An empirical study of driving behavior and vehicle rebound effects in Pennsylvania

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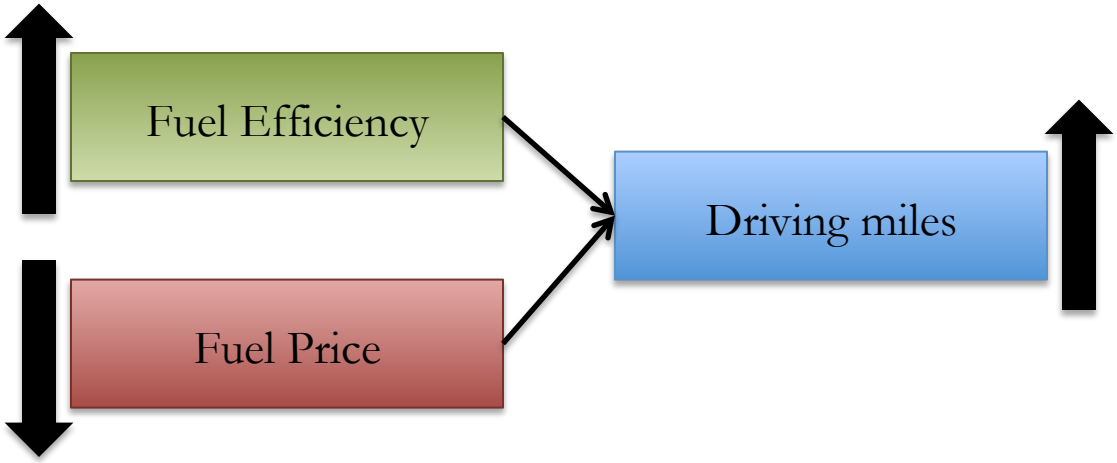
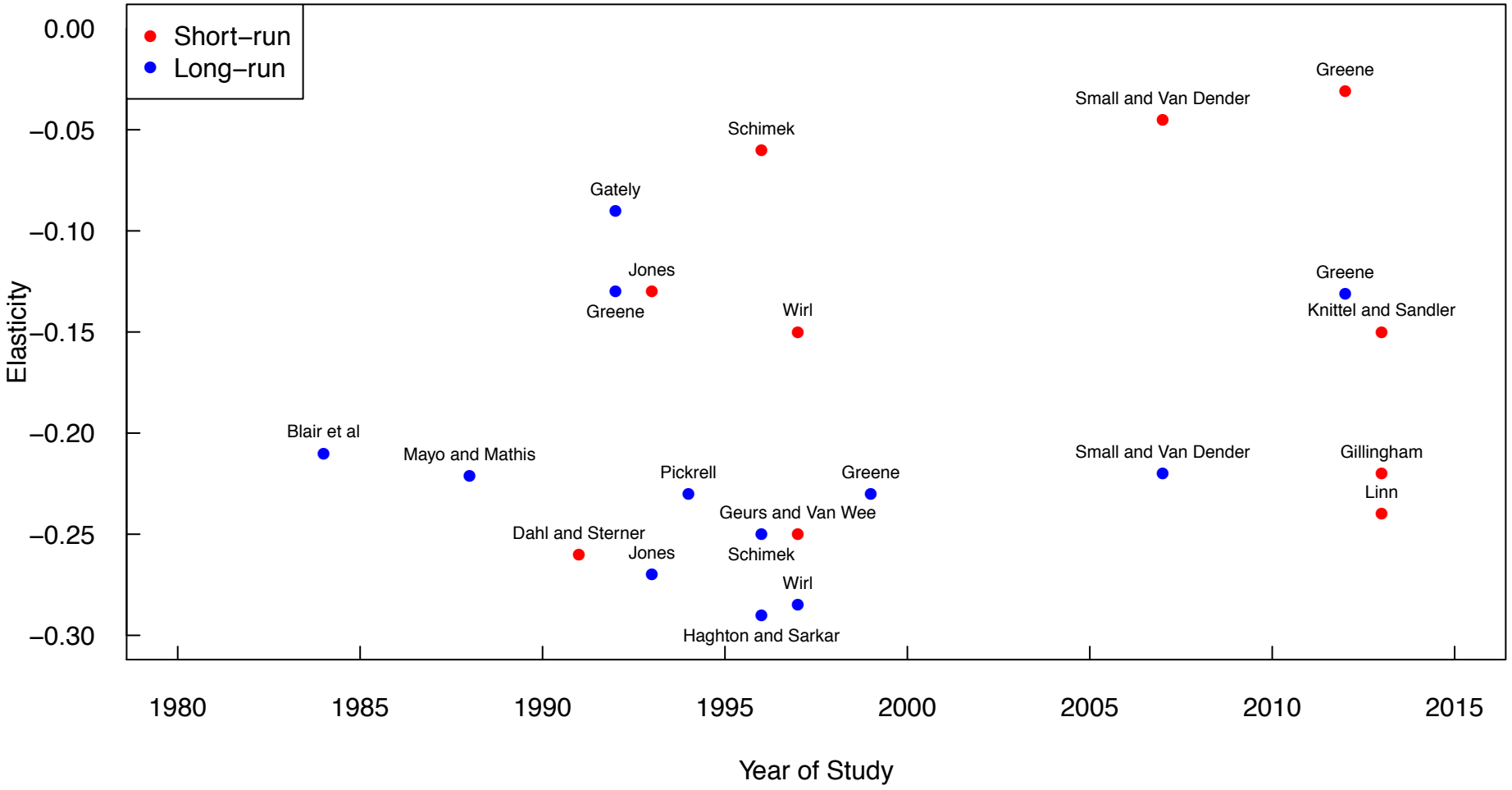
Direct Rebound Effect



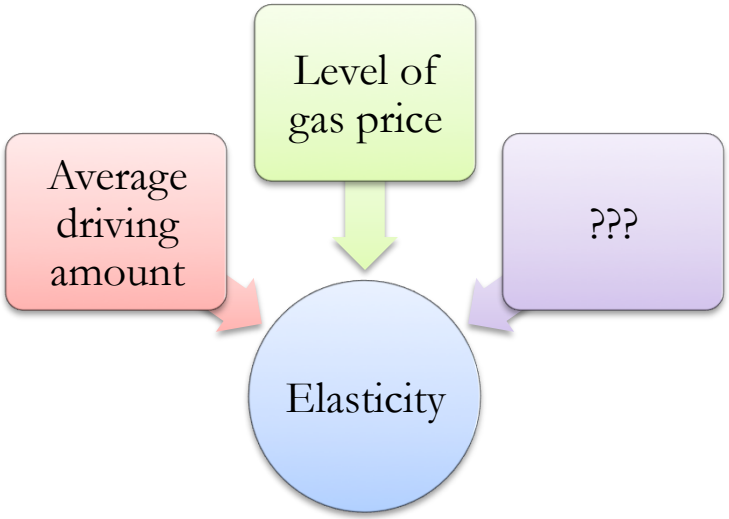
- Determination of the rebound effect has typically been from small samples or survey based data
- Difficult to measure due to lack of data
- Often represented as price elasticity of driving

Literature Review

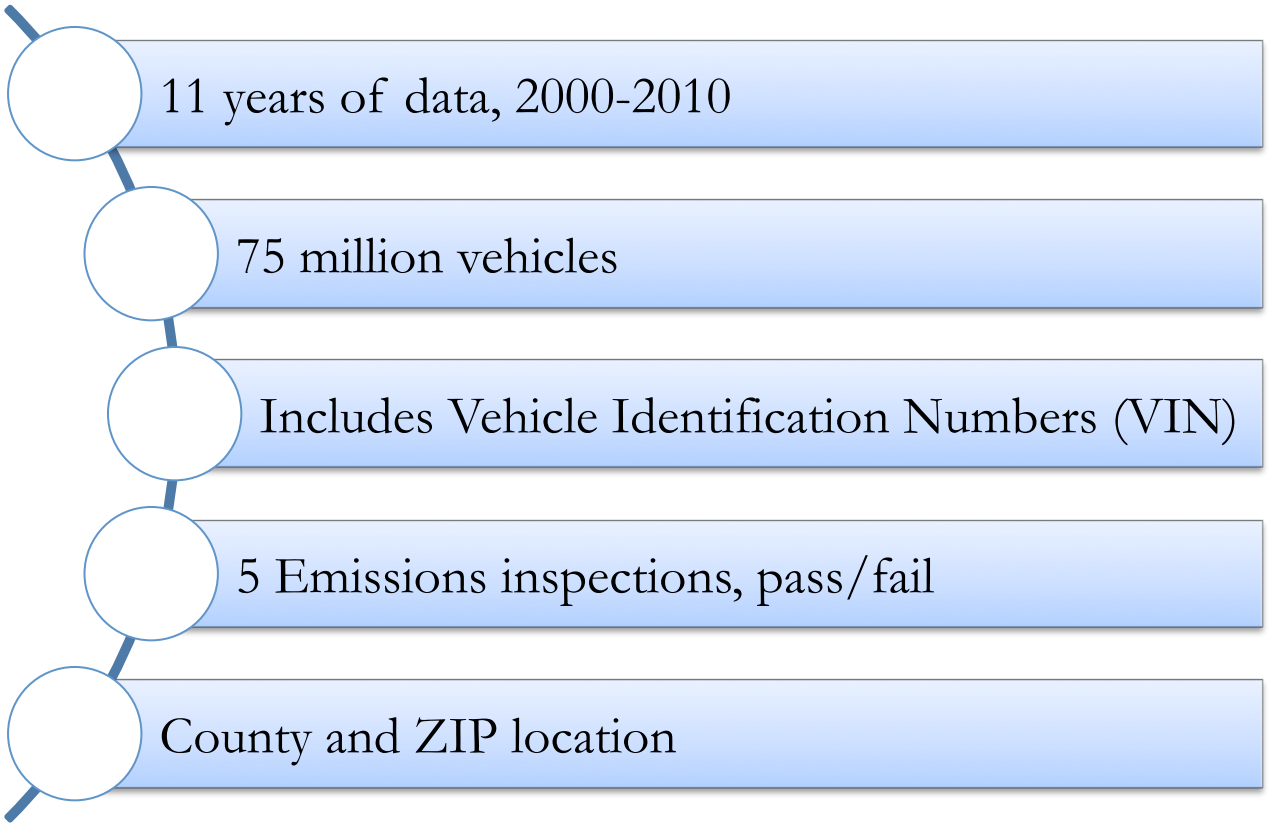


Breaking down elasticity

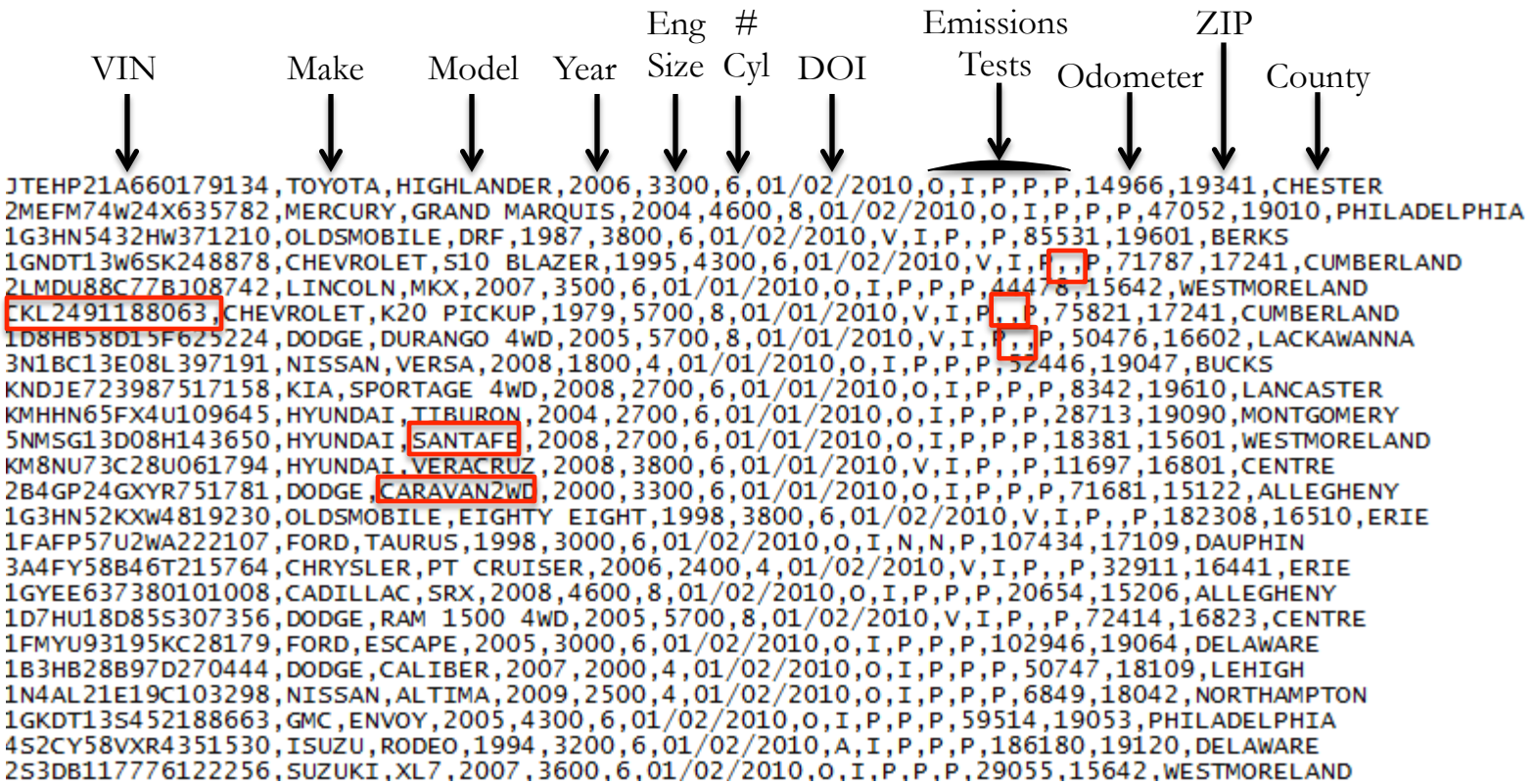
- Most studies focus on average effects for the elasticity of price on driving
- Response may be different across number of other factors



Comprehensive Emissions Inspection Dataset from PennDot



Sample of data



Distribution of Vehicles

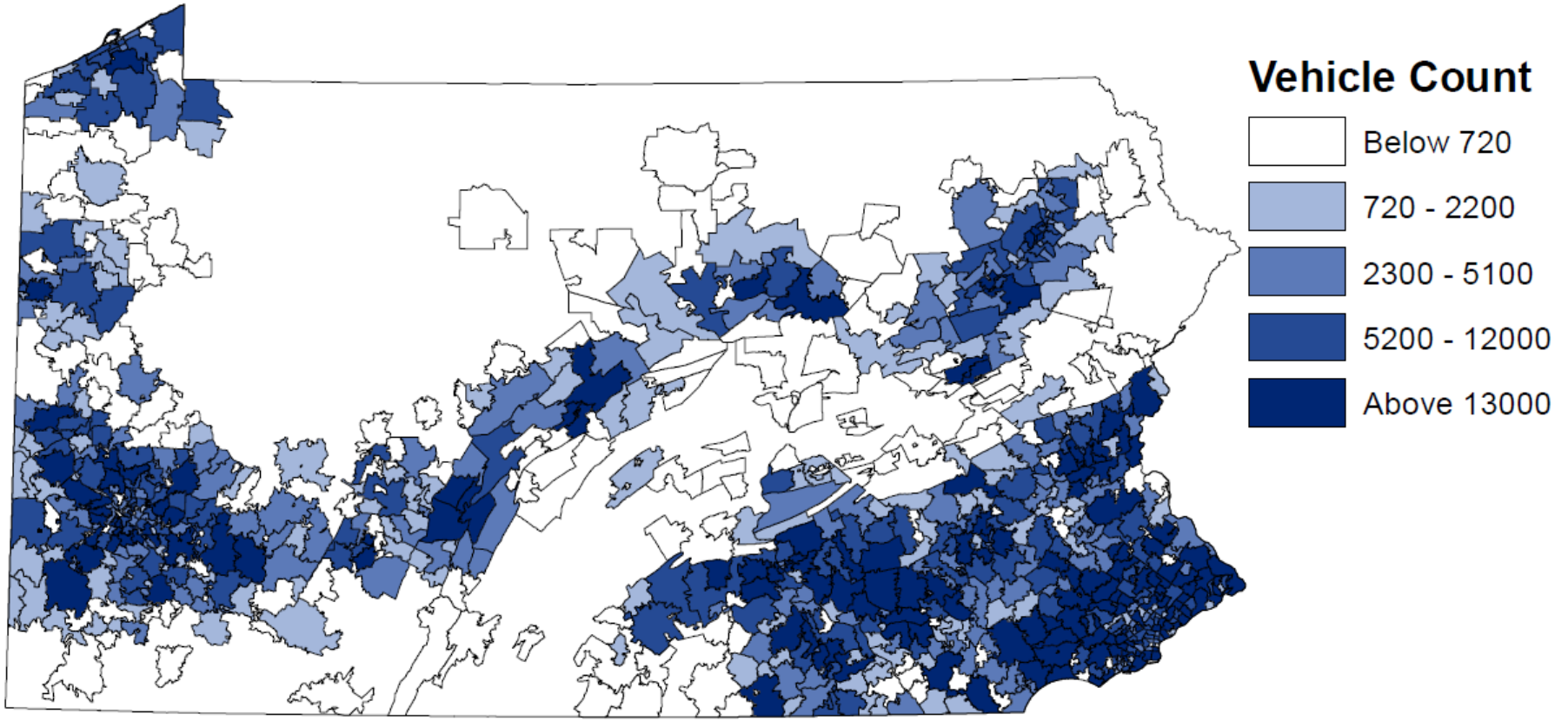


Figure 1: Distribution of vehicle counts in Pennsylvania by ZIP code

Distribution of Fuel Efficiency

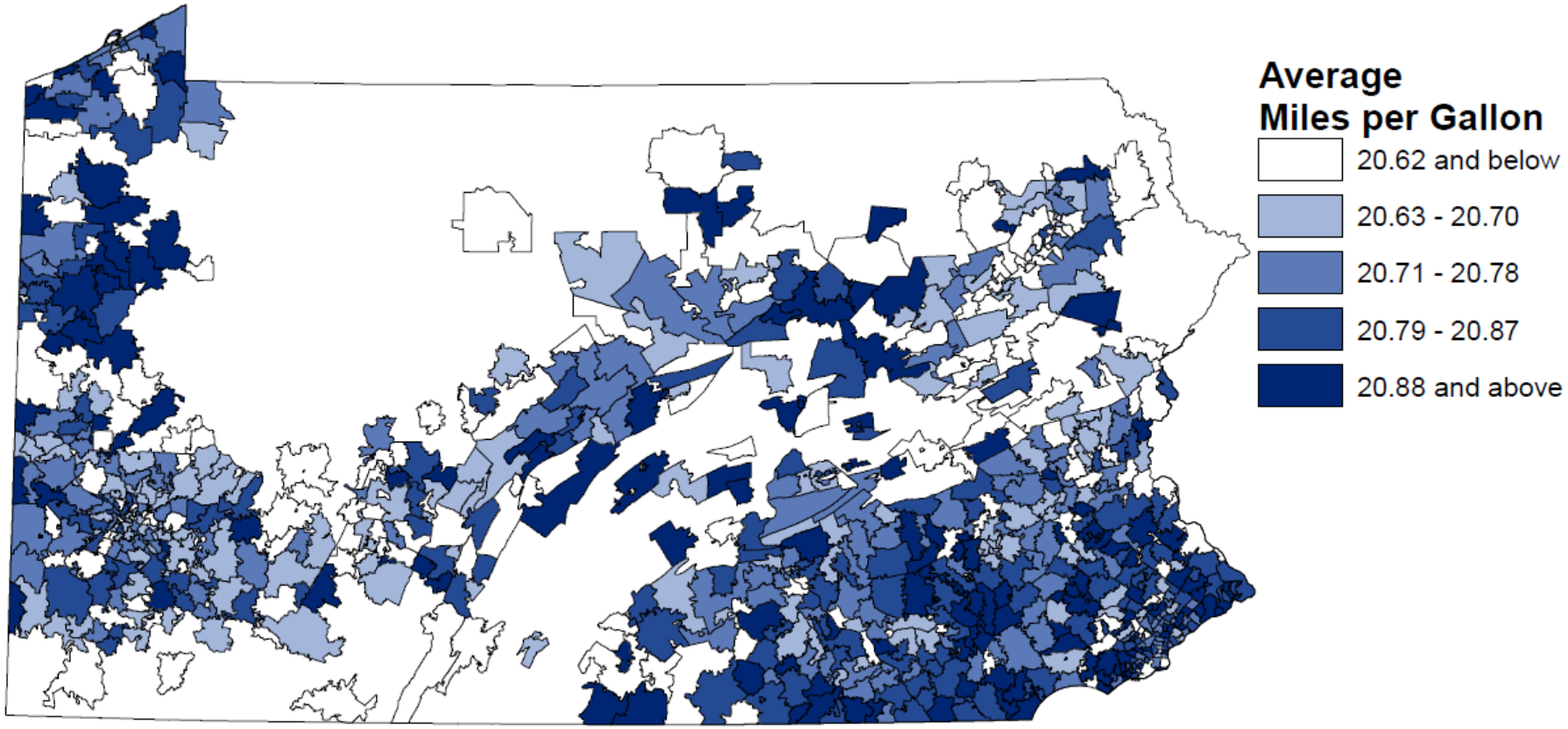


Figure 2: Distribution of vehicle fuel efficiency in Pennsylvania by ZIP code

Annual Driving Behavior

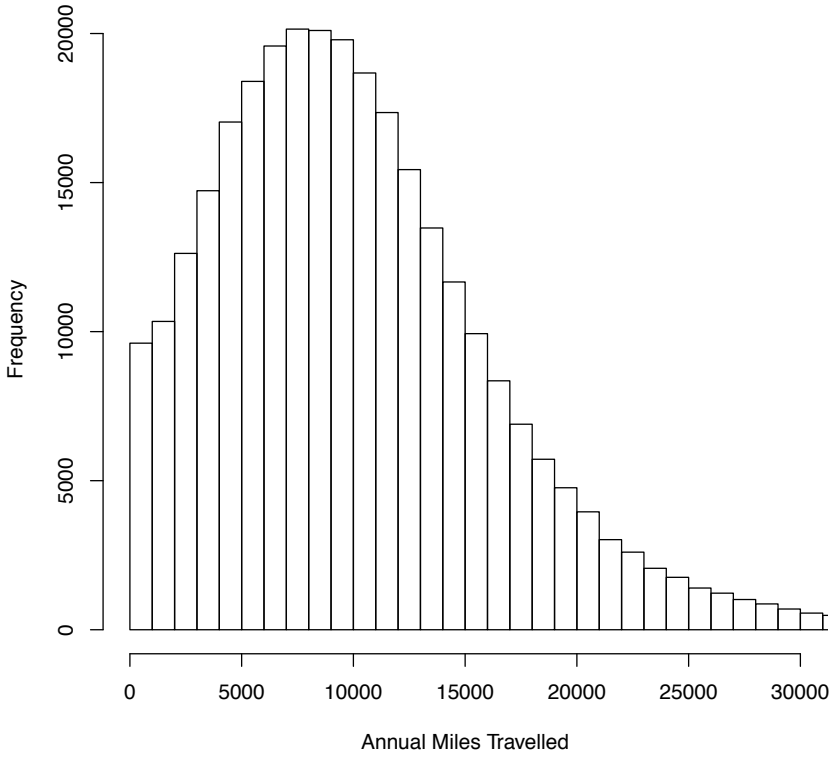


Figure 3: Histogram of annual vehicle miles travelled in PA

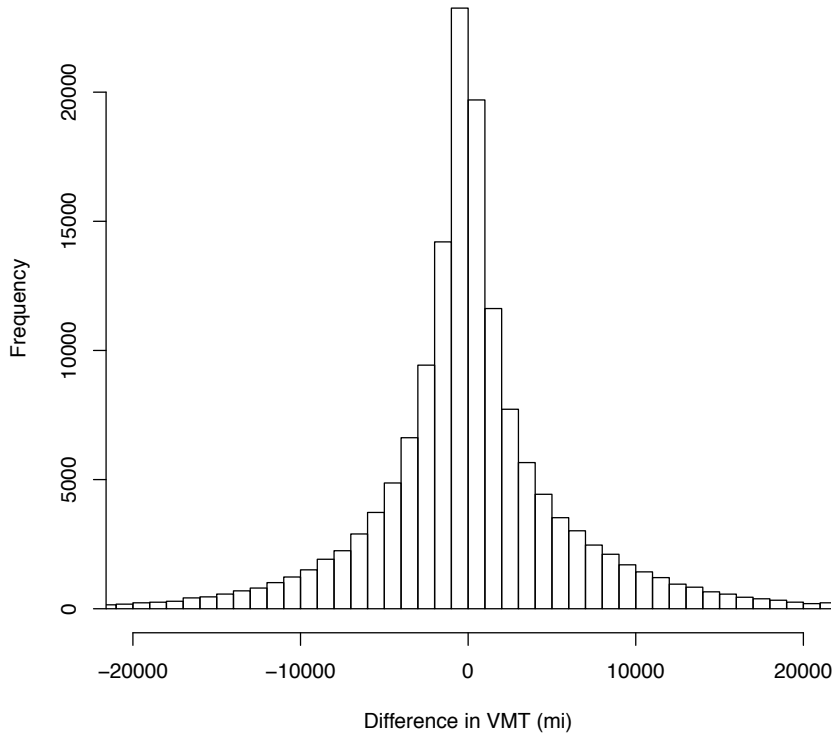


Figure 4: Histogram of annual differences in vehicle miles travelled in PA

General specification model

Vehicle attributes (depends on panel variables):
- Age
- Model
- Make
- Fuel efficiency
- Price
- …

Average gas price a consumer faces between inspections

Fixed effects groups:
- VIN
- Monthly time dummies
- ZIP code/county
- [Vehicle attributes]

$$\log(VMT_{it}) = \alpha \log(gas_t) + \beta \log(\mathbf{M_t}) + \gamma(\mathbf{V_t}) + \zeta(\mathbf{D_{it}}) + \delta(\mathbf{x_{it}}) + u_{it}$$

Macroeconomic variables:
- GDP
- Unemployment
- …

Demographic variables (depends on panel variables):
- Education
- Income
- Commuting information

Regression Results

Table 1: Elasticity results from a series of different FE models

Variable	Coefficient	Std. Error	Pr(>|t|)	Model Description
log(avggas)	-0.0349	0.0460	0.4481	Panel on ID, time dummies
log(avggas)	0.0393	0.1353	0.7712	Data on 1st Quantile of Avg VMT
log(avggas)	0.1594	0.1028	0.1212	Data on 2nd Quantile of Avg VMT
log(avggas)	-0.3471***	0.0948	0.0003	Data on 3rd Quantile of Avg VMT
log(avggas)	-0.2837**	0.0868	0.0011	Data on 4th Quantile of Avg VMT
log(avggas)	0.0976	0.0987	0.3223	Data on 5th Quantile of Avg VMT
log(avggas)	0.1460	0.1533	0.8295	For avg gas prices: $1-$2 (gas price level dummies)
log(avggas)	-0.0606	0.1257	0.6851	For avg gas prices: $2-$3 (gas price level dummies)
log(avggas)	-0.3411***	0.0412	0.0000	For avg gas prices: $3-$4 (gas price level dummies)
log(avggas)	-0.5318***	0.1109	0.0000	For avg gas prices: >$4 (gas price level dummies)
pc.gas	-0.0231	0.0165	0.1619	Percentage change in gas price diff (period differences)

Average elasticity is similar to lower end results from previous studies

As individuals drive more, they become more responsive to increases in fuel prices except at the highest levels.

As fuel prices increase, driving behavior response increases at higher levels of fuel prices.

Gas price differences (% change in gas prices) yield similar results to the levels.

Conclusions

- Elasticity of driving with respect to fuel prices increases as the average amount driven increases
- Responses to price signals are significantly higher at increased gas prices
- Understanding individual response to specific factors that interact with changes in gasoline prices is critical to policy decisions that may have effects on behavior differing from the average

Acknowledgments

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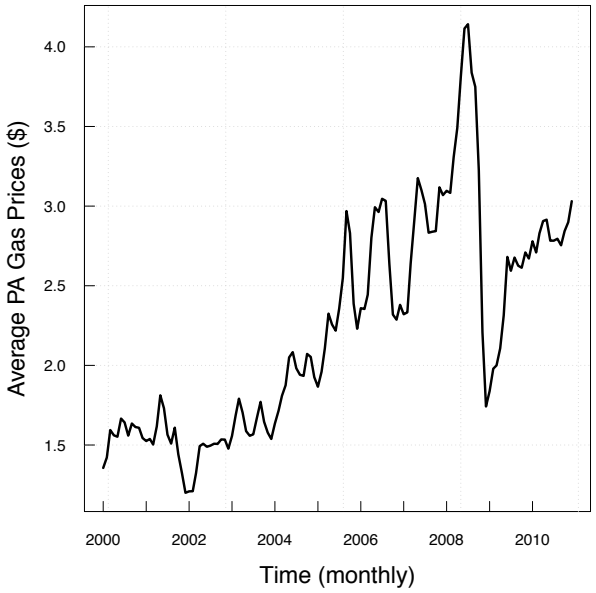
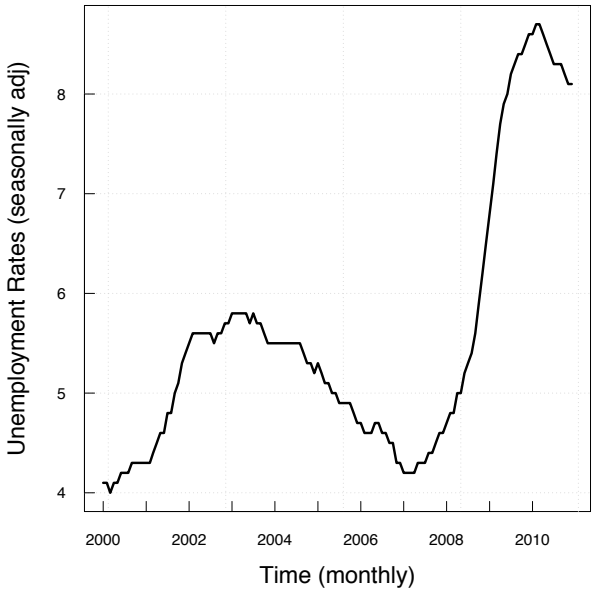
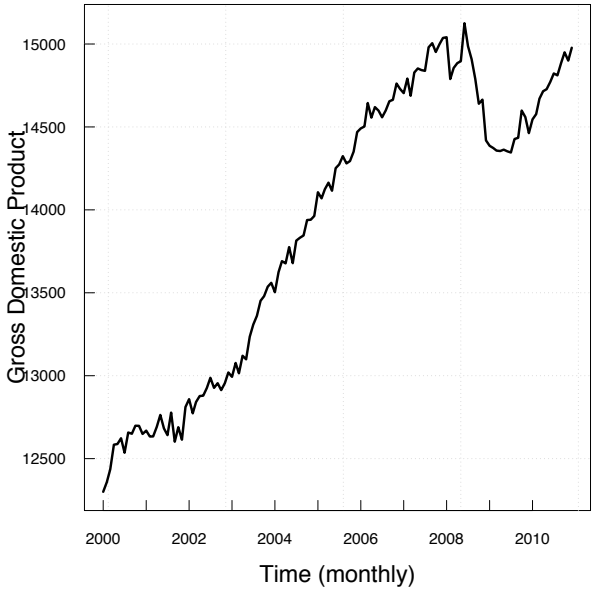
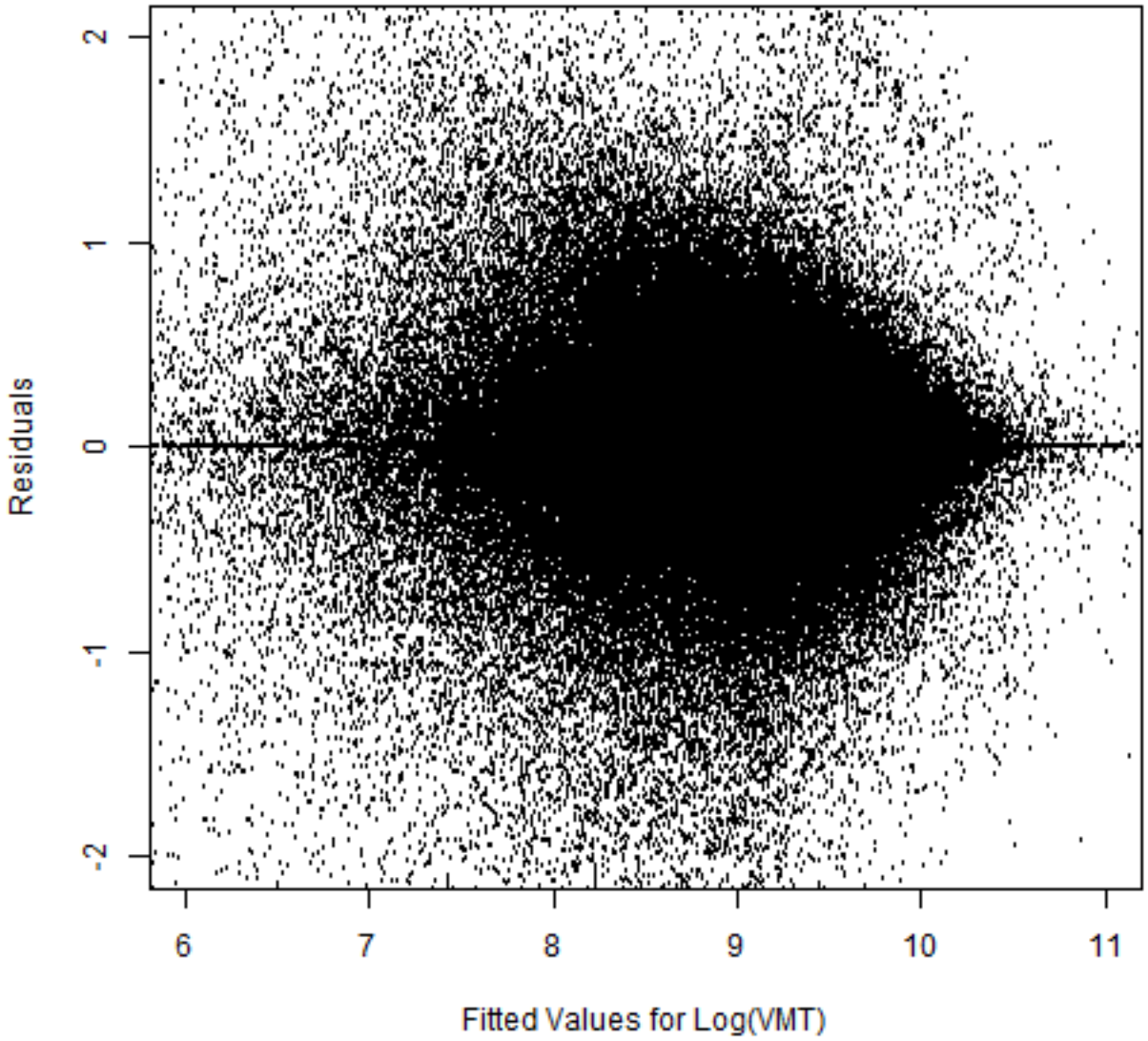

Average PA Gas Prices ($)
4.0
3.5
3.0
2.5
2.0
1.5
2000
2002
2004
2006
2008
2010
Time (monthly)


Unemployment Rates (seasonally adj)
8
7
6
5
4
2000
2002
2004
2006
2008
2010
Time (monthly)


Gross Domestic Product
15000
14500
14000
13500
13000
12500
2000
2002
2004
2006
2008
2010
Time (monthly)


Residuals
2
1
0
-1
-2
6
7
8
9
10
11
Fitted Values for Log(VMT)