

# TIME PREFERENCES, HEALTH BEHAVIORS, AND ENERGY CONSUMPTION

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# Motivation(s)

- Consumers seem to apply very large discount rates when purchasing energy-intensive durable goods
  - The “energy paradox” or the “energy-efficiency gap”
- Can this behavior be accounted for by *present bias*?
  - E.g. quasi-hyperbolic ( $\beta\delta$ ) preferences with  $\beta < 1$
- [If so, policy implications]
- Individuals seem to underinvest in health
  - Exercise
  - Diet
  - Preventative health
- Can this behavior be accounted for by *present bias*?
  - E.g. quasi-hyperbolic ( $\beta\delta$ ) preferences with  $\beta < 1$
- [If so, policy implications]

# Motivation

- Specific applications to energy/environmental economics and to health economics
- Similar motivation regarding financial decisions (e.g. savings, borrowing)
  - Can these behaviors be explained by present bias?
- More general motivations:
  - To what extent can laboratory-measured time preferences explain actual market behavior?
  - Do individuals exhibit different time discounting behavior over different domains of their decisions (e.g. health vs. energy)?
  - Do risk preferences help to explain correlations between measured time preferences and outcomes?
  - How do self-reported measures of time and risk preference perform relative to elicited measures?

# What We Do to Answer These Questions

- An online survey asks individuals:
  - Questions to elicit their time preferences ( $\beta$  and  $\delta$ ) and risk preferences (CRRA)
  - Questions about their energy consumption decisions
    - E.g. do you own a fuel-efficient car?
  - Questions about health outcomes and behaviors
    - E.g. do you smoke?
  - Questions about financial behavior
    - E.g. do you have any retirement savings?
- Are there correlations between measured time preferences and these outcome variables?
- Does controlling for risk preferences mitigate the correlation?
- Do self-reported measures of time and risk preferences correlate with outcomes or with elicited measures?

# What We Find

- Many outcomes are correlated with  $\delta$  and/or with  $\beta$ 
  - Overall self-assessed health, smoking, drinking, health insurance, automobile fuel economy, installation of energy-efficient light bulbs
- Controlling for risk preferences has no effect on correlations
- Self-reported time and risk preferences don't give us much

# Background – Quasi-Hyperbolic Discounting

- Discount factor applied in the present between any two consecutive future periods is  $\delta$  (long-run discount factor)
- Discount factor used between the current period and the following period is  $\beta\delta$ , where  $\beta < 1$  (present bias)
  - $U = u_0 + \beta \sum \delta^t u_t$
- This is time-inconsistent; consumer's decision about actions at time  $t$  will differ at time  $t-1$  compared to time  $t$

# Survey Design

- Online – Qualtrics.com
- Buy 1300 respondents
- Four sets of questions
  1. Demographics (age, gender, race, income, education, marital status, number of children)
  2. Multiple price list (MPL) questions to elicit time and risk preferences
  3. Health, energy, financial behaviors and outcomes
  4. Self-reported time and risk preferences, cognitive reflection test, time preferences over health decisions

# MPL questions

- Series of binary questions about smaller payoffs now vs. larger payoffs later
  - E.g. “Would you like to receive \$29 today or \$30 in one month?”
  - Used to calculate measures of time preferences
    - $\delta_{avg}$ : assuming time-consistent preferences
    - $\delta_{qh}$  and  $\beta_{qh}$ : quasi-hyperbolic discount factors
- Series of binary questions about lotteries
  - E.g. Lottery A: 20% chance of winning \$20, 80% chance of winning \$16; Lottery B: 20% chance of winning \$38.50, 80% chance of winning \$1.50
  - Used to calculate CRRA risk parameter
- Randomly pay out 10% of respondents; pay out on one question
  - Amazon.com gift cards



# Results

- Is there any correlation between time preferences and any of several health, energy, and financial outcomes?
- All OLS regressions include unreported demographic controls
  - Five-year-interval age categories
  - Income and income squared
  - Gender, race (white vs. all other)
  - Five education categories
  - Marital status, # of children
  - Cognitive Reflection Test score ([Frederick \(2005, JEP\)](#))
- One specification assuming time-consistent  $\delta$
- One specification allowing time-inconsistent  $\delta$  and  $\beta$

# Results 1 – Self-Reported Health

	(1)	(2)	(3)	(4)
	Good Health Indicator	Good Health Indicator	Days Physical Health Not Good	Days Physical Health Not Good
$\delta$	0.257***		0.387	
	(0.0983)		(2.108)	
$\delta_{qh}$		0.270***		0.514
		(0.0996)		(2.161)
$\beta_{qh}$		0.194**		0.983
		(0.0766)		(1.673)
<b>N</b>	915	915	916	916
<b>R<sup>2</sup></b>	0.100	0.104	0.048	0.049
	(5)	(6)	(7)	(8)
	Days Mental Health Not Good	Days Mental Health Not Good	Days Kept from Activities	Days Kept from Activities
$\delta$	-6.085**		-3.825*	
	(2.413)		(2.107)	
$\delta_{qh}$		-6.371**		-4.064*
		(2.477)		(2.159)
$\beta_{qh}$		-2.267		-1.783
		(1.894)		(1.573)
<b>N</b>	916	916	916	916
<b>R<sup>2</sup></b>	0.070	0.071	0.057	0.058

# Results 2 – Risky Behavior and Preventative Health

	(1)	(2)	(3)	(4)	(5)	(6)
	Obese	Obese	Exercise Days per Month	Exercise Days per Month	Current Smoker	Current Smoker
$\delta$	0.113		6.730***		-0.358***	
	(0.128)		(2.315)		(0.114)	
$\delta_{qh}$		0.105		7.239***		-0.375***
		(0.131)		(2.366)		(0.116)
$\beta_{qh}$		-0.0893		1.832		-0.117
		(0.0865)		(1.952)		(0.0838)
N	850	850	917	917	914	914
R <sup>2</sup>	0.072	0.074	0.074	0.075	0.160	0.161
	(7)	(8)	(9)	(10)	(11)	(12)
	Binge Drinker	Binge Drinker	Health Insurance	Health Insurance	Bought own Health Insurance	Bought own Health Insurance
$\delta$	-0.130		0.181		0.220	
	(0.115)		(0.120)		(0.149)	
$\delta_{qh}$		-0.116		0.188		0.204
		(0.118)		(0.123)		(0.151)
$\beta_{qh}$		-0.0588		0.0522		0.0160
		(0.0864)		(0.0858)		(0.133)
N	914	914	913	913	350	350
R <sup>2</sup>	0.117	0.117	0.161	0.161	0.217	0.217

# Results 3 – Energy

	(1)	(2)	(3)	(4)	(5)	(6)
	High mpg	High mpg	Installed CFL	Installed CFL	Well-Insulated	Well-Insulated
$\delta$	0.0419		0.295**		0.101	
	(0.148)		(0.125)		(0.0967)	
$\delta_{qh}$		0.0677		0.302**		0.0989
		(0.151)		(0.128)		(0.0981)
$\beta_{qh}$		0.281***		0.0704		0.0936
		(0.107)		(0.0916)		(0.0760)
<b>N</b>	752	752	913	913	908	908
<b>R<sup>2</sup></b>	0.049	0.058	0.083	0.083	0.056	0.057
	(7)	(8)	(9)	(10)		
	Energy Audit	Energy Audit	Intended Energy Audit	Intended Energy Audit		
$\delta$	-0.291***		-0.204**			
	(0.104)		(0.0956)			
$\delta_{qh}$		-0.300***		-0.215**		
		(0.106)		(0.0980)		
$\beta_{qh}$		-0.108		-0.174***		
		(0.0730)		(0.0622)		
<b>N</b>	910	910	906	906		
<b>R<sup>2</sup></b>	0.055	0.056	0.066	0.071		

# Results 4 – Financial

	(1)	(2)	(3)	(4)	(5)	(6)
	Credit Card Balance	Credit Card Balance	Non- retirement Savings	Non- retirement Savings	Retirement Savings	Retirement Savings
$\delta$	-15,216 (13,813)		0.0829 (0.115)		0.154 (0.111)	
$\delta_{qh}$		-16,217 (14,504)		0.115 (0.117)		0.170 (0.113)
$\beta_{qh}$		-3,356 (3,665)		0.106 (0.0857)		-0.0225 (0.0783)
Observations	563	563	906	906	908	908
R-squared	0.072	0.074	0.192	0.194	0.197	0.198

# Summary of Results

- Many outcomes are correlated with time preferences

# Control for Risk Preferences

- Are our measures of time preference really measuring risk preference?
  - Andersen et al. (2008, *Econometrica*)
  - Andreoni and Sprenger (2012, *AER*)
- Let's also control for CRRA risk coefficient in the same regressions
  - Not (yet) using “simultaneous” methods of calculating time and risk preference
    - Double MPL
  - Not using convex budget sets
- Results: No change

# Self-Reported Risk and Time Preference Questions

- “On a scale of 1 to 10...”
  - How willing are you to take risks in general?
  - How patient are you in general?
  - How strong is your willpower/ability to control your impulses?
  - How difficult is it for you to avoid eating a snack food you enjoy (e.g. chocolate chip cookies, ice cream, potato chips) if it is easily available, even if you are not hungry?



# Results – Self-reported measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Willing to Take Risks	Willing to Take Risks	Patient	Patient	Willpower	Willpower	Easy to Avoid Junk Food	Easy to Avoid Junk Food
$\delta$	0.500		0.826		1.857***		0.343	
	(0.765)		(0.766)		(0.713)		(0.774)	
$\delta_{qh}$		0.384		0.816		1.931***		0.290
		(0.783)		(0.785)		(0.732)		(0.791)
$\beta_{qh}$		-0.267		-0.320		0.978*		-0.146
		(0.573)		(0.556)		(0.528)		(0.591)
Observations	911	911	907	907	907	907	909	909
R-squared	0.057	0.057	0.055	0.056	0.076	0.077	0.039	0.039

# Conclusions

- Elicited time preferences are correlated with many outcomes (health, energy, financial)
- In quasi-hyperbolic specification, both  $\delta$  and  $\beta$  matter for many outcomes
- Controlling for risk preferences does not mitigate these correlations
- Extensions
  - Simultaneous estimation of risk and time preferences
  - Alternate measures of time preference from MPLs not over monetary payouts
  - ???

# THE END

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Thanks

# Background

- Survey evidence
  - Discount factor (time-consistent) correlated with exercise, BMI, smoking (Chabris et. al. 2008)
  - Discount factor ( $\beta\delta$ ) correlated with smoking, BMI, credit scores, job-related outcomes (Burks et. al. 2012)
- Energy and Present Bias
  - Big discount rates (Hausman 1979)
  - Evidence mixed (Allcott and Greenstone 2012, Gillingham et. al. 2009)
- Health and Present Bias
  - Dellavigna and Malmendier (2006)
  - Ruhm (2012)
- Policy implications?
  - Present bias alone can justify policy intervention (O'Donoghue and Rabin 2006)
  - Two instruments for two market failures (Heutel 2011, Allcott et. al. 2012)

# Multiple Price Lists – Time Preferences

- Infer discount factor from switching point
- Can infer present bias by comparing switching points across blocks
  - Time-consistent preferences would give the same switching point for now-vs-one-month and six-months-vs-seven-months

Red Block (today vs. one month from today)

Decide for each question if you would like the smaller payment for sure today or the larger payment for sure in one month.

Question 1

\$29 today

\$30 in one month

Would you like to receive \$29 today or \$30 in one month?



Question 2

\$28 today

\$30 in one month

Would you like to receive \$28 today or \$30 in one month?



Question 3

\$26 today

\$30 in one month

Would you like to receive \$26 today or \$30 in one month?



Question 4

\$24 today

\$30 in one month

Would you like to receive \$24 today or \$30 in one month?



Question 5

\$21 today

\$30 in one month

Would you like to receive \$21 today or \$30 in one month?



Question 6

\$17 today

\$30 in one month

Would you like to receive \$17 today or \$30 in one month?



Question 7

\$13 today

\$30 in one month

Would you like to receive \$13 today or \$30 in one month?



NEXT

0%  100%

Red Block				Black Block				Blue Block			
Payoff Today	Payoff in One Month	Discount factor if indifferent	Percent Choosing Larger Amount	Payoff Today	Payoff in Six Months	Discount factor if indifferent	Percent Choosing Larger Amount	Payoff in Six Months	Payoff in Seven Months	Discount factor if indifferent	Percent Choosing Larger Amount
\$29	\$30	0.9667	24.22	\$29	\$30	0.9944	10.43	\$29	\$30	0.9667	37.83
\$28	\$30	0.9333	31.38	\$28	\$30	0.9886	13.99	\$28	\$30	0.9333	42.80
\$26	\$30	0.8667	45.78	\$26	\$30	0.9764	18.68	\$26	\$30	0.8667	51.39
\$24	\$30	0.8000	60.37	\$24	\$30	0.9634	28.03	\$24	\$30	0.8000	61.81
\$21	\$30	0.7000	73.38	\$21	\$30	0.9423	40.31	\$21	\$30	0.7000	72.33
\$17	\$30	0.5667	85.69	\$17	\$30	0.9097	62.34	\$17	\$30	0.5667	83.99
\$13	\$30	0.4333	87.09	\$13	\$30	0.8699	71.88	\$13	\$30	0.4333	85.57
				\$8	\$30	0.8023	78.51				

# Multiple Price Lists - Risk Preference

- Infer CRRA from switching point

This block of questions asks you to choose one of two lotteries, in which you would win one of two amounts of money depending on chance. Please answer all of the following questions by indicating whether you would prefer lottery A or lottery B.

Question 23:

- Lottery A: 20% chance of winning \$20, 80% chance of winning \$16
- Lottery B: 20% chance of winning \$38.50, 80% chance of winning \$1

Question 24:

- Lottery A: 30% chance of winning \$20, 70% chance of winning \$16
- Lottery B: 30% chance of winning \$38.50, 70% chance of winning \$1

Question 25:

- Lottery A: 40% chance of winning \$20, 60% chance of winning \$16
- Lottery B: 40% chance of winning \$38.50, 60% chance of winning \$1

Question 26:

- Lottery A: 50% chance of winning \$20, 50% chance of winning \$16
- Lottery B: 50% chance of winning \$38.50, 50% chance of winning \$1

Question 27:

- Lottery A: 60% chance of winning \$20, 40% chance of winning \$16
- Lottery B: 60% chance of winning \$38.50, 40% chance of winning \$1

Question 28:

- Lottery A: 70% chance of winning \$20, 30% chance of winning \$16
- Lottery B: 70% chance of winning \$38.50, 30% chance of winning \$1

Question 29:

- Lottery A: 80% chance of winning \$20, 20% chance of winning \$16
- Lottery B: 80% chance of winning \$38.50, 20% chance of winning \$1

Question 30:

- Lottery A: 90% chance of winning \$20, 10% chance of winning \$16
- Lottery B: 90% chance of winning \$38.50, 10% chance of winning \$1

Lottery A				Lottery B				EV(A)	EV(B)	Difference	CRRRA if just indifferent	Percent Choosing A
p	\$	p	\$	p	\$	p	\$					
20%	\$ 20.00	80%	\$ 16.00	20%	\$ 38.50	80%	\$ 1.00	\$ 16.80	\$ 8.50	\$ 8.30	-0.95	86.96
30%	\$ 20.00	70%	\$ 16.00	30%	\$ 38.50	70%	\$ 1.00	\$ 17.20	\$ 12.25	\$ 4.95	-0.49	84.46
40%	\$ 20.00	60%	\$ 16.00	40%	\$ 38.50	60%	\$ 1.00	\$ 17.60	\$ 16.00	\$ 1.60	-0.15	82.62
50%	\$ 20.00	50%	\$ 16.00	50%	\$ 38.50	50%	\$ 1.00	\$ 18.00	\$ 19.75	\$ (1.75)	0.14	73.11
60%	\$ 20.00	40%	\$ 16.00	60%	\$ 38.50	40%	\$ 1.00	\$ 18.40	\$ 23.50	\$ (5.10)	0.41	64.67
70%	\$ 20.00	30%	\$ 16.00	70%	\$ 38.50	30%	\$ 1.00	\$ 18.80	\$ 27.25	\$ (8.45)	0.68	54.73
80%	\$ 20.00	20%	\$ 16.00	80%	\$ 38.50	20%	\$ 1.00	\$ 19.20	\$ 31.00	\$ (11.80)	0.97	46.63
90%	\$ 20.00	10%	\$ 16.00	90%	\$ 38.50	10%	\$ 1.00	\$ 19.60	\$ 34.75	\$ (15.15)	1.37	41.55



# Time and Risk Preference Summary Statistics

$\delta_{avg}$	0.8460 (0.1464) [1154]
$\delta_{qh}$	0.8635 (0.1592) [1154]
$\beta_{qh}$	0.9359 (0.2501) [1154]
CRRA	0.5756 (0.8383) [963]

# Cognitive Reflection Test

- Frederick (2005, *JEP*)
  1. A bat and a ball cost \$1.10. The bat costs \$1.00 more than the ball. How much does the ball cost? \_\_\_\_\_ cents
  2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? \_\_\_\_\_ minutes
  3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? \_\_\_\_\_ days

# Discount factor based on hypothetical health questions

- MPL questions where payoffs are not money
- Hypothetical questions about migraine headache drugs
  - Drug A – can start now, will work for 12 months
  - Drug B – can start in 6 months, will work for 24 months
- Use responses (switch points) to calculate a  $\delta_{migraine}$
- Mean of  $\delta_{migraine}$  about the same as mean of  $\delta_{avg}$
- No correlation between  $\delta_{migraine}$  and  $\delta_{avg}$  or between  $\delta_{migraine}$  and any outcome variable