

How does Media Coverage of Climate Change Influence Consumer Purchase of Sustainable Products? Evidence from U.S. Hybrid Vehicles

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Abstract

As consumers increasingly seek sustainable products for consumption, firms must better understand the drivers behind consumer adoption of these products to improve marketing effectiveness. This paper examines the roles of media in the diffusion of sustainable products. Based on data from the 1999~2007 U.S. hybrid vehicle market, it studies how media coverage of broad sustainability issues influences the sales of hybrid vehicles. We find that the media coverage of climate change exerts an overall positive impact on hybrid vehicle sales. The media coverage enhances the sales effect of fuel economy, a key product attribute that has environmental and sustainability implications. However, it reduces the impact of vehicle design, which is not linked to sustainability, on purchase. We find substantial competitive effects for hybrid vehicles as a category: the media coverage of climate change shifts consumer purchase from conventional towards hybrid vehicles. Finally, our results show that such media coverage reduces the effectiveness of tax incentives intended to stimulate hybrid purchase. These findings demonstrate the important roles of media on the diffusion of sustainable products. The implications for marketing strategies and public policy are discussed.

Keywords: *Media, Sustainability, Climate Change, Hybrid Vehicle, Social Marketing.*

The primary purpose of gathering and distributing news and opinion is to serve the general welfare by informing the people and enabling them to make judgments on the issues of the time.

–The American Society of Newspaper Editors

In the 21st century one such “issue of the time” has to do with the environment. Global concerns about climate change are increasingly shaping the market landscape. In a recent survey, nearly two thirds of individuals globally stated that the problem of climate change is “very serious” and of importance to them (Global Scan/BBC World Service Poll2009). The same poll also shows that despite global recession, 61 percent of the respondents would support their governments making investments to address climate change issues, even if those actions may hurt the economy in the short run. Meanwhile, individual consumers are themselves increasingly seeking sustainable alternatives for purchase and consumption (Leonidou, Leonidou and Kvasova 2010). A consumer survey by McKinsey & Company finds that more than half the consumers globally are willing to seek sustainable alternatives such as energy-saving and environmentally friendly products to stop climate change (Bonini and Oppenheim2008).

Given these trends, it is critical for firms and policy makers to understand how sustainable products, both as a broad category and in specific product forms, are diffused through the society (e.g., Gallagher and Muehlegger 2011; Ozaki and Sevastyanova 2011). A growing body of research has started to examine the drivers of consumer adoption of sustainable products. Perhaps not surprisingly, most of the research focuses on the financial drivers of the purchase decision. For example, gasoline price and vehicle fuel economy (i.e., gas mileage) are two major factors related to fuel consumption costs. Beresteanu and Li (2011) estimate that hybrid vehicle sales in 2006 would have been 37 percent lower had gasoline price stayed at the 1999 level. Gallagher and Muehlegger (2011) find that rising gasoline price induced greater demand for high

fuel-economy vehicles. Similarly, Diamond (2009) shows a strong relationship between gasoline price and the adoption of hybrid vehicles. From a policy perspective, how government actions (such as the provision of tax incentives) influence hybrid vehicle sales has also been explored in these studies.

In this paper we examine the effects of mass media coverage of environmental issues, specifically the media coverage of climate change, on the adoption and diffusion of sustainable products. Mass media coverage, which is fundamentally different from firm-initiated promotion and public policy actions, is a unique and independent voice in the marketplace. It reaches a large number and a wide range of audiences; hence, media can be a major social force that has broad impact on consumers, firms and governments. Even though researchers have suggested that mass media is often the primary information source for early adopters and plays a pivotal role in new product diffusion (e.g., Mahajan, Muller and Srivastava 1990; Rogers 1995; Tellefsen and Takada 1999), the effects of media on the adoption of sustainable products have remained largely unstudied. We seek to fill this gap.

A novel element of our research is that the media coverage of climate change is general—it is *not* specific to a particular product or brand. This has two key benefits for the study. Conceptually, it taps into the impact of broad social movements and social forces on the sales of a particular product. Demonstrating such effects would suggest substantial influence of general media on consumer adoption of sustainable products. Methodologically, studying the media coverage of general environmental issues helps remove a key form of endogeneity associated with firm- and industry-specific media coverage. For instance, unobserved characteristics in the automobile industry could simultaneously influence both hybrid vehicle sales and the media coverage of issues specific to the industry and/or a brand. Of course, other

unobserved factors that simultaneously affect both the media coverage of climate change and hybrid vehicle sales could still exist; we explicitly account for the potential endogeneity in the empirical study.

The basic premise of our paper is that, through informing and educating consumers about climate change and reinforcing social norms, the media coverage of climate change can enhance the relevance of sustainable consumption, thus motivating consumers to adopt sustainable products. Furthermore, we argue that such media coverage will *differentially* influence the sales effect of certain product attributes versus others. Based on observations that products attributes can be distinguished into sustainability-related attributes (e.g., fuel economy) and non-sustainability related attributes (e.g., vehicle design, style and comfort) (Luchs et al. 2010), we suggest that by enhancing the relevance of sustainable consumption, the media coverage of climate change should increase the sales effect of sustainability-related attributes but not necessarily that of non-sustainability attributes. To the extent that sustainability-related attributes become more salient when there is greater media coverage of climate change, the sales effects of non-sustainability related attributes could even be reduced. In addition, we examine how such media coverage may moderate the effect of a critical policy factor—government tax incentives to consumers.

Our study is situated in the U.S. hybrid vehicle market. This market is an attractive empirical setting for several reasons. First, automobiles have long been regarded as a major contributor to air pollution and global warming. The report generated by the Intergovernmental Panel on Climate Change (IPCC 2007) suggests a strong connection between the emission of greenhouse gas from automobiles and climate change. The International Energy Agency report (IEA 2007) suggests that by 2030 the transport sector will account for 50% of worldwide

greenhouse gas emissions. Hence, the media coverage of climate change is likely to have a very salient effect in the automobile market.

Second, compared to other products where sustainable solutions are only currently being developed, the automobile industry has a well-defined environmentally friendly alternative in the form of hybrid vehicles. Compared with their conventional counterparts, hybrid vehicles combine the functionality of fossil-fuel engines and electric motors. The benefit from improved fuel economy and reduced emissions has led hybrid vehicles to be considered a key tool in combating climate change (National Energy Policy Report 2001).

Third, and pertinent to the conceptual foundation of our research, there are clearly defined sustainability-related and non-sustainability related attributes in the automobile industry. As we discuss in later sections, our data contain the measures of vehicle fuel economy and vehicle design ratings from J.D. Power and Associates. These measures enable us to empirically disentangle the interaction between media coverage and sustainable versus non-sustainable attributes.

Lastly, automobile purchase is a high-involvement decision. Just like other sustainable products, hybrid vehicles usually have higher price premiums that provide comparatively meager lifetime financial savings over their non-hybrid counterparts (Consumer Reports 2006). The high up-front costs, coupled with a diffused and public-good nature of the benefits from lower emission, act as a major barrier for adoption. While many sales factors such as product attributes, marketing actions and tax incentives exist, consumers are often exposed to news reports about environmental issues. It is important to analyze whether and how such media report will influence consumer purchase of hybrid vehicles.

Theoretical Background and Hypotheses

A major challenge in the marketing of sustainable products is that consumers often do not fully appreciate or act on their value. Unlike other products, the consumption of sustainable products serves dual purposes: generating utility to the individual (the private good) and providing benefit to the society (the public good). For instance, in addition to providing the typical transportation function, a hybrid vehicle also reduces energy consumption and greenhouse gas emission, thus helping preserve the environment and combating climate change.

Yet, the “public good” feature of sustainable products is often undervalued by potential adopters for a variety of reasons. Firstly, the environmental benefits from their consumption are only available at an unknown future date. Secondly, these benefits are diffuse and their value to a particular consumer is difficult to quantify. Thirdly, as the benefits are received by both the individual as well as other consumers (and the society as a whole), some consumers are motivated to “free-ride” and not pursue the sustainable product themselves. As Kahn (2007) indicates, even people who label themselves as environmentalists may not always “practice what they preach.”

Another challenge in the diffusion of sustainable products is the price tag. In the automobile market, a hybrid car usually costs several thousand dollars more than a comparable conventional vehicle. The high price constitutes a major barrier for the adoption of sustainable products. In response, governments have implemented a variety of incentive programs to mitigate the adverse impact of high prices. In the U.S., under the Energy Policy Act of 2005, the federal government provided tax credit to consumers who purchased sustainable products.

Related to these challenges, extant studies have suggested three distinctive motivations for the purchase of hybrid vehicles (e.g., Ozaki and Sevastyanova 2011). The first is the ideology

of environmentalism, where the concern about the environment directs consumers to buy hybrid vehicles as a useful solution for reducing carbon footprint. Gallagher and Muehlegger (2011) use Sierra Club membership as a proxy for environmental preference to show that, across states, per-capita membership has a positive correlation with owning high fuel-economy hybrid vehicles such as the Toyota Prius. Likewise, Kahn (2007) uses the share of Green Party registered voters to proxy environmentalism and finds that communities with more environmentalists tend to have more hybrid car adopters.

The second motivation is the symbolic value—consumer follow a social trend and adopt high-priced environmentally friendly products as a status symbol to signal their own social responsibility and upward mobility (Griskevicius, Tybur and van den Bergh 2010; Heffner, Kurani and Turrentine 2007; Kahn 2007). Different from the environmentalism motivation, the symbolic motivation is stimulated by the prevailing social norms and a desire to be part of a socially desirable trend.

The third motivation is pragmatic or financial, where consumers make hybrid vehicle purchase decisions based on the savings generated. As discussed earlier, several papers show that gasoline price has a strong effect on hybrid vehicle sales and suggest that the saving on fuel cost can be an important driver for adoption. The research on government financial incentives, however, has produced mixed results. Diamond (2009) finds very limited sales effect of monetary incentives provided by the government. Chandra, Gulati and Kandlikar (2010) find that tax incentive on hybrid vehicles is not the most effective way for consumer to switch to hybrid cars. However, Beresteanu and Li (2011) and Gallagher and Muehlegger (2011) identify positive consumer response to sales and income tax incentives.

Our key thesis is that how media coverage of climate change may affect hybrid vehicle

adoption depends on the roles that the mass media plays in influencing the message recipients. We now turn to developing the hypotheses on the overall effect of the media coverage on hybrid vehicle sales, and how it may moderate the sales effect of key product attributes and tax incentives.

Linking the Roles of Media to the Motivations of Hybrid Purchase

Research in sociology, psychology and mass communication (e.g., Atkin and Wallack 1990; Signorielli and Morgan 1990; Turner 1991; Yanovitzky and Stryker 2001) points to two distinct roles of mass media when it comes to affecting individual behavior: an *information-education role* and a *norm-reinforcement role*.

The information-education role is about mass media providing information to increase the public awareness of certain issues or trends in the society (Atkin and Wallack 1990). Mass media is a popular and in many ways most accessible information source about environmental issues (Boykoff and Rajan 2007; Wilson 1995). As such, the media coverage of climate change helps create awareness and disseminate knowledge about the environment and environmental concerns. As Dunwoody and Peters (1992) show, environmental hazards conveyed through mass media strongly affect public opinions. Moreover, appropriate knowledge is a prerequisite for environmentally conscious behavior (Thøgersen 2005). Previous research shows that the perceived importance of environmental issues affects the effectiveness of environmental campaign (Kronrod, Grinstein and Wathieu 2012). Thus, the media coverage of climate change will increase consumer awareness of environmental issues, subsequently heightening the salience of sustainable consumption and the perceived value of hybrid vehicles as a prospective solution.

The norm-reinforcement role prescribes that mass media creates and reinforces social norm about certain behavior (Yanovitzky and Stryker 2001). In the context of climate change,

media coverage works to direct social value and promote sustainable consumption behavior. More intensive coverage of climate change effectively “sets the agenda” on public opinion, establishing that actions that reduce carbon footprint and greenhouse gas emission are appropriate and socially valuable (Buenstorf and Cordes 2008; Holt and Barkemeyer 2010). As a result, environmental consciousness will be perceived more socially desirable (Derksen and Gartrell 1993), and purchasing environmentally friendly products such as a hybrid vehicle helps the consumer gain social approval as a socially responsible citizen.

Based on the roles of mass media, we predict that media coverage of climate change will have a *positive* impact on consumer motivation of adopting hybrid vehicles. The information-education role directly enhances the extent of environmental concerns in the society, thus strengthening the ideology of environmentalism that motivates hybrid vehicle purchase. It does not directly build up social norms about environmentally conscious behavior, but will provide the knowledge foundation for such social norms to develop. The norm-reinforcement role verifies environmental concerns and signals social approval for adopting environmentally friendly products. It thus strengthens the symbolic motive of hybrid vehicle purchase.

The implication of the information-education role and the norm-reinforcement role of media coverage for the pragmatic (financial) motivation is unclear. Both roles are rooted in how environmental issues are perceived in the society. They do not necessarily enhance or reduce the (perceived) financial benefit of driving hybrid vehicles.

Put together, we predict an overall positive effect of media coverage on hybrid vehicle adoption, summarized in Hypothesis 1:

H1: Media coverage of climate change has a positive impact on hybrid vehicle sales.

Moderating the Sales Effects of Sustainability vs. Non-sustainability Factors

How does media coverage of climate change moderate the sales effect of factors that influence hybrid vehicle purchase? In light of the different roles that the media plays to influence consumers, we categorize these factors into two categories—sustainability or environment related factors versus non-sustainability related factors.

Recall that through the information-education role, the media coverage of climate change enhances the awareness and knowledge of environmental issues in the society. In contrast, the norm-reinforcement role strengthens the social norm of environmentally friendly behavior. It is particularly important in inducing the symbolic value of sustainable purchase. Although these two roles contribute to the adoption of sustainable products via different routes, both effectively heighten the salience of environmental and sustainability issues among consumers. Thus, whether the media coverage of climate change will enhance the sales effect of a certain market factor depends on whether that factor has sustainability and environmental implications. When the media coverage of climate change is more extensive, the sales effect of sustainability-related factors is likely to be enhanced. On the contrary, the sales effect of non-sustainability related factors should not be affected. To the extent that the media coverage of climate change makes consumers pay more attention to sustainability-related factors, less attention will be paid to non-sustainability related factors and their sales effect will even be reduced.

We now turn to discussing three key sales factors in the hybrid vehicle market—fuel economy of the vehicles, vehicle design ratings, and tax incentives—and how media coverage may influence their sales effectiveness.

Vehicle fuel economy. The most prominent sustainability-related factor in a hybrid vehicle is fuel economy. This is typically measured as the weighted average of miles per gallon

(MPG) that the vehicle delivers for within-city and highway travel. Compared with conventional automobiles, hybrids deliver significantly better fuel economy. For instance, the 2012 model of the Honda Civic sedan delivers 28 MPG for city drive, while the hybrid model delivers 44 MPG. Less gasoline consumption provides financial benefits to consumers when they purchase hybrid vehicles. Fuel economy is saliently displayed on vehicles for sale, and previous research has shown that fuel economy has a direct impact on hybrid vehicle sales (e.g., Gallagher and Muehlegger 2011).

In addition to financial benefits, fuel economy also has direct implications for greenhouse gas emission. According to the U.S. Department of Energy, every gallon of gasoline consumed adds 26 pounds of CO₂ into the atmosphere, and driving hybrid vehicles could cut the global warming pollution by 30% or more. *fueleconomy.gov*, the U.S. government website that provides fuel economy information about different vehicles, explicitly links fuel economy to “protect the environment and save you money.” This linkage between fuel economy and a better environment is often highlighted in the marketplace. For instance, in its consumer communications, Ford ties fuel economy to environment protection as “the two go hand in hand.”¹ Similar strategies are implemented by other firms such as Chevrolet, Honda, and Hertz. In fact, the new EPA/DOT label (window sticker) on vehicles for sales has “Fuel Economy and Environment” in the title, and prominently displays gas mileage and greenhouse gas ratings information (see Figure 1).

[Insert Figure 1 about here]

Therefore, vehicle fuel economy has direct environmental implications in addition to the financial benefits to consumers. As discussed earlier, both the information-education role and the norm-reinforcement role of mass media leads to greater salience of the sustainability and

¹ Source: *The New York Times*, 12-11-2006, quote from Kristen Kinley, Global Research and Metrics Communications Manager at Ford.

environmental issue when there is greater media coverage of climate change. Thus, we predict that such media coverage will enhance the sales effect of vehicle fuel economy:

H2: Greater media coverage of climate change increases the sales of hybrid vehicles that have better fuel economy.

Vehicle design. A common perception about sustainable products is that, in the pursuit of sustainability benefits, the product performance is usually compromised and is inferior relative to conventional products (Lin and Chang 2012; Pickett-Baker and Ozaki 2008; Sen and Bhattacharya 2001). This is the suggested reason why consumers often overuse “green” dishwashing detergents, hand sanitizers, and glass cleansers (Lin and Chang 2012). This perception relates to a major barrier for the adoption of sustainability products that we discussed earlier: consumers often make the trade-off between obtaining individual benefits and pursuing public and environmental interests when considering the purchase.

In the automobile market, an important factor related to individual benefits is vehicle design. In industry customs, this is the overall functionality of the vehicle that is measured by its style, features and instrumentation panel, comfort and performance (jdpower.com). Auto industry sources such as J.D. Power Associates frequently provide vehicle design ratings for the vehicles in the market.

A better vehicle design should positively influence sales. More importantly, however, vehicle design does not have direct environmental implications. The benefits of owning a car with better design are mainly towards the driver herself. As the media coverage of climate change works to heighten the salience of environmental issues, it should not influence how vehicle design would affect consumer purchase.

Furthermore, higher salience on sustainability issues may even *reduce* the impact of non-

sustainability attributes such as vehicle design. First, it is well established in behavioral research that consumers have limited cognitive capability in processing information stimuli (Chernev 2003; Malhotra, Jain and Lagakos 1982; Scheibehenne, Greifeneder and Todd 2010). As the salience of sustainability attributes becomes greater, consumers are less likely to notice and be influenced by other attributes. Second, to the extent that consumers make a trade-off between pursuing private benefits versus public benefits, the media coverage of climate change will shift the balance and induce a greater weight on environmental benefits. As a result, as consumers choose between protecting the environment and driving a more functional and comfortable car, greater media coverage could reduce the impact of vehicle design on hybrid vehicle sales.

Therefore, we make the following prediction:

H3: Greater media coverage of climate change reduces the sales of hybrid vehicles that have higher vehicle design ratings.

Tax incentives. In addition to the firm, a critical element in the promotion and diffusion of sustainability products is government and public policy. The National Energy Policy Report (2001) considers the hybrid technology as the promising alternative to improve fuel economy and reduce emission. Following the recommendation of this report, the federal government started providing tax deduction of up to \$2,000 for new hybrid vehicle purchase during 2001 to 2005. Later on, the Energy Policy Act of 2005 replaced the income tax deduction with an income tax credit of up to \$3,400 for hybrid vehicles purchased since January 1, 2006 (IRS 2010).

The tax incentive policy is implemented to reduce the financial barrier associated with purchasing hybrid vehicles. Despite this clear intention, however, existing studies have generated mixed findings about the effectiveness of tax incentives. Some research finds that tax incentives are positively associated with hybrid vehicle sales (e.g., Gallagher and Muehlegger 2008), but

others show that the effect is minimal or non-existing for all hybrid models through the years (Ariely, Bracha, and Meier 2009; Chandra, Gulati, and Kandlikar 2010; Diamond 2009).

Our focus is on how the media coverage of climate change moderates the effects of tax incentives. Similar to vehicle design, the implication for tax incentives for consumers is mostly individual (and financial) but not public or environmental. Therefore, greater media coverage of climate change should not affect the sales effect of tax incentives, and may even reduce it due to lower salience and less weight caused by greater attention to sustainability related factors.

Furthermore, different from the case of vehicle design, greater financial benefits associated with tax incentives may induce extra negative effect when sustainability and environmental issues are enhanced. That is, for the consumers who are more heavily driven by environmental and symbolic motives to purchase hybrid vehicles, financial benefits provided by tax incentives may be counter-productive since (at least some of) these consumers do not want to be perceived as merely pursuing financial gains. This potential drawback of government tax incentives was highlighted by several studies (Chandra, Gulati and Kandlikar 2010; Diamond 2009). Therefore, when media coverage makes the environmental issues more salient, it is very likely to reduce the impact of tax incentives on purchase.

In summary, we propose Hypothesis 4 as follows:

H4: *Greater media coverage of climate change reduces the sales of hybrid vehicles when there is greater tax incentive.*

Data and Empirical Method

The hypotheses are tested with longitudinal sales data of hybrid vehicles in the United States. As discussed earlier, we obtain the results for the media coverage of climate change that is *neither* an endorsement for a particular vehicle *nor* firm- or brand-specific.

Data and Variables

We compile our data from a number of sources. The hybrid vehicle sales data came from CNW Marketing Research, beginning with 1999 when the first hybrid vehicle (Honda Insight) was introduced. Our study period runs from December 1999 to October 2007, during which the monthly unit sales for twelve hybrid models are available. Two models are excluded due to very limited market presence and extremely low sales towards the end of the study period. The remaining ten models include Ford Escape Hybrid, Mercury Mariner Hybrid, Honda Accord Hybrid, Honda Civic Hybrid, Toyota Highlander Hybrid, Honda Insight, Lexus GS450h, Lexus LS600h, Toyota Camry Hybrid, and Toyota Prius. The final dataset consists of 376 model-level observations over 95 months.

Media Coverage of Climate Change. Data on the media coverage of climate change are obtained from LexisNexis Academic database through keyword search. Environmental studies indicate that “climate change” and “global warming” are used interchangeably by scientists and journalists (Palfreman 2006). Thus we searched for both terms and looked for all publications within the U.S. to identify relevant articles or news briefings. We included both television and print media because research has shown that people get most of their news from these two mass media sources (Boykoff and Rajan 2007). Whereas many media-related studies focus on a subsample of newspapers or television (e.g. top four national newspapers, local newspapers, top five television channels), we took a more comprehensive approach and covered all possible news sources in order to make fewer assumptions about consumers’ information sources. Media coverage is measured as the monthly count of news articles that either contained the keyword “global warming” or “climate change”.

Fuel Economy. We collected annual fuel economy data from the website

fuelconomy.gov. This website, as the “official U.S. government source for fuel economy information”, is maintained by the U.S. Department of Energy (DOE)’s Office of Energy Efficiency and Renewable Energy, with the original data provided by the U.S. Environmental Protection Agency (EPA). For vehicle fuel economy, we used the combined miles per gallon (MPG) incorporating both city and highway MPG for each model-year as suggested by *fuelconomy.gov*. The formula is given as: $1/(0.55/\text{city MPG}+0.45/\text{highway MPG})$.

Vehicle Design. Vehicle design rating measures the overall vehicle performance, style, features and instrument panel, and comfort. It covers multiple factors that are not related to the environment but are vital in a consumer’s purchase decision. We gathered the annual vehicle design ratings from the *Automotive Performance, Executive and Layout (APEAL) Study* by J.D. Power and Associates. Vehicle design rating ranges from 1 to 5, with 5 being the highest. The rating is based on owner satisfaction during the initial 90 days after purchase (jdpower.com).

Tax Incentive. We collected detailed data from the U.S. EPA and DOE websites to compute tax incentive for each hybrid vehicle model. As discussed in Diamond (2009), each vehicle was entitled to get a \$2,000 tax deduction before 2006. At an average tax rate of 28%, this translates to a \$560 tax incentive for each hybrid model. After Jan 1, 2006, the tax credit benefits ranged from \$250 to \$3,150 before phasing out. Our vehicle-model specific measure of tax incentive included both forms of tax incentives spanning from 1999 to 2007. Tax incentive dollar values are inflation-adjusted using December 1999 as the baseline in our estimations.

Other Variables. The Manufacturer Suggested Retail Price (MSRP) data are available from *autos.msn*. We used the inflation-adjusted MSRP of each hybrid model to obtain vehicle price. Data on gasoline prices are gathered from the website of the U.S. Energy Information Administration (EIA) which provides monthly retail gasoline prices (cents per gallon) for all

grades and formulations of gasoline. This data was also adjusted for inflation. Finally, we controlled for within-year cyclical patterns of sales with seasonal dummies (i.e. Summer, Fall, Winter).

Table 1 presents the descriptive statistics for the variables used in the analysis. Figure 2 depicts the number of news articles covering climate change and the hybrid vehicle sales during the time period. The news coverage increased significantly from 817 articles in December 1999 to 12,191 in October 2007. The monthly hybrid vehicle sales in the U.S. market ranges from a few dozen in December 1999 to about 44,000 units in May 2007. Both media coverage and hybrid vehicle sales were comparatively flat before 2004, but experienced greater increase after 2004 and spiked after 2006.

[Insert Table 1 and Figure 2 about here]

Method

We model the demand for hybrid vehicles as a function of the media coverage of climate change, fuel economy, vehicle design, tax incentives and a set of covariates. Since fuel economy and vehicle design are specific to a model, our analysis is at the vehicle-model level. Further, given the panel structure of our data, fixed effect models are used for estimation.² As pointed out by Halaby (2004), fixed effect models help make causal inference when the independent variables are correlated with unit-specific unobservables. In our study, there could be vehicle-model specific characteristics that we do not observe or measure (such as the perceived image of the vehicle). To the extent that these characteristics are correlated with some independent variables, omitting them could bias the estimation. The vehicle-model fixed effects help remove the influence and assess the net effects of independent variables. Besides vehicle-model fixed

² Random effects model as another possible alternative is rejected by Hausman test. Another reason for not adopting random effects model is that it assumes the unobservables are uncorrelated with the explanatory variables, which is a strong assumption that is unlikely to hold in our case. Thus fixed effects model is used.

effects, we also control for time fixed effects as our data spans over eight years. There could be regulatory or demand shocks from 1999 to 2007 (e.g., the implementation of policy allowing single occupancy hybrid vehicles in the carpool lane).

The model specification is thus as follows:

$$\begin{aligned} \text{Sales}_{it} = & \alpha_i + v_t + \beta_1 \text{MediaCoverage}_{t-1} + \beta_2 \text{FuelEconomy}_{it} + \beta_3 \text{Design}_{it} + \beta_4 \text{TaxIncentive}_{it} \\ & + \beta_5 \text{MediaCoverage}_{t-1} \times \text{FuelEconomy}_{it} + \beta_6 \text{MediaCoverage}_{t-1} \times \text{Design}_{it} \\ & + \beta_7 \text{MediaCoverage}_{t-1} \times \text{TaxIncentive}_{it} + \beta_{8-12} \text{Controls}_{it} + \varepsilon_{it}. \end{aligned}$$

Sales_{it} is the sales units of hybrid vehicle model i in month t . α_i is the model-specific fixed effect that captures unobserved, time-invariant heterogeneity associated with each model. v_t is the time-specific fixed effect that captures unobserved, time-variant shocks common to all vehicle models. $\text{MediaCoverage}_{t-1}$ is the amount of news coverage in period $t-1$. FuelEconomy_{it} , Design_{it} and TaxIncentive_{it} are the sales factors that we are studying. These sales factors are vehicle-model specific. The control variables include gasoline price, vehicle price and seasonality.

Several econometric issues arise in the data and need to be accounted for. The first is heteroskedasticity and autocorrelation. For example, the market shares of Toyota Prius and Toyota Camry have larger variance than that of Honda Insight. In order to cope with this and the potential serial correlation, we employed heteroskedasticity-autocorrelation (HAC) robust standard errors in the estimation. Second, as the model involves interaction terms, we mean-centered the continuous variables to reduce potential multicollinearity (Cronbach 1987; Vosgerau and Gatignon 2007). We further checked the variance inflation factor (VIF) to ensure that multicollinearity is not an issue.

Third, endogeneity could exist if both media coverage and the dependent variable—vehicle sales—are affected by common, unobserved factors. The estimates then will be biased

due to omitted variable bias. Another potential concern for endogeneity is that the relationship between media coverage and hybrid vehicle sales could be bi-directional. That is, greater sales of hybrid vehicles might encourage journalists to report more extensively on climate change and global warming. This is, however, an unlikely scenario because the sales measure in our dataset is for each vehicle model in each month. Nevertheless, we take a conservative approach to treat the endogeneity issue in two ways.

First, instead of using contemporaneous measures, we lagged media coverage by one month and estimate its impact on the current period sales. This tackles the bi-directional influence issue since the current period sales cannot influence media coverage in a previous period. Furthermore, allowing a time lag between media coverage and purchase decision is conceptually appealing. Similar to what Goolsbee and Klenow (2002) indicate for social learning, “the stock should influence the flow” (p. 327).

Second, and more importantly, we employed the instrumental variable approach to cope with potential endogeneity in media coverage. Two pieces of publicly available information are good candidates as instruments: the Climate Extremes Index (CEI) and the academic articles on climate change (SSSCI). The CEI is provided by the U.S. National Oceanic and Atmospheric Administration (NOAA) with the aim of summarizing the multivariate and multidimensional climate changes in the United States. It is calculated based on an aggregate set of conventional climate extreme indicators, including monthly maximum and minimum temperature, daily precipitation, monthly Palmer Drought Severity Index, and land-falling tropical storm and hurricane wind velocity. To construct SSSCI, we searched the SSCI Index and the SCI index for articles in both natural sciences and social sciences, using keywords such as “global warming” and “climate change.” As Wilkins (1993) reports, academic researchers often use the term

“greenhouse effect” while journalists prefer the term “global warming.” We thus also included “greenhouse effect” in our keyword search. Conceptually, both CEI and SSSCI are good instruments because they should be correlated with the media coverage of climate change, but they should not be related to the error terms in monthly hybrid vehicle sales.

Findings, Discussion and Implications

The results of the fixed effects instrument variable (FEIV) estimation are presented in Table 2. Model (1) controls for the fixed effects but does not use instruments. It shows a positive effect of media coverage on hybrid vehicle sales, a positive interaction between media coverage and vehicle fuel economy, and negative interactions between media coverage and vehicle design and tax incentives. These results are consistent with the predictions that we developed earlier.

Model (2) is the FEIV estimation. As expected, applying instruments to handle endogeneity reduced the estimated impact (and significance level) of media coverage, in both the main and interaction effects. We will thus focus on the FEIV estimation to discuss the results.

[Insert Table 2 here]

Estimation Results

The estimation shows a positive main effect of media coverage of climate change on hybrid vehicle sales. This provides support for Hypothesis 1 that the media coverage enhanced the motivation for consumers to purchase hybrid vehicles. Model (2) also shows that media coverage significantly increased the effect of vehicle fuel economy on sales. Fuel economy has a main effect on sales, and greater media coverage of climate change makes consumers more responsive and purchase more hybrids that have higher fuel economy. This supports Hypothesis 2 where we predict that the media coverage of general environmental issues will enhance the sales effect of sustainability related product attributes. As a result, firms producing high fuel

economy vehicles, or products in general that are clearly differentiated for environmental benefits and sustainability, will benefit the most from a greater number of media reports on the environment.

In terms of non-sustainability factors, Model (2) shows negative interactions between media coverage and both vehicle design and tax incentives. Greater media coverage reduced the sales effect of vehicle design, which has a positive main effect, and tax incentives, which has an insignificant main effect. These results support Hypotheses 3 and 4—as consumers shift attention from (and perhaps placing less weight on) non-sustainability related factors due to greater media coverage of environmental issues, firms will see sales become less responsive to these factors.

Note that the main effect of tax policy is positive but fails to reach significant levels. This is consistent with previous studies that did not find tax policy alone to be effective in motivating hybrid vehicle sales beyond what would have occurred due to social trends and shifting consumer preferences (e.g., Chandra, Gulati and Kandlikar 2010; Diamond 2009). Our finding sheds light on this issue from a new perspective: the effect of tax incentives withstanding, greater media coverage of environmental issues will further reduce its effectiveness.

Competitive Effects against Conventional Products

As yet, we have shown the results for model-specific unit sales of hybrid vehicles. A closely related issue is the category competitive effect: Does media coverage cause any shift in purchase from conventional to hybrid vehicles? This issue has general and broad implications for the long-run diffusion and adoption of the sustainable alternative. As the popularity of sustainable products grows, they need to compete with not only other sustainable alternatives but also the convention products that have been in the marketplace for a longer time.

To estimate these category competitive effects, we computed the market share of each

hybrid vehicles among all passenger cars and trucks sales each month. The previous results have shown the overall gain across hybrid vehicles in unit sales due to media coverage. A positive effect on the market share measures will not only strengthens the previous results, but also indicates that at least some of the gains in unit sales are from conventional vehicles.

Table 3 presents the estimation. First, the results are remarkably consistent with those reported in Table 2. Greater media coverage has a positive main effect. It enhanced the sales effect of vehicle fuel economy but reduced that of vehicle design and tax incentives. Hypotheses 1 to 4 are thus again supported. Second, these results are obtained for the market share of hybrid vehicles in all passenger cars and trucks, indicating that the media coverage of climate change benefited the hybrid vehicles at the expense of conventional vehicles.

[Insert Table 3 about here]

Cumulative Media Effects

The diffusion literature suggests that it might take some time for consumers to make purchase decisions after they are exposed to media messages (McQuail 1979). This is particularly likely for high-involvement durable goods such as hybrid vehicles because of their higher price tag. In the results we reported earlier, we have used one-month lag to allow for some delayed effects (and to mitigate the concern for reverse causality). However, it is still possible that consumers react to cumulative media messages that they have been exposed to.

To investigate how our results might change if the effects of cumulative media coverage are estimated, we trace back to three months' of media coverage of climate change for each observation, and use this cumulative measure as the independent variable.

As Table 4 shows, the results remain similar to those reported in Table 2. While providing further support to the hypotheses, these results further reduce concerns on reverse causality and

the associated endogeneity—it is difficult for the sales performance of hybrid vehicles in any given month to influence the total media coverage of climate change in the previous three months.

Finally, to further examine the robustness of the lag measures, we used different time lags and assigned different weights for media coverage to account for temporal decay (Smed and Jensen 2003). For instance, to allow for greater decaying rate for news in the more distant past, we differentially weigh the 3-period, 2-period and 1-period lagged media coverage. The results remain similar.

[Insert Table 4 about here]

Implications

Our results provide several important implications for firms marketing sustainable products. We summarize them below.

Strategically monitor and respond to media trends and interest. Our finding suggests that firms selling sustainable products need to actively monitor media interests and, when media coverage is favorable, try to make strategic use of it. The influence of mass media is above and beyond the firm's own marketing strategy. Tracking the trends and focuses of media coverage can provide useful information for firms to predict consumer interest and plan marketing strategies accordingly. As media coverage of environmental issues increases, consumers become favorable towards sustainable products. Firms should respond and facilitate consumer purchase through marketing and promotional actions. For example, firms could schedule special events, enhance distribution and access for purchase, or provide timely sales promotions incentives.

Be sensitive to the differential effects of product attributes. The results indicate that greater media coverage of climate change could enhance the sales effect of product attributes that

have environmental or sustainability implications. However, it also reduces the effectiveness of non-sustainability attributes. Thus, firms selling sustainable products or services should carefully determine what product attributes they should highlight during promotional campaigns. Indeed, from a long-term perspective, firms would also benefit from deciding on what product attributes to focus on when designing and producing the product. In an environment where the media interest in environmental issues is high and there is extensive media coverage, firms should focus on attributes such as fuel economy for hybrid vehicles so that the sales effect can be amplified. The bottom line is that firms need to choose what attributes to promote more intensively amid different media environment.

Proactively influence media to enhance sustainable product sales. Firms may proactively influence media coverage in order to increase consumer interest and thus product sales. This can be done through targeted media advocacy, i.e., the “strategic use of the mass media as a resource to advance a social or public policy initiative” (Pertschuk 1989). Media advocacy has been used successfully in the public health domain to promote healthy behavioral change (e.g., Jernigan and Wright 1996). An interesting possibility is that, relative to inducing consumer purchase through advertising and other promotional activities, spending resource on media advocacy campaigns could provide greater return on investment. This is particularly true given that media coverage of sustainability issues is more likely to motivate the environmentalism ideology and symbolic value of purchase than firm-initiated advertising.

More broadly, firms of sustainable products should consider broad corporate sustainability strategies and integrated marketing communication campaigns to influence the mass media. For instance, cause marketing (Smith and Alcorn 1991) may not directly expose the product itself, but it could induce valuable media coverage of certain sustainable causes, which

eventually benefit product sales. Similarly, social marketing and media advocacy by governments or non-government organizations (NGOs) to increase media coverage of broad environmental issues can effectively facilitate consumer adoption of sustainable products.

Develop cooperative strategies to influence media interests. Although there is inter-brand competition within sustainable product categories, sustainable products as a broad category need to receive general public support to grow. Our results show that media coverage of general environmental and sustainability issues improved the market share of hybrid vehicles relative to all vehicles including the conventional products. This suggests that media coverage can benefit sustainable products as a category. Therefore, cooperative promotional strategies targeting mass media can be beneficial to all firms involved.

Conclusion

This study is among the early research in marketing to investigate the diffusion of sustainable products. There has been growing interests among marketing scholars to address environmental and social concern in the marketplace from the corporate social responsibility perspective (e.g., Chen, Ganesan and Liu 2009; Luo and Bhattacharya 2006; Sen and Bhattacharya 2001). However, few studies have studied sustainable products and consumer adoption of such products.

Given the unique feature of sustainable products, how consumers make choices facing the tradeoff between public interests and individual interests are important issues. As sustainable consumption and the sustainability issue in general gain attention and momentum in the society, marketing will play increasingly important roles in the production and promotion processes. Researchers, managers and policy makers alike all seek to better understand what drives consumer purchase of sustainable products. We hope to make a contribution by examining the

effects of media and how it moderates the sales effect of environmentally-related product attributes that benefit the environment and society (e.g., fuel economy) versus environmentally-unrelated product attributes that benefit the individual (e.g., vehicle design, tax incentive).

It is well-known that the media functions in dual modes – the market mode and the public sphere mode (Croteau and Hoynes 2006). The market mode views media audience as consumers, and prescribes that the objective of media is to target individual consumers so as to generate profits. Advertising is perhaps the most significant commercial activity enabled by the market mode of mass media. The public sphere mode, on the other hand, views media audience as citizens. It prescribes that the objective of media is to inform citizens and serve a broad public interest. The public sphere mode is highlighted by the *Statement of Principles of the American Society of Newspaper Editors* that we quote at the beginning of this article. Corresponding to the dual functions of sustainable products (i.e., to serve individual needs and to serve the collective needs of the society), the dual modes of mass media suggests that it could play unique roles in the diffusion of sustainable products.

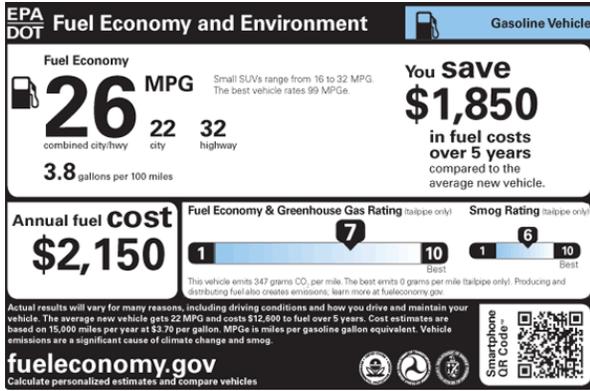
The market mode of media has been examined extensively in the literature through topics such as advertising, two-sided markets, and audience research (e.g., Chen and Xie 2007; Rinallo and Basuroy 2009). However, to the best of our knowledge, the current study is one of earliest in marketing to examine the public interest effects of mass media. We show that, as an independent voice in the marketplace, mass media coverage of broad environmental issues may effectively influence consumer adoption of sustainable products.

Finally, the extant studies have examined how the sales factors such as vehicle design, tax incentive and fuel economy may influence hybrid vehicle purchase. However, they do not differentiate the implications of these factors for consumer motivation. Our conceptual

framework decomposes the motivations of sustainable product purchase, and links these motivations to both media activities and the sales factors. Doing so allows us to tease out some subtle but important differences between these factors.

FIGURE 1
EPA/DOT Fuel Economy and Environment Labels on New Vehicles

(a) Gasoline Vehicles



(b) Hybrid Vehicles

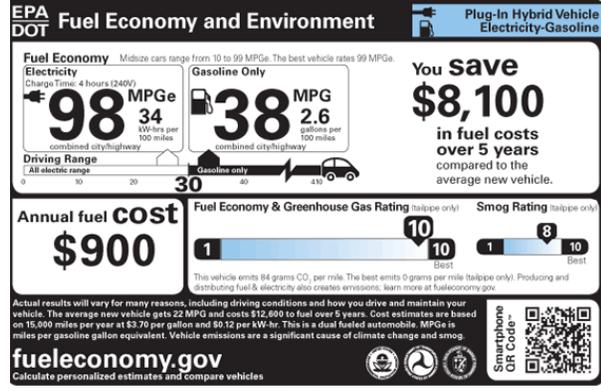


FIGURE2
Media Coverage of Climate Change and Total Hybrid Car Sales

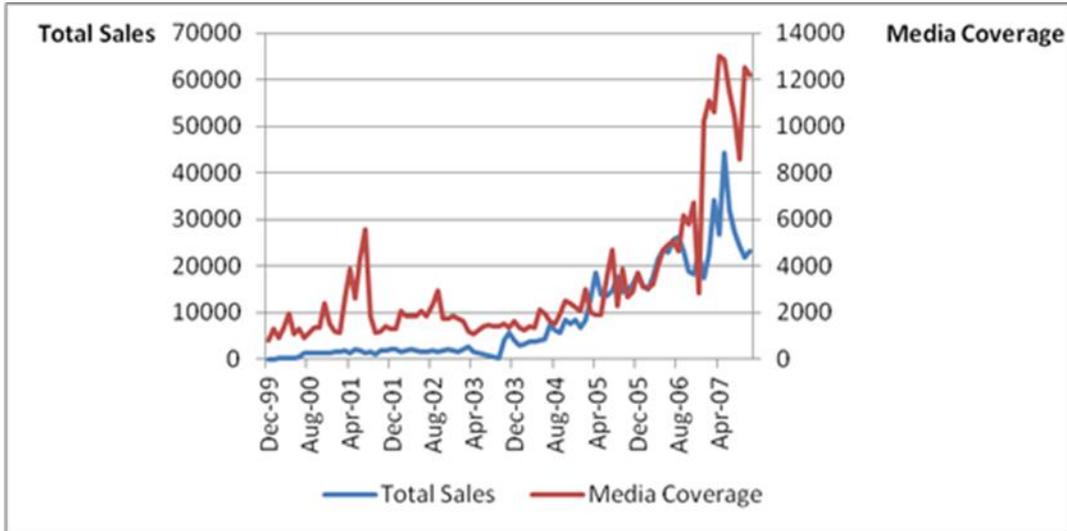


TABLE 1
Descriptive Statistics and Correlations among Key Variables

	Mean	S.D.	1	2	3	4	5	6	7
1 Sales	2235.928	3195.316	1						
2 Media coverage	5050.715	3810.435	.178	1					
3 Fuel economy	37.734	10.452	.170	-.478	1				
4 Tax incentive	976.108	646.094	.122	.247	-.289	1			
5 Design	3.457	.835	-.028	-.011	-.339	-.165	1		
6 Vehicle Price	22597.8	7220.183	-.212	.338	-.745	.760	.602	1	
7 Gas price	195.943	39.867	.229	.624	-.553	.468	.204	.372	1

Notes: All dollar values are inflation adjusted.

TABLE 2
Estimation of Media Coverage Effects on Hybrid Vehicle Sales

Variables	(1) Estimation without instruments	(2) Correcting endogeneity with instruments (FEIV)
MediaCoverage	.362 (.107)***	.318 (.170)*
FuelEconomy	971.0 (134.3)***	944.6 (137.0)***
TaxIncentive	.663 (.395)*	.241 (.534)
Design	484.6 (332.8)	577.1 (338.9)*
MediaCoverage × FuelEconomy	.034 (.009)***	.028 (.011)**
MediaCoverage × Design	-.098 (.037)***	-.105 (.047)**
MediaCoverage × TaxIncentive	-2.67e-4 (8.14e-5)***	-1.82e-4 (9.62e-5)*
VehiclePrice	-.300 (.201)	-.158 (.313)
GasPrice	2.453 (4.848)	5.242 (7.690)
Seasonality	Y	Y
Model Fixed Effects	Y	Y
Time Fixed Effects	Y	Y
Obs.	376	376
R ²	.730	.725
F-stat	15.32	17.40

Note: (1) DV is unit sales. Dollar values are inflation adjusted. (2) In all estimations of the paper, the coefficient estimates are reported with heteroskedasticity-autocorrelation robust standard errors in parentheses.

*** $p < .01$, ** $p < .05$. * $p < .10$.

TABLE 3
Market Share of Hybrid Vehicles in All Vehicles (FEIV Estimation)

Variables	Parameter estimates
MediaCoverage	.027 (.011)**
FuelEconomy	65.28 (9.718)***
TaxIncentive	.037 (.030)
Design	44.64 (23.78)*
MediaCoverage × FuelEconomy	.002 (7.16e-4)***
MediaCoverage × Design	-.009 (.003)***
MediaCoverage × TaxIncentive	-1.77e-5 (6.03e-6)***
VehiclePrice	-.008 (.021)
GasPrice	.080 (.005)
Seasonality	Y
Model Fixed Effects	Y
Time Fixed Effects	Y
Obs.	376
R ²	.747
F-stat	18.54

Note: Market shares are scaled by 10^5 to enhance readability.

*** $p < .01$, ** $p < .05$. * $p < .10$.

TABLE 4
Effects of Cumulative Media Coverage (FEIV Estimation)

Variables	Parameter estimates
CumMediaCoverage	.101 (.061)*
FuelEconomy	961.3 (137.5)***
TaxIncentive	.289 (.439)
Design	512.1 (338.6)
CumMediaCoverage × FuelEconomy	.010 (.004)***
CumMediaCoverage × Design	-.037 (.015)**
CumMediaCoverage × TaxIncentive	-7.16e-5 (3.11e-5)**
VehiclePrice	-.220 (.305)
GasPrice	5.372 (6.094)
Seasonality	Y
Model Fixed Effects	Y
Time Fixed Effects	Y
Obs.	374
R ²	.723
F-stat	16.83

Note: DV is unit sales. CumMediaCoverage is the sum of media coverage during past three months.

*** $p < .01$, ** $p < .05$. * $p < .10$.

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