

Impact of in-car instruments on driver behaviour

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Driver Behavior: broadly speaking

- Eco-driving e.g., lower top speeds, less aggressive acceleration and braking, more coasting...
 - ...and links to other behaviors affecting energy use and emissions
 - Car purchase, including alternative fuels and electric-drive, total vehicle travel, vehicle assignment within households
- Conditions under which consumers *can* act
 - Context
 - Opportunity
 - Control
 - Information (energy use and cost feedback, training)
 - Incentive (symbolic, functional, and/or financial)
 - Reinforcement

Data Sources

- ITS-Davis
 - 1993-4 California Purchase Intention and Range Estimation Games
 - Household Interviews, $n = 51$
 - 1995 California Statewide Electric and Alt. Fuel Vehicle Market Study
 - Reflexive survey, $n = 454$ households; 908 drivers
 - 2002-2003 Fuel Economy Study (Northern California)
 - Household interviews, $n = 57$ households; about 90 drivers, 125 vehicle transactions
 - 2004-2005 HEV Buyers (Northern California)
 - Household interviews, $n = 51$ households; about 80 drivers
 - 2006-2007 Plug-in Hybrid Drivers (USA, but predominately CA)
 - Personal interviews, $n = 23$
- Nissan
 - 2007 Japan
 - Drive tests, $n = \text{tens}$

Context

- What are our theories of behavior?
 - *Homo economicus*: Preferences, information, prices
 - Planned Behavior: Attitudes, norms, beliefs, constraints, intentions
 - Habit? Automatic and controlled behavior. When do we use heuristics, and what are they?
 - Symbolic construction: What does eco-driving mean to people? What does it communicate?
 - Narrative Identity: How does eco-driving help me tell a better story about who I am? How does narrative memory shape present and future behaviour?
- Individual Agency and Social Practice?
 - Giddens' structuration approach
 - Practical and Discursive consciousness

Context

- Locus of control: Where is control over vehicle fuel use and emissions located?
 - With regulators and engineers? With consumers?
 - Where is eco-driving enacted?
- Longstanding bias in energy studies against consumers.

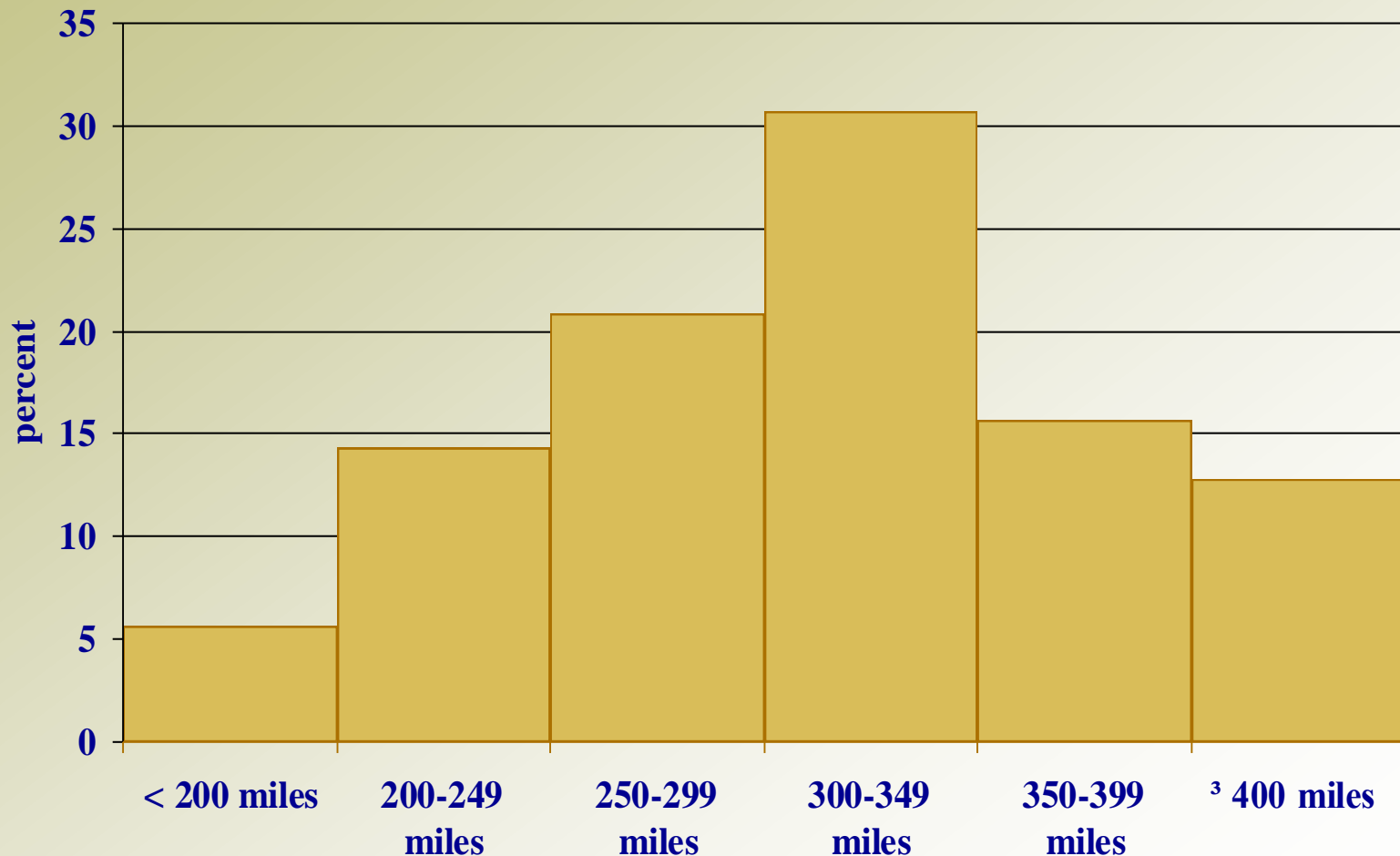
McDougall *et al* (1981)

“...recognize that *probable* energy savings represents a net impact based on *potential* savings in a technical sense, reduced to allow for imperfect behavioral response.”

- What if that bias is wrong?
 - How do we engage consumers in a productive way in producing social benefits?
 - What happens if we give consumers more control, e.g., eco-driving?

Lack of Information

- Drivers often don't know gross fuel use, e.g., total distance per tank or miles per gallon

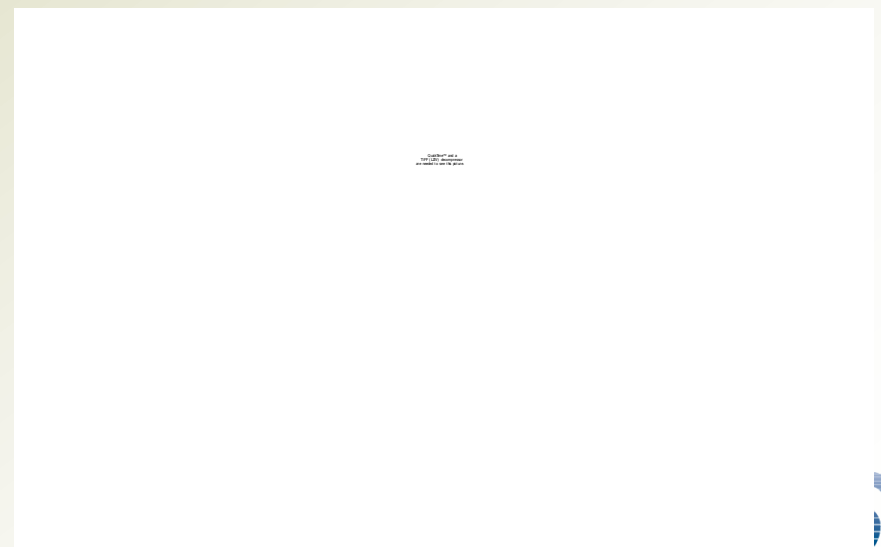


HEV Energy Instrumentation

- Toyota HEV Energy Monitor Screen
 - Energy flows out of ICE, through electric motor, and in/out of storage battery



- Toyota HEV Fuel Consumption Screen
 - Current (~instant) fuel economy (MPG)
 - 5-minute average MPG for past 30 minutes
 - Average MPG over (driver re-set) distance



Information

- Interviews with buyers of HEVs, several accounts suggest drivers were saving far more energy than technical analysts would calculate
 - In some cases, the HEV prompts further thinking by the owner about energy reductions.
 - Most directly and in contradiction to economists' concerns of a rebound effect, some HEV drivers actively attempt to drive their HEV less than the vehicle it displaced.

Information

- Energy instrumentation allows HEV drivers to learn to drive in a less energy intensive way, and to then apply those lessons to driving their other vehicles, too.
- Similar stories from drivers of battery electric vehicles, too.
 - Energy instrumentation lead to energy conservation “games”
 - Requests of the vehicle manufacturers that drivers be able to select cruise control modes to maintain either constant speed or constant energy consumption.
- These energy games are not limited to early adopters and environmentalists.
 - Car & Driver columnist describes his enjoyment in seeing how far and how fast he could drive an HEV (in this case a late-model Prius) without the internal combustion engine (Bedard, 2005).

Effects of Energy Instrumentation

- Vehicle buyer behavior: Attracts attention to the vehicle
- Driving behavior
 - Use energy instrumentation to keep Prius in electric-only mode
 - Monitor fuel economy
 - Personal behavior: Consumption screen “teaches you to be a better driver...to be more efficient,” “a great training tool,” “playing the fuel economy game”
 - Social interaction: Post fuel economy online, talk about it with others; compete
 - Apply lessons to other vehicles in the household
- Vehicle owner behavior
 - Reinforces symbolic meanings
 - Displays that the vehicle is “intelligent,” “honest”
 - “Smart consumer,” “high technology,” “lower resource use”
 - Represents vehicle to non-HEV owners

Incentive

- Vehicle assignment within multi-vehicle households
 - In gaming interviews, households provided with an incentive in the form of a large cost savings through the use of electricity rather than gasoline, appeared to quickly learn to adapt their travel between the use of a (hypothetical) battery EV and their actual vehicles.
- Is “energy use” too abstract? What would be the effects of translating energy use into...
 - Greenhouse gas emissions?
 - Energy costs?
 - Other symbolic meanings?
 - Kilograms of chocolate?
 - User’s choice?

Reinforcement: Retrospective information

Donmez, B., et al (in press) “Mitigating driver distraction with retrospective and concurrent feedback.” Accident Analysis and Prevention

“Real time feedback...has potential to enhance immediate performance.”

“Retrospective feedback after the events occur (i.e., once a trip is completed)...can support the memory of critical incidents and driver understanding of the degree to which their engagement in distracting activities results in critical incidents.”

“...retrospective and combined feedback resulted in faster response to lead vehicle braking events as depicted by shorter accelerator release times.”

Another Approach: Driver Training

- Since 1998, Ford Germany has run a test and training program “Ford Eco-Driving” with the German Federation of Driving Instructor Associations and the German Road Safety Council.
 - 25% savings in terms of fuel and emission reduction (CO₂)
 - By 2004, some 7,000 randomly recruited participants completed the training course
- Consumer research – including in-depth interviews and questionnaires – revealed learning and long-term information retention with changed behaviour.

Conclusions

- As Nissan reports, direct effects may average 18 percent *under specific conditions*
 - How general are those conditions?
- Indirect effects include
 - Apply learned behaviors to other (non-eco-drive equipped) vehicles
 - Reduce overall vehicle travel
 - Transfer travel to vehicle with lower fuel consumption
 - Reported but unmeasured in our past work
 - Appear to be positive, but what are possible negative indirect effects?
- Engaging citizen/consumers in the design of policy and products

Future Research

- What are the effects of time contexts on eco-driving?
 - Relevant-time: continuous, end-of-trip, end-of-day, ..., lifetime
 - Does immediate intervention achieve the short term goal (through somatic response)?
 - Pre-trip, during trips, post-trip
 - Does post-trip reinforcement allow for memories to be formed, responses to be cognized, events to be incorporated into a narrative?
- When and where is control exerted, and who exerts it?
 - If we assume the driver has control of the car, is eco-driving conscious or habitual modulation of the accelerator pedal?
 - But drivers don't always feel in control. They are responding to immediate events around them and to longer and long-term scheduling and pace of life.

Future Research

- Social dimensions of eco-driving
 - Display of fuel economy performance to other drivers
 - Websites, Exterior displays on vehicles, Networked vehicles
- Build ties to safety researchers and policymakers?
 - Lower top speeds, less aggressive driving may have stronger safety meanings than environmental meanings

Fin

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