Adverse Selection in the Loan Market

Gregory Crawford \(^1\) Nicola Pavanini \(^2\) Fabiano Schivardi \(^3\)

\(^1\)University of Warwick, CEPR and CAGE

\(^2\)University of Warwick

\(^3\)University of Cagliari, EIEF and CEPR

May 18, 2012
PEDL Inaugural Workshop
Introduction I

- Asymmetric information is an important matter in insurance and credit markets
  - Enormous theoretical literature; seminal contributions from:
    - Akerlof (1970), Rothschild and Stiglitz (1976),
    - Stiglitz and Weiss (1981)
- But... empirical evidence about the scope and effects of asymmetric information is scarce:
  - Why?
Asymmetric information is, by definition, hard to measure:

- Adverse selection = Hidden information
- Moral hazard = Hidden action(s)

Empirical approaches in the literature:

- Test for the presence of asymmetric info
  - e.g. Chiappori and Selanié (2000)
- Estimate its distribution using structural methods
  - Some recent work in insurance markets
  - Very little in credit markets
Contribution I

What we do in this paper:

- Employ a unique set of linked datasets in the Italian market for small business lines of credit from 1988-1998
- Estimate a structural model of demand and supply (pricing) of credit with adverse selection
  - Based on Stiglitz and Weiss (1981)

The goals:

1. Measure the extent of asymmetric information in an important credit market
2. Understand the interaction between adverse selection and competition
Preview of Results

- None yet.
  - We are cleaning the data and developing our econometric model.

- The goal today:
  - Describe the kinds of data we are using
  - Briefly describe the model of adverse selection we’ll be taking to this data
Vast theoretical work on asymmetric info since 1970s.

(Discussed above)

Recent interest in structural models of insurance and credit markets with asymmetric info.

- Cohen and Einav (2007)
- Einav, Jenkins, and Levin (2011)**

Evidence on competition effects of asymmetric info in Italian credit markets.

(See next slide)
Asymmetric Information in Italian Banking

- New banking entrants often perform poorly relative to incumbents:
  - Bofondi and Gobbi (2006):
    - Entrants experience higher default rates than incumbents
  - Gobbi and Lotti (2004):
    - Interest rate spreads positively correlated with entry of de novo banks (but not existing banks in other markets)

- Mergers enhance pricing of (observable) risk:
  - Panetta, Schivardi, and Shum (2009):
    - Merged banks match better interest rates and default risk
    - Due to better information processing, not from info sharing

- Our focus: (unobserved) info effects on (price) competition
  - [Pavanini JMP (2013): Info effects on entry decisions]
We employ a unique set of linked datasets in the Italian market for small business lines of credit from 1988-1998:

1. 1.2m individual loan contracts (S: *Centrale dei Rischi*)
   - By firm-bank-year: Credit granted, credit used, interest rate, default

2. 62k Italian non-financial and non-agricultural firms (S: *Centrale dei Bilanci*)
   - By firm-year: balance sheet, income statements, location
   - Wide coverage of small- and medium-sized firms
   - Representing 30% of gross operating profits of all Italian non-financial firms (S: *ISTAT*)
The Data II

Linked datasets, cont.:

3. 90 banks accounting for 80% of bank lending (S: Banking Supervision Register)
   - By bank-year: Size, assets, costs, share of bad loans

4. Yearly bank branches at city-council level (~ 8,000 in Italy)
Features of Credit Lines

- Defined as short-term non-collateralized loans
- With these features:
  - Bank can change interest rate anytime
  - Firm can close credit line without notice
- Main source of external financing of Italian firms
  - (53% of total firms’ debt in 1994)
## Firms (Obs: Firm-Year)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; pc</th>
<th>Median</th>
<th>95&lt;sup&gt;th&lt;/sup&gt; pc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td>145,510</td>
<td>28,370</td>
<td>588,445</td>
<td>1,632</td>
<td>7,715</td>
<td>65,698</td>
</tr>
<tr>
<td>Net Assets</td>
<td>145,510</td>
<td>7,543</td>
<td>301,499</td>
<td>36</td>
<td>1,031</td>
<td>14,583</td>
</tr>
<tr>
<td>ST Debts</td>
<td>145,510</td>
<td>5,463</td>
<td>61,307</td>
<td>0</td>
<td>1,271</td>
<td>15,525</td>
</tr>
<tr>
<td>Sales</td>
<td>145,510</td>
<td>29,415</td>
<td>294,744</td>
<td>1,698</td>
<td>10,967</td>
<td>73,855</td>
</tr>
<tr>
<td>Profits</td>
<td>145,510</td>
<td>2,879</td>
<td>87,280</td>
<td>-358</td>
<td>732</td>
<td>6,576</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>145,510</td>
<td>2,085</td>
<td>72,809</td>
<td>-256</td>
<td>349</td>
<td>4,666</td>
</tr>
<tr>
<td>Leverage</td>
<td>145,504</td>
<td>0.55</td>
<td>12.84</td>
<td>0</td>
<td>0.64</td>
<td>0.98</td>
</tr>
<tr>
<td>Score</td>
<td>145,510</td>
<td>5.30</td>
<td>1.77</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

Assets, Debts, Sales, Profits, Cash Flow in thousands of €. Net Assets are Total Assets minus liabilities. ST Debts are debts within 1 year. Leverage is debt/liabilities. Obs is firm-year. Omitting left-censored observations (60% of loans, 49% of credit granted).
Score is an indicator of the risk profile of each firm, computed annually using a series of balance sheet indicators. It approximates the information available to the bank at the time of lending.
## Firms across Risk Categories

<table>
<thead>
<tr>
<th>Variables</th>
<th>Safe</th>
<th>Solvent</th>
<th>Vulnerable</th>
<th>Risky</th>
<th>Ever Defaulted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td>31,772</td>
<td>32,846</td>
<td>28,534</td>
<td>23,774</td>
<td>24,565</td>
</tr>
<tr>
<td>Net Assets</td>
<td>15,457</td>
<td>11,123</td>
<td>6,600</td>
<td>3,784</td>
<td>1,384</td>
</tr>
<tr>
<td>ST Debts</td>
<td>1,957</td>
<td>4,636</td>
<td>5,717</td>
<td>6,664</td>
<td>7,810</td>
</tr>
<tr>
<td>Sales</td>
<td>44,284</td>
<td>37,428</td>
<td>28,471</td>
<td>20,480</td>
<td>16,823</td>
</tr>
<tr>
<td>Profits</td>
<td>5,976</td>
<td>4,787</td>
<td>2,649</td>
<td>854</td>
<td>757</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>5,106</td>
<td>3,931</td>
<td>1,849</td>
<td>133</td>
<td>-286</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.20</td>
<td>0.41</td>
<td>0.63</td>
<td>0.66</td>
<td>0.83</td>
</tr>
<tr>
<td>Score</td>
<td>1.60</td>
<td>3.75</td>
<td>5.46</td>
<td>7.23</td>
<td>6.83</td>
</tr>
<tr>
<td>N of Firm-Year</td>
<td>10,543</td>
<td>39,605</td>
<td>47,298</td>
<td>48,064</td>
<td>5,344</td>
</tr>
</tbody>
</table>

Assets, Debts, Sales, Profits, Cash Flow in thousands of €. Net Assets are Total Assets minus liabilities. ST Debts are debts within 1 year. Leverage is debt/liabilities. Obs is firm-year. These are all means.
Observations Per Firm

Distribution of Firms by Number of Years in the Sample

Percentage of Firms

Number of Years

1 2 3 4 5 6 7 8 9 10
Firm Dynamics

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>5th pc</th>
<th>Median</th>
<th>95th pc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years in Data</td>
<td>38,339</td>
<td>3.77</td>
<td>2.36</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Max in-sample Δ Score</td>
<td>38,630</td>
<td>1.26</td>
<td>1.32</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Last-First Δ Score</td>
<td>38,630</td>
<td>-0.06</td>
<td>1.43</td>
<td>-2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Max in-sample Δ Sales</td>
<td>38,630</td>
<td>11,273</td>
<td>77,017</td>
<td>0</td>
<td>3,094</td>
<td>36,029</td>
</tr>
<tr>
<td>Last-First Δ Sales</td>
<td>38,630</td>
<td>5,846</td>
<td>72,392</td>
<td>-5,937</td>
<td>657</td>
<td>26,989</td>
</tr>
<tr>
<td>Max in-sample Δ Leverage</td>
<td>38,630</td>
<td>0.38</td>
<td>3.46</td>
<td>0</td>
<td>0.17</td>
<td>0.95</td>
</tr>
<tr>
<td>Last-First Δ Leverage</td>
<td>38,625</td>
<td>0.08</td>
<td>3.44</td>
<td>-0.42</td>
<td>0</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Obs is firm. Max in-sample Δ is the in-sample difference between the max and min of each variable.

Last-First Δ is the change in each variable between the beginning and end of the firm's sample life.
## Banks (Obs: Bank-Year)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>SD</th>
<th>5&lt;sup&gt;th&lt;/sup&gt;pc</th>
<th>Median</th>
<th>95&lt;sup&gt;th&lt;/sup&gt;pc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td>900</td>
<td>10,727</td>
<td>16,966</td>
<td>482</td>
<td>3,709</td>
<td>54,354</td>
</tr>
<tr>
<td>Employees</td>
<td>896</td>
<td>3,180</td>
<td>4,583</td>
<td>206</td>
<td>1,137</td>
<td>14,038</td>
</tr>
<tr>
<td>Bad Loans</td>
<td>893</td>
<td>6.2</td>
<td>6.3</td>
<td>1.9</td>
<td>4.9</td>
<td>15.8</td>
</tr>
<tr>
<td>Cost/Income</td>
<td>893</td>
<td>34.5</td>
<td>6.1</td>
<td>25.4</td>
<td>33.1</td>
<td>43.2</td>
</tr>
</tbody>
</table>

Obs is bank-year. Assets in millions of €. Cost/Income is Fixed Costs/Gross Income.
Other Firm and Bank Data

- **Additional Firm Data:**
  - Industrial sector at 4-digit level (648 sectors)
  - Operational location at city-council level

- **Additional Bank Data:**
  - Bank type (national, local, savings, cooperative, commercial)
  - Mergers and acquisitions
  - Location of each bank’s branch network

- **Together:**
  - $\Rightarrow$ distance between firm and banks’ nearest branch
Credit Lines (Obs: Firm-Year-Loan)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>5&lt;sup&gt;th&lt;/sup&gt;pc</th>
<th>Median</th>
<th>95&lt;sup&gt;th&lt;/sup&gt;pc</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Main Line</td>
<td>502,515</td>
<td>0.24</td>
<td>0.43</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Amount Used</td>
<td>502,515</td>
<td>245</td>
<td>2,147</td>
<td>0</td>
<td>37</td>
<td>832</td>
</tr>
<tr>
<td>Amount Granted</td>
<td>502,515</td>
<td>508</td>
<td>4,887</td>
<td>0</td>
<td>150</td>
<td>1,500</td>
</tr>
<tr>
<td>Used/Granted</td>
<td>465,828</td>
<td>0.61</td>
<td>2.41</td>
<td>0</td>
<td>0.36</td>
<td>1.58</td>
</tr>
<tr>
<td>Avg Loan Rate</td>
<td>502,515</td>
<td>14.10</td>
<td>5.01</td>
<td>7.43</td>
<td>13.26</td>
<td>23.27</td>
</tr>
<tr>
<td>Default</td>
<td>502,515</td>
<td>0.01</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

First main line is the largest loan (in amount used) in the first year the firm is in the sample. Amount Used and Granted in thousands of €. Obs is firm-bank-year.
Distribution of Interest Rate - All loans

Interest Rate Distribution

Percent

0 10 20 30 40
0 2 4 6 8

Interest Rate
Distribution of Amount Granted - All loans under 1 Mil. €
### Credit Lines per Firm (Obs: Firm-Year)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; pc</th>
<th>Median</th>
<th>95&lt;sup&gt;th&lt;/sup&gt; pc</th>
</tr>
</thead>
<tbody>
<tr>
<td>N of Lines</td>
<td>145,510</td>
<td>3.45</td>
<td>2.64</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Amount Used</td>
<td>145,510</td>
<td>845</td>
<td>7,521</td>
<td>0</td>
<td>186</td>
<td>2,817</td>
</tr>
<tr>
<td>Amount Granted</td>
<td>145,510</td>
<td>1,754</td>
<td>19,170</td>
<td>20</td>
<td>500</td>
<td>4,978</td>
</tr>
<tr>
<td>Used/Granted</td>
<td>140,659</td>
<td>0.64</td>
<td>4.89</td>
<td>0</td>
<td>0.42</td>
<td>1.52</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>145,510</td>
<td>14.28</td>
<td>4.40</td>
<td>8</td>
<td>13.78</td>
<td>21.92</td>
</tr>
<tr>
<td>Default</td>
<td>145,510</td>
<td>0.01</td>
<td>0.09</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1st Main Used</td>
<td>82,801</td>
<td>520</td>
<td>3,661</td>
<td>0</td>
<td>122</td>
<td>1,761</td>
</tr>
<tr>
<td>1st Main Granted</td>
<td>82,801</td>
<td>765</td>
<td>7,486</td>
<td>0</td>
<td>250</td>
<td>2,300</td>
</tr>
<tr>
<td>1st Main Used/Granted</td>
<td>77,782</td>
<td>0.83</td>
<td>2.84</td>
<td>0</td>
<td>0.62</td>
<td>2</td>
</tr>
<tr>
<td>1st Main Interest Rate</td>
<td>82,801</td>
<td>14.08</td>
<td>4.82</td>
<td>7.63</td>
<td>13.31</td>
<td>22.93</td>
</tr>
<tr>
<td>1st Main Default</td>
<td>82,801</td>
<td>0.01</td>
<td>0.09</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Share 1st Main Used</td>
<td>64,266</td>
<td>0.77</td>
<td>0.24</td>
<td>0.33</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td>Share 1st Main Granted</td>
<td>79,315</td>
<td>0.66</td>
<td>0.31</td>
<td>0.13</td>
<td>0.67</td>
<td>1</td>
</tr>
</tbody>
</table>

Amount Used and Granted in thousands of €. Obs is firm-bank-year.
First Main Line across Risk Categories (Obs: Firm-Year)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Safe</th>
<th>Solvent</th>
<th>Vulnerable</th>
<th>Risky</th>
<th>Ever Defaulted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Main Used</td>
<td>110</td>
<td>226</td>
<td>314</td>
<td>492</td>
<td>583</td>
</tr>
<tr>
<td>1st Main Granted</td>
<td>471</td>
<td>512</td>
<td>508</td>
<td>614</td>
<td>491</td>
</tr>
<tr>
<td>1st Main Used/Granted</td>
<td>0.25</td>
<td>0.47</td>
<td>0.72</td>
<td>1.01</td>
<td>1.40</td>
</tr>
<tr>
<td>1st Main Interest Rate</td>
<td>10.55</td>
<td>10.74</td>
<td>11.58</td>
<td>12.49</td>
<td>13.01</td>
</tr>
<tr>
<td>1st Main Default</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.19</td>
</tr>
<tr>
<td>Ever Defaulted</td>
<td>0.00</td>
<td>0.01</td>
<td>0.02</td>
<td>0.08</td>
<td>1.00</td>
</tr>
<tr>
<td>N of Firm-Year</td>
<td>10,543</td>
<td>39,605</td>
<td>47,298</td>
<td>48,064</td>
<td>5,344</td>
</tr>
</tbody>
</table>

Amount Used and Granted in thousands of €. Obs is firm-bank-year. These are all means.
Amount Granted and Used by Risk Category

Amount Granted and Used by risk category

Only 5 years relationships
Amount Granted and Used - Defaulters

![Bar Chart: Amount Granted and Used - Ever Defaulted](image)

- **Mean of Amount Granted**
- **Mean of Amount Used**

Only 5 years relationships
Following the previous literature

- We analyzed our data for reduced-form evidence of asymmetric information
- (e.g. Chiappori and Selanié (2000))

The intuition:

- A loan is like an insurance contract
  - The bank shares in the cost of a firm’s bad investments
- Riskier firms should therefore select larger loans

(Analogous to sicker people choosing larger insurance cover)
The test: specify reduced-form models of both

1. Loan size \( (y_i) \)
2. Ever defaulted \( (z_i) \)

\[
y_i = 1(X_i \beta + \varepsilon_i > 0) \\
z_i = 1(X_i \gamma + \eta_i > 0),
\]  

(1)

where \( X = \) year FE, region FE, sector FE, bank FE, score, other firm’s balance sheet’s variables
Reduced Form Evidence III

\[ y_i = 1(X_i\beta + \varepsilon_i > 0) \]
\[ z_i = 1(X_i\gamma + \eta_i > 0) \]

1. Specify the distribution of \((\varepsilon_i, \eta_i)\) as a joint Normal with correlation coefficient, \(\rho\)
   - \(\Rightarrow\) Bivariate Probit model

2. Positive and significant \(\rho\) suggests the presence of asymmetric information.

3. Complementary evidence:
   - Correlation should be stronger for the first main line
   - Correlation should be stronger if we exclude observable risk measures ("score")
## Reduced Form Results

**Table:** Bivariate probit regression’s estimates of $\rho$

<table>
<thead>
<tr>
<th>Loan Amount</th>
<th>First Loan Ever</th>
<th>Whole Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
<td>No Score</td>
</tr>
<tr>
<td>Used</td>
<td>0.107*** (0.014)</td>
<td>0.139*** (0.014)</td>
</tr>
<tr>
<td>Used/Granted</td>
<td>0.166*** (0.015)</td>
<td>0.205*** (0.015)</td>
</tr>
</tbody>
</table>
To measure the extent of adverse selection in the Italian loan market

We specify and estimate an econometric model based on the canonical work of Stiglitz and Weiss (1981)

The intuition:

- Firms are risk neutral, but differ in their underlying riskiness
  - Measured by the variance in their return from a project for which they seek loan financing

- Firms know their risk type; banks do not

- Banks are differentiated (by location, type, years in market) and set interest rates in competition with other banks
The Model: Introduction II

- Intuition, cont.:
  - Firms’ expected profits increase with risk
    - Due to the insurance nature of loan contracts:
    - Banks share in the cost of bad project outcomes
  - At any interest rate, riskier firms are more likely to accept than safer firms
    - \( \Rightarrow \) any bank increasing rates attracts a riskier group of firms...
    - ...raising their costs due to higher resulting default rates
  - Asymmetric info can soften the effects of market power:
    - Monopoly banks would like to raise rates
    - But adverse selection reduces the benefits of doing so
The Model

Formally:

\[ i = 1, \ldots, I \] Firms:

- Want to invest in project with returns \( Y_i \sim N(\mu_i, 1/\theta_i^2) \)
- Have only access to loans offered to their type \( k \)
- Choose one bank \( j \) from which to borrow, amount \( B_j \) given
  - (Currently relaxing this assumption; will let firms choose loan amount)
- Choose to repay or default depending on project’s success

\[ j = 1, \ldots, J \] Banks:

- Provide credit (no rationing), observe \( \mu_i \) but not \( \theta_i \)
- Set interest rates \( r_{jk} \) from Bertrand-Nash competition and firms’ types
The Model

Assumptions:

- Asymmetric information on variance of returns
- First year of main new credit line
- Posted interest rates for market and type of borrower
- Exogenous amount of credit $B_j$
- No moral hazard
The Model

Probability of default of firm $i$ on loan $j$:

$$d_{ij} = \Phi(\theta_i(1 + r_j)B_j - \theta_i\mu_i). \quad (2)$$

Firm’s profits in case of successful project:

$$E(\pi_{ij}|success) = E(Y_i - (1 + r_j)B_j|Y_i > (1 + r_j)B_j)$$

$$= \mu_i + \frac{1}{\theta_i} \frac{\phi(\theta_i(1+r_j)B_j - \theta_i\mu_i)}{1 - \Phi(\theta_i(1+r_j)B_j - \theta_i\mu_i)} - (1 + r_j)B_j. \quad (3)$$

DEMAND (Firm $i$’s expected profits from access to credit):

$$E\pi_{ij} = (1 - d_{ij})E(\pi_{ij}|success)$$

$$= (1 - \Phi_{ij})(\mu_i - (1 + r_j)B_j + \frac{1}{\theta_i} \frac{\phi_{ij}}{1 - \Phi_{ij}}). \quad (4)$$
Credit as an insurance device for the firm:

Figure: Firm’s profits increase with risk
Banks face riskier batch of firms as interest rate increases:

**Figure:** Demand for credit is decreasing in interest rate
Figure: Default probability is increasing in the interest rate
The Model

Expected claim of firm $i$ to lender $j$:

$$
E\gamma_{ij} = (1 - d_{ij})E(\gamma_{ij} | Y_i > (1 + r_j)B_j) + d_{ij}E(\gamma_{ij} | Y_i \leq (1 + r_j)B_j)
$$

$$
= d_{ij} \left[ (1 + r_j)B_j - \mu_i + \frac{1}{\theta_i} \frac{\phi_{ij}}{1 - \Phi_{ij}} \right]
$$

(5)

**SUPPLY** (Bank $j$’s expected profit function):

$$
E\Pi_j = \sum_k \left[ (1 + r_{jk})TB_{jk} - TC(TB_{jk}) \right]
$$

(6)

**PRICING EQUATION** (f.o.c. of profit function):

$$
\frac{\partial \Pi_j}{\partial (1 + r_{jk})} = (1 + r_{jk}) + \frac{(1 + r_{jk})}{e_{jk}} - MC_{jk}
$$

$$
= (1 + r_{jk}) + \frac{(1 + r_{jk})}{e_{jk}} - (DP_j + \sum_i^k E\gamma_{ij}),
$$

(7)
Model Predictions

Figure: Bank’s profits are concave in the interest rate
Econometric Specification

Let:

- $m = 1, \ldots, M$ index markets (omit for convenience)
- $k = 1, \ldots, K$ index types (omit for convenience)
- $X'_{i}$ be firm observable characteristics
- $W'_{j}$ be bank/loan observable attributes
- $\xi_{j}$ be bank/loan unobservable attributes
- $Y_{i} \sim N(X'_{i}\beta, 1/\theta_{i}^{2})$ be returns from $i$’s project

Parameters to be estimated: $\alpha, \beta, \theta_{i}, \omega$, with $\theta_{i} = \theta + \sigma_{\theta}\nu_{i}$ and $\nu_{i} \sim N(0, 1)$. $\theta_{i}$ evidence of adverse selection.

Probability of default of firm $i$ on loan $j$:

$$d_{ij} = \Phi[D_{ij}],$$

with $D_{ij} = \theta_{i}(1 + r_{j})B_{j} - \theta_{i}(X'_{i}\beta)$. \hspace{1cm} (8)
Econometric Specification

DEMAND (Expected profit for firm $i$ from loan $j$):

$$\pi_{ij} = \delta_j + \bar{\pi}_{ij} + \varepsilon_{ij}$$

(9)

with

$$\delta_j = \alpha(1 + r_j)B_j + W'_{1ij}\omega_1 + \xi_j,$$

$$\bar{\pi}_{ij} = (1 - d_{ij})\left[X_i'\beta + \frac{1}{\theta_i} \frac{\phi(D_{ij})}{1 - \Phi(D_{ij})}\right] - d_{ij}\alpha(1 + r_j)B_j + W'_{2ij}\omega_2,$$

$$\varepsilon_{ij} \sim \text{IID Type 1 EV}.$$

Probability that firm $i$ chooses bank/loan $j$:

$$s_{ij} = \int \frac{\exp \left(\delta_j + \bar{\pi}_{ij}\right)}{1 + \sum_{j=1}^{J_m} \exp \left(\delta_j + \bar{\pi}_{ij}\right)} \phi(\nu_i) d\nu_i.$$  

(10)
Let $\psi$ be the parameters to be estimated, the moment conditions to construct the GMM objective function are:

\[
\begin{align*}
g_1(\psi) &= \sum_i \sum_j [Q_{ijm} - q_{ijm}(\psi)] = 0, \\
g_2(\psi; \xi) &= \sum_i \sum_j [P_{ijm} - p_{ijm}(\psi; \xi)] z_{ijm} = 0, \\
g_3(\psi; \xi) &= \sum_j \sum_m \xi_{jm}(\psi) z_{jm} = 0,
\end{align*}
\]

(11)

MPEC constrained optimization approach:

\[
\begin{align*}
\min_{\psi, \xi, g_1, g_2, g_3} & \quad g' W g \\
\text{subject to} & \quad s(\psi; \xi) = S \\
& \quad g_1 = g_1(\psi) \\
& \quad g_2 = g_2(\psi; \xi) \\
& \quad g_3 = g_3(\psi; \xi)
\end{align*}
\]

(12)
Preliminary Results

Table: Estimates of Default and Demand Parameters

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>1.558</td>
</tr>
<tr>
<td>$\sigma_\theta$</td>
<td>0.657</td>
</tr>
<tr>
<td>$\beta_0$</td>
<td>24.503</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>9.195</td>
</tr>
<tr>
<td>$\omega_2$</td>
<td>2.087</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.040</td>
</tr>
<tr>
<td>N</td>
<td>1,803</td>
</tr>
</tbody>
</table>
Counterfactuals (Planned)

- No asymmetric information
- Greater competition with asymmetric information
Conclusions

- Estimate the extent of adverse selection in Italian loan markets
  - And how competition and adverse selection interact to influence interest rates and credit
- Exploit a unique set of proprietary datasets with detailed information about loans, firms, and banks
  - Reduced-form evidence in the data suggest the presence of asymmetric information
- Econometric estimation and counterfactual experiments in progress


