

# **What's in a Picture? Evidence of Discrimination from Prosper.com**

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**Imagine you are a loan officer...**



**“Need a car”**



**“Medical expenses”**



**“Becoming debt free”**



**“Take a trip”**



**“Need school supplies”**



**“Fix my roof”**

## **We study discrimination in the Prosper.com marketplace.**

### **PRIMARY RESEARCH QUESTIONS**

- How do lenders respond to information found in the pictures and text of online credit listings?
- Is the lender response to this information efficient?  
(Becker (1957) and Arrow (1973))

### **KEY ADVANTAGES TO USING PROSPER.COM DATA**

- All information about borrowers that is seen by lenders is available to the econometrician.
- Loan terms and relevant ex-post performance of borrowers is available.



## Outline

- Introduction
- Background of Prosper.com
- Data
- Determinants of access to credit (disparate treatment?)
- Efficiency of discrimination (taste-based discrimination?)
- Discussion and conclusion

## Background of Prosper.com


- Borrowers create loan listing
- All loans have 3-year terms and are uncollateralized
- Individual lenders bid to fund a portion of a loan (min. \$50)
- Loan funds only if total bids fully cover the requested loan size
- Once fully funded, auction process determines final interest rate
- Prosper charges closing costs of 1.5 – 3% of loan amount
- Defaulted loans reported to credit agencies and collection agency

# An example of a Prosper.com loan listing

## Paying off my high interest debt


Personal loan (Listing #351871)

**Listing Summary** [Help](#)



**\$5,500.00 @ 14.85%**  
 Bid down from 17.50%

**Bid Now**  
 Bid \$50 or more


Funding:  100% funded

Bids: [113 bids](#)  
 1 day 19 hours 25 minutes left

Borrower APR: 17.02%

Mo. payment: \$190.26 (3y loan)

**Credit Profile** [Help](#)

<b>C credit grade</b>	 Homeowner	<b>15% debt to income ratio</b>	
Now delinquent:	0	First credit line:	Jul-1987
Amount delinquent:	\$0	Current / open credit lines:	16 / 13
Delinquencies in last 7y:	0	Total credit lines:	31
Public records last 12m / 10y:	0 / 0	Revolving credit balance:	\$23,317
Inquiries last 6m:	1	Bankcard utilization:	86%
		Employment status:	Full-time
		Length of status:	0y 10m
		Income range:	\$75,000-\$99,999
		Occupation:	Professional

### Description

#### Purpose of loan:

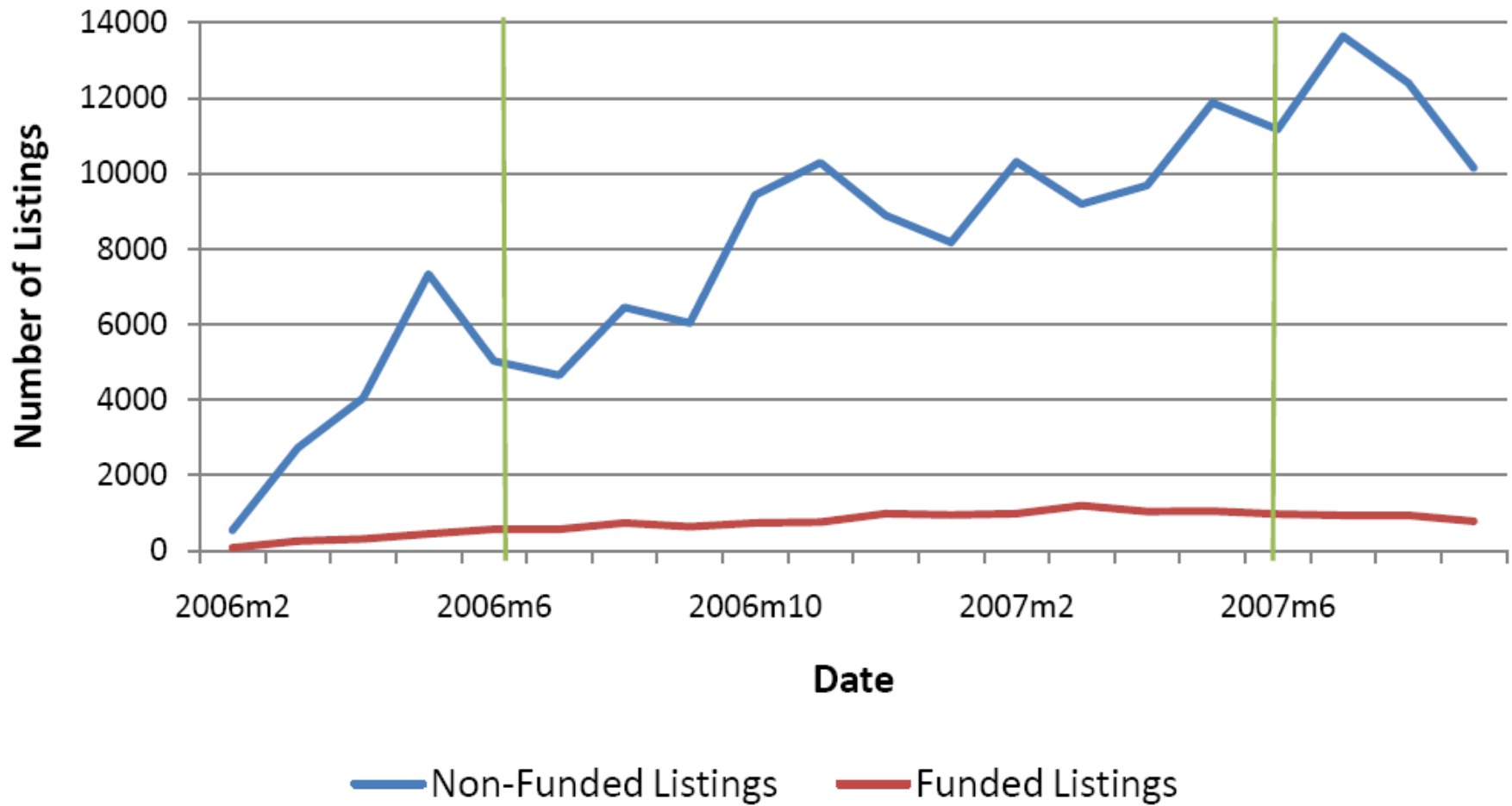
This loan will be used to... pay off a high interest credit card. I am making good, solid payments but almost half of my installment is going to interest and it seems that I am just spinning my wheels.

#### My financial situation:

I am a good candidate for this loan because... I have had some challenges in the past but I have overcome them all and have not taken the easy way out. I accept my obligations and am serious about becoming debt free within the next five years. I have successfully paid off a number of my accounts and am proud of that accomplishment.

# Figure 1. Total Listings Across Time

## By Funded Status



Funded over 24,000 loans worth \$154 million to date

## Data collection process

### DATA

- Our analysis focuses on all loan listings between June 2006 and May 2007.
- 110,333 distinct loan listings (10,207 funded loans)
- All credit and listing information that was provided to lenders was made available by Prosper.com
- Undergraduates systematically coded information from borrower's picture and one-line description without seeing other parameters of the listing.

Information from Listings			Information from Pictures (for those with a picture)		
Variables	All Listings	Funded Listings	Variables	All Listings	Funded Listings
<b>Credit Grade</b>			<b>Main Content of Picture</b>		
AA (760-800)	0.03	0.10	Adult/Adults	0.65	0.67
A (720-760)	0.03	0.09	Just Children	0.10	0.07
B (680-720)	0.04	0.11	Buildings	0.04	0.05
C (640-680)	0.07	0.16	Animals	0.04	0.04
D (600-640)	0.11	0.17	Automobiles	0.02	0.02
E (560-600)	0.18	0.17			
HR (520-560)	0.54	0.20	<b>For Pictures with Adults:</b>		
NC	0.01	0.01	<b>Gender</b>		
			Single Male	0.38	0.40
<b>Loan Information</b>			Single Female	0.35	0.31
\$ Requested	7,154	5,930	Couple	0.20	0.22
Borrower's Max Rate	0.17	0.20	Group	0.07	0.07
Final Rate	NA	0.18			
Fraction Funded	0.12	1.00	<b>Race</b>		
Closed Auction Loans	0.43	0.37	White	0.67	0.83
			Black	0.20	0.11
<b>Other Information Provided</b>			Asian	0.03	0.03
Debt to Income Ratio	0.63	0.39	Hispanic	0.03	0.02
Group Member	0.51	0.69			
Owns a Home	0.27	0.39	<b>Age</b>		
Provided a Picture	0.46	0.64	Less than 35 yrs	0.53	0.54
			35-60 yrs	0.41	0.41
<b>Information Coded From</b>			More than 60 yrs	0.02	0.02
<b>Descriptions:</b>					
<b>Purpose of Loan</b>			<b>Happiness</b>		
Consolidate or Pay Debt	0.30	0.33	Happy	0.74	0.77
Business/Entrepreneurship	0.10	0.10	Neutral	0.23	0.21
Pay Bills	0.04	0.02	Unhappy	0.01	0.01
Education Expenses	0.03	0.03			
Medical/Funeral Expenses	0.03	0.02	<b>Weight</b>		
Home Repairs	0.02	0.03	Not overweight	0.73	0.75
Auto Purchase	0.02	0.02	Somewhat overweight	0.20	0.18
Home/Land Purchase	0.02	0.02	Very overweight	0.03	0.02
Auto Repairs	0.01	0.01			
Luxury Item Purchase	0.01	0.01	<b>Attractiveness</b>		
Wedding	0.01	0.01	Very attractive	0.05	0.06
Reinvest in Prosper	0.01	0.02	Average	0.91	0.91
Taxes	0.01	0.01	Very unattractive	0.03	0.02
Vacation or Trip	0.01	0.01			
Multiplie of Above Reasons	0.06	0.05	<b>Other</b>		
Unclear/Other	0.34	0.33	Profesionally Dressed	0.13	0.14
			Child Also in Picture	0.21	0.21
			Signs of Military Involvement	0.02	0.02
<b>Observations</b>	110,333	10,207		50,820	6,571

## Related research on Prosper.com

### **FREEDMAN & JIN (2008)**

- Study evolution of market
- Analyze Prosper.com's business model and profits to lenders

### **RAVINA (2008)**

- 1-month of Prosper data
- Primarily focuses on the effect of beauty

# **Determinants of Access to Credit**



## Approach to identifying discrimination (disparate treatment)

### ESTIMATION

- Probability of receiving loan funding and interest rate conditional on funding as functions of listing variables
- Focusing on effect of characteristics such as race, age, and gender

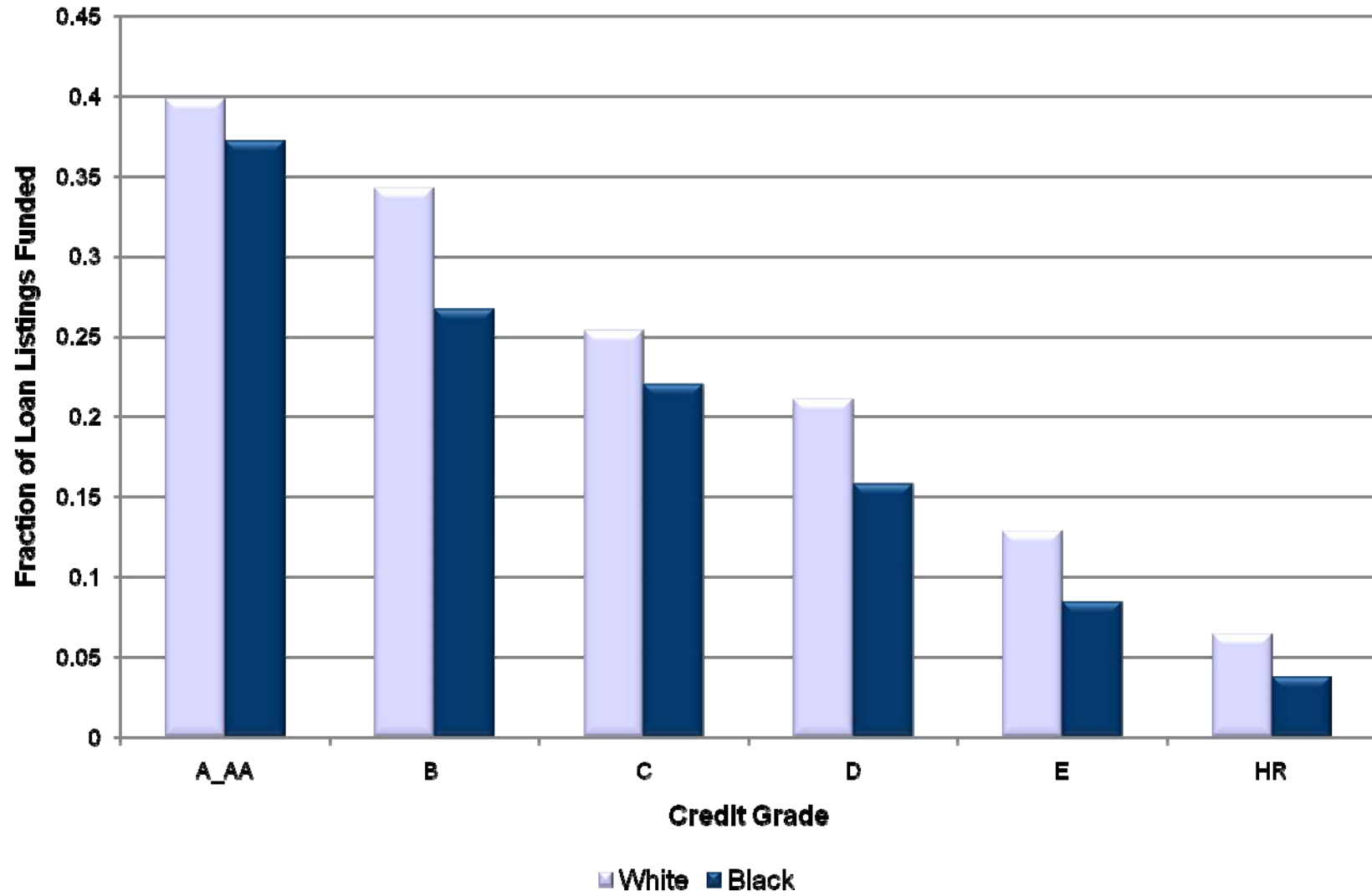
### OBSERVATIONAL DATA

- E.g., Boston Fed studies (1996)
- Potential omitted variable bias & model specification questions
- Potential to track ex-post performance

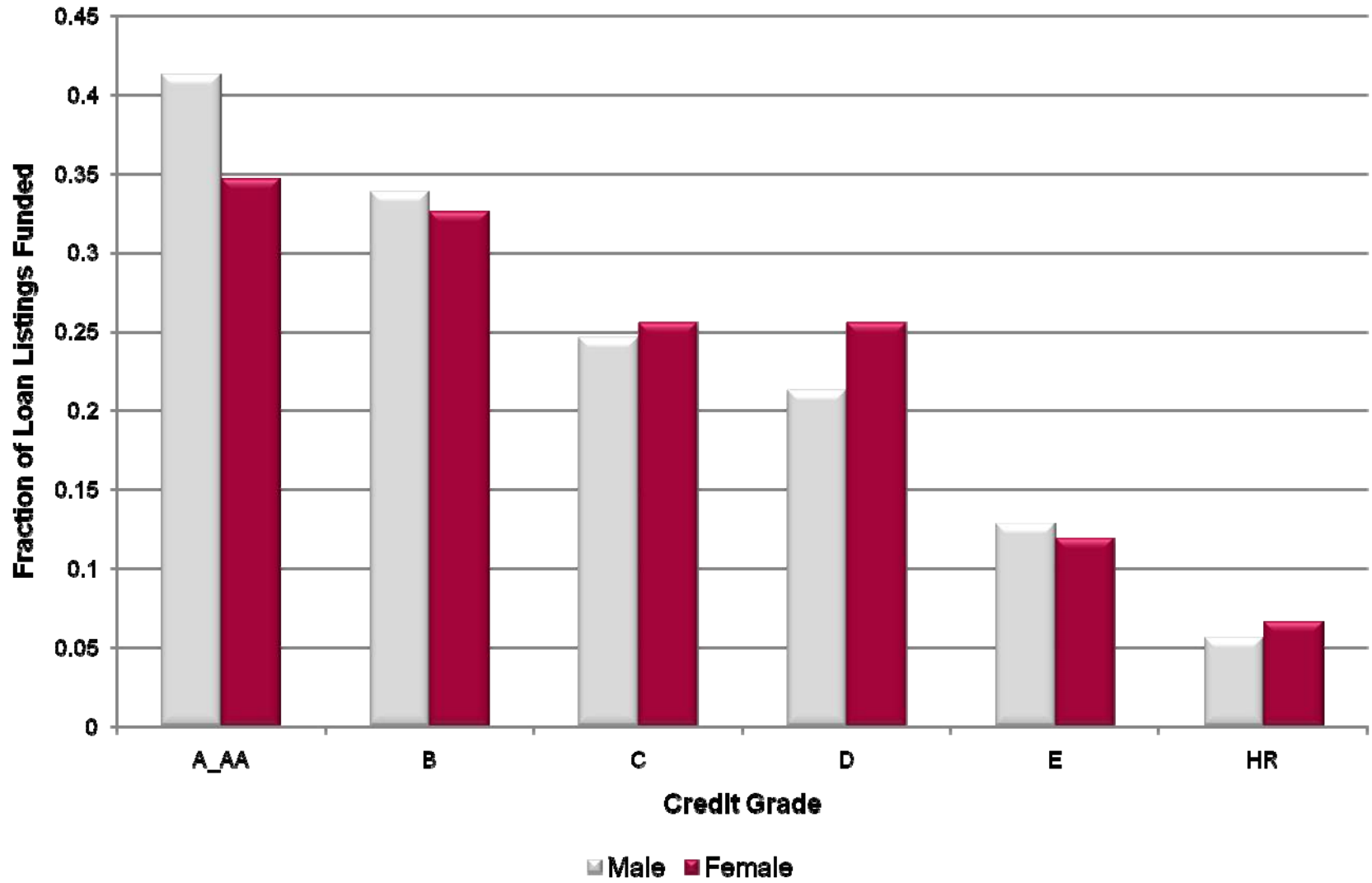
### AUDIT/FIELD EXPERIMENTS

- E.g., Bertrand & Mullainathan (2004)
- Random assignment
- Typically difficult to track ex-post

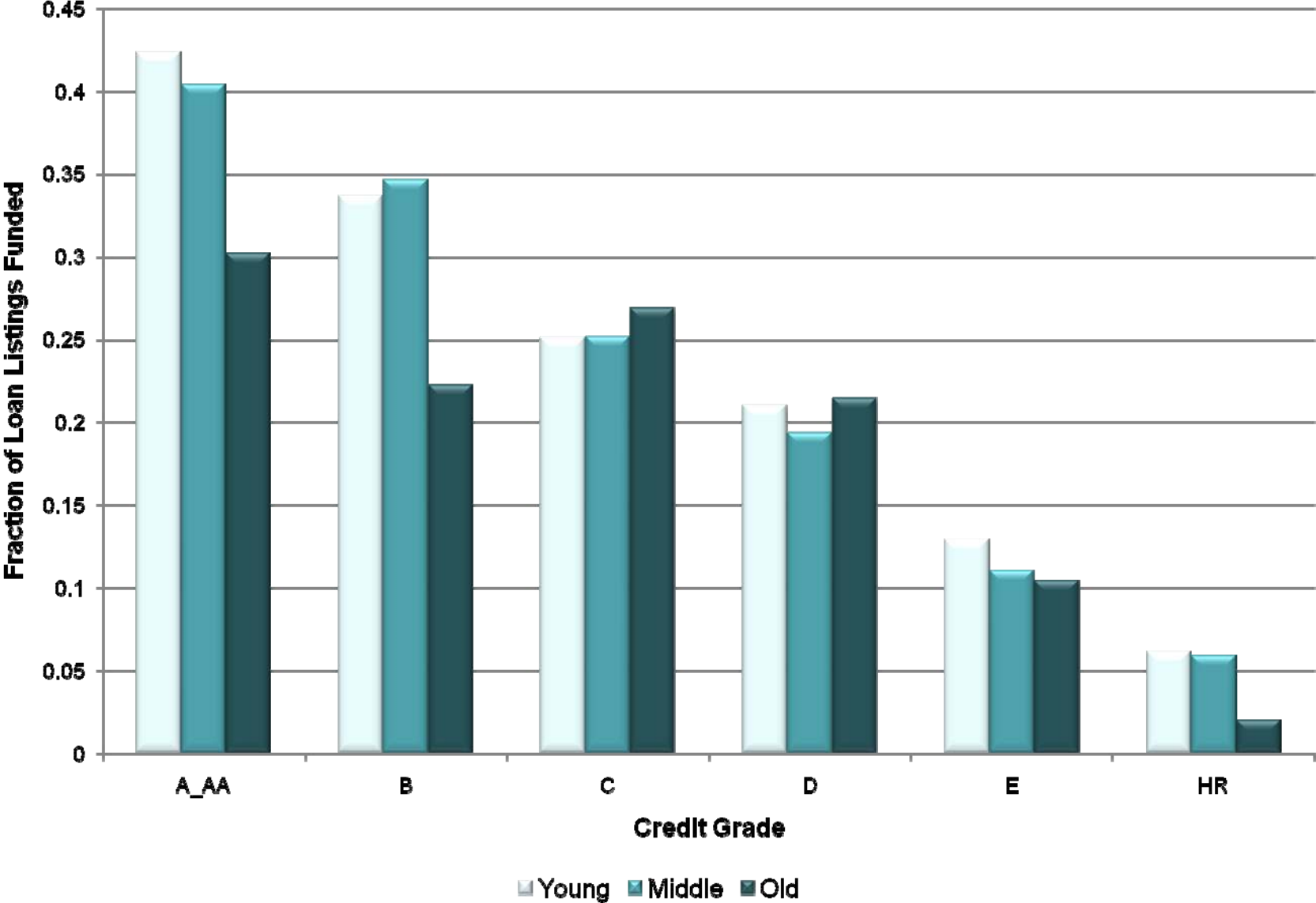
## Race



## Gender



# Age



## Main OLS specification

$$Y_i = \alpha + X_i\beta + Z_i\theta + \varepsilon_i$$

- $Y_i$  is an indicator for whether the listing got funded.
- $X_i$  is a matrix of variables coded from pictures and text
- $Z_i$  is a matrix of other listing variables (e.g., credit controls)

## ESTIMATION TECHNIQUES

- OLS
- Logit (marginal effects)
- Propensity score

**Table 2. The Effect of Borrower Characteristics and Purpose on Loans Being Funded**

Dependent Variable: Indicator = 1 if the Loan was Funded			
	Logit		Logit
<b>Mean of Dependent Variable</b>	0.093	<b>Loan Purpose (BG: Unclear)</b>	
<b>Gender (BG: Single Male)</b>		Consolidate or Pay Debt	0.004 (0.002)*
Single Female	0.011 (0.003)**:	Business/Entrepreneurship	-0.006 (0.003)**
Couple	-0.001 (0.003)	Pay Bills	-0.010 (0.006)
Group	-0.004 (0.004)	Education Expenses	0.001 (0.005)
<b>Race (BG: White)</b>		Medical/Funeral Expenses	-0.014 (0.006)**
Black	-0.024 (0.003)**:	Home Repairs	0.005 (0.006)
Asian	0.004 (0.006)	Auto Purchase	-0.005 (0.006)
Hispanic	-0.006 (0.005)	Home/Land Purchase	-0.015 (0.006)*** :
<b>Age (BG: 35-60 yrs)</b>		Auto Repairs	-0.015 (0.007)**
Less than 35 yrs	0.004 (0.002)*	Luxury Item Purchase	-0.011 (0.008)
More than 60 yrs	-0.011 (0.007)*	Wedding	-0.006 (0.007)
<b>Happiness (BG: Neutral)</b>		Reinvest in Prosper	-0.010 (0.006)*
Happy	0.002 (0.002)	Taxes	0.008 (0.011)
Unhappy	-0.016 (0.009)*	Vacation or Trip	0.006 (-0.011)
<b>Weight (BG: Not Overweight)</b>		Multiplie of Above Reasons	-0.003 (0.003)
Somewhat overweight	0.003 (0.003)	<b>Picture Characteristics</b>	<b>X</b>
Very overweight	-0.008 (0.006)	<b>Month Fixed Effects</b>	<b>X</b>
<b>Attractiveness (BG: Average)</b>		<b>Credit Controls</b>	<b>X</b>
Very attractive	0.004 (0.005)	<b>Observations</b>	110,332
Very unattractive	-0.005 (0.007)		
<b>Misc. Adult Information</b>			
Profesionally Dressed	0.002 (0.003)		
Child With Adult in Picture	0.001 (0.002)		
Signs of Military Involvement	0.025 (0.009)***		

**Table 3. The Effect of Race on Loans Being Funded - Specification Robustness**

	Dependent Variable: Indicator = 1 if the Loan was Funded							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Mean of Dependent Variable</b>	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093
<b>Race (BG: White)</b>								
Black	-0.051 (0.002)***	-0.028 (0.003)***	-0.027 (0.002)***	-0.022 (0.003)***	-0.021 (0.003)***	-0.021 (0.003)***	-0.024 (0.003)***	-0.024 (0.003)***
Asian	0.010 (0.008)	0.000 (0.006)	0.006 (0.006)	0.006 (0.006)	0.007 (0.006)	0.006 (0.006)	0.005 (0.006)	0.004 (0.006)
Hispanic	-0.028 (0.006)***	-0.013 (0.006)**	-0.012 (0.006)**	-0.007 (0.006)	-0.006 (0.006)	-0.005 (0.005)	-0.006 (0.005)	-0.006 (0.005)
<b>Credit Grade (BG: HR &amp; NC)</b>								
AA		0.745 (0.004)***						
A		0.704 (0.004)***						
B		0.624 (0.004)***						
C		0.477 (0.004)***						
D		0.315 (0.004)***						
E		0.106 (0.003)***						
<b>Other Key Credit Variables</b>								
Maximum Borrower's Rate		1.756 (0.022)***						
Debt to Income Ratio		-0.014 (0.001)***						
\$ Requested (thousands)		-0.000 (.000)***						
<b>Cubic of Borrower's Max Rate x Credit Grades</b>			X	X	X	X	X	X
<b>Cubic of Debt to Income Ratio and Amount</b>			X	X	X	X	X	X
<b>All other Credit Controls</b>				X	X	X	X	X
<b>Long Description Text Controls</b>					X	X	X	X
<b>Month Fixed Effects</b>						X	X	X
<b>Other Picture Characteristics</b>							X	X
<b>Loan Purpose Fixed Effects</b>								X
<b>Observations</b>	110,333	110,333	110,333	110,333	110,333	110,333	110,333	110,333

**Table 4. The Effect of Race on Loans Being Funded - Sample Cuts**

Dependent Variable: Indicator = 1 if the Loan was Funded

Panel A

	Sample Cut by Credit Grades				Sample Cut by Time	
	AA & A	B & C	D & E	HR & NC	First 6 Months	Last 6 Months
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Mean of Dependent Variable</b>	0.335	0.225	0.108	0.035	0.087	0.096
<b>Race (BG: White)</b>						
Black	-0.041 (0.031)	-0.054 (0.014)***	-0.033 (0.005)***	-0.013 (0.002)***	-0.020 (0.004)***	-0.026 (0.003)***
Asian	0.011 (0.027)	0.000 (0.019)	-0.004 (0.011)	0.006 (0.006)	0.002 (0.011)	0.005 (0.006)
Hispanic	0.072 (0.054)	0.005 (0.026)	-0.011 (0.010)	-0.006 (0.004)	-0.022 (0.008)***	0.006 (0.007)
<b>Other Picture Characteristics</b>	X	X	X	X	X	X
<b>Loan Purpose Fixed Effects</b>	X	X	X	X	X	X
<b>Month Fixed Effects</b>	X	X	X	X	X	X
<b>Credit Controls</b>	X	X	X	X	X	X
<b>Observations</b>	5,587	12,123	32,154	60,391	45,941	64,386



**Table 5. The Effect of Borrower Characteristics and Purpose on the Final Interest Rate for Funded Loans**

Dependent Variable: The Final Interest Rate for Funded Loans			
	OLS		OLS
<b>Mean of Dependent Variable</b>	0.182	<b>Loan Purpose (BG: Unclear)</b>	
<b>Gender (BG: Single Male)</b>		Consolidate or Pay Debt	-0.002 (0.001)*
Single Female	-0.004 (0.001)***	Business/Entrepreneurship	0.002 (0.001)*
Couple	-0.001 (0.001)	Pay Bills	0.007 (0.004)*
Group	0.001 (0.002)	Education Expenses	0.003 (0.002)
<b>Race (BG: White)</b>		Medical/Funeral Expenses	0.005 (0.003)*
Black	0.006 (0.002)***	Home Repairs	-0.001 (0.002)
Asian	0.002 (0.002)	Auto Purchase	0.001 (0.003)
Hispanic	0.002 (0.003)	Home/Land Purchase	0.000 (0.003)
<b>Age (BG: 35-60 yrs)</b>		Auto Repairs	0.004 (0.004)
Less than 35 yrs	-0.001 (0.001)	Luxury Item Purchase	-0.001 (0.003)
More than 60 yrs	0.000 (0.003)	Wedding	0.010 (0.004)**
<b>Happiness (BG: Neutral)</b>		Reinvest in Prosper	0.004 (0.002)**
Happy	-0.001 (0.001)	Taxes	-0.007 (0.004)*
Unhappy	0.002 (0.004)	Vacation or Trip	0.005 (0.004)
<b>Weight (BG: Not Overweight)</b>		Multiplie of Above Reasons	0.003 (0.002)
Somewhat overweight	0.002 (0.001)*	<b>Open Funding Option Only</b>	
Very overweight	0.003 (0.002)	<b>Picture Characteristics</b>	<b>X</b>
<b>Attractiveness (BG: Average)</b>		<b>Month Fixed Effects</b>	<b>X</b>
Very attractive	0.003 (0.002)*	<b>Credit Controls</b>	<b>X</b>
Very unattractive	0.006 (0.003)**	<b>R-Squared</b>	0.79
<b>Misc. Adult Information</b>		<b>Observations</b>	10,207
Profesionally Dressed	0.003 (0.001)**		
Child With Adult in Picture	0.003 (0.001)***		
Signs of Military Involvement	-0.002 (0.003)		

# Efficiency of Discrimination

# Disentangling motives and understanding the efficiency of discrimination

## IMPLICATIONS OF DIFFERENT THEORIES OF DISCRIMINATION

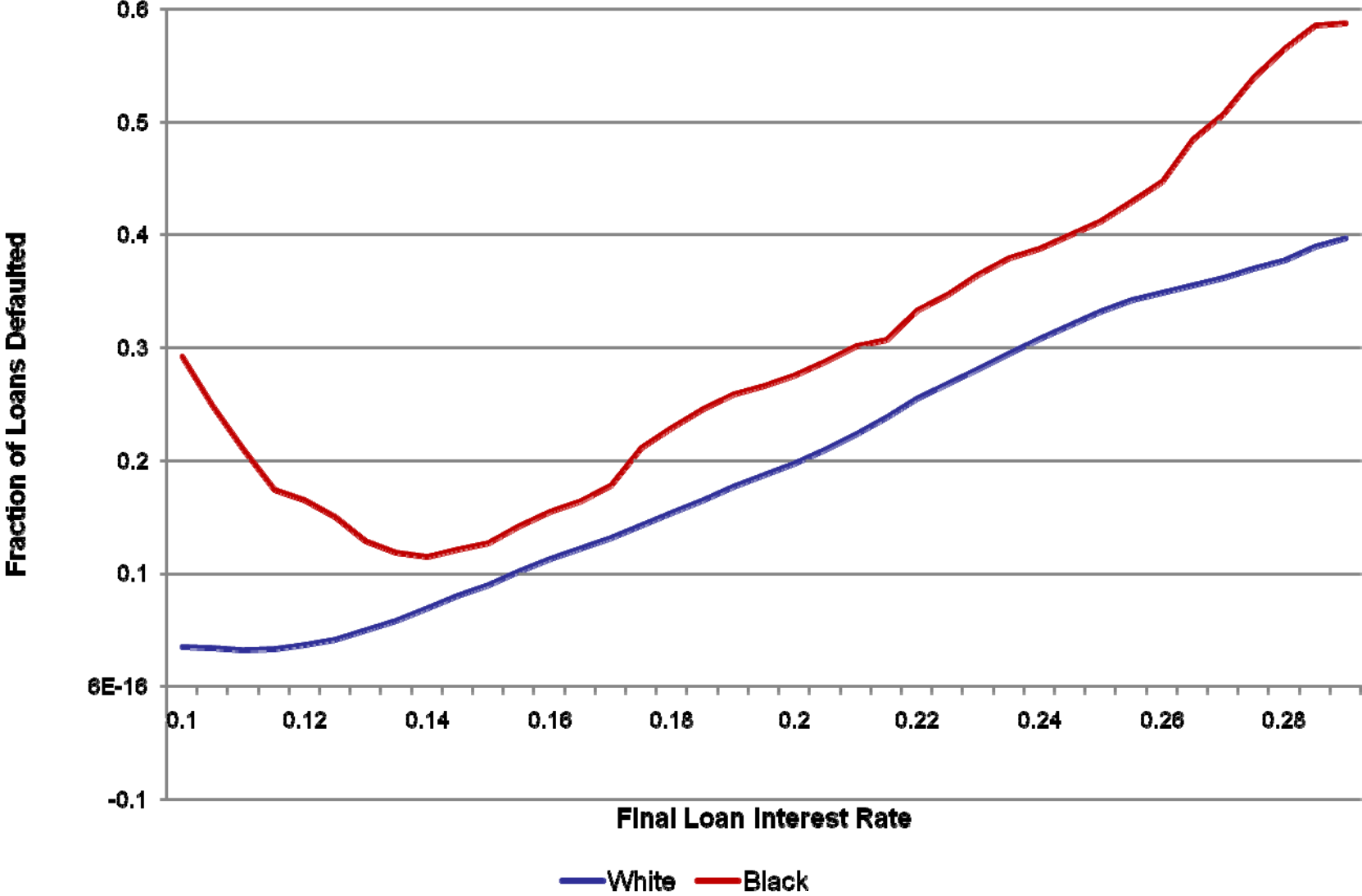
*Assuming lenders interested in expected net returns...*

- Accurate statistical discrimination → Identical net returns
- Taste-based discrimination → Different net returns
- Inaccurate beliefs

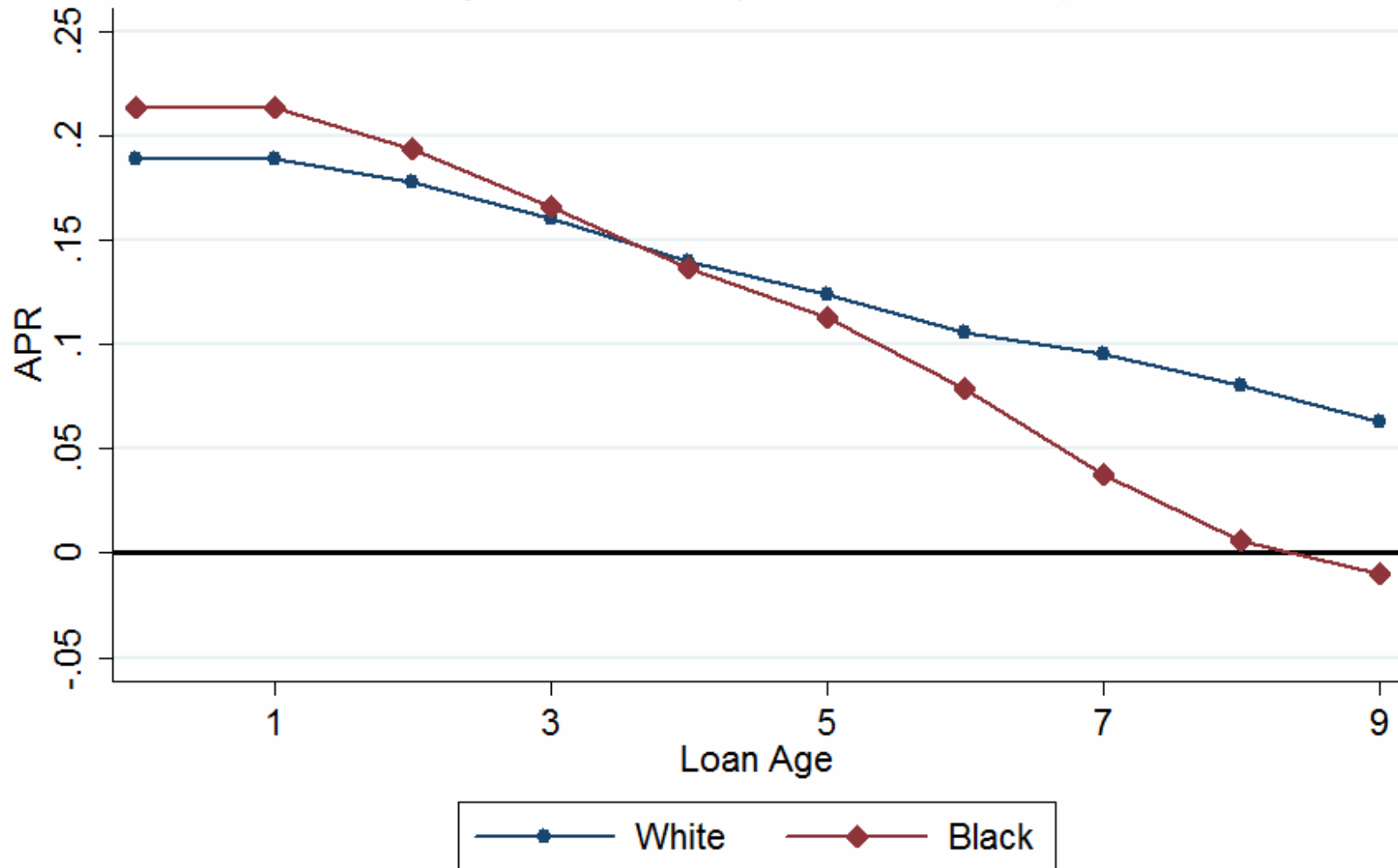
**Table 6. Loan Performance Summary Statistics**

	Current Status of All Funded Loans (Fractions Reported)					Total # of Loans
	Current or Paid Off	1 Month Late	2 Months Late	3 Months Late	4+ Months Late	
<b>All Loans</b>	0.78	0.02	0.02	0.02	0.17	10,118
<b>Age of the Loan (Months)</b>						
7	0.91	0.02	0.04	0.01	0.02	230
8	0.86	0.03	0.02	0.02	0.07	1,073
9	0.84	0.03	0.02	0.01	0.10	1,095
10	0.84	0.02	0.01	0.02	0.11	1,153
11	0.77	0.02	0.02	0.03	0.16	912
12	0.76	0.02	0.02	0.02	0.19	982
13	0.74	0.02	0.02	0.02	0.20	950
14	0.73	0.01	0.02	0.02	0.22	701
15	0.72	0.01	0.02	0.02	0.24	704
16	0.76	0.02	0.01	0.01	0.20	613
17	0.71	0.01	0.01	0.02	0.24	753
18	0.74	0.01	0.01	0.01	0.24	560
19	0.71	0.02	0.01	0.01	0.25	392
<b>Race</b>						
White	0.79	0.02	0.02	0.02	0.15	3,756
Black	0.63	0.03	0.02	0.03	0.29	533
Asian	0.80	0.02	0.02	0.02	0.14	163
Hispanic	0.69	0.02	0.04	0.04	0.21	103

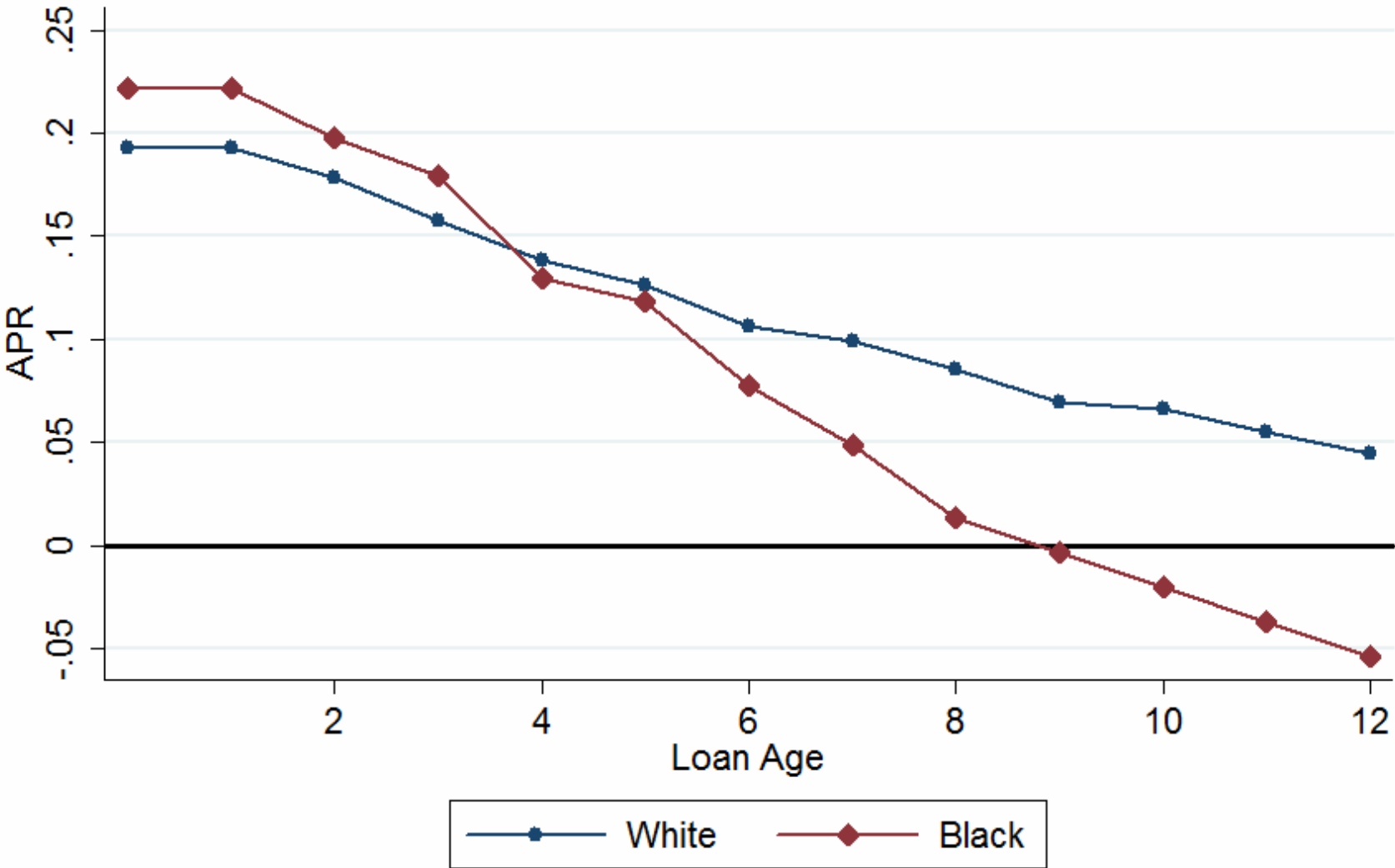
# Final Interest Rate and Default by Race



Cumulative APR by Loan Age  
by Race Grade (9-Month Window)



Cumulative APR by Loan Age  
by Race Grade (12-Month Window)



**Table 7. The Effect of Borrower Characteristics on Net Return on Investment**

	Hazard Model - Dep	OLS - Dep Var: 3-Year Return on Each Dollar		
	Var: Default	Invested by Return Type		
	Default	Return Type I	Return Type II	Return Type III
<b>Mean of Dependent Variable</b>		1.047	1.066	1.084
<b>Gender (BG: Single Male)</b>				
Single Female	0.139 (0.094)	-0.023 (0.016)	-0.016 (0.016)	-0.016 (0.016)
Couple	-0.064 (0.110)	0.001 (0.016)	0.002 (0.016)	0.003 (0.016)
Group	0.077 (0.161)	0.001 (0.026)	-0.001 (0.026)	0.005 (0.025)
<b>Race (BG: White)</b>				
Black	0.346 (0.100)***	-0.086 (0.023)***	-0.082 (0.023)***	-0.084 (0.023)***
Asian	-0.230 (0.210)	0.017 (0.034)	0.017 (0.033)	0.015 (0.032)
Hispanic	0.050 (0.231)	-0.050 (0.047)	-0.051 (0.047)	-0.031 (0.046)
<b>Age (BG: 35-60 yrs)</b>				
Less than 35 yrs	-0.008 (0.082)	0.000 (0.014)	-0.003 (0.013)	-0.003 (0.013)
More than 60 yrs	-0.042 (0.362)	-0.037 (0.044)	-0.039 (0.043)	-0.012 (0.041)
<b>Happiness (BG: Neutral)</b>				
Happy	-0.072 (0.083)	0.022 (0.015)	0.017 (0.014)	0.012 (0.014)
Unhappy	0.443 (0.266)*	-0.016 (0.060)	-0.039 (0.060)	-0.070 (0.060)
<b>Weight (BG: Not Overweight)</b>				
Somewhat overweight	0.116 (0.095)	-0.021 (0.017)	-0.017 (0.017)	-0.008 (0.017)
Very overweight	-0.164 (0.207)	0.072 (0.039)*	0.052 (0.039)	0.052 (0.040)
<b>Attractiveness (BG: Average)</b>				
Very attractive	-0.097 (0.181)	-0.012 (0.030)	-0.014 (0.030)	0.012 (0.028)
Very unattractive	0.309 (0.234)	-0.049 (0.048)	-0.046 (0.046)	-0.056 (0.045)
<b>Misc. Adult Information</b>				
Professionally Dressed	0.129 (0.117)	-0.025 (0.018)	-0.013 (0.018)	-0.012 (0.017)
Child With Adult in Picture	0.130 (0.080)	-0.035 (0.014)**	-0.029 (0.014)**	-0.022 (0.013)*
Signs of Military Involvement	0.458 (0.260)*	-0.034 (0.048)	-0.029 (0.047)	-0.052 (0.046)
<b>Loan Purpose Fixed Effects</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
<b>Month Fixed Effects</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
<b>Credit Controls</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
<b>R-Squared</b>		0.26	0.26	0.26
<b>Observations</b>	9,963	10,113	10,113	10,113



## Interpreting the results

### HIGHER DEFAULT RATE AMONG BLACKS

- Skin color is clearly not a causal factor of default
- Must be factors that lenders cannot perfectly observe that predict default and are correlated with race (e.g., education, neighborhood effects, support networks, and labor-market discrimination)

### LOWER NET RETURNS AMONG BLACKS

*Maintaining the assumption of accurate beliefs...*

- Statistical discrimination against blacks
- &
- Taste-based discrimination against whites

## Interpreting the results cont.

### AN ALTERNATIVE EXPLANATION

- Lenders understand that due to certain unobservables blacks are more likely to default than whites.
- Lenders under appreciate the impact that unobservables have on the likelihood of default or the correlation between race and unobservables.

### LONG RUN EQUILIBRIUM IN MARKET

- Difference in net returns may disappear in the long run.
- Disappearance in the long run could be interpreted as evidence of inaccurate beliefs.

# Conclusions

## KEY RESULTS

- Evidence of racial discrimination in a new credit market.
- Differences in net returns across races suggests taste-based discrimination in favor of blacks or inaccurate beliefs.

## IMPLICATIONS FOR DISCRIMINATION LITERATURE

- Results highlight potential importance of inaccurate beliefs when examining theories of discrimination.
- Simple evidence of disparate treatment may be misleading when thinking about the sources of discrimination.

**Thank You!!**