular beneficiaria: Usted podrá retirar sus apoyos con su Tarjeta de Débito a partir de la fecha indicada en cajeros automáticos ó establecimientos autorizados (que aceptan tarjetas VISA).

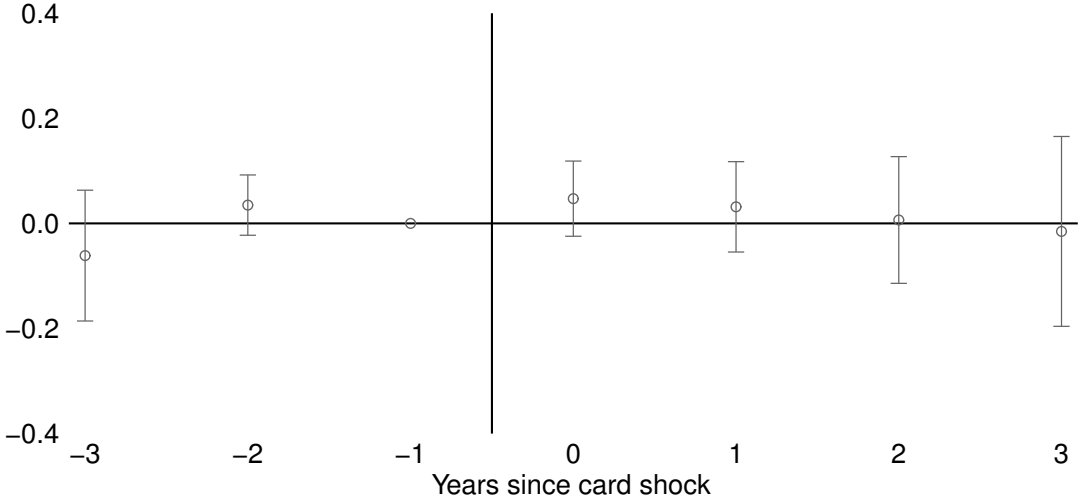
Recuerde que en cajeros automáticos podrá realizar dos operaciones (retiros ó consultas) gratuitas al bimestre, también puede utilizar su Tarjeta para comprar en establecimientos que aceptan Tarjetas de Débito VISA.

Pamphlet provided with debit card



No change in number of beneficiaries

$$\log \textit{Number of Beneficiaries}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$



Rollout not correlated with observables

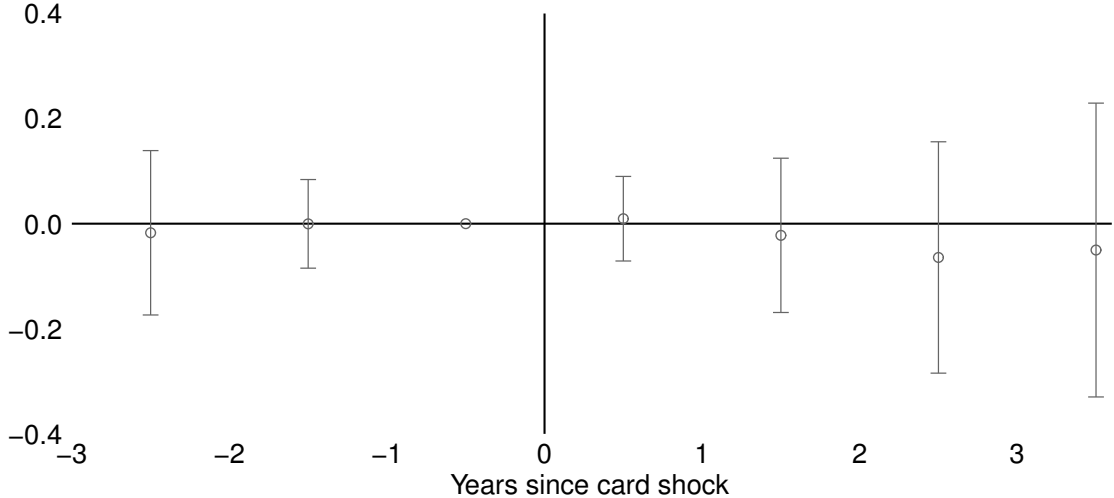
Panel A: Banco de México, CNBV, population, Prospera, and electoral data Variable	(1) Mean	(2) Standard deviation	(3) Discrete time hazard
Log point-of-sale terminals	5.82	1.84	0.006 (0.007)
Δ log point-of-sale terminals	0.68	0.17	−0.012 (0.026)
Log bank accounts	9.97	3.53	0.002 (0.004)
Δ log bank accounts	2.07	4.02	0.001 (0.004)
Log commercial bank branches	2.55	1.44	0.014 (0.018)
Δ log commercial bank branches	0.65	0.97	−0.009 (0.018)
Log government bank branches	0.64	0.59	0.031 (0.019)
Δ log government bank branches	0.18	0.41	0.001 (0.016)
Log commercial bank ATMs	3.12	1.77	−0.018 (0.013)
Log government bank ATMs	0.16	0.37	−0.009 (0.022)
Log population	11.29	1.27	0.016 (0.012)
Δ log population	0.10	0.18	−0.021 (0.031)
Log Prospera beneficiaries	7.09	1.11	−0.003 (0.010)
Δ log Prospera beneficiaries	0.07	0.38	−0.000 (0.015)
% vote share PAN	29.01	15.00	0.000 (0.001)
Δ % vote share PAN	−0.51	17.49	0.001 (0.001)
Mayor = PAN (× 100)	19.31	39.55	−0.000 (0.000)
Δ mayor = PAN (× 100)	−11.97	58.17	0.000 (0.000)

Panel B: INEGI measures used to track development Variable	(1) Mean	(2) Standard deviation	(3) Discrete time hazard
% illiterate (age 15+)	6.13	3.94	0.007 (0.005)
Δ % illiterate	−0.01	0.01	−0.757 (1.118)
% not attending school (6-14)	4.23	1.94	−0.011 (0.006)
Δ % not attending school	−0.03	0.02	−0.435 (0.686)
% without primary education (15+)	40.20	10.18	−0.000 (0.003)
Δ % without primary education	0.17	0.04	0.264 (0.371)
% without health insurance	46.51	15.82	0.000 (0.001)
Δ % without health insurance	−0.05	0.08	−0.003 (0.108)
% with dirt floor	5.31	5.30	−0.000 (0.002)
Δ % with dirt floor	−0.02	0.02	0.494 (0.361)
% without toilet	5.81	3.50	−0.006 (0.004)
Δ % without toilet	−0.02	0.04	−0.024 (0.167)
% without water	6.23	9.00	0.000 (0.001)
Δ % without water	−0.04	0.05	0.088 (0.109)
% without plumbing	3.62	6.20	0.004 (0.002)
Δ % without plumbing	−0.06	0.06	0.111 (0.139)
% without electricity	4.32	2.19	0.006 (0.006)
Δ % without electricity	0.02	0.03	0.109 (0.629)
% without washing machine	33.81	14.47	0.001 (0.001)
Δ % without washing machine	−0.10	0.05	−0.017 (0.252)
% without refrigerator	17.31	10.13	−0.002 (0.001)
Δ % without refrigerator	−0.08	0.06	0.043 (0.268)

▸ Pre-trends

Rollout not correlated with political party

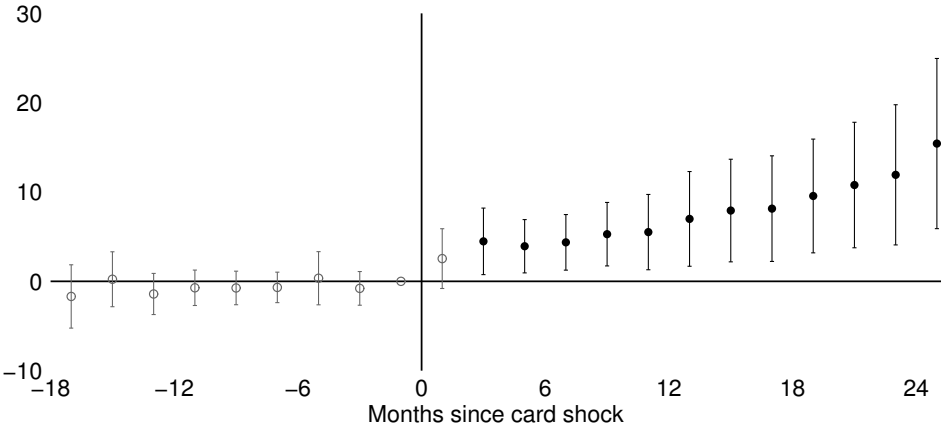
$$\mathbb{I}(Mayor_{jt} = PAN) = \xi_j + \delta_t + \sum_k \phi_k D_{jt}^k + \varepsilon_{jt}$$



Corner stores increase adoption of POS

Data: Universe of point-of-sale terminal "contract changes" (adoptions, cancellations, etc.), 2006–2017

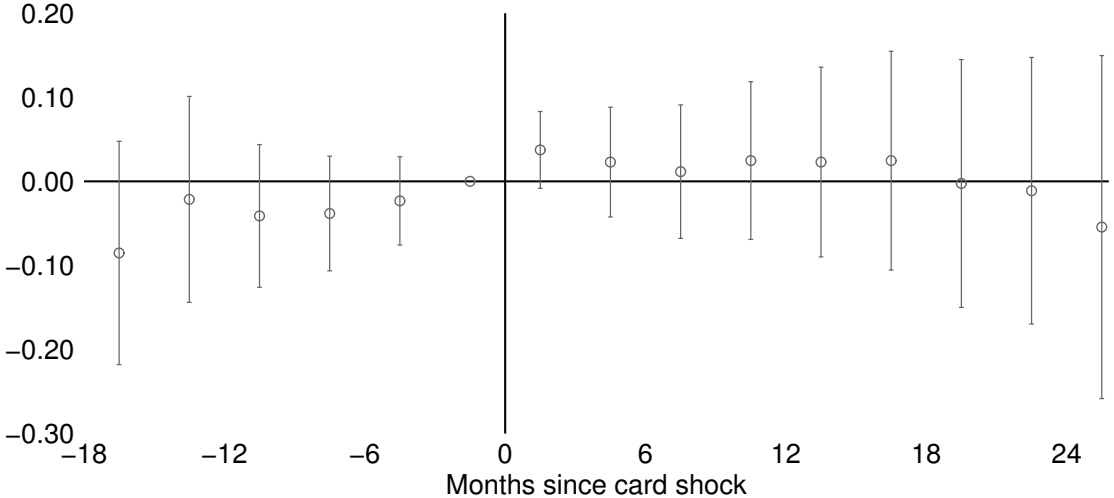
$$\textit{Number of POS}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D^k_{jt} + \varepsilon_{jt}$$



▸ In logs

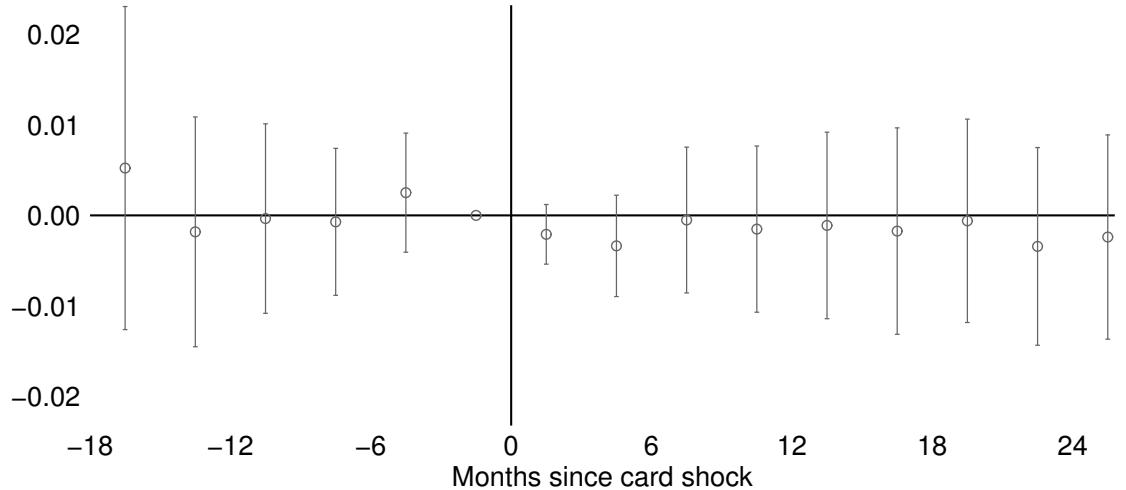
Banks do not appear to respond to shock: ATMs

$$\log \textit{Number of ATMs}_{jt} = \lambda_j + \delta_t + \sum_k \phi_k D_{jt}^k + \varepsilon_{jt}$$



Banks do not appear to respond to shock: fees

$$\log \textit{Transaction fee}_{jt} = \lambda_j + \delta_t + \sum_k \phi_k D_{jt}^k + \varepsilon_{jt}$$



Costs of POS adoption

Low-adoption equilibrium requires network externalities and fixed cost of adoption

POS rented to retailer from bank

- Requires firm to have an account at that bank
- Non-bank e-payment companies (e.g. Square) did not enter until 2013

Low initial cost ($23) but $27/month if transact $<$ $2000/month on POS

- Constraint binds for 95% of corner stores

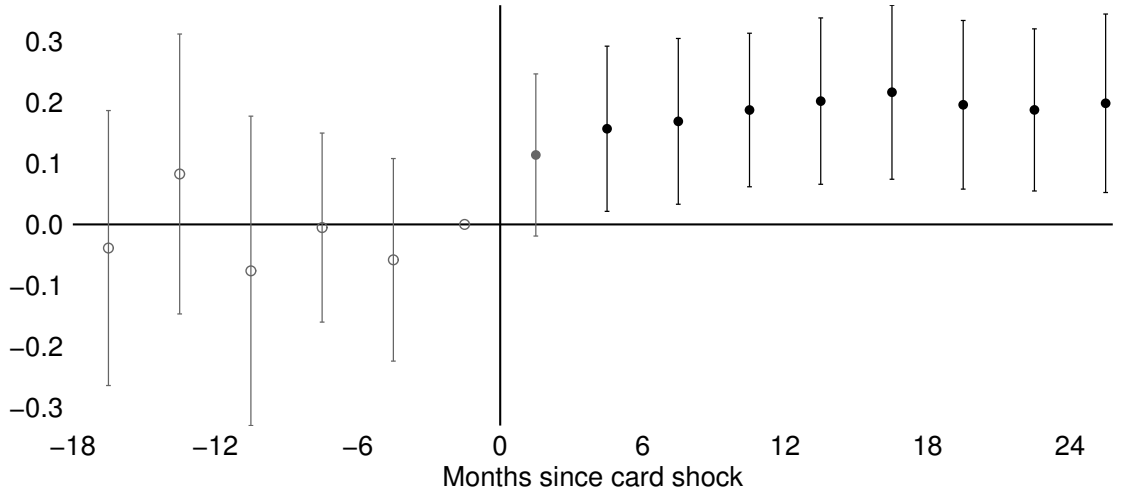
Per-transaction cost: 1.75% for retail

Potential tax cost (frequently mentioned in focus groups)

Non-monetary costs e.g. paperwork (but not required to be formal)

Spillovers to other consumers' card adoption

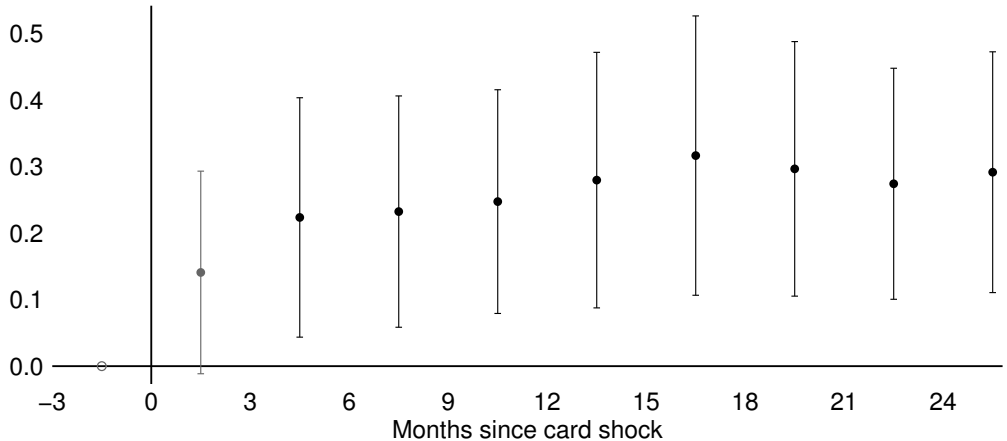
$$\log \textit{Number of Credit and Debit Cards}_{mt} = \xi_m + \delta_t + \sum_k \phi_k D^k_{mt} + \varepsilon_{mt}$$



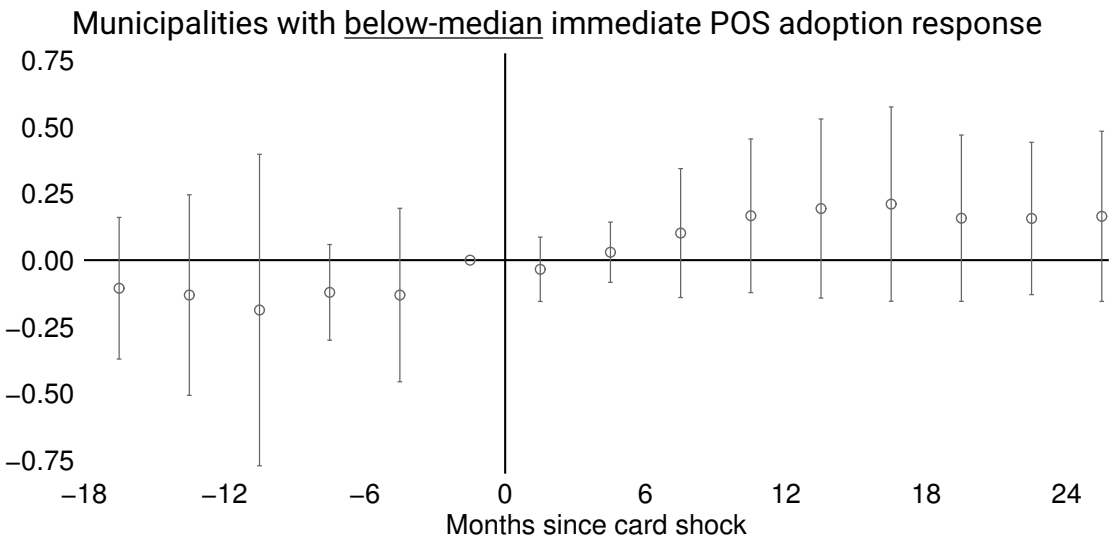
Spillovers to other consumers' card adoption (balanced over time)

All 255 municipalities in rollout:

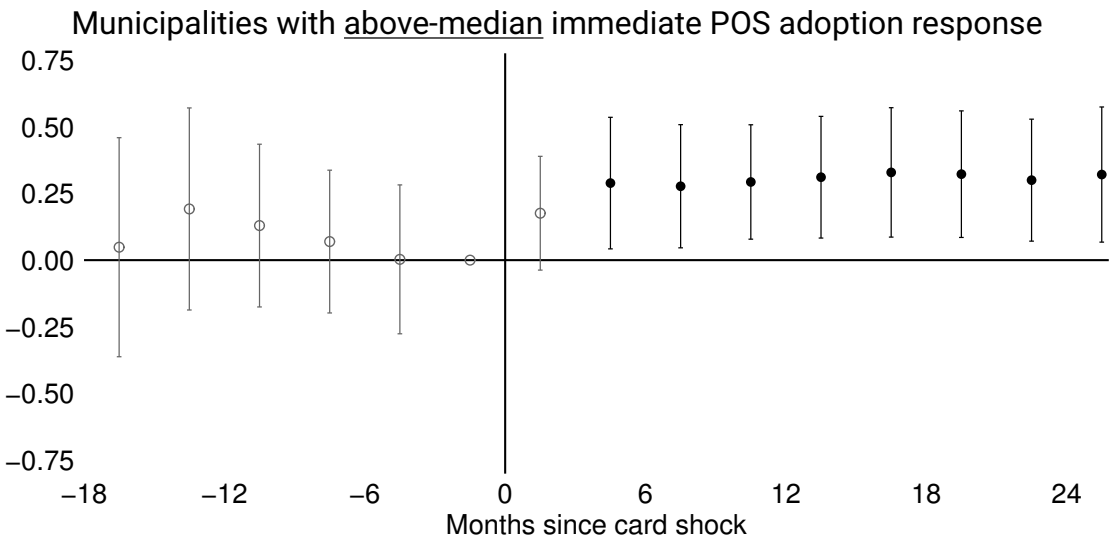
$$\log \textit{Number of Debit Cards}_{mt} = \xi_m + \delta_t + \sum_k \phi_k D^k_{mt} + \varepsilon_{mt}$$



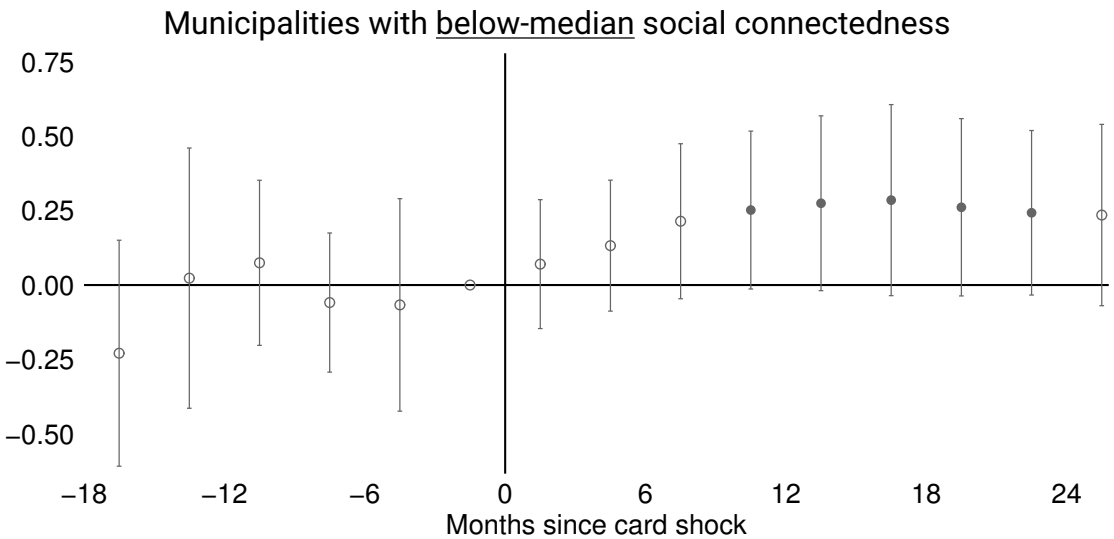
Heterogeneity by immediate POS adoption response



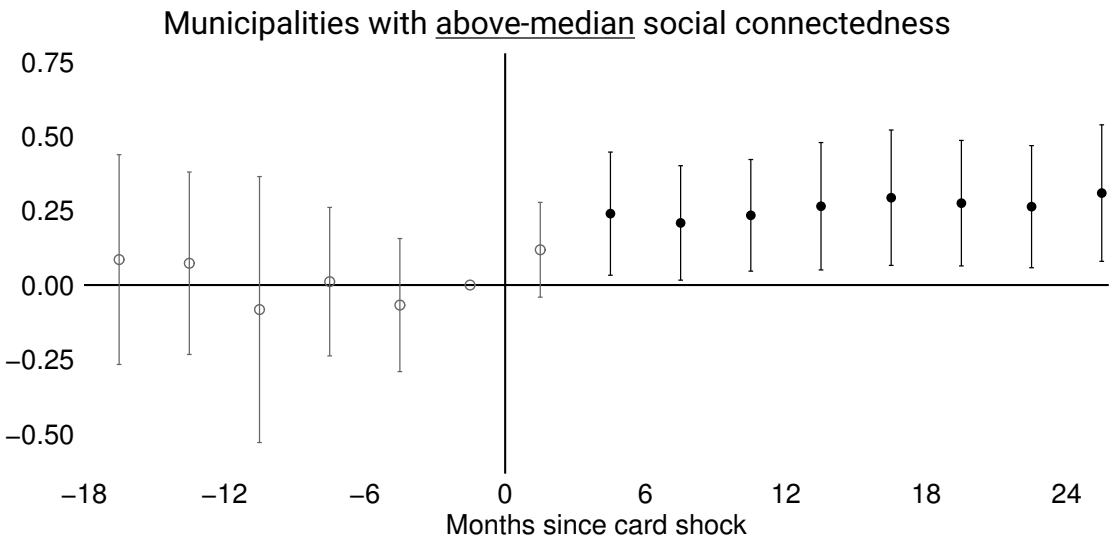
Heterogeneity by immediate POS adoption response



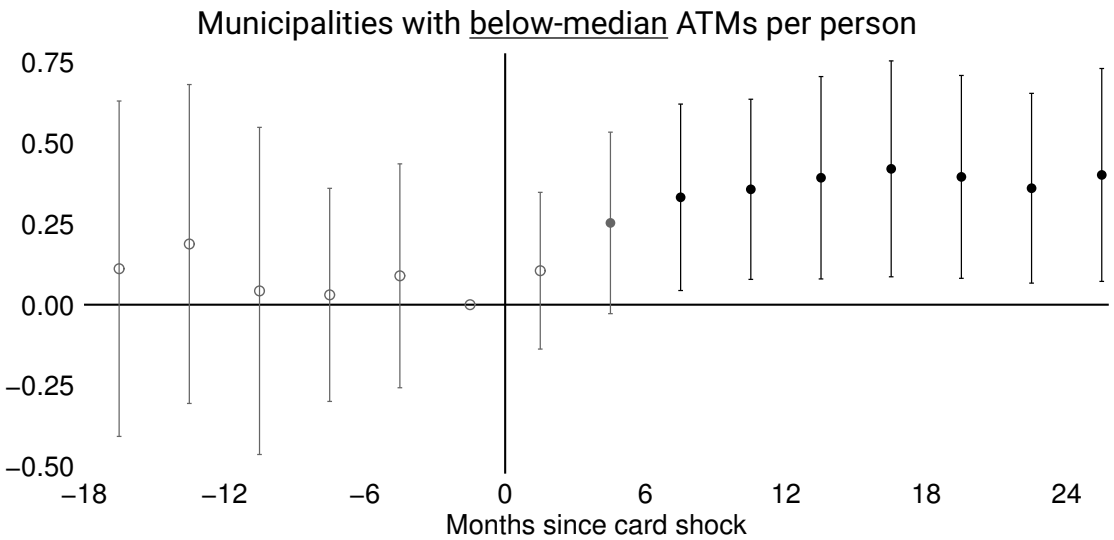
Heterogeneity by social connectedness



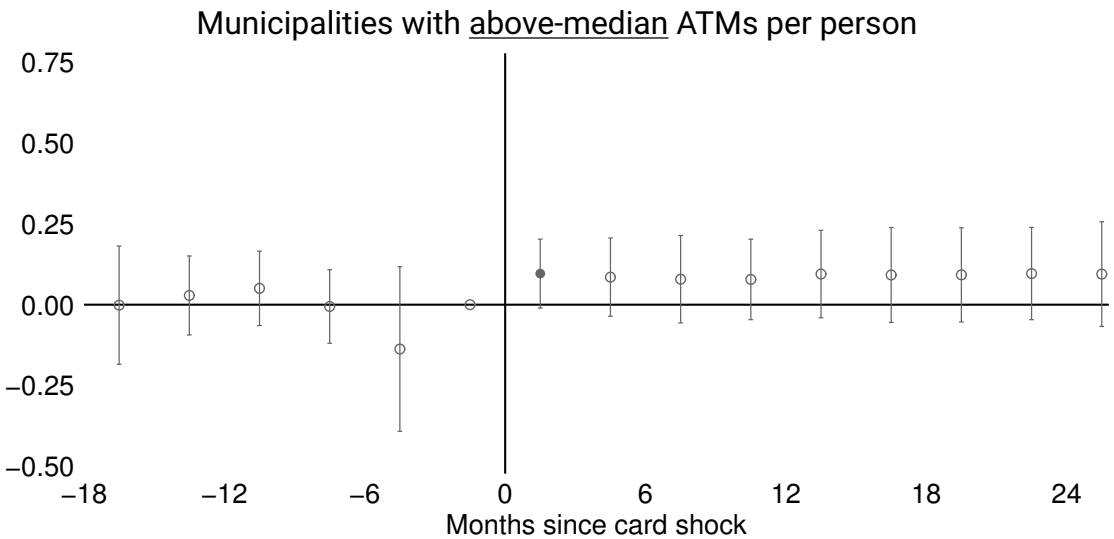
Heterogeneity by social connectedness



Heterogeneity by ATM density

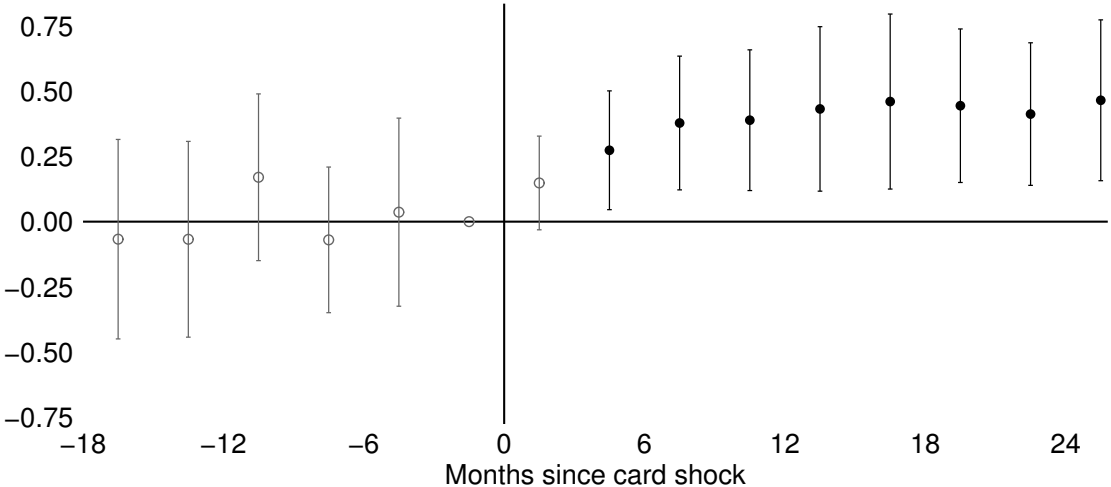


Heterogeneity by ATM density



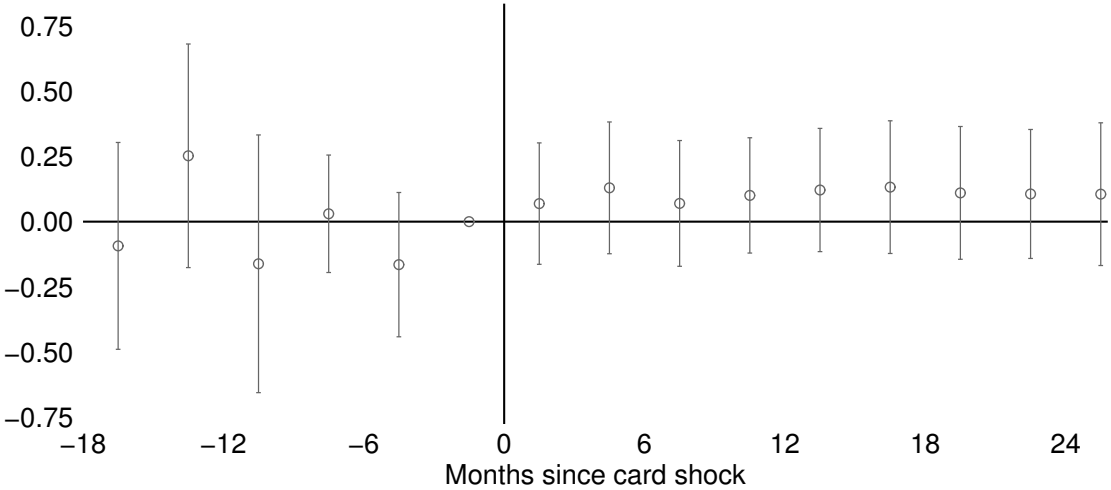
Heterogeneity by where beneficiaries shop

Municipalities with below-median beneficiary transactions at supermarkets



Heterogeneity by where beneficiaries shop

Municipalities with above-median beneficiary transactions at supermarkets



Consumption across stores

$$\log Spending^{s}_{it} = \lambda_{j(i)} + \delta_t + \gamma D_{j(i)t} + \varepsilon_{it}$$

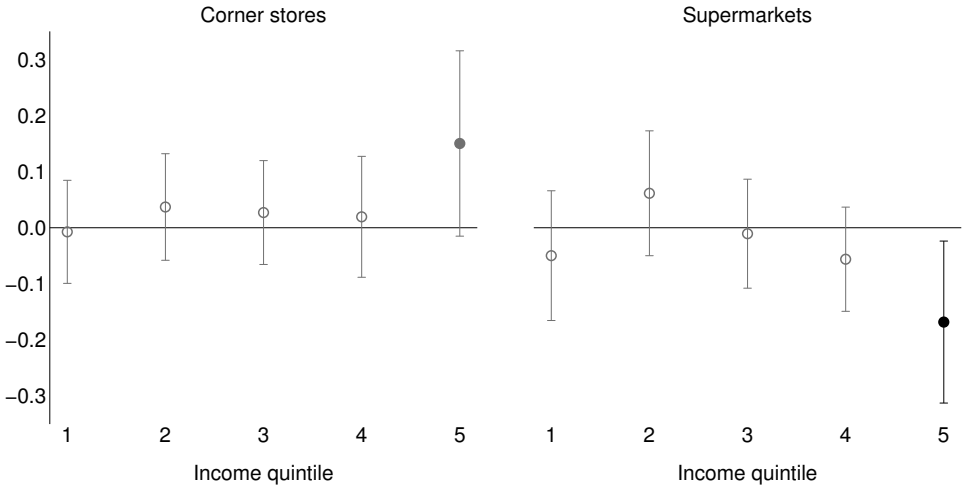
$$\log Spending^{s}_{it} = \xi_{h(i)j(i)} + \eta_{h(i)t} + \gamma D_{j(i)t} + \omega D_{j(i)t} \times h_{it} + \varepsilon_{it}$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent variable: log spending at…								
	Corner stores			Supermarkets			Total		
Diff-in-diff	0.067**	0.051	0.076**	−0.018	0.003	−0.016	0.029	0.029	0.041
	(0.032)	(0.033)	(0.033)	(0.043)	(0.050)	(0.045)	(0.030)	(0.033)	(0.030)
Diff-in-diff × has credit card		0.061			−0.058			−0.012	
		(0.040)			(0.062)			(0.040)	
Diff-in-diff × Prospera beneficiary			−0.127**			−0.030			−0.161**
			(0.060)			(0.133)			(0.063)
P-value DID + (DID × interaction)		[0.009]***	[0.423]		[0.250]	[0.732]		[0.581]	[0.073]*
Number of households	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810
Number of localities	220	220	220	220	220	220	220	220	220
Locality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Locality by card/beneficiary fixed effects		Yes	Yes		Yes	Yes		Yes	Yes
Card/beneficiary by time fixed effects		Yes	Yes		Yes	Yes		Yes	Yes

▸ Consumption ▸ Profits

Consumption across stores: quantity of food (kg and liters)

$$\log Quantity^{s}_{it} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(quintile = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$



▸ Consumption

Prices

Data: High-frequency store by product by week price data, 2002–2014

- Microdata used to construct Mexico's Consumer Price Index
- $\sim$10 million price quotes
- Product codes are barcode-equivalent (e.g., 600ml Coca-Cola bottle)

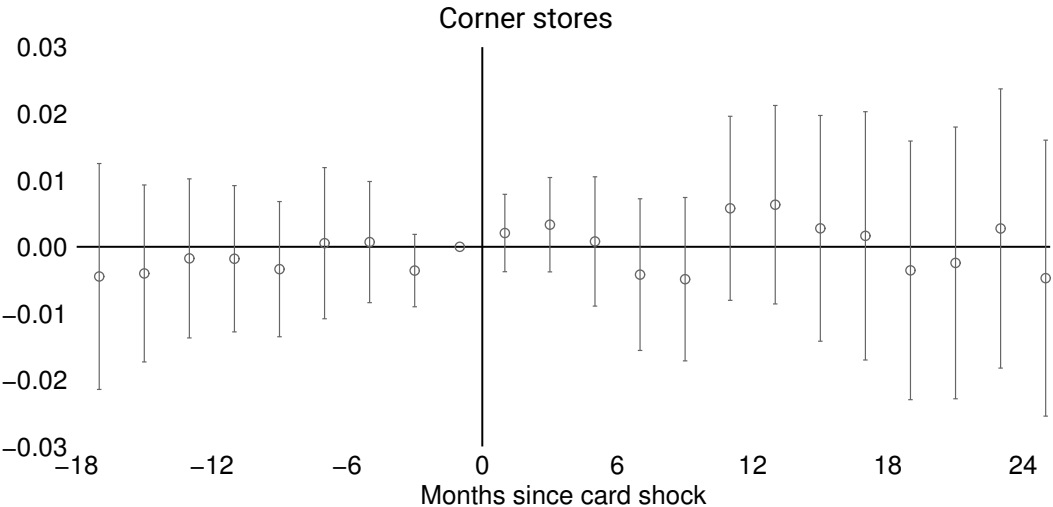
Specification: Event study difference-in-differences

$$\log Price_{gst} = \eta_{gs} + \delta_t + \sum_k \phi_k D^k_{m(s)t} + \varepsilon_{gst}$$

- η_{gs} are barcode-level-good by store fixed effects
- $D^k_{m(s)t} = 1$ if municipality m received the card shock k periods ago
- As before, aggregated to 2-month periods

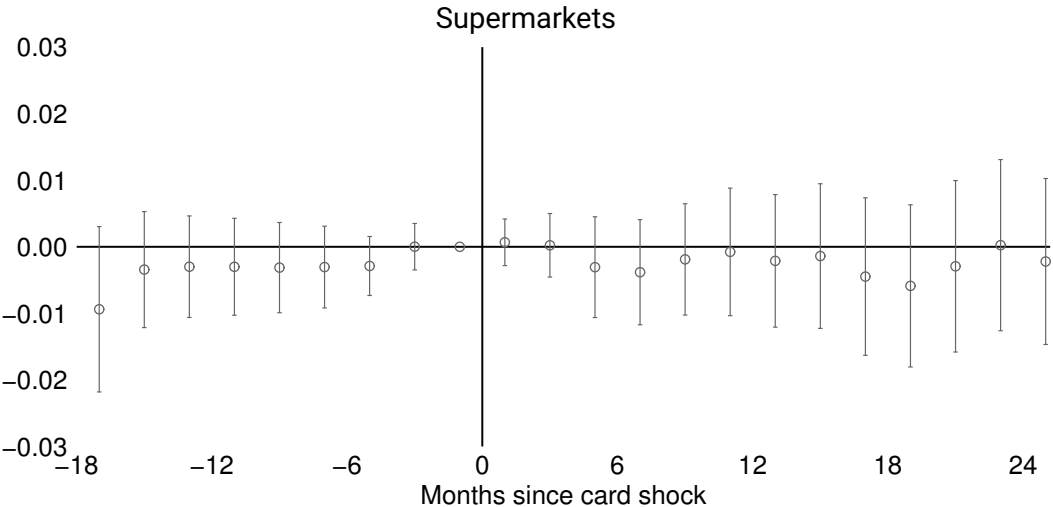
No price effect

$$\log Price_{gst} = \eta_{gs} + \delta_t + \sum_k \phi_k D^k_{m(s)t} + \varepsilon_{gst}$$



No price effect

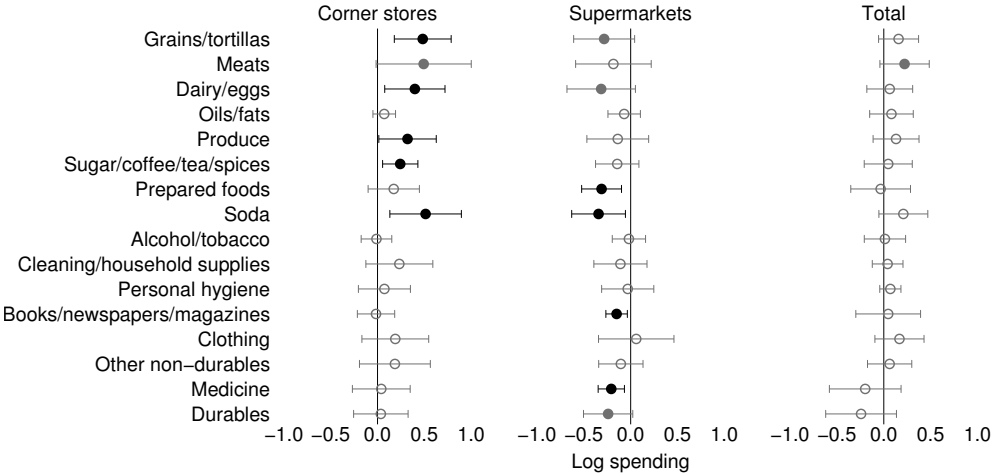
$$\log Price_{gst} = \eta_{gs} + \delta_t + \sum_k \phi_k D^k_{m(s)t} + \varepsilon_{gst}$$



Consumption across stores: by product category

$$\log Spending_{it}^{gs} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(quintile = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$

Results for richest quintile



Consumption across corner stores: by category (food)

$$\log Spending^{s}_{it} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(quintile = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$

	(1) Grains/ tortillas	(2) Meats	(3) Dairy/ eggs	(4) Oils/ fats	(5) Produce	(6) Sugar/ coffee/tea/ spices	(7) Prepared foods	(8) Soda	(9) Alcohol/ tobacco
Panel A: Corner stores									
Quintile 1	−0.051	0.145	0.292	−0.015	0.307	0.329	−0.031	−0.060	0.089
	(0.096)	(0.175)	(0.154)	(0.101)	(0.137)	(0.145)	(0.149)	(0.141)	(0.057)
Quintile 2	0.033	0.080	0.068	0.159	0.052	0.055	−0.243	0.180	0.070
	(0.099)	(0.167)	(0.130)	(0.078)	(0.120)	(0.115)	(0.145)	(0.136)	(0.071)
Quintile 3	−0.025	0.003	0.140	0.097	0.221	0.135	−0.056	0.191	0.128
	(0.109)	(0.160)	(0.132)	(0.073)	(0.133)	(0.124)	(0.129)	(0.129)	(0.079)
Quintile 4	0.144	0.167	0.162	0.013	0.130	0.019	−0.060	0.234	−0.053
	(0.103)	(0.145)	(0.124)	(0.074)	(0.145)	(0.102)	(0.150)	(0.131)	(0.079)
Quintile 5	0.483	0.493	0.399	0.072	0.321	0.243	0.173	0.514	−0.011
	(0.154)	(0.258)	(0.163)	(0.061)	(0.156)	(0.096)	(0.139)	(0.194)	(0.083)
Baseline mean	5.772	4.289	4.765	0.740	3.660	1.683	2.501	4.332	0.580
Number of observations	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810
Number of localities	220	220	220	220	220	220	220	220	220
Locality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quintile × time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

▸ Consumption

Consumption across supermarkets: by category (food)

$$\log Spending^{s}_{it} = \lambda_{j(i)} + \theta_{q(i)t} + \gamma D_{j(i)t} + \sum_{q=2}^{5} \psi_q \mathbb{I}(quintile = q)_{it} \times D_{j(i)t} + \varepsilon_{it}$$

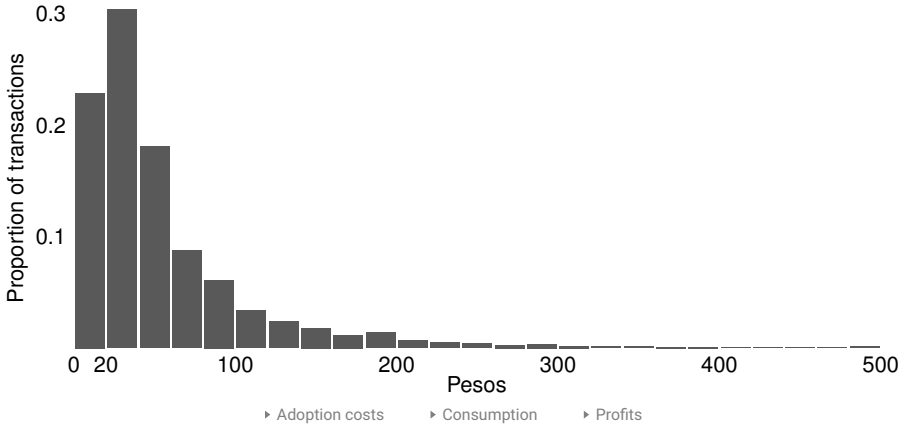
	(1) Grains/ tortillas	(2) Meats	(3) Dairy/ eggs	(4) Oils/ fats	(5) Produce	(6) Sugar/ coffee/tea/ spices	(7) Prepared foods	(8) Soda	(9) Alcohol/ tobacco
Panel B: Supermarkets									
Quintile 1	−0.024	−0.013	−0.092	0.018	−0.069	0.011	0.004	−0.096	0.039
	(0.142)	(0.122)	(0.121)	(0.079)	(0.138)	(0.099)	(0.069)	(0.089)	(0.036)
Quintile 2	0.210	0.151	0.161	0.121	0.086	0.250	−0.024	0.009	−0.007
	(0.151)	(0.128)	(0.132)	(0.068)	(0.143)	(0.120)	(0.073)	(0.093)	(0.038)
Quintile 3	−0.034	0.121	−0.070	0.076	−0.004	0.207	−0.022	−0.004	0.095
	(0.125)	(0.123)	(0.121)	(0.073)	(0.111)	(0.113)	(0.071)	(0.087)	(0.054)
Quintile 4	−0.030	0.057	−0.167	−0.087	−0.049	−0.048	0.013	−0.125	−0.092
	(0.113)	(0.141)	(0.108)	(0.071)	(0.124)	(0.092)	(0.088)	(0.095)	(0.054)
Quintile 5	−0.283	−0.184	−0.315	−0.069	−0.138	−0.144	−0.311	−0.343	−0.019
	(0.165)	(0.205)	(0.185)	(0.088)	(0.167)	(0.117)	(0.108)	(0.145)	(0.090)
Baseline mean	2.065	2.122	2.042	0.542	1.895	0.956	0.634	1.311	0.242
Number of observations	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810	49,810
Number of localities	220	220	220	220	220	220	220	220	220
Locality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quintile × time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

▸ Consumption

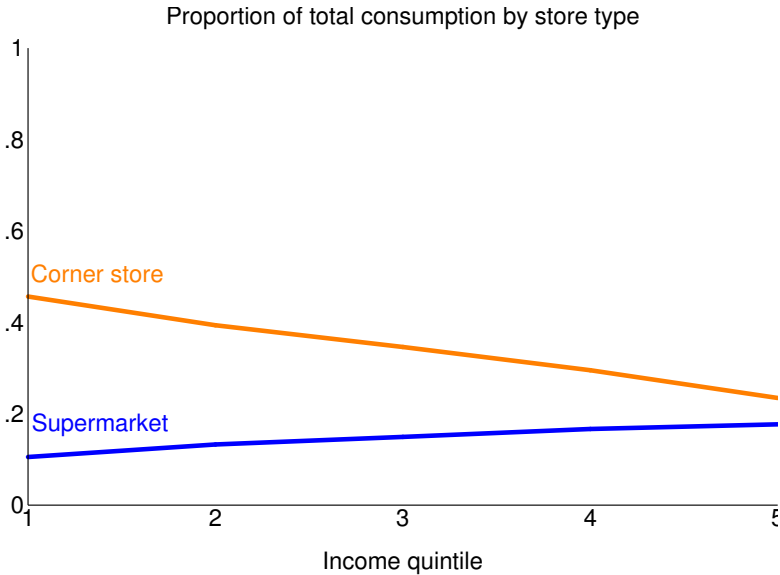
Transaction sizes

Data: Universe of transactions at corner stores (by all cardholders)

Result: $>$20% less than US$2, $>$50% less than US$4

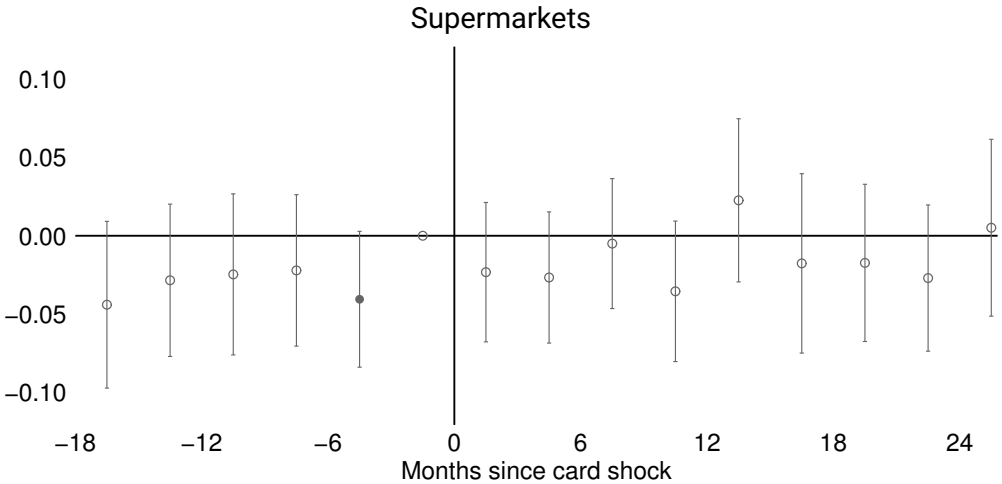


Consumption shares by store type (control)



No wage effect

$$\log Wage_{it} = \lambda_{m(i)} + \delta_t + \sum_k \phi_k D^k_{m(i)t} + \varepsilon_{it}$$



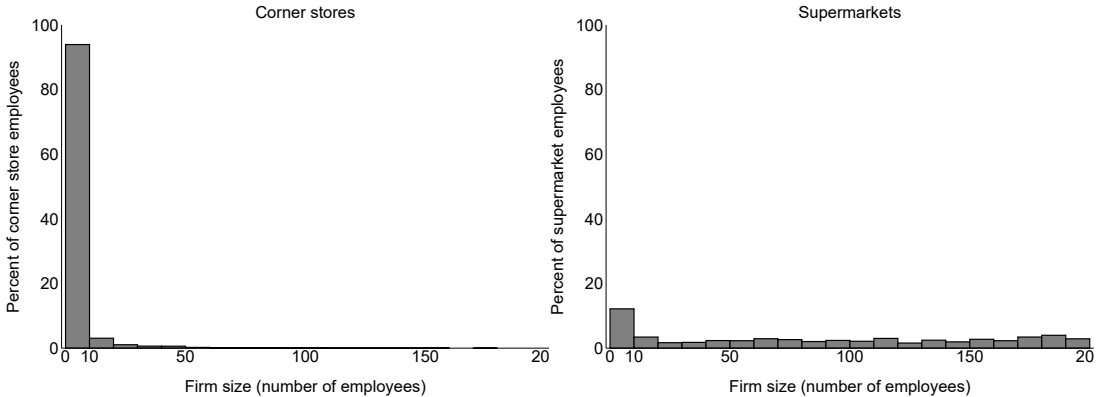
▸ Profits

No wage effect

$$\log Wage_{it} = \lambda_{m(i)} + \delta_t + \sum_k \phi_k D^k_{m(i)t} + \varepsilon_{it}$$

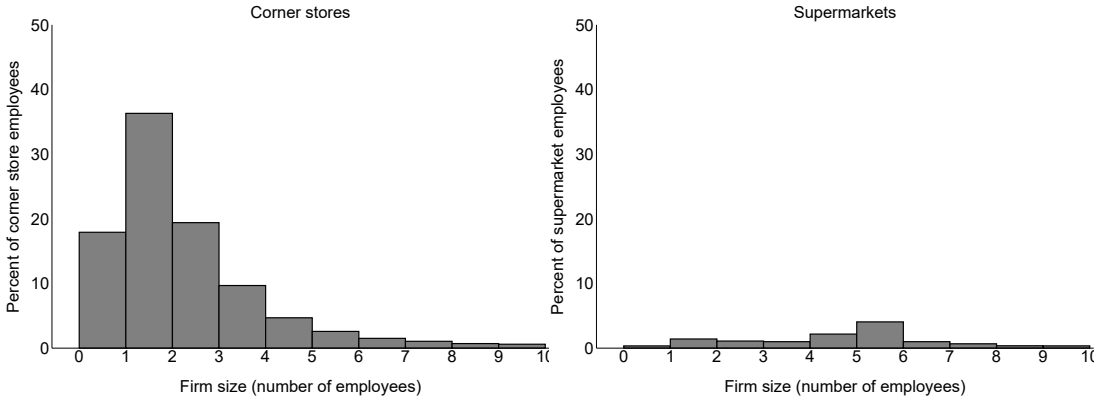
▸ Profits

Distribution of retail employment share by firm size



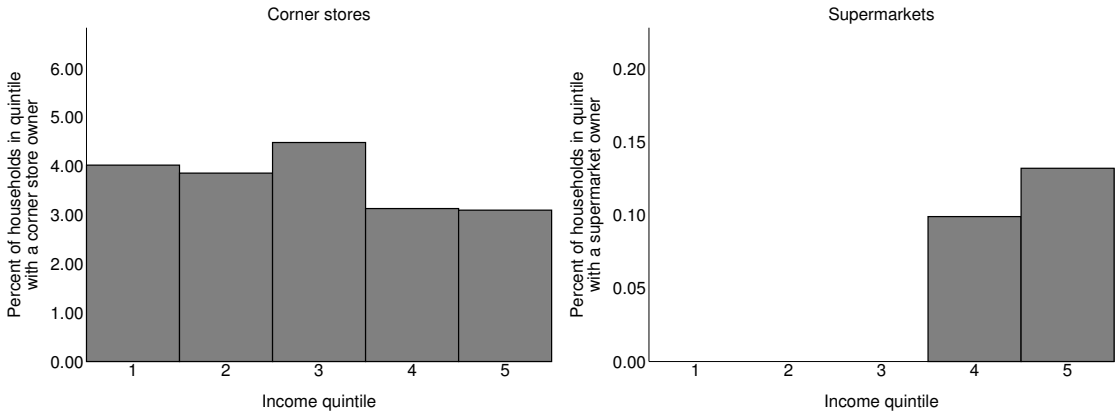
▸ Profits

Employment share distribution of retailers with < 10 employees



▸ Profits

Retail firm owners by income quintile



▸ Profits

Corner store churn

$$y_{jt} = \lambda_j + \delta_t + \beta D_{jt} + \varepsilon_{jt}$$

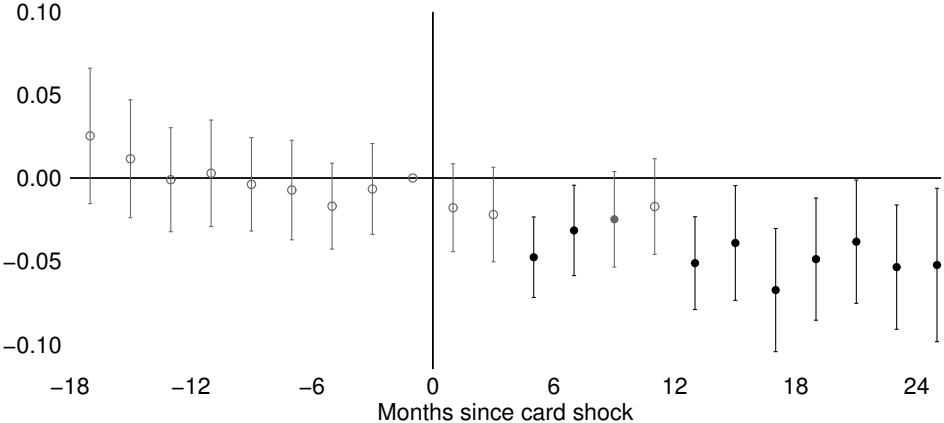
	(1)	(2)	(3)	(4)
	Only 2008 stores		All stores	
	Number of Corner Stores	Log Number of Corner Stores	Number of Corner Stores	Log Number of Corner Stores
	−3.056***	−0.048	0.076	0.006
	(1.171)	(0.040)	(0.642)	(0.056)
Number of localities	250	250	250	250
Locality fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes

▸ Profits

Reduction in Google searches for supermarkets

Data: Google searches for supermarket names + locality name, 2006–2017

$$\log \textit{Searches for supermarkets}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D_{jt}^k + \varepsilon_{jt}$$

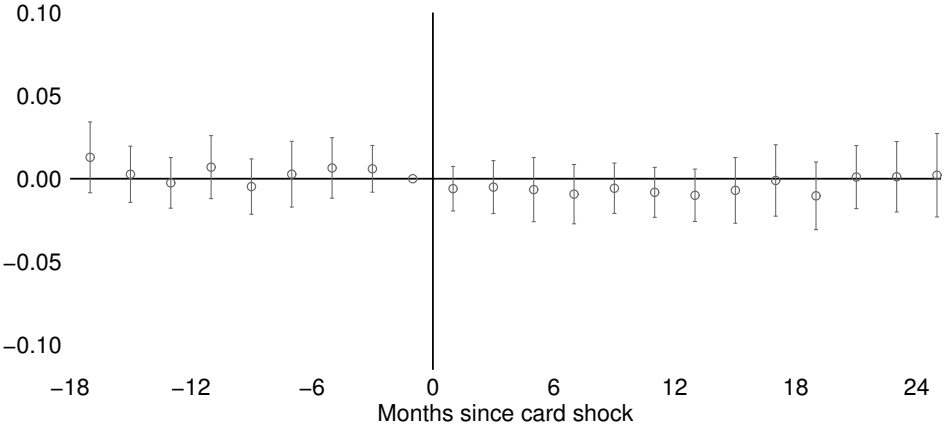


▸ Consumption ▸ Number of trips

Google searches for weather (placebo)

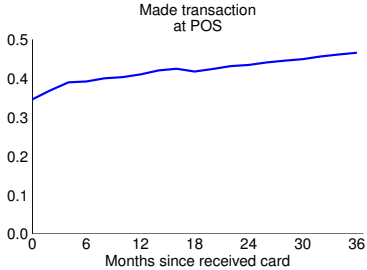
Data: Google searches for weather + locality name, 2006–2017

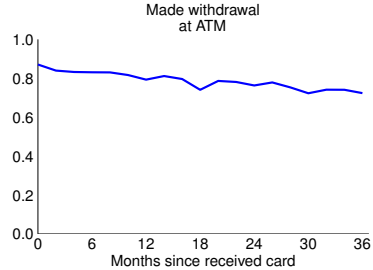
$$\log \textit{Searches for weather}_{jt} = \xi_j + \delta_t + \sum_k \phi_k D_{jt}^k + \varepsilon_{jt}$$

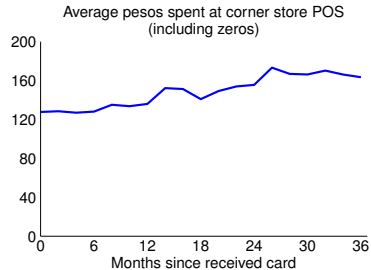


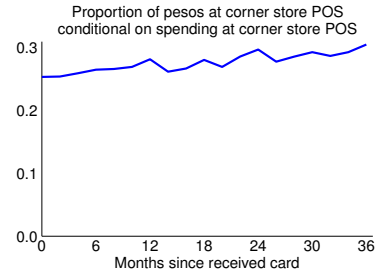
▸ Consumption ▸ Number of trips

New cardholders make purchases at POS

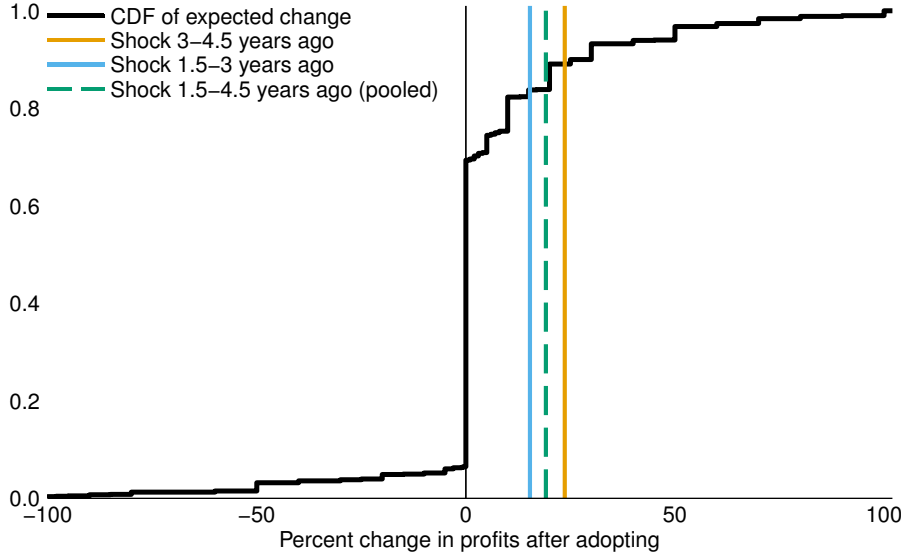








Corner store estimates of change in profits after adopting



▸ Profits

Consumer gains from supply-side POS adoption

For each shopping trip, consumer makes discrete–continuous choice

Discrete choice over which store

Continuous choice over goods at store

- Cobb-Douglas preferences over goods
- Preferences for store characteristics enter utility

$$u_{ist} = \left(\prod_g x_{igst}^{\phi_{a(i)gst}} \right)^{\alpha_{k(i)}} \cdot \exp\left(\theta_{k(i)} POS_{ist} + \xi_{a(i)k(i)st} + \varepsilon_{ist} \right)$$

for consumer i of type k in census tract a at store type s at time t; g indexes goods

▸ Conclusion ▸ Goal of exercise ▸ Additional steps

Consumer gains from supply-side POS adoption

$$\log \phi_{akst} - \log \phi_{ak0t} = -\alpha_k(\log P_{ast} - \log P_{a0t}) + \theta_k \overline{POS}_{z(a)st} + \eta_{j(a)ks} + \delta_{kst} + \nu_{akst}$$

Estimate with three consumer groups k

- Prospera beneficiaries
- Existing credit card holders
- Others (includes existing debit card holders and new adopters)

Endogeneity of demand

- Hausman instrument for prices
- Debit card shock as instrument for POS adoption

$-\theta_k/\alpha_k$ is price-equivalent value of no stores with POS $\rightarrow$ all stores with POS

$-(\theta_k/\alpha_k)\Delta POS_{ks}$ is value to consumers of supply-side response to shock

▸ Conclusion ▸ θ_k/α_k interpretation ▸ Consumer surplus derivation

Consumer gains from supply-side POS adoption

Dependent variable: difference in log expenditure shares			
	Log prices ($-\alpha_k$)	Stores with POS (θ_k)	Share spent at corner
Prospera beneficiaries	−3.35*	0.24	0.46
	(1.93)	(0.30)	
Credit card holders	−2.01	0.58**	0.28
	(1.29)	(0.23)	
Others	−2.93**	0.55***	0.37
	(1.26)	(0.21)	
First-stage joint F-test		46.56	
Number of observations		21,775	
Locality × consumer type × store type FE		Yes	
Store type × consumer type × time FE		Yes	

Consumer gains from supply-side POS adoption

Beneficiaries: 1.8% ↑ consumer surplus on average

Existing cardholders: 0.5% ↑ consumer surplus

New card adopters: depends on cost of adoption

- Bounds: 0–0.4% ↑ consumer surplus

55–58% of **total** ΔCS is spillovers to non-beneficiaries

- Intuition:
  - Twice as many existing cardholders as beneficiaries
  - Existing cardholders richer, and absolute spending enters CS formula

Cost–benefit analysis: consumer gains from spillovers 37 times as large as rollout cost

Quantifying the indirect network externalities

Goal: quantify what proportion of total consumer gains are spillovers to other consumers

- To do so, estimate consumer gains for three types of consumers
  1. Prospera beneficiaries who receive cards
  2. Existing cardholders
  3. New adopters

Estimate a demand model that combines features of

- Atkin, Faber, Gonzalez-Navarro (2018)
- Björnerstedt & Verboven (2016)
- Einav et al. (2017)

▸ Conclusion ▸ Set-up

Consumer gains from supply-side POS adoption

Plug in Marshallian demand $x_{igst} = \phi_{a(i)gst}(y_{it}/p_{a(i)gst})$

Integrate over ε_{ist} assuming extreme value 1 and integrate over POS_{ist}

Subtract off outside option $s = 0$ (open air markets)

Leads to equation for difference in log expenditure shares (at census tract $\times$ consumer type $\times$ store type $\times$ time):

$$\log \phi_{akst} - \log \phi_{ak0t} = -\alpha_k(\log P_{ast} - \log P_{a0t}) + \theta_k \overline{POS}_{z(a)st} + \eta_{j(a)ks} + \delta_{kst} + \nu_{akst}$$

where $\log P_{ast} = \sum_g \phi_{agst} \log p_{agst}$ (Stone price index)

▸ Conclusion ▸ Set-up

Consumer gains from supply-side POS adoption

$-\theta_k/\alpha_k$ is price-equivalent value of no stores $\rightarrow$ all stores with POS:

$$-\frac{\theta_k}{\alpha_k} = \frac{d \log \phi_{akst} / d\overline{POS}_{z(a)st}}{d \log \phi_{akst} / d \log P_{ast}} = \frac{d \log P_{ast}}{d\overline{POS}_{z(a)st}}$$

$-(\theta_k/\alpha_k)\Delta POS_{ks}$ is value to consumers of supply-side response to shock

- ΔPOS_{ks} is observed change in adoption in response to shock

Next: plug in $-\frac{\theta_k}{\alpha_k}\Delta POS_{ks}$ for $d \log P_s$ in standard consumer surplus formula

▸ Conclusion ▸ Estimating equation

Consumer gains from supply-side POS adoption

First-order approximation of compensating variation:

$$CV = e(P^0, U^0) - e(P^1, U^0)$$

First-order Taylor expansion of $e(P^0, U^0)$ around P^1:

$$\approx \left[e(P^1, U^0) + \sum_s \frac{\partial e(P^1, U^0)}{\partial P_s} (P_s^0 - P_s^1) \right] - e(P^1, U^0)$$

Shephard's lemma and duality:

$$\approx -\sum_s x_s^1 (P_s^1 - P_s^0) \approx -\sum_s P_s^1 x_s^1 \left(\frac{P_s^1 - P_s^0}{P_s^1} \right) \approx \sum_s P_s^1 x_s^1 \left(\frac{\theta}{\alpha} \Delta POS_s \right)$$

Proportional Δconsumer surplus $\approx \sum_s \phi_s^1 \, (\theta/\alpha) \, \Delta POS_s$

▸ Conclusion ▸ Estimating equation