Traveled Distance, Stock and Fuel Efficiency of Private Vehicles in Canada: Price Elasticities and Rebound Effect

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Climate changes, Oil price, foreign dependancy

Policies to reduce gasoline demand

Vehicle Fuel Economy

- US: new CAFE (2007)
- Japan: +20% by 2015
- Europe: 130 gr CO2/km by 2012

Taxes

Rebound effect: 20%

10% 2%

↑Fuel Economy → ↓Operating Costs → ↑ Driving

→ Limit Fuel Saving & increase trafic externalities

8%

In this paper

- Evaluate the rebound effect in Canada + price and income elasticities of gasoline determinants
- Huge literature but:
  - 1. Few Canadian evidence
  - 2. Recent data
  - 3. Simultaneous analysis of DISTANCE, STOCK and FUEL RATING

Methodology

- Short panel: 10 provinces/ 1990-2004 (NRCan)
- Based on Small and Van Dender (2007) EJ
- System of three equations:

Distance

$$\ln(KA_{it}) = \alpha_0 + \alpha_1 \ln(KA_{i,t-1}) + \alpha_2 \ln(SA_{it}) + \alpha_3 \ln(PKM_{it})$$
$$+ \alpha_4 \ln(GDP_{it}) + \alpha_5 Urban_{it} + \alpha_6 Trend_t + \alpha_i + \varepsilon 1_{it}$$

Stock

$$\ln(SA_{it}) = \beta_0 + \beta_1 \ln(SA_{i,t-1}) + \beta_2 \ln(KA_{it}) + \beta_3 \ln(PKM_{it}) + \beta_4 \ln(PV_{it})$$
$$+ \beta_5 \ln(GDP_{it}) + \beta_6 Urban_{it} + \beta_7 Trend_t + \beta_i + \varepsilon 2_{it}$$

Fuel rate

$$\ln(CR_{it}) = \gamma_0 + \gamma_1 \ln(CR_{i,t-1}) + \gamma_2 \ln(KA_{it}) + \gamma_3 \ln(GPI_{it})$$
$$+ \gamma_4 \ln(GDP_{it}) + \gamma_5 Urban_{it} + \gamma_6 Trend_t + \gamma_i + \varepsilon 2_{it}$$

Estimation issues

- Fixed-effects + dynamics
- Endogenous explanatory variables
- Serial correlation
- ➔ Partial information FE/2SLS

Table 2: Results For Equation 1, Travel Kilometers per Adult (KA)

Variable	Estimated Using FE		Estimated Using FE-2SLS	
KA_{t-1}	0.5239***	(0.0781)	0.5711***	(0.1514)
SA	0.0354	(0.0646)	0.1692	(0.2339)
PKM	-0.0800**	(0.0410)	-0.0802*	(0.0431)
GDP	0.1318*	(0.0745)	0.0716	(0.1274)
Urban	-0.0001	(0.0032)	0.0004	(0.0035)
Trend	-0.0022	(0.0023)	-0.0012	(0.0031)
NL	0.043	(0.0836)	0.0231	(0.0933)
PEI	0.2242	(0.1819)	0.1758	(0.2025)
NS	0.1873***	(0.0660)	0.1461	(0.0987)
NB	0.1704	(0.1294)	0.1247	(0.1525)
QC	0.0334	(0.0358)	-0.0031	(0.0722)
ON	0.0632	(0.0532)	0.0265	(0.0860)
MB	0.0343	(0.0211)	0.0071	(0.0509)
SK	0.045	(0.0543)	0.0202	(0.0701)
AB	0.0638	(0.0310)	0.0425	(0.0514)
BC (reference)	--	--	--	--
Constant	7.801*	(4.3260)	5.8890	(5.6270)
No. of obs.	130		130	
Adjusted R^2	0.94		0.96	
Tests:	H_0: α_i=0, $\forall i$ F(9,114)=3.49		H_0: αi=0, $\forall i$ F(9,114)=1.60	

Hubber/White standard error in parenthesis robust to heteroskedasticity and within province correlation of the error terms.
NL - Newfoundland, *PEI* - Price Edward Island, *NS* - Nova Scotia, *NB* - New Brunswick, *QC* - Quebec, *ON* - Ontario, *MB* - Manitoba, *SK*- Saskatchewan, *AB* - Alberta, *BC* - British Columbia
*: Statistically significant at 10%,
**: Statistically significant at 5%,
***: Statistically significant at 1%

Table 3: Results for Equation 2, Vehicle Stock per Adult (SA)

Variable	Estimated Using FE		Estimated Using FE-2SLS	
SA_{t-1}	0.2711***	(0.0871)	0.1598	(0.2458)
KA	-0.0542	(0.1200)	-0.2378	(0.2300)
PKM	-0.0082	(0.0724)	-0.0556	(0.0867)
GDP	0.2847***	(0.1044)	0.3466***	(0.1313)
PVI	-0.0564	(0.1006)	-0.1289	(0.1319)
Urban	-0.0009	(0.0045)	-0.0028	(0.0051)
Trend	-0.0031	(0.0049)	-0.0018	(0.0052)
NL	0.1531	(0.1210)	0.1366	(0.1243)
PEI	0.2984	(0.2613)	0.3210	(0.2661)
NS	0.1864*	(0.0960)	0.2422**	(0.1151)
NB	0.2642	(0.1856)	0.2935	(0.1916)
QC	0.1662***	(0.0503)	0.2126**	(0.0835)
ON	0.1346*	(0.0775)	0.2063*	(0.1178)
MB	0.1339***	(0.0302)	0.1706***	(0.0577)
SK	0.1625**	(0.0759)	0.1812**	(0.0851)
AB	0.0734	(0.0487)	0.1279	(0.0793)
BC (reference)	--	--		
Constant	3.775	(8.6640)	2.5917	(8.9587)
No. of obs.	130		130	
Adjusted R^2	0.82		0.84	
Tests:	$H_0 : \alpha_i=0, \forall i$		$H_0 : \alpha_i=0, \forall i$	
	F(9,113)=5.19		F(9,113)=1.56	

Hubber/White standard error in parenthesis robust to heteroskedasticity and within province correlation of the error terms.
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***: Statistically significant at 1%

Table 4: Results for Equation 3, Average Fuel Consumption Rate (CR)

Variable	Estimated Using FE		Estimated Using FE-2SLS	
$CR_{i,t-1}$	0.6791***	(0.0473)	0.6722***	(0.0686)
KA	-0.0821***	(0.0226)	-0.1764***	(0.0407)
GPI	-0.0285**	(0.0122)	-0.0380***	(0.0135)
GDP	-0.0205	(0.0203)	0.0045	(0.2340)
Urban	-0.0014	(0.0009)	-0.0020*	(0.0010)
Trend	0.0030***	(0.0006)	0.0026***	(0.0007)
NL	-0.0372	(0.0244)	-0.0405	(0.0269)
PEI	-0.0563	(0.0534)	-0.0374	(0.0590)
NS	-0.0421*	(0.0193)	-0.0118	(0.0231)
NB	-0.0570	(0.0375)	-0.0402	(0.0412)
QC	0.0144	(0.0090)	0.0256**	(0.0105)
ON	0.0422***	(0.0143)	0.0627***	(0.0170)
MB	0.0267***	(0.0058)	0.0348***	(0.0076)
SK	0.0201	(0.0175)	0.0201	(0.0210)
AB	0.0487***	(0.0088)	0.0647***	(0.0113)
BC (reference)	--	--		--
Constant	-5.6710***	(1.2090)	-4.0694***	(1.4156)
No. of obs.	130		130	
Adjusted R^2	0.98		0.98	
Tests:	$H_0 : \alpha_i=0, \forall i$ F(9,114)=6.45		$H_0 : \alpha_i=0, \forall i$ F(9,114)=5.09	

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***: Statistically significant at 1%

	Literature	Canadian evidence	SVDD 66-01 (97-01)	This paper
Rebound				
ST	10%	20-30%	4% (2%)	8%
LT	30%	na	22% (10%)	20%
Gasoline price elasticity				
ST	-0.2	-0.3	-0.08 (-0.06)	-0.1 (80% ΔKA)
LT	-0.6	-0.9	-0.4 (-0.3)	-0.3 (60% ΔKA)

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Table: Elasticities (ste)

Elasticity		Price	Income
DISTANCE	**Short term**	**-0.08*** **(0.04)**	**0.07** **(0.12)**
	Long term	**-0.18*** **(0.10)**	**0.16** **(0.26)**
STOCK	**Short term**	**-0.05** **(0.08)**	**0.34*** **(0.13)**
	Long term	**-0.06** **(0.09)**	**0.41*** **(0.13)**
FUEL RATE	**Short term**	**-0.03*** **(0.01)**	**0.004** **(0.23)**
	Long term	**-0.11*** **(0.05)**	**0.013** **(0.07)**

Conclusion

- Gasoline demand inelastic in Canada
- Drivers mostly react to gasoline price by driving less.
- Some rebound effect to be expected but limited.
- Some indications of a decline in price elasticities (need to be confirmed)