The Effect of Public Policies on Consumers' Preferences. Lessons from the French automobile market.

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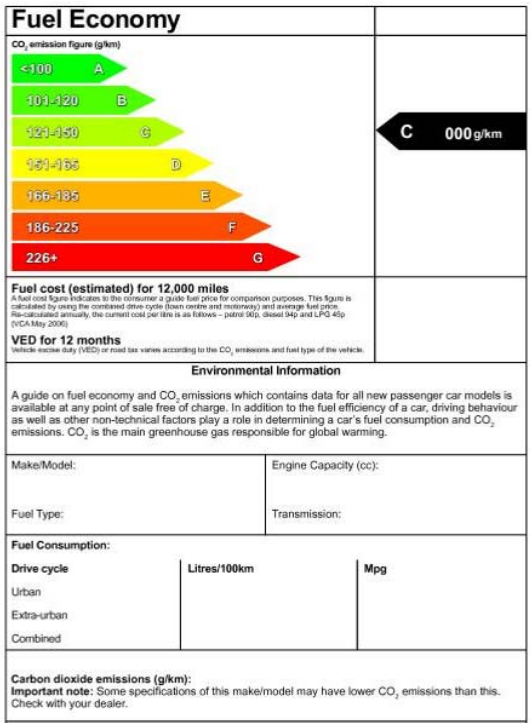
CREST

Introduction : environmental regulation

Automobile transportation = 20% CO_2 emissions in 2009

Two environmental policies in the 2000's :

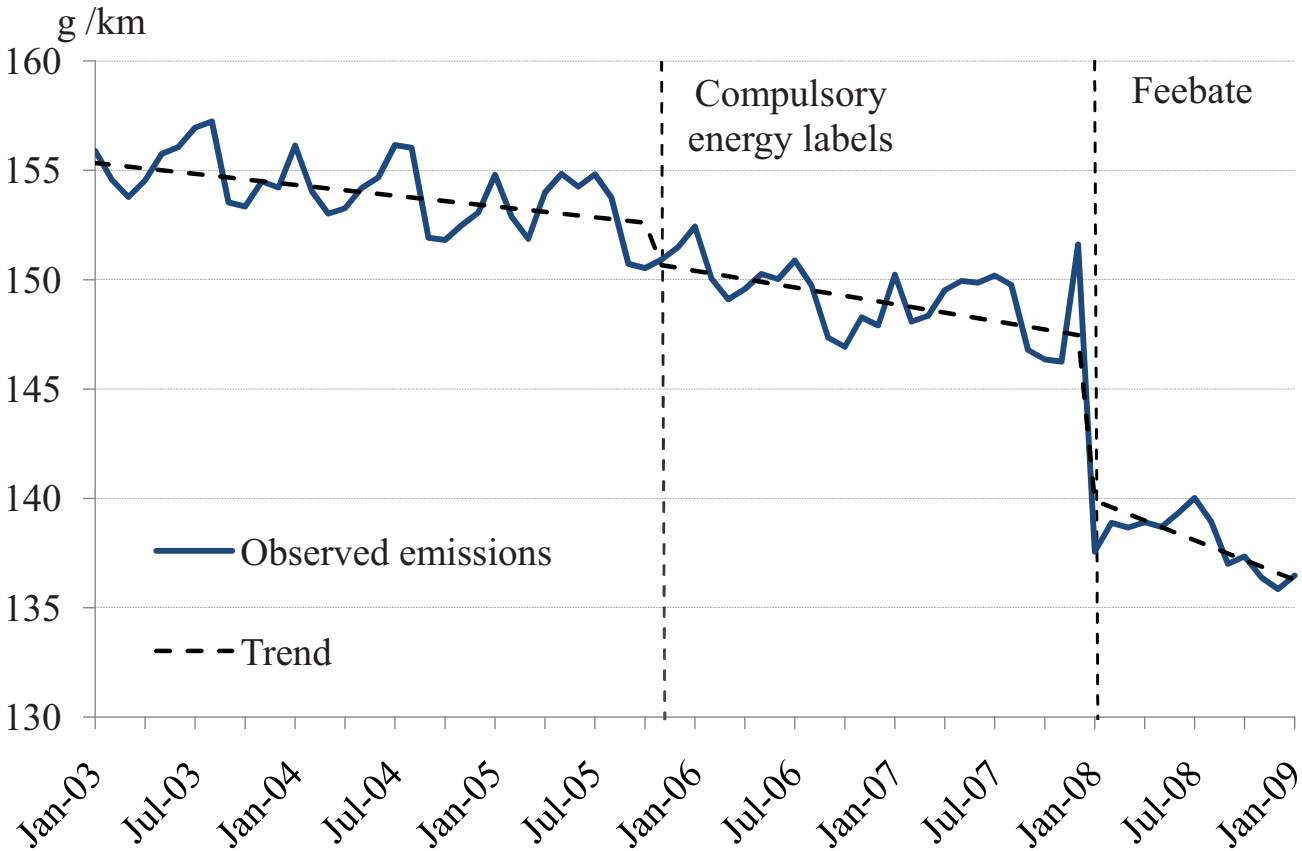
Compulsory energy label, November 2005



Bonus/penalty policy, January 2008 :

Class of emissions	Emissions (in g/km)	Bonus/ penalty
A	(60-100]	+1000€
B	(100-120]	+700€
C+	(120-130]	+200€
C-	(130-140]	0€
D	(140-160]	0€
E+	(160-165]	-200€
E-	(165-200]	-750€
F	(200-250]	-1600€
G	> 250	-2600€

CO_2 EMISSIONS OF NEW VEHICLES PURCHASED



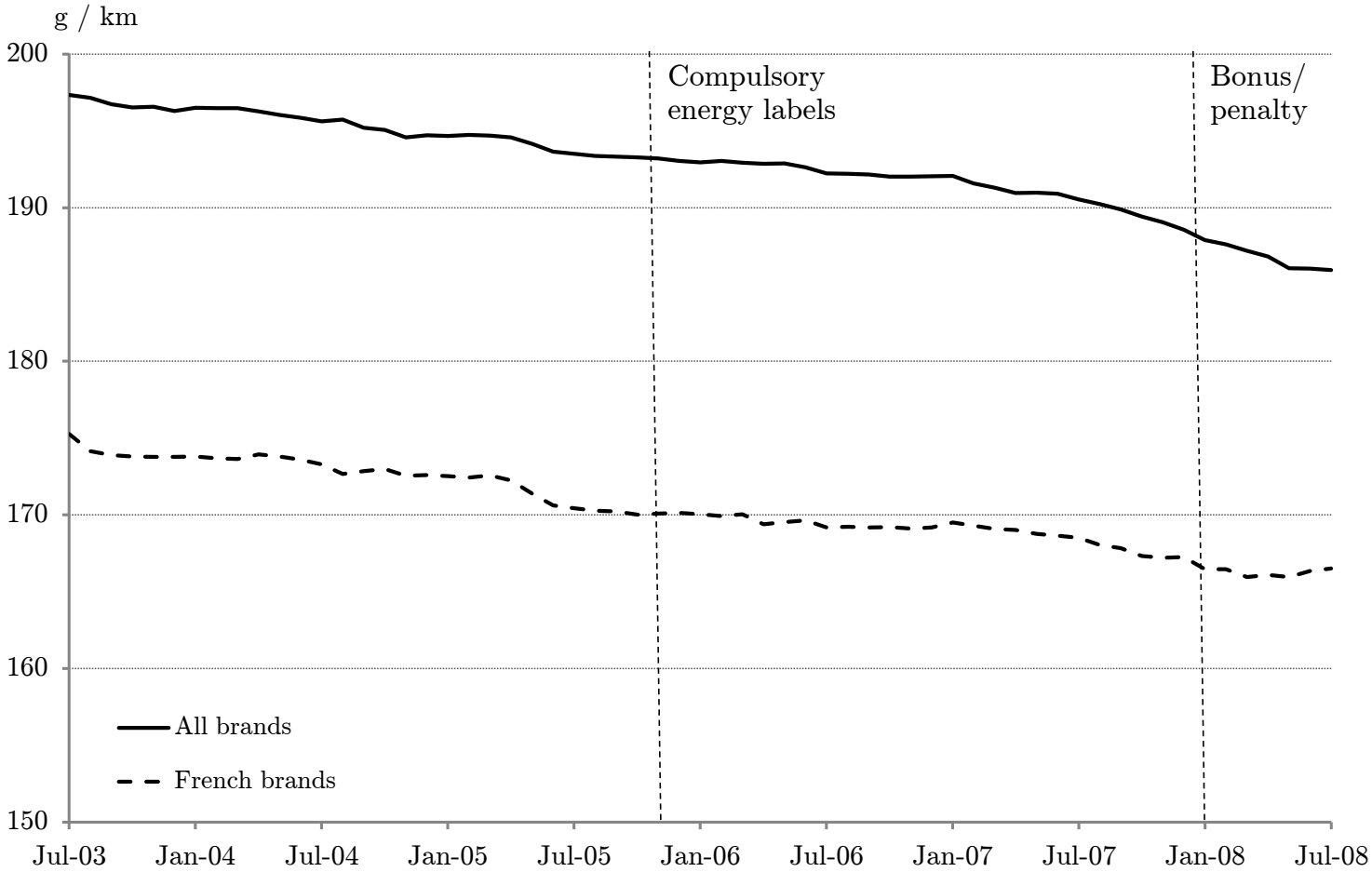
General decreasing trend + shifts after environmental policies

Potential explanations ?

...difficult to rationalize with the monetary effect of the feebate only :

Class of emissions	CO_2 emissions	Malus	Market shares 2007	Market shares 2008	Mean price	Average ratio |malus|/price
B	[101,120]	-700€	19.9%	38.4%	15,647€	4.7%
E+	[160,165]	+200€	2.9%	2.0%	20,172€	1.2%
E-	[166,200]	+750€	15.1%	7.8%	29,910€	2.8%

CO_2 EMISSIONS OF VEHICLES SUPPLIED



Technical progress but no adjustment after policies

Explanations

Decrease of CO_2 emissions related to :

1. Supply-side effects :
   - Technical progress
   - No immediate reaction to the feebate policy :
     Bonus/penalty announced two months before its application
     Certification of new vehicles is a long process
     Conducted at French level only
2. Demand-side effects :
   - Monetary incentive effect of the bonus/penalty policy
   - Reaction to evolution of gasoline prices
   - **Shift in environmental preference**

$\Rightarrow$ Our approach allows to disentangle these effects

Main question

Does (a growing) environmental concern appear through purchases of new cars between 2003 and 2008 ?
We estimate the preference for environmental quality of vehicles
Effects on the evolution of CO_2 emissions

Main results :

- Difficult to estimate *per se* preference for environmental attribute...
- ...But possible to estimate **the evolution** of this preference
- Positive and significant evolution of this preference, in line with the timing of the environmental policies

- WTP increased by 536€ between 2003 and 2008 (in average)
- 20% decrease of CO_2 emissions explained by shifts in environmental preferences

Assessment of environmental preference

Estimate a structural model of demand for automobile that incorporates environmental attribute, from market-level data
Utility function is modeled and its parameters are estimated

Traditional approaches in environmental valuation :

- Contingent analysis : Brownstone & al. (2000), Kishi & Satoh (2005)
- Conjoint analysis : Potoglou & Kanaroglou (2007)
  Based on stated preferences, problem of hypothetical bias
- Hedonic pricing : difficult to apply to automobile market

Our approach relies on a structural model estimated with market data (revealed preferences)

Description of the data

Source : CCFA (Comité des Constructeurs Français d'Automobile)
Purchases of new cars by French households between Jan. 2003 and Jan. 2009, monthly and by department
Characteristics of the cars :

- Brand, model, CO_2 emissions, horsepower, weight, nb of seats, type of gas, nb of doors
- Prices : retail prices

Some individual characteristics :

- Precise town
- Age
- Income (approximated)

Outline

Discrete-choice model of demand

Berry (1994), Berry & al. (1995) : Nested Logit and Random coefficients models

Our strategy : Nested Logit with observed heterogeneity

- Cars are nested into homogenous groups
- Each consumer purchases one car within the set available or chooses not to buy any **(outside option)**
- Consumers have preferences for vehicles attributes **and** environmental quality : the utility is linearly dependant on attributes
- Consumers with same demographic characteristics have same preferences

Nested logit model

Utility of consumer i, with demographic characteristics d purchasing good k

Utility function :

$$\begin{aligned} U_{ik}^{d} &= -\beta^{d} p_k + \gamma^{d} X_k + \xi_k^{d} + \zeta_{ig}^{d} + (1-\sigma^{d})\varepsilon_{ik}^{d} \\ &= \delta_k^{d} + \zeta_{ig}^{d} + (1-\sigma^{d})\varepsilon_{ik}^{d} \end{aligned}$$

X_k and ξ_k : observable and unobservable characteristics
ζ_{ig} : group-specific error term
ε_{ik} : product-specific error term, iid following an E.V distribution
Property : $\zeta_{ig}^{d} + (1-\sigma^{d})\varepsilon_{ik}^{d} \sim$ *E.V. distribution so that :*

$$s_k^{d} = \frac{\exp^{\delta_k^{d}/(1-\sigma^{d})}}{D_g^{d(\sigma)} \times \sum_{g'=0}^{G} D_{g'}^{(1-\sigma^{d})}} \quad with : D_g^{d} = \sum_{j \in \mathcal{J}_g} \exp^{\delta_j^{d}/(1-\sigma^{d})}$$

Interpretation of σ^{d} : intra-group correlation $\in [0,1]$
β^{d} represents the price sensitivity, must be positive

Reduced form

Normalisation : $\delta_0^d = 0$

Equation to estimate

$$\ln s_k^d - \ln s_0^d = -\beta^d p_k + \gamma^d X_k + \sigma^d \ln \bar{s}_{k/g}^d + \xi_k^d$$

Estimation technique : linear model, **IV method**
Endogenous variables : price and intra-group market-share

Identification strategy : existence of instruments

- Correlated with $\bar{s}_{k/g}^d$, p_k but uncorrelated with ξ_k^d
- As usual : functions of other products characteristics

Specification of utility

Control variables (X_k) :

- Continuous characteristics : Price (net feebate), horsepower, weight, km/€ (monetary variables in euro 2008)
- Discrete characteristics : Car body style, fuel type, number of doors
- Fixed effects : model, time

Environmental characteristic : CO_2 emissions, CO_2 emissions $\times$ years

Definition of 18 demographic groups :

- Age class ([18-29], [30-59], [$\geq$60])
- Income class ([0-22 000], [22 000-32 000], [$\geq$ 32 000])
- Rural area vs. urban area

Restrictions imposed on parameters :

- Same intra-group variance : $\sigma_d = \sigma \quad \forall d$
- Parameters linear in each demographic component

Outline

Estimation of preferences parameters

Estimated parameters of preference for vehicle attributes (bases and deviations) :

	Base	Urban	Age$\in$[40 ;59]	Age$\geq$ 60	Medium income	High income
Price	0.144**	-0.017**	-0.042**	-0.069**	-0.010*	-0.030**
Weight	0.157**	-0.009	-0.037**	-0.116**	0.002	-0.016
Horsepower	0.154**	-0.024*	-0.130**	-0.239**	-0.018	-0.052**
Km/€	0.047**	-0.007	-0.042**	-0.072**	-0.010	-0.027**
Cylinder capacity	0.045**	-0.003	-0.003	0.016**	-0.003	-0.010**
Station-wagon	-0.404**	-0.060**	-0.004	-0.083**	0.015	0.043*
3 doors	-0.204**	0.002	-0.132**	-0.465**	-0.056**	-0.083**
Diesel	0.537**	-0.335**	0.142**	-0.171**	0.081*	0.002

Concl. :

Expected signs of parameters and significant heterogeneity

$\hat{\sigma} \simeq 0.3$: nested logit relevant model

Average price-elasticity in the population : $\bar{\eta}$ =-3.14

Environmental valuation

Variable	(1)	(2)	(3)
CO_2 emissions	-0.931^{**} (0.041)	-0.951^{**} (0.042)	-0.936^{**} (0.042)
CO_2 emissions$\times$Trend	-0.102^{**} (0.006)	-	-
CO_2 emissions$\times$2004	-	-0.010 (0.024)	-0.062^{*} (0.025)
CO_2 emissions$\times$2005	-	-0.163^{**} (0.042)	-
CO_2 emissions$\times$2006	-	-0.249^{**} (0.036)	-
CO_2 emissions$\times$2007	-	-0.190^{**} (0.041)	-
CO_2 emissions$\times$2008	-	-0.410^{**} (0.028)	-0.424^{**} (0.028)
CO_2 emissions$\times$(2005-2007)	-	-	-0.244^{**} (0.038)

(1) : Trend significant

(2) : Significant evolution of environmental preference from 2005

(3) : Two shifts in environmental preference, 2005-2007 and 2008

CO_2 variable not interpreted, may reflect unobservables...

Environmental valuation

		Rural area			Urban area		
Income/Age		18-39	40-59	$\geq$ 60	18-39	40-59	$\geq$ 60
0-22,000	2005-07	-0.44^{**} (0.06)	-0.23^{**} (0.06)	-0.07 (0.06)	-0.41^{**} (0.06)	-0.19^{**} (0.06)	-0.04 (0.06)
	2008	-0.55^{**} (0.07)	-0.31^{**} (0.07)	-0.20^{**} (0.07)	-0.54^{**} (0.07)	-0.30^{**} (0.07)	-0.19^{**} (0.07)
22,000-32,000	2005-07	-0.42^{**} (0.06)	-0.21^{**} (0.06)	-0.05 (0.06)	-0.38^{**} (0.06)	-0.17^{**} (0.06)	-0.01 (0.06)
	2008	-0.61^{**} (0.06)	-0.36^{**} (0.06)	-0.26^{**} (0.06)	-0.60^{**} (0.06)	-0.35^{**} (0.06)	-0.25^{**} (0.06)
$\geq$ 32,000	2005-07	-0.44^{**} (0.06)	-0.23^{**} (0.06)	-0.07 (0.06)	-0.41^{**} (0.06)	-0.19^{**} (0.06)	-0.04 (0.06)
	2008	-0.69^{**} (0.06)	-0.45^{**} (0.06)	-0.34^{**} (0.06)	-0.68^{**} (0.06)	-0.44^{**} (0.06)	-0.33^{**} (0.06)

Young people value more the environment. In 2008, everyone is more concerned by the environment than before.

Evolution of willingness to pay

$$WTP^d = -\frac{\gamma^d_{CO2}}{\beta^d}$$

		Rural area			Urban area		
Income/Age		18-39	40-59	≥ 60	18-39	40-59	≥ 60
0-22,000	2005-07	308 (35)	226 (48)	98 (73)	322 (39)	230 (58)	65 (97)
	2008	382 (54)	301 (65)	265 (92)	426 (57)	350 (78)	327 (125)
22,000-32,000	2005-07	312 (37)	223 (49)	74 (81)	327 (41)	227 (60)	25 (114)
	2008	453 (53)	396 (66)	395 (92)	511 (57)	473 (78)	516 (125)
$\geq$ 32,000	2005-07	389 (46)	321 (65)	162 (115)	422 (53)	357 (85)	134 (186)
	2008	611 (66)	630 (91)	772 (140)	709 (74)	811 (116)	1,225 (220)

Average variations in WTP (for a 10g reduction of CO_2 emissions) :
235€ in 2005-2007
536€ in 2008

What if preferences did not change ?

Year	Observed	No shift
2003	152.6	152.6
2004	151.2	151.2
2005	150.1	152.6
2006	146.5	148.9
2007	146.2	148.3
2008	136.6	139.9

Simulation of average CO_2 emissions : decrease by 12.7g

- Technical progress (4.3g in 4 years) $\simeq$ 1.1g/year
- Monetary incentive of the feebate in 2008 (7.3g)

Concl. : The 16g decrease between 2003 and 2008 can be explained by :

- Technical progress (5.5g, 34%)
- Monetary incentive (7.3g, 46%)
- Shift in environmental preference (3.3g, 20%)

Outline

What about company cars purchases ?

	Passenger cars		Company cars	
Price	-0.117**	(0.015)	-0.064**	(0.016)
Price × urban	0.029**	(0.003)	-0.015*	(0.007)
ln($\bar{s}$) (σ)	0.265**	(0.011)	0.292**	(0.023)
Weight	0.132	(0.018)	0.126**	(0.031)
Horsepower	0.055*	(0.023)	-0.033	(0.024)
Km/€	-0.005	(0.004)	-0.025*	(0.012)
Cylinder capacity	0.048**	(0.003)	0.047**	(0.008)
Station wagon car-body	-0.428**	(0.016)	-0.202**	(0.045)
Coupe/convertible	-0.265**	(0.052)	-0.599**	(0.083)
3 doors	-0.471**	(0.015)	-0.668**	(0.047)
Diesel	0.604**	(0.039)	1.04**	(0.090)
CO_2 emissions	-0.923**	(0.046)	-0.765**	(0.189)
CO_2 × (2005-2007)	-0.258**	(0.045)	0.070	(0.065)
CO_2 × 2008	-0.407**	(0.018)	0.149	(0.106)
Nb. of observations	100 877		13 869	

Concl. : No significant preference for environmental quality from company

What about preference for emission classes ?

Another variable to assess environmental preference

"Positive classes"			"Negative classes"		
A ×(2004)	-0.028	(0.22)	E+ ×(2004)	0.119**	(0.041)
A ×(2005-2007)	0.015	(0.180)	E+ ×(2005-2007)	-0.064†	(0.034)
A ×(2008)	0.793**	(0.171)	E+ ×(2008)	-0.228**	(0.040)
B ×(2004)	0.004	(0.052)	E- ×(2004)	-0.123**	(0.029)
B ×(2005-2007)	0.366**	(0.044)	E- ×(2005-2007)	-0.189**	(0.024)
B ×(2008)	1.08**	(0.049)	E- ×(2008)	-0.234**	(0.029)
C+ ×(2004)	0.115*	(0.051)	F ×(2004)	0.015	(0.031)
C+ ×(2005-2007)	0.480**	(0.044)	F ×(2005-2007)	-0.082**	(0.030)
C+ ×(2008)	0.614**	(0.048)	F ×(2008)	-0.171**	(0.059)
C- ×(2004)	0.165**	(0.042)	G ×(2004)	0.058	(0.039)
C- ×(2005-2007)	0.001	(0.034)	G ×(2005-2007)	-0.005	(0.055)
C- ×(2008)	0.102**	(0.038)	G ×(2008)	0.194**	(0.051)

Concl. : Increase in valuation of "positive classes"
Decrease in valuation of "negative classes"
Robust to the introduction of characteristics × Trend

Correlation to electoral results

Correlation of WTP to 2007 election results across towns

	Votes	ΔWTP 2005-07	ΔWTP 2008
Green politics (Voynet)	1.57%	694.3** (44.2)	1820** (100)
Left	34.85%	−202.7** (8.60)	−718.3** (19.5)
Centrism (Bayrou)	18.61%	Ref.	Ref.
Right	44.98 %	−58.79** (8.30)	−318.5** (18.8)
Constant	-	294.1** (6.72)	876.3** (15.3)
Nb. of observations	29,967		

Concl. : Interpretation as environmental preference

Conclusion

Main results :

- Evidence of a growing environmental concern
- Likely related to environmental policies
- Suggests that besides incentive effects, feebate policy shifted environmental preferences

Question about predictability of policy effects ?