The Economics of Two-Sided Payment Card Markets: Pricing, Adoption and Usage

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June 21, 2008
The Development of Payment Card Market

- Credit and debit cards become prominent form of payments
  - 38% US consumer expenditure
  - 75% households own credit cards; 6.3 cards per household
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Legal battles and regulations against the credit card networks
  - US: 50 pending cases; Credit Card Fair Fee Act 2008
  - Worldwide: EU, UK, Australia, Netherlands and etc.
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- Legal battles and regulations against the credit card networks
  - US: 50 pending cases; Credit Card Fair Fee Act 2008
  - Worldwide: EU, UK, Australia, Netherlands and etc.
- The controversy of interchange fees
  - Fees charged to merchants for card payments
  - Totals $42 billion or $370 per US household (2007)
Card Payment System: An Illustration

Card Network

- Cardholder pays $p(1+f_c)$
- Merchant pays $p(1-f_m)$

Merchant

sells good at price $p$
The Literature

- Two-sided market theories
  - Fundamental externalities in card payment systems
  - Asymmetric pricing on the two-sides
  - Interchange fee: is it too high?
The Literature

- Two-sided market theories
  - Fundamental externalities in card payment systems
  - Asymmetric pricing on the two-sides
  - Interchange fee: is it too high?

- Some limitations
  - Unspecified convenience benefits from card usage
  - Fixed consumer demand invariant to payment choices
  - Imperfect competition among merchants
A New Two-sided Market Analysis

- Monetary benefits from the payment card usage
A New Two-sided Market Analysis

• Monetary benefits from the payment card usage
• Consumer demand for goods depends on payment choices
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- Cross subsidy between card users and cash users
Supporting Evidence and New Findings

- The card adoption patterns of consumers and merchants
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- The card adoption patterns of consumers and merchants
- Three types of merchants who accept cash, card or both
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- Rising interchange fees at falling card costs
Supporting Evidence and New Findings

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- Three types of merchants who accept cash, card or both
- Rising interchange fees at falling card costs
- The “two-sided market” effect and the “inflation” effect
Share of Transaction %

- Movie (Entertainment)
- Tickets (Entertainment)
- Fast food (Restaurant)
- Mid-price (Restaurant)
- High-price (Restaurant)
- Grocery (Stores)
- Dept. (Stores)

1996 vs 2001
Basic Elements of the Model

- Consumers
  - Cobb-Douglass preference, heterogenous income
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- Merchants
  - contestable market, heterogenous size
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- Card service provider
  - the monopoly network who maximizes profit
  - the social planner who maximizes consumer surplus
  - the policy maker who sets an interchange fee ceiling
Pre-card Market Equilibrium

- A competitive merchant selling good $\alpha$ sets the cash price $p_{\alpha,c}$:

\[(1 - \tau_m)p_{\alpha,c} = c_{\alpha} \implies p_{\alpha,c} = \frac{c_{\alpha}}{1 - \tau_m}\]
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- A consumer with income $I$ purchases $x_\alpha$ units of good $\alpha$:
  \[
  U = \text{Max} \int_\alpha x_\alpha \ln x_\alpha dG(\alpha) \quad \text{s.t.} \quad \int_\alpha (1 + \tau_c)p_{\alpha,c}x_\alpha,IdG(\alpha) = I
  \]
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- A consumer $I$'s demand and spending on good $\alpha$:
  \[x_{\alpha,I} = \frac{\alpha I}{(1 + \tau_c)p_{\alpha,c}E(\alpha)}, \quad p_{\alpha,c}x_{\alpha,I} = \frac{\alpha I}{(1 + \tau_c)E(\alpha)}\]
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- Total market demand and spending on good $\alpha$:

  $$x_\alpha = \frac{\alpha E(I)}{(1 + \tau_c)p_{\alpha,c}E(\alpha)}, \quad p_{\alpha,c}x_\alpha = \frac{\alpha E(I)}{(1 + \tau_c)E(\alpha)}$$
Introducing the Payment Card

- The payment card service is provided by a monopoly network
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Introducing the Payment Card

- The payment card service is provided by a monopoly network.
- Merchants and consumers are each charged a fee $f_m$ and $f_c$.
- Card service costs for merchants and consumers are $d_m$ and $d_c$.
- Merchants and consumers pay an adoption cost $k_m$ and $k_c$. 
Card Adoption and Usage

- Merchants’ choice
Card Adoption and Usage

- Merchants’ choice
  - Large merchants \((\alpha \geq \alpha_1)\) accept cards and charge price \(p_{\alpha,d} \leq p_{\alpha,c}\)
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  - Large merchants \( (\alpha \geq \alpha_1) \) accept cards and charge price \( p_{\alpha,d} \leq p_{\alpha,c} \)
  - Contestable market:
    \[
    p_{\alpha,d} x_{\alpha,d}^{\text{card}} = \frac{\alpha [E_{I>0} (I - k_c)]}{E(\alpha)(1 + f_c)}, \quad p_{\alpha,d} x_{\alpha,d}^{\text{cash}} = \frac{\alpha [E_{I<0} (I)]}{E(\alpha)(1 + \tau_c)},
    \]
    \[
    (1 - f_m)p_{\alpha,d} x_{\alpha,d}^{\text{card}} + (1 - \tau_m)p_{\alpha,d} x_{\alpha,d}^{\text{cash}} = c_{\alpha} x_{\alpha,d}^{\text{card}} + c_{\alpha} x_{\alpha,d}^{\text{cash}} + k_m.
    \]
Card Adoption and Usage

- **Merchants’ choice**
  
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    $$(1-f_m)p_{\alpha,d}x_{\alpha,d}^{\text{card}} + (1-\tau_m)p_{\alpha,d}x_{\alpha,d}^{\text{cash}} = c_\alpha x_{\alpha,d}^{\text{card}} + c_\alpha x_{\alpha,d}^{\text{cash}} + k_m.$$ 
    
  - These pin down the price $p_{\alpha,d}$:
    
    $$p_{\alpha,d} = \frac{c_\alpha \frac{\alpha[E_{I>0}(I-k_c)]}{(1+f_c)} + c_\alpha \frac{\alpha[E_{I<0}(I)]}{(1+\tau_c)}}{(1-f_m)\frac{\alpha[E_{I>0}(I-k_c)]}{1+f_c} + (1-\tau_m)\frac{\alpha[E_{I<0}(I)]}{1+\tau_c} - k_mE(\alpha)}.$$
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    \]
  - \(p_{\alpha,d} \leq p_{\alpha,c} = \frac{c_{\alpha}}{1 - \tau_m}\) implies
    \[
    \alpha_1 = \frac{E(\alpha)k_m}{[E_i > I_0 (I - k_c)](\frac{1 - f_m}{1 + f_c} - \frac{1 - \tau_m}{1 + f_c})}.
    \]
Card Adoption and Usage

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\]
Card Adoption and Usage

- Merchants’ choice

- Large merchants ($\alpha \geq \alpha_1$) accept cards and charge price $p_{\alpha,d} \leq p_{\alpha,c}$

$$\alpha_1 = \frac{E(\alpha)k_m}{[E_{I>I_0}(I-k_c)](\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c})}$$

- Intermediate merchants ($\alpha_0 \leq \alpha < \alpha_1$) specialize. They either accept cards and charge $p_{\alpha,d}$, where $\frac{1+\tau_c}{1+f_c}p_{\alpha,c} \geq p_{\alpha,d} > p_{\alpha,c}$, or they do not accept cards and charge $p_{\alpha,c}$

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  - Small merchants ($\alpha < \alpha_0$) do not accept cards and charge $p_{\alpha,c}$
Card Adoption and Usage

- Consumers’ choice
Card Adoption and Usage

● Consumers’ choice

A consumer with income $I$ compares utility between adopting card ($V_d$) or not ($V_c$)

$$V_d = \int_\alpha^{\alpha_0} \alpha \ln \left( \frac{\alpha(I - k_c)}{(1 + \tau_c)p_{\alpha,c}E(\alpha)} \right) dG(\alpha) + \int_{\alpha_0}^{\bar{\alpha}} \alpha \ln \left( \frac{\alpha(I - k_c)}{(1 + f_c)p_{\alpha,d}E(\alpha)} \right) dG(\alpha),$$

$$V_c = \int_\alpha^{\alpha_1} \alpha \ln \left( \frac{\alpha I}{(1 + \tau_c)p_{\alpha,c}E(\alpha)} \right) dG(\alpha) + \int_{\alpha_1}^{\bar{\alpha}} \alpha \ln \left( \frac{\alpha I}{(1 + \tau_c)p_{\alpha,d}E(\alpha)} \right) dG(\alpha)$$
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The threshold income level $I_0$ for card adoption

$$I \geq I_0 = \frac{(1 + \tau_c)E_{\alpha > \alpha_0}(\alpha)/E(\alpha)k_c}{(1 + f_c)E_{\alpha > \alpha_0}(\alpha)/E(\alpha) - \exp(\int_{\alpha_0}^{\alpha_1} \alpha \ln(p_{\alpha,d}/p_{\alpha,c}) dG(\alpha)/E(\alpha))}$$
Monopoly Network vs. Social Planner

- The monopoly network maximizes network profit subject to merchants and consumers’ card adoption

\[
\max_{f_c, f_m} \frac{E_{\alpha > \alpha_0}(\alpha) E_{I > I_0}(I - k_c)}{E(\alpha)(1 + f_c)} (f_c + f_m - d_m - d_c)
\]
Monopoly Network vs. Social Planner

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\[
\max_{f_c, f_m} E_{\alpha > \alpha_0} (\alpha) E_{I > I_0} (I - k_c) \\ E(\alpha) (1 + f_c) (f_c + f_m - d_m - d_c)
\]

- The social planner maximizes consumer surplus subject to merchants and consumers’ card adoption

\[
\max_{f_c, f_m} \int \bar{I} (U_{I,d} - U_{I,c}) dF(I)
\]
Short-run (Transitional) Dynamics

- Two-sided market interactions

\[ \alpha_0 = \frac{E(\alpha) k_m}{[E_{I>I_0}(I - k_c)](\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c})} \]

\[ I_0 = \frac{(1+\tau_c) E_{\alpha > \alpha_0}(\alpha)/E(\alpha) k_c}{(1+\tau_c) E(\alpha) - \exp \left( \int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left( \frac{(1-\tau_m)\alpha}{(1-f_m)\alpha-(1+f_c)\alpha_0 (\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c})} \right) \, dG(\alpha) \right)} \]
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\[ I_0 = \frac{\left(\frac{1+\tau_c}{1+f_c}\right)E_{\alpha > \alpha_0}(\alpha)/E(\alpha)k_c}{\left(\frac{1+\tau_c}{1+f_c}\right)\frac{E_{\alpha > \alpha_0}(\alpha)}{E(\alpha)} - \exp\left(\int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln\left(\frac{(1-\tau_m)\alpha}{(1-f_m)\alpha - (1+f_c)\alpha_0 \left(\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c}\right)}\right) dG(\alpha)\right)} \]

- Assume \( \alpha \in [0, 1] \) is uniformly distributed, and \( I \in [0, \infty) \) is exponentially distributed.
Long-run Dynamics

- Long-run dynamics are characterized by the time path of the high-adoption equilibrium
Long-run Dynamics

- Long-run dynamics are characterized by the time path of the high-adoption equilibrium
- Driving forces:
  - Declining card usage costs $d_m + d_c$
  - Declining card adoption costs $k_c$ and $k_m$
  - Rising consumer income $E(I)$
Simulation Parameterization

- Under the monopoly network
Simulation Parameterization

- Under the monopoly network
- Under the social planner
Simulation Parameterization

- Under the monopoly network
- Under the social planner
- Under the policy of interchange ceiling ($f_m \leq 0.03$)
Simulation Parameterization

- Under the monopoly network
- Under the social planner
- Under the policy of interchange ceiling \((f_m \leq 0.03)\)

Parameterization

<table>
<thead>
<tr>
<th>Case</th>
<th>(k_m)</th>
<th>(k_c)</th>
<th>(E(I))</th>
<th>(\tau_m)</th>
<th>(\tau_c)</th>
<th>(d_m+d_c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>160</td>
<td>160</td>
<td>10,000</td>
<td>0.05</td>
<td>0.05</td>
<td>(0, 0.05)</td>
</tr>
<tr>
<td>Case 2</td>
<td>120</td>
<td>200</td>
<td>10,000</td>
<td>0.05</td>
<td>0.05</td>
<td>(0, 0.05)</td>
</tr>
<tr>
<td>Case 3</td>
<td>128</td>
<td>128</td>
<td>10,000</td>
<td>0.05</td>
<td>0.05</td>
<td>(0, 0.05)</td>
</tr>
<tr>
<td>Case 4</td>
<td>160</td>
<td>160</td>
<td>12,500</td>
<td>0.05</td>
<td>0.05</td>
<td>(0, 0.05)</td>
</tr>
</tbody>
</table>
Figure A5: Monopoly Outcome vs. Social Optimum (Case 1)
Figure A5: Monopoly Outcome vs. Social Optimum (Case 1)
Figure A6: Monopoly Outcome with and without An Interchange Fee Ceiling (Case 1)
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The Findings

- Monopoly outcome is very different from social optimum
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- Monopoly outcome is very different from social optimum
  - The card network maximizes the profit
    - it cares only about the card users but not the cash users
    - lowering card fees to consumers help inflate the value of card transactions, so the network prefers high interchange fees
  - The social planner maximizes the consumer surplus
    - it cares about both card users and cash users
    - lowering card fees to merchants help increase consumers’ real purchase, so the social planner prefers low interchange fees

Imposing an interchange ceiling may improve consumer welfare
The Findings

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Conclusion

The paper provides a new theory for two-sided payment card markets with better micro-foundations
- Monetary benefits from the payment card usage
- Consumer demand is affected by payment choices
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- The paper derives card adoption and usage patterns that are consistent with empirical evidence
  - Rich consumers and large merchant adopt cards earlier
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- The paper derives card adoption and usage patterns that are consistent with empirical evidence
  - Rich consumers and large merchant adopt cards earlier
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- The paper offers new insights on payment card pricing
  - The decline of card service costs is consistent with increasing interchange fees
  - The card network has the incentive to inflate the nominal value of card transactions
  - Interchange ceiling may improve consumer welfare