Democratization of Credit and the Rise in Consumer Bankruptcies

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Motivation

- Large changes in consumer credit markets over last 30 yrs.
  - Increase in bankruptcies
  - Increase in borrowing

- In Livshits, MacGee and Tertilt (AEJM 2007) we ruled out
  - changes on consumer side (e.g. more income risk)
  - legal changes

- This paper: technological progress in consumer credit sector.
  → increased access to credit (Democratization of Credit)
Debt and Defaults over Time

filings per 1000
revolving credit
credit card charge-off rate

### Changes in Access to Credit Cards

<table>
<thead>
<tr>
<th>Year</th>
<th>% Pop. has card</th>
<th>% Pop. has balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>43%</td>
<td>22%</td>
</tr>
<tr>
<td>1989</td>
<td>56%</td>
<td>29%</td>
</tr>
<tr>
<td>1995</td>
<td>66%</td>
<td>37%</td>
</tr>
<tr>
<td>1998</td>
<td>68%</td>
<td>37%</td>
</tr>
<tr>
<td>2001</td>
<td>73%</td>
<td>39%</td>
</tr>
<tr>
<td>2004</td>
<td>72%</td>
<td>40%</td>
</tr>
</tbody>
</table>

⇒ Large changes on extensive margin.

Due to changes in lending technology?
Computational Advances

- Nordhaus (JEH 2007) documents increase in computational speed, and decrease in computational cost for a long time period.
- Finds most rapid pace of improvement: 1985-1995.

→ Our hypothesis: Enabled widespread use of credit scoring technology.
Diffusion of Credit Scoring Technology

Evidence from newspaper keywords

NYT: credit scor* OR score card*/consumer credit
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>MBNA (first monoline) was founded, national credit cards</td>
</tr>
<tr>
<td>1984</td>
<td>First Deposit Corporation was founded (Andrew Kahr), ultimately became Providian.</td>
</tr>
<tr>
<td></td>
<td>SEGMENTATION: focus on particular segment of people</td>
</tr>
<tr>
<td>1980s</td>
<td>non-bank entrants (such as Sears, GM, and ATT), have informational advantage because they have some data on their own customers.</td>
</tr>
<tr>
<td>1988</td>
<td>Richard Fairbank and Nigel Morris: Information-based strategy (IBS), they start at Signet which becomes Capital One. EXPERIMENTATION with credit card terms and market segments, then analyze data and use only profitable segments.</td>
</tr>
<tr>
<td>1988</td>
<td>About half of all banks use credit scoring as a loan approval tool</td>
</tr>
<tr>
<td>1991</td>
<td>Amex/Citi: target low risk customers</td>
</tr>
<tr>
<td>early 1990s</td>
<td>credit cards have become hotly competitive, CUSTOMIZED PRODUCTS with thousands of combinations of rates, fees, credit lines, rewards, and services.</td>
</tr>
<tr>
<td>Early 1990s</td>
<td>Credit card companies rapidly expanded their use of risk-based pricing</td>
</tr>
<tr>
<td>1990s</td>
<td>Use of SCORECARDS as a loan approval tool soared.</td>
</tr>
<tr>
<td>2000</td>
<td>About seven-eighths of all banks use credit scoring as a loan approval tool</td>
</tr>
</tbody>
</table>
Our Interpretation

“Credit-scoring systems generally involve significant **fixed costs** to develop, but their "operating" cost is extremely low—that is, it costs a lender little more to apply the system to a few million cases than it does to a few hundred.”

Federal Reserve Board Report, 2007

- There exists a fixed cost of designing credit contract: selecting target market, analyzing data sets, development of scoring models, experimentation, customer service tailored to product.

- Costs needs to be paid on recurring basis (scoring models are constantly re-estimated, as economic conditions change).

- Fixed cost may have fallen over time due to better computing technologies.

- Accuracy of scoring technology may have increased over time.

→ Changes in who has access to credit. In particular: more risky
What We Do

1. Model *endogenous* consumer credit contracts with default
   - Fixed cost of offering a contract
   - Imperfect information about consumer’s riskiness
     - adverse selection

2. Study implications of technology improvement:
   (a) Increase in precision of signal
   (b) Decrease in fixed cost

3. Compare predictions of model to data:
   (a) Greater interest rate heterogeneity
   (b) More risk based pricing
   (c) Increased lending to lower income (riskier) households
Preview of Results

- Fixed cost of offering lending contract generates
  1. Finite number of contracts in equilibrium
  2. Each contract serves subset of population

- Increase in precision of signal and/or decline in cost of contract lead to
  1. Each contract serves a smaller subset
     - “Pools” become smaller
     - More accurate risk-based pricing
  2. More contracts offered in equilibrium
     - More borrowing
     - Expansion of credit to riskier borrowers
     - More defaults

- Consistent with observations
- Insight into Ausubel (1991) puzzle?
Related Literature

- Rise in consumer bankruptcy:
  Athreya (2004), Livshits, MacGee and Tertilt (2010)

- Technological Progress: focus on intensive margin
  Narajabad (2012), Nosal and Drozd (2007),

- Credit history and lending:
  Chatterjee, Corbae and Rios-Rull (2007, 2008)

- More risk-based pricing of consumer loans in US:
  Edelberg (2006)

- Lending and adverse selection:
  Jaffee and Russell (1976), Rotshild and Stiglitz (1976),
  Wilson (1977), Hellwig (1987)
Simple Model: Key Features

- Two period endowment economy
- Endowment stochastic in second period
- Household types differ in risk of endowment
- Risk-free interest rate (cost of funds) exogenous
- Incomplete markets: Non-contingent debt only
- Exogenous bankruptcy rule
- Financial intermediaries (lenders) pay fixed cost $\chi$ to offer debt contract (interest rate, loan size, eligibility set)
- Lenders observe noisy signal of HH risk type
Model: Consumers

- Risk-neutral borrowers:
  \[ u(c_1, c_2) = c_1 + \beta E_i c_2 \]

- Endowment:
  - No uncertainty in period 1
  - In period 2, \( y_i \in \{y_l, y_h\} \)

- Heterogeneity:
  - Consumers differ in probability \( \rho_i \) of good state \( y_h \)
  - \( \rho_i \) distributed uniformly on \([0, 1]\)
  - Lenders see signal \( \sigma \) of household type:
    - with probability \( \alpha \) signal is accurate: \( \sigma_i = \rho_i \)
    - otherwise signal is pure noise: \( \sigma \sim U[0, 1] \)
Bankruptcy

- Borrowers can declare bankruptcy in period 2.
  - Bankruptcy option introduces partial contingency.
- Cost of bankruptcy:
  - Lose a fraction $\gamma$ of endowment.
- Endogenous borrowing limits:
  - $L \leq \gamma y_l$
    - **Risk-free contract:** Always repaid.
  - $\gamma y_l < L \leq \gamma y_h$
    - **Risky contract:** Repaid with probability $\rho_i$.
  - $L > \gamma y_h$ is never repaid.
A contract is a triplet \((q, L, \bar{\sigma})\) offered by one intermediary.

- \(L\) is the loan size (face value)
- \(q\) is the bond price
  - Interest rate \(r = \frac{1}{q} - 1\)
- \(\bar{\sigma}\) specifies the eligibility set:
  - All consumers with \(\sigma \geq \bar{\sigma}\) are eligible for the contract
Model: Financial Intermediaries

- Competitive intermediaries.
- Intermediaries pay fixed cost $\chi$ to offer contract $(q, L, \bar{\sigma})$.
- Can borrow at rate $\bar{r}$. Define $\bar{q} = \frac{1}{1+\bar{r}}$.
- Assume $\bar{q} > \beta$ (otherwise no borrowing).
- Lenders see public signal $\sigma$, not $\rho$.
- Special case: complete info ($\alpha = 1$).
- All contracts observable by competition and households.
Timing (Wilson 1977, Hellwig 1987)

1.a. Lenders pay fixed costs $\chi$ and announce contracts.
1.b. HHs observe all contracts and choose which to apply for realizing some intermediaries may choose to exit.
1.c. Intermediaries decide whether to exit the market.
1.d. Remaining lenders notify approved applicants.
1.e. Borrowers choose best contract offered to them.

2.a. Households realize endowments and make default decisions.
2.b. Non-defaulting households repay their loans.

Assures existence.
Characterizing Equilibria

Proposition 1: All contracts offered feature either

- $L = \gamma y_l$ (risk-free contract)
- or $L = \gamma y_h$ (risky contracts)

Proposition 2: If $\alpha = 1$, all risky contracts $(q_k, L = \gamma y_h, \bar{\rho}_k)$ feature the following interest rate/eligibility cut-off relationship:

$$q_k = \bar{q}\bar{\rho}_k$$

Proof: $\bar{\rho}_k$ is the “break-even” type for a loan with price $q_k$.

⇒ The “riskiest” borrower accepted by a contract makes no contribution to the overhead cost $\chi$.

Corollary: Can order risky contracts: $1 = \bar{\rho}_0 > \bar{\rho}_1 > \bar{\rho}_2 > \ldots$
Equilibria: Characterization \((\alpha = 1)\)

- Free entry into intermediations determines “supply” of equilibrium contracts.

- Zero profit condition (of contract that serves interval \((\rho_n, \rho_{n-1})\)).

\[
\int_{\rho_n}^{\rho_{n-1}} (\rho_i \bar{q} - q_n) L di = \chi
\]

- Household participation decision determines contract “demand” – If top (lowest risk) household in interval participates, then all HH in interval participate.

- 2 Participation constraints:
  a) risky contract preferred over risk-free contract.
  b) risky contract preferred over autarky.
Proposition 3: Finitely many ($N$) risky contracts offered. Each contract $(q_n, \gamma y_h, \rho_n)$ serves borrowers in interval $\rho \in (\rho_n, \rho_{n-1}]$, where

$$\rho_n = 1 - n \sqrt{\frac{2\chi}{y_h \gamma q}}$$

$$q_n = \bar{q} \rho_n$$

Implications:
- Effective “pooling” even w/o asymmetric info
- some types are denied credit.
Equilibrium Set of Contracts
Complications of Asymmetric Information

- Good borrowers with bad signals will opt out.
- While bad borrowers with good signals stay in.
- Affects the pool of applicants for risky contracts.
- Makes contract pricing more difficult.
Characterizing Equilibria

**Proposition 4:** All risky contracts \((q_k, L = \gamma y_h, \bar{\sigma}_k)\) generate exactly zero profit in equilibrium.

**Proof:** Follows from free entry.

**Proposition 5:** Finitely many \((N)\) risky contracts offered. Each contract \((q_n, \gamma y_h, \bar{\sigma}_n)\) serves borrowers in interval \(\sigma \in [\bar{\sigma}_n, \bar{\sigma}_{n-1})\), where

\[
\bar{\sigma}_n = 1 - n\Theta
\]

and

\[
\Theta = \sqrt{\frac{2}{y_h \gamma} \frac{\chi}{\bar{q} \alpha}}
\]

Note: Higher \(\alpha\) implies lower \(\Theta\).
Equilibrium Set of Contracts

is determined by the participation constraints:

- Risky contracts must be preferred to alternatives
  - Either risk-free contract or autarky need to be checked
  - Find cut-off type $\hat{\rho}_n \in [\bar{\sigma}_n, 1]$ for each contract
  - This pins down the number of risky contracts, $N$

- Risk-free contract
  - Serves borrowers with $\sigma < \bar{\sigma}_N$ and $\rho > \hat{\rho}_n$
  - Offered only if it is preferred to autarky
With Asymmetric Information

The diagram illustrates the concept of asymmetric information in contracts. The axes represent different variables, and the shaded regions correspond to different outcomes or decisions. The legend indicates areas where entities might opt out or not belong to certain categories.
Outline of Rest of Talk

Use model to analyze two channels of improved credit technology:

1. Decrease in fixed cost
2. Increase in precision of risk assessment

Both channels can generate an increase in product variety.

Compare model predictions to data:

- Number of different contracts
- Borrower characteristics and pricing
- Household access to unsecured credit

Summary of Model Implications

Both technological changes imply

- more access of credit to riskier people.
- more total borrowing.
- more bankruptcies.
- increase in dispersion of interest rates.
- increase in ex-ante welfare.

Key Mechanism: extensive margin.
Comp statics in fixed cost $\chi$

1: Number of Risky Contracts

2: Length of Risky Contract Interval

3: Fraction of Population with Risky Debt

4: Total Risky Debt

5: Default Rates

6: Interest Rates

Default/Population

Default/Borrower

max

average

min

Costly Contracts – p. 28/47
Comp statics in signal accuracy $\alpha$

1: Number of Risky Contracts

2: Length Risky Contract Interval

3: Fraction Population with Risky Debt

4: Total Risky Debt

5: Default Rates

6: Interest Rates

Costly Contracts – p. 29/47
Data

- Use data from
  - Borrowers: Survey of Consumer Finance (SCF)
  - Lenders: interest rate data collected by the Fed

Key changes in unsecured consumer lending market:

1. Greater heterogeneity of lending contracts
2. More risk based pricing
3. Increased lending to lower income (riskier) households
Fact 1a: Increase in “Contract Variety”

- Focus on interest rates as measure of number of contracts
- Increase in number of different credit card interest rates reported by households:

<table>
<thead>
<tr>
<th>Year</th>
<th>All HH</th>
<th>HH with Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>78</td>
<td>47</td>
</tr>
<tr>
<td>1995</td>
<td>142</td>
<td>118</td>
</tr>
<tr>
<td>1998</td>
<td>136</td>
<td>115</td>
</tr>
<tr>
<td>2001</td>
<td>222</td>
<td>155</td>
</tr>
<tr>
<td>2004</td>
<td>211</td>
<td>145</td>
</tr>
</tbody>
</table>

Source: Survey of Consumer Finance.

- More disperse distribution of reported interest rates.
Fact 1b: More Dispersed Interest Rates

24-month consumer loan rates

Credit card rates
Fact 1c: “Flatter” Interest Rate Distribution

Distribution of Credit Card Interest Rates U.S. (%)

1983

2001
Fact 1d: Greater Spread
Fact 2: More Risk Based Pricing, 1983 vs 2001

PANEL A

Histogram of Interest Rates, 1983

PANEL B

Histogram of Interest Rates, 2001
Fact 3: Increased Lending to Lower Income

CDF Credit Card Borrowing vs Earned Income

- Red line: 2004
- Blue line: 1983
- Green line: 1995

Costly Contracts – p. 36/47
Fact 3. Increased Lending to Lower Income

Percent HH with Bank Credit Card, U.S.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>11%</td>
<td>17%</td>
<td>28%</td>
<td>29%</td>
<td>38%</td>
<td>38%</td>
</tr>
<tr>
<td>Balance &gt; 0</td>
<td>40%</td>
<td>43%</td>
<td>57%</td>
<td>59%</td>
<td>60%</td>
<td>61%</td>
</tr>
<tr>
<td>2nd Lowest</td>
<td>27%</td>
<td>36%</td>
<td>54%</td>
<td>58%</td>
<td>65%</td>
<td>61%</td>
</tr>
<tr>
<td>Balance &gt; 0</td>
<td>49%</td>
<td>46%</td>
<td>57%</td>
<td>58%</td>
<td>59%</td>
<td>60%</td>
</tr>
<tr>
<td>Highest</td>
<td>79%</td>
<td>82%</td>
<td>95%</td>
<td>95%</td>
<td>95%</td>
<td>96%</td>
</tr>
<tr>
<td>Balance &gt; 0</td>
<td>47%</td>
<td>46%</td>
<td>50%</td>
<td>45%</td>
<td>38%</td>
<td>44%</td>
</tr>
</tbody>
</table>

Source: Survey of Consumer Finance.
Other Comparative Statics: Ausubel (1991)

- Ausubel (1991) Puzzle: Why did credit card interest rate not ↓ with T-bill rate ↓ in 80s?
- Debate: credit card industry not competitive?
- What are predictions of our model for ↓ risk-free rate?
  Lower risk-free rate can lead to greater number of contracts

$$\rho_n = 1 - n \sqrt{\frac{2x}{y_n \gamma q}}$$

$$q_n = \overline{q} \rho_n$$

- Avg. interest rate of existing borrowers declines.
- Avg. interest rate of all borrowers changes little due to expansion of credit to riskier households.
Comp statics in safe interest rate $\bar{r}$

1: Number of Risky Contracts

2: Length of Risky Contract Interval

3: Fraction of Population with Risky Debt

4: Total Risky Debt

5: Interest Rates

Costly Contracts – p. 39/47
Summary

Simple model of unsecured lending with default with
- Fixed costs of creating contracts
- Adverse selection (noisy signals)

Can qualitatively generate key changes (more debt, more defaults, more interest rate variety, more access to credit for higher risk types) in consumer credit markets through
- improved signal quality (credit scoring)
- decline in cost of offering contracts (data mining)

Key Mechanism: extensive margin

Next:
- Quantitative relevance?
- Which channel is more important?
- Decomposition: extensive vs. intensive margin
Figure 1: Consumer Bankruptcies per 1000 of 18-64 yr-old
Debt as % of Disposable Income, USA

Graph showing the percentage of disposable income as debt in the USA from 1968 to 2000, with data for total debt, mortgage debt, consumer debt, and revolving debt.
# Overview Bankruptcy Law

<table>
<thead>
<tr>
<th>United States</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch. 7, 13</td>
<td>Straight, Proposal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Chapter 7</strong></th>
<th><strong>Straight Bankruptcy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge unsecured debt in exchange for assets.</td>
<td></td>
</tr>
<tr>
<td>Non-dischargeable: child support, taxes, etc.</td>
<td></td>
</tr>
<tr>
<td>6 years between filings</td>
<td>No limit on frequency</td>
</tr>
<tr>
<td>( \approx 4 ) months</td>
<td>9 months</td>
</tr>
<tr>
<td>( \approx 70% ) of filings</td>
<td>( \approx 85% ) of filings</td>
</tr>
</tbody>
</table>
**Fact 1.b: More Dispersed Interest Rates**

**Coefficient of Variation** of Limits and Interest Rates, SCF:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Int Rate (all)</td>
<td>0.22</td>
<td>NA</td>
<td>0.32</td>
<td>0.37</td>
<td>0.56</td>
</tr>
<tr>
<td>Int Rate (bal &gt; 0)</td>
<td>0.21</td>
<td>NA</td>
<td>0.35</td>
<td>0.40</td>
<td>0.56</td>
</tr>
<tr>
<td>Credit Limit</td>
<td>NA</td>
<td>1.60</td>
<td>1.45</td>
<td>1.64</td>
<td>1.49</td>
</tr>
<tr>
<td>Credit Limit/Income</td>
<td>NA</td>
<td>1.27</td>
<td>1.85</td>
<td>1.53</td>
<td>1.82</td>
</tr>
<tr>
<td>Balance (all)</td>
<td>1.80</td>
<td>2.22</td>
<td>2.35</td>
<td>2.87</td>
<td>2.29</td>
</tr>
<tr>
<td>Balance (bal &gt; 0)</td>
<td>1.08</td>
<td>1.45</td>
<td>1.60</td>
<td>1.99</td>
<td>1.59</td>
</tr>
</tbody>
</table>

Credit limit/balance more disperse than interest rates but ↑ trend in dispersion larger in interest rates.
# Consumer Credit Card Facts

Mean Values of Limits and Interest Rates Credit Cards, SCF

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Int Rate (all)</td>
<td>18.05%</td>
<td>NA</td>
<td>14.46%</td>
<td>14.36%</td>
<td>11.49%</td>
</tr>
<tr>
<td>Int Rate (bal &gt; 0)</td>
<td>18.08%</td>
<td>NA</td>
<td>14.48%</td>
<td>14.20%</td>
<td>11.81%</td>
</tr>
<tr>
<td>Credit Limit</td>
<td>NA</td>
<td>7077</td>
<td>12846</td>
<td>13552</td>
<td>15424</td>
</tr>
<tr>
<td>Credit Limit/Income</td>
<td>NA</td>
<td>0.19</td>
<td>0.41</td>
<td>0.37</td>
<td>0.41</td>
</tr>
<tr>
<td>Balance (all)</td>
<td>497</td>
<td>952</td>
<td>1695</td>
<td>1452</td>
<td>1860</td>
</tr>
<tr>
<td>Balance (bal &gt; 0)</td>
<td>971</td>
<td>1828</td>
<td>3096</td>
<td>2706</td>
<td>3312</td>
</tr>
</tbody>
</table>
Indirect Evidence: Interest Rates

- Survey of Consumer Finance: interest rates paid by consumers on credit card debt.
- Bank Survey conducted by Board of Governors: most common interest rate charged.

⇒ both data sets show an increase in “interest rate variety.”
Equilibria: Characterization

**Proposition 3:** Finitely many \((N)\) risky contracts offered. Each contract \((q_n, \gamma y_h, \rho_n)\) serves borrowers in interval \(\rho \in (\rho_n, \rho_{n-1}]\), where

\[
\rho_n = 1 - n \sqrt{\frac{2\chi}{y_h \gamma q}} \\
q_n = \overline{q} \rho_n
\]

Implications:
- Effective “pooling” even w/o asymmetric info
- Some types are denied credit.

If risk-free contract \((q_f, \gamma y_l)\) offered, serves borrowers with \(\rho \in [0, \rho_N]\).

\[
q_f = \overline{q} - \frac{\chi}{y_i \gamma \rho_N}
\]