Who bears the welfare costs of monopoly?
The case of the credit card industry

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The views expressed herein are those of the authors and not necessarily those of the Federal Reserve System.
Introduction

Key features of U.S. credit card (CC) industry

1. Large degree of market concentration
   - Regional monopoly in 60s/70s, Oligopoly in 2016
2. Excess spreads and profits
3. Lawsuits for anti-competitive practices
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   - Explains 25-40 percent of excess spreads & profits
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   - Measure distribution of welfare losses from non-competitive behavior
Competitive reforms

1. Monopoly in 1970 to duopoly
   - Measure welfare on transition path
   - Poor gain from improved consumption smoothing
     - Higher limits, lower spreads
     - Reform worth 0.10-0.76% of lifetime consumption for zero-asset HH
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Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?” p.2
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2. Duopoly to Oligopoly in 2016
   - Equivalent one-time transfer worth 1.32% of GDP to current cohort
Related Literature

**Workhorse consumer credit models**
- Chatterjee et al. (2007), Livshits et al. (2007, 2010)

**Non-competitive Empirics**

**Search and matching in credit market**

**Credit lines, non-exclusive contracts, and market power**

**This paper**
1. Finite number of non-atomistic lenders
2. Non-exclusive credit lines
Key features of U.S. credit card industry
1. Concentration: Regional monopoly in 60s/70s

i. Visa/Mastercard owned by founding banks
   - Visa-West, Mastercard-Midwest, Amex-East

ii. Exclusive contracts by networks ban competing cards
   - No competition across regions
   - Per se illegal (worst noncompetitive behavior in Sherman Act)
   - Abandon exclusionary contracts in 1976

iii. Networks prohibit low-fee new-entrant credit cards
   - No competition within regions
   - Sears attempts to issue low rate card
   - Visa bans Sears and all cards "deemed competitive"

iv. Interest rate collusion
   - Wells Fargo & others sued for interest rate fixing in 80s (settled)
   - Knittel & Stango (2003): widespread collusion at interest rate ceilings
   - 1978 Marquette Act facilitates national competition
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Table: Revolving credit share by issuer

<table>
<thead>
<tr>
<th>Company</th>
<th>Cumulative share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Citigroup</td>
<td>18</td>
</tr>
<tr>
<td>2. JP Morgan</td>
<td>34</td>
</tr>
<tr>
<td>3. Capital One</td>
<td>46</td>
</tr>
<tr>
<td>4. Bank of America</td>
<td>58</td>
</tr>
<tr>
<td>5. Discover</td>
<td>66</td>
</tr>
<tr>
<td>6. Synchrony</td>
<td>73</td>
</tr>
<tr>
<td>7. American Express</td>
<td>78</td>
</tr>
<tr>
<td>8. Wells Fargo</td>
<td>83</td>
</tr>
<tr>
<td>9. Barclays</td>
<td>86</td>
</tr>
<tr>
<td>10. Other</td>
<td>100</td>
</tr>
</tbody>
</table>

- 9 issuers account for 86 percent of market share

- Oligopoly in 2016
2. Excess Spreads

- **Actual Spread:**
  \[ \tau_{actual} = \frac{r_b - r}{\text{credit card interest rate} - \text{risk-free rate}} \]

- **Zero profit spread:** what lenders should charge above risk-free rate to break-even
  \[ (1 - D)B(1 + r + \tau_{zero}) = B(1 + r + \tau_o) \]
  \[ \text{interest income - charge-offs} = \text{cost - non-interest income} \]

- \( \tau_o = \text{rewards/fraud + operational cost - fee/interchange income} < 0 \)

- Significant non-interest income: \( \tau_o = -0.052 \)

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2. Excess Spreads = $\tau_{actual} - \tau_{zero}$

Average CC charges 3.4-8.8 p.p. above break-even, $r = \text{Aaa}$
2. Excess Profits: Return on Assets (ROA)

\[
\frac{\text{[Interest and non-interest income - Charge-offs]}}{\text{Assets}} = r + \tau_{\text{actual}} - D
\]

(a) Average ROA

Top 25 CC Banks (average = 11.0)

All Banks (average = 4.8)

(b) Excess ROA

Top 25 CC - All Banks (average = 6.2)
Summary of Key features of U.S. CC industry

i. Large degree of market concentration

ii. Average CC charges 3.4-8.8 p.p. above break-even

iii. Excess profits 5 p.p. more than industry average

iv. Lawsuits for anti-competitive practices
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Next
- Model with finite number of non-atomistic CC firms
  - Implications for excess spreads and excess profits
  - Measure distribution of welfare losses from non-competitive behavior
Model
Model Overview

Consumers

- Choose consumption, savings, and default/repayment
- $(i, \theta, \epsilon, a)$: credit flag (good/bad), permanent earnings, persistent earnings shock, assets
- Extreme value shocks over default and repayment $\zeta_R$ and $\zeta_D$
Model Overview

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\(N\) lenders issue non-exclusive credit lines

- One credit line per lender - contracts are long-term
- Choose limit \(\bar{l}\) and spread \(\tau\) to maximize profits
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Representative firm
- Hires workers, rents capital competitively

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Credit Lines Example: N=3

- Borrow from lowest spread first, $\tau_1$, then next lowest, $\tau_2$, ...
Credit Lines Example: N=3

- Borrow from lowest spread first, $\tau_1$, then next lowest, $\tau_2$, . . .
Credit Lines Example: N=3

- Borrow from lowest spread first, $\tau_1$, then next lowest, $\tau_2$, ...
Consumer’s Problem: Repayment or Default

- Let credit line state \( S = \{(\tau_1, \bar{l}_1), \ldots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N \)

- Repay or universal default

- Value of consumer

\[
V(i, \theta, \epsilon, a) = E_{\zeta_D, \zeta_R} \max \left\{ \underbrace{V^D(\theta, \epsilon) + \zeta_D}_{\text{default}}, \underbrace{V^R(i, \theta, \epsilon, a) + \zeta_R}_{\text{repay}} \right\}
\]

- Probability of default \((\kappa = \text{scaling parameter})\)

\[
p(i, \theta, \epsilon, a) = \frac{\exp(\kappa V^D(\theta, \epsilon))}{\exp(\kappa V^D(\theta, \epsilon)) + \exp(\kappa V^R(i, \theta, \epsilon, a))}
\]
Consumer: Value of Repayment in Good Standing

- May freely save or borrow on credit lines

\[
V^R \left( g, \theta, \epsilon, a \right) = \max_{c, a'} U(c) + \beta E_{\epsilon'} V \left( g, \theta, \epsilon', a' \right)
\]

\[
\text{s.t.} \quad c + a' = w \theta \epsilon + (1 + r) a + \sum_{j=1}^{N} \tau_j a_j(a) + \Pi
\]

\[
a' \geq - \sum_{j=1}^{N} \bar{l}_j
\]
Consumer: Value of Default

- Period of default: autarky 1 period, incur stigma $\chi$
- Period after default: can save, with probability $\phi$ can re-enter
Lenders: Profits

- Lender $k \in \{1, \ldots, N\}$ chooses $(\tau^k, \tilde{r}^k)$ to maximize profits
- Skip mapping from credit line rank to CC firm
- Flow profit from the $j^{th}$ ranked credit line

$$\Pi_j = \int \left[ -(1 - p(g, \theta, \epsilon, a)) \tau_j a_j(a) \right.$$

\hspace{1cm} \text{spread if repaid}

$$+ p(g, \theta, \epsilon, a)(1 + r)a_j(a) \right] d\Omega(g, \theta, \epsilon, a)$$

\hspace{1cm} \text{loss upon default ergodic dist}

- Discount at rate $r_t$ (relevant for transition)
Lenders: Competition

- $N = 1$: Monopoly lender
  - Monopolist maximizes profits by choosing $\tau^1$ and $\bar{l}^1$

- $N = 2$: Stackelberg Duopoly
  - Second mover chooses $\tau^2$ and $\bar{l}^2$ given $\tau^1$ and $\bar{l}^1$
  - First mover chooses $\tau^1$ and $\bar{l}^1$ given $\tau^2(\tau^1, \bar{l}^1)$ and $\bar{l}^2(\tau^1, \bar{l}^1)$

- $N > 1$: 2-stage game
  - Stage 2: All lenders compete symmetric Nash on limits
  - Stage 1: Collusion on spreads/leader picks spread

Final Good Firm’s Problem and Equilibrium Definition
Calibration

- Take standard parameters from literature
- Estimate remaining parameters to match moments
- Calibrate monopoly \((N=1)\) in 1971-75
Parameters Calibrated to Match Moments

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopoly</td>
<td>Year = 1971-75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\chi) Stigma</td>
<td>8.188</td>
<td>Charge-off rate</td>
<td>2.57</td>
<td>2.56</td>
</tr>
<tr>
<td>(\kappa) Scaling parameter</td>
<td>0.712</td>
<td>Defaults: health care, divorce, lawsuit</td>
<td>44.81</td>
<td>44.90</td>
</tr>
<tr>
<td>(\beta) Discount rate</td>
<td>0.960</td>
<td>Risk free rate</td>
<td>1.27</td>
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Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Equilibrium properties: monopolist profit function

- Borrowing limits (percent of GDP per capita), spreads (percentage points), profits (percent of GDP)
- Interior solution

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
### Non-targeted moments (1971-75)

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<td>Credit to GDP</td>
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<td>0.74</td>
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<td>Spread</td>
<td>5.15</td>
<td>8.48</td>
</tr>
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<td>Excess spread: actual - zero-profit</td>
<td>2.55</td>
<td>5.70</td>
</tr>
<tr>
<td>Excess profits: return on assets</td>
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- Generate **40%** of excess spreads
Non-targeted moments (1971-75)

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- Generate 40% of excess spreads

Next: 1970 Competitive Reform from monopoly to Stackelberg duopoly
Fix 1st mover optimal limit and vary 1st mover spread:

- 2nd mover undercuts high spreads
- Strategic complements of spreads $\implies$ 2nd mover advantage

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Equilibrium Properties: Duopoly

Fix 1st mover optimal spread and vary 1st mover limit:

- 2nd mover sets low limit when 1st mover sets high limit
- Strategic substitutability of limits $\implies$ 1st mover advantage
1970 Reform: Monopoly to Stackelberg Duopoly

<table>
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<tr>
<th>Variable</th>
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<th>Duopoly</th>
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<tr>
<td>Firm 1: first mover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrowing limit to initial GDP pc</td>
<td>6.39</td>
<td>1.78</td>
</tr>
<tr>
<td>Spread</td>
<td>5.15</td>
<td>2.43</td>
</tr>
<tr>
<td>Market share of outstanding credit</td>
<td>100.00</td>
<td>46.26</td>
</tr>
<tr>
<td>Market share of total profits</td>
<td>100.00</td>
<td>24.75</td>
</tr>
<tr>
<td>Firm 2: second mover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrowing limit to initial GDP pc</td>
<td>_</td>
<td>4.85</td>
</tr>
<tr>
<td>Spread</td>
<td>_</td>
<td>5.34</td>
</tr>
<tr>
<td>Market share of outstanding credit</td>
<td>_</td>
<td>53.74</td>
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<td>_</td>
<td>75.25</td>
</tr>
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<td>2.55</td>
<td>1.67</td>
</tr>
<tr>
<td>Excess profits: return on assets</td>
<td>2.50</td>
<td>1.62</td>
</tr>
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</table>

- Lower spread on first line and higher total limit
- Lower excess spread and excess profits

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
- Unexpected transition from monopoly to duopoly at $t = 1$
- Perfect foresight thereafter
- Both lenders re-optimize and commit

(a) Spread

(b) Limit
Transition Path 1970 Monopoly to Stackelberg Duopoly

(a) Credit

(b) Default Rate

(c) Profits

(d) Risk-free Rate

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Welfare Measure: **Wealth Equivalent Variation (WEV)**

- One time equivalent transfer such that consumer is indifferent between monopoly and transition

- Advantages
  1. agents re-optimize
  2. aggregate across agents

\[
\min \ WEV \\
\text{s.t.} \\
V_0(i, \theta, \epsilon, a + WEV) \geq V_t(i, \theta, \epsilon, a) \\
\quad a + WEV \geq -\bar{I}^1 \quad \text{if } i = g \\
\quad a + WEV \geq 0 \quad \text{if } i = b
\]
Distribution of Gains 1970 Reform (Stackelberg)

(a) By earnings decile (2016 dollars)

(b) By earnings decile (percent of earnings)

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Distribution of Gains 1970 Reform (Stackelberg)

(a) By earnings decile (2016 dollars)

(b) By earnings decile (percent of earnings)

- **Poor**: better ability to smooth consumption
- **Rich**: consume precautionary savings & higher $r$
- Equivalent one time transfer worth **0.26%** of GDP to current cohort
- Consumption equivalence for consumer with no assets = **0.10** percent

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Monopoly to 2-stage duopoly
2-stage game

- Stage 2: Given spread, equilibrium limit determined from symmetric Nash game (left)
- Stage 1: Collusion on spread/leader picks spread (right)

(a) Stage 2 Example

(b) Stage 1 Profits

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Distribution of Gains/Losses 1970 Reform (2-stage)

(a) By earnings decile (2016 dollars)

(b) By earnings decile (percent of earnings)

- Equivalent one time transfer worth **0.59%** of GDP to current cohort
  - Gains mainly from higher limit
- Consumption equivalence for consumer with no assets = **0.22** percent

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Monopoly to Perfect Competition

Selection criteria: borrowing limits and spreads that maximize welfare of an unborn agent with zero net assets

Subject to weakly positive profits

Equivalent one time transfer worth 2.17% of GDP to current cohort

Only spread = 0.41% of GDP to current cohort

Only limit = 1.41% of GDP to current cohort

Consumption equiv. for consumer with no assets = 0.76 percent

Upper bound for gains from 1970 reforms

Decomposing Gains

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Monopoly to Perfect Competition

- **Selection criteria**: borrowing limits and spreads that maximize welfare of an unborn agent with zero net assets
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Monopoly to Perfect Competition

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  - Only limit = 1.41% of GDP to current cohort

- Consumption equiv. for consumer with no assets = **0.76** percent
  - Upper bound for gains from 1970 reforms

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Duopoly to 2016 Oligopoly with Discrimination
Lenders price discriminate WRT permanent earnings \( (\theta \in \{\theta_L, \theta_M, \theta_H\}) \)

- Total profit decreases with more lenders (left)
- Total limit increases with more lenders (right)
- Equivalent one time transfer worth 1.32\% of GDP to current cohort
Conclusion

- Integrate oligopolistic lenders into consumer credit model
  - Generates 25-40% of observed spreads & excess profits

- Estimate distribution of welfare gains from competitive reforms
  - 1970: reform from monopoly to duopoly, 0.26-2.17% WEV
  - 2016: reform from duopoly to oligopoly, 1.32% WEV

Next: policy on rate caps and minimum limits

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?” p.32
Appendix
Transaction cost - non-interest income (Agarwal et al. 2015)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(unit = percent of average daily balance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td></td>
</tr>
<tr>
<td>Rewards and fraud</td>
<td>2.2</td>
</tr>
<tr>
<td>Operational costs</td>
<td>3.4</td>
</tr>
<tr>
<td>Total non-interest income</td>
<td></td>
</tr>
<tr>
<td>Total fees</td>
<td>7.6</td>
</tr>
<tr>
<td>Interchange income</td>
<td>3.2</td>
</tr>
<tr>
<td>Other transactions</td>
<td>-5.2</td>
</tr>
</tbody>
</table>

- Negative transaction cost net of non-interest income!
- Firms make profits ignoring interest charges, charge-offs, and cost of funds
Details: $\tau_{zero}$

$\tau_{zero}$: denote zero-profit spread

- $D$ charge-off rate (Credit Cards, Flow of Funds)
- $B$ outstanding revolving credit (Cancels)
- $r$ Moody’s Aaa rate for Commercial Paper (4.0% Jan, 2016)
- $\tau_o$ transition cost net of non-interest income

\[
\tau_o = \frac{\text{operational cost} + \text{rewards and fraud} - \text{fees income} - \text{interchange income}}{\text{outstanding revolving credit}}
\]
2. Excess Spreads: Alternate risk-free rate

Grodzicki (2017), spreads using 1-year constant maturity treasury

**Notes:** The figure shows the trend in the mean difference between banks’ most commonly offered credit card interest rate and the cost of funds, or mean spread. Data through August 1994 are from the Federal Reserve Board’s Quarterly Report of Interest Rates on Selected Consumer Loans (form 2825). Data through 2008 are from the Board’s Quarterly Report of Credit Card Interest Rates (Form 2835a) and are available from the Board’s website. The cost of funds is the market rate on U.S. treasury securities at 1-year constant maturity (FRB series H.15 - 4) plus 75 basis points.
2. Excess Spreads: Alternate risk-free rate

Grodzicki (2017), relative ROA

Figure 2: Profitability of Credit Card Lending 1990-2008

*Notes:* The figure shows trends in the (asset weighted) mean return on assets (ROA) for large credit card banks. Relative profitability is defined as the difference between the asset weighted mean ROA of the largest 25 credit card banks (by credit card assets) and the asset weighted mean profitability of all banks in the sample. Data are from each year’s 1st and 3rd quarter Call Report filings. For detailed ROA definitions see appendix.
Lack of price discrimination

<table>
<thead>
<tr>
<th>Credit score</th>
<th>Interest rate (percent)</th>
<th>90+ DPD in last 24 months (percent)</th>
<th>Credit limit (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 660</td>
<td>19.63</td>
<td>51</td>
<td>2,561</td>
</tr>
<tr>
<td>661 − 700</td>
<td>14.50</td>
<td>21</td>
<td>4,324</td>
</tr>
<tr>
<td>701 − 740</td>
<td>15.35</td>
<td>14</td>
<td>4,830</td>
</tr>
<tr>
<td>&gt; 740</td>
<td>14.70</td>
<td>5</td>
<td>6,941</td>
</tr>
</tbody>
</table>

Source: Agarwal, Chomsisengphet, Mahoney, and Stroebel (2017)

Interest rate hardly changes above credit score of 660
3. Lawsuits for anti-competitive practices

- Repeated lawsuits for anti-competitive practices (US/EU)
  - Multi-billion dollar damages and settlements
  - No reforms to industry

- **Example:** Black Card LLC vs. Visa, JP Morgan Chase, Capital One (2018, pending)
  - Black Card: new luxury card offering higher quality benefits
  - Visa, JP Morgan and Capital One colluded to launch competitive products and block the entry of Black Card
  - Very hard to enter
There is a representative, perfectly competitive firm that produces the final good by hiring labor, \(L\), and renting capital, \(K\), in order to maximize profits:

\[
\max_{K,L} K^\alpha L^{1-\alpha} - wL - rK
\]

Factor prices are given by \(r = \alpha (K/L)^{\alpha-1}\) and \(w = (1-\alpha)(K/L)^\alpha\). The firm earns zero profits.
Consumer: Value of Repayment in Bad Standing

- Can save, but not borrow
- May **redefault** on expense shock, even if already in bad standing (end of period)

\[
V^R (b, \theta, \epsilon, a) = \max_{c, a'} \ U(c) + \beta E_{\epsilon'}|\epsilon \ [\phi V(g, \theta, \epsilon', a') \\
+ (1 - \phi) V(b, \theta, \epsilon', a')]
\]

\[s.t.
\]
\[c + a' = w\theta \epsilon + (1 + r)a + \Pi
\]
\[a' \geq 0
\]
2016 Competitive Reform

Bertrand competition equilibrium:

- Keep number of lenders fixed, $N = 2$
- Banks can offer a maximum of 2 credit lines
- Assume consumer must pick a bank exclusively
  - Selection criteria: borrowing limits and spreads that maximize welfare of an unborn agent with zero net assets, subject to weakly positive profits
- Any deviation by the other bank will not be adopted by the consumer
Final Good Firm

- Competitive final output market

- Hire labor, $L$, and rent capital, $K$, in order to maximize profits:

$$\max_{K,L} K^\alpha L^{1-\alpha} - \omega L - rK$$

- Factor prices are given by $r = \alpha (K/L)^{\alpha - 1}$ and $\omega = (1 - \alpha)(K/L)^\alpha$. 

back
Def. Equilibrium

Set of credit lines $S$, distribution $\Omega(i, \theta, \epsilon, a)$, wage rate $w$, interest rate $r$, profits $\Pi$, default probability $p(i, \theta, \epsilon, a)$, savings/borrowing policy $a'(i, \theta, \epsilon, a)$, best responses $\tau^k(\cdot), \bar{\tau}^k(\cdot) \}^N_{k=1}$, and final good firm’s $\{K, L\}$ s.t.

i. given $S$, $w$, $r$, and $\Pi$, policies $p(i, \theta, \epsilon, a)$, and $a'(i, \theta, \epsilon, a)$ solve the consumer’s problem.

ii. for $k \in \{1, 2, \ldots, N\}$, $\{\tau^k(\cdot), \bar{\tau}^k(\cdot)\}^N_{k=1}$ maximizes credit card firm’s profits.

iii. final good firm’s choices give factor prices $r = \alpha (K/L)^{\alpha-1}$ and

$w = (1 - \alpha)(K/L)^\alpha$.

iv. distribution $\Omega(i, \theta, \epsilon, a)$ consistent with policy functions.

v. labor market clears:

$$L = \int \epsilon \ d\Omega(i, \theta, \epsilon, a)$$

vi. capital market clears:

$$K = \int a \ d\Omega(i, \theta, \epsilon, a)$$

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?” p.42
1. Concentration: CC Networks (2016)

<table>
<thead>
<tr>
<th>Company</th>
<th>Cumulative share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visa</td>
<td>51</td>
</tr>
<tr>
<td>2. American Express</td>
<td>74</td>
</tr>
<tr>
<td>3. Master Card</td>
<td>96</td>
</tr>
<tr>
<td>4. Discover</td>
<td>100</td>
</tr>
</tbody>
</table>

- 3 networks account for 96% of market share
- Visa/MasterCard founded and jointly owned by largest banks
- Set large interchange fees (scale with rewards) paid to banks
  - Rewards programs generate net revenues for banks
  - Not in model

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Distribution of Gains 1970 Reform: GE vs SOE

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”
Credit Lines

- Consumer first borrows from cheapest credit line
  - Ignore firm identity for now
  - Let $j$ denote the spread ranking of a credit line

- Sort credit lines in ascending order by spreads
  - $(\tau_1 \leq \tau_2 \leq \ldots \tau_j \leq \ldots \leq \tau_N)$ w/ corresponding limits $({\bar l}_1, {\bar l}_2, \ldots, {\bar l}_N)$

- Balance on credit line $j \in 1, 2, \ldots, N$

$$a_j(a) = \begin{cases} -{\bar l}_j & \text{if } a \leq -\sum_{k=1}^{j} {\bar l}_k \\ \min \left[ a + \sum_{k=1}^{j} {\bar l}_k - {\bar l}_j, 0 \right] & \text{if } a > -\sum_{k=1}^{j} {\bar l}_k \end{cases}$$
- We assume that each period corresponds to one year.

- Capital share $\alpha = 0.33$, Depreciation rate $\delta = 0.045$, Risk aversion $\sigma = 2$

- Re-entry prob. good credit standing $\phi = 0.1$ (10-year exclusion)

- AR(1) process from Guvenen, Ozkan, Song (2014)
  \[ \rho_\epsilon = 0.953 \text{ and } \sigma^2_\epsilon = 0.06 \]

- 3 permanent types $\theta \in \{\theta_L, \theta_M, \theta_H\}$
  Quartiles of fixed effects in earnings estimation
Consumer: Value of Default

- Period of default: autarky 1 period, incur stigma $\chi$

- Period after default: can save, with probability $\phi$ can re-enter

$$V^D(\theta, \epsilon) = U(w\theta\epsilon + \Pi) - \chi$$
$$+ \beta E_{\epsilon'}|\epsilon [\phi V(g, \theta, \epsilon', 0) + (1 - \phi) V(b, \theta, \epsilon', 0)]$$

back

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?” p.47
Decomp. Gains: Consumers Lowest Earnings Decile

(a) Average consumption

(b) Variance consumption

(c) Average net assets

(d) Default Rate

Herkenhoff & Raveendranathan, “Who bears the welfare costs of monopoly?”