On Factors of Consumer Heterogeneity in (Mis)-valuation of Future Energy Costs: Evidence for the German Automobile Market

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Motivation

Consumer valuation of future energy costs:

▶ Policy-relevant: to assess instruments that address externalities related to car use

▶ Marketing-relevant: to provide insight on what constitutes the best product offer

Automobile purchase ...

... involves intertemporal tradeoff b/w upfront investments and operating costs

... is highly involved decision-making process

... incurs extensive financial consequences

⇒ Incentive to make a "right" (cost-minimization) purchase decision
⇒ BUT mixed empirical evidence

Mixed empirical evidence

Rational behavior: 1€ investment upfront (WTP) $\overset{!}{=}$ 1€ reduction in discounted future energy costs (Savings)

Just-valuation	WTP = Savings	e.g. Sallee et al. (2016) Busse et al. (2013) Dreyfus and Viscusi (1995) Kahn (1986)
Under-valuation	WTP < Savings	e.g. Allcott and Wozny (2014) Fan and Rubin (2010) Train and Winston (2007) Arguea et al. (1994)
Over-valuation	WTP > Savings	e.g. Vance and Mehlin (2009) Espey and Nair (2005) Brownstone et al. (2000)

Contribution

- ▶ Not only **direction and magnitude** of consumer valuation
- ▶ But also **determinants** of consumer heterogeneity in the valuation
- ▶ For both diesel and gasoline vehicles, various car classes
- ▶ Novel sources of identifying variation

while controlling for

- ▶ highly-detailed definition of a car type (supplementary features)
- ▶ potential driving for business purposes
- ▶ correlation in tastes over car attributes

Empirical strategy / Data

Data type	Anonymous survey with individuals who purchased a new passenger car Private car ownership Germany, 2000-2006
N of consumers	121313
Engine types	Gasoline (N=82552); Diesel (N=38761)
Car classes	Minis; Superminis; Compact; Middle; Upper Middle; Upper class
Variables	Chosen car attributes Consumer- and transaction-specific characteristics Individual car usage expectations
Framework	Hedonic discrete choice model (Bajari and Benkard, JPE 2005)

Modelling framework

$$\begin{cases} maxU_{nj} = \beta_{n,PVFC}\text{PVFC}_{nj} + \sum_k \beta_{n,k}X_{kj} + \beta_{n,\xi}\xi_j + (Y_n - P_{nj}) \\ \text{s.t. } Y_n \geq P_{nj} + p_C \times C \\ \text{where } P_{nj} = \mathbf{p}(PVFC_{nj}, X_{kj}, \xi_{nj}) \end{cases}$$

> U_{nj}: utility from product j for consumer n
> $PVFC_{nj}$: present-discounted value of future fuel costs
> X_{kj}: $k = 1, ..., K$ observed product attributes
> ξ_j: unobserved product attribute
> $\beta_{n,PVFC}$; $\beta_{n,k}$; $\beta_{n,\xi}$: taste parameters
> P_{nj}: transaction price
> $\mathbf{p}(X_{kj}, \xi_j)$: hedonic price function
> Y_n: consumer's income
> C: "outside option"
> p_C: price of "outside option"$\equiv 1$

$\Rightarrow$ **Rational cost-minimizing behavior:** $|\beta_{\mathbf{n,PVFC}}| \overset{!}{=} 1$.

Sources of identifying variation

▶ **Individual purchase prices** for detailed car specification

▶ vs. **Individual PVFC** over buyers of identical cars

▷ Consumer heterogeneity in **annual vehicle usage** (KM_n) ↔ importance by Bento et al. (2012)

▷ Consumer heterogeneity in **ownership length** (T_n)

$$PVFC_{nj} = \sum_{t=0}^{T_n} \frac{1}{(1+r)^t} \times (FP \times KM_n \times FC_j)$$

– FP: Fuel prices at the time of purchase
– KM: Individual expected annual driving
– FC: Vehicle fuel consumption, liter/100km
– T: Individual length of car ownership
– r: Discount rate

High heterogeneity in values within products

Individual purchase prices (SD)
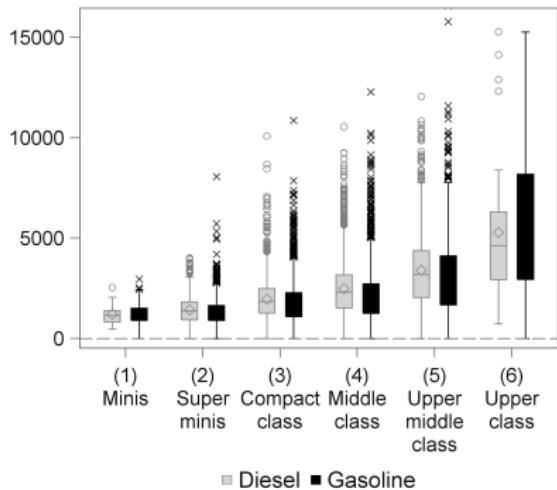
Individual Net PVFC (SD)
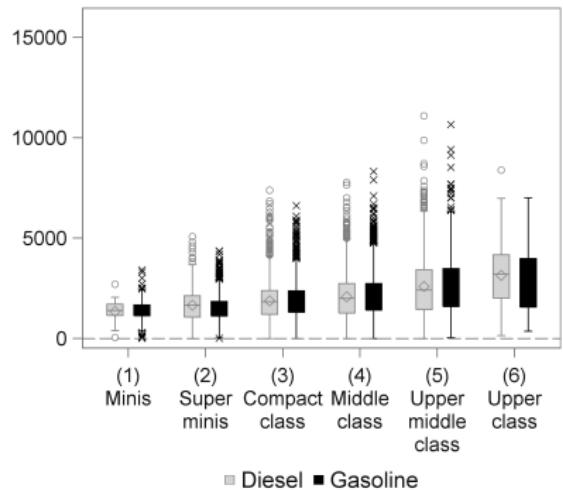
- ▶ Shown is a variation in within-product SD values over all products
- ▶ Net PVFC is PVFC net of tax-deductible expenses for potential vocational kilometers

Estimation

(I) **Hedonic price regression**:

$$P_{nj} = \mathbf{p}(PVFC_{nj}, X_{nkj}, \xi_{nj})$$

    ▷ Direction and magnitude of valuation
    ▷ Separate nonparametric estimation for 2 engine types $\times$ 6 car classes
    ▷ WTP for a €1 less in PVFC $= \dfrac{\partial \widehat{\mathbf{p}}(\cdot)}{\partial \text{PVFC}} \ \forall n$
    ▷ Rational cost-minimizing behavior: $\text{WTP}_{\mathbf{n,PVFC}} \overset{!}{=} 1$

(II) **Quantile regression**:

$$\text{WTP}_{\mathbf{n,PVFC}} = \gamma_0(\tau) + \sum_d \gamma_d(\tau) Z_{dn} + \eta_n(\tau)$$

    ▷ Determinants of consumers' heterogeneity (Z_{dn}) in their valuation
    ▷ Estimation of the whole family of conditional quantile functions
    ▷ Determinants' effects at different levels of PVFC valuation

(I) Hedonic price regression results

▶ Pseudo-R^2 between 0.62 and 0.96

▶ Overall, the estimates of the expected sign, all significant

▶ Estimated median WTP varies from €0.08 to €0.32 (<€1)

▶ Higher WTP for diesel compared to gasoline vehicles ($p<0.05$ ∀ car class)

▶ Higher WTP for higher car classes

▶ High variation in WTP within engine types and car classes: SD varies from 0.08 to 0.55

(II) What explains heterogeneity in the undervaluation?

$$\text{Undervaluation}_n \stackrel{\text{def}}{=} 1 - \text{WTP}_{n,\text{PVFC}}$$
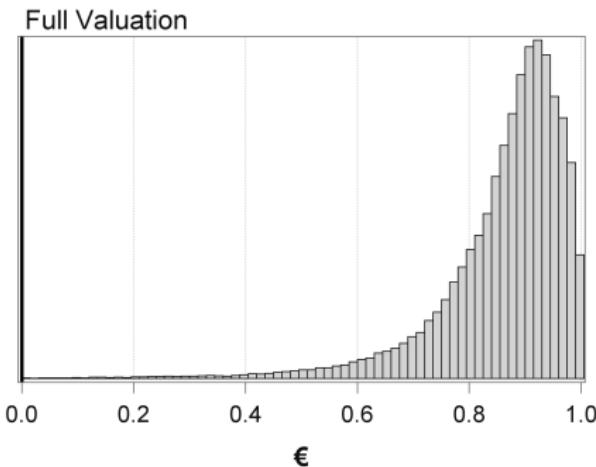
Full Valuation

- Quantile regression: $\text{Undervaluation}_n = \gamma_0(\tau) + \sum_d \gamma_d(\tau) Z_{dn} + \eta_n(\tau)$
- Estimation by engine type with car class fixed effects

Heterogeneity determinants (Z_{dn})

Characteristics	Units	Diesel vehicles (N = 38761) Mean	SD	Gasoline vehicles (N = 82552) Mean	SD
Demographics					
Gender ("male" = 1)	0/1	0.83	0.38	0.72	0.45
Age	years old	48.22	13.56	52.15	14.57
Children under 18	number	0.52	0.87	0.35	0.71
University degree ("yes" = 1)	0/1	0.28	0.45	0.20	0.40
Town size	8 groups	3.89	1.92	4.21	2.02
Capital Constraints					
Monthly net income	15 groups	8.43	2.76	7.39	2.88
Financing ("savings" =1)	0/1	0.60	0.49	0.64	0.48
Financing ("loan" =1)	0/1	0.35	0.48	0.32	0.47
Considered used car ("yes"=1)	0/1	0.33	0.47	0.28	0.45
Car Usage					
Holiday driving ("frequent usage"=1)	0/1	0.93	0.25	0.86	0.34
Weekend driving ("frequent usage"=1)	0/1	0.71	0.45	0.67	0.47
Cars in use	number	1.65	0.72	1.48	0.65
Two cars and more ("yes"=1)	0/1	0.53	0.50	0.40	0.49
Same make as previous ("yes"=1)	0/1	0.53	0.50	0.58	0.49

(Part of) Quantile regression results

- ▶ Gasoline; Dependent variable: undervaluation in € cents
- ▶ Negative $\gamma_d(\tau)$ values $\Rightarrow$ lower undervaluation of future fuel savings
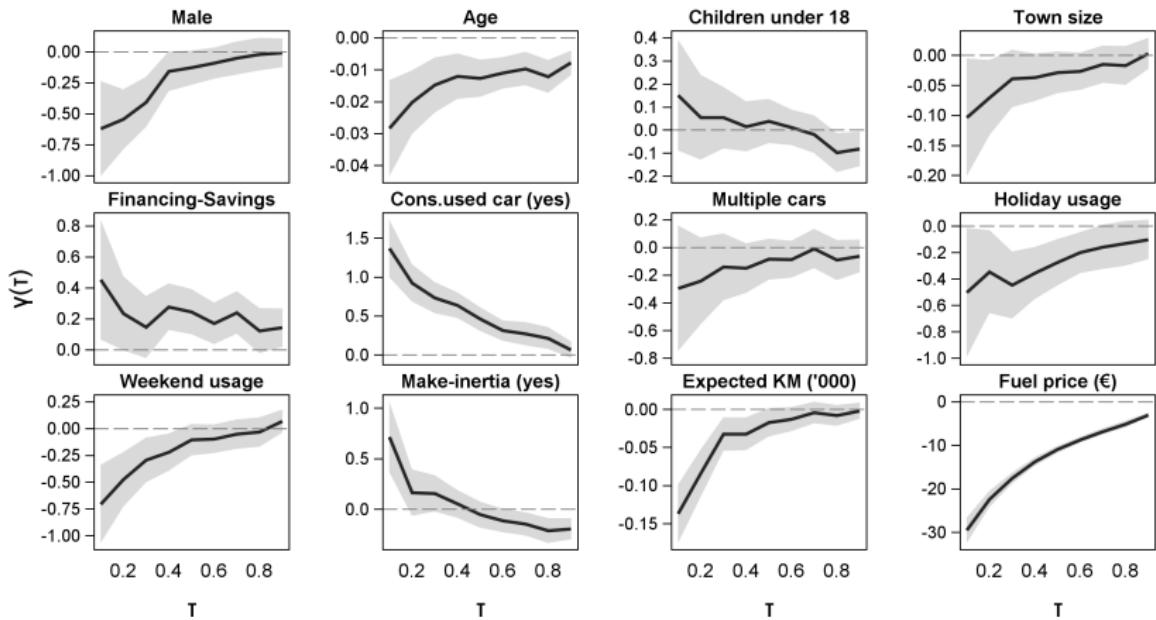
Determinants of undervaluation*

Market failures	**Insufficient information**	No differences for a subsample after official introduction of energy labels
	Capital constraints	Controlled by income, number of kids; town size; cars in use Negative effects
Behavioural biases	**Cognitive limitations**	No MPG Illusion applied Education has a negative effect Education effect decreases with income
	Choice-inertia	Various effects Reflects either reduced task complexity, or inattention
	Time preferences	Partly ruled out by controlling for financing method Using savings for the purchase has a positive effect
	Usage uncertainty	Controlled by EKM; holding length; purposes of car use Frequency and intensity of a car use have negative effects

* See for example Gerarden et al. (2015)

Conclusion

▶ (Heterogeneous) undervaluation of future energy savings for buyers of diesel and gasoline vehicles of various car classes

⇒ Efficiency standards are superior to Pigovian taxes (fuel taxes; CO_2 emission taxes)

▶ Financial ability, education, and choice-inertia of consumers are the most important determinants of investment (in)efficiency

⇒ Complementary policies can help to reduce the energy-efficiency gap (information provision policies + financial incentive schemes)

Thank you for your attention

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Supplementary material

Fuel prices and benchmark interest rate

Year	Gasoline (2010 €cent/l)(1)	Diesel (2010 €cent/l)(1)	Interest Rate,% (2)
2000	118.33	93.33	4.04
2001	116.75	93.58	4.25
2002	118.06	94.37	3.21
2003	121.91	98.73	2.25
2004	124.52	103.02	2.00
2005	131.57	114.68	2.02
2006	136.35	118.08	2.79
Average	123.93	102.26	2.94

Sources:
(1) From the largest automobile club in Germany, ADAC
(http://www.adac.de/infotestrat/autodatenbank);
(2) ECB interest rates for the main refinancing operations provided by the German Federal Bank at
http://www.bundesbank.de/.

High heterogeneity in values within products

		Minis	Superminis	Compact	Middle	Upper Middle	Upper
				Diesel vehicles (N consumers = 38761)			
Purchase price (2010€)	Mean	16,338.69	19,154.53	26,197.62	33,749.17	45,528.92	66,851.66
	SD	1,216.76	1,433.24	1,969.30	2,489.53	3,415.14	5,280.34
PVFC (2010€)	Mean	3,422.64	3,883.72	4,718.48	5,602.40	6,737.98	8,148.74
	SD	1,915.30	2,073.53	2,210.69	2,556.37	3,143.57	3,946.22
Net PVFC (2010€)*	Mean	2,668.13	3,005.18	3,713.32	4,373.93	5,345.53	5,901.87
	SD	1,353.01	1,672.65	1,883.14	2,090.10	2,601.47	3,158.42
Expected annual KM	Mean	15,235.41	17,841.35	18,136.32	18,745.54	19,060.83	19,641.95
	SD	5,037.52	5,386.54	5,509.92	5,656.25	6,341.62	8,470.17
Holding length, years	Mean	5.12	4.95	5.09	5.07	5.06	4.65
	SD	2.60	2.41	2.29	2.22	2.28	2.33
Number of products	N	42	792	2939	4108	1909	132
				Gasoline vehicles (N consumers = 82552)			
Purchase price (2010€)	Mean	13,460.99	17,104.27	23,424.80	31,396.87	45,186.61	79,084.14
	SD	1,214.18	1,337.11	1,779.75	2,152.96	3,137.35	6,177.42
PVFC (2010€)	Mean	3,500.58	4,330.55	5,617.86	6,737.22	8,340.06	10,100.88
	SD	1,840.89	2,108.61	2,492.23	2,944.20	3,615.84	4,047.65
Net PVFC (2010€)*	Mean	2,613.73	3,141.84	4,416.06	5,147.67	6,795.43	8,610.68
	SD	1,399.16	1,514.85	1,891.16	2,136.18	2,702.30	3,067.04
Expected annual KM	Mean	9,841.12	10,458.76	12,179.19	13,318.79	14,741.26	15,911.40
	SD	3,538.79	3,490.46	4,033.36	4,321.14	5,145.92	5,567.75
Holding length, years	Mean	5.73	6.02	5.78	5.47	5.35	5.06
	SD	2.80	2.54	2.36	2.29	2.20	1.95
Number of products	N	309	2204	4881	5459	1791	168

Note: Net PVFC is PVFC net of tax-deductible expenses for potential vocational KM

Determinants (group variables) I

	Home Townsize	N	Percent
0	Not Stated	547	0.45
1	< 2,000	10142	8.36
2	2,000 - 4,999	13117	10.81
3	5,000 - 19,999	32436	26.74
4	20,000 - 49,999	22881	18.86
5	50,000 - 99,999	11341	9.35
6	100,000 - 299,999	13987	11.53
7	300,000 - 499,999	4286	3.53
8	≥500,000	12576	10.37
	Overall	121313	100

	Monthly Net Income, €	N	Percent
0	Not Stated	15764	12.99
1	< 1000	1284	1.06
2	1000 - 1249	3012	2.48
3	1250 - 1499	5321	4.39
4	1500 - 1749	7166	5.91
5	1750 - 1999	8806	7.26
6	2000 - 2249	10152	8.37
7	2250 - 2499	10358	8.54
8	2500 - 2999	12618	10.40
9	3000 - 3499	14654	12.08
10	3500 - 3999	14107	11.63
11	4000 - 4999	9395	7.74
12	5000 - 7499	6046	4.98
13	7500 - 9999	1411	1.16
14	10000 - 14999	662	0.55
15	≥15000	557	0.46
	Overall	121313	100

Determinants (group variables) II

	Weekend driving		N	Percent
0	Not answered	NA	13843	11.41
1	Almost Every Day	Frequent	15245	12.57
2	At Least Once A Week	Frequent	58544	48.26
3	At Least Once A Month	Infrequent	26313	21.69
4	At Least Once A Year	Infrequent	7368	6.07
5	Never/Not Applicable	Infrequent	372	0.31
		Overall	121313	100

	Holiday driving		N	Percent
0	Not answered	NA	8315	6.85
3	At Least Once A Month	Frequent	5969	4.92
4	At Least Once A Year	Frequent	94079	77.55
5	Never/Not Applicable	Infrequent	12950	10.67
		Overall	121313	100

Estimation (I): Hedonic price regression

$$\ln(\text{Price})_{nj} = \alpha_{PVFC,n}\text{PVFC}_j + \sum_k \alpha_{n,k} X_{kj} + \sum_s \alpha_{s,n}\text{Extras}_{sj} + f_j + \xi_{nj}$$

▷ X_{kj}: Horse Power per Weight; Weight; Displacement; Transmission
▷ Extras_{sj}: Supplementary features (sunroof; air conditioning; cruise control; leather seats; GPS navigation; park distance sensor)
▷ f_j: Fixed effects for make-model, year, quarter-of-year, region

Estimated WTP (€) for a €1 less in PVFC

▶ $\text{WTP}_n = \dfrac{\partial \widehat{\mathbf{p}}(\cdot)}{\partial PVFC} = \widehat{\alpha}_{PVFC,n} \times Price_{nj} \ \forall n$

	Diesel Vehicles					
	N	Mean	SD	P10	Median	P90
Minis	114	0.17	0.17	0.06	0.11	0.32
Superminis	3733	0.13	0.09	0.04	0.11	0.23
Compact Class	12207	0.14	0.11	0.03	0.12	0.25
Middle Class	11376	0.20	0.16	0.04	0.17	0.37
Upper Middle Class	3825	0.23	0.19	0.05	0.19	0.47
Upper Class	226	0.45	0.55	0.03	0.31	1.05

	Gasoline Vehicles					
	N	Mean	SD	P10	Median	P90
Minis	3468	0.12	0.08	0.04	0.11	0.22
Superminis	17247	0.09	0.08	0.02	0.08	0.16
Compact Class	27504	0.12	0.11	0.03	0.10	0.24
Middle Class	16384	0.16	0.16	0.03	0.12	0.33
Upper Middle Class	3191	0.20	0.17	0.04	0.17	0.39
Upper Class	297	0.41	0.35	0.11	0.32	0.90

Quantile regression results (I)

Variable	Diesel vehicles (N=31248)						Gasoline vehicles (N=67352)					
	OLS	Q10	Q25	Q50	Q75	Q90	OLS	Q10	Q25	Q50	Q75	Q90
Male	-0.17	-0.45	-0.46**	-0.11	-0.10	-0.14	-0.25**	-0.62***	-0.50***	-0.13*	0.01	-0.01
	(0.20)	(0.41)	(0.23)	(0.16)	(0.18)	(0.16)	(0.10)	(0.19)	(0.11)	(0.07)	(0.07)	(0.05)
Age	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.02***	-0.03***	-0.02***	-0.01***	-0.01***	-0.01***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Children under 18	-0.05	0.17	-0.21**	-0.31***	-0.37***	-0.19**	0.08	0.15	0.06	0.04	-0.02	-0.08**
	(0.09)	(0.18)	(0.11)	(0.09)	(0.08)	(0.09)	(0.06)	(0.12)	(0.08)	(0.06)	(0.05)	(0.04)
Town size	-0.12***	-0.28***	-0.09**	-0.06*	-0.04	-0.06**	-0.09***	-0.10**	-0.05**	-0.03*	-0.02	0.00
	(0.04)	(0.10)	(0.05)	(0.03)	(0.04)	(0.03)	(0.02)	(0.05)	(0.03)	(0.02)	(0.02)	(0.01)
University degree (yes)	-1.06	-0.82	-0.79	0.64	0.89	1.46	-6.82***	-9.34**	-7.16***	-6.08***	-3.64***	-3.45***
	(1.96)	(4.51)	(2.91)	(1.79)	(2.27)	(2.00)	(1.41)	(4.29)	(2.35)	(1.52)	(1.06)	(0.89)
Financing (Savings)	1.04***	2.00***	1.31***	0.59***	0.25*	0.03	0.27***	0.45**	0.20*	0.25***	0.15**	0.14**
	(0.17)	(0.33)	(0.18)	(0.16)	(0.15)	(0.13)	(0.10)	(0.20)	(0.11)	(0.07)	(0.07)	(0.06)
Cons. used car (yes)	0.70***	1.98***	0.73***	0.37**	0.06	0.00	0.68***	1.37***	0.73***	0.46***	0.20***	0.07
	(0.16)	(0.30)	(0.17)	(0.15)	(0.14)	(0.12)	(0.10)	(0.20)	(0.11)	(0.08)	(0.07)	(0.06)
Income (under 1000)	0.67	-1.11	2.46	2.26	2.37	2.59	0.15	2.49	0.08	-1.28*	-0.17	0.05
	(1.79)	(4.70)	(2.49)	(1.57)	(2.13)	(1.94)	(1.01)	(2.95)	(1.29)	(0.73)	(0.69)	(0.66)
Income (1000-1249)	2.11	1.11	3.38	3.29**	3.07	2.40	-0.06	2.48	-0.05	-1.34*	-0.27	-0.26
	(1.65)	(5.02)	(2.60)	(1.60)	(1.87)	(1.99)	(0.96)	(2.89)	(1.28)	(0.73)	(0.69)	(0.65)
Income (1250-1499€)	2.51	1.33	3.53	4.15***	3.01	2.51	0.10	2.25	0.16	-1.13	-0.14	-0.12
	(1.59)	(4.05)	(2.50)	(1.48)	(1.92)	(1.80)	(0.95)	(2.82)	(1.27)	(0.72)	(0.66)	(0.63)
Income (1500-1749€)	2.24	1.67	3.29	3.65**	2.71	2.51	0.10	2.23	0.04	-1.07	-0.17	-0.06
	(1.57)	(3.74)	(2.44)	(1.46)	(1.83)	(1.80)	(0.95)	(2.84)	(1.26)	(0.71)	(0.67)	(0.63)
Income (1750-1999€)	2.43	2.36	4.01*	3.90***	2.30	2.20	0.21	2.59	0.24	-1.01	-0.08	-0.06
	(1.57)	(3.72)	(2.35)	(1.40)	(1.78)	(1.72)	(0.94)	(2.84)	(1.25)	(0.70)	(0.66)	(0.62)
Income (2000-2249€)	2.34	1.82	3.69	3.58**	2.41	2.33	-0.39	1.68	-0.57	-1.51**	-0.32	-0.00
	(1.55)	(3.69)	(2.39)	(1.41)	(1.79)	(1.79)	(0.94)	(2.89)	(1.30)	(0.71)	(0.66)	(0.63)
Income (2250-2499€)	1.92	0.44	3.24	3.55**	2.13	2.11	-0.13	2.06	-0.23	-1.23*	-0.26	-0.06
	(1.55)	(3.70)	(2.38)	(1.41)	(1.81)	(1.80)	(0.94)	(2.87)	(1.28)	(0.71)	(0.66)	(0.64)
Income (2500-2999€)	1.90	1.87	3.24	3.27**	2.34	2.40	-0.82	0.83	-0.96	-1.63**	-0.54	-0.17
	(1.54)	(3.70)	(2.34)	(1.43)	(1.82)	(1.79)	(0.94)	(2.89)	(1.28)	(0.72)	(0.68)	(0.63)
Income (3000-3499€)	1.52	0.40	2.71	2.88**	2.40	2.32	-0.47	0.88	-0.48	-1.34*	-0.36	-0.10
	(1.54)	(3.71)	(2.36)	(1.42)	(1.80)	(1.77)	(0.94)	(2.86)	(1.30)	(0.70)	(0.67)	(0.64)
Income (3500-3999€)	1.26	-1.01	2.09	3.22**	2.13	2.67	-0.61	0.91	-0.55	-1.17	-0.09	-0.02
	(1.52)	(3.78)	(2.38)	(1.42)	(1.79)	(1.78)	(0.94)	(2.91)	(1.27)	(0.72)	(0.68)	(0.64)

Quantile regression results (II)

Variable	Diesel vehicles (N=31248)						Gasoline vehicles (N=67352)					
	OLS	Q10	Q25	Q50	Q75	Q90	OLS	Q10	Q25	Q50	Q75	Q90
Income (4000-4999€)	0.98	-0.88	1.61	3.13**	2.26	2.62	-2.00**	-1.79	-1.68	-2.15***	-0.77	-0.26
	(1.55)	(3.73)	(2.44)	(1.46)	(1.81)	(1.78)	(0.95)	(2.89)	(1.31)	(0.72)	(0.72)	(0.64)
Income (5000-7499€)	0.38	-5.20	1.53	3.05**	2.64	2.47	-2.26**	-1.55	-2.20	-2.12***	-0.57	-0.19
	(1.57)	(4.17)	(2.56)	(1.55)	(1.83)	(1.83)	(0.97)	(3.09)	(1.41)	(0.76)	(0.71)	(0.66)
Income (7500-9999€)	-2.22	-7.75	-1.10	1.14	0.91	1.15	-2.47**	-3.82	-4.24**	-2.65**	-0.70	0.22
	(1.76)	(6.06)	(3.10)	(1.76)	(2.14)	(2.66)	(1.12)	(3.56)	(1.68)	(1.06)	(0.83)	(0.77)
Income (10000-14999€)	0.96	-5.32	4.92	4.31*	4.00	3.23	-3.07**	-8.17	-2.57	-4.53***	-1.78	-0.40
	(2.11)	(6.87)	(3.87)	(2.26)	(2.84)	(2.18)	(1.32)	(6.07)	(2.12)	(1.60)	(1.40)	(1.10)
Income (under 1000€) x Uni (yes)	4.37	10.36	5.83*	0.97	-0.38	-2.75	6.29***	9.46*	5.82**	5.14**	2.38*	2.97**
	(3.28)	(9.81)	(3.47)	(2.28)	(2.95)	(3.16)	(2.01)	(5.65)	(2.62)	(2.03)	(1.40)	(1.43)
Income (1000-1249€) x Uni (yes)	0.70	3.28	-1.47	-2.33	0.65	0.03	6.52***	9.17**	6.49**	5.51***	3.63***	3.33***
	(2.98)	(7.65)	(4.21)	(3.44)	(2.61)	(2.40)	(1.69)	(4.91)	(2.54)	(1.60)	(1.30)	(1.08)
Income (1250-1499€) x Uni (yes)	0.14	-2.47	-0.41	-0.49	-0.05	-0.19	6.97***	9.85**	7.28***	6.55***	4.34***	3.49***
	(2.48)	(7.56)	(4.05)	(2.26)	(2.56)	(2.25)	(1.57)	(4.22)	(2.31)	(1.58)	(1.13)	(0.99)
Income (1500-1749€) x Uni (yes)	1.13	-0.23	1.36	-0.04	-0.53	-0.31	6.52***	8.92**	6.18**	5.53***	3.13***	3.10***
	(2.28)	(4.80)	(3.43)	(2.03)	(2.43)	(2.11)	(1.51)	(4.24)	(2.48)	(1.59)	(1.14)	(0.99)
Income (1750-1999€) x Uni (yes)	1.78	0.39	0.70	-0.22	-0.87	-1.46	6.58***	9.37**	7.11***	5.62***	3.37***	3.32***
	(2.17)	(4.46)	(2.97)	(1.90)	(2.31)	(2.02)	(1.47)	(4.36)	(2.38)	(1.51)	(1.09)	(0.91)
Income (2000-2249€) x Uni (yes)	1.12	0.49	0.45	-0.53	-0.83	-0.97	7.21***	10.05**	7.31***	6.37***	3.69***	3.36***
	(2.11)	(4.53)	(3.08)	(1.86)	(2.34)	(2.13)	(1.46)	(4.30)	(2.36)	(1.56)	(1.05)	(0.88)
Income (2250-2499€) x Uni (yes)	1.58	2.33	1.93	0.35	-0.11	-0.25	6.94***	8.33**	7.25***	6.02***	3.96***	3.39***
	(2.09)	(4.46)	(2.99)	(1.82)	(2.35)	(2.01)	(1.46)	(4.42)	(2.40)	(1.56)	(1.10)	(0.91)
Income (2500-2999€) x Uni (yes)	1.51	0.07	1.28	0.58	-0.08	-0.90	7.05***	10.28**	8.00***	6.15***	4.12***	3.53***
	(2.04)	(4.55)	(3.01)	(1.80)	(2.27)	(2.01)	(1.45)	(4.37)	(2.35)	(1.54)	(1.09)	(0.92)
Income (3000-3499€) x Uni (yes)	1.57	1.46	1.28	0.23	-0.59	-1.15	7.28***	11.08***	7.32***	6.14***	3.67***	3.31***
	(2.01)	(4.51)	(2.99)	(1.84)	(2.25)	(2.03)	(1.44)	(4.26)	(2.40)	(1.53)	(1.06)	(0.91)
Income (3500-3999€) x Uni (yes)	1.55	2.94	1.33	-0.55	-0.69	-1.65	7.34***	10.20**	7.93***	6.19***	3.76***	3.58***
	(2.01)	(4.56)	(3.00)	(1.84)	(2.24)	(2.01)	(1.44)	(4.36)	(2.37)	(1.54)	(1.10)	(0.92)
Income (4000-4999€) x Uni (yes)	2.12	2.87	2.77	-0.43	-0.61	-1.45	7.91***	11.13**	7.60***	6.60***	4.13***	3.75***
	(2.02)	(4.46)	(3.03)	(1.87)	(2.33)	(2.02)	(1.45)	(4.37)	(2.39)	(1.52)	(1.09)	(0.90)
Income (5000-7499€) x Uni (yes)	0.98	3.89	1.31	-1.57	-1.62	-1.86	7.64***	10.46**	7.09***	6.32***	3.82***	3.53***
	(2.04)	(4.93)	(3.09)	(1.92)	(2.37)	(2.12)	(1.48)	(4.43)	(2.40)	(1.59)	(1.11)	(0.98)
Income (7500-9999€) x Uni (yes)	4.38*	7.15	4.72	2.35	1.06	0.02	4.22**	4.57	6.00**	4.20**	2.56*	2.26**
	(2.28)	(6.99)	(3.63)	(2.31)	(2.57)	(2.53)	(1.67)	(6.21)	(2.97)	(1.95)	(1.40)	(0.95)

Quantile regression results (III)

Variable	Diesel vehicles (N=31248)						Gasoline vehicles (N=67352)					
	OLS	Q10	Q25	Q50	Q75	Q90	OLS	Q10	Q25	Q50	Q75	Q90
Income (10000-14999€) x Uni (yes)	0.05	8.44	-0.84	-2.79	-3.74	-3.82	3.91**	8.81	4.80	5.28**	3.94**	1.72
	(2.69)	(8.62)	(4.29)	(2.96)	(3.38)	(2.46)	(1.92)	(10.34)	(3.43)	(2.44)	(1.86)	(1.53)
Multiple cars	-0.09	0.19	-0.24	-0.10	-0.08	-0.02	-0.27***	-0.29	-0.21*	-0.08	-0.04	-0.06
	(0.16)	(0.35)	(0.21)	(0.15)	(0.15)	(0.13)	(0.10)	(0.21)	(0.11)	(0.08)	(0.07)	(0.06)
Holiday (Frequent usage)	-0.46	-1.16**	-0.97***	-0.73***	-0.34	-0.04	-0.22	-0.50**	-0.36**	-0.27***	-0.14*	-0.10
	(0.31)	(0.52)	(0.33)	(0.23)	(0.25)	(0.21)	(0.14)	(0.23)	(0.14)	(0.09)	(0.08)	(0.07)
Weekend (Frequent usage)	-0.13	-0.16	-0.22	0.06	-0.05	0.08	-0.28***	-0.71***	-0.47***	-0.10	-0.03	0.07
	(0.17)	(0.34)	(0.21)	(0.16)	(0.15)	(0.13)	(0.10)	(0.20)	(0.11)	(0.08)	(0.07)	(0.05)
Expected KM (000)	-0.02*	-0.08***	-0.03*	-0.01	0.01	0.01	-0.06***	-0.14***	-0.04***	-0.02*	-0.00	-0.00
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Fuel price (FP)	-2.18***	-9.54***	-5.41***	0.94	3.91***	3.97***	-16.06***	-29.56***	-19.62***	-10.95***	-5.92***	-3.02***
	(0.71)	(1.48)	(0.83)	(0.64)	(0.59)	(0.52)	(0.51)	(1.49)	(0.68)	(0.38)	(0.32)	(0.29)
Make-inertia (yes)	-0.24	0.26	-0.26	-0.20	-0.41***	-0.37***	0.30***	0.71***	0.14	-0.05	-0.19***	-0.19***
	(0.15)	(0.29)	(0.18)	(0.14)	(0.13)	(0.11)	(0.10)	(0.18)	(0.10)	(0.06)	(0.06)	(0.05)
Intercept	71.22***	51.33***	65.64***	67.99***	78.69***	91.24***	90.91***	78.38***	87.16***	86.77***	90.05***	94.04***
	(1.96)	(6.57)	(2.79)	(1.71)	(2.44)	(2.09)	(1.30)	(4.17)	(1.67)	(1.21)	(1.11)	(1.01)
Car class dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Reference group: female; no university degree; income of $\geq$ €500,000; loan; no considered used car; one car in household; other makes; infrequent weekend trips; infrequent holiday trips; upper class