Gasoline price volatility and vehicle choice: the case for an adjustable carbon tax

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Environmental taxation

Reducing emissions from private transportation

- Promoting the diffusion of electric vehicles
- Efficiency of the internal combustion vehicle fleet

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1. Carbon pricing is the most cost-effective policy approach for making cars greener (Anderson and Sallee, 2016).
2. Use of carbon pricing is limited by political constraints (Jenkins and Karplus, 2016). Thus, carbon pricing and other approaches, notably efficiency standards, coexist.

This paper

- We find evidence of negative effects of gasoline price volatility on the choice of efficient cars (high gasoline price volatility induces consumers to buy **less** efficient cars)
- We propose an adjustable gasoline tax (AGT) on gasoline as an effective instrument for promoting green cars, at no expected extra cost in terms of social acceptance.

Existing literature

Standard optimal carbon pricing: just set the carbon tax equal to the Marginal Social Cost of Carbon (MSCC) (Parry and Small, 2005).

Possible problems

- If the gasoline price **decreases**: this potentially offsets the effect of a gasoline tax
- If the gasoline price **increases**: tax gets unpopular, very difficult for policy makers to commit keeping it in place

Existing literature: MPG and other attributes

1. Marketing literature: multi-attribute utility functions to model car's features (Abbas, 2010)
2. Difficult to take into account the interaction between the characteristics of the same vehicle. MPG is not known with certainty as it depends on the gasoline price.
3. Anderson et. al. (2013) estimate the following equation:

$$u_{ijt} = -\alpha p_{ijt} - \gamma E_{it}[\sum_{s=0}^{T}(1+r_i)^{-s} g_{t+s} m_{ij,t+s} MPG_j] + \beta X_j + \xi_j + \epsilon_{ijt}$$

   - The expected value of the gasoline price is related to MPG
   - They do not consider the effects of price variation
   - The interaction between attributes (namely, MPG and power) is not taken into account

Existing literature: volatility, prices and taxes

- There are few studies on the effects of price volatility on consumer's choice of durable goods.
  1. Backer (2013) studies how uncertainty impacts on the consumer decision of buying a new (efficient) product.
  2. Lin and Prince (2013) find that gasoline price volatility decreases consumer demand for gasoline in the intermediate run
  3. Scott (2015) finds that consumers are not just interested in the current gasoline prices but also into their future path, when they undertake an investment choice.

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- Several papers such as Davies and Kilian (2011), Rivers and Schaufele, 2015; Li et al., 2014 and Tiezzi and Verde (2016) study the impact of prices and taxes on consumers choices and find that taxes have a stronger impact than prices on consumer's choices.
- We follow Tiezzi and Verde (2016) and test whether taxes and prices have a different effect on consumers' choices

Estimation method

1. We follow Li et.al. (2013) for the estimation method and we include in their specification the variance of the gasoline price:

$$ln(MPG_{i,s,t}) = f(ln(p_{s,t}), ln(1 + frac\tau p), ln\sigma(p_{s,t-x}), \mathbf{H_i}, \mathbf{D_i}, \mathbf{D_s})$$

   in which s is the state, t is the month and i is the vehicle.

2. Household and vehicle characteristics (including purchase month): Microdata from the US 2009 National Household Travel Survey.
3. Gasoline prices: State-level monthly average prices (tax-inclusive) from Energy Information Administration and Dept. of Transportation.
4. Our sample: 41,985 vehicles (N) purchased within 24 months before the interview

We use the results of the estimation to simulate the effects of an adjustable gasoline taxation

Econometric results

Figure: Effect of variance on car's efficiency.

ln(p)	0.088***	0.072***	0.051***
	(0.02)	(0.02)	(0.02)
tax ratio	0.499***	0.482***	0.381***
	(0.12)	(0.11)	(0.10)
σ_6	-0.002		
	(0.01)		
σ_{12}		-0.018**	
		(0.01)	
σ_{18}			-0.082**
			(0.03)

tax ratio is defined as: $ln(1 + \frac{\tau}{p})$

An adjustable gasoline taxation-1

The AGT has two components:

1. The tax rate ($/gallon)
2. Its adjustment, which depends on the difference between the oil price and the reference oil price in the previous period.

For the AGT to be revenue-neutral, the adjustment is bound by the reserve accumulated in previous periods any time the oil price was lower than the reference level.

Definitions

$\overline{C}$:Gasoline tax rate

C_t: Adjusted gasoline tax rate

A_t : Adjustment

$\overline{B}$: Reference Brent price

B_t: Brent price

R_t: Reserve

β: Estimated change in wholesale gasoline price given \$ 1 change in Brent oil price (=\$ 0,024 according to Borenstein, 2008)

An adjustable gasoline taxation

$$C_t = \overline{C} + A_t$$

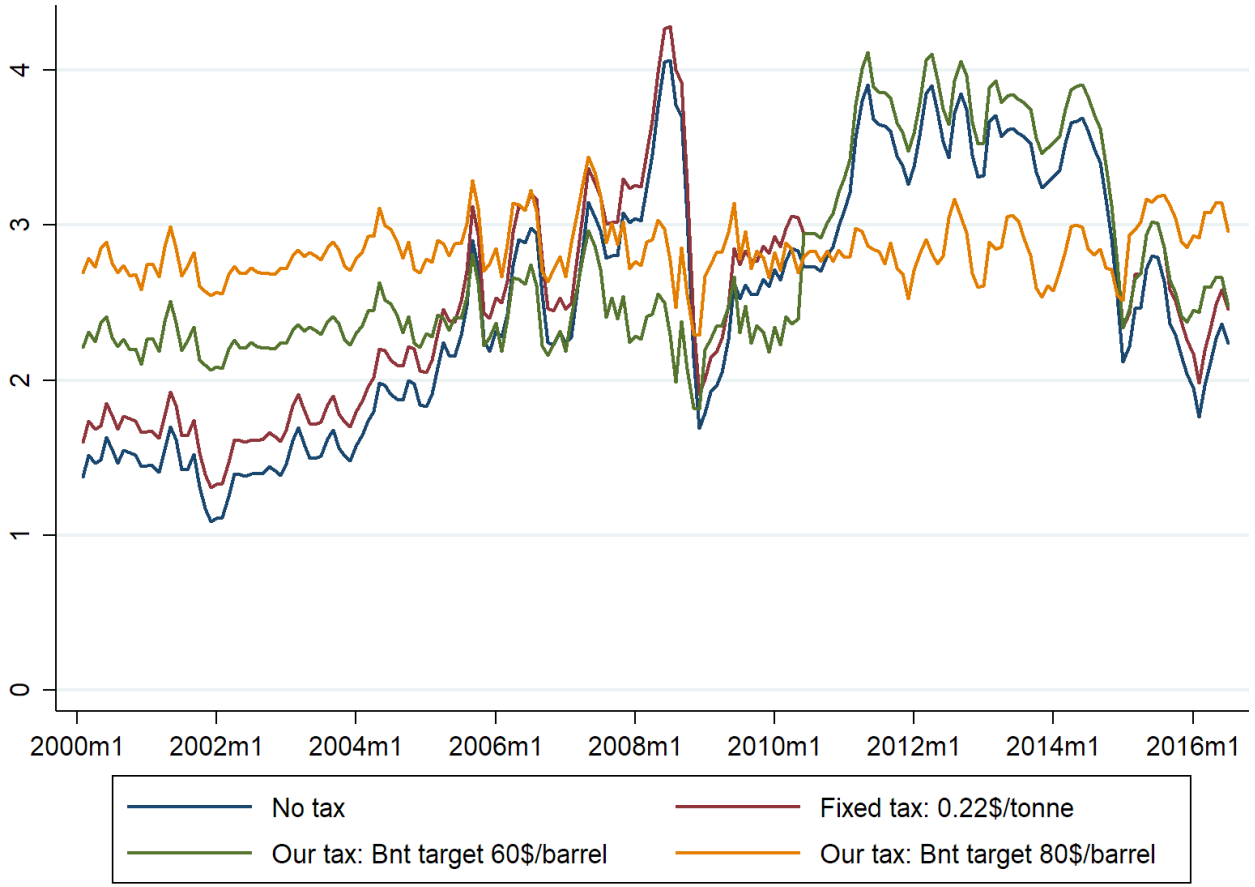
$$A_t = \begin{cases} \beta(\overline{B} - B_{t-1}) & \text{if } \beta(\overline{B} - B_{t-1}) - \overline{C} > 0 \\ \text{-min}[-1[\beta(\overline{B} - B_{t-1}) - \overline{C}]; R_{t-1}] & \text{if } \beta(\overline{B} - B_{t-1}) - \overline{C} < 0 \end{cases}$$

$$\begin{aligned} R_t &= R_{t-1} + A_t \\ R_0 &= 0 \end{aligned}$$

1. When the difference between the brent target and the observed price of oil is positive, the tax should cover this difference, in order to align the observed price with the target.
2. When this difference is negative ($B_{t-1} > \overline{B}$), the tax may be transformed in a buffer against future price shocks.

Simulation results

Figure: *Tax comparison*



Simulation results

Figure: Add caption

	No tax	Fixed tax (0,22 $/gal-lon)	Our tax: bnt=60$/b	Our tax: bnt=80$/b
Mean	2,51	2,73	2,73	2,83
σ	0,83	0,83	0,63	0,18

Figure: Percentage variation

	Fixed vs target 60$	Fixed vs target 80$
Mean	0,05	3,67
σ	-24,17	-78,15

Impact of AGT

Figure: Effect of AGT on MPG compared with the fixed taxation, %

	Target 60$	Target 80$
Price Effect	0,004	0,264
Variance Effect	0,435	1,407
Net Effect	**0,439**	**1,671**

Conclusions

1. We have investigated the effect of gasoline price volatility on vehicle fuel efficiency. As far as we are aware, we are the first to do it.
2. The effect is found to be negative and significant
3. The AGT we propose would have been significantly more effective than an ordinary GT in increasing vehicle fuel efficiency, as it takes into account dynamic efficiency.

Conclusions

Thank you

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Appendix

Figure: P and tax separate

$ln(p+t)$	0.061***	0.036**	0.011
	(0.02)	(0.01)	(0.01)
σ_6	0.002		
	(0.01)		
σ_{12}		-0.017**	
		(0.01)	
σ_{18}			-0.103***
			(0.03)
Income	*YES*	*YES*	*YES*
Education	*YES*	*YES*	*YES*