Static discrete choice models: application 2

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Application on valuation of fuel costs I

- Paper to be discussed: Grigolon, L., Reynaert, M. and Verboven, F.. 2018. "Consumer valuation of fuel costs and tax policy: Evidence from the European car market". *American Economic Journal: Economic Policy*,10(3): 193-225.
- Uses RC logit on aggregate data of market shares of cars in Europe
- Investigate trade-off for government: sales tax on inefficient cars or tax on fuel
  - If households are myopic: should use a sales tax
  - If households are heterogeneous in mileage: should use a fuel tax
- RC crucial to allow for heterogeneity in mileage distribution
  - Leads to conclusion that fuel tax is more effective and better for welfare

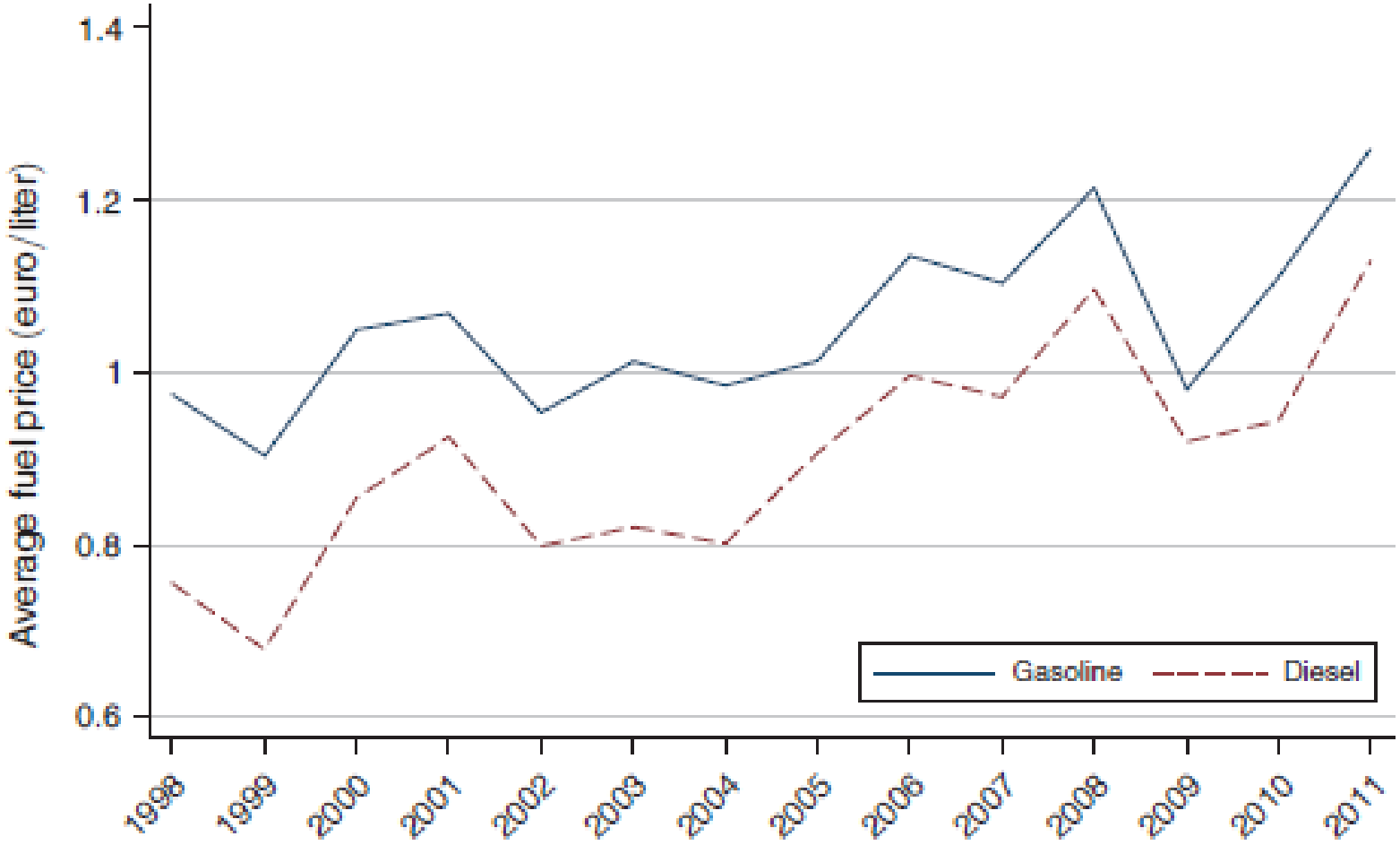
Data I

TABLE 1—SUMMARY STATISTICS

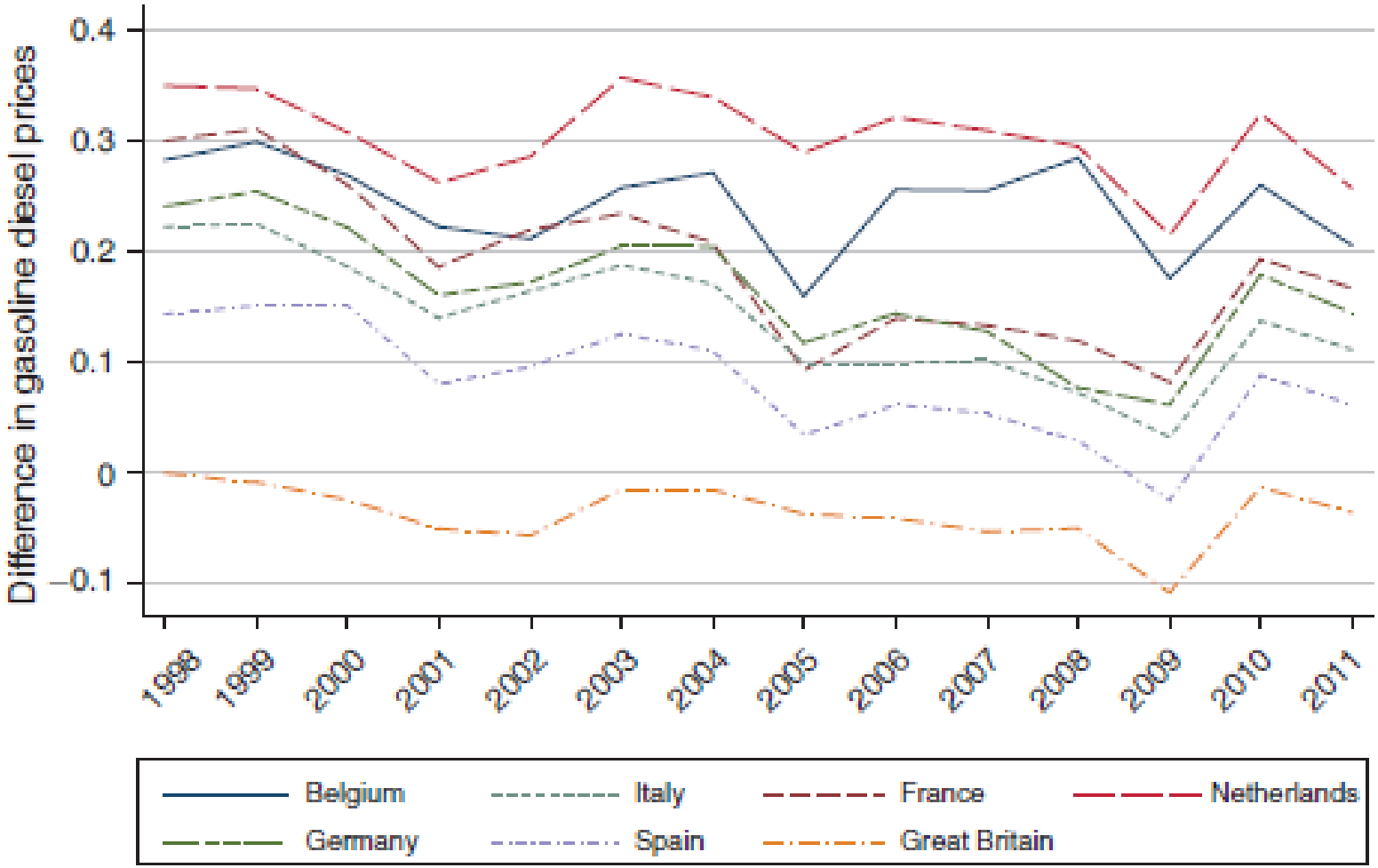
	All years		1998	2011
Variable	Mean	SD	Mean	Mean
Sales (1,000 units)	1.8	5.1	2.7	1.3
Price/Income	1.1	0.7	1.1	1.1
Fuel consumption (L/100 km)	7.3	2.1	7.8	6.3
Yearly fuel costs/income (× 100)	4.3	1.5	4.7	4.3
Horsepower (in kW)	107.4	54.6	85.1	122.0
Size (1,000 cm^2)	76.7	9.9	74.0	79.5
Height (cm)	148.5	10.7	144.1	150.1
Foreign (0–1)	0.9	0.4	0.8	0.9
Diesel (0–1)	0.4	0.5	0.3	0.5
Months market presence (1–12)	11.4	1.8	11.4	11.5
Observations	82,151		4,380	6,898

Notes: The table reports means and standard deviations of the main variables for all years and for years 1998 and 2011 separately. The total number of observations (model/engines combinations and markets) is 82,166, where markets refer to 7 countries and 14 years.

Data II


Average fuel price (euro/liter)
1.4
1.2
1
0.8
0.6
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Gasoline
Diesel

Data III


Difference in gasoline diesel prices
0.4
0.3
0.2
0.1
0
−0.1
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Belgium
Italy
France
Netherlands
Germany
Spain
Great Britain

Data IV

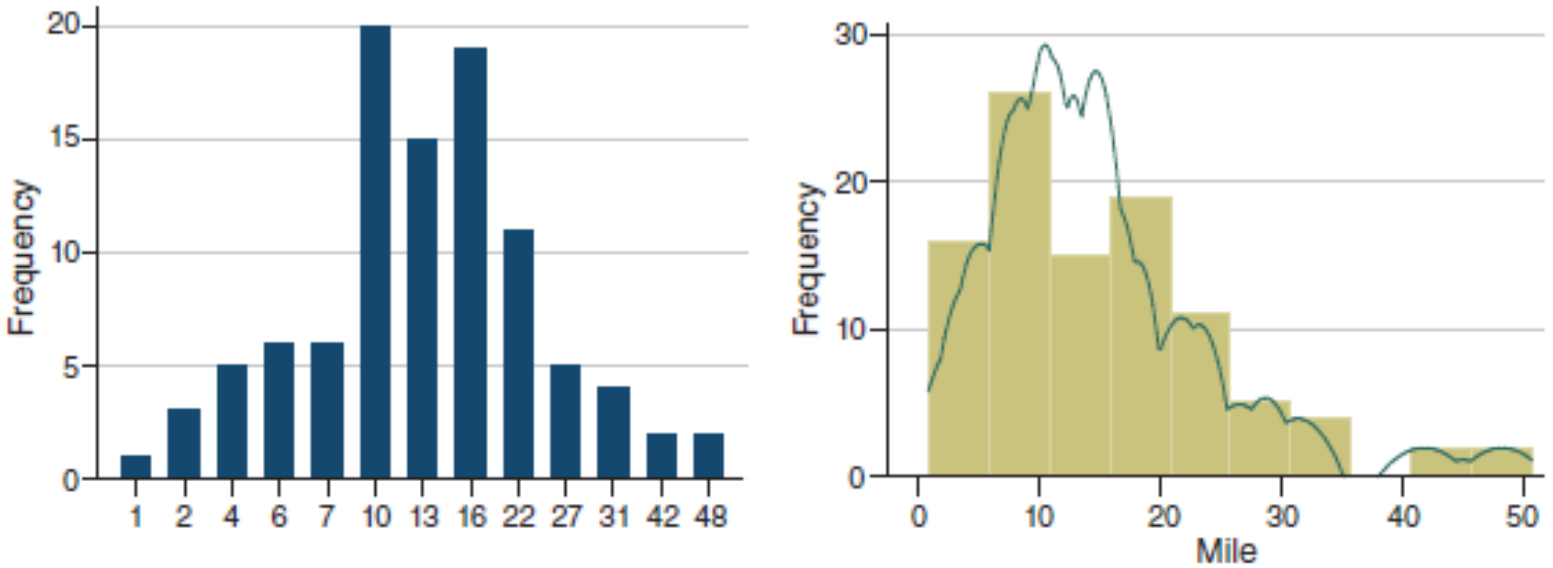


FIGURE 2. UK MILEAGE SURVEY

Notes: This figure shows the frequency distribution for the UK mileage survey in 2007. The left panel has x-axis bins in 1,000 of km traveled per year; the mean of the distribution is 14,761 km traveled. The right panel shows the distribution with equal sized 5,000 km bins and a plotted kernel.

Model I

- model j with engine variant k
- x_{jk} car characteristics, p_{jk} price and G_{ijk} expected future fuel cost

$$u_{ijk} = x_{jk}\beta_i^x + \alpha_i(p_{jk} + \gamma G_{ijk}) + \xi_{jk} + \epsilon_{ijk}$$

- with

$$G_{ijk} = \rho\beta_i^m e_{jk} g_k$$

- β_i^m mileage, g_k fuel price, e_{jk} fuel consumption in liter/km and

$$\rho = \sum_{s=1}^{S}(1+r)^{-s}$$

- with S the expected lifetime of a car
- Households can also choose not to adopt a car by consuming the outside good of which utility is normalized to 0

Model II

- Normal distribution for most parameters but covariances set to 0
- 2 parameters are treated a bit different
  - $\alpha_i = \frac{\alpha}{y_t}$
  - β_i^m is not estimated but simulated from an observed distribution
- Panel data allows for fixed effects

$$\xi_{jkt} = \xi_j + \xi_t + \widetilde{\xi}_{jkt}$$

Estimation method I

- RC logit on aggregate data: see BLP (1995) and Nevo (2000)
- We covered this if there would be no random coefficients:

$$u_{ijk} = x_{jk}\beta^x + \alpha(p_{jk} + \gamma G_{jk}) + \xi_{jk} + \epsilon_{ijk}$$

$$\text{with } G_{jk} = \rho\beta^m e_{jk} g_k$$

- What are market shares now? And how to estimate?
- What about endogeneity?
  - More details about instruments and identification in BLP, see Berry and Haile (2014, 2016)
  - For optimal instruments of Chamberlain (1987) , see Reynaert and Verboven (2014)

Estimation method II

- Why do we need a more flexible specification here?
- How to do this?
  - $\beta_i^x = \overline{\beta}^x + \sum^x \nu_i^x$ with $\sum^x$ a diagonal matrix with SDs on the diagonal
  - Use simulated values for ν_i^x and calculate market share using the logit formula
  - Use a contraction mapping to get the mean utilities
- This will lead to a GMM estimator where $\widetilde{\xi}_{jkt}$ is a function of parameters and interacted with a set of instruments
- Of particular interest is the random coefficient on fuel efficiency with a clear economic explanation: households should not care about fuel efficiency in the same way because they will have different mileage
- Authors don't estimate that distribution, why not?

Estimation results I

TABLE 3—PARAMETER ESTIMATES FOR ALTERNATIVE DEMAND MODELS

	Logit		RC Logit I		RC Logit II	
	Est.	SE	Est.	SE	Est.	SE
Panel A. Mean valuations						
Price/inc. (α)	−4.52	0.19	−6.22	0.22	−5.33	0.21
Fuel costs/inc. ($\alpha\gamma\rho$)	−39.03	1.41	−46.48	0.94	−47.11	9.22
Power (kW/100)	2.28	0.14	2.60	0.17	0.25	0.61
Size (cm^2/10,000)	13.25	0.44	16.69	0.48	16.77	2.02
Height (cm/100)	3.00	0.30	4.45	0.32	5.19	0.33
Foreign	−0.83	0.02	−0.75	0.02	−0.89	0.04
Panel B. Standard deviations of valuations						
Power (kW/100)	–	–	–	–	1.95	0.25
Size	–	–	–	–	4.31	2.04
Foreign	–	–	–	–	0.49	0.43
Mileage distribution	No		Yes		Yes	
Panel C. Valuations of future fuel costs						
Fuel costs/price ($\gamma\rho$)	8.63	0.55	7.47	0.24	8.84	1.77
Future valuation γ ($r = 6\%$)	0.89	0.06	0.77	0.02	0.91	0.18
Consumer loss from mis-optim. (€)	73.07		328.13		39.71	
Implicit interest rate ($T = 10$)	2.77		5.69		2.31	
Implicit interest rate ($T = 15$)	7.87		10.32		7.48	

Policy counterfactual I

- We want to know how households respond to (1) a tax on fuel (50c) and (2) a tax on cars as a function of their fuel efficiency (3.5k for a 5l/100km car)
- Can we use the estimates directly? Under what conditions can we do that?
- In IO, researchers often recompute prices in counterfactuals by assuming multi-product betrand competition with differentiated goods (why?)
- Nevertheless, the authors find almost complete pass-through which means that ignoring the change of prices would not change the results a lot

Policy counterfactual II

TABLE 5—THE EFFECT OF A FUEL TAX AND A PRODUCT TAX ON FUEL CONSUMPTION AND FUEL USAGE

	Outside good percentage point change	Fuel consumption percent change	Fuel usage percent change
Logit			
Fuel tax	14.06	−2.16	−31.89
Revenue equivalent product tax	14.06	−2.16	−31.89
RC Logit I—Mileage only			
Fuel tax	10.78	−0.80	−38.19
Revenue equivalent product tax	7.33	−1.49	−22.97
RC Logit II			
Fuel tax	5.71	−1.16	−18.13
Revenue equivalent product tax	4.84	−1.53	−12.00
RC Logit III—Extra RC on fuel cost			
Fuel tax	6.53	−1.05	−20.54
Revenue equivalent product tax	5.66	−1.33	−13.76
RC Logit IV—Extra heterogeneity in fuel cost			
Fuel tax	3.78	−1.85	−9.52
Revenue equivalent product tax	3.74	−1.96	−8.96
RC Logit V—Lifetime varies with miles			
Fuel tax	6.23	−1.17	−16.20
Revenue equivalent product tax	5.87	−1.29	−12.78

Notes: The table reports the effect of a €0.50 fuel tax and a revenue-equivalent product tax on the share of the outside good, average fuel consumption, and total annual fuel usage. The simulations are based on the parameter

Policy counterfactual III

TABLE 8—THE WELFARE EFFECTS OF A FUEL TAX VERSUS A PRODUCT TAX

Change in Mln euro:	Revenue	Consumer surplus	Belief error (internality)	Externality	Welfare
Panel A. General externality increase and corrective taxes					
			Logit ($\gamma = 0.89$)		
Fuel tax	1,565	−335	−116	2,165	265
Product tax	954	−335	496	2,165	265
			RC Logit II ($\gamma = 0.91$)		
Fuel tax	2,246	−3,409	−234	1,584	186
Product tax	3,512	−5,294	310	1,584	112
Panel B. Diesel externality increase and corrective diesel taxes					
			Logit ($\gamma = 0.89$)		
Fuel tax	1,009	−1,389	−107	632	146
Product tax	761	−1,389	141	632	146
			RC Logit II ($\gamma = 0.91$)		
Fuel tax	1,555	−1,547	−185	364	187
Product tax	2,579	−2,923	30	364	50

Conclusion I

- Authors find modest undervaluation of fuel costs and lots of heterogeneity in mileage
- Therefore the counterfactuals show that fuel taxes are more effective
- Why is it okay to have a static model here?
  - See also Allcott and Wozny (2014) with a similar model and who say it can be derived from a dynamic model
- Static model does not mean we assume households are not forward looking in any way
- Future enters through valuation of fuel economies
- What makes the model static is that households do not consider the possibility of buying a car in the future
- When is this important?

Conclusion II

- How would it change our estimates and therefore also conclusions?
- Why don't the authors do it here?

More recent work

- Similar in Massachusetts but relaxing inelastic fuel demand: Lu (2018)
- 2 in-house experts environmental economics of car market: Isis Durrmeyer and Mathias Reynaert

References I


Hunt Allcott and Nathan Wozny.
Gasoline Prices, Fuel Economy, and the Energy Paradox.
Review of Economics and Statistics, 96(5):779–795, December 2014.


Steven Berry, James Levinsohn, and Ariel Pakes.
Automobile Prices in Market Equilibrium.
Econometrica, 63(4):841, July 1995.


Steven T. Berry and Philip A. Haile.
Identification in Differentiated Products Markets Using Market Level Data.
Econometrica, 82(5):1749–1797, 2014.

References II

Steven T Berry and Philip A Haile.
Identification in Differentiated Products Markets.
Annual Review of Economics, 8:27–52, 2016.

Gary Chamberlain.
Asymptotic Efficiency in Estimation with Conditional Moment Restrictions.
Journal of Econometrics, 34:305–334, 1987.

Laura Grigolon, Mathias Reynaert, and Frank Verboven.
Consumer valuation of fuel costs and tax policy: Evidence from the European car market.
American Economic Journal: Economic Policy, 10(3):193–225, 2018.

References III

Tingmingke Lu.
Response of New Car Buyers to Alternative Energy Policies: The Role of Vehicle Use Heterogeneity.
SSRN Electronic Journal, 2018.

Aviv Nevo.
A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand.
Journal of Economics & Management Strategy, 9(4):513–548, 2000.