Online Appendix to Consumer valuation of fuel costs and tax policy: Evidence from the European car market

Laura Grigolon, Mathias Reynaert, Frank Verboven*

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A Appendix A. Computational details

In this Appendix, we first derive the analytic expressions for the demand effects of a fuel tax and a product tax based on fuel economy. We then describe the specific approach to implement the policy counterfactuals. Finally, we describe how we incorporate the empirical millage distribution in our estimation.

A.1 Impact of small tax changes on demand

Assume for simplicity that the fuel tax and product tax is uniform, i.e. there is no distinction between gasoline and diesel engine k. The individual choice probability for product jk of a consumer i can be written as:

$$s_{ijk}\left(t^G, t^E; \beta_i\right) = \frac{\exp(v_{ijk})}{1 + \sum_{j'}^{J} \sum_{k'=1}^{K_{j'}} \exp(v_{ij'k'})}.$$

and total sales of product product jk under taxes (t^G, t^E) are:

$$q_{jk}\left(t^G, t^E\right) = \int_\beta s_{ijk}\left(t^G, t^E; \beta\right) dF_\beta(\beta) I,$$

*Laura Grigolon: McMaster University. Email: Laura.Grigolon@mcmaster.ca. Mathias Reynaert: Toulouse School of Economics. Email: Mathias.Reynaert@gmail.com Frank Verboven: University of Leuven and C.E.P.R. (London). Email: Frank.Verboven@kuleuven.be.

where the individual utility minus extreme value random variable is defined as

$$v_{ijk} \equiv x_{jk}\beta_i^x - \alpha_i(p_{jk} + t^E e_{jk} + \gamma\rho\beta_i^m e_{jk}\left(g_k + t^G\right)) + \xi_{jk}.$$

The own- and cross-effects of a change in individual utility on the individual choice probabilities take the usual form:

$$\begin{aligned}
\frac{\partial s_{ijk}}{\partial v_{ijk}} &= s_{ijk}\left(1 - s_{ijk}\right) \\
\frac{\partial s_{ijk}}{\partial v_{ij'k'}} &= -s_{ij'k'}s_{ijk}.
\end{aligned}$$

The effect of a uniform fuel tax t^G on the individual choice probability is then:

$$\begin{aligned}
\frac{\partial s_{ijk}}{\partial t^G} &= -\alpha_i\gamma\rho\beta_i^m \sum_{j'}\sum_{k'} \frac{\partial s_{ijk}}{\partial v_{j'k'}} e_{j'k'} \\
&= -\alpha_i\gamma\rho\beta_i^m s_{ijk}\left(e_{jk} - \sum_{j'}\sum_{k'} s_{ij'k'}e_{j'k'}\right) \\
&= -\alpha_i\gamma\rho\beta_i^m s_{ijk}\left(e_{jk} - (1 - s_{i0})\sum_{j'}\sum_{k'} e_{j'k'}\frac{s_{ij'k'}}{1 - s_{i0}}\right) \\
&= -\alpha_i\gamma\rho\beta_i^m s_{ijk}\left(e_{jk} - \overline{e}^i + s_{i0}\overline{e}^i\right)
\end{aligned}$$

where

$$\overline{e}^i = \sum_{j'}\sum_{k'} e_{j'k'}\frac{s_{ij'k'}}{1 - s_{i0}}$$

is the expected fuel economy of consumer i.

The effect of the fuel tax on total demand is then given by:

$$\begin{aligned}
\frac{\partial q_{jk}}{\partial t^G} &= \int_\beta \frac{\partial s_{ijk}}{\partial t^G} dF_\beta(\beta) I \\
&= -\int_\beta \alpha_i\gamma\rho\beta_i^m s_{ijk}\left(e_{jk} - \overline{e}^i + s_{i0}\overline{e}^i\right) dF_\beta(\beta) I.
\end{aligned}$$

We can follow similar steps to compute the effect of a product tax t^E, so that the effects of both taxes are summarized as:

$$
\begin{aligned}
\frac{\partial q_{jk}}{\partial t^G} &= -\int_\beta \alpha_i \gamma \rho \beta_i^m s_{ijk} \left(e_{jk} - \overline{e}^i + s_{i0}\overline{e}^i\right) dF_\beta(\beta) I \\
\frac{\partial q_{jk}}{\partial t^E} &= -\int_\beta \alpha_i s_{ijk} \left(e_{jk} - \overline{e}^i + s_{i0}\overline{e}^i\right) dF_\beta(\beta) I,
\end{aligned}
$$

which are the expressions presented in the main text. This shows several things. First, the tax effect is similar to a price elasticity of industry demand, except for the term $e_{jk} - \overline{e}^i$. If $e_{jk} - \overline{e}^i = 0$, the effect is just like elasticity of industry demand. If $e_{jk} > \overline{e}^i$, then the effect is bigger (worst fuel efficient cars loose most). If $e_{jk} - \overline{e}^i < 0$, the effect is smaller and may easily turn positive. Second, the energy tax is different from product tax because of γ and β_i^m. This can be confirmed from revenue equivalent tax below. Note also that the expressions simplify if the outside good is absent (inelastic market demand). Then the sign of the tax effect simply depends on sign of $e_{jk} - \overline{e}^i$.

A.2 Details on the policy counterfactuals

In this Appendix, we derive the expressions used in our policy counterfactuals to compute the effects of the fuel tax t_k^G and the product tax t_k^E on market shares, tax revenues, average fuel consumption and total fuel usage, and the various welfare components: tax revenues, decision consumer surplus, belief error (internality) and the externality.

Let $k = 1$ refer to gasoline, and $k = 2$ refer to diesel. Denote the vector of taxes by (t^G, t^E), where $t^G = (t_1^G, t_2^G)$ is the energy tax vector, and $t^E = (t_1^E, t_2^E)$ is the product tax vector.

Sales We slightly modify some of the expressions in the previous subsection to account for the fact that the fuel tax and product tax can vary per fuel type. The choice probability for product jk of a consumer i with a random coefficient vector $\beta_i = (\beta_i^x, \alpha_i, \beta_i^m)$ facing tax vector t^G and t^E is:

$$
s_{ijk}\left(t^G, t^E; \beta_i\right) = \frac{\exp(v_{ijk})}{1 + \sum_{j'}^{J} \sum_{k'=1}^{K_{j'}} \exp(v_{ij'k'})},
$$

where the individual utility minus the extreme value random variable is now defined with non-uniform taxes as

$$
v_{ijk} \equiv x_{jk}\beta_i^x - \alpha_i(p_{jk} + t_k^E e_{jk} + \gamma\rho\beta_i^m e_{jk}\left(g_k + t_k^G\right)) + \xi_{jk}.
$$

Total sales of product product jk under taxes (t^G, t^E) are again:

$$q_{jk}\left(t^G, t^E\right) = \int_\beta s_{ijk}\left(t^G, t^E; \beta\right) dF_\beta(\beta) I$$

So the predicted quantity after a change in the fuel tax by Δ^G is $q_{jk}\left(t^G + \Delta^G, t^E\right)$ and the predicted quantity after a change in the product tax by Δ^E is $q_{jk}\left(t^G, t^E + \Delta^E\right)$. Based on these predicted quantities per product jk we can compute the market shares per fuel consumption quartile (or any other aggregated quantity or market share).

Tax revenues Conditional on buying product jk, an individual consumer pays taxes $\left(t_k^E + \rho\beta_i^m t_k^G\right) e_{jk}$, i.e. the sum of the product tax plus capitalized future energy taxes. Total tax revenues over all products jk are defined as:

$$R\left(t^G, t^E\right) = \int_\beta \sum_j \sum_k \left(t_k^E + \rho\beta_i^m t_k^G\right) e_{jk} s_{ijk}\left(t_k^G, t_k^E; \beta\right) dF_\beta(\beta) I,$$

i.e. the expected tax revenue over all cars per consumer, averaged over all consumers. We can then compute the tax revenues from a change in energy taxes $R\left(t^G + \Delta^G, t^E\right)$ or product taxes $R\left(t^G, t^E + \Delta^E\right)$ as:

$$\begin{aligned} R\left(t^G + \Delta^G, t^E\right) &= \int_\beta \sum_j \sum_k \rho\beta_i^m t_k^G e_{jk} s_{ijk}\left(t^G + \Delta^G, t^E; \beta\right) dF_\beta(\beta) I \\ R\left(t^G, t^E + \Delta^E\right) &= \int_\beta \sum_j \sum_k t_k^E e_{jk} s_{ijk}\left(t^G, t^E + \Delta^E; \beta\right) dF_\beta(\beta) I. \end{aligned}$$

With uniform taxes, we consider an increase in the energy tax by 50c, $\Delta^G = 0.5$, so that the revenue-neutral product tax is the solution of Δ^E to $R\left(t^G + 0.5, t^E\right) = R\left(t^G, t^E + \Delta^E\right)$.

Sales-weighted average fuel consumption and total energy usage Weighted average fuel consumption (given that people purchase a car) is

$$E\left(t^G, t^E\right) = \sum_j \sum_k e_{jk} \frac{q_{jk}\left(t_k^G, t_k^E; \beta_i^m\right)}{\sum_j \sum_k q_{jk}\left(t_k^G, t_k^E; \beta_i^m\right)},$$

where

$$q_{jk}\left(t^G, t^E\right) = \int_\beta s_{ijk}\left(t^G, t^E; \beta\right) dF_\beta(\beta) I.$$

Total annual fuel usage is given by

$$F\left(t^G, t^E\right) = \int_\beta \sum_j \sum_k \beta_i^m e_{jk} s_{ijk}\left(t_k^G, t_k^E; \beta\right) dF_\beta(\beta) I.$$

This accounts for the fact that consumers may substitute to the outside good after a tax increase, so that they do not consume any fuel.

Based on this, we can compute the percentage change in average fuel consumption and the percentage change in fuel usage for both taxes. For example, the percentage change in average fuel consumption after a fuel tax change by Δ^G is $\%\Delta E = E\left(t^G + \Delta^G, t^G\right) / E\left(t^G, t^E\right) - 1$.

Welfare The first welfare component consists of tax revenues, already derived above. The second welfare component is experienced consumer surplus. Following Allcott (2013), this is equal to decision consumer surplus minus belief error. Decision consumer surplus is given by the standard expression in logit models (aggregated over the distribution of consumer valuations):

$$CS\left(t^G, t^E\right) = \int_\beta \frac{1}{\alpha_i} \ln\left(1 + \sum_j \sum_k \exp(v_{ijk})\right) dF_\beta(\beta) I,$$

and belief error is the difference between the actual and perceived fuel expenditures:

$$CS^b\left(t^G, t^E\right) = (1-\gamma) \int_\beta \sum_j \sum_k \rho \beta_i^m \left(g_k + t_k^G\right) e_{jk} s_{ijk}\left(t_k^G, t_k^E; \beta\right) dF_\beta(\beta) I.$$

Experienced consumer surplus is then $CS^*\left(t^G, t^E\right) = CS\left(t^G, t^E\right) - CS^b\left(t^G, t^E\right)$.

The final welfare component is the externality. Let h_k be the externality cost per liter of fuel type k (which includes the CO_2 costs, but also other pollution costs, congestion and accident externalities). The externality is then given by:

$$EXT\left(t^G, t^E\right) = \int_\beta \sum_j \sum_k \rho \beta_i^m h_k e_{jk} s_{ijk}\left(t_k^G, t_k^E; \beta\right) dF_\beta(\beta) I$$

Total welfare is the sum of the various components:

$$W\left(t^G, t^E\right) = R\left(t^G, t^E\right) + CS\left(t^G, t^E\right) - CS^b\left(t^G, t^E\right) + EXT\left(t^G, t^E\right).$$

To perform our welfare analysis, we need a measure of the externality cost per liter h_k for each fuel type k. We compute both h_k such that welfare is maximized at the current fuel tax levels, i.e. such that $\partial W / \partial t_k^G = 0$ for each fuel type k. We then assume that h_k increases by a certain amount, and compare the welfare impact of a fuel tax and an externality-neutral product tax, as discussed in the text.

A.2.1 Multi-product Bertrand competition

The above discussion considered the impact of the taxes on the various welfare components, but implicitly held constant the pre-tax prices p_{jk} (entering indirect utility and hence demand). As discussed in the text, we have also considered the possibility that pre-tax prices adjust to a new equilibrium, assuming multi-product Bertrand competition (instead of perfect competition).

Each firm f owns a portfolio of products F_f. Its total variable profits are given by the sum of the profits for each product $jk \in F_f$:

$$\Pi_f(\mathbf{p}) = \sum_{jk \in F_f} (p_{jk} - c_{jk})\, q_{jk}(\mathbf{p})$$

where c_{jk} is the constant marginal cost for product jk and $q_{jk}(p)$ is demand, now written as a function of the price vector p. The profit-maximizing price of each product jk should satisfy the following first-order condition:

$$q_{jk}(\mathbf{p}) + \sum_{j'k' \in F_f} (p_{j'k'} - c_{j'k'})\, \frac{\partial q_{j'k'}(\mathbf{p})}{\partial p_{jk}} = 0$$

or in matrix notation

$$\mathbf{q}(\mathbf{p}) + \left(\boldsymbol{\theta}^F \odot \boldsymbol{\Delta}(\mathbf{p})\right)(\mathbf{p} - \mathbf{c}) = 0.$$

where $\Delta(p) \equiv \partial q(p)/\partial p'$ is the Jacobian of demand derivatives; θ^F is a block-diagonal matrix with a typical element $\theta^F(jk, j'k')$ equal to 1 if products jk and $j'k'$ are produced by the same firm and 0 otherwise; and the operator $\odot$ denotes element-by-element multiplication of two matrices of the same dimension. This can be inverted to give:

$$\mathbf{p} = \mathbf{c} - \left(\boldsymbol{\theta}^F \odot \boldsymbol{\Delta}(\mathbf{p})\right)^{-1} \mathbf{q}(\mathbf{p}). \tag{1}$$

Based on this equation, we can recover the current marginal cost vector c using the observed prices and estimated price elasticities of demand. We can subsequently compute the new price equilibrium after a change in taxes. We use both the Newton method and fixed point iteration on (1), and this gave the same results.

A.3 Incorporating the empirical mileage distribution

In both estimation and counterfactuals we make use of the empirical mileage distribution. Suppose there are R mileage types, where for each type $r = 1...R$ there is a fraction λ_r (such that $\sum_{r=1}^{R} \lambda_r = 1$) and a corresponding mileage β_r^m. Total sales for product jk are

$$q_{jk} = \underbrace{\sum_{i=1}^{R} \lambda_i s_{rjk} \left(\beta_r^m\right) I}_{s_j},$$

where $s_{rjk}\left(\beta_i^m\right)$ is the probability that mileage type r chooses product jk (i.e. the integral of the individual choice probabilities over all heterogeneity other than mileage).

In practice, we do not observe the unconditional mileage fractions λ_r, but rather the fractions l_r conditional on buying a car. Based on these observed conditional fractions, total sales for product jk can also be written as

$$q_{jk} = \sum_{i=1}^{R} l_i s_{rjk|B} \left(\beta_r^m\right) Q,$$

where $s_{rjk|B}\left(\beta_r^m\right) = s_{rjk}\left(\beta_i^m\right) / \sum_{j=1}^{J} \sum_k s_{rjk}\left(\beta_i^m\right)$ is the conditional probability that mileage type r chooses jk, conditional on buying a car. from equating the above two expressions, it follows that

$$\lambda_i = l_i \cdot (Q/I) / \sum_{j=1}^{J} \sum_k s_{rjk}\left(\beta_i^m\right),$$

where $Q = \sum_{j=1}^{J} \sum_k q_{jk}$. We use this to write all expressions in terms of the observed conditional mileage fractions.

A.4 Heterogeneity in fuel cost valuation for other reasons than mileage

Our base specification assumed that heterogeneity in fuel cost valuation only stems from heterogeneity in annual mileage. In one of our extension, RC Logit IV, we allow for additional heterogeneity in fuel cost valuation for other reasons. We add this heterogeneity based on survey evidence from Anderson, Kellogg and Sallee (2013). In section 8.3 and Table 9 of their paper, they report the relative importance of four components behind consumer heterogeneity in the valuation of fuel costs: annual mileage, local fuel prices, discount factors and fuel price forecasts. They use four different scenarios about future fuel prices and forecasts. They report that the variance in fuel cost valuation declines by 33%-42% under homogenous mileage, by 0.5%-1.2% without local fuel price variation, by 28%-51% with homogenous discounting and by 14%-60% with homogenous fuel price forecasts. Adding up the numbers for all components except annual mileage would crudely indicate that the variance of fuel cost valuation declines between 67% and 89% if there is only mileage heterogeneity. We use a conservative 85% to rescale the variance of the draws between sampled mileage types. Specifically, we increase the variance of fuel costs across sampled individuals by a factor of 6.6 (1/0.15) by adding additional independent and normally distributed draws to each mileage type.

We find that this lowers the estimated effectiveness of fuel taxes relative to product taxes. The reason for this is that we create heterogenous valuations such that low mileage consumers might have higher valuation for fuel costs than a high mileage consumer (e.g. because of an expected increase in fuel prices). This additional heterogeneity is uncorrelated to mileage and thus will shrink the difference in effectiveness of both taxes. (If consumers would only have normally distributed tastes for fuel costs and homogenous mileage we would find the equivalance result of the logit model again.) An important question for future research is therefore how and for what reasons consumers value usage costs differently, and to which extent these sources are correlated with mileage heterogeneity.

B Appendix B. Additional Tables

Table B.1: Alternative Instruments and First Stage

	Full Sample				Cost Sample					
	No IV		Sums IV		Cost IV I		Cost IV II		All IV's	
	Est.	St.Er.	Est.	St.Er.	Est.	St.Er.	Est.	St.Er.	Est.	St.Er.
Price/Inc. (α)	-0.03	0.03	-4.52	0.19	-4.03	0.25	-3.37	0.24	-3.89	0.16
Fuel Cost/Inc.	-53.90	1.02	-39.03	1.41	-42.67	1.37	-44.49	1.31	-43.06	1.25
Power	-7.18	0.29	2.28	0.14	2.11	0.18	1.65	0.17	2.01	0.12
Size	12.9	0.31	13.25	0.44	15.12	0.40	14.70	0.39	15.01	0.38
Height	2.56	0.23	3.00	0.30	4.12	0.28	3.89	0.27	4.07	0.28
Foreign	-1.06	0.02	-0.83	0.02	-0.88	0.02	-0.91	0.02	-0.89	0.02
Fuel Costs/Price ($\gamma\rho$)	-	-	8.63	0.55	10.60	0.89	13.21	1.18	11.08	0.66
Future Valuation γ	-	-	0.89	0.06	1.03	0.09	1.28	0.11	1.08	0.06
					First Stage - Excluded Instruments					
					Sums of all other vehicles' characteristics:					
Fuel Cost/Inc.			-1.23	0.11					-1.07	0.12
Power			-2.02	0.61					-1.18	0.74
Size			3.09	0.35					2.50	0.40
Height			3.66	3.14					5.63	3.17
# products			-2.24	0.51					-2.22	0.54
					Sums of own firm other vehicles characteristics:					
Fuel Cost/Inc.			2.72	0.43					2.56	0.44
Power			-2.80	0.39					-2.70	0.40
Size			8.65	1.84					7.89	1.81
Height			7.03	1.81					6.95	1.89
# products			-1.47	0.31					-1.41	0.32
					Cost Shifters					
Labor Costs					0.49	0.06	0.47	0.07	0.25	0.05
Local Prod.					-0.02	0.01	-0.02	0.01	-0.01	0.01
Steel Pr.							0.02	0.05	0.11	0.06
Weight*Steel Pr.							-0.05	0.05	-0.10	0.06
					Joint F Stat Exc.Instr. (p-val)					
			291	(0.0)	273	(0.0)	531	(0.0)	237	(0.0)

The table reports the parameter estimates for the demand parameters of the logit model (Panel I), the second panel gives first stage estimates for excluded instruments. Column I gives results for the OLS.

Column II replicates the logit model presented in the main paper. Columns III-V give results using a smaller sample (76,634 observations instead of 82,151) for which we obtained cost shifter instrument: labor costs, local production, steel prices and steel prices interacted with weight. Column III uses labor costs and local production. Column IV adds steel prices and their interaction with weight as instruments. Column V includes all cost shifters and the instrument set used in the main paper. Note that all regressions include model fixed effects, the cost shifters thus only vary when versions are produced in different plants, or when a model moves between production plants over time. Reported standard errors for the first stage estimates are clustered at the model level.

Table B.2: Parameter Estimates for Alternative Demand Models Part I

	Logit Av. FC		Logit Futures		Logit Eurostat		Logit Fuel F.E.	
	Est.	St.Err.	Est.	St.Err.	Est.	St.Err.	Est.	St.Err.
				Mean valuations				
Price/Inc. (α)	-2.90	0.17	-4.14	0.18	-4.19	0.22	-3.83	0.16
Fuel Costs/Inc. ($\alpha\gamma\rho$)			-44.16	1.21	-56.79	1.13	-32.49	1.25
Av. Fuel Cost ($\alpha\gamma\rho$)	-28.17	1.13						
Power (kW/100)	1.04	0.12	2.21	0.13	2.41	0.16	1.87	0.11
Size (cm^2/10,000)	14.64	0.35	15.40	0.37	15.34	0.37	15.02	0.36
Height (cm/100)	3.63	0.25	3.86	0.02	3.92	0.27	4.16	0.26
Foreign	-0.92	0.02	-0.85	0.02	-0.84	0.02	-0.87	0.02
				Valuations of Future Fuel Costs				
Fuel Costs/Price ($\gamma\rho$)	9.71	0.84	10.75	0.62	13.54	0.71	8.47	0.57
Future Valuation γ	1.00	0.09	1.11	0.06	1.39	0.07	0.82	0.06

The table reports the parameter estimates and standard errors for the different logit demand models. The Table presents similar results as Table 3 in the paper but with different definitions of fuel costs. In Logit Av. FC, we eliminate all variation in fuel prices over time and estimate the model with average fuel costs per market. In Logit Futures, we compute fuel costs by rescaling fuel spot prices by the percentage difference in crude oil spot price and the futures prices from NYMEX (we take an average of futures prices over 1 up to 15 years). In Logit Eurostat we change the mean mileage to the mean mileage reported by Eurostat per country. In Logit Fuel F.E. we add fuel type by model fixed effect. Each specification includes model, market/diesel and market/time controls. The total number of observations (combinations of model/engine/market) is 82,151, where markets refer to 7 countries and 14 years.

Table B.3: Parameter Estimates for Alternative Demand Models Part II

	RC Logit Eurostat		RC Logit III		RC Logit IV		RC Logit V	
	Est.	St.Err.	Est.	St.Err.	Est.	St.Err.	Est.	St.Err.
			Mean valuations					
Price/Inc. (α)	-5.96	0.25	-5.25	0.20	-5.91	0.20	-4.82	1.32
Fuel Costs/Inc. ($\alpha\gamma\rho$)	-48.10	1.82	40.59	6.27	-57.32	3.23	-	-
ρ_i*Fuel Costs/Inc. ($\alpha\gamma$)	-0.77	0.34	-	-	-	-	-4.61	1.27
Power (kW/100)	19.87	0.47	-0.68	1.50	-0.52	0.10	-2.27	1.06
Size (cm^2/10,000)	5.99	0.33	17.46	1.22	19.56	0.48	18.26	1.98
Height (cm/100)	-1.85	0.08	5.22	0.33	5.81	0.32	5.44	1.03
Foreign			-0.91	0.02	-1.14	0.04	-0.97	0.11
			Standard Deviations of valuations					
Power (kW/100)	2.67	0.10	2.33	0.07	2.56	0.06	2.98	0.91
Size (cm^2/10,000)	0.17	1.18	3.62	1.36	0.70	0.15	3.30	0.68
Foreign	4.74	0.26	0.21	0.36	3.04	0.24	0.47	2.30
Fuel type			1.65	0.40	-	-		
Mileage distribution	Recentered		Yes		Yes		Yes	
			Valuations of Future Fuel Costs					
Fuel Costs/Price ($\gamma\rho$)	8.08	0.41	7.74	1.35	9.71	0.51	-	-
Future Valuation γ ($r = 6\%$)	0.83	0.04	0.80	0.14	1.00	0.05	0.96	0.52

The table reports the parameter estimates and standard errors for the different RC logit demand models. The Table presents similar results as Table 3 in the paper but with different assumptions. In RC Logit Eurostat we introduce heterogeneous mileage, with Eurostat means and a rescaling of the UK mileage distribution around that mean. RC Logit III introduces a random coefficient on fuel type. RC Logit IV increases the variance of the mileage distribution across individuals. RC Logit V allows vehicle lifetime to depend on a consumer's annual mileage. Each specification includes model, market/diesel and market/time controls. The total number of observations (combinations of model/engine/market) is 82,151, where markets refer to 7 countries and 14 years.

Table B.4: Parameter Estimates for Alternative Demand Models Part II

	Implied γ	St.Err.	Implied γ	St.Err.
	$S = 10$		$S = 15$	
	Logit			
r = 0%	0.91	0.07	0.61	0.04
r= 3%	1.04	0.08	0.74	0.05
r= 6%	1.17	0.09	0.89	0.06
r = 10%	1.35	0.10	1.09	0.07
	RC Logit I - Mileage only			
r = 0%	0.79	0.03	0.53	0.02
r= 3%	0.90	0.03	0.64	0.02
r= 6%	1.01	0.04	0.77	0.02
r = 10%	1.17	0.04	0.95	0.03
	RC Logit II			
r = 0%	0.94	0.19	0.62	0.13
r= 3%	1.07	0.21	0.76	0.15
r= 6%	1.20	0.24	0.91	0.18
r = 10%	1.39	0.28	1.12	0.22
	RC Logit III on fuel type			
r = 0%	0.82	0.14	0.55	0.10
r= 3%	0.93	0.16	0.67	0.12
r= 6%	1.05	0.18	0.80	0.14
r = 10%	1.21	0.21	0.98	0.17
	RC Logit IV - Add noise on fuel cost			
r = 0%	1.03	0.05	0.69	0.04
r= 3%	1.17	0.06	0.84	0.04
r= 6%	1.32	0.07	1.00	0.05
r = 10%	1.52	0.08	1.23	0.06

The table reports implied attention weights γ for different estimates and varying assumptions for the interest rate r and vehicle lifetime S.

Table B.5: Parameter Estimates Country by Country

	Belgium		France		Germany		Great Britain	
	Estimate	St.Error	Estimate	St.Error	Estimate	St.Error	Estimate	St.Error
			Mean valuations					
Price/Inc.	-6.62	0.53	-4.47	0.56	-6.13	0.75	-4.00	0.31
Fuel Costs/Inc.	-23.2	3.53	-43.49	2.94	-86.74	3.20	-26.53	2.41
Power (kW/100)	2.95	0.36	2.70	0.41	4.01	0.54	1.19	0.17
Size (cm^2/10,000)	8.55	0.69	6.66	0.83	1.37	0.09	0.79	0.08
Height (cm/100)	2.37	0.71	3.49	0.66	3.72	0.69	2.08	0.62
	Italy		Netherlands		Spain			
Price/Inc.	-9.43	0.80	-6.8	0.41	-2.19	0.30		
Fuel Costs/Inc.	-51.06	3.75	-44.24	3.77	-56.16	2.84		
Power (kW/100)	6.77	0.62	3.84	0.31	1.47	0.29		
Size (cm^2/10,000)	2.22	0.13	1.66	0.10	2.92	0.95		
Height (cm/100)	39.2	0.91	4.19	0.70	9.09	0.78		

The table reports the results from estimating logit models per country, parallel to the logit model for all countries reported in Table 3 in the paper.

Table B.6: The Effect of a Fuel Tax and a Product Tax on Market Shares by Fuel Consumption Quartile

		$\gamma = 0.50$		$\gamma = 0.91$		$\gamma = 1.00$	
Change in Market Share	Current	% Point	€ Δp	% Point	€ Δp	% Point	€ Δp
				Fuel Tax			
Tax per liter		€0.50		€0.50		€0.50	
Fuel Consumption Q1 (lowest)	37	1.4	0	2.1	0	2.4	0
Fuel Consumption Q2	37	-0.2	0	-0.4	0	-0.5	0
Fuel Consumption Q3	20	-0.6	0	-0.9	0	-1.1	0
Fuel Consumption Q4 (highest)	6	-0.6	0	-0.7	0	-0.8	0
				Revenue Equivalent Product Tax			
Tax per liter/100km		€834		€700		€663	
Fuel Consumption Q1 (lowest)	37	3.6	0	3.1	0	2.9	0
Fuel Consumption Q2	37	-0.3	0	-0.4	0	-0.5	0
Fuel Consumption Q3	20	-1.6	0	-1.4	0	-1.4	0
Fuel Consumption Q4 (highest)	6	-1.7	0	-1.2	0	-1.1	0

The table reports the same results as in Table 4 for full pass through (we do not let firms change prices in response to the tax).

Table B.7: The Effect of a Fuel Tax and a Product Tax on Fuel Consumption and Fuel Usage ($\gamma = 0.5$)

	Outside Good % Point Change	Fuel Consumption % Change	Fuel Usage % Change
		Logit	
Fuel Tax	7.19	-1.45	-12.01
Revenue Eq. Product Tax	18.71	-3.37	-30.33
		RC Logit I - Mileage Only	
Fuel Tax	10.89	-0.77	-29.07
Revenue Eq. Product Tax	17.74	-3.17	-36.08
		RC Logit II	
Fuel Tax	4.12	-0.77	-12.01
Revenue Eq. Product Tax	7.09	-2.08	-15.21
		RC Logit III - Extra RC on fuel cost	
Fuel Tax	3.98	-0.79	-10.43
Revenue Eq. Product Tax	8.00	-1.86	-15.65
		RC Logit IV - Extra heterog. in fuel cost	
Fuel Tax	3.05	-0.99	-6.11
Revenue Eq. Product Tax	6.29	-2.18	-11.39
		RC Logit V - Lifetime varies with miles	
Fuel Tax	3.45	-0.74	-7.70
Revenue Eq. Product Tax	7.18	-1.61	-13.26

The table reports the effect of a 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 estimates in Table 3 and Table B.3. In each model we set $\gamma = 0.5$, so there is no variation in undervaluation across the different models. The figures refer to Germany in 2011.

Table B.8: The Effect of a Fuel Tax on Gasoline and Diesel Separately

	Fuel Usage			Diesel Share
	All cars	Gasoline cars	Diesel cars	
	% Change	% Change	% Change	% Point Change
Fuel Tax, Gasoline only	-9.9	-33.2	17.1	10.0
Fuel Tax, Diesel only	-3.5	17.5	-27.8	-8.0
Fuel Tax, both Gas. and Diesel	-15.9	-20.7	-10.3	2.4

The table reports the effect of a discriminatory fuel tax for gasoline and diesel cars on total fuel usage as in Table 6 but simulations are based on the parameter estimates of RC Logit III in Table B.3. The figures refer to Germany in 2011.

Table B.9: Explaining the Diesel Market Shares Across Countries

	Current Situation			Change in Diesel Share: Equalization of		
	Fuel price gap	Fuel Cons. Gap	Diesel Share	Fuel Price	Fuel Cons.	Both
			Year 1998			
Belgium	-0.25	-1.91	52%	-7%	-7%	-14%
France	-0.26	-2.04	38%	-8%	-7%	-14%
Germany	-0.22	-2.35	15%	-3%	-4%	-7%
Great Britain	0.00	-2.24	15%	0%	-4%	-4%
Italy	-0.19	-2.08	21%	-4%	-5%	-9%
Netherlands	-0.29	-2.12	21%	-6%	-5%	-10%
Spain	-0.11	-1.85	51%	-5%	-8%	-14%
			Year 2011			
Belgium	-0.24	-2.01	75%	-2%	-7%	-9%
France	-0.19	-1.81	69%	-2%	-8%	-10%
Germany	-0.16	-2.23	46%	-3%	-10%	-12%
Great Britain	0.04	-2.04	50%	1%	-9%	-8%
Italy	-0.13	-2.05	56%	-2%	-10%	-12%
Netherlands	-0.28	-2.22	30%	-3%	-7%	-10%
Spain	-0.07	-2.08	69%	-1%	-9%	-11%

The table reports: (i) in the first three columns, the currently observed gaps in fuel prices and fuel consumption between gasoline and diesel cars, and the diesel market shares in the seven countries of our dataset in 1998 (upper panel) and 2011 (lower panel); in the last three columns, how the diesel market share would change if the fuel price gap and fuel consumption gap were eliminated. The simulations are based on the parameter estimates of RC Logit III in Table B.3.