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Analysis of Heterogenous Speeding Behavior

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ABSTRACT

Analysis of Heterogenous Speeding Behavior [*]

Do drivers adjust speeds to save money when gasoline prices rise? Previous research produced mixed results of this energy saving hypothesis. In this paper, building upon Wolff (2012), we first replicate the analysis using a hourly dataset of Washington State highway speeds. We find a modest but statistically significant decline in speeds due to increasing gasoline prices. Precisely, an one dollar increase in gas prices reduces the average speed by 0.27 mph, changing the average highway speed from 70.82 to 70.55 mph, which could translate into substantial gas expenditure savings on the order of $1 billion annually if similar reductions were seen on all U.S. highways. Second, in terms of heterogeneity, our research finds that the fastest drivers reduce speeds underproportionately, potentially undermining the safety objective of a gasoline tax. Finally, the speed changes are mainly caused by the gasoline price that drivers pay at the pump. The high public media attention given to gas prices had relatively little effect on speeding behavior.

JEL Classification: J22, Q49

Keywords: value of time, heterogeneous speeding behavior, highways

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[*] Note: Portions of this paper have been previously submitted. The working paper is referenced here as Wolff (2012) and available at http://faculty.washington.edu/hgwolff/VOT.pdf. We feel this portion is worth repeating in the transportation literature, especially as lead-in to the second half of the paper on heterogeneity, which is new material.

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INTRODUCTION

Do drivers seek to conserve gasoline by reducing speeds in times of high gasoline prices? It has been repeatedly hypothesized in the literature that speeds decrease with rising gas prices. (1, 2, 3, 4) These studies have used annual U.S. traffic speed data and generally claim to find strong evidence in favor of the energy saving hypothesis. Annual data, however, can be difficult because of changes in trends in the vehicle composition, types of measuring stations used and fluctuating yearly weather patterns. More recently, Burger and Kaffine measure the speed-price relationship using weekly speed data from Los Angeles and they find the opposite: with *rising* gas prices, speeds *increase.* (5) Though at first counterintuitive, this result stems from the fact that higher gas prices decrease congestion. Burger and Kaffine then investigate the price-speed relationship exclusively during uncongested night time periods only and they reject the energy saving hypothesis that drivers reduce speeds when gas prices are high. (5)

In agreement with earlier work and disagreement with Burger and Kaffine, previous work by the authors takes a fresh look at the data and estimates a statistically significant and robust negative relationship between drivers' speeding behavior and gasoline prices (6). In this study, instead of using annual data (1, 2, 3) or weekly data (5), the most disaggregated available hourly dataset of speeds for the highway system within the State of Washington has been collected. In addition, because gasoline prices are highly cyclical over the calendar year (with high prices during the summer and lower prices during darker winter months), this previous work shows that neglecting to cautiously control for external driving conditions will produce an erroneous rejection of the gasoline conservation hypothesis (6).

The same dataset is used in this study. This dataset is constructed with the most homogenous exterior environment as possible, controlling for weather and traffic related congestion effects. In sum, these changes to the estimation method are essential to obtain a much cleaner and more precise coefficient estimate of the causal effect of gasoline prices on drivers' speeding behavior.

The research presented here reiterates the findings of the vehicle-speed-gas price relationship and investigates two additional questions. First, this study seeks to determine if the incentive mechanism is heterogeneous across different types of drivers. This dataset contains the whole distribution of speeds within each hour, therefore the relationship at various percentiles can be estimated. Additionally, the information mechanism by which drivers are affected is isolated, allowing analysis as to whether the changes in speed are due to the price signal at the gasoline station, or due to public media attention. Repeatedly, news outlets have covered tips on how to save gas, i.e. "*You can assume that each 5 m.p.h. you drive over 60 m.p.h. is like paying an additional $0.24 per gallon for gas*" (7). Therefore, a weekly dataset on the number of articles from the *New York Times* and the *Seattle Times* that refer to gas prices has been constructed.

STUDY DATA

The ideal situation to observe the effect of gas price on vehicle speed would be a freeway with no speed limit in a location with no congestion under perfect weather conditions. In this situation, drivers would only be constrained by their perceived gas usage and the perceived safety impacts of their speed. Therefore, this study is limited to locations with a speed limit of 70 mph, the highest speed limit in Washington State.

For this study, hourly data was merged from the following five datasets from January 3, 2005 to December 31, 2008:

1. Hourly speed data collected by the Transportation Data Office of the Washington State Department of Transportation (WSDOT) at eight rural locations in Washington (see Table 1) (8, 9).
2. Hourly temperature precipitation and visibility information from the weather stations closest to our speed measurement sites, downloaded from the NOAA Local Climatological Data database (10).
3. Weekly average gasoline prices from the Department of Energy's Energy Information Administration, averaged across the state of Washington using sales of all grades (11).
4. Site specific monthly local unemployment rate statistics from Local Area Unemployment Statistics of the Bureau of Labor Statistics (12).
5. Site specific per capita personal income of the metropolitan statistical areas nearest to the respective highway location from the CA1-3 series of the Regional Economic Accounts at the Bureau of Economic Analysis (13).

For the speed data, sites free from horizontal curvature, with relatively level terrain, away from on-ramps and off-ramps, and with speed limits of 70 mph in *both* directions of the highway were chosen to minimize the influence of such outside factors. All sites are entirely located in low traffic volume areas, with a per-lane average of one vehicle passing the loop detector every 29.5 seconds. This has the advantage that neighboring vehicles have relatively little influence on peer drivers. Each hour WSDOT records all vehicles passing over the loop detectors and quantifies speeds in five mile per hour (mph) increments from 35 mph to above 100 mph. Table 2 summarizes the descriptive statistics of the data used in the analysis.

The relationship between gasoline price and weekly average vehicle speed is displayed in Figure 1 using the data from the eight speed measuring sites. As is clearly visible on the right axis, gas prices have generally been increasing with a definite spike in mid-2008. In addition, gas prices are cyclical in nature with higher prices in the summer and lower prices in the winter months. With respect to the speed measurements shown on the left axis, each dot represents the average weekly speed by highway location. The bold grey line displays average speed estimated by the locally weighted scatterplot smoothing method with bandwidth of 0.3. Often observations are missing in large portions of the dataset, which is typical for this type of data. Rather than interpolating the missing hourly speed data, all observations are dropped from the dataset with missing speed information, which reduced the original dataset by 18.9%.

DATASET REFINEMENT

Burger and Kaffine show that this direct effect of the price of gasoline on speeding behavior has to be estimated in the absence of congestion because otherwise observed speeds are merely a reaction of changes in travel demand affecting congestion by using both on uncongested and congested freeways in Los Angeles (5). They find that in an uncongested condition there does not exist any statistically significant effect on gasoline prices. In contrast, in congested conditions (from 6 to 8am and 4 to 6pm), they find that for every $1 increase in gas prices, the average increase in freeway speeds is 3.4 miles per hour (mph). Based on the insignificant change in uncongested speeds, they conclude that perhaps the value of time is high enough that the difference in speed cannot be controlled by a change in gasoline prices.

As a point of reference, the relationship between speed and gasoline is estimated in the author's earlier work using the same method as in Burger and Kaffine. By aggregating the dataset to weekly data, the WSDOT dataset also suggests that the energy conservation hypothesis should be rejected (6). Therefore, in order to further eliminate factors that confound the relationship between speed and gas price, some data refinements are applicable. Compared to the previous estimation methods, two major changes are made. First, instead of using weekly averages, *hourly speed data* is used. Secondly, a dataset with the most homogenous exterior conditions as possible is constructed. Data has been filtered (dropped) for any hour and site with the following conditions:

A. All observations are dropped if the average speed is less than 67 mph. By filtering for time periods with unusually low speeds (due to accidents, temporal construction activities, congestion or other factors) any unusual hour is removed from these typically uncongested segments of roadway.
B. To use only traffic information at times of perfect sky conditions, all observations with a NOAA variable 'visibility' of less than ten miles are dropped.
C. To account for the effect of precipitation on traffic behavior, all hours within two hours of rain, including hours with trace amounts of rain, are dropped from the data set.

D. Finally, all hours are dropped with outside temperatures of 32 degrees Fahrenheit or less. In addition, all hours are dropped if temperature is missing in a ‘winter’ month, where ‘winter’ is defined site-specific as the set of months with historic (2005 to 2008) minimum temperatures below 32 Fahrenheit.

Note that none of the conditions A. to D. should be correlated with the direct behavioral response of speeds due to a change in gas price. To obtain this dataset, the total number of observations was reduced by 36%. The percentage reductions by each variable are displayed in Table 3 in columns 1 and 2 and the PM period in column 3 and 4. As will be explained below, the PM period is major focus in the analysis. Overall Table 3 shows that the weather variables have the largest influence on the reduction of the number of observations.

By conditioning on the set A. through D. to obtain the dataset of speeds with the most homogenous exterior conditions as possible, the direct impact of the price of gasoline on drivers speeding behavior is estimated by

$$Speed_{ih} = S(P,\theta) = \alpha + \beta * price_t + M_t + Y_t + F_i + \gamma X_{it} + \varepsilon_t$$

where *Speed* is the average speed at hour *h* and site *i*, $price_t$ is the weekly average gas price, F_i are freeway site fixed effects, Y_t are year fixed effects and X_{it} are precipitation, holiday and summer dummies as well as income and unemployment.

RESULTS

The resulting estimates of coefficients together with their robust standard errors which are clustered by week are shown in Table 4 and 5, along with the adjusted R-squared statistic measuring the fit for each equation.

Table 4 shows that speeds significantly decrease by 0.16 to 0.19 miles per hour (mph). Column 1 confirms the significance of the month dummies. Note, however, that the inter-year speed range is equal to 0.6 miles per hour from January to July and hence the cyclicality is much less pronounced compared to the cyclicality in the weekly regression of Table 3. Column 2 in addition displays the hourly fixed effects and shows that speeds are generally highest in the afternoon/after-work time period of 4pm to 6pm. The final regression, column 3, additionally controls for timeblock dummies which account for non-workdays (Saturday, Sunday and Holidays), and weekday time periods whereby weekday time periods are further divided into AM (6 to 10 am), Midday (10 am to 4 pm), PM (4 pm to 6 pm), Evening (6 pm to 12 am) and Night (12 to 6 am) fixed effects.

Building upon this basic regression framework, in Table 5 all fixed effects are interacted with each other to find that the magnitude of the gas price coefficient slightly increases to -.20 and -.0.22 in column 1 and 3, the latter also controlling for income and unemployment. While both income (correlation of 0.41) and unemployment (correlation of 0.32) are highly correlated with gas price, only unemployment has a modest but significant negative effect on speed, while income instead is insignificant. Finally in column 2 and 4, the gas price coefficient is unpooled over the timeblocks to find that generally speeds reduce most in the weekday PM period and reduce least in the AM period and at night time (statistical significant based on p<0.01 level Wald-tests). The speed reduction effects due to a one dollar increase in the price per gallon of gas are displayed in Figure 2 joint with their 95% confidence intervals.

Because speeds are generally highest in the PM timeblock (see column 2 of Table 4), the PM time period will be analyzed in more detail. This PM vehicle fleet is likely more representative with respect to the behavior of private vehicle owners. In other time periods of the day, a greater percentage of the fleet is made up of trucks and commercial vehicles, which can have more heterogeneous speeds due to vehicle type and weight. While this data does not include vehicle classification, the variance of speeds within the PM period is 50% lower compared to other time periods. This indicates that the PM time period is more homogenous with respect to the composition of the type of vehicles. Also, the incentive to conserve gasoline by commercial drivers is different if gasoline expenses are reimbursed.

Table 6 displays the results of the PM models analogous to the previous specifications and shows that gas prices reduce speeds by 0.25 or 0.29 mph for a $1 increase in the price of gasoline per gallon. Also note that for the PM model now income renders significant with a positive sign, as expected. The preferred estimate of the PM model is column 3 implying a significant reduction of speed by 0.27 mph or equivalent an elasticity of speed with respect to the price of gasoline of minus 0.01.

IMPACT OF GAS PRICE ON THE DISTRIBUTION OF SPEEDS

The previous analysis shows that gas prices do affect the speed of drivers. In addition, the fastest drivers are the least efficient from a consumption perspective. According to

Davis *et al*., vehicles traveling 75 mpg consume on average between 24% (midsize car) to 34% (large SUV) more gasoline compared to a speed of 55 mph (14). Do high gasoline prices effect these fast drivers overproportionally? Or do these drivers enjoy speeding on its own, irrespective of the price of gas? Information on the hourly speed distributions is used to test this by running bin percentile regressions of the proportion of vehicles in each hour within the ten speed bins from 55 mph to the fastest bin of drivers speeding above 100 mph in 5 mile per hour increments. The resulting estimates of elasticity coefficients are shown in Figure 3, Panel (a), for the PM period. The ten displayed elasticities are derived by respective ten separate regressions with the dependent variable being the natural logarithm of the proportion of vehicles driving within the indicated speed bin and the independent variable defined as the logarithm of the gas price. All regressions include year, month and site fixed effects. The 95% confidence intervals are computed via robust standard errors clustered by week.

For the majority of drivers, this sequence of estimated elasticities is approximately U shaped with a minimum at the 70 to 80 mph bin regressions. At the left tail, all estimated elasticities are negative but for the two slowest bins. This is consistent with the story that these are the bins where some of the previous faster drivers accumulate. Also the elasticity is positive for the very fastest drivers with speeds above 100 mph. However, the confidence intervals in the tails become very large. To obtain a better picture, the relationship is re-estimated using a larger dataset with all observations from any workday in Panel (b) of Figure 3. Despite the fact that the confidence intervals are still large, Panel (b) more clearly shows the U-shaped nature with negative elasticities in the range of the 70 to 85 and a positive point elasticity for the very fastest speed bracket. This positive elasticity for the vehicles above 100 mph can be interpreted as evidence that these drivers enjoy speeding by itself, irrespective of the gas price. Further, because with higher gas prices traffic volumes decrease, more space between vehicles on the highway may provide an additional incentive to 'test' the vehicles speeding ability.

INFORMATION EFFECTS

Finally, it is useful to single out the cause of the information mechanism by which drivers are affected. Are the changes in speed influenced by the price signal paid at the gasoline station pump, or is public media attention affecting the driving behavior? Using all articles from the *Seattle Times* from 2005 to 2008, the number of times the term "gas price" occurred by week was counted (15). As shown in column 1 and column 3 in Table 7, both the gasoline price and the magnitude of news reporting reduce traffic speeds significantly. When both variables are included simultaneously in the regression (displayed in column 2), the news variable becomes insignificant, while the price coefficient is qualitatively the same as in the basic model (yet reducing in magnitude by 15% from -0.27 to -0.23). Drivers react primarily to the price signal and the news reports merely are correlated with gas prices but do not seem to substantially affect driving behavior. Columns 4 and 5 repeat the regressions for the *New York Times* which leads to similar implications that drivers in Washington State react mostly to the pain at the pump. The gas price coefficient in the joint estimation of column 4 is 33% below in magnitude compared to the basic model without news of column 1 (a reduction from -.27 to -.18). In sum, these regressions show that the media impact explains about 15% (*Seattle Times*) to

33% (*New York Times*) of the speed reduction behavior and that the majority of the impact is caused by the price signal at the pump.

CONCLUSION

This paper contributes to the rapidly evolving transportation literature asking: Do drivers seek to conserve gasoline by reducing speeds in times of high gasoline prices? The time period from 2005 to 2008 saw an unprecedented increase in retail gas prices from below \$2.00 to over \$4.40 per gallon of gasoline. The headlines from the summer 2008 tell the story best: “Record gas prices may curb summer demand.” (16); or “Outraged consumers look to sustainable fuel solutions for gas price pain relief” (17). As the debate on gasoline taxes continues to unfold (18), economists are increasingly interested in the mechanisms by which gasoline prices affect gasoline demand.

This research adds to this literature by providing the first empirical estimate of habit formation effects using disaggregated hourly speeding data, and finds that a one dollar increase in gas prices reduces the average speed by 0.27 mph, changing the average highway speed from 70.82 to 70.55 mph. This could translate into a gas expenditure savings on the order of \$1 billion annually if similar reductions were seen on all U.S. highways. These results may not be generalizeable to other areas of the country however depending on the psychology of driving patterns and usage habits. This study should be replicated in other locations where similar hourly speed data is available.

Furthermore, this research sought to determine if the incentive mechanism is heterogeneous across different types of drivers. Using a dataset containing the whole distribution of speeds within each hour, the relationship at various percentiles was estimated. Speeds are reduced most in the range of 70 to 80 mph. Fast drivers (above 85 mph) reduce speeds under-proportionately. In the extreme tail of the distribution, the number of drivers speeding above 100 mph even increases with gas prices. Higher prices reduce traffic volumes and the additional space between motorists provides incentives to test the speeding ability of the vehicle. Hence, because gasoline prices least influence the fastest drivers, a gasoline tax targeting safety has limited effects.

Finally, this research has isolated the information mechanism by which drivers are affected to investigate whether the changes in speed are due to the price signal at the gasoline station, or due to public media attention. Repeatedly, news outlets have covered tips on how to save gas, i.e. "*You can assume that each 5 m.p.h. you drive over 60 m.p.h. is like paying an additional $0.24 per gallon for gas*" (6). Using a weekly dataset on the number of articles that refer to gas prices constructed from the *New York Times* and the *Seattle Times*, the time series of gas price and media coverage are found to be highly correlated. Statistically, it is the price at the pump which dominates the observed changes in speeding behavior.

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TABLE 1 Speed Data Site Locations

Site	WSDOT Site	Jurisdiction	Freeway	Direction	NOAA Weather Site
1	R045	Woodland	I-5 MP 20.14	Northbound	Kelso
2	R045	Woodland	I-5 MP 20.14	Southbound	Kelso
3	R061	Eltopia	SR 395	Northbound	Tri-cities
4	R061	Eltopia	SR 395	Southbound	Tri-cities
5	R014	Tyler	I-90	Westbound	Spokane
6	R014	Tyler	I-90	Eastbound	Spokane
7	R055	Moses Lake	I-90	Westbound	Ephrata
8	R055	Moses Lake	I-90	Eastbound	Ephrata

TABLE 2 Descriptive Statistics

Variable	Unit	Observations	Mean	Std. Dev.	Min	Max
Average speed	mph	227158	69.189	2.70	32.5	76.88
Gas price	U.S. dollar	227158	2.91	0.59	1.831	4.412
Volume	vehicles per hour	227158	510.79	586.81	0.0	2852
Visibility	statute miles	219644	9.35	2.00	0.0	10.0
Precipitation	inches per hour	227158	.002	.023	0.0	6.60
Temperature	Fahrenheit	219546	51.42	17.45	-14	111
Income	U.S. $	227158	29948.1	2239.6	25963.0	34011.0
Unemployment	%	227158	6.12	1.27	4.00	10.50

Note: unit of observation is per site and hour.

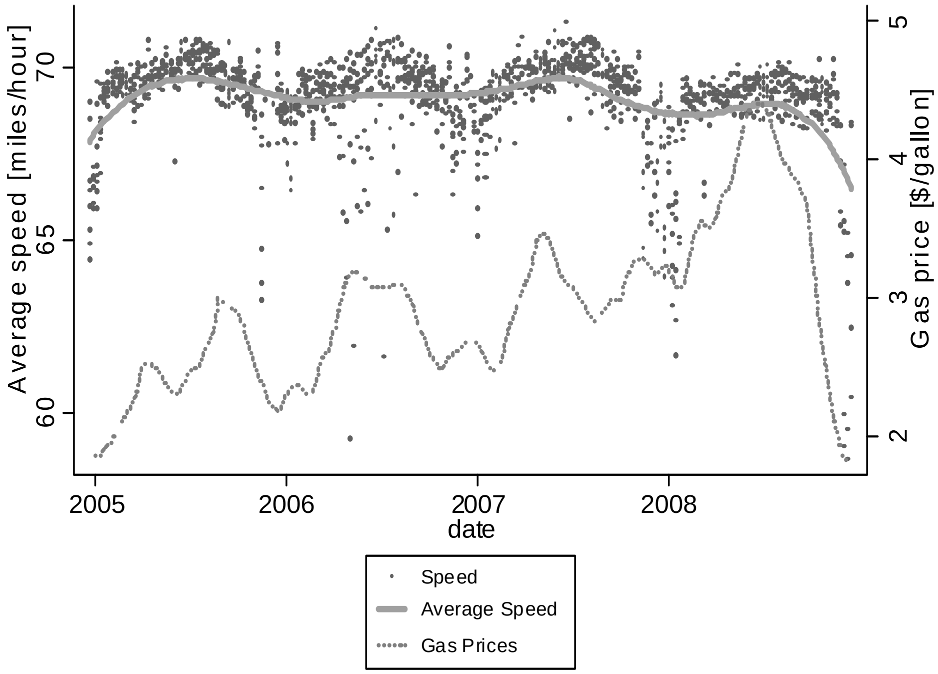


FIGURE 1 Average Speed per Week and Gas Prices, 2005 to 2008

TABLE 3 Data Removed for Regressions

	All Day		PM period	
Data	(1) Observations	(2) %	(3) Observations	(4) %
Rain	30617	13.5%	1754	13.7%
Temp≤32	29967	13.2%	892	6.9%
Visibility < 10	28674	12.6%	1117	8.7%
Avg Speed<67	33326	14.7%	294	2.3%
Total observations Removed	82409	36.3%	3003	23.4%
Total observations remaining	144749	63.7%	9850	76.6%

Note: The sum over the observations removed by each variable do not add to the 'total observations remaining'.

TABLE 4 Hourly Vehicle Speed Regressions

COEFFICIENT	(1) Basic Model (Month, Site & Year fixed effects)	(2) Basic Model & Hour Fixed Effects	(3) Basic Model & Hour & Work and Non-work time Fixed Effects
Gas price	-0.1587***	-0.1688***	-0.1856***
	(0.0478)	(0.0483)	(0.0359)
January	-0.2574***	-0.4730***	-0.5151***
	(0.0849)	(0.0911)	(0.0531)
February	-0.0203	-0.2795***	-0.3182***
	(0.0979)	(0.0900)	(0.0682)
March	-0.0347	-0.1152	-0.0864*
	(0.0787)	(0.0833)	(0.0490)
May	0.0869	0.1031	0.0937*
	(0.0660)	(0.0734)	(0.0529)
June	0.1076*	0.1730**	0.1861***
	(0.0642)	(0.0695)	(0.0546)
July	0.3806***	0.4794***	0.4253***
	(0.0654)	(0.0718)	(0.0482)
August	0.3317***	0.4273***	0.4648***
	(0.0613)	(0.0672)	(0.0439)
September	0.1036	0.1609*	0.1053**
	(0.0770)	(0.0854)	(0.0526)
October	0.0138	-0.0063	-0.0206
	(0.0612)	(0.0671)	(0.0479)
November	0.0216	-0.0956	-0.2369***
	(0.0975)	(0.1012)	(0.0650)
December	-0.0886	-0.2989*	-0.2897**
	(0.1513)	(0.1653)	(0.1338)
Hour 0:00		-2.2348***	-2.4409***
		(0.0278)	(0.0354)
Hour 1:00		-2.5490***	-2.8573***
		(0.0307)	(0.0346)
Hour 2:00		-2.7420***	-3.1392***
		(0.0354)	(0.0340)
Hour 3:00		-2.8335***	-3.2199***
		(0.0365)	(0.0370)
Hour 4:00		-2.7067***	-2.9306***
		(0.0318)	(0.0354)
Hour 5:00		-1.9833***	-2.1432***
		(0.0323)	(0.0405)
Hour 6:00		-1.4900***	-1.5932***
		(0.0294)	(0.0389)
Hour 7:00		-1.0669***	-1.1636***
		(0.0222)	(0.0324)
Hour 8:00		-1.0112***	-1.1080***
		(0.0201)	(0.0318)
Hour 9:00		-0.9508***	-1.0449***

		(0.0209)	(0.0322)
Hour 10:00		-0.8824***	-0.6043***
		(0.0187)	(0.0243)
Hour 11:00		-0.7951***	-0.5160***
		(0.0183)	(0.0246)
Hour 12:00		-0.6975***	-0.4193***
		(0.0170)	(0.0231)
Hour 13:00		-0.5820***	-0.2956***
		(0.0158)	(0.0235)
Hour 14:00		-0.4040***	-0.1194***
		(0.0155)	(0.0239)
Hour 15:00		-0.1628***	0.1205***
		(0.0133)	(0.0232)
Hour 17:00		-0.0153	-0.0171
		(0.0190)	(0.0186)
Hour 18:00		-0.1767***	-0.0162
		(0.0348)	(0.0375)
Hour 19:00		-0.5164***	-0.3513***
		(0.0412)	(0.0424)
Hour 20:00		-0.9375***	-0.7764***
		(0.0347)	(0.0361)
Hour 21:00		-1.3618***	-1.2065***
		(0.0225)	(0.0233)
Hour 22:00		-1.6253***	-1.4796***
		(0.0235)	(0.0239)
Hour 23:00		-1.9395***	-1.8118***
		(0.0252)	(0.0265)
Constant	69.9580***	71.0453***	70.7466***
	(0.1896)	(0.1963)	(0.1439)
Observations	138,162	138,162	138,162
Adjusted R^2	0.06	0.36	0.54

Robust standard errors in parentheses clustered by week. All regressions include month, site and year fixed effects (Basic Model). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

TABLE 5 Hourly Vehicle Speed Regressions

COEFFICIENT	(1) Interacted Fixed Effects Model	(2) Interacted Fixed Effects Model Gas price effect unpooled over Timeblocks	(3) Interacted Fixed Effects Model & unemployment, income	(4) Interacted Fixed Effects Model Gas price effect unpooled over Timeblocks & unemployment, income
Gas price	-0.1950***	-0.2724***	-0.2206***	-0.3009***
	(0.0329)	(0.0490)	(0.0318)	(0.0477)
Gas price x “AM”		0.1233***		0.1279***
		(0.0467)		(0.0465)
Gas price x “Midday”		0.0622		0.0572
		(0.0404)		(0.0401)
Gas price x “Evening”		0.0133		0.0195
		(0.0448)		(0.0449)
Gas price x “Night”		0.1435**		0.1582**
		(0.0623)		(0.0623)
Gas price x “Non-workday“		0.1059		0.1091
		(0.0689)		(0.0671)
Unemployment			-0.1986***	-0.1993***
			(0.0361)	(0.0362)
Income			0.0000	0.0000
			(0.0000)	(0.0000)
Constant	70.8179***	71.1027***	71.0899***	71.4287***
	(0.1370)	(0.1903)	(1.2549)	(1.2684)
Observations	138,162	138,162	138,162	138,162
Adjusted R^2	0.65	0.65	0.65	0.65

Note: The interacted fixed effects model includes month, site, hour, year, timeblock fixed effects as well as the interacted fixed effects of month-timeblock, month-site, month-hour, hour-timeblock, hour-site, site-timeblock, year-site and year-timeblock. Robust standard errors in parenthesis clustered by week. *** p<0.01, ** p<0.05, * p<0.1.

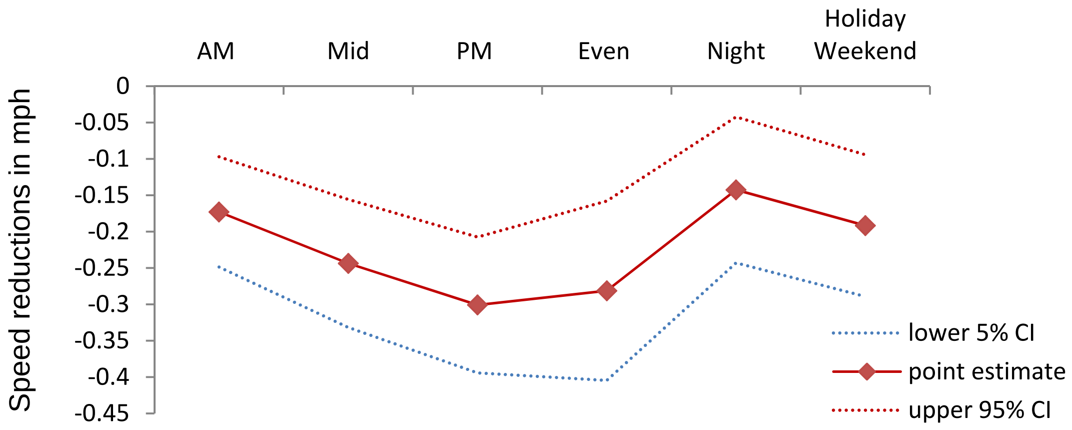
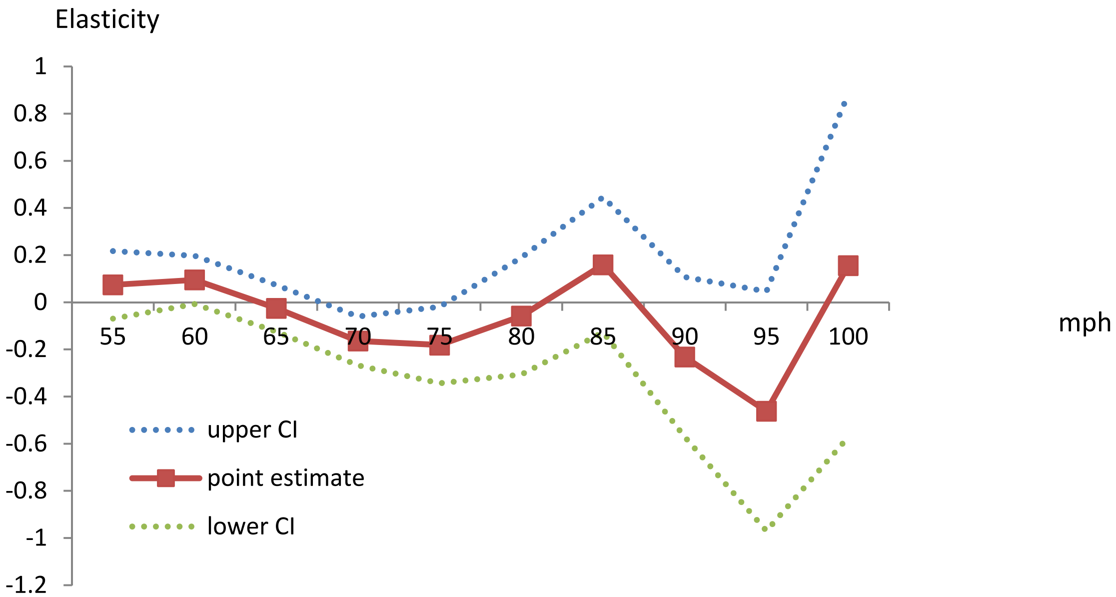


FIGURE 2 Speed Reduction Effects due to a One Dollar Increase in Price per Gallon of Gas

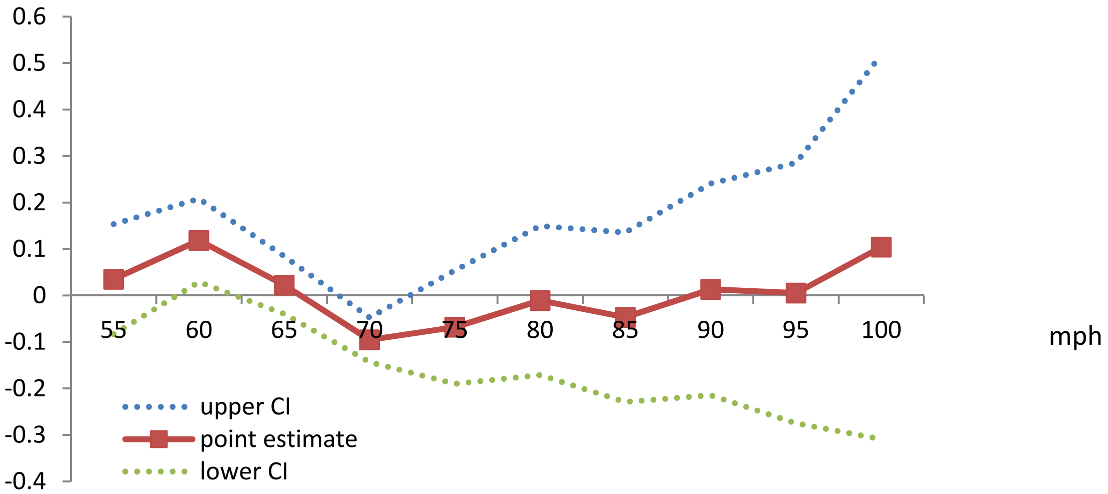
TABLE 6 Hourly Gas Price Speed Relationship in the PM Time Period

COEFFICIENT	(1) Basic Model	(2) Interacted Fixed Effects Model	(3) Interacted Fixed Effects Model with unemployment & income
Gas price	-0.2874***	-0.2491***	-0.2701***
	(0.0528)	(0.0488)	(0.0483)
Unemployment			-0.1514***
			(0.0547)
Income			0.0001***
			(0.0000)
Constant	71.2125***	71.0748***	68.3257***
	(0.2122)	(0.1908)	(1.5866)
Observations	9,390	9,390	9,390
Adjusted R^2	0.27	0.37	0.38

All regressions include month, site and year fixed effects (Basic Model). The interacted fixed effects include month, site, hour, year fixed effects as well as the interacted fixed effects of month-site, month-hour, hour-site and year-site.
Robust standard errors in parentheses clustered by week *** $p<0.01$, ** $p<0.05$, * $p<0.1$



Panel (a) PM Time Period



Panel (b): All 24 Hours on Workdays

FIGURE 3 Percentage Speed Elasticities with Respect to the Price of Gasoline

TABLE 7 Prices versus Information Effects in the PM Time Period

VARIABLES	(1) Basic Model	(2) Basic Model & Seattle Times News	(3) As column 2 without gas price regressor	(4) Basic Model & New York Times News	(5) As column 4 without gas price regressor
Gas price	-0.2701***	-0.2308***		-0.1780***	
	(0.048)	(0.053)		(0.052)	
NY Times				-0.0097***	-0.0128***
				(0.002)	(0.002)
Seattle Times		-0.0024	-0.0046***		
		(0.002)	(0.002)		
Constant	68.3257***	68.3841***	84.3958***	67.5751***	83.8480***
	(1.587)	(1.556)	(0.793)	(1.507)	(0.775)
Observations	9,390	9,390	9,390	9,390	9,390
Adjusted R^2	0.375	0.375	0.372	0.377	0.376

Note: Here 'Basic Model' refers to the 'Interacted Fixed Effects Model' with unemployment and income as additional regressors as in Table 5 column 3 and include month, site, hour, year, timeblock fixed effects as well as the interaction of fixed effects of month-timeblock, month-site, month-hour, hour-timeblock, hour-site, site-timeblock, year-site and year-timeblock. In parenthesis: robust standard errors clustered by week. *** p<0.01, ** p<0.05, * p<0.1.