



Short-run fuel price responses: At the pump and on the road



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ABSTRACT

We provide evidence that motorists respond to short-run fluctuations in fuel prices at the gas pump and not on the road. Employing variants of censored panel regression to control for censoring of the dependent variable, we find that the fuel price has a negative impact on the quantity of fuel purchased, but no consistently significant impact on the subsequent distance driven until the next refill. Over the short run, drivers thus appear to cope with high fuel prices by adjusting fuel purchases with each visit to the filling station, but without altering their daily mileage.

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1. Introduction

Understanding the responsiveness of motorists to fuel price fluctuations is critical to a range of issues that have relevance for public policy, including environmental protection, transport infrastructure planning, and public finance. The estimation of short-run fuel price reactions is of particular importance for two reasons. First, short-run estimates provide insights into how motorists cope with increases in fuel prices when longer run behavioral responses, such as purchasing a new car or changing residential location, are effectively precluded. Second, as a lower-bound estimate of the response to higher fuel costs, the short-run elasticity affords policy-makers with a conservative indicator of the likely effectiveness of price-based instruments in influencing driving behavior and energy consumption more generally.

To date, truly short-run analyses – ones that conclusively hold fixed the role of technology and other long term influences – are relatively smaller in number than long-run analyses or those that draw no temporal distinction. Indeed, as [Graham and Glaister \(2004, p. 271\)](#) note, there is no clear consensus of what constitutes the short- or long run, with the temporal threshold differing across studies. [Hughes et al. \(2008\)](#), for example, derive short-run elasticity estimates from pooled data measured at a monthly frequency, while [Goodwin's \(1992\)](#) and [Crandall's \(1992\)](#) reviews designate the short run as generally referring to any period of a year or less. [Hanly et al. \(2002\)](#) define the short run by way of dynamic models, obtaining estimates varying between -0.01 and -0.57 . Alternatively, in her comprehensive meta-analysis of fuel elasticities, [Espey \(1998, p. 288\)](#) denotes the short run based not on time but on the empirical specification, suggesting that models which include some measure of vehicle ownership and fuel efficiency capture the “shortest” short run by isolating the influence of price and income changes.

Drawing on daily travel survey data from Germany collected annually over a period of six weeks, the current study contributes to the above literature with an analysis that definitively isolates

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the short-run impact of fuel prices on tanking and driving behavior. Several features distinguish the analysis.

First, we operate with the highest possible frequency of observations by taking into account all fuel purchases with each visit to the filling station as well as the daily distance driven following the visit. Second, the model includes household fixed effects, which, together with the tight time interval separating observations, allows us to control for a wide range of unobservable variables that could otherwise bias the estimates. Third, to accommodate constraints imposed by the size of the fuel tank that may prevent motorists from purchasing the desired amount of fuel, our fixed-effects models additionally incorporate the censoring of the dependent variable using a technique proposed by [Alan et al. \(2014\)](#). Fourth, following [Lin and Prince \(2013\)](#), we allow for differential price responses according to recent volatility in crude oil prices by interacting the gas price with the variance in oil prices. Last, because the six week survey is conducted annually, we are able to conduct confirmatory analysis by running a model for each year between 2002 and 2013 separately. This affords the unique opportunity to assess the stability of our model results by using information from an identical data generation process for each of 12 years.

Our findings indicate that when controlling for the censoring of the dependent variable, the relation between fuel price and quantity tanked is in most years statistically significant, with a one percent increase in the fuel price associated with a reduction in the share of the tank filled ranging between 0.25 and 0.87 percentage points. In cars with a tank size of 50 liters, this would amount to a reduction of between 0.125 and 0.435 liters for each percent increase in the fuel price. Conversely, we find that for most of the years analyzed, the fuel price does not determine the daily distance driven between refills. Over the short run, German motorists thus appear to be insensitive to changes in the costs of driving. Unlike [Lin and Prince \(2013\)](#), we find that including controls for the oil price variance and its interaction with the gas price has no substantial bearing on this conclusion. In interpreting these results, we contrast our estimates with those of [Frondel et al. \(2008; 2009; 2012\)](#), who use the same data source but obtain considerably higher estimates of the effect of fuel price on the distance driven.

2. Data description and model specification

This paper uses data from the German Mobility Panel ([MOP, 2013](#)), an ongoing travel survey that annually collects information on the mobility behavior of a representative sample of German households. We focus on a subset of this data referred to as the “tank survey”, which until 2008 drew a 50% sub-sample of randomly selected car-owning households from the larger MOP. As of 2009, the full sample of car-owning households is surveyed. The tank survey takes place over a six-week period in the spring, during which time respondents record various information upon each visit to the gas station, including the price paid for fuel, the amount of fuel purchased, and the odometer reading. Participating households complete the tank survey upwards of three times over three consecutive years, with exiting households replaced by a new cohort.

[Frondel et al. \(2008; 2009; 2012\)](#) sum the distance traveled over the entire six weeks of the survey, and use this sum as the dependent variable in a panel set-up that defines the household as the cross-sectional unit and the year of the survey as the temporal unit. The present analysis takes a different tact. We maintain the household as the cross-sectional unit but structure the temporal dimension of the panel based on the days elapsed between each visit to the gas station within the six week survey period. Distance

traveled between each visit is calculated based on the difference in the odometer reading and normalized by dividing by the number of elapsed days. The resulting measure of daily distance traveled serves as one of our dependent variables. The other dependent variable is defined by the percent of the tank that is filled directly following each visit to the gas station.

To capture responsiveness to fuel prices, the specification includes three explanatory variables: the fuel price paid at the pump, the variance of Brent crude oil prices, and the interaction of the variance with the fuel price. This set-up is similar to that used by [Lin and Prince \(2013\)](#) in an analysis of the role of price volatility on the elasticity of demand for gasoline using aggregate time series data from the U.S. They find not only that gasoline price volatility has a direct effect in decreasing consumer demand for gasoline, but also that the magnitude of the fuel price elasticity is inversely related to price volatility, with a lower elasticity resulting when volatility is medium to high.

As the MOP data set only includes the price paid for gas at the visit to the station, it is not possible to directly follow [Lin and Prince \(2013\)](#) in calculating the gas price volatility for any period preceding the purchase. We instead draw on a daily time series of Brent crude oil prices obtained from the U.S. Energy Information Administration and use the variance in this series over the previous seven days as a proxy. The validity of this proxy depends, of course, on the extent to which Brent crude and retail prices are correlated. Some support is provided by the Federal Ministry for Economic Affairs and Energy ([BMW, 2015](#)), according to which gasoline prices in Germany fundamentally follow Brent crude prices, a point verified empirically by [Kihm et al. \(forthcoming\)](#) in an analysis of retail gas competition. Another question is whether a seven-day interval is sufficiently long to capture an impact of the variance on tanking and driving behavior. This is ultimately an empirical question, one that was explored using alternative intervals of upwards of 30 days, none of which had a fundamental bearing on the results to be presented.

We complete the specification with controls for weekend days. In the model of tanking behavior, this entails the inclusion of a dummy variable indicating whether the gas purchase took place on a Saturday or a Sunday. In the model of distance driven, this variable takes the form of a count of the number of weekend days falling between visits to the gas station. We would expect a negative coefficient on these controls given that weekend travel is largely discretionary.

In assembling the estimation sample, the data is pared along several dimensions. First, recognizing that diesel fuel is not only of higher energy content but also considerably cheaper in Germany compared to gasoline, we remove observations on diesel cars. Second, we remove households who reported taking a car vacation during the observation period, as such episodes are unlikely to be representative of short-run driving behavior. Last, to avoid the complexities of substitution effects among households owning multiple cars, our main focus is on a sample that is limited to households owning just one car, which comprises roughly 62% of all car owning households in Germany ([Ritter and Vance, 2013](#)). We perform a robustness check on a sample that is expanded to include multi-car households. For these households, we select the car that has the highest reported mileage over the survey period.

A separate data set is created for each year between 2002 and 2013. From [Fig. 1](#), we see that the real fuel price in Euros of 2010 for gasoline increased steadily between 2002 and 2008, when the gas price increased from about 1.19 Euro per liter to about 1.50 Euro per liter. The price dropped steeply in 2009 before rising to another peak in 2012 at 1.55 Euros per liter. [Table 1](#) presents descriptive statistics for select variables used in the models as well as variables that describe the structure of the data

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