

Media Coverage of Climate Change and Sustainable Product Consumption: Evidence from Hybrid Vehicle Market

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Abstract

As sustainable consumption becomes increasingly important, firms must better understand the drivers behind the consumption of these products. This paper examines the effects of mass media in the context of U.S. hybrid vehicle market. Based on monthly sales data, we provide evidence that the general coverage of climate change or global warming by major media outlets exerts an overall positive impact on the sales of hybrid vehicles. This impact mainly comes from the media reports that admit climate change or global warming. In contrast, media coverage that either denies climate change or holds a neutral stand on the issue has little impact. We provide preliminary evidence that social norm, which advocates for environmentally-friendly consumption, plays an important role in how media coverage affects consumer purchase. The paper provides implications for theory and practice, and calls for future research that examines the causal impact of media in general on consumer decisions, especially in domains that are crucial for the society.

Keywords: *Media, Sustainability, Climate Change, Global Warming, 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” is the global concern about climate change and global warming, which are increasingly shaping the social and market landscapes. In a survey undertaken by Global Scan/BBC World Service, nearly 65% of respondents stated that the problem of climate change is “very serious” and of importance to them. The same survey also showed that 61% of respondents would support their governments making investments to address climate change, even if those actions hurt the economy in the short run. Meanwhile, individual consumers are themselves seeking alternatives that are consistent with sustainable consumption (Leonidou, Leonidou and Kvasova 2010). A survey by McKinsey & Company found that more than half the consumers globally were willing to seek sustainable alternatives such as energy-saving and environmentally-friendly products to stop climate change (Bonini and Oppenheim 2008). Given these trends, it is critical for firms and policy makers to understand what impacts the adoption and the diffusion of sustainable products through the society (Bollinger and Gillingham 2012; Gallagher and Muehlegger 2011).

We study this issue empirically in the context of the market for hybrid vehicles in the U.S. Even though a growing body of literature has examined the drivers of hybrid vehicle sales, most research has hitherto focused on the *financial* factors. For instance, Diamond (2009), Beresteanu and Li (2011) and Gallagher and Muehlegger (2011) show a positive relationship between gasoline prices and the demand for vehicles with better fuel economy, and suggest that the purchase of hybrid vehicles is influenced by consumers’ “total cost of ownership”. The literature has also studied the effects of government policy, especially the financial incentives through tax

exemptions or deductions (e.g., Diamond 2009; Gallagher and Muehlegger 2011).

We complement this work by studying the effects of a different yet critical factor, mass media. Mass media outlets such as newspapers, magazines, radio and TV are a unique voice in the marketplace that supplies society with news and reports that are fundamentally different from firm-initiated marketing communications; as such, mass media and media coverage can be major social forces that have broad impact on consumers, firms and policy makers (Yanovitzky and Stryker 2001). We specifically examine how the media coverage of climate change or global warming impacts the sales of hybrid vehicles in the U.S.¹ The key novelty in our context and research question is that the media reports of climate change or global warming are general; they are *not* specifically related to either a product category (automobile) or any specific products within the category (firms or vehicle models). Studying the effects of general media coverage provides important conceptual and methodological benefits.

Conceptually, studying the effects of general media coverage enables us to investigate the impact of broad social movements, which are independent of firm-centric and industry-centric marketing actions. This helps shed light on the role that media coverage plays in the consumption of products that are relevant to the social movements. Based on the arguments made by Chan (1998) and Yanovitzky and Stryker (2001), we suggest that in the context of sustainable products like hybrid vehicles, mass media – through the coverage of climate change or global warming – helps the *generation and enforcement of a social norm* regarding desirable socially-conscious behavior. Such a social norm not only reduces the private disutility that consumers face (because hybrid vehicles are more expensive than their conventional counterparts), but also enhances the private utility that consumers get (by providing them with a

¹ The coverage of environmental issues in both media and policy circles has predominantly revolved around global warming. As we note later in the data section, global warming and climate change are used interchangeably by scientists and journalists. We hence include both these terms in the conceptual discussion and empirical analysis.

symbolic status from socially desirable purchase and consumption). It is through this norm generation and enforcement role that mass media coverage can impact consumer behavior and positively influence market-wide purchase of hybrid vehicles.

Methodologically, studying the general media coverage of social issues, as opposed to category- or product-specific media coverage, helps remove a key form of endogeneity associated with the empirical analysis. For instance, both hybrid vehicle sales and the media coverage of the automobile industry (or a particular firm within that sector) could be influenced by unobserved characteristics such as technological developments, labor issues or other macro-economic events in the automobile industry. Focusing on media coverage of general social issues (e.g., climate change) that avoids any reference to automobiles or hybrid vehicles helps obviate endogeneity issues related to such unobserved characteristics.²

Across a number of empirical specifications, we find consistent and robust evidence that media coverage of climate change or global warming has a strong positive impact on the sales of hybrid vehicles. Equally importantly, we find that this positive impact mainly comes from media coverage that *admits rather than denies* climate change or global warming. In contrast, media coverage that either takes a neutral stand or denies climate change or global warming has little impact on hybrid vehicle sales. Our results are robust to alternative specifications including the use of lagged dependent variable and instrument variable estimation. By comparing media coverage that mentions social norm versus those that does not mention social norm, we also provide preliminary evidence that social norms that advocate for environmentally-friendly behavior play an important role in how media coverage affects consumer purchase of sustainable products.

² Of course, other unobserved factors that simultaneously affect both the media coverage of climate change and the demand for hybrid vehicles could still exist. We account for this issue in several ways in the empirical study.

The rest of the paper is organized as follows. In the next section we briefly review the literature on the motivations behind the purchase of hybrid vehicles and the roles of mass media. We follow that with the description of data, model specification, and identification. We then report the results, together with the robustness checks under alternative estimation methods. We also present findings that shed further light on the roles of media. Finally, we discuss managerial and theoretical implications and suggest directions for future research.

Conceptual Background

Sustainable Products and Hybrid Vehicles

The consumption of a sustainable or “green” product simultaneously serves two purposes. As a private good, the consumption generates direct utility to the consumer. For instance, hybrid vehicles provide transport at a lower operational cost. As a public good, sustainable consumption in the form of using hybrid vehicles provides important societal benefits, such as reduced energy consumption and reduced greenhouse gas emission. Unfortunately, the public good nature of such products often poses a challenge for their adoption because the societal benefits are diffuse, hard to quantify, and only obtained at an unknown future date. Further, consumers could free-ride on others’ purchase for these societal benefits. As Kahn (2007) indicates, even people who label themselves as environmentalists may not always “practice what they preach.” In addition, even with tax incentives, sustainable products are often more expensive than conventional ones.

Given these challenges, what drives the consumers’ *purchase behavior* for sustainable products? Hybrid vehicles, which possess the private-public good duality, are an ideal context to study this problem. First, automobiles have long been regarded as a major contributor to air

pollution and climate change;³ hence, concerns about climate change and the media coverage of it are likely to have a major impact on the automobile market. Second, in the form of hybrid vehicles, the auto industry has a well-defined environmentally-friendly alternative to conventional products. Third, hybrid vehicles sell at a significant price premium and provide relatively meager savings on the total cost of ownership basis compared to their conventional counterparts (Consumer Reports 2006). These meager savings and the public-good nature of the benefits from lower emission act as major barriers for their adoption.

Extant research in marketing on green products has mainly focused on consumer *attitude* towards these products. These include how consumers form perceptions of green products (Lin and Chang 2012; Gershoff and Frels 2015), how the introduction of green products affects brand perception (Olsen, Slotegraaf and Chandukala 2014), and the effects of environmental messages on consumer attitude (Kronrod, Grinstein, and Wathieu 2012). The actual *purchase behavior* in real market settings has been rarely studied. One notable exception is the study by Narayanan and Nair (2013) who focus on the network effect and find that, in California, consumer purchase of the Toyota Prius was affected by the installed base (i.e., the number of consumers who have previously bought Prius) in the same neighborhood. Multiple factors such as social preferences, word-of-mouth effect, and observational learning could all contribute to the installed-based effect in their research. Our focus, in contrast, is very different – rather than network or peer effects, we examine the impact of mass media as a major social force on the adoption of hybrid vehicles in the entire U.S. market.

To elucidate the drivers of purchase behavior in this sector, we draw on the theories and prior research that identify economic versus non-economic prosocial motives and the roles of

³ The International Energy Agency report (IEA 2007) suggests that by 2030 the transport sector will account for 50% of worldwide greenhouse gas emissions.

mass media. Table 1 summarizes the theoretical arguments and methods used in representative studies in this domain. We briefly discuss the key issues below.

[Insert Table 1 about here]

Motivation for Hybrid Vehicle Purchase

Economic Motives. Research on the extrinsic, financial factors that influence the purchase of hybrid vehicles has found a strong relationship between gasoline price and the adoption of fuel-efficient vehicles. Studies such as Diamond (2009), Beresteanu and Li (2011) and Gallagher and Muehlegger (2011) show that savings on fuel cost, and consequently the total cost of ownership, is a key driver of adoption. The findings related to government incentives, however, are mixed. For instance, Diamond (2009) finds very limited sales effect of tax incentives whereas Gallagher and Muehlegger (2011) find that the upfront state sales tax waivers are three times more effective than the delayed income tax credits in stimulating hybrid car sales.

Intrinsic and Social Status Motives. Prior research has also found a significant influence of intrinsic factors on hybrid vehicle purchase. Using the share of Green Party registered voters to proxy the degree of environmentalism in a community, Kahn (2007) shows that communities with more environmentalists have more hybrid car adopters. Likewise, Gallagher and Muehlegger (2011) find that per-capita membership in the Sierra Club is positively related to owning fuel-efficient hybrid vehicles. Narayanan and Nair (2013) find an installed-base effect on the adoption of a particular model – Toyota Prius – in California. In a different category of sustainable products, Bollinger and Gillingham (2012) also find a peer effect in the diffusion of solar photovoltaic panels.

These findings are consistent with experimental research that shows the effect of image/identity on prosocial behavior. For instance, Ariely, Bracha and Meier (2009) find that

image motivation is an important driver of donations to charity and that this effect is stronger in public than in private settings. Likewise, Griskevicius, Tybur and Van den Bergh (2010) find that activating status motives not only leads individuals to choose green products over more luxurious non-green products but also increases the desire for green products when the shopping is public (v.s. private) and when the green products are costlier than non-green products.

Collectively, these studies suggest that prosocial behavior could be motivated by an individual's desire to adhere to a social norm through enhancing his or her public identity or image.

The Role of Mass Media

A large body of literature in communication, environmental management, public health, and economics, has discussed the roles of media and its impact on the public. However, the literature has focused on different roles and the findings regarding the impact of media are far from conclusive (see Table 1 for summary). Several scholars have noted that while it is easy to inform about problems and suggest solutions, it is much more difficult to motivate and achieve actual behavioral changes (e.g., Aavage 2004; Atkin and Wallack 1990; Felson 1996).

A key role of media in bridging the gap between awareness/attitude and behavior is the creation and the enforcement of social norms. With strong social norms in place, consumers are more likely to act upon their attitudes if the attitudes are consistent with the social norm. For instance, Chan (1998) finds that social norms are a key predictor of recycling behavior and that the mass media is a major source in the creation of such social norms. Likewise, Yanovitzky and Stryker (2001) show that the media coverage on youth binge drinking helps shape and reinforce the social norm which increases social disapproval and consequently leads to a change in behavior.

Consistent with these arguments and the findings on the buying behavior in other environmentally-friendly product categories like solar panels (Bollinger and Gillingham 2012), we contend that the purchase of hybrid vehicles is influenced by social norms (Axsen and Kurani 2009) and that the role of mass media in creating and facilitating such social norms is particularly relevant. Media coverage of climate change or global warming, especially those that inform the public about the issue and advocate that reducing our carbon footprint has important consequences and hence an important action to take, can create a social norm that promotes and supports environmentally-friendly behavior (Holt and Barkemeyer 2010) and motivate consumers to purchase sustainable products like hybrid vehicles. As noted earlier, image motivation is key for publicly visible prosocial behavior (Ariely et al. 2009; Griskevicius et al. 2010). Hence, sustainable consumption such as the purchase of a hybrid vehicle also functions as a conspicuous display of compliance with a social norm and often as a signal for social status.

In summary, we predict that the media coverage of climate change or global warming, regardless of whether the news reports mention a specific product category or not, can positively influence the consumption of sustainable products due to a norm creation and enforcement role. This is particularly true for the media coverage that admits climate change or global warming. We will test this prediction in the specific context of hybrid vehicles.

Data

Our data is compiled from a number of sources. The hybrid vehicle sales data were purchased from CNW Marketing Research, beginning with 1999 when the first hybrid vehicle, Honda Insight, was introduced. The data period runs from December 1999 to October 2007, for a total of 95 months during which the monthly unit sales for twelve hybrid vehicle 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 included in our study belong to three major automobile firms (Toyota, Honda and Ford), and include the Ford Escape Hybrid, Mercury Mariner Hybrid, Honda Accord Hybrid, Honda Civic Hybrid, Honda Insight, Toyota Highlander Hybrid, Lexus GS450h, Lexus RX400h, Toyota Camry Hybrid, and Toyota Prius. Since some models were introduced or terminated during the study period, not all models have sales in all months. The data comprise 376 vehicle model-month observations. Table 2 provides the month of market entry and the number of model-month observations for each vehicle model.

[Insert Table 2 about here]

Media Data and Variables

We collected the data on media coverage of climate change or global warming from the LexisNexis Academic database through keyword search. Environmental research (PalFREMAN 2006) indicates that “climate change” and “global warming” are used interchangeably by scientists and journalists. Thus we searched for news articles containing either term in twelve major news outlets in the U.S. – the New York Times, Washington Post, Wall Street Journal, USA Today, US News and World Reports, Newsweek, CNN, FOX News Network, ABC, NBC, CBS, and NPR. We used two criteria to select these media. The first was the popularity of the media outlet. According to the Project for Excellence in Journalism (2006), these twelve media consistently have more readers, viewers, or listeners than others and are among the most influential national news outlets. The second criterion was that, since these media outlets have been studied in previous research, we could employ established results when coding certain variables such as media ideology (GROSECLOSE and MILYO 2005). Compared to previous research on climate change that covers four to eight news media (BOYKOFF and RAJAN 2007; BOYKOFF and BOYKOFF 2004, 2007), we took a more comprehensive approach and included media outlets from

a variety of communication channels (i.e., newspaper, magazine, TV and radio).

This search resulted in a total of 20,670 news articles on climate change and/or global warming. Through its SmartIndexing Technology, LexisNexis also supplements each article with a list of index terms that indicate the relevance of each term to the article. The relevance scores range from 0% to 100%, with a higher percentage indicating that a particular term (e.g., climate change) is more relevant to the article. These scores provide a good measure of whether climate change or global warming is the central focus for each article. We collected the relevance scores for “Climate Change” and “Global Warming” separately, and used the higher score as the measure for its overall relevance to the article. We then summed the relevance scores over all news articles for a media outlet in a given month to generate the relevance-weighted measures of media coverage for that time period.

We then used content analysis (e.g., Kerlinger 1973) to code the sentiment of each article. Eleven coders, graduate and senior undergraduate students in a major business school, were trained to read and code the 20,670 news articles on whether they admit, deny, or are neutral to climate change or global warming as an environmental concern. The coders were required to discuss with the researchers any issues during the coding process to ensure quality and consistency. Finally, we obtained the number of words appearing in each news article.

Vehicle Characteristics and Other Variables

We collected the following data from other sources. First, we obtained information on the fuel economy of each vehicle model from fueleconomy.gov. The U.S. Department of Energy (DOE)’s Office of Energy Efficiency and Renewable Energy maintains this website as the “official U.S. government source for fuel economy information.” The fuel economy of each vehicle model is the composite miles per gallon (MPG) that incorporates both city and highway

MPG.⁴ The fuel economy does not change within a particular model year.

Second, we obtained the annual vehicle design ratings from the *Automotive Performance, Executive and Layout (APEAL) Study* conducted by J.D. Power and Associates. Ranging from 1 to 5, with 5 being the highest, these ratings are an integrated measure of four important vehicle attributes – overall vehicle performance, style, features and instrument panel, and comfort.

Third, we used data from the U.S. EPA and DOE websites to compute the tax incentive available for each hybrid model. The buyer of a hybrid vehicle was entitled to receive a \$2,000 tax deduction before 2006 (Diamond 2009). Considering an average tax rate of 28%, this translates to a \$560 tax incentive for each purchase. After January 1, 2006, the tax credit ranged from \$250 to \$3,150 before being phased out. Our model-specific measure included both forms of benefits (tax deduction and credit) and spanned from 1999 to 2007. The dollar values were inflation-adjusted using December 1999 as the baseline.

Finally, we obtained the Manufacturer Suggested Retail Price (MSRP) from the automotive section of msn.com. The dollar values were inflation-adjusted using December 1999 as the baseline. We also gathered gasoline price data from the U.S. Energy Information Administration (EIA) website which provides monthly retail gasoline prices (in cents per gallon, inflation-adjusted) for all grades and formulations.

Model Specification and Identification

Table 3 presents the descriptive statistics for the main variables and their corresponding data sources. Figure 1 illustrates how the number of news reports related to climate change or global warming correlates with the overall hybrid vehicle sales for the study period. Media coverage in term of the number of reports increased from approximately 70 articles in December

⁴ The formula that the US EPA website provides is $1/(0.55/\text{city MPG}+0.45/\text{highway MPG})$. In the estimations reported in subsequent sections, we scale the values of fuel economy by 1,000 to enhance readability.

1999 to more than 700 in October 2007. In the same time period, the monthly hybrid vehicle sales ranged from a few dozen to almost 45,000 units. Prior to 2004, the trajectory of sales was mostly flat but media coverage had much greater variation. Both media coverage and hybrid vehicle sales experienced robust growth after 2004 (around month 60), even though significant variation continued to exist for each variable.

[Insert Table 3 and Figure 1 about here]

Model Specification

We model the overall demand for a hybrid vehicle as a function of the media coverage of climate change or global warming, fuel economy of the vehicle, overall vehicle design, tax incentives, vehicle price and a set of control variables. The model specification is as follows:

$$\begin{aligned} \text{Sales}_{ijt} = & \beta_1 \text{MediaCoverage}_{t-1} + \beta_2 \text{FuelEconomy}_{ijt} + \beta_3 \text{Design}_{ijt} + \beta_4 \text{TaxIncentive}_{ijt} \\ & + \beta_5 \text{MSRP}_{ijt} + \beta_6 \text{GasPrice}_t + \beta_7 \text{Seasonality}_t + \beta_8 \text{Year}_t + \beta_9 \text{Firm}_j \\ & + \beta_{10} \text{ModelAge}_{ijt} + \beta_{11} \text{MediaCovariates}_t + \varepsilon_{ijt}. \end{aligned} \quad (1)$$

Since sales and vehicle attributes are specific to a vehicle model and a particular month, our analysis is at the model-month level. Sales_{ijt} is the unit sales of vehicle model i from firm j in month t . $\text{MediaCoverage}_{t-1}$ is the relevance-weighted number of media reports in the preceding month. The next five variables are fuel economy, JD Power Associates' annual vehicle design ratings, tax incentives, vehicle MSRP, and monthly gasoline price respectively. Since auto sales often exhibit seasonal variation, we control for within-year cyclical patterns using seasonality dummies to indicate each quarter of the year. For instance, auto sales in general are higher around Memorial Day and during the fourth quarter.

We include year dummy variables in the estimation. Such, year-fixed effects serve two important purposes. First, they provide direct control for the impact of climate change on hybrid

vehicle sales over time. Second, beyond the climate impact, year-fixed effects also control for trend in the hybrid vehicle sales due to both supply side factors (such as technological development and manufacturing capabilities) and consumer factors (such as familiarity with the category).

We further include a number of covariates in the specification. First, to control for the baseline demand differences between different manufacturers, we include firm-specific dummy variables to capture firm-fixed effects. Consumer choice of automobile products often occurs on vehicles with a similar size or style between different manufacturers, since the need for a certain vehicle size or style is usually the first decision. For instance, consumers are more likely to decide whether to buy a Honda Accord or a Toyota Camry than to decide whether to buy a Honda Accord sedan or a Honda Pilot SUV. Thus, it is important to control for the firm-fixed effect.⁵

Second, consumer awareness of particular vehicle models may vary with the newness of the model in the market. We thus calculated the age of each hybrid model (in months) since its initial launch and included it in the estimation.⁶

Third, we control for two media covariates: coverage depth and potential ideology effects associated with the media. For coverage depth or details in media reports, we include the average length of the media articles for each month. For potential influence of media ideology, we included the monthly average Americans for Democratic Action (ADA) score for the news reports. The ADA score measures the media ideology ranging from extremely conservative (0) to extremely liberal (100). We adopted the ADA scores estimated by Groseclose and Milyo (2005)

⁵ Alternatively one can use firm-year fixed effects. However, doing so did not change our results but caused multicollinearity problems in the estimation.

⁶ We thank an anonymous reviewer for this suggestion. Moreover, controlling for the entry/exit of each vehicle model does not change our results. In all analyses we checked the VIF to ensure multicollinearity is not a problem.

for the news media in our data, and computed the monthly average based on the number of news reports by each media.

Identification

The set of independent variables identified above cover important firm-, model-, and month-level factors that could influence hybrid vehicle sales. For proper identification of the effects, however, it is necessary to consider the potential endogeneity that could arise due to simultaneity and omitted variables (Meyer 1995).

In our context, the basic concern regarding simultaneity is about reverse causality. Specifically, the relationship between media coverage and hybrid vehicle sales could be bi-directional. However, this is unlikely in our data. Note that our sales measure is for particular hybrid models in each month, and the media variable is the news coverage on climate change in twelve specific news outlets. It is rather implausible for the sales of a particular vehicle model to influence the media coverage over general climate change issues.

The issue of omitted variables is about unobserved social trends or cultural shifts that could influence both the media coverage of climate change and the consumer purchase of hybrid vehicles; not accounting for these unobservables could result in biased estimates. Note that our estimation includes year-fixed effects. Consistent with the “unobserved effect models” (Germann, Ebbes, and Grewal 2015), these year-fixed effects help control for the omitted variables. The identifying assumptions are: (1) the omitted variables are time variant in the yearly time periods, and (2) there is clear variation in media coverage and hybrid vehicle sales for estimation. Both of these assumptions hold. First, unobserved social trends or cultural shifts are likely to develop over longer time periods (i.e. annually rather than weekly or monthly). Year-fixed effects, hence, provide good control for these unobserved effects.

Second, with both firm- and year-fixed effects incorporated in the model, the estimation of equation (1) relies on within-firm and within-year variance for identification. Figures 2 and 3 provide the model free evidence. In Figure 2, the sales of hybrid vehicles within firms (using Toyota and Ford as examples) are plotted against the media coverage of climate change in the previous month. As the plots show, there is significant variance in both media coverage and within-firm sales. Even though Toyota had greater overall sales volume than Ford (this difference will be captured by firm-fixed effects), the hybrid vehicle sales in both firms exhibit a positive correlation with lagged media coverage. Figure 3 further explores the within-year variation for specific hybrid models, using Toyota Prius and Ford Escape Hybrid in the year 2006 as the example. Again, there is significant within-year variance in model sales, and the positive correlations between monthly sales and (lagged) monthly media coverage are discernable.⁷

[Insert Figure 2 and Figure 3 about here]

Estimation Results

Impact of Media Coverage on Hybrid Vehicle Sales

Table 4 presents the results of the main estimation. Column (1) shows the impact of overall media coverage on hybrid vehicle sales. The greater the number of media articles (weighted by their relevance to climate change or global warming) in a previous month, the higher the sales of hybrid vehicles in the current month. The parameters of the vehicle characteristics all have expected signs: fuel economy and vehicle design positively influence sales whereas vehicle price has a negative impact. Greater tax incentives from the government

⁷ Following the suggestion of one reviewer, we conducted a series of estimations to verify that the within-firm and within-year variances are useful for the estimation. We started with a basic model (eq. 1) without firm or year effects and then sequentially added firm-fixed and year-fixed effects. The model R^2 rose from 0.36 in the basic model to 0.64 with firm-fixed effects and to 0.66 when both firm- and year-fixed effects were added. Both AIC and BIC shows that the full model has better model fit. The effect of media coverage, the focus of our analysis, remains significantly positive in all estimations.

also induce the purchase of hybrid vehicles.

Columns (2) through (4) separately estimate the impact of media coverage that admits, is neutral on, or denies climate change or global warming respectively. Our hypothesis is that if media coverage is to exert a positive influence on purchase behavior, it should at least admit that climate change is occurring so that the implicit social norm of acting towards reducing pollution and preserving the environment becomes salient. This means the media coverage admitting climate change should have the largest impact on hybrid vehicle sales. This prediction is supported by the results shown in Column (2). Columns (3) and (4) show that neither neutral nor negative media coverage on climate change has an effect on the sale of hybrid vehicles. Finally, we estimated the effect of the net amount of media coverage, i.e., the difference between the number of news reports that admit versus deny climate change. As Column (5) shows, the impact of media coverage is positive. The estimates for all other variables are consistent across the models.

[Insert Table 4 about here]

Alternatives Estimations

Besides using fixed effects models, one could apply instrumental variables and lagged dependent variable as alternative ways to handle potential omitted variable bias (Germann, Ebbes, and Grewal 2015). We conducted these estimations and found that the results are consistent with those reported in the main results using fixed effects.

Instrumental Variable Estimation. In our context, a valid instrument should correlate with the coverage of climate change in national news media (the relevance criterion) but be uncorrelated with the omitted variables that influence consumers in their hybrid vehicle purchase (the exclusion restriction). A good candidate is the Climate Extremes Index (CEI), a scientific

index from the U.S. National Oceanic and Atmospheric Administration (NOAA) that summarizes the multidimensional aspects of climate data in the U.S. The CEI is calculated based on an aggregate set of climate indicators, including monthly maximum and minimum temperature, daily precipitation, monthly Palmer Drought Severity Index, and land-falling tropical storm and hurricane wind velocity.

The CEI is widely used in technical and academic analysis that often translates into scientific news and academic publications. The news media, in turn, often picks up news-worthy reports from these sources. Hence, we can expect variation in news media coverage on climate change to correlate well with variation in CEI. Furthermore, similar to the media coverage on climate change, the CEI is also time variant and can be obtained at the monthly interval. At the same time, it is implausible that general consumers will refer to scientific data on specific measures of climate data when they make vehicle purchase decision. Most consumers are unlikely to be aware of the CEI. Hence, the CEI will not correlate with the demand shocks beyond the set of independent variables that drive hybrid vehicle sales.

Before we turn to instrumental variable estimation, we estimated equation (1) by adding CEI directly as a covariate. We found the impact of media coverage on hybrid vehicle sales remains robust while the impact of CEI is not significant. Since CEI captures the weather patterns of climate change, this provides further evidence that the estimated effect of media coverage is not due to the potential endogeneity caused by climate change affecting both media coverage and hybrid vehicle sales.⁸

We employed two-stage least square (2SLS) estimation using the CEI as an instrument. Both the first-stage and second-stage results are provided in Table 5. In the first stage estimation, we included all exogeneous variables and the instrument variable CEI as independent variables.

⁸ We thank an anonymous reviewer for this suggestion.

In the second stage, we included the fitted media coverage and all exogenous variables as independent variables. The results are consistent with those reported earlier: the impact of media remains positive, the media coverage that admits climate change has a positive effect, and those that either deny or stay neutral on the issue do not have an impact.⁹

[Insert Table 5 about here]

Lagged Dependent Variable Approach. Since the omitted variables are time variant, it is possible to include the lagged dependent variable on the right-hand side of the estimation to handle the endogeneity issue (Germann, Ebbes, and Grewal 2015). The key identifying assumption here is that the lagged hybrid vehicle sales contains the influence of the omitted variables. This estimation using lagged dependent variables has an additional benefit. As discussed earlier, it is conceptually implausible that hybrid vehicle sales at the model-month level could cause nationwide changes in media coverage of climate change. Empirically, should such reverse causality be a concern, adding lagged hybrid vehicle sales as independent variables will *diminish* the estimated impact of the media coverage on sales.

Since lagged sales are often highly correlated with current sales, accounting for them provides us a strong test on the impact of media coverage. As such, we added lagged vehicle model sales, $Sales_{ij(t-1)}$, to eq. (1). The specification is as follows:

$$\begin{aligned} Sales_{ijt} = & \beta_1 MediaCoverage_{t-1} + \beta_2 FuelEconomy_{ijt} + \beta_3 Design_{ijt} + \beta_4 TaxIncentive_{ijt} \\ & + \beta_5 MSRP_{ijt} + \beta_6 GasPrice_t + \beta_7 Seasonality_t + \beta_8 Year_t \\ & + \beta_{10} ModelAge_{ijt} + \beta_{11} MediaCovariates_t + \beta_{12} Sales_{ij(t-1)} + \varepsilon_{it}. \end{aligned} \quad (2)$$

In the lagged model sales estimation, we allow for firm random effects to avoid potential clustering bias. Table 6 provide the estimation results. Not surprisingly, adding lagged sales

⁹ As expected, due to the instrument variable estimation, the coefficients are obtained at a lower level of significance. The effect size increases from that in Table 4, indicating that the unobservables are correlated with media coverage and consumer purchase in different directions.

absorbs significant variation in current vehicle sales – the parameters of the lagged sales variable are significant and positive. More importantly, however, the effect of media coverage remains consistent. Greater overall media coverage on climate change or global warming increases vehicle sales. In addition, this impact is only significant for media coverage that admits climate change or global warming.

[Insert Table 6 about here]

Alternative Measures of Media Coverage

Thus far we have used a one-month lag to study the impact of media on the sales of hybrid vehicle in a subsequent month. To test whether the results still hold if we allow for a longer delay of the media impact, we traced back three months of media coverage for each observation to construct a cumulative measure. To accommodate for the potentially diminishing return of the media stock over time (Smed and Jensen 2003), we temporally discounted media coverage in two different ways. One is the commonly used exponential decay, and the other is the decay based on an inverse function of time (Chen, Liu and Zhang 2012). Specifically, in exponential decay, the lagged media coverage from the $(t-1)^{\text{th}}$ month is further discounted by e^{-t} whereas in the inverse-function decay, the discount factor is $1/t$. The time-weighted media measures are then used to construct the cumulative media coverage. We re-estimate model specification (1) with the time-decayed media coverage. Table 7 presents the estimation result. Column (1) through (4) are based on cumulative media coverage from exponential decay and (5) through (8) are based on inverse-function decay. Across both decay patterns, the estimation results remain similar to the main findings reported earlier.

[Insert Table 7 about here]

News Coverage on Hybrid Vehicles

Recall that our theoretical argument for the media effect on sustainable consumption does not rely on the media reports mentioning a specific category or a specific firm's product within that category. This is indeed our main findings – all the analyses are for general media coverage of climate change or global warming, regardless of whether the news reports mentioned hybrid vehicles or not. An extension of this theoretical argument would be that, for the news coverage of climate change that also mentions the product category (i.e., hybrid vehicles), the media effect on the consumption of that category (i.e., hybrid vehicle purchase) should be greater than the effect of general media coverage alone.

To test whether this prediction holds, we recoded all the news reports on whether each of them mentioned hybrid vehicle besides climate change or global warming. We then constructed two new measures: (1) the amount of media coverage of climate change *without mentioning* hybrid vehicle, (2) the amount of media coverage of climate change that *also mentioned* hybrid vehicle. Based on our theoretical argument, the former measure will still have a significant impact on hybrid vehicle sales, while the latter will have a significantly greater impact than that reported in Table 4 for general media coverage. As indicated in Table 8, these are indeed the results when we re-estimated the models with these new measures.

[Insert Table 8 about here]

General Discussion

Theoretical Contributions

Our study has key implications for theory and future research. First, a growing body of literature has started addressing 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 the existing research has primarily focused on consumer attitudes rather than actual purchase behavior (e.g., Gershoff and Frels 2015). Our study is among the early research in marketing to empirically investigate the actual adoption of sustainable products.

Second, given the joint public/private good nature of sustainable products, it is critical to understand the tradeoffs consumers make between their public and private interests. Extant research in this domain (e.g., Diamond 2009, Beresteanu and Li 2011) has mainly focused on the private incentives (e.g., extrinsic monetary issues such as gasoline prices and government tax subsidies) to purchase hybrid vehicles. Our research, in contrast, focuses on the public interest and shows how mass media that provides information about climate change or global warming can influence consumer purchase by priming social status motives (e.g., social status through socially-valued consumption). Similarly, our research contributes to the psychology/behavioral economics literature on the motivation behind prosocial behavior (e.g., Ariely, Bracha and Meier 2009; Griskevicius, Tybur, and Van den Bergh 2010) by empirically examining the actual purchase behavior of hybrid vehicles and, more importantly, shedding light on the role of mass media in creating and reinforcing a prosocial norm that influences consumer purchase.

Third, extant research in mass media has found very limited evidence on the effects of media on behavior change (e.g., Atkin and Wallack 1990; Snyder et al. 2004). Our study contributes to this literature by providing new evidence that mass media can affect consumer purchase. In the context of sustainable products like hybrid vehicles where social norms are likely to play an important role, mass media is likely to influence behavior through the role of norm-creation and norm-enforcement.

While our discussion is rooted in the effects of media coverage being significantly positive, the parameter estimates from the main analysis (Table 4) provide a practical guidance

on the effect size. Recall that the media coverage variable is the relevance-weighted measure through SmartIndexing by LexisNexis. Thus, for each major media report that devoted 100 percent of its discussion to climate change and global warming, there was a sales increase of about six hybrid vehicles across all firms. Taking a longer term perspective, the estimates with lagged model sales suggest that the accumulative effect of media coverage can be 2~3 times larger. These indicate the substantial influence of mass media on sustainable consumption.

Fourth, when studying the role of media in the marketplace, the extant marketing literature mainly focuses on the market (AKA “commercial”) mode of media operations. In this mode, the audiences are viewed as consumers and the objective of the media is to target certain consumers to generate revenue (e.g., Chen and Xie 2007; Rinallo and Basuroy 2009). However, it is important to recognize that the media functions in dual modes – the market mode and the public sphere mode (Croteau and Hoynes 2006). The latter views the audience as citizens and prescribes that the objective of the media is to inform citizens and serve a broader 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. Our study is one of few in marketing to shed light on the public interest effects of mass media. Our results strongly suggest that, as an independent voice in the marketplace, media coverage of broad environmental issues can effectively influence consumer adoption of sustainable products. With the rise of new media types (e.g., social media platforms on the Internet), we expect more opportunities to study how both the market mode and public sphere mode of the media jointly affect the marketplace.

Future theoretical research can build on our empirical finding to explicitly model the social benefit through a specification that incorporates altruism in utility models. Methodologically this is akin to the way that the installed base is added to the utility function in

network externality models. This expanded analytical framework can then be used to examine the implications for individual choice, firm competition, and public policy.

Exploration of the Theoretical Mechanism

Our theoretical argument is that the media coverage on climate change and global warming affects the sales of hybrid vehicles through an influence on social norm. As we discussed earlier, this mechanism is rooted in the media research literature (e.g., Chan 1998; Yanovitzky and Stryker 2001) and plays an important role in the research on the diffusion of hybrid vehicle (e.g., Kahn 2007; Gallagher and Muehlegger 2011) and other sustainable products such as solar panel (Bollinger and Gillingham 2012). As one of the first studies to empirically examine how mass media coverage influences the adoption of hybrid vehicles, our focus in this paper is on demonstrating whether the impact of media coverage on actual consumption of sustainable products exists. However, to shed some lights on the underlying mechanism, we conducted two exploratory studies to explore the roles of social norm.

First, we coded all of the news articles in our current data based on whether each involved a discussion of social norm, i.e., whether an article mentions how people are taking actions in response to climate change or global warming. Similar to the coding procedure we employed to code the valence of each news article, five research assistants were hired to read the articles independently after being trained by the authors, and any disagreement was resolved through discussion among the coders.

For all media coverage and for the media coverage that admits climate change and global warming, this generated two new variables that incorporate social norm into the media coverage measure: the amount of media coverage that mentioned or discussed the social norm (MediaNorm1), and the amount of media coverage that did not mention or discuss the social

norm (MediaNorm0). We replace the general media coverage variable (MediaCoverage) in eq. (1) with these two variables to test whether social norm plays the role between media coverage and hybrid vehicle sales. As Table 8 shows, only the media coverage that mentions social norm has an impact. This holds for (1) all media coverage and (2) the media coverage that admits climate change and global warming. These results provide direct evidence on social norm as a key theoretical mechanism behind our findings presented in the paper.

[Insert Tables 8 about here]

Managerial Implications

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

Proactively influence the media to shape the social norm for sustainable consumption.

While sustainable products can function as symbols of status, one important pre-condition for such function is that sustainable consumption should be seen as a normatively desirable social behavior. For instance, one key reason why Tesla is struggling to make inroads in China is that living a sustainable lifestyle has not become a desirable norm in Chinese society (Forbes 2015). Our results show that the media coverage of climate change or global warming can influence hybrid vehicle sales because such coverage can create and shape the norm that sustainable consumption is socially desirable. This suggests that an effective, long-run marketing strategy for firms like Tesla would be to consider proactively working with the media on sustainability issues rather than simply focusing on marketing their own products. This is particularly important in international markets where the social norms are nascent. For instance, this could 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 1991). 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 resources on media advocacy campaigns could provide greater return on investment – that is, media coverage of sustainability issues is more likely to motivate the genuine desire to undertake a socially-valued consumption (that also serves as a status symbol for conspicuous products) than firm-initiated advertising.

More broadly, producers of sustainable products should consider broader 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 consumers to the product itself, but it could induce valuable media coverage of certain sustainable causes, which eventually benefits 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.

Strategically monitor and respond to media trends and interest. The influence of mass media is above and beyond the firm's own marketing strategy. Our finding suggests that firms selling sustainable products need to actively monitor media interests and, when media coverage is supportive of environmental concerns, try to leverage this value in a strategic manner. Tracking the trends and focuses of such media coverage can provide useful information to firms in terms of predicting current and future consumer interests and planning their marketing strategies accordingly. As media coverage of environmental issues increases, consumers and social norms become more favorably oriented towards sustainable products. Firms should

respond quickly through marketing actions to facilitate consumer purchase. For example, firms could schedule special events and enhance distribution and access for purchase.

Limitation and Future Research

This study is motivated by the premise that major news coverage of important social issues can influence consumer behavior related to these issues. Besides a strong intuitive appeal, such an impact has valuable implications for consumption, public policy and media behavior. Even though we have employed a variety of tools such as fixed effect models, instrumental variables, and lagged dependent variables to quantify the impact, we acknowledge the caveat that to fully quantify causal effects in these contexts is empirically challenging. Although our research provides a useful step in this direction, the results approximate causality and should be viewed as evidence based on correlations. It will be helpful to conduct further research with different contexts and possibly different methods. For instance, longitudinal field experiments or studies that exploit quasi-experiment opportunities will be highly valuable in demonstrating such effects.

In closing the paper, we would like to call for more research that examines how media in general could influence consumers, especially in domains that are crucial for the society such as sustainable consumption, technology adoption, and charitable behavior.

FIGURE 1
Patterns of Media Coverage of Climate Change and the Number of Hybrid Vehicles Sold

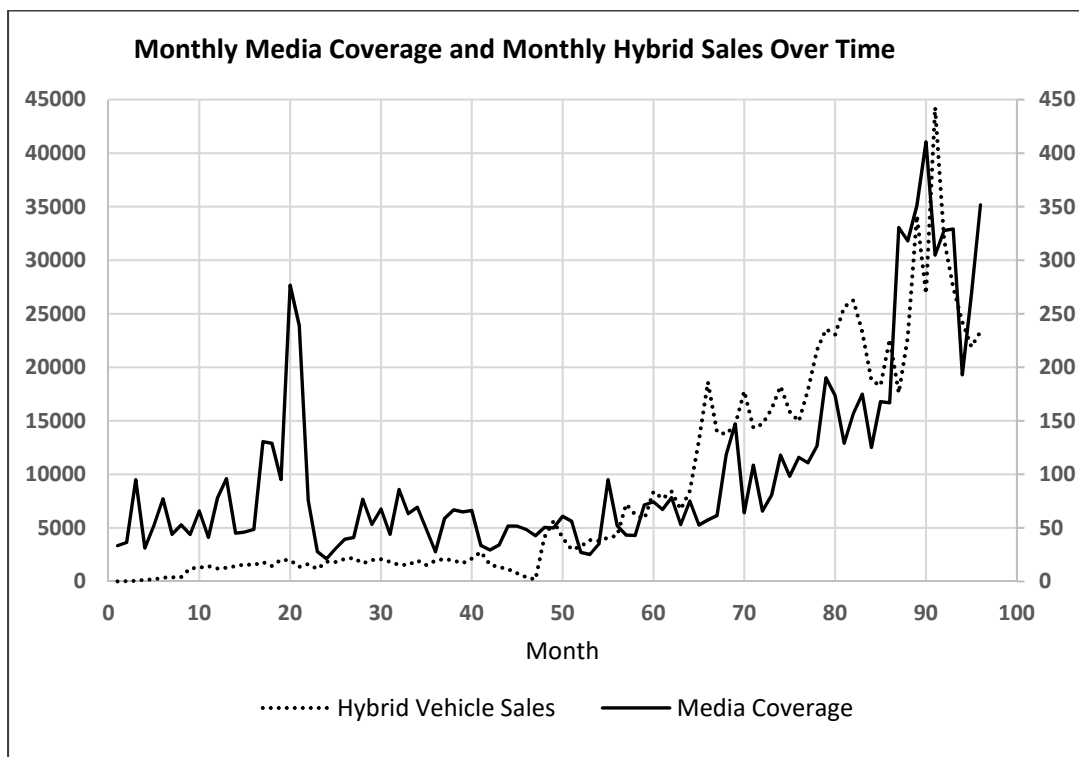


FIGURE 2
Illustration of Monthly Media Coverage versus Firm-level Sales

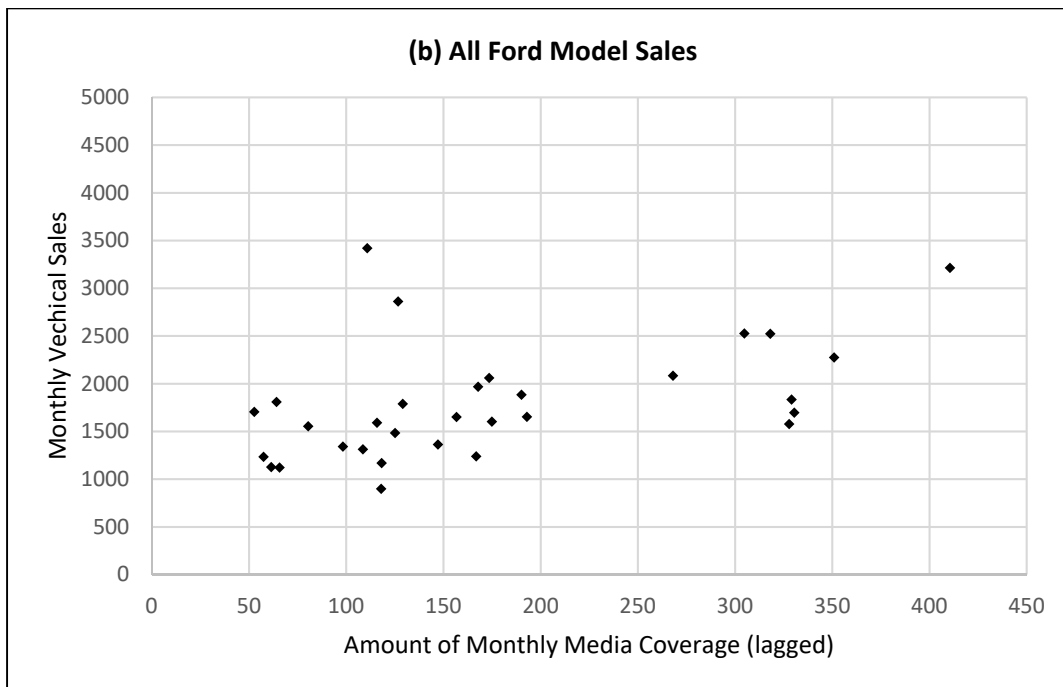
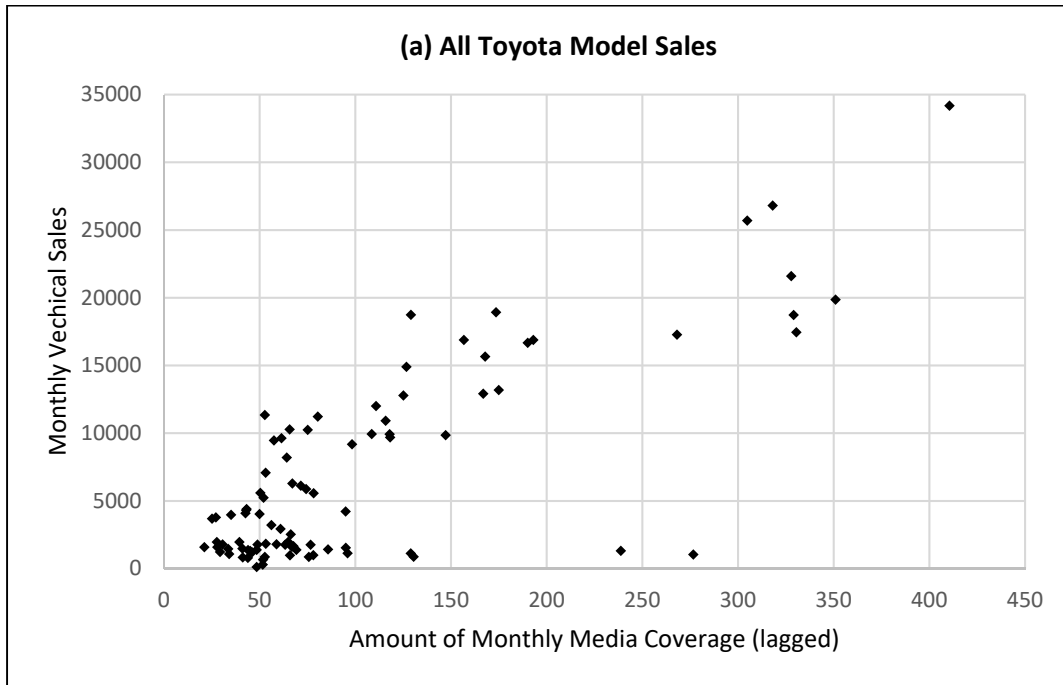


FIGURE 3
Illustration of Media Coverage versus Model-level Sales in Year 2006

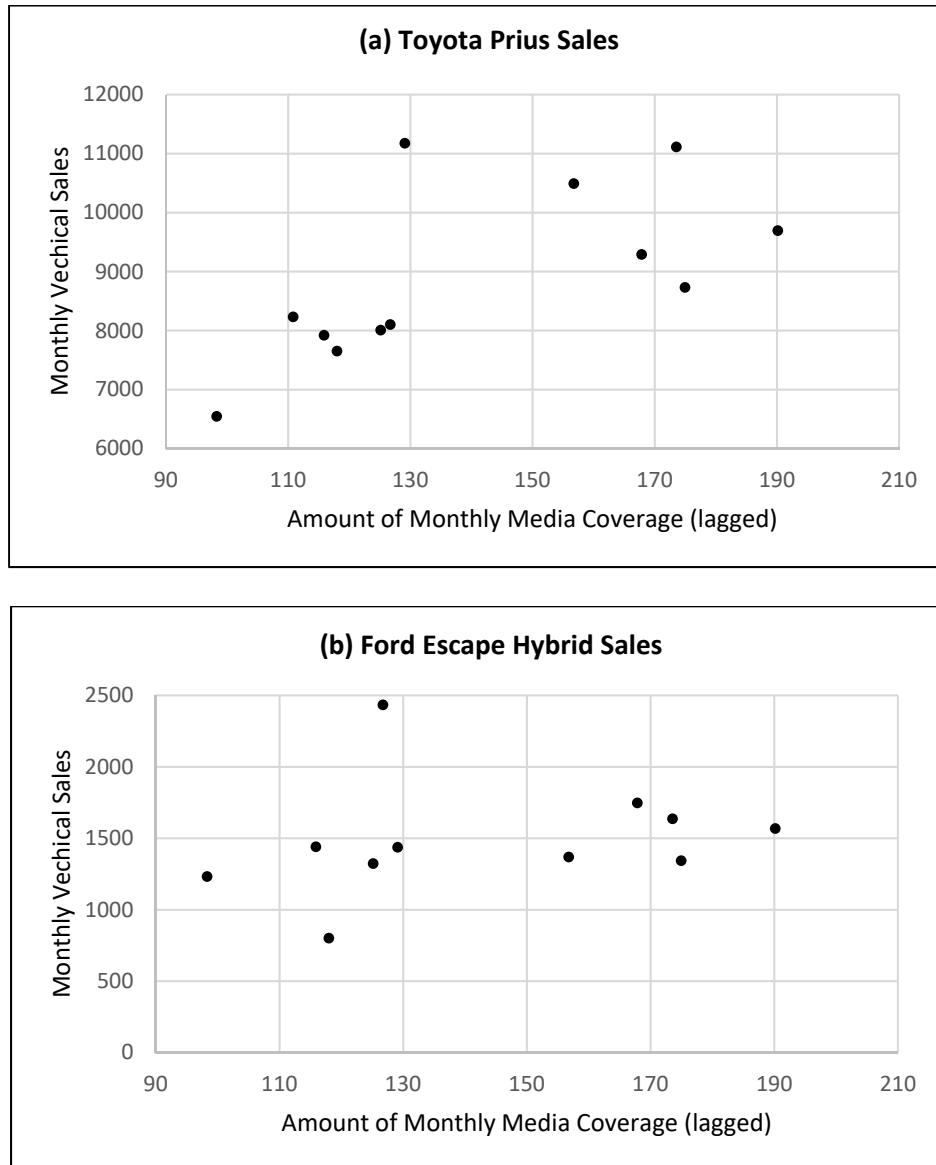


TABLE 1 Comparison of Related Literature

Study (<i>Method</i>)	Research Issues	Key Findings	Theoretical Arguments
<i>The Literature on Hybrid Vehicle Sales</i>			
Diamond (2009) (<i>Secondary-data econometric study</i>)	Impacts of the U.S. government incentives on the adoption of hybrid vehicles	There is a strong relationship between gas price and hybrid adoption, but a much weaker relationship between government incentives and hybrid adoption.	Consumers will highly discount most government incentives, which are usually not upfront.
Gallagher and Muehlegger (2011) (<i>Secondary-data econometric study</i>)	Effects of state tax incentives on consumer purchase of hybrid vehicles	State sales tax waivers are three times more effective than state income tax credits.	The form of the government incentives is as important as the incentive amount.
Beresteanu and Li (2011) (<i>Secondary-data econometric study</i>)	Impacts of gas prices and income tax incentives on hybrid vehicle demand	Both gas price and federal tax incentive help increase hybrid vehicle sales, but the federal tax incentive is not very effective.	Only individuals whose income tax liability is greater than the tax credit can enjoy the maximum benefit.
Kahn (2007) (<i>Secondary-data econometric study</i>)	Impacts of consumer environmental ideology on consumer purchase of hybrid vehicles	Environmentalists are more likely to purchase hybrid vehicles than non-environmentalists.	Sustainable lifestyle help environmentalists reduce utility loss from pollution, adhere to green neighborhood social norm, or enhance their moral authority.
Narayanan and Nair (2013) (<i>Secondary-data econometric study</i>)	How to properly estimate the installed-base effect in consumer adoption	Using instrument variable and a new bias-correction approach to identify the installed-base effect in consumer adoption of Toyota Prius in California.	Observing others' adoption can increase consumer purchase due to social preferences, observational learning, word-of-mouth, or network effects.
<i>The Psychology/Behavioral Economics Literature on the Motivation of Prosocial Behavior</i>			
Ariely, Bracha and Meier (2009) (<i>Experimental study</i>)	Effects of image motivation and monetary motivation as drivers in prosocial behavior	Image motivation is important for prosocial behavior (charity donation), has stronger effects in public than private settings, and can be crowded out by monetary incentives in public settings.	With extrinsic incentives, the image value of prosocial act gets diluted, as an individual is suspected to be acting prosaically for the extrinsic rewards rather than out of intrinsic motivation.
Griskevicius, Tybur, and Van den Bergh (2010) (<i>Experimental study</i>)	Effects of status motivation on the purchase intention of green products	Activating status motives leads people to choose green products, especially when green products cost more and in public.	Altruism can function as a costly signal associated with status, which motivates consumer purchase decision.

Literature on the Role of Media and its Impacts on Individual Behavior Change

Mazur (1981) (<i>Case study</i>)	How does media coverage affect public perception of scientific controversies?	The increase of media coverage of a scientific controversy can increase public opposition against the new technology.	Media play an active role in shaping and constructing controversy rather than just reporting it.
Gentzkow and Shapiro (2010) (<i>Secondary-data econometric study</i>)	What drives media slant or bias?	Consumer ideology strongly affects media slant.	Media reflect and thus are biased by the ideology of the consumers.
Gunther (1992) (<i>Survey data research</i>)	What drives the skeptical public attitude towards media?	The social group identification has the strongest effect on audience's distrust on media.	Media credibility is more about a receiver assessment than source characteristics.
Snyder et al. (2004) (<i>Meta-analysis of survey data research</i>)	Effects of mediated health communication campaigns on behavior change	Deliberate health media campaigns have small effects on behavior change. Only 3-5% target population change behavior after non-enforcement campaigns.	It is more difficult to achieve behavior change than to inform problems and solutions, or to motivate change, due to the knowledge-behavior gap.
Chan (1998) (<i>Survey data research</i>)	The role of mass media in promoting the voluntary waste recycling behavior	Mass media is a major source of social norm, which is one of the main factors in predicting recycling behavioral intention.	Media play an important role in setting up the expectation and behavior role model in society.
Yanovitzky and Stryker (2001) (<i>Survey data research</i>)	The norm reinforcement role of media on health behavior changes	The impact of media coverage on behavior change is mediated by changes in the social acceptability of the risky behavior.	Media can play indirect roles in behavior change through norm-reinforcement and increasing the social disapproval.

This Study

This study (<i>Secondary-data econometric study</i>)	Effects of media coverage of climate change or global warming on hybrid vehicle purchase	Greater media coverage increases the hybrid car sales at the model level. However, this impact mainly comes from media reports that admit climate change or global warming. In contrast, media coverage that either denies climate change or holds a neutral stand on the issue has little impact.	Greater media coverage helps reinforce sustainable consumption as a social norm, which increases the social status signaling value for consumers and leads to increased adoption.
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TABLE 2 Vehicle Models in the Data

Vehicle Model	Month of Market Entry	Number of Model-Month Observations
Ford Escape Hybrid	April, 2005	31
Honda Accord Hybrid	April, 2005	31
Honda Civic Hybrid	July, 2004	40
Honda Insight	February, 1999	76
Mercury Mariner Hybrid	October, 2005	25
Lexus GS450h	April, 2006	19
Lexus RX400h	October, 2005	24
Toyota Camry Hybrid	May, 2006	18
Toyota Highlander Hybrid	November, 2005	24
Toyota Prius	July, 2000	88
<i>Total model-month observations</i>		376

Note: There were five month observations missing for Honda Insight, and one month missing for Lexus RX400h.

TABLE 3 Descriptive Statistics and Correlations among Key Variables

Variable and Data Source	Mean	Std Dev	1	2	3	4	5	6
1 Vehicle sales (monthly units, CNW Marketing Research)	2,235.93	3,195.32	----					
2 Media coverage (relevance-weighted, LexisNexis)	99.73	85.18	0.187	----				
3 Fuel economy (Combined MPG, US DOE)	38.29	10.43	0.170	-0.364	----			
4 Tax incentive (\$, US EPA and DOE)	968.41	643.89	0.122	0.274	-0.295	----		
5 Vehicle design rating (1~5 by J.D. Power Associates)	3.44	0.82	-0.028	-0.022	-0.360	-0.162	----	
6 Vehicle price (MSRP, the autos section on msn.com)	22,552.21	7,213.00	-0.212	0.334	-0.747	0.079	0.606	----
7 Gasoline price (cents per gallon, US EIA)	170.51	38.32	0.229	0.646	-0.486	0.467	0.198	0.379

Notes: All dollar values are inflation adjusted.

TABLE 4 Effects of Media Coverage on Hybrid Vehicle Sales

Variables	1 (all media)	2 (admitting)	3 (neutral)	4 (denying)	5 (net of admitting and denying)
Media coverage (lagged)	6.411*** (2.189)	9.865*** (2.899)	8.065 (6.936)	10.232 (70.290)	10.106*** (2.935)
Fuel economy	68.923*** (25.586)	74.352*** (25.645)	51.155** (25.021)	45.887* (24.700)	74.735*** (25.642)
Vehicle design rating	1.380*** (0.220)	1.382*** (0.219)	1.380*** (0.222)	1.382*** (0.222)	1.382*** (0.219)
Tax incentive	0.758** (0.294)	0.755** (0.292)	0.790*** (0.296)	0.803*** (0.297)	0.757** (0.292)
Vehicle price (MSRP)	-0.249*** (0.028)	-0.249*** (0.028)	-0.250*** (0.028)	-0.251*** (0.028)	-0.249*** (0.027)
Gas price	10.020 (6.943)	8.924 (6.901)	15.277** (6.824)	17.685*** (6.509)	8.761 (6.905)
Length of media coverage	0.222 (0.462)	0.223 (0.460)	0.187 (0.468)	0.133 (0.473)	0.236 (0.460)
ADA of media	142.797 (122.899)	143.863 (121.417)	88.579 (124.515)	50.909 (120.506)	144.769 (121.363)
Months since model launch	33.481*** (7.746)	31.739*** (7.773)	38.986*** (7.558)	40.522*** (7.473)	31.625 (7.771)
Seasonality	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Obs.	376	376	376	376	376
R ²	0.665	0.667	0.658	0.657	0.668

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

TABLE 5 Instrumental Variable Estimation

Variables	1 (all media)		6 (admitting)		7 (neutral)		8 (denying)	
	First stage	Second stage	First stage	Second stage	First stage	Second stage	First stage	Second stage
Media coverage (lagged)	----	12.451* (7.173)	----	15.324* (8.742)	----	71.452 (45.725)	----	96.620 (68.738)
CEI (instrument)	5.983*** (0.979)	----	4.860*** (0.730)	----	1.042*** (0.323)	----	0.077** (0.032)	----
Fuel economy	-1.892*** (0.630)	90.933** (35.873)	-1.495*** (0.469)	90.284** (35.254)	-0.388* (0.208)	95.091** (41.826)	-0.009 (0.021)	75.928** (37.246)
Vehicle design rating	0.001 (0.005)	1.379*** (0.222)	0.001 (0.004)	1.382*** (0.220)	0.000 (0.002)	1.367*** (0.247)	0.000 (0.000)	1.358*** (0.275)
Tax incentive	0.001 (0.007)	0.713** (0.301)	0.000 (0.005)	0.727** (0.297)	0.001 (0.002)	0.662* (0.342)	0.000 (0.000)	0.516 (0.420)
Vehicle price (MSRP)	-0.000 (0.001)	-0.248*** (0.028)	-0.000 (0.000)	-0.248*** (0.028)	-0.000 (0.000)	-0.245*** (0.032)	0.000 (0.000)	-0.253*** (0.035)
Gas price	0.881*** (0.157)	2.752 (10.800)	0.631*** (0.117)	4.051 (10.113)	0.249*** (0.052)	-4.047 (15.694)	0.009 (0.005)	12.862 (8.734)
Length of media coverage	-0.010 (0.011)	0.296 (0.474)	-0.006 (0.008)	0.266 (0.467)	-0.005 (0.004)	0.524 (0.572)	0.001*** (0.000)	-0.925 (0.954)
ADA of media	-11.513*** (2.781)	230.276 (158.957)	-7.102*** (2.073)	195.759 (145.252)	-0.439*** (0.919)	394.791 (258.182)	-0.098 (0.091)	181.558 (175.512)
Months since model launch	0.535*** (0.194)	26.748*** (10.914)	0.430*** (0.145)	26.823** (10.777)	0.102 (0.064)	26.101** (12.430)	0.003 (0.006)	30.876*** (11.502)
Obs.	376	376	376	376	376	376	376	376
R ²	0.828	0.658	0.828	0.663	0.736	0.609	0.446	0.558

Note: *** $p < .01$, ** $p < .05$, * $p < .10$. Due to space limit, the results of net media coverage between admitting and denying are not presented; they are similar to those in Table 4. Seasonality, firm and year effects are similarly included.

TABLE 6 Estimation with Lagged Sales

Variables	1 (all media)	2 (admitting)	3 (neutral)	4 (denying)	5 (net of admitting and denying)
Media coverage (lagged)	3.351*** (1.220)	5.302*** (1.614)	2.870 (3.859)	60.213 (38.760)	5.336*** (1.636)
Fuel economy	31.715** (14.418)	35.069** (14.453)	21.609 (14.109)	21.389 (13.885)	35.020*** (14.462)
Vehicle design rating	0.280** (0.139)	0.283** (0.129)	0.271** (0.131)	0.263** (0.131)	0.284** (0.129)
Tax incentive	0.210 (0.163)	0.210 (0.163)	0.227 (0.165)	0.212 (0.165)	0.212 (0.163)
Vehicle price (MSRP)	-0.043** (0.017)	-0.044** (0.017)	-0.042** (0.018)	-0.041** (0.018)	-0.044** (0.017)
Gas price	2.305 (3.927)	1.677 (3.899)	5.276 (3.880)	5.739 (3.708)	1.682 (3.902)
Length of media coverage	0.033 (0.258)	0.033 (0.257)	0.009 (0.261)	-0.071 (0.263)	0.039 (0.257)
ADA of media	1.134 (68.941)	3.387 (68.012)	-36.319 (69.837)	-42.510 (66.985)	2.973 (68.024)
Months since model launch	1.569 (4.512)	0.613 (4.520)	4.305 (4.447)	4.153 (4.409)	0.641 (4.521)
Lagged model sales (one month)	0.832*** (0.029)	0.829*** (0.029)	0.838*** (0.030)	0.841*** (0.029)	0.829*** (0.029)
Seasonality	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Obs.	364	364	364	364	364
R ²	0.902	0.903	0.900	0.901	0.903

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

TABLE 7 Alternative Measures of Media Coverage: Estimation Results of Cumulative Media Coverage

Variables	Exponential decay				Inverse function decay			
	1 (all media)	2 (admitting)	3 (neutral)	4 (denying)	1 (all media)	2 (admitting)	3 (neutral)	4 (denying)
Media coverage (lagged three month cumulative)	5.804*** (1.763)	8.472*** (2.318)	11.030* (6.176)	28.238 (68.870)	4.927*** (1.533)	7.089*** (2.007)	10.419* (5.603)	34.428 (64.221)
Fuel economy	72.305*** (26.140)	77.824*** (26.281)	52.931** (25.453)	44.367* (25.135)	72.853*** (26.290)	77.983*** (26.445)	54.184** (25.546)	44.975* (25.187)
Vehicle design rating	1.390*** (0.220)	1.393*** (0.219)	1.383*** (0.222)	1.383*** (0.223)	1.394*** (0.220)	1.396*** (0.219)	1.385*** (0.222)	1.383*** (0.223)
Tax incentive	0.778*** (0.293)	0.778*** (0.292)	0.795*** (0.296)	0.801*** (0.298)	0.793*** (0.293)	0.793*** (0.292)	0.801*** (0.296)	0.800*** (0.298)
Vehicle price (MSRP)	-0.250*** (0.028)	-0.250*** (0.028)	-0.251*** (0.028)	-0.252*** (0.028)	-0.250*** (0.028)	-0.250*** (0.028)	-0.251*** (0.028)	-0.252*** (0.028)
Gas price	6.536 (7.347)	5.916 (7.243)	12.139* (7.328)	17.748*** (6.609)	5.519 (7.552)	5.082 (7.418)	10.832 (7.604)	17.486*** (6.651)
Length of media coverage	0.285 (0.464)	0.309 (0.463)	0.213 (0.468)	0.123 (0.475)	0.295 (0.465)	0.328 (0.464)	0.211 (0.468)	0.108 (0.477)
ADA of media	157.450 (123.759)	160.158 (122.846)	112.747 (124.986)	65.117 (122.597)	143.913 (123.053)	148.018 (122.458)	106.483 (123.949)	64.917 (122.289)
Months since model launch	32.219*** (7.927)	30.422*** (7.981)	38.381*** (7.686)	40.909*** (7.606)	31.929*** (7.988)	30.252*** (8.047)	37.934*** (7.723)	40.692*** (7.629)
Obs.	374	374	374	374	374	374	374	374
R ²	0.666	0.669	0.659	0.656	0.666	0.668	0.659	0.656

Note: *** $p < .01$, ** $p < .05$, * $p < .10$. Due to space limit, the results of net media coverage between admitting and denying are not presented; they are similar to those in Table 4. Other covariates such as seasonality and firm dummies are included.

TABLE 8 Exploration of the Roles of Social Norm

Variables	All media coverage	Media coverage that admits global warming
Media coverage with social norm (MediaNorm1) <i>lagged</i>	16.454*** (2.598)	15.516*** (4.497)
Media coverage without social norm (MediaNorm0) <i>lagged</i>	-4.997 (5.089)	-2.487 (8.067)
Obs.	376	376
R ²	0.670	0.669

Note: *** $p < .01$, ** $p < .05$, * $p < .10$. All covariates are identical to those in the main model.

Reference

- Aavage, Joanna (2004), "Does Viewing Violent Media Really Cause Criminal Violence? A Methodological Review", *Aggression and Violent Behavior*, 10, 99-128.
- Ariely, Dan, Anat Bracha, and Stephan Meier (2009), "Doing Good or Doing Well? Image Motivation and Monetary Incentives in Behaving Prosocially", *American Economic Review*, 99 (1), 544-555.
- Atkin, Charles K. and Lawrence Wallack (1990), *Mass Communication and Public Health: Complexities and Conflicts*. Newbury Park, CA: Sage.
- Axsen, Jonn and Kenneth S. Kurani (2009), "Interpersonal Influence within Car Buyers' Social Networks: Five Perspectives on Plug-in Hybrid Electric Vehicle Demonstration Participants", UC Davis Institute of Transportation Studies UCD-ITS-WP-09-04.
- Beresteanu, Arie and Shanjun Li (2011), "Gasoline Prices, Government Support, and the Demand for Hybrid Vehicles in the United States", *International Economic Review*, 52 (1), 161-182.
- Bollinger, Bryan and Kenneth Gillingham (2012), "Peer Effects in the Diffusion of Solar Photovoltaic Panels," *Marketing Science*, 31 (6, November-December), 900-912.
- Bonini, Sheila M. J. and Jeremy M. Oppenheim (2008), "Helping 'Green' Products Grow", *McKinsey Quarterly*, McKinsey & Company.
- Boykoff, Maxwell T., Jules M. Boykoff (2004), "Balance as Bias: Global Warming and the US Prestige Press", *Global Environmental Change*, 14, 125-136.
- , — (2007), "Climate Change and Journalistic Norms: A Case-study of US Mass-media Coverage", *Geoforum*, 38(6), 1190-1204.
- and S. Ravi Rajan (2007), "Signals and Noise: Mass-Media Coverage of Climate Change in the USA and the UK", *European Molecular Biology Organization*, 8 (3), 1-5.
- Chan, Kara (1998), "Mass Communication and Proenvironmental Behaviour: Waste Recycling in Hong Kong", *Journal of Environmental Management*, 52, 317-325.
- Chen, Yubo, Shankar Ganesan and Yong Liu (2009), "Does a Firm's Product Recall Strategy Affect its Financial Value? An Examination of Strategic Alternatives during Product-harm Crises," *Journal of Marketing*, 73 (6), 214-226.
- , Yong Liu, and Jurui Zhang (2012), "When Do Third-party Product Reviews Affect Firm Value and What Can Firms Do? The Case of Media Critics and Professional Movie Reviews," *Journal of Marketing*, 76 (2), 116-134.
- Chen, Yuxin and Jinhong Xie (2007), "Cross-market Network Effect with Asymmetric Customer Loyalty: Implications on Competitive Advantage," *Marketing Science*, 26 (Spring), 52-66.
- Consumer Reports (2006), "The Dollars and Sense of Hybrids", *Consumer Reports*, (April 2006), 18-21.
- Croteau, David and William Hoynes (2006), *The Business of Media*, Pine Forge Press.

- Diamond, David (2009), “The Impact of Government Incentives for Hybrid-Electric Vehicles: Evidence From US States”, *Energy Policy*, 37 (3), 972–983.
- Felson, Richard B. (1996), “Mass Media Effects on Violent Behavior Source”, *Annual Review of Sociology*, 22, 103-128.
- Forbes (2015), “Why Tesla Continues to Flop In China,” (accessed Feb. 19, 2015), [available at <http://www.forbes.com/sites/junhli/2015/02/17/whytelsacontinuestoflopinchina>]
- Gallagher, Kelly and Erich Muehlegger (2011), “Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology”, *Journal of Environmental Economics and Management*, 61 (1), 1–15.
- Gentzkow, Matthew and Jesse M. Shapiro (2010), “What Drives Media Slant? Evidence from U.S. Daily Newspapers,” *Econometrica*, 78, 35-71.
- Germann, Frand, Peter Ebbes and Rajdeep Grewal (2015), “The Chief Marketing Officer Matters!” *Journal of Marketing*, 79 (May), 1-22.
- Gershoff, Andrew D. and Judy K. Frels (2015), “What Makes It Green? The Role of Centrality of Green Attributes in Evaluations of the Greenness of Products”, *Journal of Marketing*, 79 (1), 97-110.
- Global Scan/BBC World Service Poll (2009), “Climate Concerns Continue to Increase: Global Poll”, (accessed June 2, 2013), [available at [http://www.globescan.com/news_archives/bbc2009_climate_change/.](http://www.globescan.com/news_archives/bbc2009_climate_change/)]
- Griskevicius, Vladas, Joshua M. Tybur and Bram Van den Bergh (2010), “Going Green to be Seen: Status, Reputation, and Conspicuous Conservation”, *Journal of Personality and Social Psychology*, 98(3), 392–404.
- Groseclose, Tim, and Jeffrey Milyo (2005), “A Measure of Media Bias,” *Quarterly Journal of Economics*, 120, 1191–1237.
- Gunther, Albert C. (1992), “Biased Press or Biased Public? Attitudes towards Media Coverage of Social Groups”, *Public Opinion Quarterly*, 56, 147-167.
- Holt, Diane and Ralf Barkemeyer (2010), “Media Coverage of Sustainable Development Issues—Attention Cycles or Punctuated Equilibrium?” *Sustainable Development*, 19 (2).
- Internal Revenue Service (2010), “Alternative Motor Vehicle Credit”, Internal Revenue Service, (accessed Feb 2, 2010), [available at <http://www.irs.gov/newsroom/article/0,,id=157632,00.html>].
- International Energy Agency (2007), “World Energy Outlook: Summary and Conclusions”, (accessed March 21, 2010), [available at <http://www.worldenergyoutlook.org>].
- Jernigan, David H. and Patricia A. Wright (1996), “Media Advocacy: Lessons from Community Experiences,” *Journal of Public Health Policy*, 17 (3), 306-330.
- Kahn, Matthew E. (2007), “Do Greens Drive Hummers or Hybrids? Environmental Ideology as a Determinant of Consumer Choice”, *Journal of Environmental Economics and Management*, 54 (2), 129–145.

- Kerlinger, Fred N. (1973), *Foundations of Behavioral Research, 2nd edition*. Holt, Rinhart and Winston, New York.
- Kronrod, Ann, Amir Grinstein and Luc Wathieu (2012), “Go Green! Should Environmental Messages Be So Assertive?” *Journal of Marketing*, 76 (1), 95-102.
- Leonidou, Leonidas C., Constantinos N. Leonidou and Olga Kvasova (2010), “Antecedents and Outcomes of Consumer Environmentally Friendly Attitudes and Behavior”, *Journal of Marketing Management*, 26 (13), 1319–1344.
- Lin, Ying-Ching, and Chiu-Chi Angela Chang (2012), "Double Standard: The Role of Environmental Consciousness in Green Product Usage", *Journal of Marketing*, 76(5), 125-134.
- Luo, Xueming and C.B. Bhattacharya (2006), “Corporate Social Responsibility, Customer Satisfaction, and Market Value,” *Journal of Marketing*, 70 (October), 1–18.
- Mazur, Allan (1981), “Media Coverage and Public Opinion on Scientific Controversies,” *Journal of Communication*, 31(2), 106-115.
- Meyer, B. D. (1995), “Natural and Quasi-Experiments in Economics”, *Journal of Business & Economic Statistics*, 13 (2), 151–161.
- Narayanan, Sridhar and Harikesh Nair (2013), “Estimating Causal Installed-base Effects: A Bias-correction Approach,” *Journal of Marketing Research*, 50 (1), 70-94.
- Olsen, Mitchell C., Rebecca J. Slotegraaf, and Sandeep R. Chandukala (2014), “Green Claims and Message Frames: How Green New Products Change Brand Attitude”, *Journal of Marketing*, 78 (5), 119-137.
- Palfreman, Jon (2006), “A Tale of Two Fears: Exploring Media Depictions of Nuclear Power and Global Warming”, *Review of Policy Research*, 23 (1), 23–43.
- Pertschuk M, Wilbur P (1991), *Media Advocacy: Reframing Public Debate*. Washington, DC: The Benton.
- Project for Excellence in Journalism (2006), “The State of the News Media 2006”, Washington, DC, USA: Project for Excellence in Journalism, (accessed January 23, 2014), [available at www.stateofthenewsmedia.org].
- Rinaldo, Diego and Suman Basuroy (2009), "Does Advertising Spending Influence Media Coverage of the Advertiser?" *Journal of Marketing*, 73 (11), 33-46.
- Sen, Sankar and C.B. Bhattacharya (2001), “Does Doing Good Always Lead to Doing Better? Consumer Reactions to Corporate Social Responsibility”, *Journal of Marketing Research*, 38 (May), 225–43.
- Smed, Sinne and Jorgen Dejgaard Jensen (2003), “Food Safety Information and Food Demand– Effects of Temporary and Permanent News”, working paper, *Workshop on Environment, Information and Consumer Behaviour*, Denmark (28–29 April 2003).
- Smith, Scott M., David S. Alcorn (1991), “Cause marketing: a new direction in the marketing of corporate responsibility”, *Journal of Consumer Marketing*, 8(3), 19– 35.

- Snyder, Leslie B., Mark A. Hamilton, Elizabeth W. Mitchell, James Kiwanuke-Tondo, Fran Fleming-Milici and Dwayne Proctor (2004), “ A Meta-analysis of the Effect of Mediated Health Communication Campaigns on Behavior Change in the United States”, *Journal of Health Communication: International Perspective*, 9(1), 71-96.
- Yanovitzky, Itzhak and Jo Stryker (2001), “Mass Media, Social Norms, and Health Promotion Efforts: A Longitudinal Study of Media Effects on Youth Binge Drinking”, *Communication Research*, 28 (2), 208-239.