

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

Alan Jenn

PhD Candidate

Carnegie Mellon University

Inês Azevedo

Assistant Professor

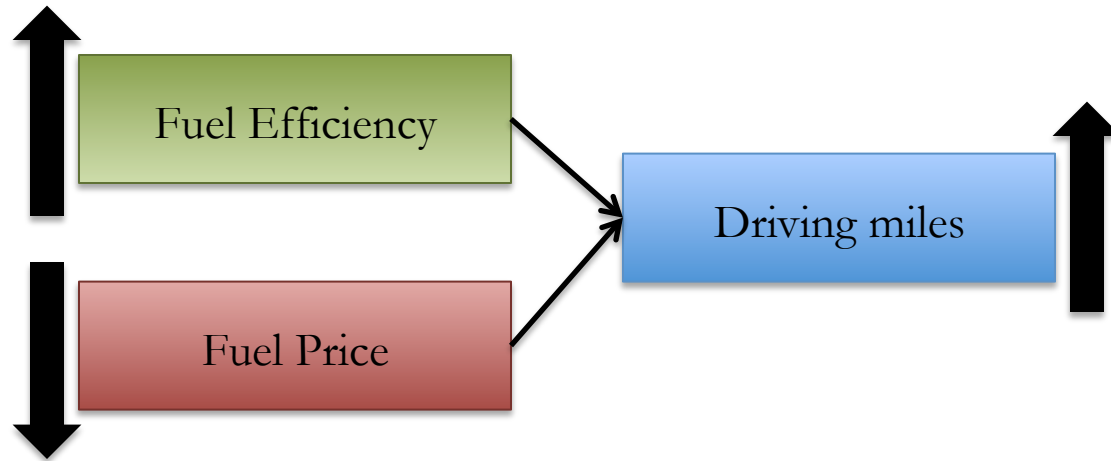
Carnegie Mellon University

Kenneth Gillingham

Assistant Professor

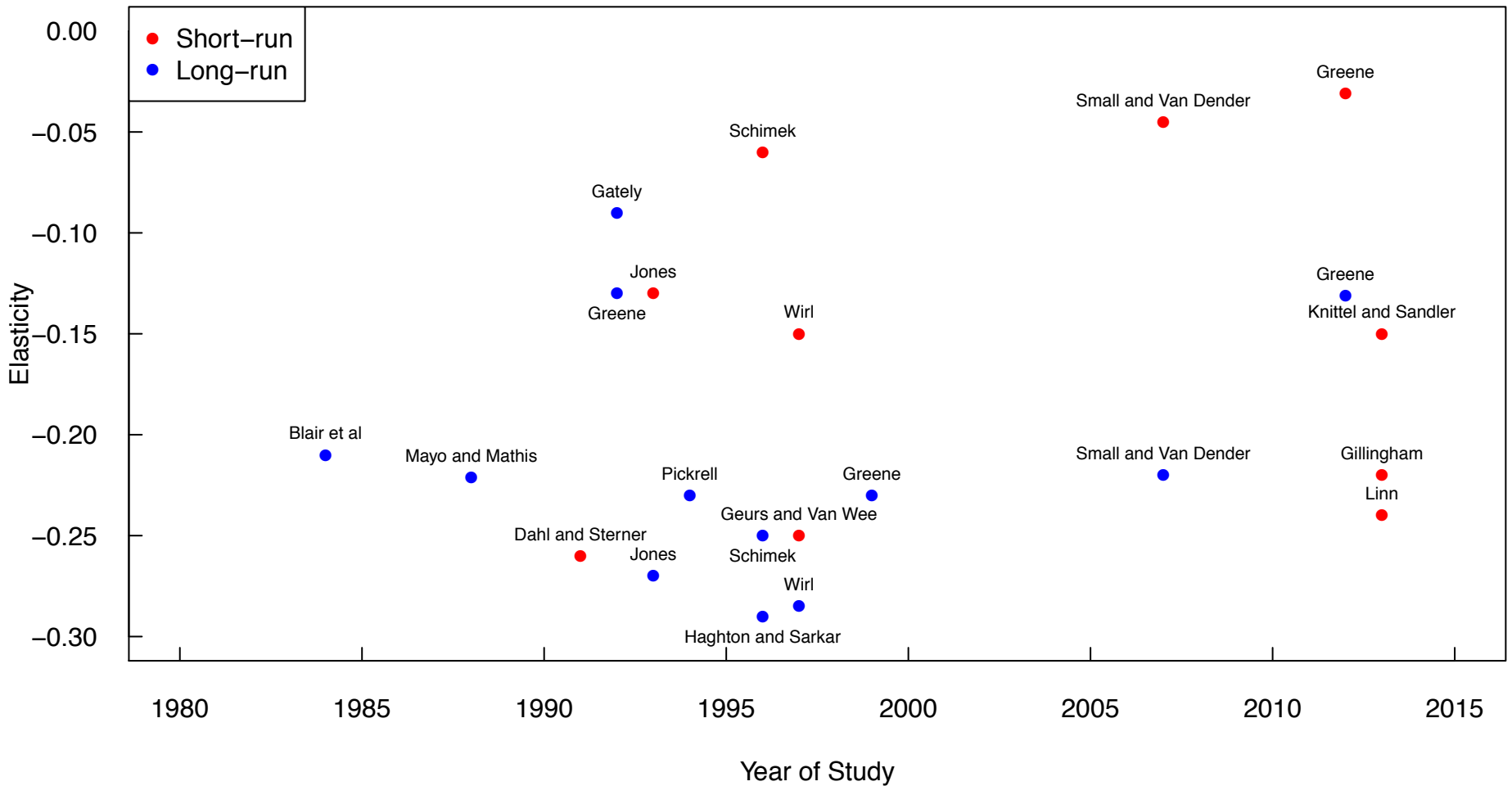
Yale University

Direct Rebound Effect



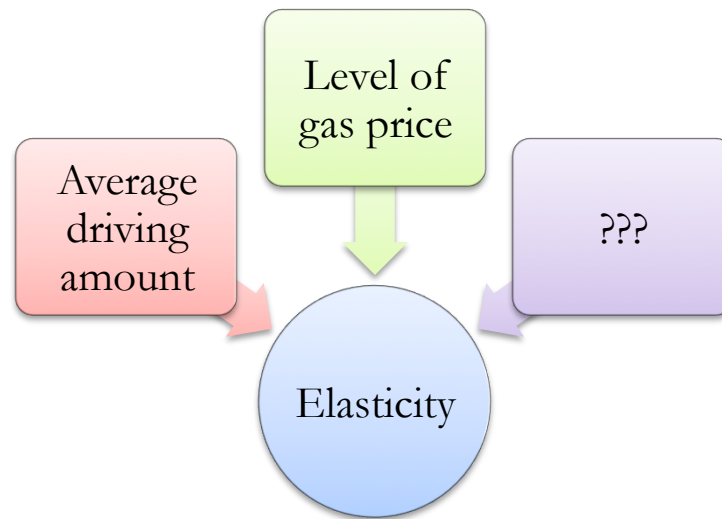
- Determination of the rebound effect has typically been from small samples or survey based data
- Difficult to measure due to lack of data
- Often represented as price elasticity of driving

Literature Review

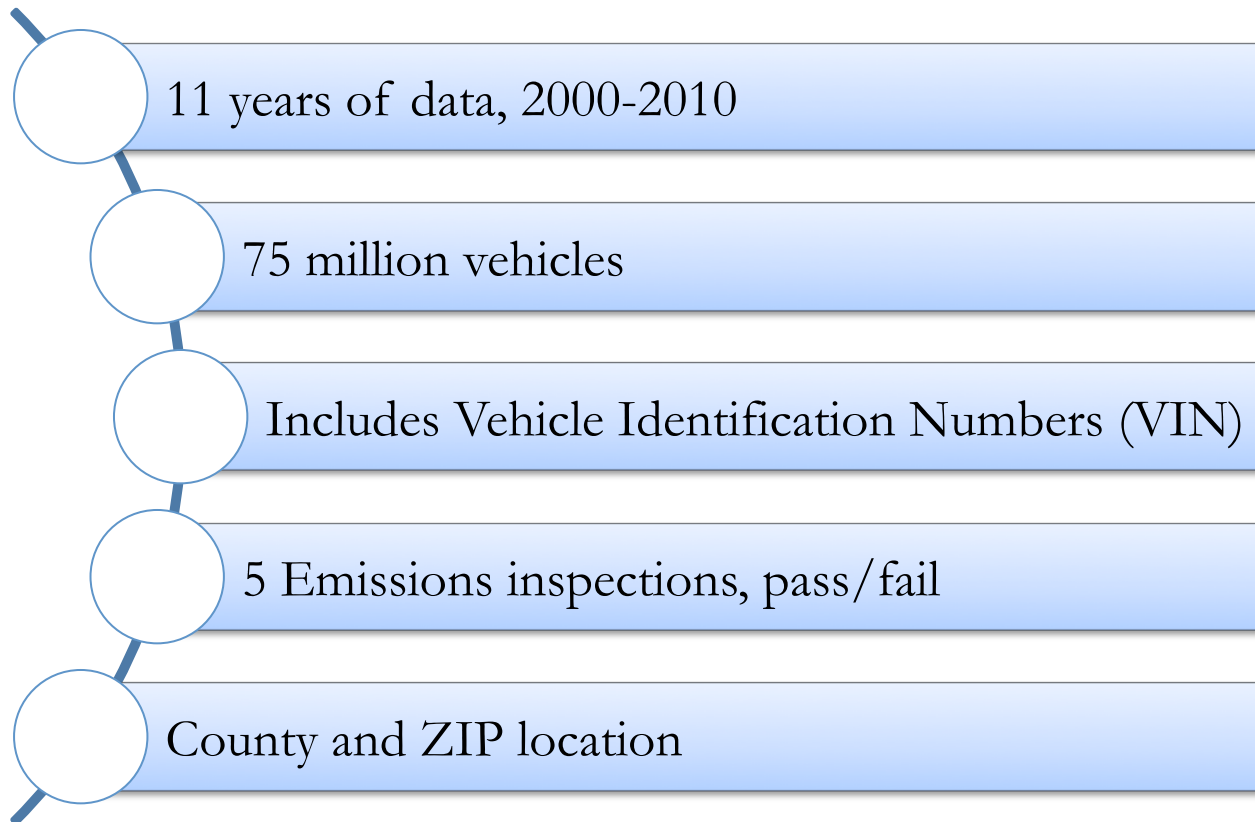


Breaking down elasticity

- 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

VIN	Make	Model	Year	Eng # Size Cyl	DOI	Emissions Tests	Odometer	ZIP	County
JTEHP21A660179134	TOYOTA	HIGHLANDER	2006	3300, 6	01/02/2010	O, I, P, P, P	14966	19341	CHESTER
2MEFM74W24X635782	MERCURY	GRAND MARQUIS	2004	4600, 8	01/02/2010	O, I, P, P, P	47052	19010	PHILADELPHIA
1G3HN5432HW371210	OLDSMOBILE	DRF	1987	3800, 6	01/02/2010	V, I, P, , P	85531	19601	BERKS
1GNDT13W6SK248878	CHEVROLET	S10 BLAZER	1995	4300, 6	01/02/2010	V, I, P, , P	71787	17241	CUMBERLAND
2LMDU88C77B108742	LINCOLN	MKX	2007	3500, 6	01/01/2010	O, I, P, P, P	44478	15642	WESTMORELAND
KL2491188063	CHEVROLET	K20 PICKUP	1979	5700, 8	01/01/2010	V, I, P, , P	75821	17241	CUMBERLAND
1D8HB58D15F625224	DODGE	DURANGO 4WD	2005	5700, 8	01/01/2010	V, I, P, , P	50476	16602	LACKAWANNA
3N1BC13E08L397191	NISSAN	VERSA	2008	1800, 4	01/01/2010	O, I, P, P, P	52446	19047	BUCKS
KNDJE723987517158	KIA	SPORTAGE 4WD	2008	2700, 6	01/01/2010	O, I, P, P, P	8342	19610	LANCASTER
KMHHN65FX4U109645	HYUNDAI	TIBURON	2004	2700, 6	01/01/2010	O, I, P, P, P	28713	19090	MONTGOMERY
5NMSG13D08H143650	HYUNDAI	SANTAFE	2008	2700, 6	01/01/2010	O, I, P, P, P	18381	15601	WESTMORELAND
KM8NU73C28U061794	HYUNDAI	VERACRUZ	2008	3800, 6	01/01/2010	V, I, P, , P	11697	16801	CENTRE
2B4GP24GXYR751781	DODGE	CARAVAN2WD	2000	3300, 6	01/01/2010	O, I, P, P, P	71681	15122	ALLEGHENY
1G3HN52KXW4819230	OLDSMOBILE	EIGHTY EIGHT	1998	3800, 6	01/02/2010	V, I, P, , P	182308	16510	ERIE
1FAFP57U2WA222107	FORD	TAURUS	1998	3000, 6	01/02/2010	O, I, N, N, P	107434	17109	DAUPHIN
3A4FY58B46T215764	CHRYSLER	PT CRUISER	2006	2400, 4	01/02/2010	V, I, P, , P	32911	16441	ERIE
1GYEE637380101008	CADILLAC	SRX	2008	4600, 8	01/02/2010	O, I, P, P, P	20654	15206	ALLEGHENY
1D7HU18D85S307356	DODGE	RAM 1500 4WD	2005	5700, 8	01/02/2010	V, I, P, , P	72414	16823	CENTRE
1FMYU93195KC28179	FORD	ESCAPE	2005	3000, 6	01/02/2010	O, I, P, P, P	102946	19064	DELAWARE
1B3HB28B97D270444	DODGE	CALIBER	2007	2000, 4	01/02/2010	O, I, P, P, P	50747	18109	LEHIGH
1N4AL21E19C103298	NISSAN	ALTIMA	2009	2500, 4	01/02/2010	O, I, P, P, P	6849	18042	NORTHAMPTON
1GKDT13S452188663	GMC	ENVOY	2005	4300, 6	01/02/2010	O, I, P, P, P	59514	19053	PHILADELPHIA
4S2CY58VXR4351530	ISUZU	RODEO	1994	3200, 6	01/02/2010	A, I, P, P, P	186180	19120	DELAWARE
2S3DB117776122256	SUZUKI	XL7	2007	3600, 6	01/02/2010	O, I, P, P, P	29055	15642	WESTMORELAND

Distribution of Vehicles

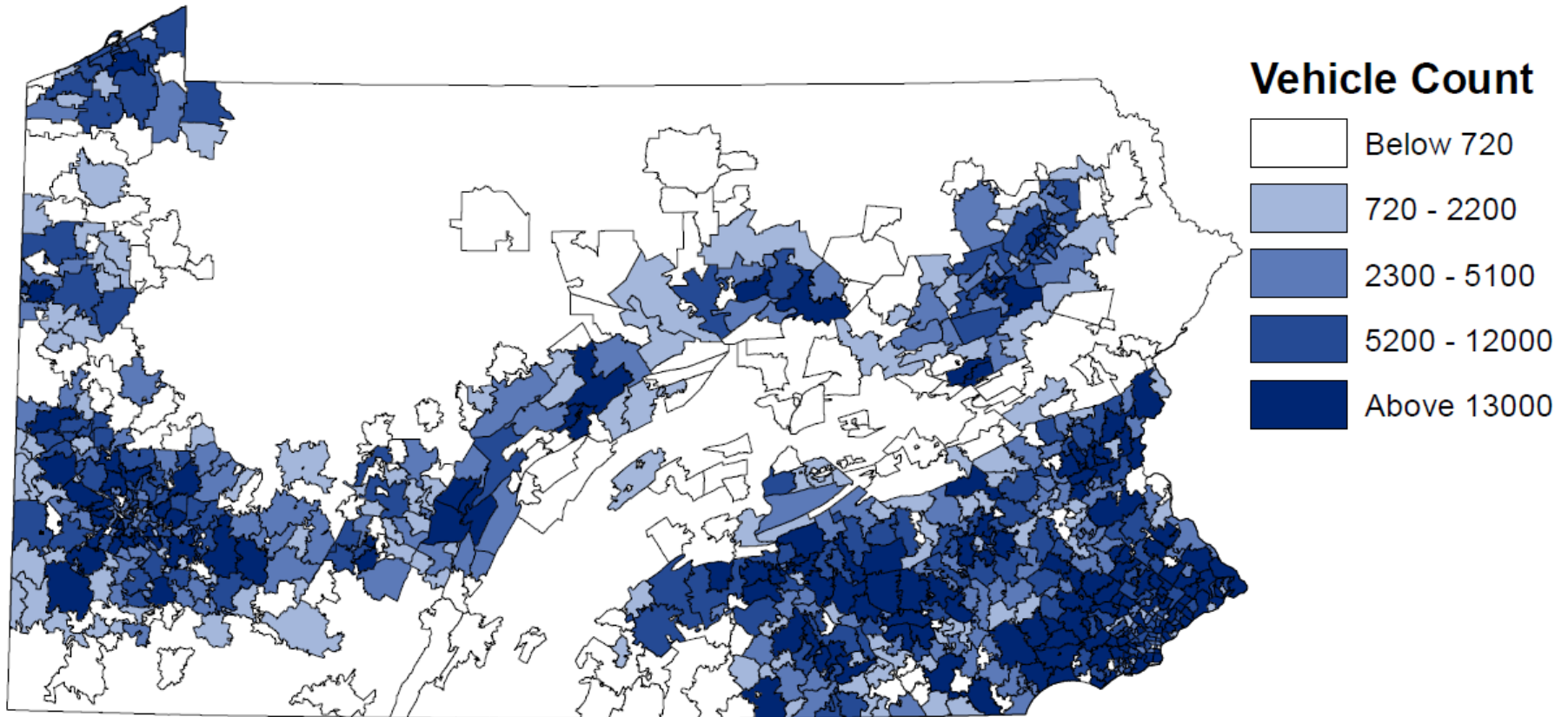


Figure 1: Distribution of vehicle counts in Pennsylvania by ZIP code

Distribution of Fuel Efficiency

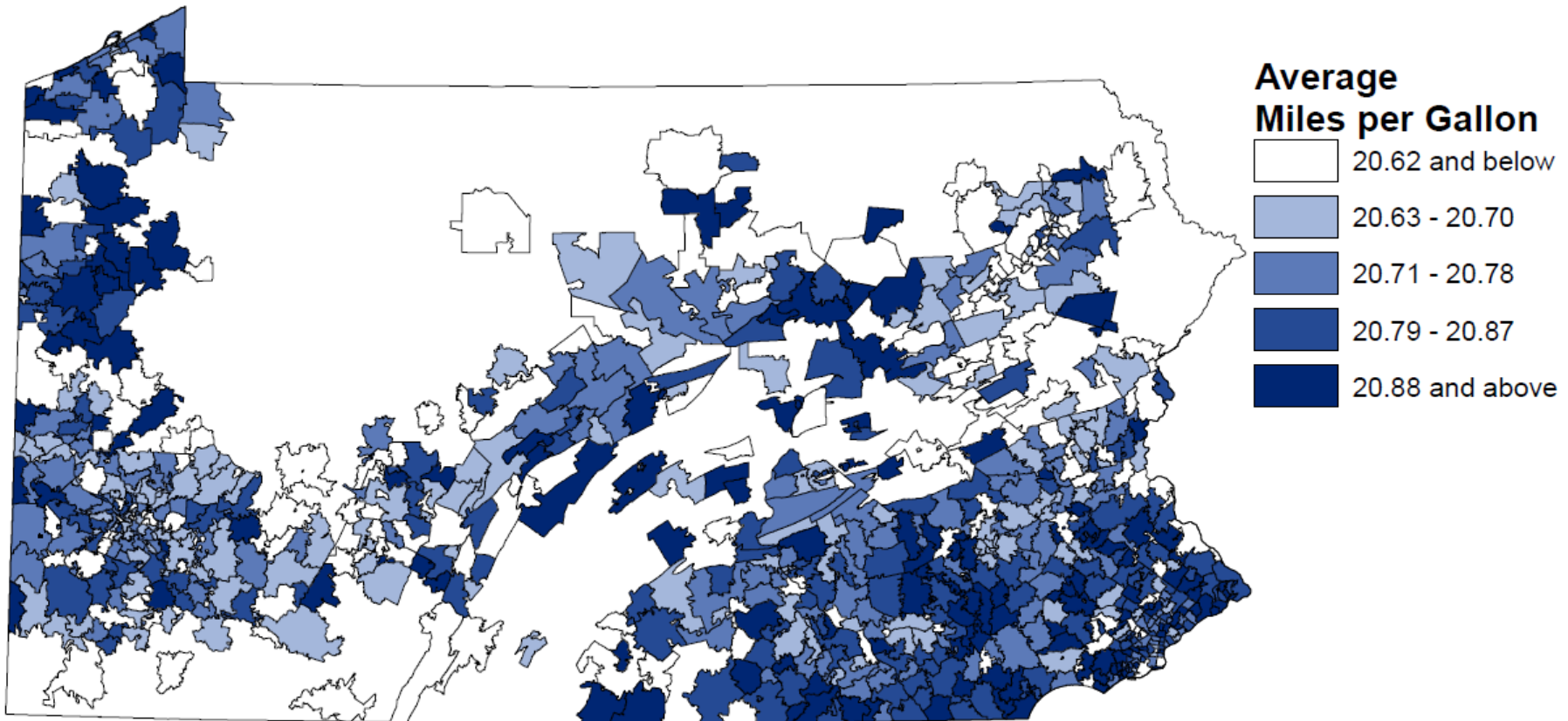


Figure 2: Distribution of vehicle fuel efficiency in Pennsylvania by ZIP code

Annual Driving Behavior

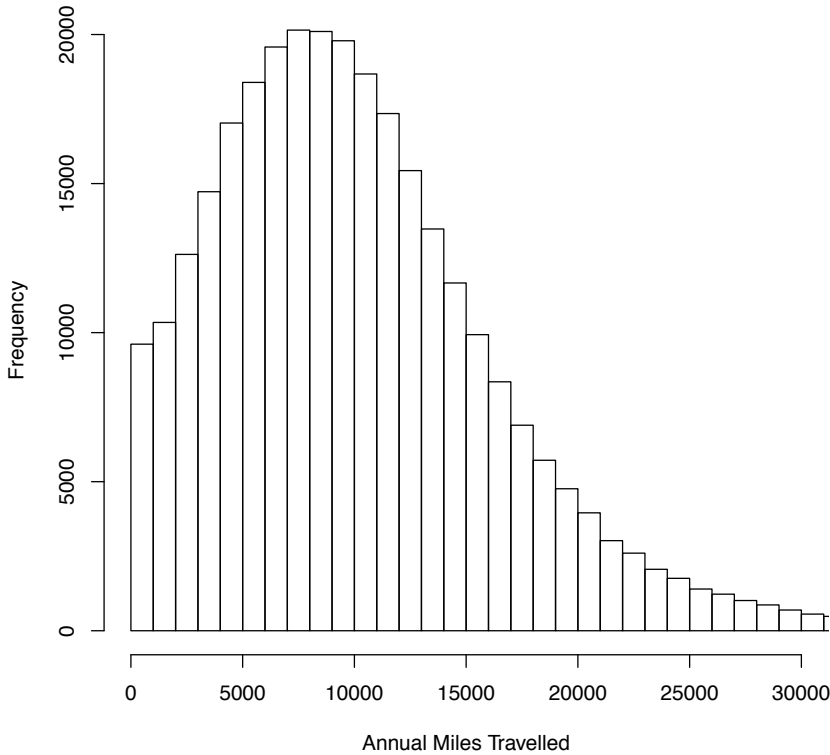


Figure 3: Histogram of annual vehicle miles travelled in PA

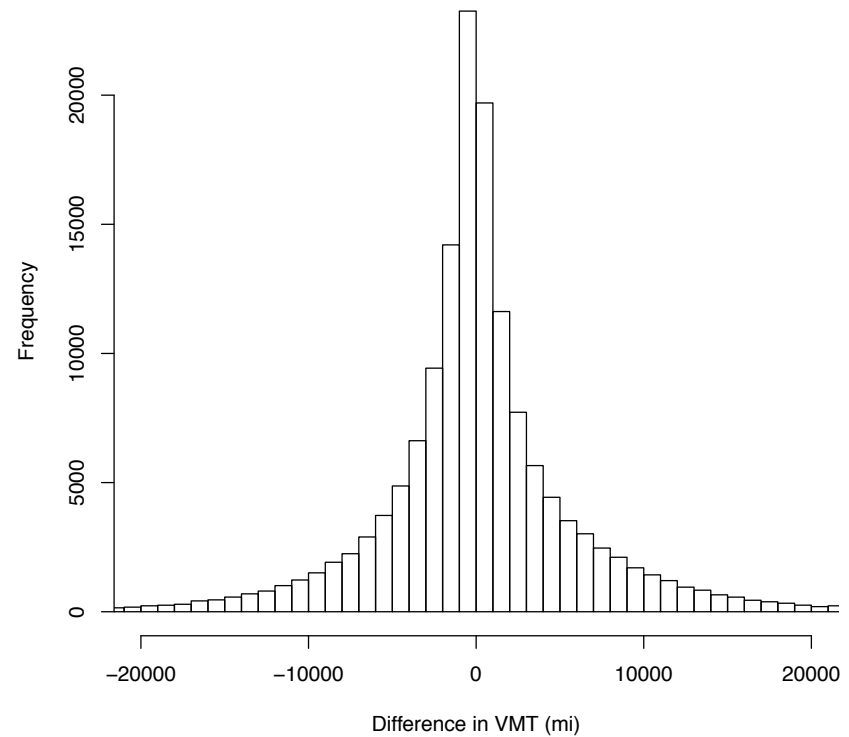


Figure 4: Histogram of annual differences in vehicle miles travelled in PA

General specification model

Average gas price a consumer faces between inspections

Vehicle attributes (depends on panel variables):

- Age
- Model
- Make
- Fuel efficiency
- Price
- ...

Fixed effects groups:

- VIN
- Monthly time dummies
- ZIP code/county
- [Vehicle attributes]

$$\log(VMT_{it}) = \alpha \log(gast_t) + \beta \log(\mathbf{M}_t) + \gamma(\mathbf{V}_t) + \zeta(\mathbf{D}_{it}) + \delta(\mathbf{x}_{it}) + u_{it}$$

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

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