Can A Gasoline Tax Reduce Carbon Emissions?

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What To Do

- How much GHG emissions can be reduced if a carbon tax is adopted in the transportation sector?
- Is it appropriate that we use the existing elasticity estimates for evaluating the effectiveness of a carbon tax?
- To answer these questions, we estimate the gasoline price elasticity induced by gasoline tax using the taxes and tax differences as instruments.

Motivation

- South Korea government has announced its medium term target for greenhouse gas emission on Nov. 17, 2009.
  - The announcement said that the country would be committed to reducing emission by 30 percent from its BAU (Business-As-Usual) level projection in 2020.
- Once the reduction targets are set, the next step for government will be deciding how to achieve its goals.

Motivation

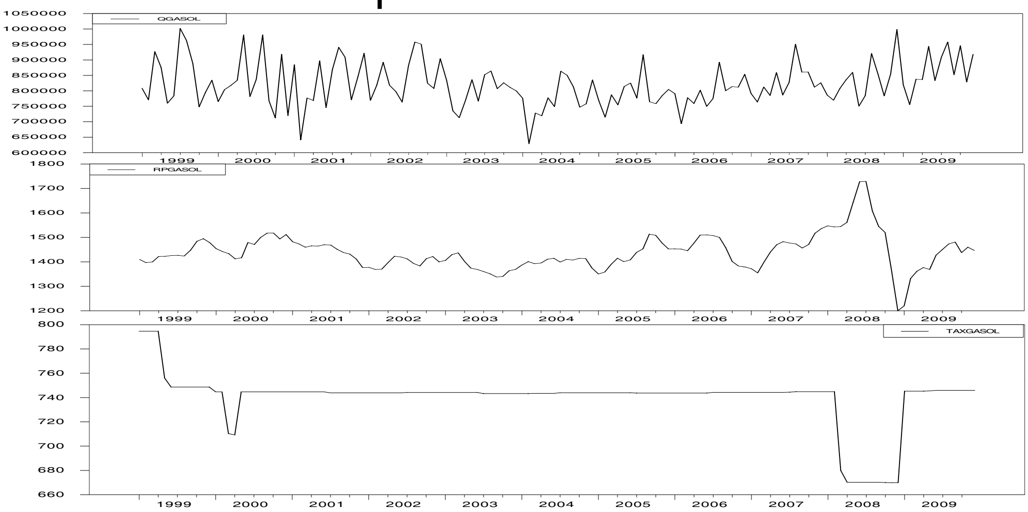
- Carbon tax system is one of the most cost-effective instruments to reduce GHG emissions
  - Many policy instruments have been considered for reducing emissions.
  - Among policy instruments, market-based policies, such as carbon tax and permit-trading programs, have an important advantage over other measures

Motivation

- How much GHG emissions can be reduced if a carbon tax is adopted in the transportation sector?
- Is it appropriate that we use the existing elasticity estimates for evaluating the effectiveness of a carbon tax?
- This paper attempts to find an answer for these two questions.

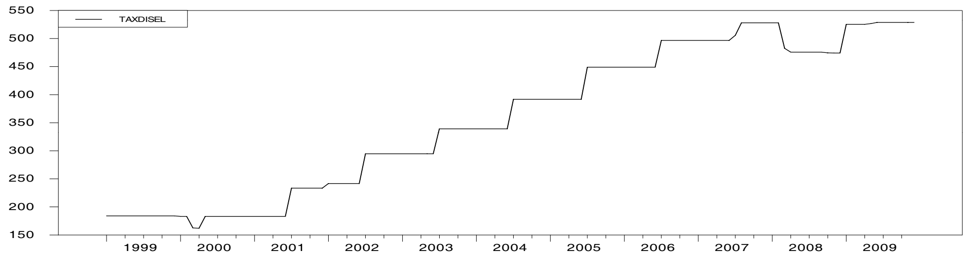
Data

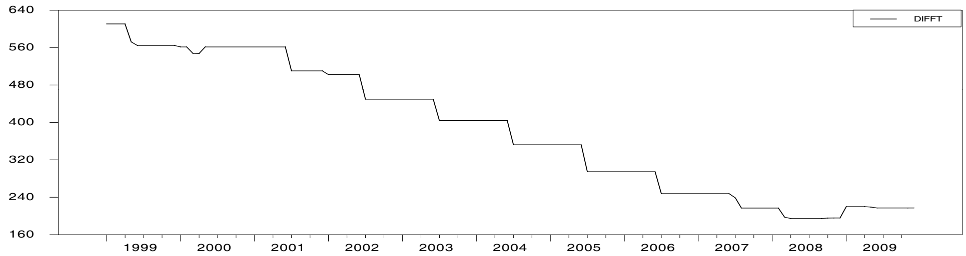
- National gasoline prices, consumption, and taxes over the period 1999.1~2009.12



Data

- Diesel taxes and tax difference between gasoline and diesel over the sample period





Prices and Taxes of Gasoline And Diesel

(Won, %)

	Gasoline	Share	Diesel	Share
Refinery price before tax	572.75	37.11	580.34	43.90
Transportation-Energy-Environment Tax	519.32	-	362.39	-
Education Tax	77.9	-	54.36	-
Motor Fuel Tax	148.29	-	103.47	-
Value-added Tax	131.87	-	110.12	-
Summation of taxes at refinery	877.38	-	630.34	-
Refinery price after tax	1,450.56	-	1,211.35	-
Retail Margin	84.3	5.46	100.45	7.60
Value-added Tax at retail	8.43	–	10.05	–
End user Price	1,543.29	100	1,321.85	100
Total Taxes	885.81	57.40	640.39	48.45

Source: KNOC

Single-Equation Models

- Gasoline Consumption Model (1)

$Ln(Q)_t = \alpha_0 + \alpha_1 ln(P)_t + m_t + e_t$

- Gasoline Consumption Model (2)

$Ln(Q)_t = \alpha_0 + \alpha_1 ln(P)_t + \alpha_2 ln(P/Pd)_t + m_t + e_t$

  - Mostly gasoline and diesel are substitutable for each other.
  - To address this substitutability, we include price differences between gasoline and diesel in the single equation model.
  - Also, we use instruments with some lags because it takes times for car users to replace their old car by a new one.
  - The inclusion of this substitutability provides us for approaching a long-run effect of gasoline taxes especially when substitutable technologies are available.

IV Estimation

- OLS Estimation
  - The estimate in the aggregate specification is consistent if prices are uncorrelated with e_t.
  - However, this orthogonality condition is unlikely to hold because of standard price endogeneity considerations.
  - Gasoline consumption increases cause prices to increase, leading to a spurious correlation between prices and e_t.
  - This correlation will cause estimates of the price elasticity to be biased toward zero as all of the predicted consumption is attributed to the prices.
- Thus, we use an instrumental variable estimation to address the price endogeneity problem.
  - Especially, we exploit the gasoline taxes as instruments, which help us identify gasoline price movements directly driven by taxes.

Tax Increases

- The price effect on consumption will be different between tax increases and decreases.
  - Consumers may respond more to gasoline price when gasoline tax increases than when the tax decreases.
- Since we focus on the effect of gasoline price on consumption induced by increases in gasoline taxes, we restrict the instruments to include the tax and tax difference only when the gasoline tax rises.

The Effect of A Gasoline Tax on Carbon Emissions

- The price elasticity estimate captures the response of a driver without substitution to alternative vehicles.
  - A driver can adjust fuel efficient driving habits, keep the speed regulations, or use public transportation.
- The cross elasticity can capture long-run response with substitution toward more fuel efficient vehicles.

Table 13. Tax Effect on Carbon Emissions

A. Tax Effect without Substitutability

tax ₩ per C ton	gasoline tax per liter	% price increase (2009)	elasticity1	% gasoline consumption decrease (2009)	decrease in gasoline consumption (1,000litre)	emission reduction (1,000 C ton)
50,000	31.3200	2.1648	0.6274	1.3582	141760.3	88.7987
100,000	62.6400	4.3296	0.6274	2.7164	283520.6	177.5973
200,000	125.2800	8.6592	0.6274	5.4328	567041.2	355.1946
300,000	187.9200	12.9887	0.6274	8.1491	850561.8	532.7919
400,000	250.5600	17.3183	0.6274	10.8655	1134082.4	710.3892
500,000	313.2000	21.6479	0.6274	13.5819	1417603.0	887.9865

B. Tax Effect with Substitutability

tax ₩ per C ton	gasoline tax per liter	% price increase (2009)	elasticity2	% gasoline consumption decrease (2009)	decrease in gasoline consumption (1,000litre)	emission reduction (1,000 C ton)
50,000	31.3200	2.1648	0.7467	1.6164	168716.0	105.6837
100,000	62.6400	4.3296	0.7467	3.2329	337432.0	211.3674
200,000	125.2800	8.6592	0.7467	6.4658	674864.0	422.7348
300,000	187.9200	12.9887	0.7467	9.6987	1012296.0	634.1022
400,000	250.5600	17.3183	0.7467	12.9316	1349728.0	845.4696
500,000	313.2000	21.6479	0.7467	16.1645	1687160.0	1056.8370

Tax Effects: with or without Substitutability

- In the upper panel in Table 13, the first row provides the effect of tax on carbon emissions without substitution to alternative vehicles if the carbon tax is charged an additional ₩50,000. The real price will rise by 2.16%, gasoline consumption decreases by 1.35%, and carbon emissions reduce by 88,799 C ton.
- In the lower panel in Table 13, the first row measures the tax impact with substitutability if the carbon tax is charged an additional ₩50,000. Gasoline consumption is decreased by 1.61%, and carbon emissions are reduced by 105,684 C ton.
- Technology and Tax Effect