Signaling in Online Credit Markets

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Motivation

"Neither borrower nor lender be."

Research Question

What is the effect of signaling on welfare and equilibrium outcomes when there is adverse selection?

- Evaluates this question in the context of online credit markets (Prosper.com)
- Setting is convenient since the econometrician observes everything the lender observes

Setting

The web site matches borrowers with lenders (adminsitrative fees for lenders)

1. Borrowers post a listing
   - Information include requested amount and reserve interest rate (maximum $25,000 and 36%)
   - Other characteristics (credit grade, home-ownership status, debt-income ratio, purpose of the loan) [verified information]
2. Lenders bid: If interested in the offer submit a bid in online auction
   - Amount between $50 to the amount (50 dollars) bids
3. Funding decision is made: similar to uniform-price auction
   - For listings that have not attracted enough money for the requested money (fraction founded not the interest rate)
   - Completely funded listings: the active interest rate.
   - No partial funding and the interest rate determined by marginal bid and apply to all lenders
4. Borrowers make monthly repayments: Loans unsecured and fixed length of 36 months. If there is a default it is reported to bureaus and collection agency.

Data

Data for 35,000 listing, of which 5,600 funded, created from May to October 2008, repayment data for funded listing until the end of 2011.

Borrower information

- Credit grade, debt-to-income ratio, home ownership
- Text information provided by the borrower
- Monthly repayment data

Lenders information

- Portfolio size (value and number of loans)
- Average interest rate

Reduced form analysis

	(1) Funded	(2) Contract Rate	(3) Default	(4) Rate of Return
Reserve rate	2.1368***	0.6834***	2.8584***	-0.5919***
	(0.0263)	(0.0145)	(0.7256)	(0.1313)
Contract rate			3.2375***	0.0540
			(0.6507)	(0.1372)
Amount	-0.1070***	0.0077***	0.0349***	-0.0045***
	(0.0024)	(0.0002)	(0.0077)	(0.0013)
Debt / income	-0.7971***	0.0731***	0.0528	-0.0314
	(0.0015)	(0.0037)	(0.0713)	(0.0197)
Home owner	-0.1513***	0.0137***	0.1400***	-0.0471***
	(0.0004)	(0.0018)	(0.0633)	(0.0117)
Grade				
AA	3.6468***	-0.3013***	-0.3966**	0.0595
	(0.0044)	(0.0061)	(0.2179)	(0.0402)
A	3.0727***	-0.2670***	-0.3208**	0.0475
	(0.0033)	(0.0055)	(0.1932)	(0.0366)
B	2.5681***	-0.2347***	-0.1516	0.0224
	(0.0022)	(0.0046)	(0.1492)	(0.0320)
C	1.8743***	-0.1862***	-0.1398	0.0380
	(0.0014)	(0.0038)	(0.1233)	(0.0288)
D	1.2754***	-0.1329***	-0.1825	0.0636**
	(0.0011)	(0.0034)	(0.1135)	(0.0272)
E	0.5022***	-0.0499***	-0.3949***	0.1155***
	(0.0014)	(0.0036)	(0.1271)	(0.0296)
Observation	35,241	35,241	91,939	5,571
R^2	0.2827			0.0224
Likelihood		-1,137	-4,805	

Interpretations of the results

Four main results

1. There is a trade-off between a larger funding probability and a lower contract interest rate
2. Borrowers are heterogeneous with respect to how they evaluate this trade-off
3. Borrowers who post high reserve rates tend to be relatively less creditworthy (and vice versa)
4. Lenders anticipate this and charge higher interest to riskier borrowers who post high reserve rate.

Signaling can be sustained in equilibrium because of borrowers' heterogeneity: high-cost types prefer high probability of getting founded (paying an higher interest rate), whereas low-cost types prefer the opposite.

The Model (Borrowers)

Borrower Repayment

Modeled as a single-agent dynamic programming problem

In each period (starting at $t = 1$), the borrower makes a decision to pay the monthly installment or to default

$$V_t(r, \varphi) = \mathbb{E}\Big[\max\{u_t(r) + \varepsilon_t + \beta V_{t+1}(r, \varphi), D(\varphi)\}\Big]$$

Default is the absorbing state

Borrower Reserve Rate Choice

At $t = 0$, a borrower makes a choice of the reserve interest rate, s, to resolve the trade-off between the effect on the probability of loan being funded, and the effect on the contracted interest rate

$$\max_{s \leq 0.36} V_0(s, \varphi) = \max_{s \leq 0.36} \Big[Pr(s) \int V_1(r, \varphi) f(r|s) dr + (1 - Pr(s))\lambda(\varphi)\Big]$$

Loan amount is not treated as a choice variable

The Model (Lenders)

A lender chooses the amount q to bid from a discrete set $\{ 50, 100, 200 \}$, or not to bid

A lender maximizes utility of the form

$$U = U^L(qZ(r)) - \varepsilon_{0j} = q\mu(Z(r)) - A_j(q\sigma(Z(r)))^2 - c_q - \varepsilon_{0j}$$

This gives rise to the following bidding strategy:

- bid amount \$ 200 at interest r' if active interest rate is in $[r', s]$
- bid amount \$ 200 at interest r' if active interest rate is in $[r'', r')$
- bid amount \$ 200 at interest r' if active interest rate is in $[r''', r'')$
- do not bid if active interest rate is in $[0, r''']$

Assumption is made that each lender behaves as if she was not pivotal

Identification

Borrower's Primitives

- Primitives: period utility function $u_t(.)$, distribution of borrower types $F_{\varphi|X}$, cost of default $D(.)$, utility from the outside option $\lambda(.)$, and distribution $F_{\epsilon|X}$
- Borrower's payment decisions are a sequence of binary decisions, so φ relies on one-to-one mapping of s to φ conditional on X (single crossing property).

Lender's Primitives

- Primitives: distribution of risk coefficient F_A, distribution of outside option $F_{\epsilon 0}$, cost of lending c_q, and distribution of the number of potential bidders F_N
- Relies to expressing the probability that the listing is funded as a function of F_N and $P_q(\mu, \sigma)$, the probability of the lender bidding an amount q given some reserve interest rate s.

Counterfactuals

The paper seeks to understand the role of signaling in this market. It considers three market designs for each of four credit grades, $\{AA, A, B, C\}$

1. Signaling: The actual mechanism used by Prosper
2. No asymmetric information: A counterfactual in which "the lenders have perfect knowledge of borrow types in equilibrium"
3. Pooling: "Computed assuming that each borrower can post a secret reserve price"—no way for lenders to identify borrower types

Qualitatively, the second market design illustrates that the problem of asymmetric information is largely overcome by signaling. The third market design illustrates the importance of screening in this market.

Counterfactuals

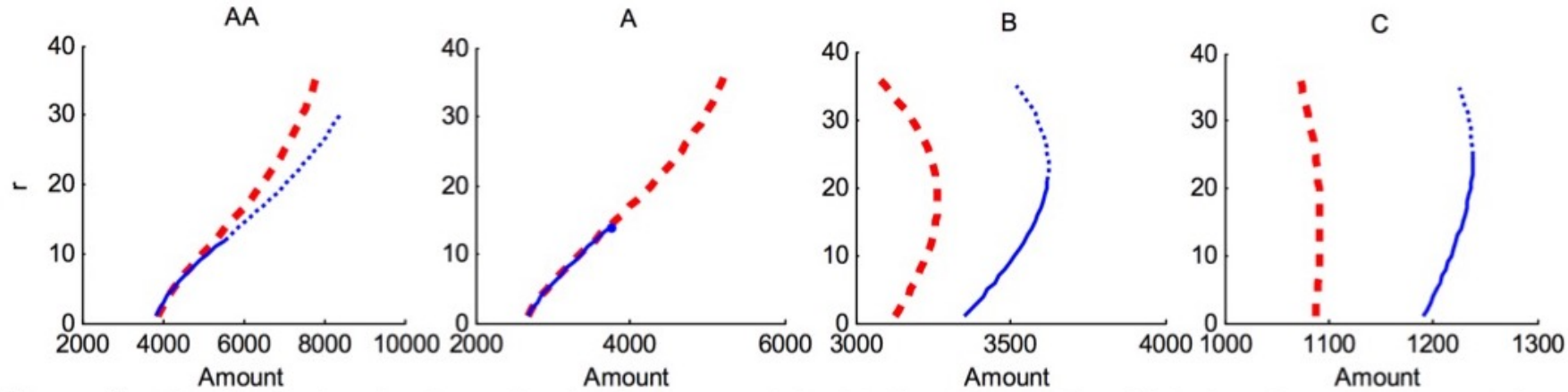

Figure 7: The Credit Supply Curve for the Borrower of the Median Type – The thick dotted curve corresponds to the credit supply curve under no signaling (i.e., pooling). The solid line corresponds to the credit supply curve under signaling, and the dotted line that lies on top of it corresponds to the credit supply curve under no asymmetric information. Borrower covariates are set to the median values.

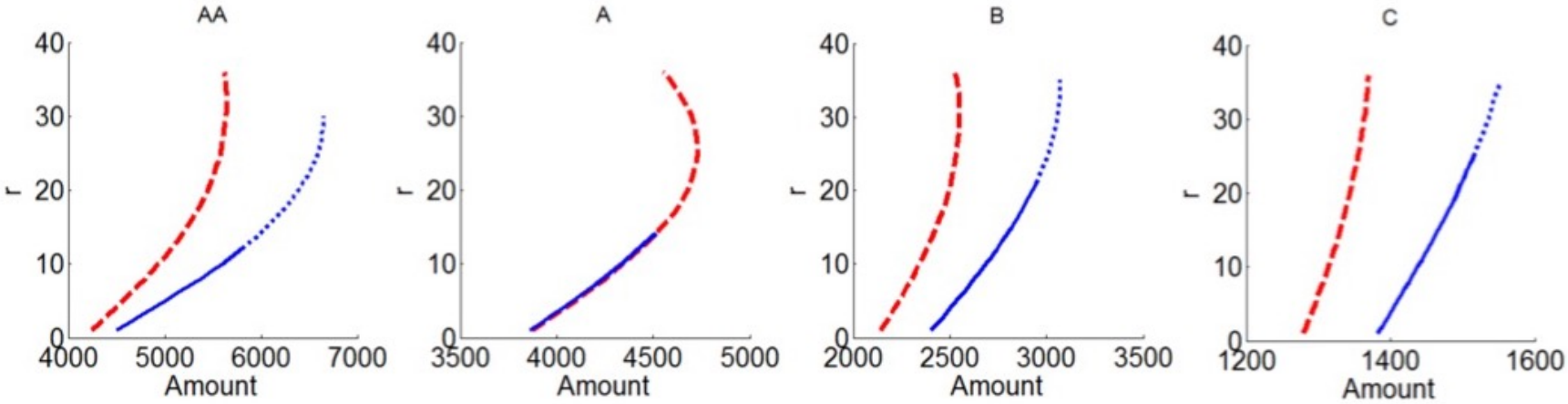

Figure 8: The Credit Supply Curve for the Borrower of the Median Type. See Figure 7 for description.

Counterfactuals

		Expected			Median		
		Borrower	Lender	Total	Borrower	Lender	Total
AA	Signaling	466.4	1642.6	2109.0	423.3	1645.2	2068.5
	Pooling	613.2	2531.4	3144.6	567.7	2587.1	3154.9
	Symmetric	675.7	2801.6	3477.2	633.0	2885.6	3518.6
A	Signaling	143.0	1470.4	1613.4	143.1	1488.6	1631.7
	Pooling	142.7	1491.7	1634.4	142.4	1497.5	1639.9
	Symmetric	143.3	1481.5	1624.8	143.1	1488.6	1631.7
B	Signaling	396.7	573.5	970.2	380.4	577.9	958.3
	Pooling	343.1	477.6	820.7	327.7	478.1	805.7
	Symmetric	398.4	579.8	978.2	382.2	581.7	963.9
C	Signaling	417.9	510.0	927.9	434.5	508.5	943.0
	Pooling	374.7	445.3	820.0	392.1	446.1	838.2
	Symmetric	425.5	518.7	944.2	446.7	517.3	964.0

Table 9: Expected Surplus for Different Market Designs by Credit Grade: The first three columns correspond to the expected surplus of the borrwer, the lender and the sum of the two. The last three columns correspond to the expected surplus genrated from loans to the median borrower.