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Understanding and Influencing Sustainable Behaviors:

***Promoting energy conservation, recycling, and
alternative transportation***

Mapping Strategies to Outcomes & The Role of Behavior



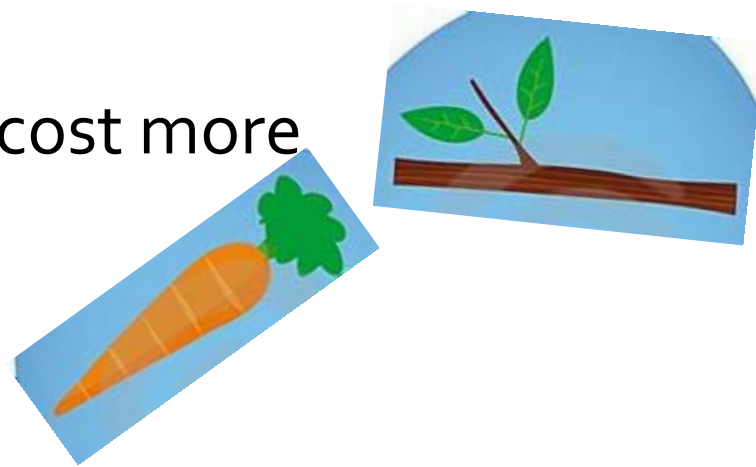
Outline

- Examples of programs to promote sustainable behaviors
- Modeling behavior
- Example of behavioral experiment and model
- Current research
- Conclusion

Examples of programs to promote sustainable behaviors

Waste Reduction

- Berkeley program
 - Larger garbage cans cost more
 - FREE! Recycling
 - FREE! Green Waste



- 57% Diverted



Southern California Edison

- Efforts of Southern California Edison to encourage energy conservation
 - ▣ Emails and text messages regarding energy use
 - No effect
 - ▣ Ambient Orb:
 - red during high energy, green during low
 - 40% reduction during peak periods

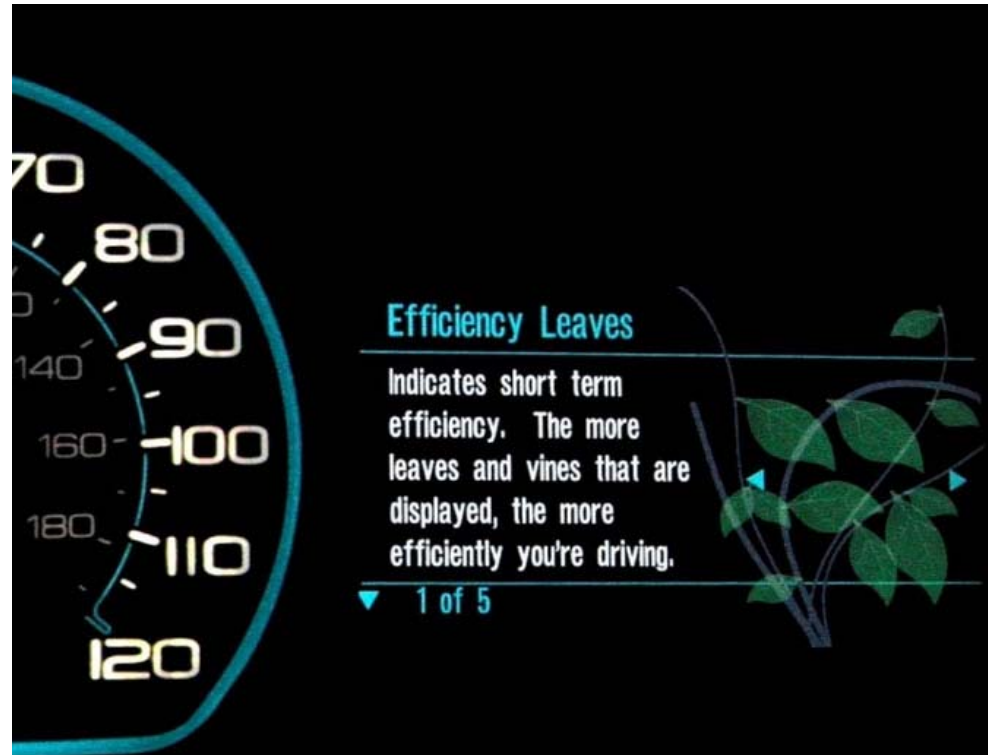
Thomson (2007)

Driving green

- Ford efficiency leaves
- Honda Insight Hybrid – leaves + score

Impact?

- Focusing on mpg
 - 7 to 14% less gas consumption
- Honda with scoring
 - Avg 10%, max 20%



Energy Use Study in CA (Schultz et al., 2007)

- Feedback approach 1:
Household energy use
Avg energy use in neighborhood
- Feedback approach 2:
Same as above, but with 😊 😞

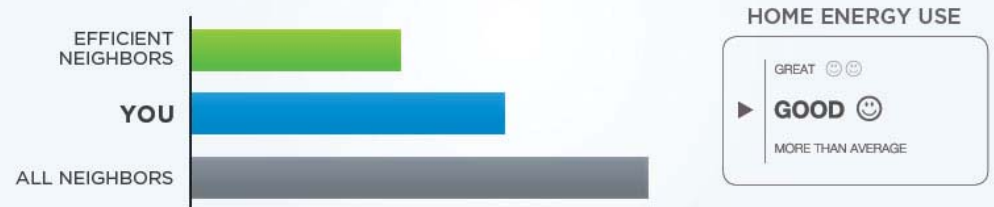
High users reduce,
Low users increase

High users reduce more,
Low users don't change

OPower

- CO₂ emissions reduced by 100,000 tons
- \$18M saved

We motivate millions to become **more energy efficient**



Our impact is rigorously **measured and verified**



Energy Smackdown

- Boston Area
- Reality TV Competition between 3 towns
- 177 households saved 52 tons of CO₂

Energy SmackdownTM
moving from awareness to action

Welectricity

- Energy Efficiency + Social Networking

The screenshot displays the Welectricity website interface. At the top, the logo "Welectricity™" is on the left, and the text "We've got users from 60 countries" is on the right, accompanied by a "Sign in" button with a dropdown arrow. Below the logo is a navigation menu with buttons for "Home", "Dashboard", "Profile", "Bills", "Friends", and "Goals".

The main content area is divided into two columns. The left column features a green background with the text "Ready to save money on your electricity bills?". Below this, a light blue circle icon is followed by the text: "Welectricity is a FREE service that helps you track and reduce your energy consumption at home!". A "Watch our Video" button with a clapperboard icon is positioned below. At the bottom of this column, a lightbulb icon is followed by the text: "Considering a new washing machine? Buy a front-loading model. It will use less energy and water than a top-loader". Below this text is a "Next Tip" link and a recycling symbol.

The right column features a white background with a numbered list of four steps: 1. "Complete your profile" (with a globe icon), 2. "Add Bill information" (with a document icon), 3. "Invite Friends" (with a group of people icon), and 4. "Set Goals, get results!" (with a bar chart icon). To the right of this list is a computer monitor displaying a globe with location pins. Below the monitor, the text reads: "Tell us something about your household and appliances". At the bottom of this column is a prominent orange "Sign Up" button.

Themes

- Sticks and carrots
- Power of information and feedback
 - ... provided in creative ways
 - Visualizing impact
 - Augmented mindfulness
 - Social norms

Modeling Behavior

Economics & Rationality

- People act in their own interest
- They can objectively evaluate all alternatives available to them and then choose the one that is best for them.

Vive le Difference

Free
Lanes
\$0.00

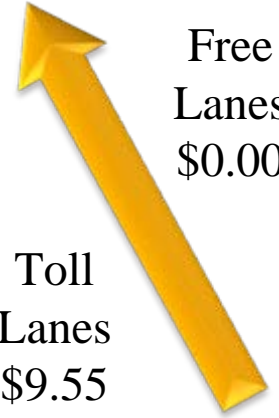


Toll
Lanes
\$1.95

Orange County Transportation Authority

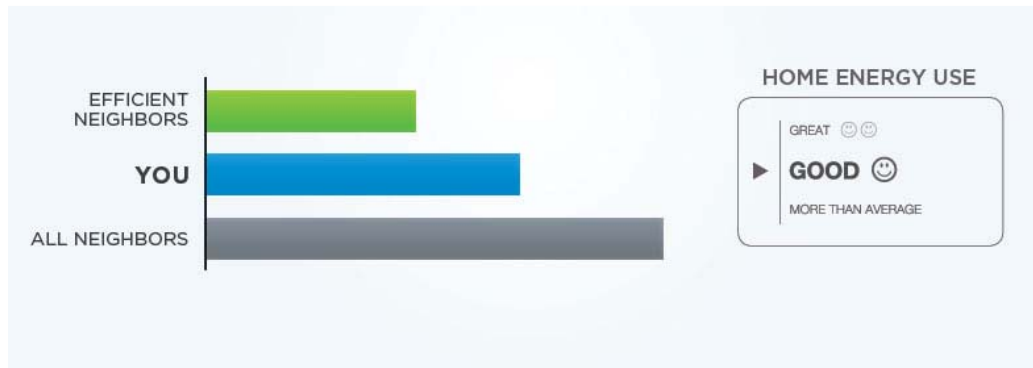


Free
Lanes
\$0.00



Toll
Lanes
\$9.55

Vive le Difference



- Detailed analysis shows works with some groups, backfires with others (Costa and Kahn, 2010)

Economics + Statistics \rightarrow Model

- Probability(person n recycles soda can)
= f (characteristics of the person
& attributes of the environment)



Microeconomics review

- Basic concepts
 - Faced with a set of alternatives (consumption bundles)
 - Consumers are able to assign preferences that rank these alternatives in terms of attractiveness
 - Utility function represents mathematically these preferences.
 - Consumers make choices that maximize their utility (subject to a budget constraint)

Utility of a Transportation Mode

- Utility function for bus

$$U_{bus} = \beta_0 + \beta_1 WT_{bus} + \beta_2 TT_{bus} + \beta_3 C_{bus}$$

- WT_{bus} waiting time (hours)
- TT_{bus} total travel time (hours)
- C_{bus} total cost of trip (dollars)

- Parameters β represent tastes, and vary by education, gender, trip purpose, etc.

$$U_{bus} = \beta_0 + \beta_1 WT_{bus} + \beta_2 TT_{bus} + \beta_3 C_{bus} / Income$$

- Cannot be measured exactly

$$U_{bus} = \beta_0 + \beta_1 WT_{bus} + \beta_2 TT_{bus} + \beta_3 C_{bus} / Income + \varepsilon_{bus}$$

Behavioral Model

- Choice from among *auto*, *bus*, *walk*

$$P(\text{auto}) = \frac{e^{V_{\text{auto},n}}}{e^{V_{\text{auto},n}} + e^{V_{\text{bus},n}} + e^{V_{\text{walk},n}}}$$

$$U_{\text{auto},n} = \beta_{\text{auto}} + \beta_2 TT_{\text{auto},n} + \beta_3 C_{\text{auto},n} / \text{Income}_n + \varepsilon_{\text{auto}}$$

$$U_{\text{bus},n} = \beta_{\text{bus}} + \beta_1 WT_{\text{bus},n} + \beta_2 TT_{\text{bus},n} + \beta_3 C_{\text{bus},n} / \text{Income}_n + \varepsilon_{\text{bus}}$$

$$U_{\text{walk},n} = \beta_{\text{walk}} + \beta_2 TT_{\text{walk},n} + \varepsilon_{\text{walk}}$$

V

How do we estimate β s?

- Gather data from a sample of people
 - His/her mode choice to campus
 - His/her sociodemographics
 - His/her home and work location
(\rightarrow travel time and travel cost of auto, bus, walk)
- Estimate the β s that best explain the observed choices.

Example application

- Joe has 3 options to come to campus

- Auto: 4 min. walk, 8 minutes in car, \$4.50
- Bus: 15 min. walk, 5 min. wait, 10 min in bus, \$4.00
- Walk: 40 min. walk

His income is \$80,000

- What is Joe's probability of driving?

- Plug into $P(auto) = \frac{e^{V_{auto,n}}}{e^{V_{auto,n}} + e^{V_{bus,n}} + e^{V_{walk,n}}}$ → $P(auto) = 0.9$

- What if campus doubles parking fees?

- Update parking cost → $P(auto) = 0.7$

Notion of tradeoffs

$$U_{bus} = \dots + \beta_{time} Time_{bus} + \beta_{cost} Cost_{bus} + \dots$$

- Marginal rate of substitution between time and cost

$$MRS = \frac{MU_{time}}{MU_{cost}} = \frac{\frac{\partial U_{bus}}{\partial Time}}{\frac{\partial U_{bus}}{\partial Cost}} = \frac{\beta_{time}}{\beta_{cost}} \frac{\$}{hour}$$

Time Value of

- Not all time is equal

$$U_{bus} = \dots + \beta_{time_wait} TimeWait_{bus} + \beta_{time_inveh} TimeInVeh_{bus} + \beta_{cost} Cost_{bus} + \dots$$

$$\beta_{time_wait} / \beta_{cost}$$

→ Value of wait time :

$$\beta_{time_inveh} / \beta_{cost}$$

→ Value of in vehicle time :

Behavioral Economics

- Cross between psychology and economics
- Focus on what *really* influences decisions as opposed to what we *think* influences them
 - Emphasis on refuting rationality
- Clever experiments
- Hot area
 - Dan Arieli's *Predictably Irrational*
 - Richard Thaler and Cass Sunstein's *Nudge*

Overconfidence and Optimism

- What percent of drivers think they are above average?
 - 90%
- What percentage of Professors think they are better than the average professor?
 - 94%

Example of Behavioral Experiment & Model

The Power and Value of **Green** in Promoting Sustainable Behaviors

Downtown Berkeley Station

2160 Shattuck Avenue , Berkeley , CA 94704

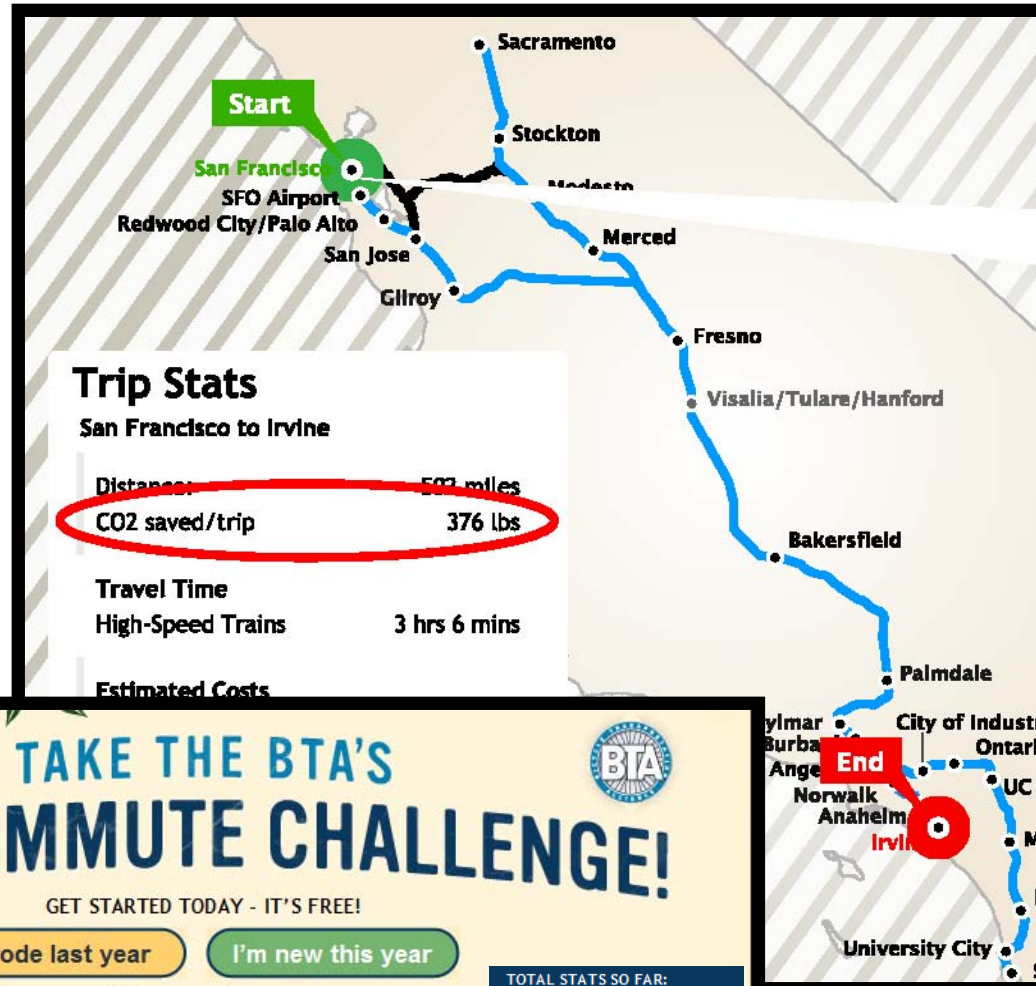
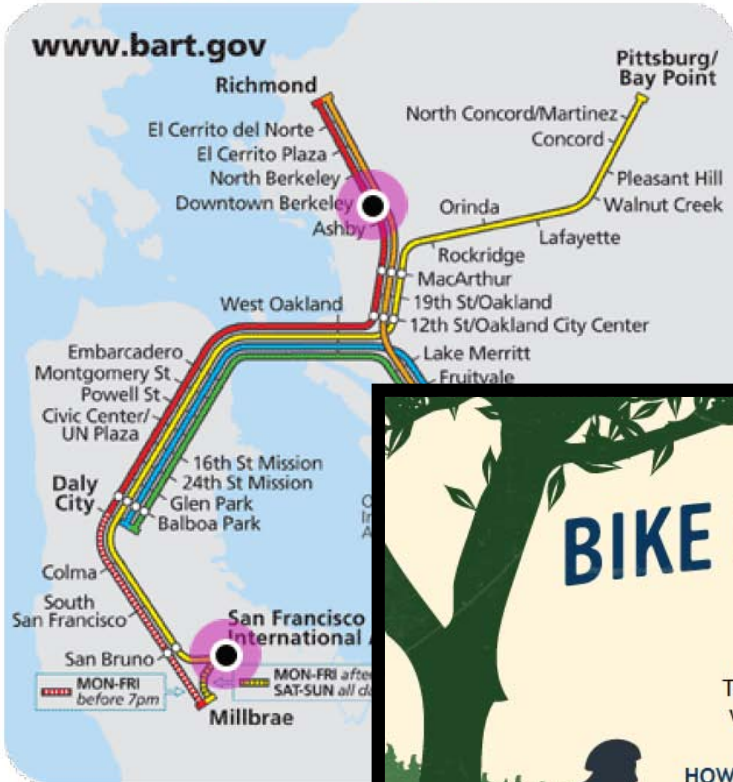
Connecting Transit, Neighborhood Map and more...

San Francisco Int'l Airport Station

International Terminal, Level 3 , San Francisco Int'l Airport , CA 94128

Connecting Transit, Neighborhood Map and more...

CO2 emissions saved by this BART trip: **23.3 pounds**. [Read more](#)



TAKE THE BTA'S BIKE COMMUTE CHALLENGE!

GET STARTED TODAY - IT'S FREE!

The Bike Commute Challenge is a friendly competition to see who can get more people biking to work in September. It's easy, fun, and free, so give it a try!

[HOW DOES IT WORK?](#) [WHAT'S IN IT FOR ME?](#) [WHO CAN PARTICIPATE?](#)

[COMMUTER RESOURCES](#) [HELP/FAQ](#)

TOTAL STATS SO FAR:

- Riders actively logging trips: **415**
- Total teams: **1,792**
- Total miles logged: **19,671**
- CO2 saved from the air (lb.): **19,277**
- Calories burned: **963,879**

XLAB Experiments

- “Experimental Social Science Laboratory”
 - Subjects paid \$15/hour
- Our experiment
 - 312 respondents



Three experiments

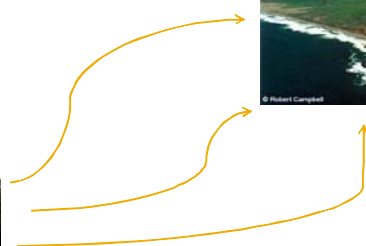
- Auto ownership



- Mode choice



- Route choice



Which car option would you choose?

- Scenario
 - Suburban house
 - Trip to work: 30 minutes by car, 60 minutes by transit

Attributes	Conventional Vehicle	Hybrid Vehicle
Purchase Price (\$)	16000	22000
Annual Cost (\$/year)	5000	4300
Greenhouse Gas Emissions (tons/year)	3.2	3.0

You may be interested in the choices made by some of your peers in the lab right now, which are displayed below.

4 of you peers chose conventional.

6 of you peers chose hybrid.

2 of you peers chose not to buy a car.

Conventional?
Hybrid?
No Car?

Which route would you choose?

Attributes	Route 1	Route 2	Route 3
Time (minutes)	70	90	90
Variation of Time (minutes)	12	18	5
Toll (dollars)	0.75	2.00	0.25
Greenhouse Gas Emission (pounds)	5	3	2
Safety	2	3	1

Experiment 3: Which mode would you choose?



Estimation Results from Route Choice Experiment

$$U_r = \beta_1 \text{TravelTime}_r + \beta_2 \text{TravelTimeVar}_r + \beta_3 \text{Cost}_r + \dots + \beta_6 \text{GHG}_r + \varepsilon_r$$

	Estimate	t-test	p-value
Travel time (hours)	-4.317	-21.3	0.00
Travel time variance (hours)	-2.400	-3.6	0.00
Cost (\$)	-0.490	-10.5	0.00
Safety dummy	0.620	12.8	0.00
FREE! route dummy	0.640	4.8	0.00
GHG emissions (pounds/trip)	-0.069	8.0	0.00
Number of observations	334 subjects * 5 responses each		
Adjusted rho-square	0.412		

Calculating the VALUE OF GREEN

Marginal rate of substitution (*MRS*) between emissions and cost

$$= \frac{MU_{\text{emissions}}}{MU_{\text{cost}}} = \frac{\partial U / \partial \text{emissions}}{\partial U / \partial \text{cost}} = \frac{\beta_{\text{emissions}}}{\beta_{\text{cost}}} \text{ in units of cost/units of emissions}$$

$U = \dots - 0.490(\text{toll cost in } \$)$

$\quad - 0.069(\text{greenhouse gas emissions in pounds/trip})$

$\quad - 4.317(\text{travel time in hours})\dots$

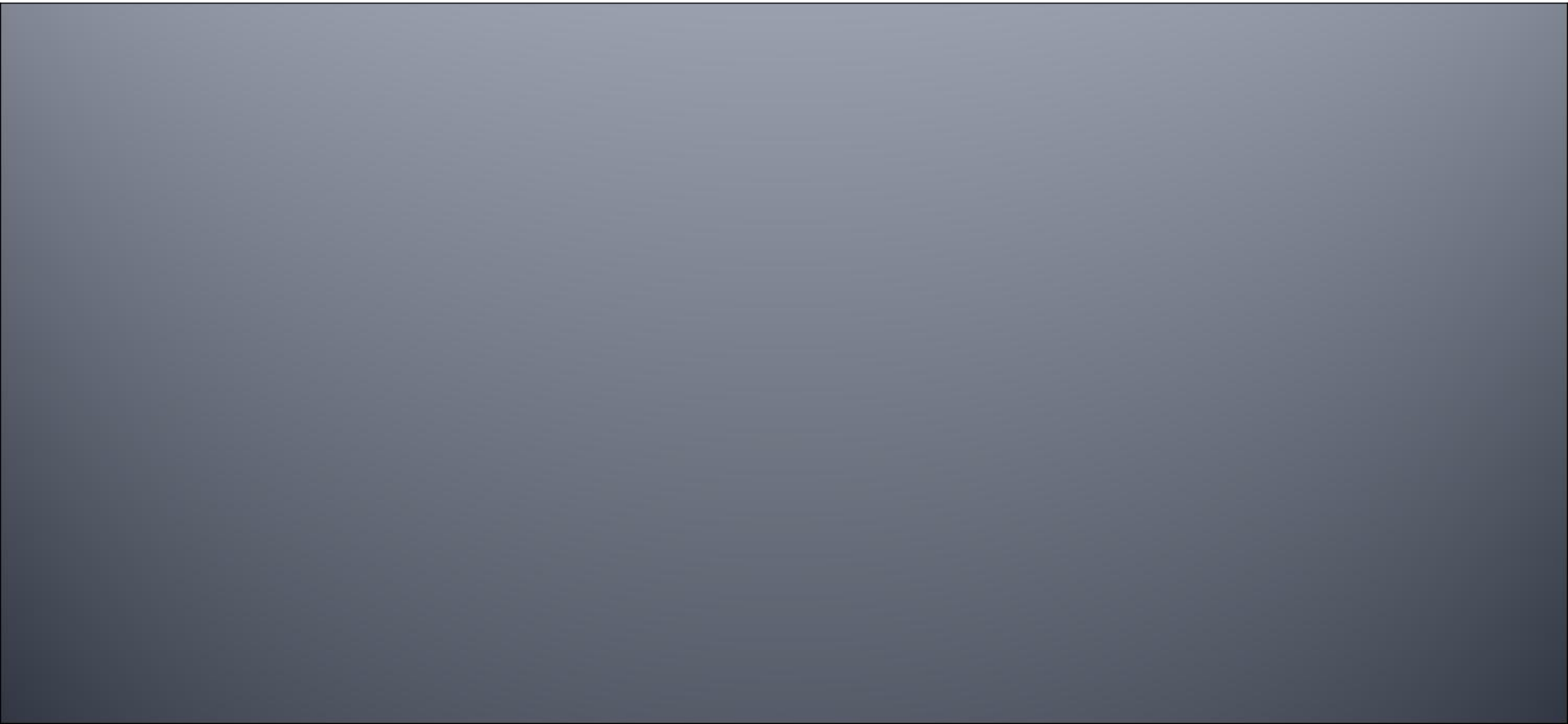
→ VALUE OF GREEN = \$0.14/POUND

→ VALUE OF TIME = \$8.81/HOUR

Findings

- Students value their time (on average) between \$6.50-\$9.00/hour
- Student value green (on average) between \$0.10-\$0.40/pound of CO₂
 - Fairly consistent across **many** variations
- Females more green than males
- Social influences positively impact being green

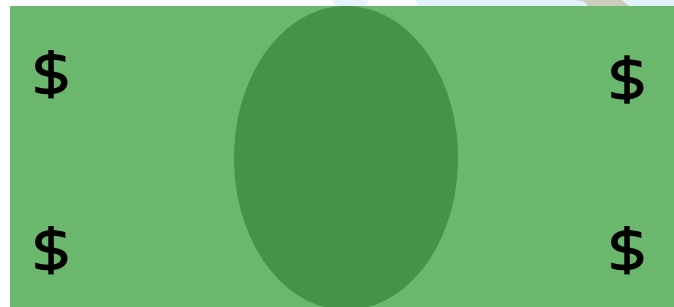
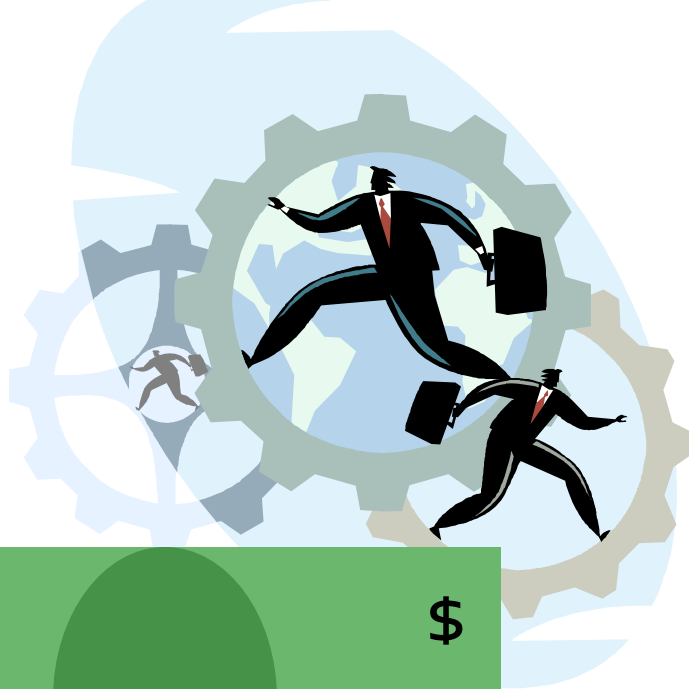
Research Direction



Real people. Real money.

BayTripper

Real-Time Transit Information for Mobile Phones



Conclusions





- Why concern regarding sustainability?
 - People!
- Why behavioral science?
 - Human response often dictates success or failure of policy
 - Cannot force actions
 - Anticipate actions of people, firms, developers, government
- Challenging
 - Dealing with humans... heterogeneous, irrational
 - Ignoring it is not an answer... must develop useful tools
 - Requires multidisciplinary effort