

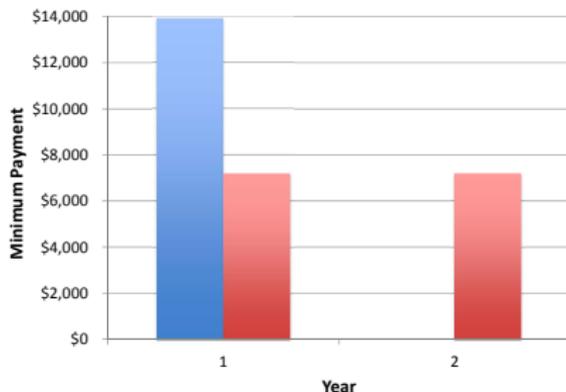
# Adverse Selection on Maturity: Evidence from Online Consumer Credit

Andrew Hertzberg (Columbia)  
with Andrés Liberman (NYU) and Daniel Paravisini (LSE)

*December 2016*

## Fixed rate loans: what does maturity really mean?

- ▶ Example: \$13,000 fixed rate 1 or 2 year amortizing loan
  - ▶ 1 year maturity: APR 7%, payment of \$13,910 due in one year
  - ▶ 2 year maturity: APR 10%, payment of \$7,190 due each of next 2 years
    - ▶ Total loan outstanding balance at end of first year: \$14,300
    - ▶ Difference in  $t = 1$  minimum payment: \$6,720



- ▶ Interpretation: 2 year loan is a one year loan *plus* the option to borrow \$6,720 at  $t = 1$  with terms set at  $t = 0$  (fixed 10% APR)

## Fixed rate loans: maturity provides insurance

- ▶ Households are exposed to shocks to their ability to repay
  - ▶ Unemployment, illness, divorce, expenditure needs

## Fixed rate loans: maturity provides insurance

- ▶ Households are exposed to shocks to their ability to repay
  - ▶ Unemployment, illness, divorce, expenditure needs
- ▶ Sequence of short term loans implies price of debt increases when marginal utility of consumption is higher
- ▶ Long term loans that lock-in contract terms (i.e., spread) provide insurance against risk of being re-classified as bad risk

# Insurance markets when consumers have private information

- ▶ If households have private information about their exposure to shocks
  - ▶ Theory of Rothschild and Stiglitz 1976 applies

# Insurance markets when consumers have private information

- ▶ If households have private information about their exposure to shocks
  - ▶ Theory of Rothschild and Stiglitz 1976 applies
- ▶ Application to loan maturity choice
  - ▶ In equilibrium lenders offer menus of maturities/price contracts to induce separation of high and low risk borrowers

# The question

- ▶ Do borrowers that are (unobservably) more exposed to shocks to their ability to repay self-select into longer maturity loans?
- ▶ Measure using the staggered introduction of long maturity loans at largest US online lending platform: Lending Club

# The identification problem

- ▶ Problem: how to identify adverse selection on maturity based on **unobservable** borrower risk

# The identification problem

- ▶ Problem: how to identify adverse selection on maturity based on **unobservable** borrower risk
- ▶ Focus on ex post loan performance (default) conditional on observable creditworthiness at origination
- ▶ Simple correlation: suppose borrowers are offered two loans:
  - ▶ Short maturity at 7% APR: lower default rate
  - ▶ Long maturity at 10% APR: higher default rate

# The identification problem

- ▶ Problem: how to identify adverse selection on maturity based on **unobservable** borrower risk
- ▶ Focus on ex post loan performance (default) conditional on observable creditworthiness at origination
- ▶ Simple correlation: suppose borrowers are offered two loans:
  - ▶ Short maturity at 7% APR: lower default rate
  - ▶ Long maturity at 10% APR: higher default rate
- ▶ Consistent with selection, but also with a causal effect of loan terms (higher APR, longer maturity, etc)

# The identification problem

- ▶ Problem: how to identify adverse selection on maturity based on **unobservable** borrower risk
- ▶ Focus on ex post loan performance (default) conditional on observable creditworthiness at origination
- ▶ Simple correlation: suppose borrowers are offered two loans:
  - ▶ Short maturity at 7% APR: lower default rate
  - ▶ Long maturity at 10% APR: higher default rate
- ▶ Consistent with selection, but also with a causal effect of loan terms (higher APR, longer maturity, etc)
- ▶ Idea: isolate selection by comparing how selected and non-selected samples perform under the same contract

## Idealized experiment

- ▶ Two observationally identical groups of borrowers: A and B
- ▶ **A** borrowers only have the option to take a **short term loan**
- ▶ **B** borrowers offered **same short term loan** AND a **long term loan**
- ▶ Default rates for ST loan are  $\gamma_A^{ST}$  and  $\gamma_B^{ST}$  for groups A and B, respectively

Maturity APR	Short $r_{ST}\%$	Long $r_{LT}\%$
Group A	$\gamma_A^{ST}$	
Group B	$\gamma_B^{ST}$	$\gamma_B^{LT}$

# Setting: Lending Club

- ▶ Largest online U.S. consumer credit lending platform
  - ▶ Facilitated \$4.4bn loans in 2014 (\$8.4bn in 2015) (roughly 3x the second biggest player, Prosper)
- ▶ Loans funded by individual investors, LC algorithm determines all loan terms (LC charges an origination fee)

The screenshot shows the LendingClub website interface. At the top, the LendingClub logo is on the left, and navigation links for Personal Loans, Business Loans, Patient Solutions, Investing, How It Works, and About Us are on the right. A 'Log In' button is also visible. The main banner features the slogan 'Better Rates. Together.' and a 'Get a Rate Quote' section. The quote section includes a form with fields for 'How much do you need?', 'What is it for?', and 'How is your credit?', along with a 'Check Your Rate' button and a note that the process is free and takes just minutes. Below the banner, there are three sections: 'Financial Innovation' which describes the peer-to-peer lending model, a circular diagram showing the flow from Investors to Loans to Borrowers with Monthly Payments, and a 'Featured Borrower' profile for Rebecca Durham, NC, with a \$5,000 credit limit.

**LendingClub** Personal Loans Business Loans Patient Solutions Investing How It Works About Us

**Better Rates. Together.**

**Get a Rate Quote**  
It's free and it takes just minutes.

How much do you need?  
What is it for?  
How is your credit?

**Check Your Rate**

**Financial Innovation**  
Lending Club is the world's largest online marketplace connecting borrowers and investors. We're transforming the banking system to make credit more affordable and lending more rewarding. We operate at a lower cost than traditional bank lending programs and pass the savings on to borrowers in the form of lower rates and to investors in the form of higher returns.

**Featured Borrower**  
Rebecca Durham, NC  
Pay Off Credit Cards  
\$5,000 credit limit

## Lending process

- ▶ Prospective borrowers are classified into one of 25 risk categories: sub grades
  - ▶ Roughly: 4-point FICO score bins adjusted by
    - ▶ Full credit report information
    - ▶ Verified income

## Lending process

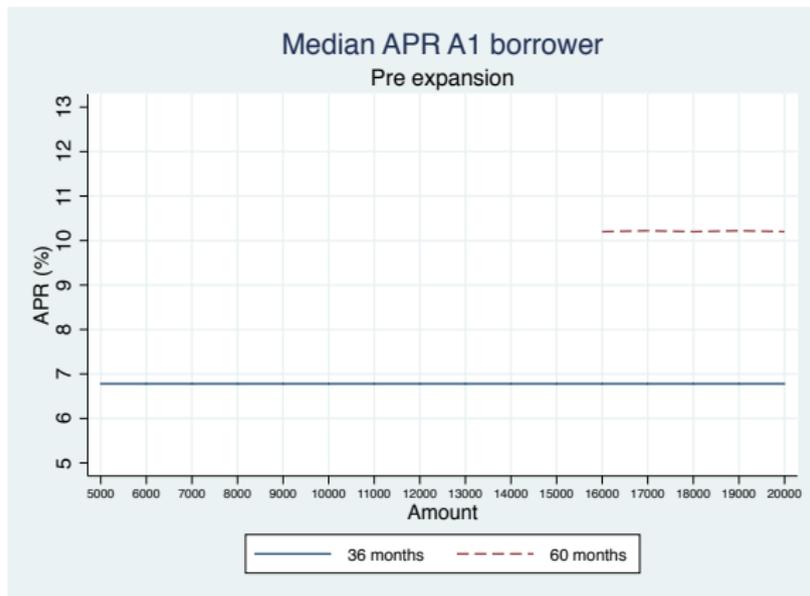
- ▶ Prospective borrowers are classified into one of 25 risk categories: sub grades
  - ▶ Roughly: 4-point FICO score bins adjusted by
    - ▶ Full credit report information
    - ▶ Verified income
- ▶ Based purely on sub grade: borrower is offered a menu of amounts/APRs/maturities (36 or 60 months);
- ▶ Terms: no collateral, fixed monthly payments, no prepayment penalty

## Lending process

- ▶ Prospective borrowers are classified into one of 25 risk categories: sub grades
  - ▶ Roughly: 4-point FICO score bins adjusted by
    - ▶ Full credit report information
    - ▶ Verified income
- ▶ Based purely on sub grade: borrower is offered a menu of amounts/APRs/maturities (36 or 60 months);
- ▶ Terms: no collateral, fixed monthly payments, no prepayment penalty
- ▶ All borrowers who choose to take a loan they are offered have it filled at rate determined by sub grade
  - ▶ Applications are denied based purely on observables (e.g. LC requires  $FICO \geq 660$ ) and rules for rejection are constant over our sample
  - ▶ No supply side changes during our sample

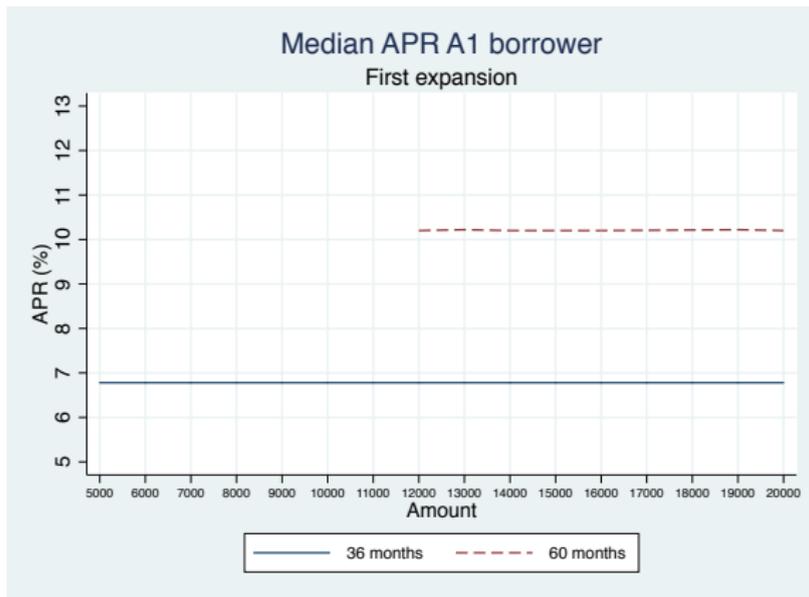
# Menu prior to expansion: Dec '12 - Feb '13

- ▶ Pre-period: 60 month loans only available at 16k and above



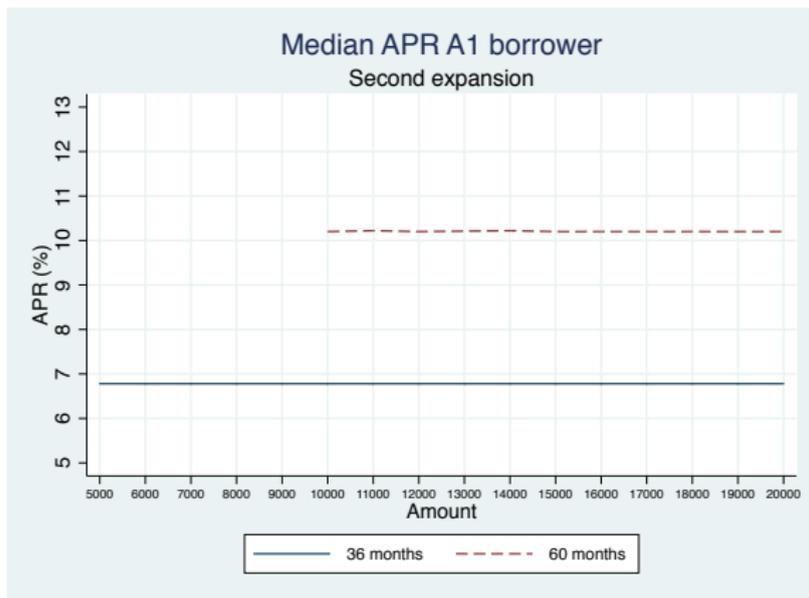
## Menu after first expansion: Mar '13 - Jun '13

- ▶ Long maturity loan was rolled-out to lower amounts in two stages: first to \$12k - \$16k

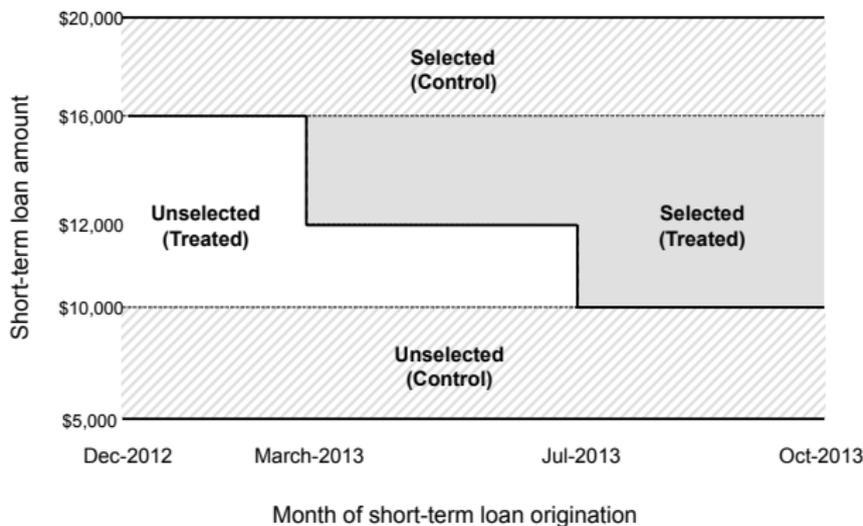


## Menu after second expansion: Jul '13 - Oct '13

- ▶ Long maturity loan was rolled-out to lower amounts in two stages: then to \$10k - \$12k



## Approximating the idealized experiment: D in D



- ▶ LC did not change the 36 month loan prices, screening standards or risk classification algorithm during the sample period Dec '12 - Oct '13

## Approximating the idealized experiment

- ▶ Study repayment of 36 month loans between \$10k and \$16k issued before (non-selected) and after (selected) the staggered availability of the 60 month loan option
  - ▶ LC did not change the 36 month loan prices or risk classification algorithm during the entire period Dec '12 - Oct '13
  - ▶ No evidence that LC advertised the expansion
- ▶ To account for time of origination-varying differences in credit demand and creditworthiness
  - ▶ Difference in differences
  - ▶ Use 36-month borrowers who are observationally equivalent at \$5k - \$10k and \$16k - \$20k, as well as treated amounts before/after they become affected, as controls

# The sample

- ▶ For each loan: all borrower information **at time of origination (Dec '12 - Oct '13)**
  - ▶ Full credit history including FICO score, verified income, state
  - ▶ Loan amount, maturity, monthly payment, APR, date of origination
  - ▶ Subgrade: i.e. the menu of loans offered to the borrower

# The sample

- ▶ For each loan: all borrower information **at time of origination (Dec '12 - Oct '13)**
  - ▶ Full credit history including FICO score, verified income, state
  - ▶ Loan amount, maturity, monthly payment, APR, date of origination
  - ▶ Subgrade: i.e. the menu of loans offered to the borrower
- ▶ For each loan: status in **April 2015**
  - ▶ Repayment status: number of days late, date of last payment
    - ▶ We classify a loan as being in default if payment is 120+ days past due
  - ▶ FICO score (*in April 2015*)

## Selection at treated loan amounts

- ▶ Before studying differences in repayment: do we see selection into the long term loan once it becomes available?
- ▶ Collapse and count the number of 36 month loans at the sub grade  $j \times \$1,000$  amount bin  $k \times$  month of origination  $t$  level as  $N_{jkt}$
- ▶ Define:

$$D_{kt} = \begin{cases} 1 & \text{if } 16,000 > \text{LoanAmount}_k \geq 12,000 \text{ and } t \geq \text{Mar13} \\ 1 & \text{if } 12,000 > \text{LoanAmount}_k < 10,000 \text{ and } t \geq \text{Jul13} \\ 0 & \text{otherwise} \end{cases}$$

- ▶ Diffs-in-diffs specification:

$$\log(N_{jkt}) = \gamma' \times D_{kt} + \beta'_k + \delta'_{jt} + \epsilon_{jkt}$$

## Selection at treated loan amounts

$$\log(N_{jkt}) = \gamma' \times D_{kt} + \beta'_k + \delta'_{jt} + \epsilon_{jkt}$$

	<i>log (#loans)</i>
	MAIN
$\gamma'$	-0.1451*** (0.033)
Obs	3,663
$R^2$	0.817
Clusters	45

# Does the unobserved quality of 36-month borrowers change with selection?

- ▶ Run the staggered introduction regression at the loan level:

$$default_i = \gamma \times D_i + \beta_i^{1000bin} + \delta_i^{subgrade \times month} + X_i + \epsilon_i$$

$$D_i = \begin{cases} 1 & \text{if } 12,000 \leq LoanAmount_i < 16,000 \text{ and } t_i \geq Mar13 \\ 1 & \text{if } 10,000 \leq LoanAmount_i < 12,000 \text{ and } t_i \geq Jul13 \\ 0 & \text{otherwise} \end{cases}$$

- ▶ Controls:
  - ▶  $\beta_i^{1000}$ : fixed effect for each \$1,000 bin
  - ▶  $\delta_i^{subgrade \times month}$ : month by sub-grade FE
  - ▶  $X_i$ : Additional controls (state and 4-point FICO bin FEs (baseline), and everything else LC observes at origination (additional))

## Performance of selected 36 month borrowers

$$default = \gamma \times D_i + \beta_i^{1000bin} + \delta_i^{subgrade \times month} + X_i + \epsilon_i$$

	<i>default</i>	<i>default</i>
$\gamma$	-0.0081** (0.004)	-0.0080** (0.004)
Obs	60,511	57,263
Controls	No	Yes
$R^2$	0.035	0.047
Clusters	45	45

- ▶ Default rate of 36-month loans drops by 0.8 percentage points when some borrowers self-select into 60-month loan

## Economic magnitude

- ▶ Average default rate for 36 month loans is 0.8% lower for borrowers who selected into the short term loan

## Economic magnitude

- ▶ Average default rate for 36 month loans is 0.8% lower for borrowers who selected into the short term loan
- ▶ Implied default rate at the short maturity of borrowers who preferred to borrow long term (i.e., the 14.5%) is **5.5% higher** ( $=0.8\%/14.5\%$ )
  - ▶ Compare this to the **average pre-period default rate of 9.2%**
- ▶ Indicates maturity may be a powerful screening device - AKA induces pronounced adverse selection

## Economic magnitude

- ▶ Average default rate for 36 month loans is 0.8% lower for borrowers who selected into the short term loan
- ▶ Implied default rate at the short maturity of borrowers who preferred to borrow long term (i.e., the 14.5%) is **5.5% higher** ( $=0.8\%/14.5\%$ )
  - ▶ Compare this to the **average pre-period default rate of 9.2%**
- ▶ Indicates maturity may be a powerful screening device - AKA induces pronounced adverse selection
- ▶ Selected group also has higher future FICO score and lower FICO score volatility

## Private information about what?

- ▶ So far: borrowers who select into long maturity loans exhibit a higher default rate at short maturity
  - ▶ We argue that this difference stems from borrowers who privately observe that they are more exposed to shocks to their ability to repay
  - ▶ Alternatively, privately informed about: timing of income
- ▶ Empirical difference: timing of default

## Timing of Default: 12 vs 24 Months from Origination

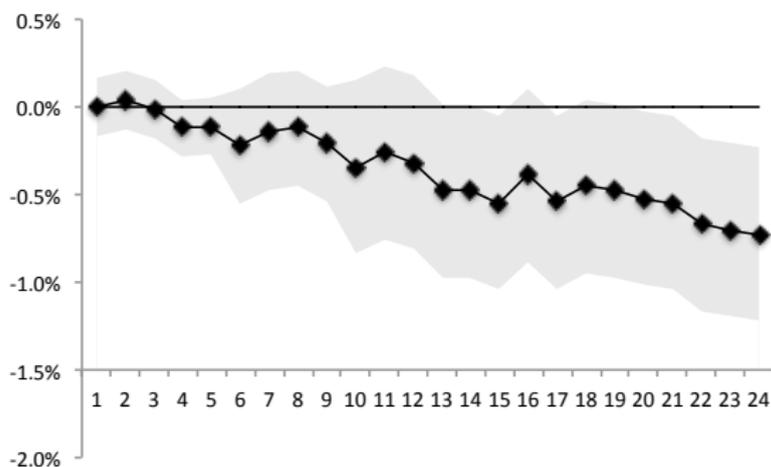
$$\text{defaultXXm} = \gamma \times D_i + \beta_i^{1000\text{bin}} + \delta_i^{\text{subgrade} \times \text{month}} + X_i + \epsilon_i$$

	<i>default12m</i>	<i>default24m</i>
$\gamma$	-0.0039 (0.003)	-0.0082* (0.004)
Obs	60,511	60,511
$R^2$	0.024	0.032
Clusters	45	45

- ▶ Differential propensity to default larger and only statistically significant after 2 years

## Timing of default: All Horizons

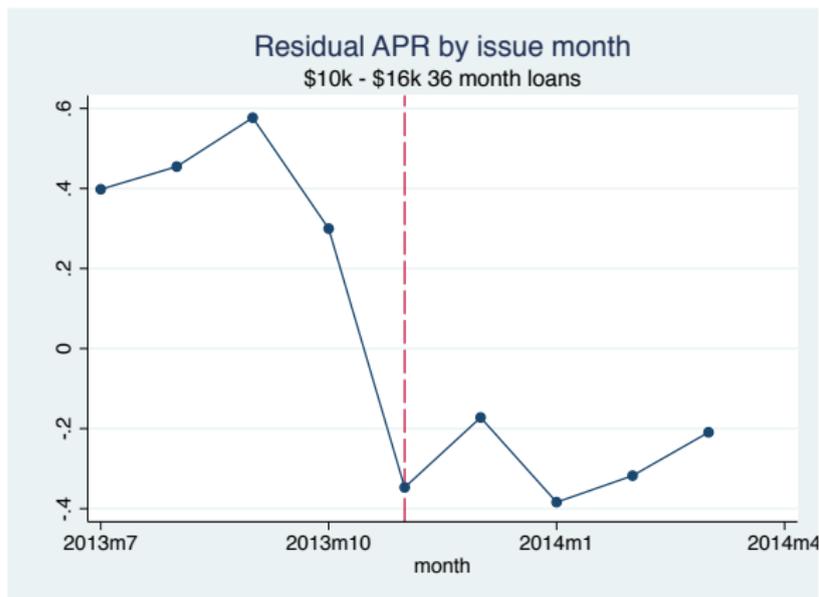
- ▶ Default specification conditioning on the last payment occurring  $m$  months after origination (plot coefficients vs  $m$ )



- ▶ Inconsistent with income timing interpretation

## Suggestive: Post period equilibrium

- ▶ After menu expansion short term rates fixed for a few months
  - ▶ Should fall in competitive screening equilibrium
- ▶ LC changed the pricing algorithm in November 2013
  - ▶ Regression residuals of rates on all observables drop 0.8 p.p.



## Suggestive: The naive comparison

- ▶ Due to extensive margin selection: cannot say anything about default rate of borrowers who self-selected into 60-month loans
  - ▶ Default probability of 60-month loans was 3% higher than that of 36-month loans (by April 2015, after controlling for  $\delta_i^{subgrade \times month}$  and  $\beta_i^{1000}$ )
  - ▶ LC charged a 3.3% higher APR for 60-month loans

## Conclusion

- ▶ First evidence of adverse selection in loan maturity choice
- ▶ Borrowers with lower repayment capacity/ability self-select into longer maturity loans
  - ▶ Can partly explain equilibrium positive correlation between maturity and risk (and rates) in consumer credit markets

## Conclusion

- ▶ First evidence of adverse selection in loan maturity choice
- ▶ Borrowers with lower repayment capacity/ability self-select into longer maturity loans
  - ▶ Can partly explain equilibrium positive correlation between maturity and risk (and rates) in consumer credit markets
- ▶ Maturity choice in consumer credit is relatively understudied (Zinman 2014)
  - ▶ Demand elasticity to maturity is large (Karlan and Zinman 2008)

# Conclusion

- ▶ First evidence of adverse selection in loan maturity choice
- ▶ Borrowers with lower repayment capacity/ability self-select into longer maturity loans
  - ▶ Can partly explain equilibrium positive correlation between maturity and risk (and rates) in consumer credit markets
- ▶ Maturity choice in consumer credit is relatively understudied (Zinman 2014)
  - ▶ Demand elasticity to maturity is large (Karlan and Zinman 2008)
- ▶ Positive: Understand pricing of common consumer loan products that offer borrowers a choice over maturity
  - ▶ Mortgages, auto loans, personal loans
- ▶ Normative: Mortgage length regulation: you cannot compare outcomes across contracts and blame the contract features!
  - ▶ Capping loan maturity (e.g U.S. Reg. Z) removes insurance

Thanks

Thank you!