The Role of Information in Consumer Debt and Bankruptcy

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Econometric Society
1. Introduction

Motivation

What do I do?

2. $2 \times 2$ model

3. QGE model

Explosive trends in consumer unsecured debt and bankruptcy during the last 20 years.

□ The bankruptcy rate (ratio of bankruptcy filings to the number of households in debt) increased around 3 times.

□ During the same period there was impressive technological progress in the information sector.

□ The financial sector uses information technologies intensively to evaluate credit risk.
Motivation

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- During the same period there was impressive technological progress in the information sector.

- The financial sector uses information technologies intensively to evaluate credit risk.
What do I do?

Provide a quantitative theory to evaluate the role of technological progress in the information sector in consumer debt and bankruptcy.

Study qualitative predictions in a $2 \times 2$ version of the model.

Calibrate the GE model to the U.S. economy for the years 1983 and 2004, and compute counterfactual economies.

Find that technological progress in the information sector explains around 40 percent of the total rise in bankruptcy during this period.
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Individuals’ problem
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□ Lifetime utility of an individual born with assets $a_1$ and income $y_n$ is
Individuals’ problem

Lifetime utility of an individual born with assets $a_1$ and income $y_n$ is

$$U(a_1, y_n; q) = \max_{a_2 \in A} u(y_n + a_1 - q(a_2, n; a_1)a_2)$$

first period utility

high income $\Rightarrow + \beta \pi_{n,H} \max\{u(y_H + a_2), u(y_H(1 - \tau))\}$

low income $\Rightarrow + \beta \pi_{n,L} \max\{u(y_L + a_2), u(y_L(1 - \tau))\}$,

where:

- $q$ indicates that a borrower must pay one unit of consumption next period for a loan of size $q$ today.
- risk-free interest rate $i$ is given.
- $\pi_{LH}$ is transition probability between state $L$ and $H$. Persistence implies $\pi_{HH} > \pi_{LH}$.
- $\tau$ is a share of income lost after bankruptcy.
There are 2 discrete choices:

1. Introduction
2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits q
   - Screening
   - Revelation
   - Contracts choice
   - Effect of info
3. QGE model
There are 2 discrete choices:

1st: Individuals can borrow using two alternative contracts:

⇒ Screening contracts (informed lenders)
• \( \bar{q} \) satisfies zero-expected profits for each \((a', n)\).
• To use \( \bar{q} \), individuals should first pay the screening cost \( C \).

⇒ Revelation contracts (uninformed lenders)
• Since there is direct-revelation, the price is also the one satisfying zero-expected profits for each \((a', n)\), \( \bar{q} \).
• However, not any \( a' \) can be offered without screening, only those \( \bar{q}(\cdot, n) \) satisfying direct-revelation.

2nd: The bankruptcy decision can be characterized by

Default if \( yn + a^2 \geq \text{income - debt} \)
Pay back otherwise.
There are 2 discrete choices:

1st: Individuals can borrow using two alternative contracts:

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2nd: The bankruptcy decision can be characterized by

- Default if $y_n + a_2 \leq y_n (1 - \tau)$,
- Pay back otherwise.
There are 2 discrete choices:

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  - To use $\tilde{q}$, individuals should first pay the screening cost $C$.

⇒ Revelation contracts (uninformed lenders)

2nd: The bankruptcy decision can be characterized by

Default if $\text{income} - \text{debt} < y_n (1 - \tau)$,

Pay back otherwise.
There are 2 discrete choices:

1st: Individuals can borrow using two alternative contracts:

⇒ **Screening contracts (informed lenders)**
   - \( \tilde{q} \) satisfies zero-expected profits for each \((a', n)\).
   - To use \( \tilde{q} \), individuals should first pay the screening cost \( C \).

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2nd: The bankruptcy decision can be characterized by

Default if $y_n + a_2 < y_n (1 - \tau)$,

Pay back otherwise.
Zero-expected-profit discount prices

Discount price, $q$

Assets, $a_2$

$\frac{1}{1+i}$

$\frac{1}{1+i} \pi_{HH}$

$\frac{1}{1+i} \pi_{LH}$

Risk-free limit

$0$
Zero-expected-profit discount prices

Discount price, \( q \)

\[
\begin{align*}
\text{risk free price} & \quad \frac{1}{1+i} \\
\frac{1}{1+i} \pi_{HH} & \\
\frac{1}{1+i} \pi_{LH} & \\
0 & 
\end{align*}
\]

Assets, \( a_2 \)

\[
\begin{align*}
a_H & \\
\text{risk-free limit} & \\
a_L & 
\end{align*}
\]
1. Introduction

2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits $q$
   - Screening
   - Revelation
   - Contracts choice
   - Effect of info

3. QGE model

Zero-expected-profit discount prices

Discount price, $q$

- $rac{1}{1+i}$
- $rac{1}{1+i} \pi_{HH}$
- $rac{1}{1+i} \pi_{LH}$

Assets, $a_2$

- $a_H$
- $a_L$

Risk-free limit

Price for individuals with high income in the first period
Zero-expected-profit discount prices

- Price for individuals with **high** income in the first period
- Price for individuals with **low** income in the first period

Discount price, $q$

- Risk-free limit
- Risk-free price

Assets, $a_2$

- $a_H$
- $a_L$

Effect of info

Indiv. problem

Screening

Revelation

Contracts choice

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1. Introduction

2. $2 \times 2$ model

3. QGE model
Equilibrium prices with screening contracts

1. Introduction
2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits $q$
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3. QGE model

\[
\begin{align*}
\text{Discount price, } q & = \frac{1}{1+i} \\
\text{risk free price, no need for screening} & = \frac{1}{1+i} \\
\text{price for individuals with high income in the first period, after screening} & = \frac{1}{1+i} \pi_{HH} - C \\
\text{price for individuals with low income in the first period, after screening} & = \frac{1}{1+i} \pi_{LH} - C
\end{align*}
\]

Assets, $a_2$

\[
\begin{align*}
a_H & \\
a_L & \\
0 &
\end{align*}
\]
Indifference curves
1. Introduction

2. 2 × 2 model
   Indiv. problem
   Zero-profits q
   Screening
   Revelation
   Contracts choice
   Effect of info

3. QGE model

\[ U_L(a_1) \]

\[ \Delta a_2 \]

\[ \Delta q \]

Indifference curves

Discount price, \( q \)

Assets, \( a_2 \)
Indifference curves

\[ U_H(a_1) \]

\[ U_L(a_1) \]

\[ \Delta q \]

\[ \Delta a_2 \]

Discount price, $q$

Assets, $a_2$
Indifference curves

\[ U_H(a_1) \]

\[ U_L(a_1) \]

\[ \Delta a_2 \]

\[ \Delta q \]

Assets, \( a_2 \)

Discount price, \( q \)
Equilibrium with revelation contracts

1. Introduction
2. $2 \times 2$ model
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   - Zero-profits $q$
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3. QGE model

Individuals with low income maximize utility given their zero-expected-profits prices.
Equilibrium with revelation contracts

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2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits $q$
   - Screening
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   - Contracts choice
   - Effect of info

3. QGE model

Equilibrium with revelation contracts

- $U^1_L(a_1)$
- $e_L$
- Individuals with low income maximize utility given their zero-expected-profits prices

Discount price, $q$

- $\frac{1}{1+i}\pi_{HH}$
- $\frac{1}{1+i}\pi_{LH}$

Assets, $a_2$
1. Introduction

2. $2 \times 2$ model
   - Indiv. problem
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Equilibrium with revelation contracts

$U^2_L(a_1)$

$U^1_L(a_1)$

Indiv. problem

Do not satisfy direct-revelation

Individuals with low income maximize utility given their zero-expected-profits prices

Discount price, $q$

$\frac{1}{1+i} \pi_{HH}$

$\frac{1}{1+i} \pi_{LH}$

Assets, $a_2$

$a_H$

$a_L$

$0$
Equilibrium with revelation contracts

1. Introduction
2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits $q$
   - Screening
   - Revelation
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3. QGE model

\[ U_L^1(a_1) \]

\[ \frac{1}{1+i} \pi_{HH} \]

\[ \frac{1}{1+i} \pi_{LH} \]

\[ a_H \]

\[ a_L \]

\[ e_L \]

\[ 0 \]

Discount price, $q$
Equilibrium with revelation contracts

1. Introduction
2. $2 \times 2$ model
   - Indiv. problem
   - Zero-profits $q$
   - Screening
   - Revelation
   - Contracts choice
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3. QGE model

$U_H^1(a_1)$
$U_L^2(a_1)$

Direct-revelation constraint is binding

$\frac{1}{1+i}\pi_{HH}$
$\frac{1}{1+i}\pi_{LH}$

Assets, $a_2$

Discount price, $q$

$0$

$a_H$

$a(a_1)$

$a_L$
Equilibrium with revelation contracts

High-income individuals are borrowing constrained

$U^2_H(a_1)$

$U^1_L(a_1)$

Direct-revelation constraint is binding

Assets, $a_2$

$\frac{1}{1+i} \pi_{HH}$

$\frac{1}{1+i} \pi_{LH}$

Discount price, $q$

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2. $2 \times 2$ model
   Indiv. problem
   Zero-profits $q$
   Screening
   Revelation
   Contracts choice
   Effect of info
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Choice of contract
1. Introduction

2. $2 \times 2$ model

   - Indiv. problem
   - Zero-profits $q$
   - Screening
   - Revelation
   - Contracts choice
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3. QGE model

   Choice of contract

   \[ U_H^2(a_1) \]
   \[ U_L^1(a_1) \]

\[
\begin{align*}
U_H^1 & (a_1) \\
U_L^2 & (a_1)
\end{align*}
\]

Assets, $a_2$

Discount price, $q$

\[
\frac{1}{1+i} \pi_{HH} - c
\]

\[
\frac{1}{1+i} \pi_{LH}
\]

\[
\frac{1}{1+i}
\]

Threshold cost of information

\[
\begin{align*}
e_H & \\
e_L
\end{align*}
\]

\[
\begin{align*}
a_H & \\
a_L
\end{align*}
\]
High information costs allocation
High information costs allocation

1. Introduction
2. 2 × 2 model
   - Indiv. problem
   - Zero-profits q
   - Screening
   - Revelation
   - Contracts choice
   - Effect of info
3. QGE model

\[ q = \frac{1}{1+i} \]

This is not the equilibrium allocation

<table>
<thead>
<tr>
<th>Assets, ( a_2 )</th>
<th>( a_H )</th>
<th>( a_L )</th>
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<tbody>
<tr>
<td>( U_{L}^{1} )</td>
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<tr>
<td>( U_{H}^{2} )</td>
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<tr>
<td>( U_{H}^{3} )</td>
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Discount price, \( q \)
High information costs allocation

1. Introduction
2. 2 × 2 model
   - Indiv. problem
   - Zero-profits q
   - Screening
   - Revelation
   - Contracts choice
   - Effect of info
3. QGE model

Discount price, q

\[ \frac{1}{1+i} \]

Assets, \( a_2 \)

Agents are better here (risk-free)

\[ e_L \]

\[ \frac{1}{1+i} \pi_{HH} \]

\[ \frac{1}{1+i} \pi_{LH} \]
1. Introduction

2. 2 × 2 model

3. QGE model

Zero information costs allocation

More debt and more bankruptcy

Zero-profits q

Indiv. problem

Screening

Contracts choice

Effect of info

Assets, $a_2$

Discount price, $q$

$\bar{a}_H$

$\bar{a}_L$

$\frac{1}{1+i THH}$

$\frac{1}{1+i TLH}$

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QGE model incorporates:

1. At any time, there is a unit mass of households.
2. Each household is endowed with one unit of time.
3. Individuals belong to different productivity groups, $n_t \in \mathbb{N}$.
4. Transition probability for $n_t$ is $\Pi(n_t, n_t + 1)$.
5. Productivity is exogenously determined by labor endowments.
6. Labor endowments depends on $n_t$, $l_t \in L(n_t) = [\bar{l}_n, \bar{\bar{l}}_n]$.
7. The conditional density function is $\phi(l_t|n_t)$. 

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- The conditional density function is $\phi(l_t \mid n_t)$.
Value functions

- period $t$
- period $t + 1$
Value functions

- Good credit flag $(G)$
  - Default $(D)$
  - No default $(V)$
- Pay back

Period $t$

Period $t + 1$
1. Introduction

2. 2 × 2 model

3. QGE model

Extensions
Calibration
Parameters
Counterfactual
Mechanism
Why information?

Value functions

- Good credit flag \( G \)
- Bad credit flag \( B \)
- Default \( D \)
- Pay back \( V \)
- Screening contracts \( \hat{V} \)
- Revelation contracts \( \hat{\tilde{V}} \)

Period \( t \)
- \( \lambda \) - exogenous probability of a fresh start
- \((1 - \lambda)\) - exogenous probability of staying with a bad credit flag

Period \( t + 1 \)
1. Introduction
2. $2 \times 2$ model
3. QGE model
   - Extensions
   - Calibration
   - Parameters
   - Counterfactual
   - Mechanism
   - Why information?

Value functions

$$\text{Good credit flag (G)}$$
$$\text{Bad credit flag (B)}$$
$$\text{Default (D)}$$
$$\text{Good credit flag (G)}$$
$$\text{No default (V)}$$
$$\text{Screening contracts (V)}$$
$$\text{Good credit flag (G)}$$
$$\text{Pay back}$$
$$\text{Revelation contracts (V)}$$
$$\text{Good credit flag (G)}$$

period $t$

period $t + 1$
Value functions

1. Introduction
2. $2 \times 2$ model
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   - Extensions
   - Calibration
   - Parameters
   - Counterfactual Mechanism
   - Why information?

**Good credit flag** ($G$)
- Default ($D$)
  - No default ($V$)
    - Screening contracts ($\tilde{V}$) (Informed lenders)
    - Revelation contracts ($\hat{V}$) (Uninformed lenders)
- Bad credit flag ($B$)

**Bad credit flag** ($B$)
- Pay back
- Exogenous probability of a fresh start ($\lambda$)
- Exogenous probability of staying with a bad credit flag ($1 - \lambda$)

Period $t$ to period $t + 1$
Value functions

1. Introduction
2. $2 \times 2$ model
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   - Extensions
   - Calibration
   - Parameters
   - Counterfactual
   - Mechanism
   - Why information?

Good credit flag \((G)\)
- default
  - Default \((D)\)
  - No default \((V)\)
    - pay back
    - Screening contracts \((\tilde{V})\)
      - Informed lenders
    - Revelation contracts \((\hat{V})\)
      - Uninformed lenders
      - Good credit flag \((G)\)

Bad credit flag \((B)\)
- exogenous probability of a fresh start \((\lambda)\)
  - Bad credit flag \((B)\)
  - Good credit flag \((G)\)

period \(t\)

period \(t + 1\)
3. QGE model

Extensions
Calibration
Parameters
Counterfactual
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Why information?

Value functions

1. Introduction
2. $2 \times 2$ model

Good credit flag $(G)$
- Pay back
- Default $(D)$
- No default $(V)$
- Screening contracts $(\tilde{V})$
- Revelation contracts $(\hat{V})$

Bad credit flag $(B)$
- Default $(D)$
- No default $(V)$
- Good credit flag $(G)$
- Bad credit flag $(B)$

Exogenous probability of staying with a bad credit flag $(1 - \lambda)$
Exogenous probability of a fresh start $(\lambda)$

Period $t$

Period $t + 1$
Calibration

-The model’s parameters are calibrated to match some moments.
Calibration

⇒ The model’s parameters are calibrated to match some moments.

⇒ There are 10 income groups.
Calibration

⇒ The model’s parameters are calibrated to match some moments.

⇒ There are 10 income groups.

⇒ This implies that there are 24 parameters to be determined.
Calibration

⇒ The model’s parameters are calibrated to match some moments.

⇒ There are 10 income groups.

⇒ This implies that there are 24 parameters to be determined.

□ 5 parameters are determined independently.
The model’s parameters are calibrated to match some moments.

There are 10 income groups.

This implies that there are 24 parameters to be determined.

5 parameters are determined independently.

19 parameters are jointly determined, using an algorithm to minimize the distance to the targets.
## Parameters and results year 1983

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor, $\beta$</td>
<td>0.92</td>
</tr>
<tr>
<td>Cost of bankruptcy, $\tau$</td>
<td>0.18</td>
</tr>
<tr>
<td>Persistence of type $n = 1$</td>
<td>0.44</td>
</tr>
<tr>
<td>Persistence of type $n = 2$</td>
<td>0.77</td>
</tr>
<tr>
<td>Persistence of type $n = {3, \ldots, 7}$</td>
<td>0.42</td>
</tr>
<tr>
<td>Transition probability from type $n = {1, \ldots, 9}$ to $n = 10$</td>
<td>0.0002</td>
</tr>
<tr>
<td>Transition probability from type $n = 2$ to $n = 1$</td>
<td>0.036</td>
</tr>
<tr>
<td>Transition probability from type $n = {2, \ldots, 8}$ to $n + 1$</td>
<td>0.12</td>
</tr>
<tr>
<td>Technology in the information sector</td>
<td>1.26</td>
</tr>
</tbody>
</table>

### Statistics

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Targets 1983</th>
<th>“1983” calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankruptcy rate</td>
<td>0.49%</td>
<td>0.507%</td>
</tr>
<tr>
<td>Debt-to-income ratio</td>
<td>0.31%</td>
<td>0.328%</td>
</tr>
<tr>
<td>Capital-to-output ratio</td>
<td>3.44</td>
<td>3.39</td>
</tr>
<tr>
<td>Proportion of debt held by income poorest 10%</td>
<td>25%</td>
<td>31%</td>
</tr>
<tr>
<td>Proportion of debt held by income poorest 20%</td>
<td>33%</td>
<td>44%</td>
</tr>
<tr>
<td>Proportion of debt held by income poorest 30%</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>Gini coefficient of income</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Mean-to-median income ratio</td>
<td>1.35</td>
<td>1.35</td>
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<tr>
<td>Gini coefficient of wealth</td>
<td>0.75</td>
<td>0.82</td>
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<tr>
<td>Mean-to-median wealth ratio</td>
<td>2.95</td>
<td>5.2</td>
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<td>Information costs to mean income ratio</td>
<td>—</td>
<td>3.9</td>
</tr>
</tbody>
</table>
Is the transition matrix similar to the data from matched March CPS?
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<table>
<thead>
<tr>
<th>Income groups between percentiles</th>
<th>Data year 1983</th>
<th>Model's &quot;1983&quot; calibration</th>
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<td>[0, 7]</td>
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<td>[7, 45]</td>
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<td>[45, 64]</td>
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<td>[64, 78]</td>
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Counterfactual exercise

Compute “1983” economy but with $z^i_{2004}(=0)$. 

Which would be the bankruptcy rate in 1983 with the technology in the information sector of 2004?

Technological progress in the information sector accounts for 45% of the total rise in the bankruptcy rate between 1983 and 2004.
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- Compute “1983” economy but with $z_{2004}^i (= 0)$.
- This exercise answers:

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Mechanism? Same than in $2 \times 2$

- The lack of information restricts the number of bankruptcy filings through changes in discount prices.
- With $z_{04}$: individuals in the 2nd income decile (or higher) can borrow only with low (or no) risk of bankruptcy.
- With $z_{04}$: they can borrow more and file for bankruptcy more often.
- The proportion of risky debt rises from 19 to 35%.
- The proportion of risky debt in the 2nd to 4th income deciles increases from 38 to 66%.
Mechanism? Same than in $2 \times 2$

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Distinguishing implications in the data

- Distinguishing implications of information on productivity as driving force:
  1. It changes the distribution of debt across income groups.
  2. It rises the dispersion of interest rates.
  3. It modifies the relationship between interest rates and income.

- Distinguishing implications in the data:
  1. ✓ Between 1983 and 2004, the percentage of debt held by individuals in the 2nd and 3rd income deciles doubled.
  2. ✓ The standard deviation of interest rates on credits cards rose from 4.1 in 1983 to 6.3 in 2004.
  3. ✓ In the year 1983, a borrower’s income is not significant explaining his interest rates. In the year 2004, borrowers with higher income pay lower interest rates (e.g. increasing income from percentile 1 to 5 decreases interest rate 1%).
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