The Effect of the 1979 Oil Price Shock on Auto Emissions

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Camp Resources Workshop

Motivation

Problem:

- Recent estimates suggest transportation sector accounted of 27% of GHG emissions
  - This trend growing domestically and abroad
- Interest in policies that induce “greener" purchases

Literature

Attention focused on:

1. How consumers alter driving behavior and vehicle choices
   - Killian and Sims (2006), Knittel and Sandler (2010), Gillingham 2010, Spiller 2010
2. Understanding the difference between perceptions of energy prices, the certainty of those predictions, and energy savings
   - Allcott et al. (2011), Allcott and Wozny (2011)

Motivation

Questions:

- How did the oil price shock of 1979 affect passenger vehicle emissions at a national level?
  - Intensive Margin: Miles Driven
  - Extensive Margin: More Fuel Efficient Autos
- Do these effects occur simultaneously?

Theoretical Model

A representative household maximizes:

$$U(c, d)$$

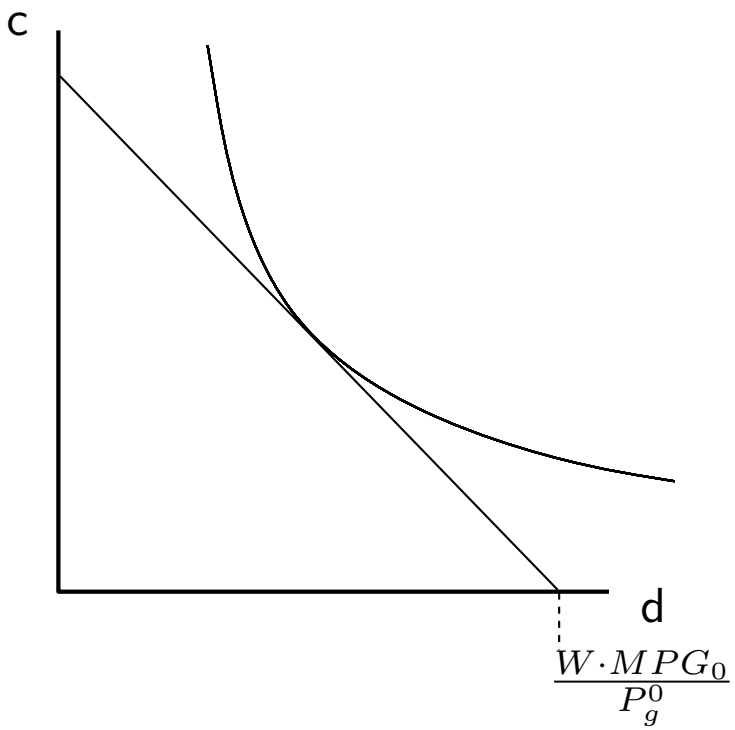
subject to

$$W = c + \frac{P_G}{MPG_0} d$$

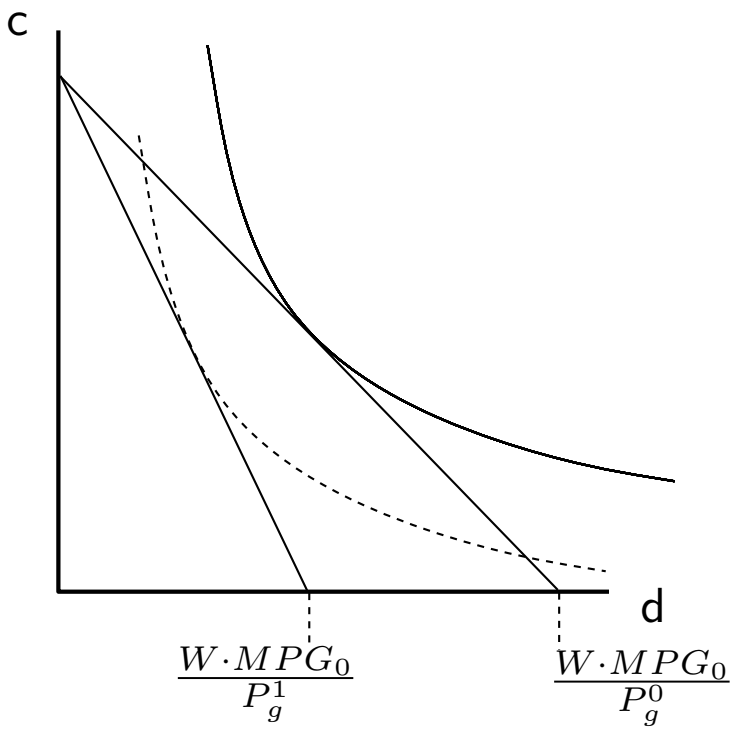
Consider, that each household has the option to choose a car, with $MPG_1 > MPG_0$. If, a different car is selected the new constraint is:

$$W - K = c + \frac{\hat{P}_G}{MPG_1} d$$

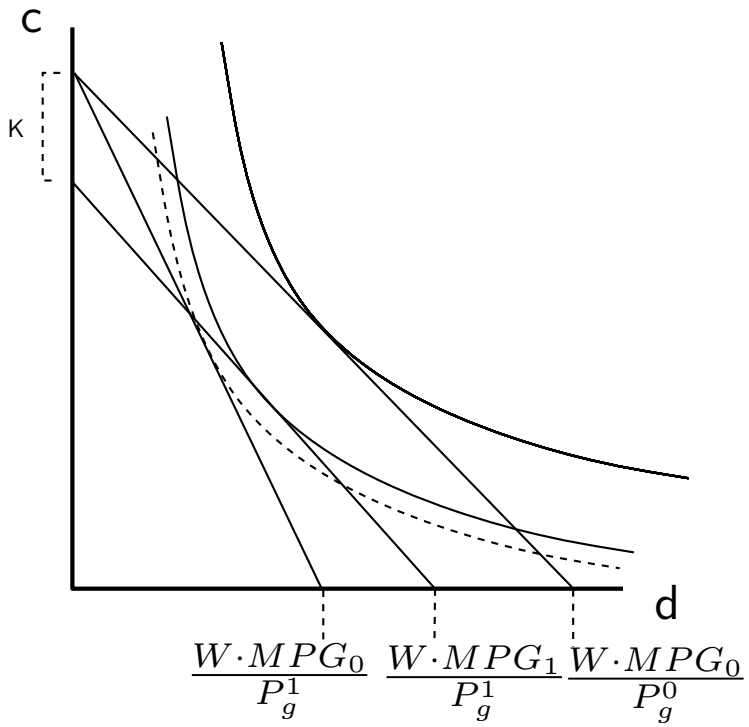
Extensive vs Intensive Margin



Extensive vs Intensive Margin

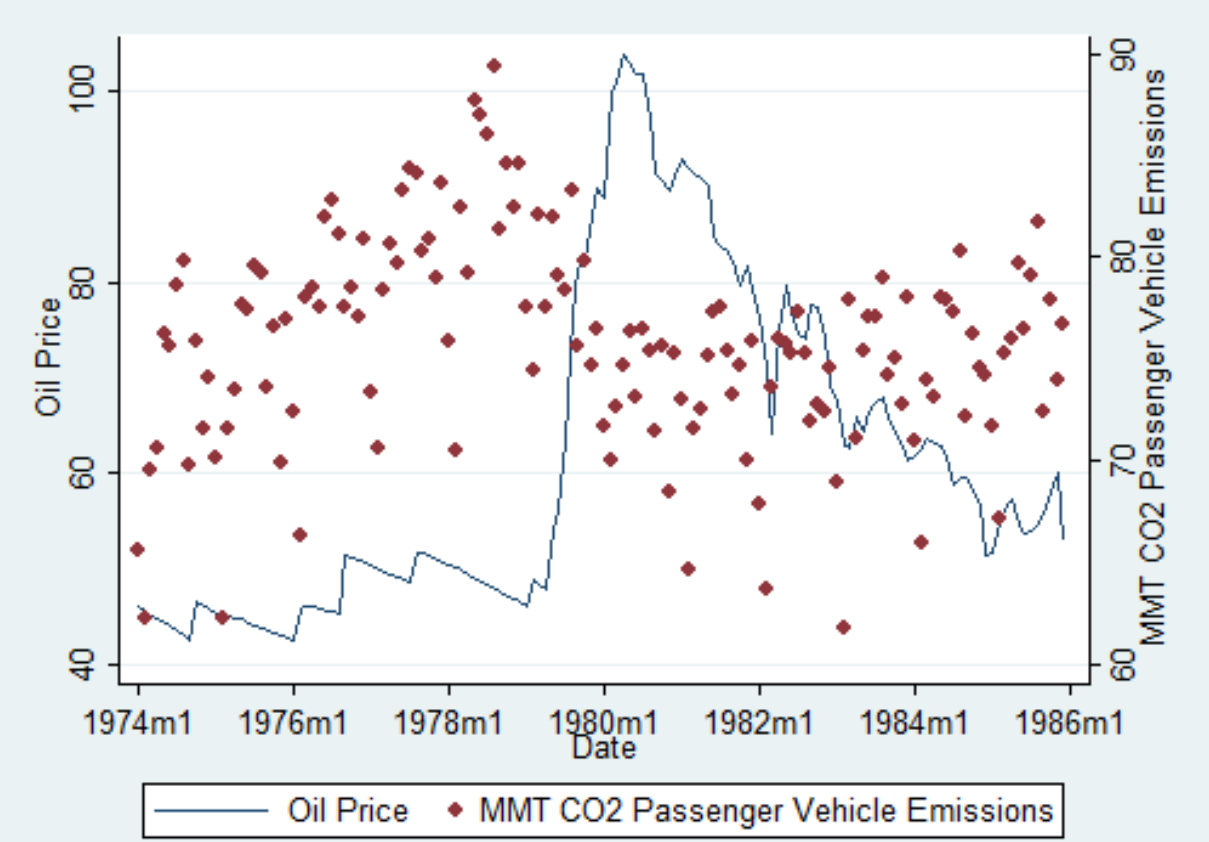


Extensive vs Intensive Margin



Empirical Strategy

Utilize RD design to test whether oil price of 1979 had an effect on the intensive and extensive margin



Empirical Strategy

Polynomial Time Trend:

$$y_t = \alpha + income_t\phi + \Sigma_{i=1}^{11} month_i\delta_i + \Sigma_{s=1}^{4} t^s\delta_s + post\ spike_t\beta + \epsilon_t \quad (1)$$

Flexible Time Trend:

$$y_t = \alpha + income_t\phi + \Sigma_{i=1}^{11} month_i\delta_i + 1\{post\ spike = 0\}\Sigma_{s=1}^{3} t^s\delta_s + 1\{post\ spike = 1\}\Sigma_{s=1}^{3} t^s\delta_s + post\ spike_t\beta + \epsilon_t \quad (2)$$

Empirical Strategy

Data:

- Monthly passenger vehicle emissions-EIA
- Monthly vehicle miles traveled- DOT
- Monthly Oil prices - West Texas Intermediate Crude
- Monthly Income-BEA

Figure: QLR Statistics for Treatment Window: Emissions

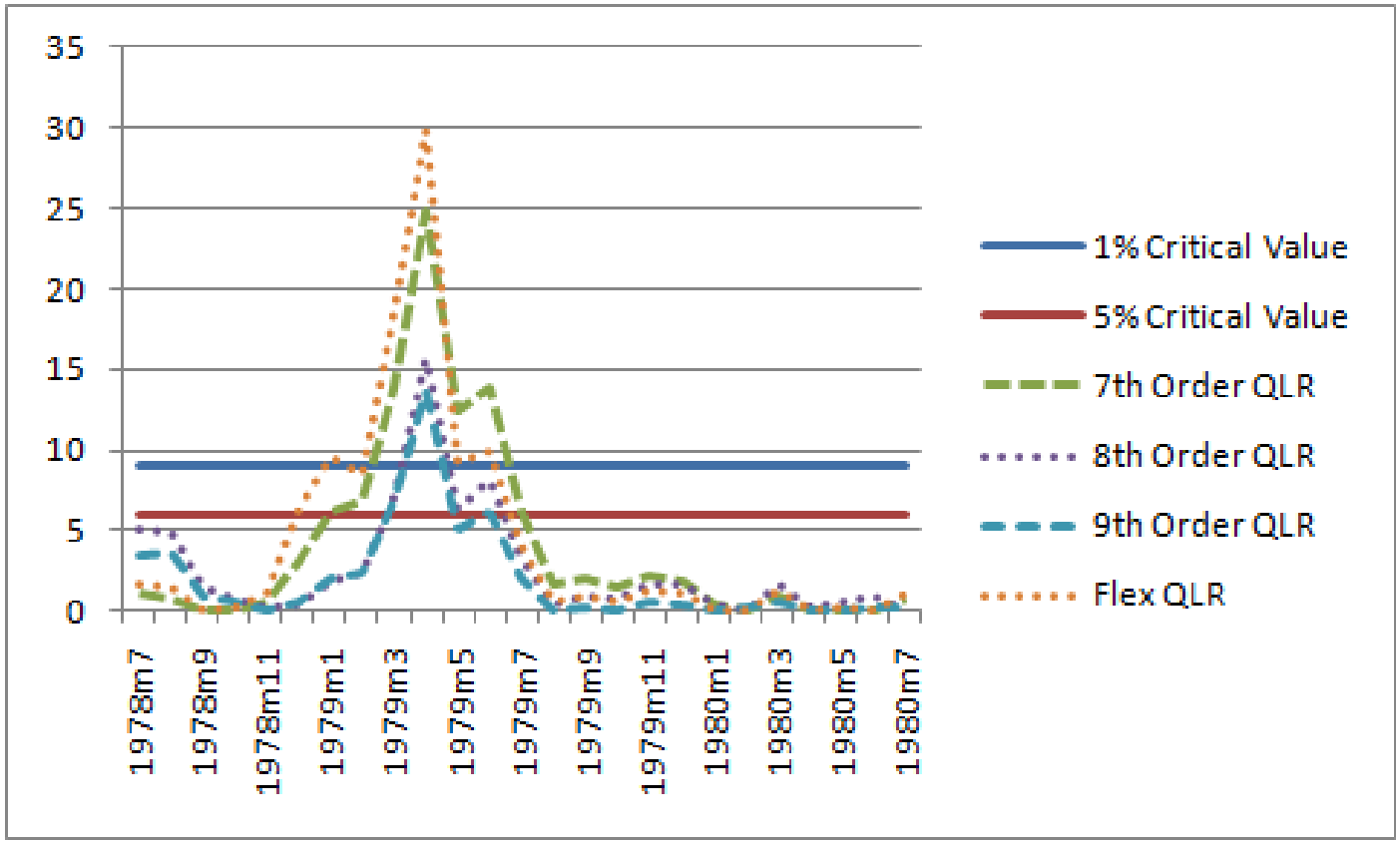
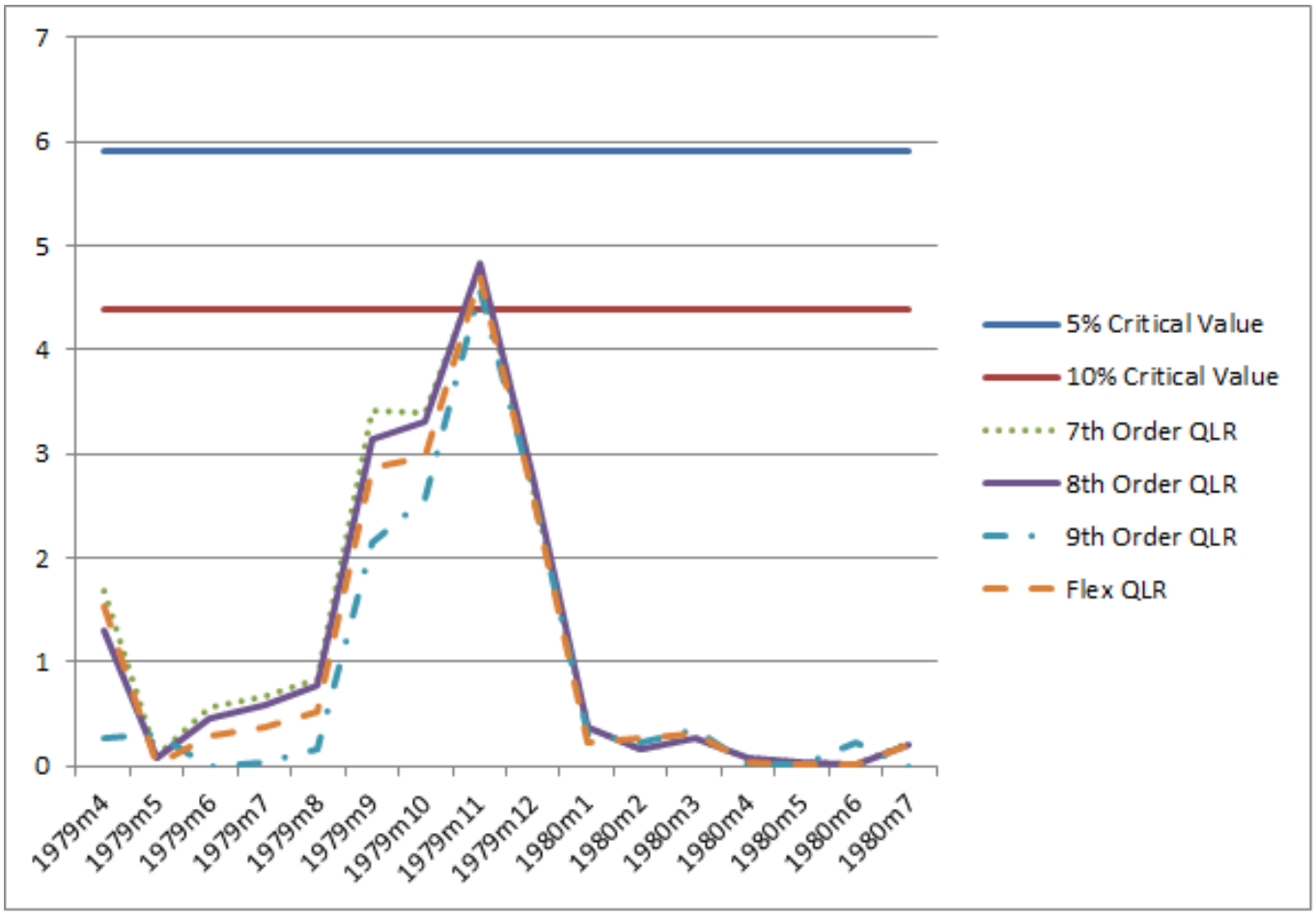
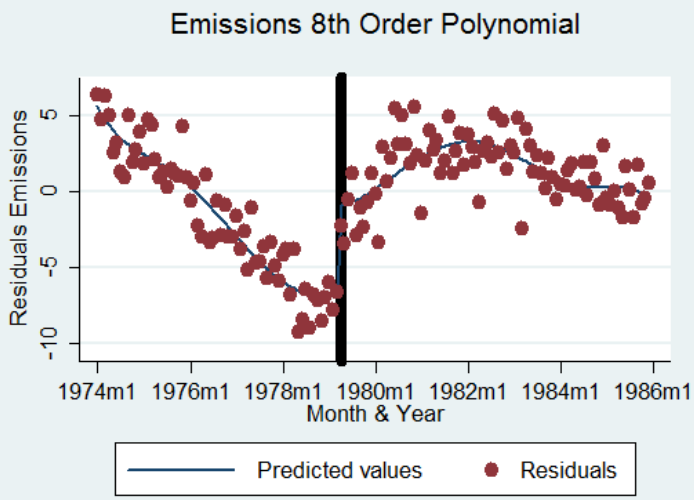
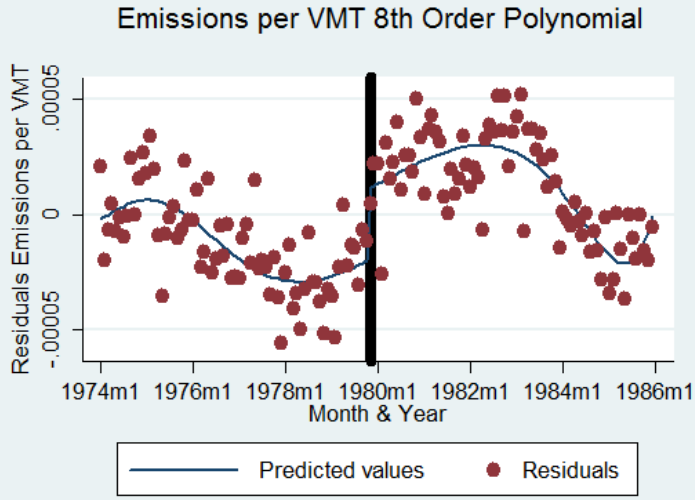
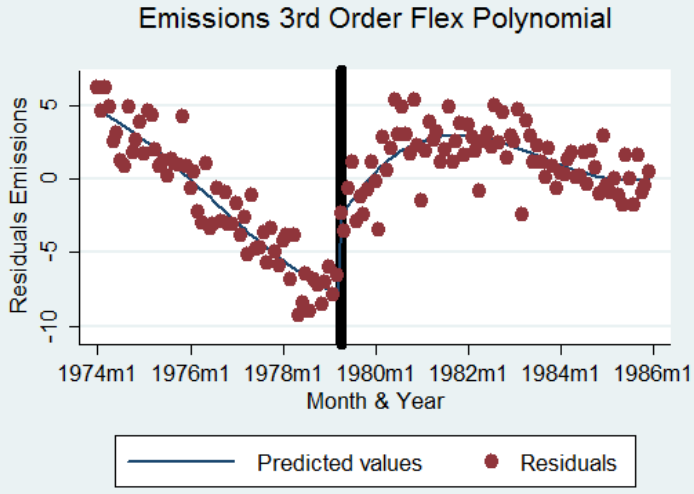


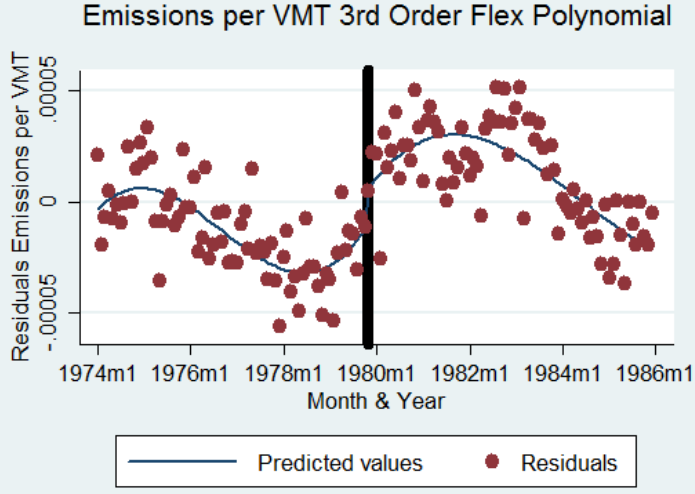
Figure: QLR Statistic for Treatment Window: Emissions per VMT




Emissions 8th Order Polynomial
Residuals Emissions
5
0
-5
-10
1974m1 1976m1 1978m1 1980m1 1982m1 1984m1 1986m1
Month & Year
Predicted values
Residuals


Emissions per VMT 8th Order Polynomial
Residuals Emissions per VMT
.00005
0
-.00005
1974m1 1976m1 1978m1 1980m1 1982m1 1984m1 1986m1
Month & Year
Predicted values
Residuals


Emissions 3rd Order Flex Polynomial
Residuals Emissions
5
0
-5
-10
1974m1 1976m1 1978m1 1980m1 1982m1 1984m1 1986m1
Month & Year
Predicted values
Residuals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.00005
0
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1974m1 1976m1 1978m1 1980m1 1982m1 1984m1 1986m1
Month & Year
Predicted values
Residuals

Table: Results from 8th Order and Flexible Polynomial

	(1) Emissions	(2) Emissions	(3) Emissions/VMT	(4) Emissions/VMT
Break	-4.147***	-5.372***	-0.0000209*	-0.0000207*
	(1.050)	(0.985)	(0.00000950)	(0.00000952)
Income	0.00270**	0.00102	7.86e-09	4.32e-09
	(0.000894)	(0.000681)	(5.56e-09)	(5.38e-09)
Monthly FE	Y	Y	Y	Y
Polynomial Trend	Y	N	Y	N
Flexible Trend	N	Y	N	Y
N	144	144	144	144
Adjusted R^2	0.898	0.898	0.957	0.956
QLR Significance	1%	1%	10%	10%

Standard errors in parentheses. June is the base month.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

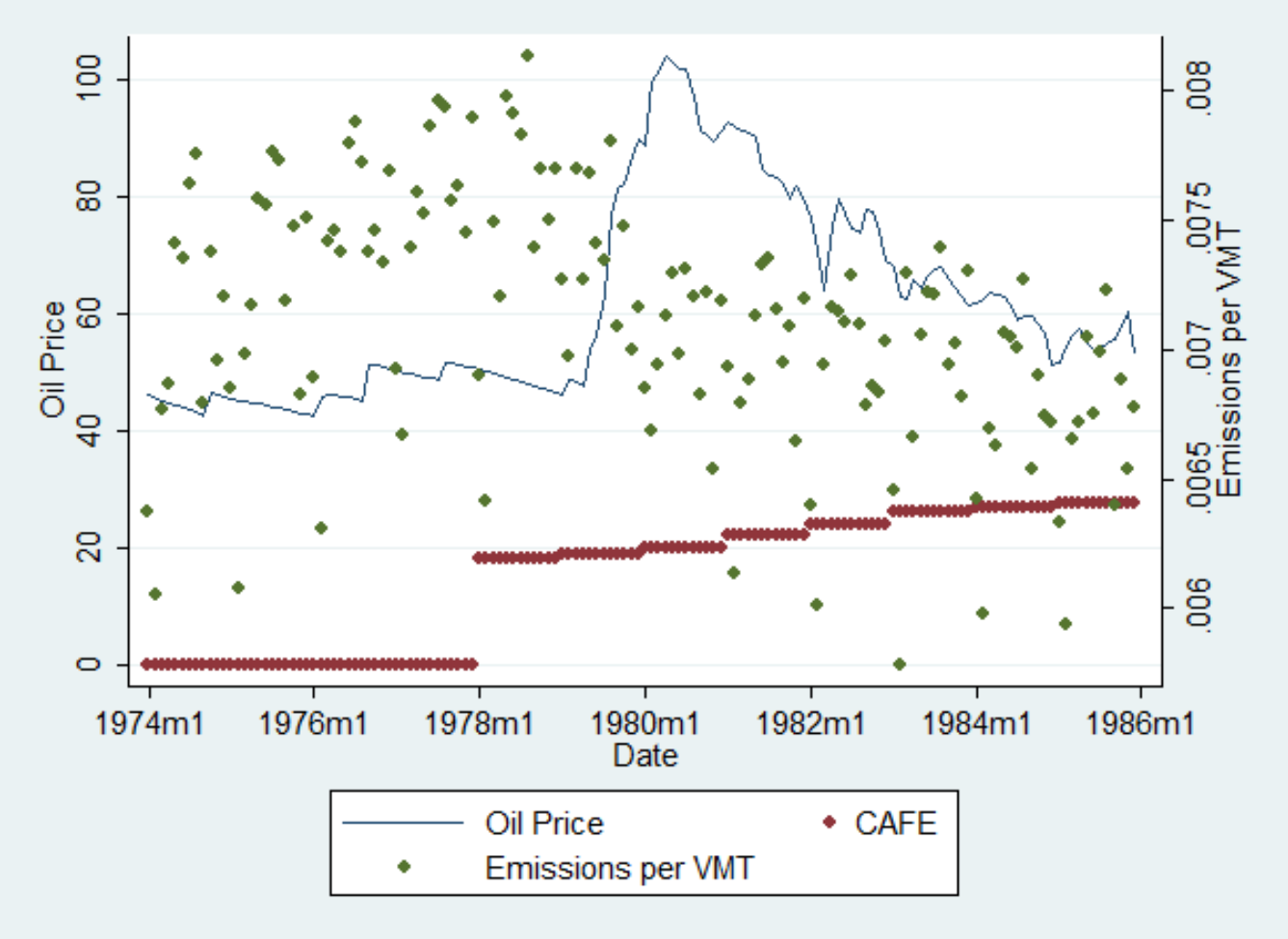

Figure: Real Oil, CAFE Standards and Emissions per VMT

Conclusions

1. Oil price spike of 1979 leads to a fall in CO_2 emissions from vehicles
   - 48% of the fall is from extensive margin

2. The effect from the intensive margin is not contemporaneous with that of the extensive margin
   - Important to allow for contemporaneous and lagged values of energy prices
   - Households will use passenger vehicles, although they will use more fuel efficient ones
   - Temporary tax may have less of an effect on extensive margin substitution

Figure: Composition of New Cars Produced for US Use by MPG Band

						YEAR					
MPG	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
5 to 10	6.6%	0.2%	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10 to 15	57.3%	57.6%	44.0%	26.8%	24.2%	5.7%	2.6%	0.3%	0.3%	0.1%	0.1%
15 to 20	23.9%	24.4%	36.7%	48.4%	48.5%	44.7%	38.1%	31.1%	33.6%	26.9%	27.5%
20 to 25	9.0%	13.2%	10.2%	13.7%	17.9%	33.0%	33.6%	31.7%	29.5%	33.1%	28.9%
25 to 30	3.1%	3.8%	6.6%	6.9%	8.0%	12.7%	18.4%	27.9%	24.8%	30.8%	33.8%
30 to 35		0.7%	1.5%	3.6%	1.0%	2.7%	5.1%	7.0%	9.5%	5.6%	7.3%
35 to 40			0.8%	0.3%	0.4%	1.0%	1.5%	1.2%	1.9%	3.0%	1.5%
40 to 45						0.2%	0.8%	0.8%	0.4%	0.4%	0.4%
45 to 50									0.0%	0.2%	0.5%
CAFE STANDARD	0	0	0	18	19	20	22	24	26	27	27.5
Lower Bound Fleet MPG	12.22	13.23	14.335	15.605	15.715	18.29	19.67	20.85	20.845	21.345	21.465
Average Bound Fleet MPG	14.7175	15.7275	16.835	18.105	18.215	20.79	22.1725	23.35	23.345	23.8475	23.965
Lower Bound Fleet MPG	17.215	18.225	19.335	20.605	20.715	23.29	24.675	25.85	25.845	26.25	26.215