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Notes and comments

Use of hybrid vehicles in Japan: An analysis of used car market data

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ABSTRACT

Despite the rapid market penetration of hybrid vehicles (HVs), their usage and contributions to environmental protection have not been examined by vehicle traveling data. In this paper, we analyzed Japan's used car market data to understand how HVs are used on the street. We find GV drivers with high travel demand switched from GVs to HVs during the transition period. Despite HV owners driving much longer distances than conventional gasoline vehicle (GV) owners, they emit less carbon dioxide (CO_2) emissions, owing to better fuel economy. We also find that HV owners spend roughly the same amount of money annually as GV owners. However, the per-kilometer travel cost of HVs is much lower than that of GVs even if the depreciation cost of the vehicle and vehicle related taxes are included in the analysis.

Introduction

Despite the rapid market penetration of hybrid vehicles (HVs), their usage and contributions to environmental protection have not been examined by vehicle traveling data.[1] This paper analyzes used car market data and examines HV usage patterns in Japan. HVs have become very popular in Japan, and they are expected to become popular in other countries as well (Fuji Keizai Management Co. Ltd., 2013). Understanding their usage and environmental impact in Japan could potentially shed light on their impact in other countries.

Additional driving (the rebound effect) induced by higher vehicle efficiency has been confirmed by previous studies (Greene et al., 1999; Greening et al., 2000; Goldberg, 1998; Linn, 2013; Mizobuchi, 2011; Small and Van Dender, 2007; West, 2004). According to the comprehensive literature survey conducted by Sorrell et al. (2009), the rebound effect is less than 30%. The latest study, Linn (2013), estimates that the rebound effect is 20–40%. Although many scholars have estimated the rebound effect in various contexts, none estimated it by explicitly separating HVs from GVs. We expect that the mileage on HVs with remarkable fuel economy will become larger than that of conventional GVs. Since previous studies, such as Kanemoto (2007), Koyama and Kishimoto (2001) and Parry et al. (2007), report that mileage-related external costs are much greater than fuel-related external costs, it is important to estimate the extent to which HVs are driven more than GVs.

In recent years, many countries have implemented rebate programs to stimulate HV sales. Empirical studies report that these programs have led to a large increase in the market share of HVs (Chandra et al., 2010; Gallagher and Muehlegger,

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[1] The studies such as Kanari et al. (2010) and Nakaue et al. (2010) have examined the effect of HV and the next generation vehicles on the CO_2 emission. However, they have conducted simulation studies and have not analyzed vehicle traveling data.

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2011). Although the reduction of carbon dioxide (CO_2) emissions has been stated as the reason for the rebate programs, it has not yet been examined whether the amount of CO_2 emitted from HVs is lesser than that from GVs. Demonstrating lower CO_2 emissions from HVs as compared to GVs would justify these promotion policies.

Although the new vehicle market share of HVs among all passenger vehicles reached 32.4% in Japan (Japan Automobile Dealers Association, 2014), it remained at 3.19% in the U.S. in 2013 (Cobb, 2014).[2] One explanation for this discrepancy is that Japanese drivers take into account an eco-friendly image when purchasing HVs, but American drivers care only about the payback period of any particular HV (Momota, 2013). Japanese hybrid owners stated that contributing to global warming prevention was one of the reasons they chose to purchase an HV (Gulliver International Co., Ltd., 2006). We examine whether HV owners in Japan emit less CO_2 than GV owners.

Considering the lack of knowledge of HV use, we analyzed Japan's used car market data and examine (1) whether the annual mileage of HVs is larger than that of GVs, (2) whether the annual CO_2 emission from HVs is smaller than that from GVs, (3) whether the drivers with high travel demand switched from GVs to HVs, and (4) whether HV owners spend more money on their vehicle than GV owners.

We find that (1) the average annual travel distance of HVs is much larger than that of GVs, (2) the average annual CO_2 emissions from HVs is about half that from GVs, (3) the drivers with high travel demand switched from GVs to HVs, and (4) HV owners spend about the same amount of money on their vehicle annually as GV owners. However, HV owners spend lesser money on per-kilometer travel costs than GV owners.

The remainder of this paper is structured as follows. Section 'Methods' explains research methods. In Section 'Results and discussion', we compare the extent of HV usage with that of GVs. Section 'Conclusions and policy implications' concludes the paper and discusses policy implications.

Methods

The hybrid vehicle market in Japan

Fig. 1 describes the changes in the share of the type of vehicles owned from 2006 to 2012. There is a special small size (light vehicle) category in Japan. Light vehicles whose engine sizes are equal to or smaller than 660 cc are subject to reduced taxes. Fig. 1 shows that the share of conventional GVs decreased from 70.09% to 61.71%, while that of light vehicles increased from 25.13% to 31.65%. The figure also shows that the share of diesel vehicles decreased from 3.72% to 1.35%, while that of hybrid vehicles increased from 0.59% to 4.83%.

According to Japan Automobile Dealers Association (2014), 3,014,651 new domestic vehicles were sold in the Japanese market in 2012, of which 899,155 were HVs. Thus, the sales share of HVs among passenger vehicles is estimated to be about 29.8%. In 2013, 33 varieties of HVs were sold in the Japanese market.

Used car market data

The purpose of this study is to examine whether HVs changed travel patterns based on the analysis of the vehicle traveling data. For this purpose, we obtain our primary data from Proto Corporation (2013), which publishes one of the most popular used car magazines, Goo. It also releases up-to-date information on a web site called "Goo-net." The Goo data cover all regions in Japan.

We focus on the data for March and September, released between 2008 and 2013. March and September are the two peak months in the Japanese used car market. For example, 4,015,909 used vehicles were registered in 2012. In the same year, 528,192 and 306,304 used vehicles were registered in March and September, respectively. The Goo data for March 2012 contains 340,301 used cars, while that for September 2012 is 352,643.

In Table 1, we report the descriptive statistics of vehicles according to fuel type. The total number of vehicles in our dataset is 3,694,846, including 1,026,213 (27.77%) light vehicles, 1,914,044 (51.80%) regular GVs, 118,058 (3.20%) diesel vehicles, and 48,942 (1.32%) regular HVs that use regular gasoline. The market share of other types of vehicles is relatively small.

The third column reports the catalog price of new vehicles. The average price of regular GVs is 22.93 thousand dollars, while that of regular HVs is 27.16 thousand dollars. Therefore, the price of HVs is higher than that of GVs. The fifth column reports the average fuel economy based on the 10–15 mode released by Ministry of Land, Infrastructure, Transport and Tourism of Japan (2013).[3] As the column shows, the average fuel economy of HVs is much higher than that of GVs.

The sixth column shows the average holding period. The column shows that expensive vehicles, such as premium gasoline, diesel, and LPG vehicles, are used for a longer period of time than regular GVs. The column shows that the holding period of HVs is shorter than that of GVs, mainly because HVs became popular after 2009 and the HVs in the dataset have recent model years.

[2] The U.S. statistics include trucks through to Class 3, which consist of trucks up to 14,000 lb gross vehicle weight.

[3] The 10–15 mode is the official fuel economy test cycle for new cars and is expressed in km/L. Carried out on a dyno rig, the 10–15 mode cycle is a series of 25 tests, which cover idling, acceleration, steady running, and deceleration, and simulate typical urban and/or expressway driving patterns (Japan Automobile Manufacturers Association, 2009). Fuel economy based on the 10–15 mode cycle is often criticized because it is much higher than the actual fuel economy. However, we use the 10–15 mode cycle data in this paper, since other data sources do not cover as many vehicles.