Two-sided Market, R&D and Payments System Evolution

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U.S. payments system is migrating to electronic forms
- The share of cash and checks continues to decline
- Credit, debit cards and other e-payments on the rise
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  - Most e-payment means were introduced decades ago
  - Market share didn’t surpass paper payments until 2000s
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  - The share of cash and checks continues to decline
  - Credit, debit cards and other e-payments on the rise
- The diffusion of electronic payments is a slow process
  - Most e-payment means were introduced decades ago
  - Market share didn’t surpass paper payments until 2000s
- Competitive efficiency issues, especially on card payments
  - Merchants fees high and rising (> $60 billion in 2010)
  - Fed has regulated debit card interchange fees since 2011
  - Other countries also regulate interchange (e.g. Australia, EU)
Stylized Facts

- Slow diffusion of electronic payments

![Graph showing the evolution of payment forms.](image)

**Fig. 1.** Relative Share in Transaction Values.

Data source: Nilson Report (various issues).

Card includes credit and debit card payments. Electronic includes card plus ACH and remote payments. Paper includes cash and check payments.
Stylized Facts

- Consumer adoption correlates with income

![Graph showing share of U.S. Households Holding Credit Cards over time by income quintile.](image)

Fig. 2. Share of U.S. Households Holding Credit Cards.

Data sources: Mester (2012) and Evans and Schmalensee (2005). They also show similar adoption and usage patterns for other electronic payment means, such as smart cards and automatic bill paying.
Stylized Facts

- Merchant acceptance correlates with transaction value

Fig. 3. Share of Transactions Using Payment Cards.
Stylized Facts

• Increasing merchant fees for accepting electronic payments

Fig. 4. Payment Card Interchange Fees for a $50 Transaction.
Research Questions

- **Slow diffusion**: Why does it take so long for more efficient electronic payments to replace paper payments?

- **Asymmetric pricing**: Why are the fees increasing (decreasing) to merchants (consumers) for using electronic payments?

- **Social optimality**: What would be the socially optimal pricing, adoption and usage of electronic payments?

- **Regulatory impact**: How would different ways of regulation affect payments system performance?
A New Theory

- We lay out a two-sided market environment where consumers with heterogeneous income and merchants of heterogeneous size make payment adoption and usage decisions under network externalities.

- Electronic payments require a high fixed cost of adoption but low marginal cost of use, so they are more cost-saving to high-income consumers and large-size merchants.

- This setting is embedded in a fully dynamic model in which a monopoly electronic payment network sets usage fees and conducts R&D to lower costs.

- We calibrate the model to U.S. payment card pricing, adoption and usage data, and conduct welfare and policy analysis.
Main Findings

- The model generates pricing, adoption and usage pattern of electronic payments that are consistent with data.

- Market power of electronic payment networks explains the slow adoption and asymmetric price changes.

- A Ramsey social planner would proceed differently and achieve higher adoption and usage of electronic payments.

- Regulating usage fees by marginal cost may reduce social welfare in a dynamic setting, while a merchant fee cap regulation improves consumer welfare without causing much dynamic inefficiency.
The Literature

Money-search models (e.g., Lagos and Wright 2005)
- Rely on information economics and mechanism design.
- Show payment arrangements overcome frictions of exchange.
- Do not explain the slow diffusion of electronic payments.
- Do not address competitive efficiency issues in payments.
The Literature

- **Money-search models (e.g., Lagos and Wright 2005)**
  - Rely on information economics and mechanism design.
  - Show payment arrangements overcome frictions of exchange.
  - Do not explain the slow diffusion of electronic payments.
  - Do not address competitive efficiency issues in payments.

- **Two-sided market theories (e.g., Rochet & Tirole, 2002, 2011)**
  - Focus on the industrial organization of payments systems.
  - Usage externalities lead to inefficiently high merchant fees.
  - Do not explain adoption and ignore technology progress.
  - Ad hoc payment benefits and fixed consumer demand.
Outline

- Motivation and findings
- Model setup
- Market equilibrium
- Model calibration
- Welfare and policy analysis
- Concluding remarks
Model Elements

- Consumers
  - Cobb-Douglas preference, heterogenous income.

- Merchants
  - Contestable market, heterogenous size.

- Electronic and paper payments: “card” vs. “cash”
  - High fixed cost of adoption, low marginal cost of usage.

- Electronic payment service provider
  - A monopoly which sets usage fees and conducts R&D.
A Cash Economy

- Merchants in a contestable market each sells a differentiated good $\alpha$:

$$p_{\alpha,h} = \frac{\mu_\alpha}{1 - \tau_m}.$$

- A consumer with income $I$ purchases $x_\alpha$ units of good $\alpha \in (0, \bar{\alpha})$:

$$\ln U_I = \text{Max } \int_0^{\bar{\alpha}} \frac{\alpha}{E(\alpha)} \ln x_\alpha, dG(\alpha) \text{ s.t. } \int_0^{\bar{\alpha}} (1 + \tau_c) p_{\alpha,h} x_\alpha, dG(\alpha) \leq I.$$

- Consumer $I$’s demand for good $\alpha$:

$$x^*_{\alpha,I} = \frac{\alpha I}{(1 + \tau_c) p_{\alpha,h} E(\alpha)}.$$

- Total market demand for good $\alpha$:

$$x_\alpha = \int_0^I x_\alpha, dF(I) = \frac{\alpha E(I)}{(1 + \tau_c) p_{\alpha,h} E(\alpha)}.$$
We now introduce an electronic payment innovation, referred to as a payment card. The card service is provided by a monopoly network. The costs of providing the card service to merchants and consumers are $\delta$ and $\delta$ per-dollar transaction respectively, and we denote the sum $\delta = \delta + \delta$. It will become clear that in our two-sided market setting, only the sum $\delta$ (but not its composition, $\delta$ and $\delta$) matters for the analysis. In return, the card service provider charges merchants and consumers a percentage fee $\phi$ and $\phi$, respectively. Figure 3 describes the transaction flow with cards in which consumers use a payment card to pay merchants. Merchants submit charges to the card network which then bills consumers. For simplicity, we model a “three-party” system where the payment card network serves consumers and merchants directly, but our analysis can equally apply to a “four-party” system where the card network serves consumers and merchants indirectly through card issuers and merchant acquirers. It is typically considered in the literature that merchant acquirers are competitive and the card network maximizes the joint profits of member issuers, so we can simply reinterpret the card network in our model to be the association of member issuers in a “four-party” system.

Fig. 5. Payment Card System.
Introducing the Payment Card

- Card service is provided by a monopoly.
- The costs for serving merchants and consumers are $d_m$ and $d_c$.
- Merchants and consumers are each charged a fee $f_m$ or $f_c$.
- Merchants and consumers each incur an adoption cost $K_m$ or $K_c$.
- The card is a more efficient payment means, which requires

$$\tau_m + \tau_c > d_m + d_c = d.$$
Within-Period Decisions

- At a point in time, with the card service cost $d$ given, we solve for a three-stage game:
  - Stage I. The monopoly card network sets the card fees $f_m$ and $f_c$.
  - Stage II. After observing $f_m$ and $f_c$, merchants and consumers decide simultaneously whether to accept or hold the card, and merchants post retail prices.
  - Stage III. Consumers decide whether to purchase, which merchants to purchase from, and what payment device to use.

- In making the decisions, consumers and merchants maximize utility or profits, and the card network maximizes profit.
Dynamic Decisions

- The industry evolves over time due to
  - Exogenous forces: Mean consumer income $E(I_t)$ grows, together with changes of card adoption costs $K_{m,t}$ and $K_{c,t}$.
  - Endogenous forces: The card network makes R&D investment $R_t$ to reduce card service costs such that
    
    $$d_{t+1} = \Gamma(d_t, R_t),$$

    where $\partial \Gamma / \partial d_t > 0$ and $\partial \Gamma / \partial R_t < 0$.

- Given the initial value of $d_0$ and the laws of motion for $E(I_t)$, $K_{m,t}$ and $K_{c,t}$, the card network chooses a sequence of $(f_{m,t}, f_{c,t}, R_t)$ to maximize the present value of profits.
Within-Period Analysis

• Merchants’ Choices
Within-Period Analysis

- Merchants’ Choices
  - Large merchants \((\alpha \geq \alpha_1)\) accept cards and charge price \(p_{\alpha,d} \leq p_{\alpha,h}\)

\[
\alpha_1 = \frac{E(\alpha)K_m}{[E_{I \geq I_0}(I - K_c)](\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+f_c})}.
\]
Within-Period Analysis

- **Merchants’ Choices**
  - Large merchants ($\alpha \geq \alpha_1$) accept cards and charge price $p_{\alpha,d} \leq p_{\alpha,h}$
    
    $$\alpha_1 = \frac{E(\alpha)K_m}{[E_{I \geq I_0}(I - K_c)](\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+f_c})}.$$ 

  - Intermediate merchants ($\alpha_0 \leq \alpha < \alpha_1$) specialize. They either accept cards and charge $p_{\alpha,d}$, where $\frac{1+\tau_c}{1+f_c}p_{\alpha,h} \geq p_{\alpha,d} > p_{\alpha,h}$, or they do not accept cards and charge $p_{\alpha,h}$
    
    $$\alpha_0 = \frac{E(\alpha)K_m}{[E_{I \geq I_0}(I - K_c)](\frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c})}.$$
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    \]
  - Small merchants ($\alpha < \alpha_0$) do not accept cards and charge $p_{\alpha,h}$. 
Within-Period Analysis

- Consumers’ Choices
Within-Period Analysis

• Consumers’ Choices

A consumer with income $I$ compares utility between adopting card ($U_{I,d}^d$) or not ($U_{I,d}^h$):

$$\ln U_{I,d}^d = \int_0^\alpha \frac{\alpha}{E(\alpha)} \ln \left( \frac{\alpha (I-K_c)}{(1+\tau_c)p_{\alpha,h} E(\alpha)} \right) dG(\alpha) + \int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left( \frac{\alpha (I-K_c)}{(1+f_c)p_{\alpha,d} E(\alpha)} \right) dG(\alpha),$$

$$\ln U_{I,d}^h = \int_0^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left( \frac{\alpha I}{(1+\tau_c)p_{\alpha,h} E(\alpha)} \right) dG(\alpha) + \int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left( \frac{\alpha I}{(1+f_c)p_{\alpha,d} E(\alpha)} \right) dG(\alpha).$$
Within-Period Analysis

**Consumers’ Choices**

- A consumer with income $I$ compares utility between adopting card ($U^d_{I,d}$) or not ($U^h_{I,d}$):

\[
\ln U^d_{I,d} = \int_0^{\alpha_0} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha(I-K_c)}{(1+\tau_c)p_{\alpha,h}E(\alpha)} dG(\alpha) + \int_{\alpha_0}^{\bar{\alpha}} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha(I-K_c)}{(1+f_c)p_{\alpha,d}E(\alpha)} dG(\alpha),
\]

\[
\ln U^h_{I,d} = \int_0^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha I}{(1+\tau_c)p_{\alpha,h}E(\alpha)} dG(\alpha) + \int_{\alpha_1}^{\bar{\alpha}} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha I}{(1+\tau_c)p_{\alpha,d}E(\alpha)} dG(\alpha).
\]

- The threshold income level $I_0$ for card adoption

\[
I \geq I_0 = \frac{(1+\tau_c)E_{\alpha \geq \alpha_0}(\alpha)/E(\alpha)k_c}{(1+\tau_c)E_{\alpha \geq \alpha_0}(\alpha)/E(\alpha) - \exp(\int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left(\frac{p_{\alpha,d}}{p_{\alpha,h}}\right) dG(\alpha))}.
\]
Within-Period Analysis

- Two-sided Market Interaction
  - Denote $Z_1 = \left( \frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c} \right)$ and $Z_0 = \left( \frac{1-f_m}{1+f_c} - \frac{1-\tau_m}{1+\tau_c} \right)$.
  - Given card fees ($f_c$ and $f_m$) that satisfy $\tau_c \geq f_c$ and $\frac{1-f_m}{1+f_c} \geq \frac{1-\tau_m}{1+\tau_c}$, there exist card adoption thresholds ($\alpha_0, \alpha_1, I_0$):
    \[
    \alpha_0 = \frac{E(\alpha)K_m}{[E_{I \geq I_0}(I - k_c)]Z_0}, \quad \alpha_1 = \frac{Z_0}{Z_1} \alpha_0 \quad \text{if} \quad f_m \leq \tau_m,
    \]
    \[
    I_0 = \frac{\left( \frac{1+\tau_c}{1+f_c} \right)E_{\alpha \geq \alpha_0}(\alpha)/E(\alpha)K_c}{\left( \frac{1+\tau_c}{1+f_c} \right)E_{\alpha \geq \alpha_0}(\alpha)/E(\alpha) - \exp(\int_{\alpha_0}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \left( \frac{1-\tau_m}{1-f_m} \right) \frac{1-\tau_m}{(1-f_m)\alpha - (1+f_c)\alpha_0 Z_0} dG(\alpha))}.
    \]
Within-Period Analysis

- Within-Period Equilibrium

- The card network, anticipating card adoption and usage decisions in Stages II and III, set card fees \((f_c,f_m)\) at Stage I to maximize its profit:

\[
\pi(d; E(I), K_m, K_c) = \max_{f_c,f_m} \frac{E_{\alpha \geq \alpha_0}(\alpha)E_{I \geq I_0}(I - K_c)}{E(\alpha)(1 + f_c)} (f_c + f_m - d).
\]

- The card network maximizes profit, consumers maximize utility, merchants break even, and goods and payments markets clear.
Dynamic Analysis

Dynamic Problem

- Over time, the market evolves due to exogenous changes in \((E(I_t), K_{m,t}, K_{c,t})\) and endogenous choices of \(R_t\).

- The value function of the card network is

\[
V(d_t; E(I_t), K_{m,t}, K_{c,t}) = \max_{R_t} \pi(d_t; E(I_t), K_{m,t}, K_{c,t}) - R_t \\
+ \beta V(d_{t+1}; E(I_{t+1}), K_{m,t+1}, K_{c,t+1})
\]

s.t. \(d_{t+1} = \Gamma(d_t, R_t)\),

\[
\pi(d_t; E(I_t), K_{m,t}, K_{c,t}) \geq R_t.
\]
Dynamic Analysis

- Dynamic Solution
  - Rewrite the R&D function into an inverse function
    \[ R_t = \Psi(d_t, d_{t+1}) \]
  - The dynamic problem is equivalent to
    \[ V(d_t; E(I_t), K_{m,t}, K_{c,t}) = \max_{d_{t+1}} \pi(d_t; E(I_t), K_{m,t}, K_{c,t}) - \Psi(d_t, d_{t+1}) \]
    \[ + \beta V(d_{t+1}; E(I_{t+1}), K_{m,t+1}, K_{c,t+1}) \]
  - The optimal path follows a second-order difference equation
    \[ \Psi_2(d_t, d_{t+1}) = \beta[\pi'(d_{t+1}; E(I_{t+1}), K_{m,t+1}, K_{c,t+1}) - \Psi_1(d_{t+1}, d_{t+2})] \]
Functional Forms

- F1. Merchant size $\alpha$ is uniformly distributed, and $I_t$ is exponentially distributed with $F(I_t) = 1 - e^{(-\lambda t I_t)}$ and $E(I_t) = 1/\lambda t$.

- F2. The mean consumer income has a constant growth rate $g_I$: 
  \[ \lambda_{t+1} = \lambda_t / (1 + g_I). \]

- F3. Card adoption costs are proportional to the mean income: 
  \[ K_{m,t} = k_m E(I_t) = k_m / \lambda_t \] and \[ K_{c,t} = k_c E(I_t) = k_c / \lambda_t. \]

- F4. The R&D function $\Gamma$ takes the form:
  \[ \frac{1}{d_{t+1}} - \frac{1}{d_t} = \left( \frac{R_t \lambda_t}{\phi} \right) \gamma d_t^{-\gamma - 1} \] with $1 > \gamma > 0$. 

Two-sided Market, R&D and Payments System Evolution
Within-Period Eqm: Characterization

- Two-sided market interaction leads to multiple equilibria

Fig. 6. Interaction of Merchants and Consumers in Card Adoption.
Within-Period Eqm: Characterization

- Network within-period profit function can be simplified:
  \[ \pi(d; \lambda) = \frac{1}{\lambda} (a_0 - a_1 d). \]

![Network Profit Function and Linear Fitting](image.png)

Fig. 7. Network Profit Function and Linear Fitting.
Dynamic Eqm: Characterization

- The R&D function implies an investment function

\[ R_t = \phi \frac{d_t}{\lambda_t} \left[ \frac{d_t}{d_{t+1}} - 1 \right]^{\frac{1}{\gamma}} \text{ with } 1 > \gamma > 0, \]

which is strictly increasing and convex in technological progress \((d_t/d_{t+1})\) and constant returns to scale in \((d_t, d_{t+1})\).

- The dynamic problem of the card network becomes

\[ V(d_t; \lambda_t) = \max_{d_{t+1}} \frac{1}{\lambda_t} (a_0 - a_1 d_t) - \phi \frac{d_t}{\lambda_t} \left[ \frac{d_t}{d_{t+1}} - 1 \right]^{\frac{1}{\gamma}} + \beta V(d_{t+1}; \lambda_{t+1}), \]

which can be explicitly solved for a balanced-growth path.
Given the functional forms, we choose parameter values to match U.S. payment card data from 1997-2008.

Credit cards, introduced in 1950s, started to gain popularity in 1970s. Debit cards, introduced in 1980s, stared to pick up in the mid-1990s. Visa and MasterCard became dominant players in both markets.

Since the late 1990s, with the wide adoption of credit cards and rapid expansion of debit cards, the card fees have raised great controversies.

By the late 1990s, 73% of U.S. households had adopted credit cards, but nearly half cardholders only used the payment function. Debit cards provide payment but not credit function.

In 2008, credit cards were used in 26.5 billion transactions worth $2.1 trillion, while debit cards had 34 billion transactions worth $1.3 trillion.
## Parameterization

<table>
<thead>
<tr>
<th>Parameter Definition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merchant cost of handing cash</td>
<td>$\tau_m$ 4.0%</td>
</tr>
<tr>
<td>Consumer cost of handing cash</td>
<td>$\tau_c$ 2.5%</td>
</tr>
<tr>
<td>Merchant cost of adopting card</td>
<td>$k_m$ 2.5%</td>
</tr>
<tr>
<td>Consumer cost of adopting card</td>
<td>$k_c$ 0.3%</td>
</tr>
<tr>
<td>Merchant cost of goods</td>
<td>$\mu_\alpha$ 1</td>
</tr>
<tr>
<td>Initial value of card service costs</td>
<td>$d_0$ 2.25%</td>
</tr>
<tr>
<td>R&amp;D function curvature</td>
<td>$\gamma$ 0.5</td>
</tr>
<tr>
<td>R&amp;D efficiency parameter</td>
<td>$\phi$ 10</td>
</tr>
<tr>
<td>Initial value of mean income</td>
<td>$1/\lambda_0$ 21,215</td>
</tr>
<tr>
<td>Growth rate of mean income</td>
<td>$g_I$ 2%</td>
</tr>
</tbody>
</table>
Calibration Results

The model calibration yields patterns that are consistent with data, as shown in Fig. 5. The model generates a declining consumer fee over time, which is consistent with an increase of consumer card rewards during the period.27 The model also generates increasing adoption of cards by consumers similar to the data, and the share of card transaction rises in parallel with the data (for the sum of credit and debit cards) though at a slightly higher level.

27 It is hard to estimate the average consumer card fees. Credit card users, if not rolling over any balances on their cards, may not need to pay a fee (or even receive rewards) for each card transaction. However, there are chances that some of those users may end up borrowing from their cards, in which case they then need to pay a very high interest rate for every transaction made. For debit cards, consumers often need to pay a PIN fee for using online debit cards in our sample period, but some of them may also receive rewards. On the other hand, industry studies show that card rewards have gained increasing popularity over time. In 2001, less than a quarter of credit card offerers included the promise of a rewards program. But by 2005, the share was 58 percent, according to Mail Monitor, a unit of consumer research company Synovate. A similar trend also happened to debit cards, as shown in 2005/2006 Study of Consumer Payment Preferences conducted by the American Bankers Association and Dove Consulting.

Fig. 8. Targeted Moments.
Calibration Results (Cont’d)

Fig. 6: Model Calibration (continued)

Beyond comparing with the data, Fig. 6 reports additional patterns generated by the model that of interest. First, the overall card adoption by merchants increases over time, with the shares of large merchants (i.e., those who accept both cash and card but charge prices lower than cash-only stores) and small merchants (who accept cash only) declining. Second, the card network invests in R&D to reduce card service costs $\delta$, with the R&D expenditure to mean income ratio declining over time. Third, with the decline in card costs, the card network charges an increasing markup, which together with a rising card spending share indicates that the card network earns an increasing profit. Finally, consumer welfare in each period, scaled by the mean income, continues to rise, while in a cash economy it would be constant (which we normalize to be 100 in the figure). The detailed derivation of consumer welfare is explained next.

5 Welfare and Policy Analysis

This section provides a normative analysis of the card payment system. First, we show introducing payment cards increases welfare for both card adopters and nonadopters.
In a cash economy, a consumer $I$ enjoys utility
\[
\ln U_{I,h} = \int_0^{\bar{\alpha}} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha I}{E(\alpha)(1 + \tau_c)p_{\alpha,h}} dG(\alpha).
\]

In a card economy, a card-adopting consumer ($I \geq I_0$) enjoys utility
\[
\ln U_{I,d}^d = \int_0^{\alpha_0} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha(I-K_c)}{E(\alpha)(1+\tau_c)p_{\alpha,h}} dG(\alpha) + \int_{\bar{\alpha}}^{\alpha_0} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha(I-K_c)}{E(\alpha)(1+f_c)p_{\alpha,d}} dG(\alpha),
\]
while a nonadopter ($I < I_0$) enjoys utility
\[
\ln U_{I,d}^h = \int_0^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha I}{(1+\tau_c)p_{\alpha,h}E(\alpha)} dG(\alpha) + \int_{\bar{\alpha}}^{\alpha_1} \frac{\alpha}{E(\alpha)} \ln \frac{\alpha I}{(1+\tau_c)p_{\alpha,d}E(\alpha)} dG(\alpha).
\]
Within-Period Decision

Within each period, for any given \(d\) and \(R\), the Ramsey social planner chooses \((f_c, f_m)\) to maximize consumer welfare subject to a balanced budget:

\[
U(d, R; E(I), K_m, K) = \max_{f_c, f_m} \int_{I_0}^{\infty} U^d_{I, d}dG(I) + \int_{0}^{I_0} U^h_{I, d}dG(I)
\]

\[
s.t. \quad \text{merchant and consumer adoption and usage equations,}
\]

and \(\pi(d; E(I), K_m, K_c) \geq R\).
Dynamic Decision

Over time, the Ramsey social planner chooses the sequence of $(f_{c,t}, f_{m,t}, R_t)$ to maximize the present value of consumer surplus

$$V(d_t; E(I_t), K_{m,t}, K_{c,t}) = \max_{R_t} U(d_t, R_t; E(I_t), K_{m,t}, K_{c,t})$$

$$+ \beta V(d_{t+1}; E(I_{t+1}), K_{m,t+1}, K_{c,t+1})$$

$$s.t. \; d_{t+1} = \Gamma(d_t, R_t),$$

where $\Gamma$ is the R&D function.
The Ramsey Social Planner charges a decreasing markup over time, while the monopoly charges an increasing one. This leads to higher consumer welfare in each period under the Ramsey planner, as it values both consumer and cash payments. The monopoly network earns profits from cash users, which the Ramsey planner does not. This allows the monopoly to charge higher fees and extract more rents, but it also reduces cross subsidies from card users to cash users. The Ramsey planner cares about consumers' real purchases and both card and cash users' welfare, whereas the monopoly only cares about increased profits. This results in the monopoly making less R&D investment than the Ramsey planner.
Ramsey Social Planner

Fig. 11. Monopoly Network vs. Ramsey Social Planner (cont’d).
**Ramsey Social Planner**

- What explain the differences between the Ramsey social planner and the monopoly network?
  - For the monopoly network, charging a high merchant fee (i) leads to high retail prices of goods and allows the network to extract more rents; and (2) reduces cross subsidies from card users to cash users through large merchants.
  - The Ramsey social planner values consumers’ real purchases rather than nominal card spending, and cares about cash users.
  - Regarding R&D decisions, the monopoly only sees the benefit of increased profit, which is a subset of social welfare, so the monopoly makes less R&D investment than the social planner.
5.3 Policy Experiments

In this section, we use our calibrated model to study two regulatory approaches on payment cards. One is the marginal-cost pricing regulation, and the other is the merchant fee cap regulation. These two approaches are the most popular ones in policy debates, and can each be justified by some existing theories.

The marginal-cost pricing regulation can find its root in traditional one-sided markets, and a naive argument is to require the card network to set fees to merchants and consumers equal to the marginal cost of serving each side, which implies $\phi_\mu = \delta_\mu$ and $\phi_\chi = \delta_\chi$.

However, as Baxter (1983) pointed out, because payment card markets are two-sided, it would be decidedly inefficient to block side payments between merchants and consumers. Instead, the socially optimal card pricing should be $\phi_\mu + \phi_\chi = \delta_\mu + \delta_\chi$. While this approach considers the two-sided nature of card markets, it is based on a static analysis and ignores the endogenous R&D of card networks.

On the other hand, the merchant fee cap regulation has been adopted in many countries. Compared with the marginal-cost pricing regulation, it is easier to implement because it regulates only the fee on the merchant side. In practice, the merchant (inter-
Policy Analysis

- Evaluating two popular regulatory approaches

  - Marginal-cost pricing regulation:
    \[ f_m + f_c = d_m + d_c. \]

  - Merchant fee cap regulation:
    \[ f_m < \overline{f}_m. \]
Policy Analysis

We simulate our calibrated model for each policy experiment by assuming the regulation is implemented at the beginning year of our sample period. For the marginal-cost pricing regulation, we require the card network to set card fees \((\phi_m, \phi_c)\) to maximize consumer welfare subject to the zero markup constraint \(\phi_m + \phi_c = \delta_t\). Figures 10 and 11 show the results. Comparing with the unregulated monopoly case, the regulated network lowers card fees to both merchants and consumers. This boosts card adoption by both sides and the fraction of large merchants who serve both card and cash users increases substantially. All these result in a higher level of consumer welfare. However, this regulation deprives the card network of R&D incentive and resources, so the card service cost \(\delta_t\) stays at the initial level \(\delta_0\). Figure 12 shows that comparing with the unregulated monopoly and the Ramsey social planner, this regulation yields a lower level of social welfare in each period except for the initial few years.

We also simulate alternative regulations that cap the merchant fee at various levels. Figures 10 and 11 show the results for the cap set at 1%. Given the binding cap on the merchant fee cap is rationalized either by an issuer-cost argument (e.g., in Australia and the U.S.) or by a merchant-benefit argument (e.g., in the EU).

Fig. 13. Policy Experiments.
Policy Analysis

Fig. 14. Policy Experiments (cont’d).
Policy Analysis

Figure 12: Comparing Social Welfare of Policy Experiments with the present value of the cash economy being normalized to 100. The marginal-cost pricing regulation maximizes consumer welfare in a static setting, but it leaves no profit for the card network to conduct R&D. As a result, it yields a higher present value of consumer welfare than the unregulated monopoly, but the present value of social welfare is lower. In comparison, the merchant fee cap regulation redistributes between network profit and consumer welfare but without hurting much the network’s R&D. We do see the lower the cap, the higher the consumer welfare, but the social welfare (which slightly increases in the cap value) changes little compared with the unregulated monopoly.

Figure 13. Comparing Present Values of Consumer and Social Welfare.

Fig. 15. Social Welfare Comparison of Policy Experiments.
Policy Analysis

Fig. 16. Present Value Comparison of Consumer and Social Welfare.
We provide a new analysis of payments system evolution and the accompanying competitive efficiency issues.

- The model generates pricing, adoption and usage pattern of electronic payments that are consistent with data.
- Market power of electronic payment networks explains the slow adoption and asymmetric fee changes.
- A Ramsey social planner would achieve higher adoption and usage of electronic payments.
- Regulating usage fees by marginal cost may reduce social welfare in a dynamic setting, while a merchant fee cap may improve consumer welfare without causing much dynamic inefficiency.