Transportation Research Part A 63 (2014) 56–66

Contents lists available at ScienceDirect

Transportation Research Part A

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

Asymmetric responses of highway travel demand to changes in fuel price: An explanation via fuel price uncertainty

Yongjae Kwon [a,1], Jaimin Lee [b,*]

[a] College of Business Administration, Kookmin University, 136-702 Seoul, Republic of Korea
[b] School of Economics and Trade, Kyungpook National University, 702-701 Daegu, Republic of Korea

ARTICLE INFO

Article history:
Received 6 February 2013
Received in revised form 27 December 2013
Accepted 16 February 2014
Available online 31 March 2014

Keywords:
Fuel prices
Highway travel demand
Uncertainty
Asymmetry
Realized volatility

ABSTRACT

Previous research has examined asymmetric effects of fuel price uncertainty on energy demand. If we consider that energy demand is related to travel demand, the changes in fuel prices may have asymmetric effects on highway travel demand via fuel price uncertainty. In other words, when in general fuel price is steadily rising, the highway traffic volume decreases by a small percentage. On the other hand, the highway traffic volume increases by a large percentage when fuel prices are falling. We hypothesize that the uncertainty in fuel prices generates this kind of asymmetric effect on highway traffic volume in Korea. We use the Korean monthly fuel price and highway traffic volume data from 2001 to 2009, and define the intra-month (weekly) fuel price changes as monthly fuel price volatility which is a proxy for monthly fuel price uncertainty. We found that the direction of the change in fuel prices had asymmetric effects on highway travel demand and that the fuel price uncertainty led drivers to respond asymmetrically to the changes in fuel prices.

1. Introduction

For example crude oil prices rose sharply in the first half of 2008 but plummeted in the second half because of the global financial crisis. Korea's economy has shown some signs of economic recovery, and subsequently there have been indications for the rise in prices of oil products. This paper hypothesizes that fluctuations in fuel prices increase the fuel price uncertainty which in turn has significant effects on behaviors of drivers of passenger vehicles and freight transport firms.

Many studies have shown that changes in fuel prices have considerable influence on behaviors of economic agents or on investment and consumption decisions. Hamilton (1983) verified that changes in fuel prices had a significant negative causal relationship with the US real GNP growth from 1948 to 1980. Mork (1989) found that GNP growth had a significant negative relationship with increases in fuel prices.

Some studies observed that fuel price uncertainty had significant effects on economic variables such as investment and consumption. Bredin et al. (2008) and Elder and Serletis (2009) measured oil price uncertainty by using a multivariate GARCH-in-mean model and found that it had a significant negative effect on the industrial production of the G-7 countries and Canada.

Guo and Kliesen (2005) analyzed the relationship between oil price volatility and the macroeconomic activity of the US by using quarterly realized oil price volatility, which is the sum of the squared changes in daily prices in a quarter year. They

* Corresponding author. Tel.: +82 53 950 7438; fax: +82 53 950 5429.
E-mail addresses: yjkwon@kookmin.ac.kr (Y. Kwon), jm064@knu.ac.kr (J. Lee).
[1] Tel.: +82 2 910 4530; fax: +82 2 910 5209.

http://dx.doi.org/10.1016/j.tra.2014.02.020
0965-8564/

found that oil price volatility had a significant negative effect on future GDP growth. Cong et al. (2008) also employed monthly oil price volatility constructed with the average of squared first-log differences in daily oil prices and estimated the relationship between oil price shocks and the Chinese stock market.

Kuper and van Soest (2006) used the conditional variance of oil prices from GARCH (1,1) for oil price uncertainty and found evidence that this uncertainty had an asymmetric effect on energy use and rendered energy-saving technologies less attractive.[2] They claimed that there is a non-zero probability for changes in fuel price reversals to take place as long as fuel price uncertainty exists. They argued that the higher the level of fuel price uncertainty, the greater the magnitude of changes in fuel price reversals. That is, they argued that it is price uncertainty that drives the asymmetric effects of fuel price changes on energy use.

Gately and Huntington (2002) estimated the effects of changes in oil prices on energy and oil demand, and showed that the increases and decreases in oil prices had the asymmetric effects on oil demand. Similarly, Dargay and Gately (1997) found that consumers did not respond in the same fashion to rising and falling prices and that fuel demand is not necessarily reversible to price changes.

Many studies have investigated the relationship between fuel price changes and traffic volume in the transport sector. Dargay et al. (2002), Graham and Glaister (2002, 2004), Goodwin et al. (2004), and Hanly et al. (2002) summarized a negative effect of the gasoline prices on traffic volume. That is, an increase in gasoline prices leads the demand for gasoline in the transport sector to decline, and this demand decrease leads the traffic demand to decrease.

In addition to studies focusing on the relationship between fuel prices and traffic volume, there have been some articles to estimate the relationship between fuel prices and fuel demand in transport sector (Bonilla and Foxon, 2009; de Freitas and Kaneko, 2011; Hughes et al., 2006).

However there have been few articles to investigate the relationship between energy price uncertainty and traffic volume levels. In particular, no study has examined the asymmetric effects of energy price changes on traffic volume.

We analyze three issues surrounding the relationship between fuel price changes and traffic volume. First, our study analyze the effects of fuel price uncertainty on traffic volume. More specifically, the question of whether fuel price uncertainty has a significant negative effect on traffic volume is addressed. Second, the asymmetric effects of fuel price changes on traffic volume are investigated. Third, the first and second are combined to determine whether fuel price uncertainty would induce asymmetric effects of fuel price changes on traffic volume.

Considering the asymmetric responses of agents to price changes, the authors expect that fuel price uncertainty would induce asymmetric responses of drivers to fuel price increases or decreases and that changes in transport volume from fuel price increases are different from those from fuel price decreases.

In our study, we investigate the effects of fuel price uncertainty on highway travel demand. The results show that fuel price uncertainty in conjunction with asymmetric behaviors of drivers in response to changes in fuel prices produces asymmetric changes in traffic volume from changes in fuel prices. More specifically, because of the effect of fuel price uncertainty on the behaviors of drivers, increases in highway traffic volume during periods of fuel price decreases exceed decreases during periods of fuel price increases.

In this paper, fuel price uncertainty is defined as reversals in fuel price changes (Kuper and van Soest, 2006). If there is an increase in the level of fuel price uncertainty, then reversals are more likely. In this case, highway commuters are less likely to respond instantaneously to fuel prices increases because they expect fuel price decreases sooner or later. In addition, this type of fuel price uncertainty is expected to have an asymmetric effect in the case of fuel prices increases or decreases.

Our study is based partly on Kuper and van Soest (2006), who estimated the relationship between oil price uncertainty and energy use by using the GARCH (1,1) model to determine fuel price uncertainty. However, our study uses realized volatility.[3]

Korean Monthly data on highway traffic volume and fuel prices from January 2001 to December 2009 are used in our study. Intra-month (weekly) fuel price changes are used to construct monthly fuel price uncertainty. In the present approach, realized volatility is a model free volatility estimator, whereas GARCH type estimators depend upon the type of model. Therefore, the present approach is more general and robust than that of Kuper and van Soest (2006).

The rest of this paper is organized as follows. Section 2 provides the theoretical background and the model specification. Section 3 describes the data. Section 4 presents the estimation results and their implications, and Section 5 concludes with a summary and limitations.

2. Theoretical background and the model specification

2.1. Theoretical background

2.1.1. Fuel prices with uncertainty

Many studies have investigated the socioeconomic factors influencing demand in the context of road traffic volume. Dargay et al. (2002), Graham and Glaister (2002), and Hanly et al. (2002) summarized the relationship between demand in road

[2] Bernanke (1983) and Pindyck (1991) claimed that agents would postpone their decision making or engage in conservative economic activity because of irreversible characteristics of investment or expenditure plans.

[3] Section 2.2 explains why conditional volatilities is replaced with realized volatility.