

Fed Liftoff and Subprime Loan Interest Rates: Evidence from the Peer-to-Peer Lending Market¹

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¹The views expressed in this presentation are solely the responsibility of the authors and should not be interpreted as reflecting the official views of Sveriges Riksbank.

Research question & main findings

- ▶ How did Fed liftoff affect interest rates in the US subprime consumer loan segment?
- ▶ Evidence for a specific market segment: P2P lending
 - Hourly data from *Prosper.com*, a US lending-based crowdfunding platform (CLP)
 - Origination data from *LendingClub.com*
 - Event study: FOMC announcement on December 16
- ▶ Main findings: after liftoff we observe a decrease in
 1. average interest rates on newly posted Prosper loans by 16.9-22.6 basis points (bps)
 2. the spread between high and low credit risk bins by 16%

Story line

- ▶ Both findings may be unexpected at first glance

▶ Literature on interest rate pass-through

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- ▶ What was special about liftoff?

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- ▶ Both findings may be unexpected at first glance

▶ Literature on interest rate pass-through

- ▶ What was special about liftoff?

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- ▶ Monetary policy signaling matters and influences private macroeconomic forecasts

→ perceived default probability reduction dominated interest rate pass-through!

Fed announcement and market expectations

FOMC announcement on Wednesday, 16 Dec. 2015:

- ▶ increase in the target federal funds rate from the range 0 – 25 bps to 25 – 50 bps
- ▶ guidance on future hikes ('gradual'; 4x25 bps in 2016), since revised downward (2x25 bps)
- ▶ positive assessment of current and future labor market conditions (possibly anticipation of surprisingly good employment data: 292,000 jobs added in Dec. 2015)

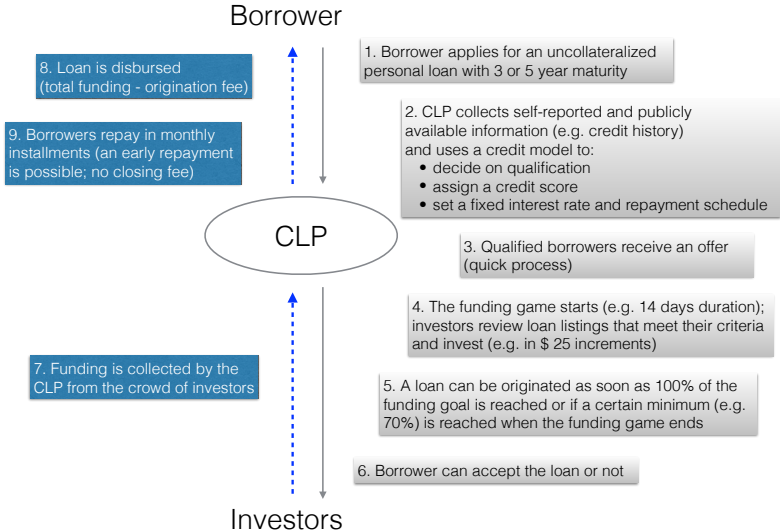
Market expectations:

- ▶ The federal funds rate hike *exceeded* market expectations in mid December 2015 ▶ CP / CB
- ▶ Bloomberg: Futures contracts implied a .84 probability of the federal funds rate range increasing from 0-25 bps to 25-50 bps and a .16 probability of remaining at 0-25 bps

Literature

- ▶ **Monetary Policy Pass-Through:** Cook & Hahn (JME, 1989); Taylor (JEP, 1995); and Bernanke & Blinder (AER, 1992)
- ▶ **Central Bank Signaling:** Blinder et al. (JEL, 2008); Andersson et al. (JME, 2006); Swanson (JMCB, 2006), Ehrmann & Fratzscher (IJCB, 2007), Ehrmann et al. (SJE, 2016), Cambell et al. (Brookings, 2012), and Nakamura & Steinsson (2015)
- ▶ **P2P Lending:** Duarte et al. (RFS, 2012); Pope & Sydnor (JHR, 2011); Ravina (2012); Iyer et al. (MS, 2015); Crowe & Ramcharan (JMCB, 2013), Senney (2016); Chen et al. (GEB, 2015); Wei & Lin (2015); Butler et al. (MS, 2015), Paravisini et al. (MS, 2016)
- ▶ **Household Credit:** Bertola et al. (Eds., 2006); Agarwal & Ambrose (Eds., 2007); Guiso & Sodini (HEF, 2013)
- ▶ **Platforms:** Rochet & Tirole (RAND, 2006), Armstrong

How does P2P lending work?



How relevant is P2P lending in the US and how do platforms make money?

Relevance

- ▶ \$12-15bn loans originated by US CLPs in 2015
- ▶ The market grows rapidly: \sim 70-100% per year
- ▶ Prosper is oldest (operating since Feb. '06) and second largest US-based CLP for unsecured consumer credit
- ▶ LendingClub and Prosper cover two-thirds of the market

The CLP business model

- ▶ Fee-based income
- ▶ Objective: maximize the origination volume

Summary of testable implications from a simple theoretical loan pricing model

The optimal interest rate is increasing

1. in the risk-free reference rate
2. in the perceived default probability
3. when the outside options of borrowers deteriorate

The probability of getting funded is increasing if

1. the perceived default probability of borrower i decreases
2. the funding gap decreases

▶ Theoretical model

Main data set

- ▶ Source: *Prosper.com* website
- ▶ Main sample: 326,044 loan-hour observations (Nov. 20 - Jan. 20)
- ▶ Observed characteristics: loan purpose, size, interest rate, maturity, monthly payment, employment status, income category, debt-to-income ratio, Prosper credit rating
- ▶ Employment status: employed, self-employed, unemployed
- ▶ Prosper rating: AA, A, B, C, D, E, HR
- ▶ Out of 4,257 loan applications in the dataset, 3,015 loans are identified as successfully originated
- ▶ The inflow of loan applications posted online can be continues around the clock
- ▶ Liftoff time: December 16th, 2pm ET

Table II: Descriptive statistics

Panel A: Full Sample											
	mean	sd	min	max	obs		obs	pct		obs	pct
size	13.10	7.13	2.00	35.00	4,257	Business	93	2.18	\$1-24,999	175	4.11
int-rate	14.22	6.46	4.32	30.25	4,257	Cons.	415	9.75	\$25,000-49,999	1,682	39.51
DTI	27.32	12.33	1	68	4,257	Debt	3,222	75.69	\$50,000-74,999	1,213	28.49
maturity	3.77	0.97	3	5	4,257	Other	344	8.08	\$75,000-99,999	601	14.12
verif.	2.30	0.76	1	3	4,257	Special	183	4.30	\$100,000+	586	13.77
Δfunding	0.95	3.91	0	99	322,600	Total	4,257	100	Total	4,257	100

Panel B1: Sample before the Liftoff						Panel B2: Sample after the Liftoff					
	mean	sd	min	max	obs		mean	sd	min	max	obs
size	13.05	7.25	2.00	35.00	2,029	size	13.14	7.01	2.00	35.00	2,228
int-rate	14.29	6.46	4.32	30.25	2,029	int-rate	14.15	6.46	4.32	30.25	2,228
DTI	27.10	12.24	1	63	2,029	DTI	27.52	12.41	1	68	2,228
maturity	3.85	0.99	3	5	2,029	maturity	3.69	0.95	3	5	2,228
verif.	2.30	0.76	1	3	2,029	verif.	2.30	0.76	1	3	2,228

Panel C1: EMP==Employed						Panel D1: CR==High					
	mean	sd	min	max	obs		mean	sd	min	max	obs
size	13.80	7.43	2.00	35.00	3,166	size	13.28	6.44	2.00	35.00	1,198
int-rate	13.66	6.35	4.32	30.25	3,166	int-rate	7.28	1.37	4.32	9.43	1,198
DTI	27.35	12.05	1	68	3,166	DTI	24.84	10.21	1	62	1,198
maturity	3.77	0.97	3	5	3,166	maturity	3.80	0.98	3	5	1,198
CreditBin	0.95	0.76	0	2	3,166						
Panel C2: EMP==Self-employed						Panel D2: CR==Middle					
	mean	sd	min	max	obs		mean	sd	min	max	obs
size	10.59	3.66	2.00	15.00	520	size	14.38	7.84	2.00	35.00	1,825
int-rate	17.42	6.40	5.76	30.25	520	int-rate	13.06	2.21	9.49	16.97	1,825
DTI	23.60	12.12	1	63	520	DTI	27.87	12.52	1	66	1,825
maturity	3.74	0.97	3	5	520	maturity	3.79	0.98	3	5	1,825
CreditBin	1.34	0.66	0	2	520						
Panel C3: EMP==Unemployed						Panel D3: CR==Low					
	mean	sd	min	max	obs		mean	sd	min	max	obs
size	11.49	7.07	2.00	35.00	571	size	11.02	6.11	2.00	30.00	1,234
int-rate	14.37	6.27	4.32	30.25	571	int-rate	22.65	3.90	17.61	30.25	1,234
DTI	30.54	13.12	1	63	571	DTI	28.90	13.53	2	68	1,234
maturity	3.75	0.97	3	5	571	maturity	3.69	0.95	3	5	1,234
CreditBin	1.04	0.73	0	2	571						

Histogram of interest rates

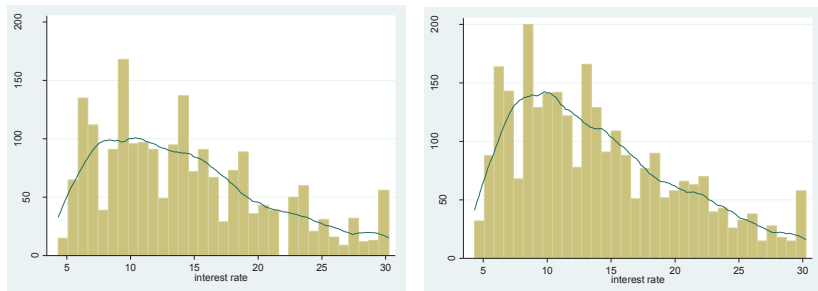


Figure: Histogram of interest rates for loans in our observed period, before (left panel) and after (right panel) Fed liftoff on December 16th, 2015.

Key result 1: interest rate reduction

	Dependent variable: Interest rate		
	(1)	(2)	(3)
Explanatory variables			
Liftoff	-0.476** (-2.13)	-0.136*** (-3.93)	-0.169*** (-4.36)
Controls			
Loan Characteristics		x	x
Borrower Characteristics		x	x
Main Effects			
Weekday FE	x		x
Hour FE	x		x
<hr/>			
Adj. R ²	0.004	0.970	0.970
Observations	4,257	4,257	4,257

Notes. The baseline regression of

$$\text{InterestRate}_{i,t} = \alpha_t + \beta_1 \text{Liftoff}_t + \gamma_1 \text{LoanCharacteristics}_i + \gamma_2 \text{BorrowerCharacteristics}_i + \epsilon_{i,t}.$$

The interest rate is in percentage points. The variable Liftoff_t is a dummy that equals 1 after the liftoff announcement on December 16, 2015. t statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Key result 2: credit spread reduction

	Dependent variable: Interest rate			
	(1)	(2)	(3)	(4)
Explanatory variables				
Liftoff	-1.810***	-1.884***	-1.891***	-1.934***
	(-2.81)	(-2.92)	(-2.87)	(-2.94)
1{EMP, HighCR}	-10.360***	-10.376***	-9.605***	-9.629***
	(-21.52)	(-21.37)	(-17.61)	(-17.55)
1{EMP, HighCR} × Liftoff	1.536**	1.654**	1.601**	1.658**
	(2.01)	(2.16)	(2.08)	(2.15)
Controls				
Loan Characteristics			x	x
Borrower Characteristics			x	x
Main Effects				
Weekday FE		x		x
Hour FE		x		x
Pre-Liftoff, int.rate mean 1{EMP, HighCR} = 0	17.805	16.085	19.974	19.315
Adj. R ²	0.663	0.668	0.671	0.675
Observations	355	355	355	355

Notes. The interest rate is regressed on the liftoff dummy, borrower riskiness (Employment and Credit Rating), and their interaction terms.

$$\text{InterestRate}_{i,t} = \alpha_t + \beta_0 1\{EMP, High\}_i + \beta_1 \text{Liftoff}_t + \beta_2 1\{EMP, High\}_i \times \text{Liftoff}_t + \gamma_1 \text{LoanCharacteristics}_i + \gamma_2 \text{BorrowerCharacteristics}_i + \epsilon_{i,t}.$$

Funding success measures

We use three measures for the dependent variable $Y_{i,t}$

- ▶ the success of loan origination: $1\{LoanFunded\}_i$
- ▶ the increase of funding for each loans:
Funding Increase $_{i,t} = \Delta(\text{Funding Percentage})_{i,t}$
- ▶ the speed of funding increase:
Funding Speed $_{i,t} = \Delta(\text{Funding Increase})_{i,t}$.

Funding success regressions

Dependent variable	(1) 1{ <i>LoanFunded</i> }	(2) Funding Increase	(3) Funding Speed
Explanatory variables			
Liftoff	0.238** (2.39)	0.137*** (11.23)	0.028** (1.98)
Controls			
Loan Characteristics	x	x	x
Borrower Characteristics	x	x	x
Main Effects			
Weekday FE	x	x	x
Hour FE	x	x	x
R ²	0.094	0.098	0.015
Observations	2,858	237,296	237,296

Notes. Funding success is regressed on a liftoff dummy, loan-borrower characteristics (as in previous regressions), and time dummies. The corresponding regressions are

$$Y_{i,t} = \alpha_t + \beta_1 \text{Liftoff}_t + \gamma_1 \text{LoanCharacteristics}_i + \gamma_2 \text{BorrowerCharacteristics}_i + \epsilon_{i,t}.$$

Results are from OLS regressions, except for a Logit regression with the funding probability 1{*LoanFunded*}. *t* statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Findings on the funding gap & on new demand

Deterioration of outside option of high rated borrowers?

- ▶ Funding gaps narrow after liftoff, but less so for the group of high rated borrowers
- ▶ The reduction in average interest rates cannot be explained by a collapse in demand
- ▶ To the contrary: demand increases after liftoff, and more so for the the group of high rated borrowers

Hypo. revisited: use state-level heterogeneity

What can we learn from state-level heterogeneity in unemployment rates?

- ▶ Overall, we find evidence that the unemployment rate is an important determinant of interest rate setting on Prosper, which resonates with our story line
- ▶ The reduction in interest rates after liftoff tends to be larger for states with higher unemployment rates (but insignificant coefficient)

Robustness and external validity

- ▶ Our main results show to be very robust (time window, changes in borrower composition, collapse in demand, changes in risk appetite, placebo effect)
- ▶ External validity *across markets* and *over time*
 1. We validate our key findings by studying LendingClub
 2. Generalize the link between improvements in the expected economic outlook and our key findings
 - ◇ Slope of the real yield curve: a proxy for measuring future economic development (Harvey 1988, Estrella and Hardouvelis 1991)
 - ◇ We find that both interest rate and spread decrease when the slope of the real yield curve increases
 - ◇ (the liftoff dummy remains significant)

Summary and conclusion

- ▶ Interest rate pass through in the subprime segment of the P2P market during the Fed liftoff
- ▶ Key findings
 - average interest rates and spreads go down
 - reduction in perceived default probabilities dominates pass-through
- ▶ Contributions
 - high frequency study of credit market response to monetary policy
 - monetary policy signaling: default risk channel versus risk free rate channel
 - interaction of P2P lending market and alternative finance
- ▶ External validity

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- ▶ External validity

Thanks for your attention!



Funding gaps: regressions

	Dependent variable: Funding gap			
	(1)	(2)	(3)	(4)
Explanatory variables				
Liftoff	-0.474*** (-23.12)	-0.477*** (-23.47)	-0.047*** (-7.99)	-0.044*** (-9.81)
1{EMP, HighCR}			0.181*** (31.09)	0.181*** (41.40)
1{EMP, HighCR} × Liftoff			0.101*** (12.03)	0.101*** (16.03)
Controls				
Main Effects				
Weekday FE		x		x
Hour FE		x		x
Pre-Liftoff, {UnEMP, LowCR} funding gap mean	2.475	2.347	0.232	0.184
Adj. R ²	0.113	0.128	0.828	0.903
Observations	1,403	1,403	650	650

Notes. The regression of funding gaps (in millions of USD) on liftoff, borrower characteristics (Employment and Credit Rating), and time dummies. The regression is

$$\text{FundingGap}_{i,t} = \alpha_t + \beta_0 1\{EMP, High\}_i + \beta_1 \text{Liftoff}_t + \beta_2 1\{EMP, High\}_i \times \text{Liftoff}_t + \epsilon_{i,t}.$$

t statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

New demand

	Dependent variable: Demand			
	(1)	(2)	(3)	(4)
Explanatory variables				
Liftoff	0.031*** (5.81)	0.030*** (5.79)	0.005* (1.70)	0.006** (2.01)
$1\{EMP, HighCR\}$			0.031*** (10.36)	0.031*** (11.77)
$1\{EMP, HighCR\} \times Liftoff$			0.030*** (6.87)	0.030*** (7.77)
Controls				
Main Effects				
Weekday FE		x		x
Hour FE		x		x
Pre-Liftoff, $\{UnEMP, LowCR\}$ demand	0.103	0.087	0.028	0.007
Adj. R ²	0.023	0.039	0.463	0.583
Observations	1,403	1,403	650	650

Notes. This table shows regressions of demand (in millions of USD) on liftoff, borrower characteristics (Employment and Credit Rating), and time dummies:

$$\text{Demand}_t = \alpha_t + \beta_0 1\{EMP, High\} + \beta_1 \text{Liftoff}_t + \beta_2 1\{EMP, High\} \times \text{Liftoff}_t + \epsilon_{i,t}.$$

t statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Robustness 1

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
Δ Int-Rate	273	-0.266	0.120	1.987	-0.503 -0.029
mean = mean(Δ Int-Rate)				t = -2.213	
H0: mean = 0				degrees of freedom = 272	
Ha: mean < 0		Ha: mean \neq 0		Ha: mean > 0	
Pr(T < t) = 0.014		Pr(T > t) = 0.028		Pr(T > t) = 0.986	

Notes. To conduct the sample t test, we measure the difference of regression coefficients by regressing the interest rate on a large set of dummies with all possible combinations of borrower characteristics: loan size, loan type, borrower income, debt-to-income ratio, credit rating, employment status, maturity, and a liftoff dummy. After the regression, we take the difference of the coefficients for the dummies that share all characteristics before and after liftoff. We then test whether the sample mean of the differences is smaller than 0. It is significant at the 5% level.

Robustness 2

	Dependent variable: interest rate					
	(1) High CR	(2) Middle CR	(3) Low CR	(4) Emp	(5) Self-emp	(6) Unemp
Explanatory variables						
liftoff	-0.0854 (-0.95)	-0.415*** (-3.56)	-0.393* (-1.71)	-0.368*** (-3.60)	0.143 (0.46)	-0.427* (-1.69)
ES==Self-employed	-0.206 (-1.61)	0.136 (0.89)	-0.686** (-2.10)			
ES==Unemployed	0.932*** (4.82)	0.848*** (5.26)	0.275 (0.96)			
CR==Middle				5.621*** (52.30)	5.737*** (11.88)	5.979*** (21.61)
CR==Low				14.980*** (123.24)	14.698*** (29.63)	15.070*** (47.70)
Controls						
Loan Characteristics	x	x	x	x	x	x
Borrower Characteristics	x	x	x	x	x	x
Main Effects						
Weekday FE	x	x	x	x	x	x
Hour FE	x	x	x	x	x	x
Average Int.Rate.	4.240	11.91	60.98	15.55	32.41	13.56
Observations	1,198	1,825	1,234	3,166	520	571
Adj. R ²	0.047	0.027	0.148	0.843	0.775	0.832

Notes. The sample divided into subgroups with credit rating (CR) or employment status (ES). "High CR" includes ratings AA and A, "Middle CR" includes B and C, and "Low CR" includes the rest. Employment statuses: Employed ("Full-time" or "Employed"), Self-employed, and Unemployed (reported as "Other").

Interest rate pass-through

What happens in the face of a monetary contraction? We might expect an *increase* in Prosper rates and spreads!

- ▶ Standard NK-models: complete interest rate pass-through by assumption (e.g. Woodford (2003))
- ▶ NK-models with incomplete interest rate pass-through (e.g. Kobayashi (IJCB, 2008))
- ▶ Bernanke and Kuttner (JF, 2005): monetary policy surprises impact stock prices via changes in risk premia
- ▶ Gertler and Karadi (AEJ:M, 2015): a contractionary monetary policy surprise is associated with a significant increase in credit spreads
- ▶ Drechsler, Savov and Schnabl (NBER WP, 2014): a positive relationship between the external finance spread of banks and the nominal interest rate

January 27, 2016 FOMC meeting results

	Dependent variable: Interest rate		
	(1)	(2)	(3)
Explanatory variables			
Post-Announcement	-0.105 (-0.54)	0.002 (0.08)	0.025 (0.72)
Controls			
Loan Characteristics		x	x
Borrower Characteristics		x	x
Main Effects			
Weekday FE	x		x
Hour FE	x		x
Adj. R ²	0.001	0.969	0.969
Observations	6,589	6,589	6,589

Notes. The dependent variable is the interest rate, in percentage points, posted on the P2P lending platform. The variable $\text{Post-Announcement}_t$ is a dummy variable that is equal to 1 after the FOMC's announcement on January 27, 2016 to leave the target federal funds rate range unchanged. The characteristic controls include the borrower's debt-to-income ratio, income group, Prosper credit score, and employment status. The loan characteristics include the loan size, the maturity, the loan purpose, and the verification stage. We also include state fixed effect, the weekday fixed effect, hour-of-the-day fixed effect, and additional covariates, such as cross products of loan-borrower characteristics and the liftoff dummy. t statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A1: average interest rate

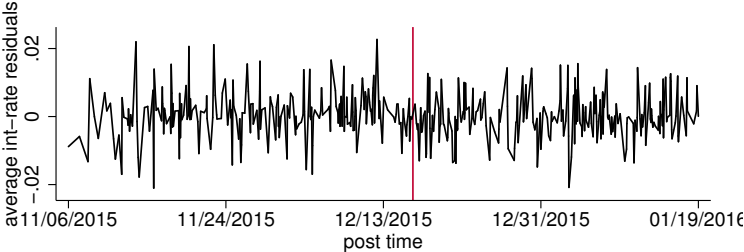
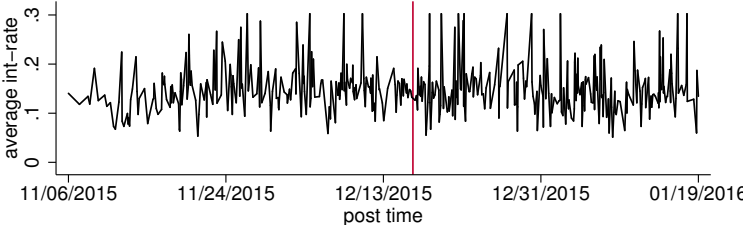
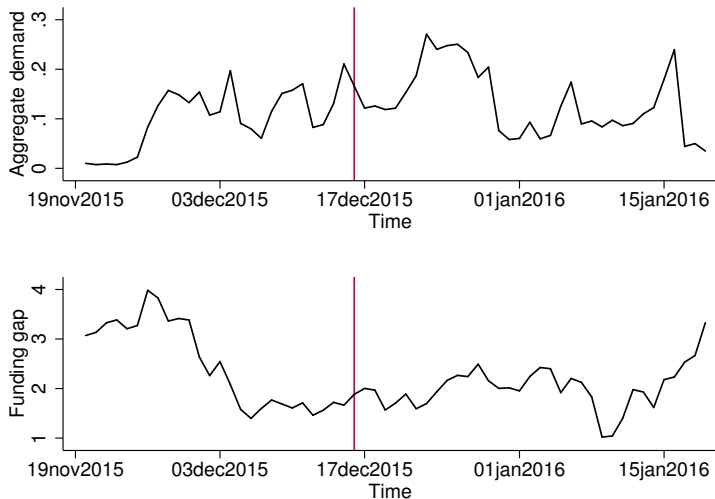


Figure A2: demand and funding gap



Papers using data from Prosper

- ▶ Appearance of borrowers: Duarte, Siegel, and Young (RFS, 2012); Pope and Syndor (JHR, 2011); Ravina (2012)
- ▶ Risk aversion of retail investors: Paravisini, Rappoport, and Ravina (forthcoming MS)
- ▶ Screening in lending decisions: Iyer, Khwaja, Luttmer, and Shue (forthcoming MS)
- ▶ Home prices and borrowing decisions: Crowe and Ramcharan (JMCB, 2013)
- ▶ Geography-based informational frictions: Senney (2016)
- ▶ Prosper auction pricing mechanism prior to Dec. 2010: Chen, Gosh, and Lambert (GEB, 2014); Wei and Lin (2015)
- ▶ Substitution between financing sources: Butler, Cornaggia, and Gurun (forthcoming MS)

Fed announcement and market expectations 2

Table: Selected interest rates around Fed liftoff

Date	Commercial Paper	Corporate Bonds
Dec. 9	0.23	2.76
Dec. 16	0.35	2.93
Dec. 23	0.39	2.92

Notes. The rates given are for 1-month, AA financial commercial paper and 3-5 year effective yields on U.S. corporate bonds (investment grade). The series are available in the St. Louis Federal Reserve's FRED database (<http://research.stlouisfed.org/fred2>) under the IDs DCPF1M (commercial paper) and 2A0C35YEY (3-5 year bonds).

▶ jump back

Hypo. revisited: use state-level heterogeneity

Regressions with state-level heterogeneity:

$$\text{InterestRate}_{i,t} = \alpha_t + \gamma_1 \text{LoanCharacteristics}_i + \gamma_2 \text{BorrowerCharacteristics}_i + \beta_0 1\{\text{StateHeterogeneity}\}_i + \beta_1 \text{Liftoff}_t + \beta_2 1\{\text{StateHeterogeneity}\}_i \times \text{Liftoff}_t + \epsilon_{i,t}.$$

with different heterogeneity measures,

- ▶ Unemployment rate: $1\{\text{Unemp}\} = 1$ for states with an unemployment rate higher than the national average, i.e. $> 5.2\%$ as of 2015.
- ▶ FRBNY CCP 2015Q4: $1\{\text{CreditCard}\} = 1$ for states with credit card balance above the national median level.
- ▶ FDIC SoD + CCP: $1\{\text{BankDeposit}\} = 1$ for states with lower deposits per capita and outstanding credit card balances per capita than the median.
- ▶ FDIC SoD: $1\{\text{BankComp}\} = 1$ for stronger local deposit market competition (HHI lower than the sample median).

State-level evidence

	Dependent variable: Interest rate			
	(1)	(2)	(3)	(4)
Explanatory variables				
Liftoff	-0.294*** (-3.26)	-0.438*** (-3.70)	-0.237*** (-3.90)	-0.212** (-2.87)
1{Unemp}	0.207** (2.35)			
1{Unemp}×Liftoff	-0.049 (-0.39)			
1{CreditCard}		-0.058 (-0.62)		
1{CreditCard}×Liftoff		0.244* (1.69)		
1{BankDeposit}			0.191** (2.10)	
1{BankDeposit}×Liftoff			-0.398** (-2.65)	
1{BankComp}				0.121 (1.48)
1{BankComp}×Liftoff				-0.210 (-1.64)
Benchmark int.rate mean	15.291	15.500	15.463	15.507
R ²	0.839	0.838	0.839	0.838
Observations	4,257	4,257	4,257	4,257

Notes. We include dummy variables to capture state level heterogeneity in unemployment rate, outstanding credit card debt, local access to capital markets and local deposit market competition. Standard errors are clustered at the state level. *t* statistics are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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