Transportation Research Part D 38 (2015) 166–177

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Fuel price elasticities in the U.S. combination trucking sector

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ARTICLE INFO

Article history:
Available online 9 June 2015

Keywords:
Freight transportation
Heavy-duty vehicles
Environmental policy
Fuel price elasticity
Rebound effect

ABSTRACT

This paper estimates fuel price elasticities of combination trucking operations in the United States between 1970 and 2012. We evaluate trucking operations in terms of vehicle miles traveled and fuel consumption for combination trucks. Our explanatory variables include measures of economic activity, energy prices, and indicator variables that account for important regulatory shifts and changes in data collection and reporting in national transportation datasets. Our results suggest that fuel price elasticities in the United States' trucking sector have shifted from an elastic environment in the 1970s to a relatively inelastic environment today. We discuss the importance of these results for policymakers in light of new policies that aim to limit energy consumption and reduce greenhouse gas emissions from heavy-duty vehicles.

Introduction

Heavy duty vehicles (HDVs) comprise an increasing share of vehicle miles traveled (VMT) and highway energy consumption in the United States (US). Although the portion of highway HDV VMT has increased modestly from 6% in 1970 to 9% in 2011 (BTS, 2014a), the share of highway HDV energy consumption has increased from 13% to 25% during the same time period (BTS, 2014b, 2014c, 2014d, 2014e). These trends have enhanced the relative importance of HDVs in national energy and emissions reduction strategies.

In 2011, the US embarked on an unprecedented regulatory program that establishes greenhouse gas (GHG) and fuel efficiency standards for the US trucking sector. These regulations were promulgated jointly through the US Environmental Protection Agency (EPA) and the US National Highway Transportation and Safety Administration (NHTSA) (EPA and NHTSA, 2011). EPA has responsibility for regulating GHG emissions from trucks (e.g., gCO_2/ton-mile), and NHTSA has responsibility for regulating fuel consumption (in gallons/1000 ton-mile). The standards, which affect trucks produced between model years 2014 and 2018, are expected to reduce fuel use by ~20% for combination trucks and ~10% for vocational trucks over the vehicle's lifetime (The White House, 2014a). In 2014 the US announced its plans to extend these regulations beyond model year 2018 (The White House, 2014b).

Yet, expectations about fuel savings from fuel efficiency standards may need to be tempered. By improving vehicle efficiencies, these types of regulations also have the effect of reducing fuel costs for trucking firms as measured in $/mile or

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http://dx.doi.org/10.1016/j.trd.2015.04.006
1361-9209/

\$/ton-mile. These reduced fuel costs may induce increased activity or demand for the HDV services that essentially "give back" some of the intended energy savings.[1] This phenomenon has been labeled the "rebound effect" in the energy policy literature (Berkhout et al., 2000; De Borger and Mulalic, 2012; Greene, 2012; Greene et al., 1999; Greening et al., 2000; Matos and Silva, 2011; Small and Van Dender, 2005; Sorrell and Dimitropoulos, 2007; Winebrake et al., 2012).

For a variety of reasons discussed in previous work (Winebrake et al., 2012), there is no widely accepted estimate of the rebound effect from HDV efficiency standards. Additionally, robust time-series data on HDV fuel efficiency is lacking, as discussed in the concluding section of this paper. As an alternative, one can look to other elasticities – such as fuel price elasticities of truck activity – as proxies for the rebound effect under certain assumptions, including the assumption that firms respond to price increases and decreases symmetrically; that firms respond to changes in fuel prices and fuel efficiency uniformly; and that fuel efficiency itself is not affected by fuel price (Winebrake et al., 2012). However, there is some suggestive evidence in the literature that these assumptions may not hold (e.g. Dargay and Gately, 1997; Gately, 1993; Greene, 2012; Hymel and Small, 2015; Sentenac-Chemin, 2012; Winebrake et al., 2012).

This paper estimates fuel price elasticities of combination truck travel activity (measured in VMT) and diesel fuel demanded for the period 1970–2012. The results may be used as a rebound effect proxy under certain assumptions, as discussed above; however, more generally the results can help inform analyses that evaluate the impact of energy pricing on truck energy use, emissions, vehicle travel, and congestion, among others (Dahl, 2012; Graham and Glaister, 2004).

The paper is divided into six sections. Our 'Background' section provides context and background on fuel price elasticities of VMT demand and HDV demand elasticities with respect to energy costs. Next, a 'Data and methodology' section presents the modeling approach we used to evaluate our data. Sections 'Results' and 'Discussion' present our results and discuss these results, respectively. Lastly, the 'Conclusion' section places our results in context with new regulatory actions that exist now or are likely to occur in the near future.

Background

Most literature related to fuel consumption and vehicle travel demand elasticities focuses on gasoline and light duty vehicle (LDV) travel (Dahl, 2012; Espey, 1998; Graham and Glaister, 2004; Greene, 2012; Litman, 2013; Poor et al., 2007). To our knowledge, very little peer-reviewed literature examines fuel price elasticities of HDV travel activity or diesel fuel demand, perhaps because LDVs have been the target of regulations for decades and have tended to dominate highway VMT and energy use in the US (BTS, 2014a, 2014b).

Price elasticities of gasoline demand in the LDV sector tend to range between −0.30 and −0.10. Elasticities of a smaller magnitude are found in the short term and with increasing incomes and lower relative gasoline prices (Brons et al., 2008; Dahl, 2012; Goodwin et al., 2004; Greene, 2012). Fuel price elasticities of LDV travel demand generate similar values; for example Goodwin et al. (2004) estimate a short-run price elasticity of VMT in the LDV sector of −0.10, and a long run elasticity of −0.30, and they note that these elasticities have declined in recent decades. Others have estimated the elasticity of vehicle travel with respect to gasoline prices in the US at approximately −0.24, for the years 1968 to 2008 (Li et al., 2014). Recent research indicates that gasoline price elasticities declined in the later decades of the twentieth century, but may be increasing in the twenty-first century (Greene, 2012; Litman, 2013). However, given the difference in structure of LDV and HDV sectors [e.g. individual, utility-seeking drivers and households versus profit- and production-maximizing firms (Berkhout et al., 2000)], we cannot apply LDV or gasoline elasticities to the HDV sector with any confidence.

With respect to the literature that directly addresses elasticities for HDVs, we can look at three categories of research. First is the literature on fuel price elasticities for diesel fuel demand (diesel representing approximately 88% of HDV energy use) (ORNL, 2013a). This body of literature is relatively scarce. However, results from studies in this area indicate in general that diesel price elasticities tend to be much smaller in magnitude compared to gasoline; Dahl (2012), for instance, reviewing global fuel price elasticity studies, reports a US price elasticity of demand for diesel at −0.07, compared to −0.30 for gasoline.[2] These results for the US tend to be much different than for other countries. Dahl (2012) reports the median price elasticity of diesel demand for all countries at −0.16; Barla et al. (2014) estimated the price elasticity of road diesel in Canada to be −0.43 (short run) to −0.8 (long run); and Liu (2004) reported a range of diesel price elasticities in OECD countries that vary by an order of magnitude and range from negative to positive.

A second category of literature exists on the *freight price* elasticity of demand for freight services, as measured as the change in ton-miles or tons shipped in response to a change in freight rates (\$/ton-mile or \$/ton) (Abdelwahab, 1998; Friedlaender and Spady, 1980; Oum et al., 1990, 1992; Winston, 1981; Zhou and Dai, 2012). These freight price elasticities vary greatly by region, commodity, shipment type, distance, availability of alternative modes, and other variables—and given the variability across published studies, elasticities estimated for these highly specific circumstances cannot be applied to aggregate trucking freight activity with much confidence. Additionally, the use of *freight price* elasticities as a proxy for *fuel*

[1] This is the definition of "rebound effect" we use in this paper, which is a common description found in the literature. We note that there are different types of rebound effects discussed in the literature – e.g., direct, indirect, and economy-wide (Winebrake et al., 2012). The results of our paper are most relevant for estimating the direct HDV rebound effect.

[2] Dahl (2012) notes that this might suggest that price is not influential for diesel demand, or there is too much noise in the data to isolate and measure the influence of fuel price changes. Dahl (2012) also showed that low price, high income countries show the least price response with more elastic response at higher price levels.