Costly Contracts and Consumer Credit

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Motivation

- Large changes in consumer credit markets over last 30 yrs.
  - Increase in bankruptcies
  - Increase in borrowing
  - Roughly constant real interest rates

- Livshits, MacGee and Tertilt (2007) found that
  - ↑ uncertainty on consumer side not driving force
  - ↓ transactions cost of borrowing and
    ↓ in cost of bankruptcy ("stigma"?) can match data.

- This paper: More detailed analysis of technological progress in consumer credit sector.
Productivity: Banking vs. Aggregate

- Private Non-farm Business Sector
- Commercial Banking Sector
Motivation

- Development of Credit Scoring Models → allows better risk assessment of borrower. Credit scoring as loan approval tool: 50% of banks in 1988 to 85% in 2000.
- Reduced costs of processing information.
- “Common view” that financial innovation ↑ number of lending contracts targeted at specific groups (Mann 2006).

“...the advent of the monoline bank (a bank that only issued credit cards and didn’t take deposits or make other types of loans). This new breed of credit card bank came on the scene in the late 1980’s and made full use of newly available consumer credit databases to make targeted offers to different populations based on risk.”

http://www.creditfront.com/credit/0-Credit-Card-Offers.html
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 (2007)

- Technological Progress:
  Narajabad (2007), 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), 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 \([a, 1]\)
  - Lenders see signal \( \sigma \) of household type:
    - with probability \( \alpha \) signal is accurate: \( \sigma_i = \rho_i \)
    - otherwise signal is pure noise: \( \sigma \sim U[a, 1] \)
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.
Model: Contracts

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.
Fixed Costs

- Key feature of model: fixed cost of creating contract
- A product in consumer credit industry is “a collection of loans or lines of credits governed by standard terms and conditions” (Lawrence and Solomon (2002)).
- Product development costs include:
  1. selecting target market and researching competition
  2. designing terms and conditions of the product
  3. testing the product (can take 18 months)
  4. preparing formal documentation
  5. annual formal review of product
  6. customer service tailored specifically to product.
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.
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 $q_k$.

$\Rightarrow$ 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 \((\rho_n, \rho_{n-1})\)).

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

- 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.
Equilibria: Characterization \((\alpha = 1)\)

**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

\[
\rho_n = 1 - n \sqrt{\frac{2(1-a)xc}{yh\gamma q}}
\]

\[
q_n = \bar{q} \rho_n
\]

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 \(\rho \in [0, \rho_N]\).

\[
q_f = \bar{q} - \frac{\chi}{y_l\gamma \rho_N}
\]
Equilibrium Set of Contracts

\[
q
\]

\[
\bar{q}
\]

\[
\rho_1 \bar{q}
\]

\[
\rho_2 \bar{q}
\]

\[
\rho_3 \bar{q}
\]

\[
q_f
\]

\[
a \quad \rho_3 \quad \rho_2 \quad \rho_1 \quad 1
\]
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
- Enlarges the pool for risk-free contract
- Need to know risk-free price to find prices of risky contracts
- Effect of adverse selection in our environment shows up only in bond price but does not affect length of each contract interval.
Proposition 3: All risky contracts \( (q_k, L = \gamma y_h, \bar{\sigma}_k) \) generate exactly zero profit in equilibrium.

Proof: Follows from free entry.

Proposition 4: 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

\[
\Theta = \sqrt{\frac{2(1 - a)}{y_h \gamma \bar{q} \chi}} \frac{\chi}{\alpha}
\]
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 \( \rho > \hat{\rho}_n \)

\[
q_f = \overline{q} - \frac{\chi}{y_l \gamma} \cdot \frac{1 - a}{\bar{\sigma}_N - a + (1 - \alpha) \Theta \sum_n (1 - \hat{\rho}_n)}
\]

- Offered only if it is preferred to autarky
  - when enough borrowers not covered by risky contracts
With Asymmetric Information

The diagram illustrates the relationship between uniform and correct signals in the context of asymmetric information. It shows how the decision to opt out or not is contingent on the values of $\rho$ and $\sigma$. In the uniform signal scenario, different ranges of $\sigma$ lead to opt out or not belonging. In the correct signal scenario, the decision likely involves thresholds $q_1$, $q_2$, and $q_3$. The diagram aids in understanding the decision-making process under asymmetric information conditions.
Outline of Rest of Talk

- Use model to analyze two frequently mentioned channels of improved credit technology:
  1. Increase in precision of risk assessment
  2. Decrease in fixed cost
- 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
Comparative Statics in $\alpha$: # of Contracts

- Length of interval served by each contract decreasing in $\alpha$.
- Number of risky contracts is (weakly) increasing with $\alpha$.

- For large enough $\uparrow \alpha$, number of risky contracts offered $\uparrow$. 

Number of Risky Contracts vs alpha (Chi = 0.0001)
Comparative Statics in $\alpha$: # of Borrowers

- Total borrowing depends upon fraction of population eligible for risky contract and fraction who accept risky contract.

- Measure HH eligible for risky contracts: $N\Theta/(1 - a)$

![Graph showing fraction of population with risky borrowing vs alpha (Chi = 0.0001, a=0.66)]
Comparative Statics in $\alpha$: Defaults per Borrower

- Extensive margin: extend credit to riskier households
- Intensive margin: $\uparrow \alpha$ may lower bankruptcies per borrower
  - improvement in the pool of eligible borrowers
  - improvement in who accepts contracts

![Graph showing Average Default Rate of Borrowers vs alpha](image)
Comparative Statics in $\alpha$: Interest Rates

- More accurate risk-based pricing as $\alpha$ increases
- More dispersed interest rates
- Little change in average borrowing interest rate
  - due to expansion of credit to riskier borrowers

![Interest Rates vs alpha](image)
Comparative Statics in $\alpha$: Overhead Costs

- Overhead cost may go up due to increase in number of contracts.

Overhead Costs as % Face Value Risky Borrowing
Comparative Statics in $\alpha$ – Summary

- More accurate risk-based pricing
- Length of interval served by each contract decreasing in $\alpha$.
- Number of risky contracts is (weakly) increasing with $\alpha$.

For sufficiently large increase in $\alpha$

- Increase in number of lending contracts
- Increased dispersion of interest rates
- Increased lending to riskier borrowers
- More bankruptcies
- Increase in ratio of overhead costs to loans
Comparative Statics in $\chi$ – Summary

- Improvements in information technology may have reduced fixed cost of contracts
- For sufficiently large decrease in $\chi$
  - Increase in number of lending contracts
  - Increased dispersion of interest rates
  - Increased lending to riskier borrowers
  - More bankruptcies (disproportionate to debt)
  - Ratio of total overhead costs to lending decreases by less than decrease in $\chi$
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

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

Cross-Bank Variation in Interest Rates
Source: Bank Surveys, Board of Governors

24-month consumer loan rates  credit card rates, TCCP data
Fact 1c: “Flatter” Interest Rate Distribution

Distribution of Credit Card Interest Rates U.S. (%)
Fact 1d: Greater Spread

TCCP data (national only), 1990-2007

interest rate (basis points)


Costly Contracts – p. 36/49
Fact 2: More Risk Based Pricing, 1983 vs 2001
Fact 3: Increased Lending to Lower Income

CDF Credit Card Borrowing vs Earned Income

2004
1983
1995

Costly Contracts – p. 38/49
## 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>
<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</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</td>
<td>49%</td>
<td>46%</td>
<td>57%</td>
<td>58%</td>
<td>59%</td>
<td>60%</td>
</tr>
<tr>
<td>Middle</td>
<td>41%</td>
<td>62%</td>
<td>71%</td>
<td>72%</td>
<td>79%</td>
<td>77%</td>
</tr>
<tr>
<td>Balance</td>
<td>58%</td>
<td>56%</td>
<td>58%</td>
<td>58%</td>
<td>61%</td>
<td>64%</td>
</tr>
</tbody>
</table>

Source: Survey of Consumer Finance.
## Comparison Model vs. Data

<table>
<thead>
<tr>
<th></th>
<th>Δ in Model</th>
<th>Δ in Data (over time)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \alpha \uparrow^* )</td>
<td>( \chi \downarrow^* )</td>
</tr>
<tr>
<td>Defaults/Population</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Borrowers/Population</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Debt</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td># interest rates</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>max ( r )</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>min ( r )</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>debt share low income</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

*Note: for sufficiently large increase \( \alpha \), decrease \( \chi \)*
Ausubel (1991) Puzzle: Why did credit card interest rate not \( \downarrow \) with T-bill rate \( \downarrow \) in 80s?

Debate: credit card industry not competitive?

What are predictions of our model for \( \downarrow \) risk-free rate?
Lower risk-free rate can lead to greater number of contracts

\[
\rho_n = 1 - n \sqrt{\frac{2x}{yn \gamma q}}
\]
\[
q_n = \bar{q} \rho_n
\]

Avg interest rate of existing borrowers declines.
Avg interest rate of *all* borrowers changes little due to expansion of credit to riskier households.
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 borrowing by higher risk types) in consumer credit markets through
  - improved signal quality (credit scoring)
  - decline in cost of offering contracts (data mining)

- Next:
  - Which of the driving forces is quantitatively relevant?
  - Address both extensive and intensive margins?
Figure 1: Consumer Bankruptcies per 1000 of 18-64 yr-old
# 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>≈ 4 months</td>
<td>9 months</td>
</tr>
<tr>
<td>≈ 70% of filings</td>
<td>≈ 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>
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<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>
<th></th>
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<th></th>
<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.”
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 \(\rho \in [0, \rho_N]\).

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