

# Increasing the Influence of CO<sub>2</sub> Emissions Information on Car Purchase

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# Background – information on CO<sub>2</sub>

## US EPA vehicle label system:

- Information sheet with ranking  
(top ranked vehicles: 0 - 236 g of CO<sub>2</sub> per mile, i.e. 147 g / km)
- Actual amount in faded print below the scale

## UK label system

- Grams per km clearly in the label

Heavy burden of knowledge (as no contextualization provided)

*Has the provision of CO<sub>2</sub> emission information  
any impact on choice at all?*

# Previous research (1)

Grams CO<sub>2</sub> per mile – has measurable impact

- Gaker and Walker, 2013; Gaker et al., 2010, 2011

Mass of CO<sub>2</sub> (grams, pounds or tons) – people uncertain whether the mass is acceptable or not

- Chatterton et al., 2009; Coulter et al., 2007

Perception of amount influenced by the context

- Waygood and Avineri, 2010, 2011, 2014
- Avineri and Waygood, 2010

Effect of CO<sub>2</sub> information only in environmentally motivated people

- Gaker and Walker, 2013; Waygood and Avineri, 2011

# Previous research (2)

WTP research – grams of CO<sub>2</sub> per distance only

- Gaker et al. 2010, 2011, 2013

Effect of CO<sub>2</sub> information presentation – only ranking exercise

- Waygood and Avineri, 2011, 2010, 2014, 2013, 2016

Possibilities to contextualize the CO<sub>2</sub> amounts:

- to provide interpretation of the amount with respect to an authority's evaluation (*injunctive norms*)
- a carbon tax (*give feedback to individuals*) – considered successful in reducing GHGs

# This research

- *determine whether changing how the CO<sub>2</sub> information is presented will have a significant impact on vehicle choice*
- *through a WTP choice experiment*
- *using latent class modeling*

# Method

On-line survey

Panel of 1,580 car owners

- Philadelphia and Boston

Dec. 2015 – March 2016

- Discrete choice experiment (12 choices)
- Environmental attitudes

Adapted the choice experiment (Gaker et al. 2010, 2011)

Vehicle choice experiment:

- D-efficient design with Bayesian priors

# Experiment attributes and levels

Attribute	Levels Vehicle A	Levels Vehicle B
Purchase price	80%, 90%, 105%, 115% of stated willingness to spend	90%, 110%, 120%, 130% of stated willingness to spend
Fuel costs per year	\$1,500; \$1,900; \$2,500	\$800; \$1,200; \$1,500
Grams of CO <sub>2</sub> per mile*	304; 320; 336	170; 215; 260

*CO <sub>2</sub> emissions presented as:	Grams per mile Pounds per year Tons per year Annual Tax on CO <sub>2</sub> (\$37/ton) Percentage of 2025 US EPA reduction target
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# Tons of CO<sub>2</sub> per year (base)



Cornell University

Imagine that you are in a situation where you must buy a vehicle.  
You have decided on which vehicle you want, but you must make some final decisions on the motor type.  
Please make your choice from the information below.

\*Annual costs are based on driving 15 000 miles/year with fuel costing \$3.70/gallon.

	Car A	Car B
Fuel Costs per year	\$1,900	\$1,200
Purchase Cost	\$25,000	\$28,000
Tons of CO <sub>2</sub> per year	5.04	2.55



# Percentage of US EPA 2025 reduction target



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	Car A	Car B
Fuel Costs per year	\$1,900	\$1,200
Purchase Cost	\$25,000	\$28,000
Tons CO <sub>2</sub> /year as % EPA 2025 objective	134%	68%

2025 government objective of a 27% reduction from 2005 levels. That means, road transportation emissions should be roughly 3.75 tons per person per year. So, for example:

3.75 tons per year = 100%

1.88 tons per year = 50%

7.50 tons per year = 200%

# Structural Model (1)

$$U_{ij} = \beta_{\text{price},i} [\text{price}_{ij} + \text{PVFC}_{ij} + \text{PVFE}_{ij}] + \varepsilon_{ij}$$

$$U_{ij} = \beta_{\text{price}} \left[ \text{price}_{ij} + \frac{OC_{ij}}{r_i} + \frac{\omega_{E,i}}{r_i} \text{emissions}_{ij} \right] + \varepsilon_{ij}$$

# Structural Model (2)

$$U_{ij} = \beta_{\text{price},i} [\text{price}_{ij} + \text{PVFC}_{ij} + \text{PVFE}_{ij}] + \varepsilon_{ij}$$

$$U_{ij} = \beta_{\text{price}} \left[ \text{price}_{ij} + \frac{OC_{ij}}{r_i} + \frac{\omega_{E,i}}{r_i} \text{emissions}_{ij} \right] + \varepsilon_{ij}$$

$$U_{ij} = \beta_{\text{price}} \text{price}_{ij} + \frac{\beta_{\text{price}}}{r} [OC_i + \text{tax}_i D_{\text{tax}} + (\omega_{\text{tons}} + \delta_{\text{gpm}} D_{\text{gpm}} + \delta_{\text{ppm}} D_{\text{ppm}})]$$

# Estimated WTP

	MNL		Latent Class Logit	
			Class 1 (54%)	Class 2 (46%)
	Month	Year	Month	Month
<b>Subjective discount rate*** : <math>r</math></b>	1.02%	13.00%	0.29%	1.76%
<b>Presentation of CO<sub>2</sub> Information</b>	\$/ton	¢/pound	\$/ton	\$/ton
<b>Base (tons per year): <math>\omega_{\text{tons}}</math></b>	190.52***	9.53	188.80***	237.07***
<b>Pounds per month: <math>\omega_{\text{tons}} + \delta_{\text{ppm}}</math></b>	198.38	9.92	209.93	250.86
<b>Societal Objective: <math>\omega_{\text{tons}} + \delta_{\text{objppm}}</math></b>	257.83**	12.89	255.77*	265.20
<b>Grams per mile: <math>\omega_{\text{tons}} + \delta_{\text{gpm}}</math></b>	47.16***	2.36	47.38***	30.52***
<b>Significance codes: *** 0.1%, ** 1%, * 5%</b>				

# Conclusions

WTP (€9.5 per pound CO<sub>2</sub>) on lower end of recent estimates in the same context:

- Gaker: €13 – 24 (grams per mile)
- Achnicht: €22 (grams per km)
- Daziano and Achnicht: €22 (grams per km)

Only contextualizing the emissions to a monthly / yearly amount – fourfold increase in influence of information on car purchase

*There are more effective means for communication with the public about the climate change emissions*

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# Selected references

- Gaker, D., and J. L. Walker. Revealing the Value of “Green” and the Small Group with a Big Heart in Transportation Mode Choice. *Sustainability*, Vol. 5, No. 7, 2013, pp. 2913-2927.
- Gaker, D., Y. Zheng, and J. Walker. Experimental Economics in Transportation. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2156, No. 1, 2010, pp. 47-55.
- Gaker, D., D. Vautin, A. Vij, and J. L. Walker. The power and value of green in promoting sustainable transport behavior. *Environmental Research Letters*, Vol. 6, No. 3, 2011, p. 034010.
- Chatterton, T. J., A. Coulter, C. Musselwhite, G. Lyons, and S. Clegg. Understanding how transport choices are affected by the environment and health: Views expressed in a study on the use of carbon calculators. *Public health*, Vol. 123, No. 1, 2009.
- Coulter, A., S. Clegg, G. Lyons, T. Chatterton, and C. B. A. Musselwhite. Exploring public attitudes to personal carbon dioxide emission information. In, Department for Transport, London, 2007.
- Waygood, E. O. D., and E. Avineri. Does "500g of CO<sub>2</sub> for a five mile trip" mean anything? Towards more effective presentation of CO<sub>2</sub> information. In *Proceedings of the Transportation Research Board 90th Annual Meeting*, Washington, D.C., 2011.
- Waygood, E. O. D., and E. Avineri. Research and Design Report. In, *Carbon Aware Travel Choices (CATCH)*, 2010.
- Avineri, E., and E. O. D. Waygood. Behavioural Inception Report. In, No. D1.1, *Carbon Aware Travel Choices (CATCH)*, 2010.
- Waygood, E. O. D., and E. Avineri. Communicating Transportation Carbon Dioxide Information: Does Gender Impact Behavioral Response? Presented at 5th International Conference on Women's Issues in Transportation, Paris, 2014.