

P2P Lending: Information Externalities, Social Networks and Loans' Substitution

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Online lending developments

- Online lending platforms: markets for consumer and business debt where lenders and borrowers match and trade directly, hence in absence of intermediation → peer-to-peer
- Emerged in 2005 (US Prosper). Highest growth in the aftermath of the crisis, in coincidence with the *fragility* of the banking system as well as the distrust of investors towards it
- Success story: relatively low loan rates and default rates down from 34% in 2009 to very low figures

P2P lending markets: costs and benefits

- Borrowers:
 - Quick turnaround, no need of collateral guarantees, no risk of early liquidation due to banks' liquidity shortages,
 - Higher interest rates
- Lenders:
 - Attractive returns (compared to standard investment by banks) and no risk of *haircut* due to banks' distress
 - More risk (in the absence of a delegated monitor that screens and monitors projects)

Main features of P2P markets

- Dis-intermediated, uncollateralized debt markets:
 - Asymmetric information
 - Innovation in screening technology: machine learning collects and makes information public, mitigating adverse selection
 - Availability of **costless public signals** that facilitate screening and mitigate lemon's market adverse selection
 - Hard information (FICO scores and other official credit-worthiness measures);
 - Soft information (e.g. recommendation from other investors);
 - Borrowers' self reports

Focus of the paper

- Assessment of the impact of information on P2P loan returns
 - Loan returns capture both default risks of projects and information premia due to asymmetric information

Main result: signals, of both *hard and soft* type, mitigate information premia

- Assessment of potential substitutability between digital platforms and traditional banking
 - Most of the increase in participation in the platforms seems to be due to erosion of trust in and perception of fragility of traditional banking sector

Main result: higher banking sector fragility (captured by currency-deposit ratio and bank failures) lowers P2P loan returns

Related literature

- Focus on the relationship between borrowers' attributes and listing outcomes in P2P markets
 - Pope and Syndor [2011, JHR] and Ravina [2012]: discrimination
 - Duarte, Siegel and Young [2012, RFS]: trust
 - Paravisini, Ravina and Rappoport [2017, MS]: risk aversion
- On asymmetric information and signals in P2P markets:
 - Freedman and Jin [2016]: learning by doing by returning lenders
 - Iyer, Khwaja, Luttmer and Shue [2016, MS] and Kawai, Onishi and Uetake [2016]: interest rates as a signal of creditworthiness
- No studies of the substitution between traditional banking and digital intermediation

Our analysis

- **General equilibrium model** (focus on price formation)
 1. Households/investors/lenders solve dynamic portfolio problem
 2. Borrowers seek funds for projects of heterogeneous and unobservable quality
 3. *a* P2P market (adverse selection):
 - Distribution of loan rates with risk and information premia
 - Public signals reduce adverse selection and information premia
 3. *b* Traditional banks: competitive; subject to risk of distress
- **Empirical analysis:** US data from Prosper and Lending Club (merged with measures of bank fragility)

Households/Lenders

$$\begin{aligned} & \text{Price of P2P loans} \quad \max E_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \quad \text{Gross return on deposits} \\ & \text{s. t.} \quad C_t + r_t X_t + D_t \leq Y_t + X_{t-1} + R_{t-1}^d D_{t-1} \\ & \quad \quad r_t X_t = \alpha_t W_t; \quad D_t = (1 - \alpha_t) W_t \\ & \quad \quad \text{P2P loans} \quad \quad \quad \text{Bank deposits} \end{aligned}$$

Borrowers

- Risk neutral
- Projects' quality is heterogeneous:
succeed and deliver R^I_t , with probability p^i , or
fail and return zero:

$$p^i \in \mathbb{U} \left[\bar{p} - \frac{\varepsilon}{2}; \bar{p} + \frac{\varepsilon}{2} \right]$$

p^i is known to borrowers, but not to lenders

Banks 1/2

- Costly screening technology: pay μ and learn project's quality (p^i) perfectly
- Fragility risk, from liquidity shortage (e.g. run or liquidity freezes) or failure, with probability ζ_t
- With probability ζ_t , banks liquidate projects early at a discount, θ
- Given the risk of distress, banks' expected return from project i is $\bar{\theta}_t p^i R_t^I$,

$$\text{where: } \bar{\theta} = \theta \zeta_t + (1 - \zeta_t)$$

Banks 2/2

- Banks are fully competitive; they fund loans with deposits; all project returns are rebated to depositors
- Banks realize returns only if projects are successful, but they have to pay depositors and the screening cost in any case
- In case of bank distress, absent insurance on banks' demand deposits, the loss from project early liquidation is eventually transferred onto depositors
- Depositors' expected return from deposits is $\bar{\theta}_t R_t^d$

Signals and pricing

- Signals (as in Ruckes 2004, Petriconi 2016):

$$\sigma_{i,\lambda} = \begin{cases} s_i = p^i & \text{with probability } \lambda \\ s_i \sim \mathbb{U} \left[\bar{p} - \frac{\varepsilon}{2}; \bar{p} + \frac{\varepsilon}{2} \right] & \text{with probability } 1 - \lambda \end{cases}$$

Signals and pricing

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- Once they receive the signal, lenders update their estimate of project's success probability which, given Bayesian updating of beliefs, results in the following posterior expectation:

$$E_t(p^i | \sigma_{i,\lambda} = s_i) = \lambda s_i + (1 - \lambda) \bar{p}$$

and the expected return from the project is: $E_t(p^i | \sigma_{i,\lambda} = s_i) R_t^I$

No arbitrage condition

- Optimality condition (for given signal precision, λ):

$$E_t(p^i | \sigma_{i,\lambda} = s_i) R_t^I = \frac{1}{\beta} E_t \left\{ \frac{U'(C_t)}{U'(C_{t+1})} \right\} = \bar{\theta}_t R_t^d$$

- It determines the P2P project that will be funded at the margin (threshold)
- **Three testable predictions** regarding P2P market liquidity and prices

Testable predictions

- 1) Substitution between banks and platform: An increase in the risk of a shock in the banking sector (ζ) raises platform liquidity and lowers P2P loans' returns (because it lowers expected defaults)
- 2) Selection: An increase in the average quality of projects, \bar{p} , increases platform liquidity and lowers loans' returns.
- 3) Information: An increase in signal's precision, i.e. in the probability that the signal is informative, λ , increases platform liquidity, and reduces information premia.

Prosper Data (2006-2014)

- **Borrower personal profiles:** amount requested, interest rate, term and purpose of loan
 - + independently verified information on credit history (FICO score, open credit lines, delinquencies), income and other debts
- **Prosper creates social networks:**
 - links borrowers in groups (tied by geography, common interests, or common loan purpose)
 - collects endorsements of other Prosper members (friends)

Prosper loans

- Loan size – Min: \$1,000; max: \$35,000
- Term – 12, 36, 60 months
- Fees of up to 2 percent of loan amount
- FICO>520
- Minimum bid: \$50
- *In 2009, Prosper registered with the SEC and changed its business model from eBay-style auctions to rates determined by proprietary algorithm based on credit history, ect.*

Summary statistics

Year of the loan	2006	2007	2008	2009	2010	2011	2012	2013	2014
Borrower lending rate	0.191	0.177	0.186	0.193	0.213	0.230	0.220	0.184	0.153
	(0.069)	(0.064)	(0.085)	(0.091)	(0.098)	(0.079)	(0.077)	(0.061)	(0.054)
Size of loans	4763	7050	6022	4355	4767	6692	7834	10545	11912
	(4404)	(6126)	(5400)	(4070)	(3714)	(4273)	(5527)	(6575)	(6684)
Term (months)	36	36	36	36	36	37	43	45	44
Time for funding	9	11	10	14	12	10	8	6	5
Median investment	96	58	45	29	35	78	89	3,000	9,000
No. of investors	36	92	95	93	103	55	53	1	1
Loans by 1 investor %	2	1	1	1	<1	1	2	51	75
For debt consolidation %		42	46	47	48	48	74	79	42
home improvement		5	9	10	11	11	6	4	5
business (%)		16	11	10	11	9	4	3	16
other (%)		37	34	33	30	32	16	14	37
# observations	5,906	11,460	11,552	2,047	5,652	11,228	19,553	33,910	11,734

tripled its size!

Loan riskiness

Year of the loan	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Completed	61%	61%	67%	85%	83%	49%	28%	7%	1%	34%
Current	-	-	-	-	-	29%	54%	89%	99%	49%
Past Due (1-120 days)	-	-	-	-	-	3%	4%	3%	-	2%
Chargedoff	16%	26%	24%	11%	14%	16%	12%	1%	-	11%
Defaulted	23%	14%	9%	4%	3%	3%	2%	0%	-	4%
	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>

- **Decline in loan riskiness:** the share of loans classified as ‘Charged off’ or in ‘Default’ was relatively high at the onset of the platform, but has fallen significantly after 2009
- In 2014, US banks charged off or reported as delinquent 16.6 percent of all **consumer loans** (18.5 percent in 2013)

Hard and soft information about borrowers

Year of the loan	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mean FICO score	609	654	674	715	714	709	711	708	703
Number of open credit lines		8	8	9	8	8	8	10	11
Number of credit inquiries	11	10	8	6	4	4	4	4	4
Borrowers w/ delinquencies (%)	52	39	23	11	14	21	20	15	10
Prosper credit rating				4.286	3.837	3.552	3.688	4.258	4.718
Estimated loss				0.075	0.093	0.097	0.091	0.073	0.062
Debt-income ratio	0.249	0.431	0.254	0.228	0.230	0.251	0.264	0.264	0.259
Monthly income	4,744	4,654	4,619	5,092	5,291	5,660	5,710	6,161	6,336
Borrowers in a group (%)	70	51	14	11	9	5	3	1	1
Borrowers w/ recomm. from Prosper friends %		17	18	8	6	3	2	1	<1
Borrowers w/ invest. from Prosper friends (%)		6	7	5	4	1	1	<1	<1
\$ investment from friends (cond. on friends)		939	1017	713	773	572	429	233	298
Borrowers w/ previous Prosper loans %	-	4	15	43	34	34	28	19	10
# observations	5,906	11,460	11,552	2,047	5,652	11,228	19,553	33,910	11,734

OLS regressions of lending rates on loan characteristics

	All	Pre-SEC	Post-SEC
Loan size (thousands)	-0.090 (0.001)***	-0.078 (0.003)***	-0.102 (0.001)***
Loan size ² (thousands)	0.019 (0.000)***	0.025 (0.001)***	0.020 (0.000)***
Term (months)	0.011 (0.000)***	-	0.012 (0.000)***
Debt consolidation ^(*)	0.004 (0.001)***	0.014 (0.002)***	0.004 (0.001)***
Home improvement ^(*)	-0.003 (0.001)***	-0.006 (0.003)*	-0.003 (0.001)***
Business funding ^(*)	0.008 (0.001)***	0.002 (0.002)	0.010 (0.001)***
<i>Adjusted R</i> ²	0.23	0.12	0.28
<i>N</i>	107,549	23,425	84,124

Note: dummies for year-quarter of listing and state of residency are included

OLS regressions of lending rates on loan characteristics and signals

	All	Pre-SEC	Post-SEC	Pre-SEC	Post-SEC	Post-SEC	
Loan size (thousands)	-0.043 (0.001)***	0.016 (0.002)***	-0.063 (0.001)***	0.018 (0.002)***	-0.063 (0.001)***	-0.061 (0.001)***	
Loan size (thousands) ²	0.010 (0.000)***	0.003 (0.001)***	0.015 (0.000)***	0.002 (0.001)***	0.015 (0.000)***	0.014 (0.000)***	
Term	0.009 (0.000)***		0.011 (0.000)***		0.011 (0.000)***	0.012 (0.000)***	
Debt consolidation ^(*)	-0.002 (0.001)***	-0.001 (0.001)	-0.001 (0.001)**	-0.001 (0.001)	-0.001 (0.001)**	-0.003 (0.001)***	
Home improvement ^(*)	0.000 (0.001)	0.001 (0.002)	0.000 (0.001)	0.001 (0.002)	0.000 (0.001)	0.004 (0.001)***	
Business funding ^(*)	0.006 (0.001)***	0.003 (0.002)*	0.005 (0.001)***	0.003 (0.002)*	0.006 (0.001)***	0.006 (0.001)***	
FICO score (hundreds)	-0.070 (0.000)***	-0.071 (0.001)***	-0.073 (0.000)***	-0.071 (0.001)***	-0.073 (0.000)***	-0.079 (0.000)***	
Open credit lines (tens)	0.003 (0.000)***	0.005 (0.001)***	0.001 (0.001)	0.005 (0.001)***	0.001 (0.001)	0.003 (0.001)***	
Credit enquiries (tens)	0.017 (0.000)***	0.009 (0.001)***	0.024 (0.001)***	0.009 (0.001)***	0.025 (0.001)***	0.030 (0.001)***	
Current delinquencies ^(*)	0.012 (0.001)***	0.027 (0.001)***	0.008 (0.001)***	0.028 (0.001)***	0.009 (0.001)***	0.009 (0.001)***	
Monthly income (thousands)	-0.001 (0.000)***	0.001 (0.001)	-0.001 (0.000)***	-0.000 (0.000)	-0.001 (0.000)***	-0.001 (0.000)***	
Debt/Income	0.012 (0.001)***	0.003 (0.000)***	0.027 (0.002)***	0.004 (0.000)***	0.027 (0.002)***	0.029 (0.002)***	
Group dummy ^(*)				-0.005 (0.001)***	-0.019 (0.001)***	0.000 (0.001)	
Recommend + no invest ^(*)				0.000 (0.001)	-0.025 (0.002)***	-0.004 (0.002)*	
Recommend + investm. ^(*)				-0.019 (0.002)***	-0.015 (0.004)***	-0.008 (0.004)**	
Investm.+ no recomm ^(*)				-0.045 (0.007)***	-0.012 (0.004)***	-0.008 (0.004)	
Previous Prosper loan ^(*)						-0.042 (0.000)***	
<i>Adjustment R²</i>		0.49	0.59	0.51	0.59	0.51	0.56
<i>N</i>		95,396	18,497	76,899	18,497	76,899	76,899

OLS regressions of lending rates on loan characteristics and signals

	All	Pre-SEC	Post-SEC	Pre-SEC	Post-SEC	Post-SEC
... ..						
FICO score (hundreds)	-0.070 (0.000)***	-0.071 (0.001)***	-0.073 (0.000)***	-0.071 (0.001)***	-0.073 (0.000)***	-0.079 (0.000)***
Open credit lines (tens)	0.003 (0.000)***	0.005 (0.001)***	0.001 (0.001)	0.005 (0.001)***	0.001 (0.001)	0.003 (0.001)***
Credit enquiries (tens)	0.017 (0.000)***	0.009 (0.001)***	0.024 (0.001)***	0.009 (0.001)***	0.025 (0.001)***	0.030 (0.001)***
Current delinquencies ^(*)	0.012 (0.001)***	0.027 (0.001)***	0.008 (0.001)***	0.028 (0.001)***	0.009 (0.001)***	0.009 (0.001)***
Monthly income (thousands)	-0.001 (0.000)***	0.001 (0.001)	-0.001 (0.000)***	-0.000 (0.000)	-0.001 (0.000)***	-0.001 (0.000)***
Debt/Income	0.012 (0.001)***	0.003 (0.000)***	0.027 (0.002)***	0.004 (0.000)***	0.027 (0.002)***	0.029 (0.002)***
Group dummy ^(*)				-0.005 (0.001)***	-0.019 (0.001)***	0.000 (0.001)
Recommend + no invest ^(*)				0.000 (0.001)	-0.025 (0.002)***	-0.004 (0.002)*
Recommend + invest ^(*)				-0.019 (0.002)***	-0.015 (0.004)***	-0.008 (0.004)**
Invest.+ no recomm ^(*)				-0.045 (0.007)***	-0.012 (0.004)***	-0.008 (0.004)
Previous Prosper loan ^(*)						-0.042 (0.000)***
<i>Adjustment R²</i>	0.49	0.59	0.51	0.59	0.51	0.56
<i>N</i>	95,396	18,497	76,899	18,497	76,899	76,899

OLS regressions of lending rates on loan characteristics and signals

- Lending rates are decreasing in the FICO score, increasing in the number of credit lines and credit enquiries and for delinquent borrowers
- Once we control for credit risk, being part of group lowers the lending rate, by 0.5-2 p.p.
- Rates are lower for borrowers with funding from friends, by up to 4.5 p.p. before 2009, up to 1.5 p.p. after 2009
- Borrowers with prior loans pay 4 p.p less; the group dummy becomes insignificant and 'friends' variables coefficients become smaller

Lending rates and signal precision

	Income can be verified All	No open credit lines All	No state of residency Pre-SEC	No reason for borrowing Post-SEC
... ..				
Income verifiable ^(*)	-0.024 (0.009)***			
No open credit lines		0.024 (0.003)***		
No US State ^(*)			0.018 (0.009)**	
No reason for borrowing ^(*)				0.006 (0.001)***
FICO score (hundreds)	-0.070 (0.000)***	-0.070 (0.000)***	-0.070 (0.001)***	-0.073 (0.000)***
Open credit lines (tens)	0.002 (0.000)***		0.005 (0.001)***	0.001 (0.001)
Credit enquiries (tens)	0.017 (0.000)***	0.017 (0.000)***	0.008 (0.001)***	0.024 (0.001)***
Current delinquencies ^(*)	0.012 (0.001)***	0.011 (0.001)***	0.026 (0.001)***	0.008 (0.001)***
Monthly income (thousands)	-0.002 (0.001)***	-0.001 (0.000)***	-0.001 (0.000)	-0.001 (0.000)***
Income • Inc. verif. ^(*)	0.002 (0.001)**			
Debt/Income	-0.000 (0.001)	0.012 (0.001)***	0.003 (0.000)***	0.027 (0.002)***
Debt/Income • Inc. is verif. ^(*)	0.021 (0.002)***			
<i>Adjustment R²</i>	0.93	0.49	0.94	0.51
<i>N</i>	95,396	95,396	20,213	76,899

Lending rates and signal precision

- No official documentation for income: 8% of sample
 - Borrowers whose income is verifiable pay 1 p.p. less
- No open credit lines → cannot tell whether more or less risky: 1% of sample
 - Borrowers with no credit lines pay 2.4 p.p. more
- No state of residency: 30% of sample (pre-2009)
 - Borrowing rates 2 p.p. higher
- No reason for borrowing: 10% of sample (post 2009)
 - Borrowing rates 0.5 p.p. higher

Lending rates, **banking failures** and signals

	All	Pre-SEC	Post-SEC
... ..			
Bank failures _{mo-1} ^(*)	-0.001 (0.002)	-0.007 (0.005)	0.000 (0.001)
Bank failures _{mo-2} ^(*)	-0.006 (0.002)***	-0.003 (0.005)	-0.003 (0.001)**
Bank failures _{mo-3} ^(*)	-0.003 (0.002)*	0.000 (0.008)	-0.002 (0.001)*
FICO score (hundreds)		-0.071 (0.001)***	-0.079 (0.000)***
Open credit lines (tens)		0.005 (0.001)***	0.003 (0.001)***
Credit enquiries (tens)		0.009 (0.001)***	0.030 (0.001)***
Current delinquencies ^(*)		0.028 (0.001)***	0.009 (0.001)***
Group dummy ^(*)		-0.005 (0.001)***	-0.000 (0.001)
Recommend + no investm. ^(*)		0.000 (0.001)	-0.004 (0.002)*
Recommend + investm. ^(*)		-0.019 (0.002)***	-0.008 (0.004)**
Investm.+ no recommend. ^(*)		-0.045 (0.007)***	-0.008 (0.004)*
Previous Prosper loan ^(*)		-0.002 (0.001)	-0.042 (0.000)***
<i>Adjustment R²</i>	0.23	0.59	0.56
<i>N</i>	107,549	18,497	76,899

Concluding remarks

- P2P lending has experienced an **impressive growth** and has penetrated most markets including high growth ones like China
- Despite the **lack of delegated monitor** and the potential costs of **asymmetric information**, data suggest that it is performing well relatively to traditional banking, thanks to...
 1. The digital technology allows *costless access to information* which increases market transparency and mitigates information asymmetry
 2. In times of bank distress the platforms provide a valuable form of borrowing and investment **substitution** that improves risk-sharing