The Value of Environmental Status Signaling

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Abstract

How much are consumers willing to pay to signal their environmental consciousness? We identify the signaling value of an environmental public good by focusing on hybrid cars and exploiting the physical uniqueness of the Toyota Prius relative to hybrids that look identical to their non-hybrid counterparts. We deploy a quasi-experimental hedonic model to estimate this willingness to pay. We find that, controlling for observable and unobservable factors, the Prius commands an environmental signaling value of $587 or 4.5 percent of its value. Our research provides lessons for economists and policymakers, and contributes to the literature on identifying signaling values.

Keywords: Environmental public goods; Signaling value; Hybrid cars; Quasi-experimental; Hedonic.
JEL Codes: Q50, Q51, D03, H40.

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1 Introduction

How much are consumers of environmental public goods willing to pay to signal their environmental consciousness? How much are consumers willing to pay to satisfy other behavioral demand motives for environmentally friendly products? A large amount of environmental economic and social research in recent years has revolved around substantial anecdotal evidence that consumption of environmental public goods is driven, at least in part, by behavioral motives. Theoretical explanations for growing demand for environmentally friendly products typically include the now classic models of altruism (e.g., Bergstrom, Blume & Varian 1986) and impure altruism (e.g., Andreoni 1989), as well as alternative behavioral hypotheses that include guilt (Kotchen 2009, Jacobsen, Kotchen & Vandenbergh 2012). In the case of highly visible environmentally friendly products, such as hybrid cars or solar panels, researchers have recently begun to explore social status signaling as an important demand driver (Dastrup, Zivin, Costa & Kahn 2012, Sexton & Sexton 2013).

The anecdotal evidence and theoretical explanations are compelling characterizations of growing consumer demand for environmental public goods, yet there is a dearth of empirical evidence quantifying the behavioral components of such demand.[1] The reason for this lack of evidence is that behavioral demand components are unobservable and often confounded by a multitude of unobservable related factors, making econometric identification of such demand components challenging. There do not exist many opportunities for researchers to construct a reliable model capable of controlling for such confounding factors. It is also likely that demand for different goods is motivated for different reasons, making generalizations of any econometric estimates difficult.

We provide a plausible empirical strategy for identifying environmental social status effects, and estimate consumer willingness to pay for highly visible environmental public goods in order to signal their environmental awareness. We contend that social status is a relevant demand component for any environmental product that is obviously visible to others: solar panels, reusable products, and hybrid cars are important examples. To put this in the context of other environmental public goods, consumption of renewable electricity purchased from the grid is not likely to be driven significantly by concern for social status as consumption of renewable energy is not generally visible by others. Evidence of social status as an important demand component for visible environmental public goods includes the disproportionate share of ownership of the Toyota Prius relative to other hybrid cars, holding constant confounding effects such as brand loyalty or Prius marketing initiatives (Sexton & Sexton 2013). The Prius, as documented by Sexton & Sexton (2013), was carefully designed by Toyota to be visually distinct from all other passenger vehicles making it highly visible as a hybrid car. Furthermore, Heffetz (2011) finds that cars are one of the most visible consumption goods available to households.

To identify the social status demand components of visible environmental public goods, we exploit the fact that the Toyota Prius is the only visually distinct hybrid car. All other hybrid cars are extensions of other conventional gasoline engine models, the most popular model being the Honda Civic hybrid. These non-Prius hybrids are only identifiable as hybrids via the small 'hybrid' label on the rear of the car.[2] Yet, we expect that any non status-seeking hybrid consumer

[1] Recent exceptions include Sexton & Sexton (2013), Dastrup et al. (2012) and Jacobsen et al. (2012). We provide a detailed review of related literature in Section 2.

[2] Sexton & Sexton (2013) explore identification of a social status demand component for the Toyota Prius based

is indifferent between a Prius and non-Prius hybrid, holding constant any confounding effects such as brand loyalty or mechanical, luxury, and safety features. In other words, if demand for the Toyota Prius is driven, at least in part, by concern for social status, we expect that the marginal value of a Toyota Prius is significantly higher than the marginal value of all other hybrids relative to conventional gasoline engine vehicles, controlling for relevant observable and unobservable confounding factors. Our econometric setup controls for any non-status behavioral demand drivers that have received much attention in recent environmental economics research.

We adopt a quasi-experimental hedonic pricing model to estimate the marginal willingness to pay for environmental status signaling associated with a Toyota Prius. Our interest is on an indicator for Toyota Prius that captures any price premium specific to the Prius. The hedonic setup allows us to account for potential observable and unobservable confounding factors that influence the price of a car, such as, fuel efficiency, safety and luxury features, mechanical specifications, or brand loyalty. We control for any unobservable non-status demand drivers common to all hybrid vehicles (e.g., altruism, warm-glow, or guilt) by including a general hybrid indicator in our hedonic regressions. Hence, our quasi-experimental hedonic setup allows us to control for both observable and unobservable confounding factors that, if unaccounted for, might bias our estimates of the status signaling value of the Prius. We carefully consider other Prius-specific unobservable demand drivers (e.g., Toyota reliability, Prius marketing, etc.) as potential confounding factors in our analysis; given marketing research and careful discussion of social status effects, we argue that these effects are not likely contaminants of our status signaling estimates. Hence, given our set of controls, we interpret statistical significance of the Toyota Prius indicator to be evidence quantifying the status signaling value of the Prius.

The data is a cross-section of consumer vehicles obtained from the 2009 National Household Travel Survey administered by the United States Department of Transportation. We obtain zip-code specific market prices for each vehicle in our sample from the Kelly Blue Book database of used car prices to exploit both the year and odometer reading unique to each vehicle in our sample, as well as variation in local market equilibrium prices. Technical specifications that form the basis for our set of hedonic control variables come from both the Kelly Blue Book database and the Wards Automotive Yearbook. Our final combined dataset contains 36,167 cross-sectional observations, of which 1,222 are Toyota Prius and 1,847 are hybrids. We further classify observations into census divisions and core-based statistical areas, which facilitates regional and local market-specific analyses in addition to a national level analysis.

Our quasi-experimental hedonic model yields a positive and significant marginal value for the Toyota Prius of approximately \$587. This means that, controlling for mechanical differences across vehicles, accounting for fuel efficiency benefits of the Prius (and hybrids in general), as well as general behavioral motivation for purchasing hybrids (e.g., altruism), the Toyota Prius has on average a social status signaling value of \$587. To put this number in perspective, the average marginal value of hybrids in general, controlling for confounding differences across vehicles, is about \$1,954. Since our general hybrid indicator potentially captures a variety of demand drivers influencing the demand for hybrids, whereas the Prius indicator only identifies the social status signaling effect net of other unobservable components, it is reasonable that our hybrid estimate

on the same general insight, however their identification strategy and empirical model is substantially different from ours. We provide more explicit details of how our work relates to theirs below.

is substantially larger than our Prius estimate. We consider a variety of different econometric specifications and market definitions to explore the robustness of this result, and find that, in general, the Prius estimate is significant and ranges from \$391 - \$1,012 and the hybrid estimate ranges significantly from \$1,521 - \$2,833. These estimates imply that, on average, the status signaling value of the Toyota Prius accounts for approximately 4.5 percent of its total value, while the general hybrid behavioral components account for approximately 14 percent of the average value of a hybrid.

Our paper has several important implications. First, our econometric setup and identification constitute an important contribution into the empirical literature quantifying behavioral motives for consumer demand in general, providing a unique opportunity to reliably measure the value of environmental social status signaling. Second, our research has clear implications in the environmental literature, providing quantitative measures of consumer demand components for environmental public goods, evidence that social status in part drives consumption of visible environmental public goods, as well as a quantitative measure of the relative value of social status signaling and other behavioral demand drivers. Finally, our empirical results are of interest to policymakers interested in the proliferation of hybrid car adoption as such policies rely on understanding the drivers of consumer demand for hybrid vehicles.

This paper is organized as follows. Section 2 provides a review of the related literature. Section 3 provides a discussion of our identification strategy as well as a description of our empirical model. Section 4 provides a detailed account of our data. Section 5 contains our primary regression results and Section 6 contains the results from several robustness checks. Section 7 presents a detailed discussion of our findings, and Section 8 concludes.

2 Review of Relevant Literature

There is a rich economic literature investigating social status as a driver of consumer demand, with roots dating back to Smith (1790) and Veblen (1899), with the latter explicitly detailing a theory of 'conspicuous consumption.' Well-known indeed, conspicuous consumption is consumption with the intent of showing off one's character - e.g., wealth, class, or in our case, environmental consciousness. Frank (1985) defines these goods to be 'positional' goods, and the social position of the consumer as dependent on his or her relative level of consumption. A large economic literature exists that shows that conspicuous consumption is prevalent (e.g., Charles, Hurst & Roussanov 2009), and Heffetz (2011) shows that the consumer vehicle market is one of the most important market segments in which consumers choose to signal.[3] Howarth (1996) provides an early theoretical model of consumption and social status in an environmental context.

Our analysis directly relates to a growing body of environmental research investigating the demand for hybrid vehicles. This literature can be divided into three broad groups. The first group is focused on the relationship between government policy and hybrid vehicle adoption. Important contributions in this area include Chandra, Gulati & Kandlikar (2010), Beresteanu & Li (2011) and Gallagher & Muehlegger (2011). Each of these papers finds evidence that government tax incentives boost demand for hybrid vehicles, however Chandra et al. (2010) find some evidence

[3]We briefly acknowledge the theoretical economic literature on social status. Important contributions include Frank (1985), Corneo & Jeanne (1997), Hopkins & Kornienko (2004) and Friedman & Ostrav (2008).

that these policies may not have been successful at inducing non-hybrid consumers to purchase a hybrid. Beresteanu & Li (2011) focus on equilibrium market outcomes under alternative gasoline price scenarios, as well as federal income tax deductions and credits. They find that while each has contributed towards increasing the market share of hybrids over the last decade, higher gas prices and federal tax credits account for over half of the sales of hybrid vehicles. Gallagher & Muehlegger (2011) focus on state-level incentives for hybrid vehicle adoption and find that state-level sales tax waivers have a significantly larger effect on hybrid vehicle adoption relative to state income tax credits. In contrast to Beresteanu & Li (2011), Gallagher & Muehlegger (2011) find that rising gas prices do not disproportionately increase the demand for hybrids relative to high-fuel efficiency vehicles.

The second body of literature is focused on identifying which types of consumers are more likely to purchase hybrid vehicles. Important papers include Kahn (2007), Kahn & Morris (2009) and Gallagher & Muehlegger (2011). Both Kahn (2007) and Gallagher & Muehlegger (2011) provide empirical evidence that environmentalists are more likely to purchase hybrids vehicles, by showing that hybrid registration rates are higher in areas with a larger fraction of environmentally conscious voters. Kahn & Morris (2009) provide general evidence that environmentalists do significantly engage in more environmentally friendly activities relative to non-environmentalists. These papers do not, however, describe the expected equilibrium market value of hybrids relative to non-hybrids.

Most closely related to our current research is the growing body of research focused on behavioral demand drivers of hybrid vehicle consumption.[4] Important contributions in this domain include Sexton & Sexton (2013), Heutel & Muehlegger (2012) and Narayanan & Nair (2013). Heutel & Muehlegger (2012) provide a model of hybrid technology diffusion under uncertainty regarding the quality of hybrid technology. They find that high quality hybrids, such as the Toyota Prius, have relatively higher market penetration rates compared to lower quality hybrids. They further show that introduction of a high quality hybrid into the market leads to a general increase in hybrid demand for all hybrid types, and that reputational advantages of the high quality hybrid over alternative hybrids dissipate over time. Narayanan & Nair (2013) provide evidence that Prius demand is, in part, driven by social influence.[5]

Sexton & Sexton (2013) provide an empirical model that is most closely related to our work. Their hypothesis and motivation is similar to ours: the Prius provides the only hybrid vehicle option for signaling environmental consciousness. In their empirical framework, the Honda Civic hybrid is used as a control group for unobserved factors that are unique to all hybrids. Their main contribution is to establish a significantly disproportionate share of Toyota Prius registration in relatively greener communities, through which they can calculate a Prius price premium which they attribute to status signaling. They calculate a Prius status signal in the range of $430 to $4,200.

The empirical framework of Sexton & Sexton (2013) is, however, substantially different from ours. They use market shares of the Prius and Civic hybrid in different communities that may

[4]Behavioral demand drivers in an environmental context has also been studied by, for example, Clark, Kotchen & Moore (2003), Kotchen & Moore (2007), Allcott (2011) and Jacobsen et al. (2012). Theoretical models of behavioral demand models of environmental consumption include, for example, Kotchen (2005, 2006, 2009) and Delgado & Khanna (2012).

[5]Narayanan & Nair (2013) refer to such social influences generally as 'installed base' effects, since "agents may care about the adoption behavior of other users because others' actions or welfare directly affect their utility..." This is, essentially, a statement regarding social status consumption.

differ in overall attitudes towards environmental protection as an indicator of relative signaling value. They provide compelling arguments that the Prius has a relatively higher value in a community with a relatively stronger preference for environmental amenities. Hence, they search for a disproportionate share of Prius ownership in relatively greener communities that, conditional on other factors, is evidence of a social status value of the Prius.

One difference between our approach and the approach deployed by Sexton & Sexton (2013) is that their model does not directly provide an econometric estimate of the signaling value of the Prius. They assume that the price elasticity of the Toyota Prius is approximately the same as those of small conventional engine sedans, such as the Toyota Corolla. While not unreasonable, this assumption is untested. The advantage of our hedonic approach is that we can avoid this assumption and directly estimate the signaling value of the Prius using a standard, well-established methodology. Further, our study is not limited to two particular geographical areas; we use a national sample of car ownership and are able to identify the signaling value of the Prius across different regions within the United States.

Our work is also closely related to Dastrup et al. (2012), who estimate the status signaling value of solar panels in California homes. Like us, Dastrup et al. (2012) deploy a hedonic model with an indicator for solar panels (in our case, the indicator is for Toyota Prius), however unlike us they do not control for alternative behavioral demand drivers that may confound their estimates of the status signal (e.g., altruism or warm-glow). They estimate that the social status signaling value of solar panels is approximately 3.5 percent of the market price of the home.

Finally, we mention the seminal work of Berry, Levinsohn & Pakes (1995, 2004) and Goldberg (1995) on vehicle choice and the automotive industry. Those authors simultaneously exploit variation in product characteristics and observed as well as unobserved consumer attributes to identify both demand and supply parameters. One advantage of the first stage hedonic approach we deploy is that we do not need to estimate both the demand and supply functions to recover an estimate of the marginal willingness to pay for environmental status. That is, while their work is related to ours, we do not need to model such a complex market structure for identifying the marginal willingness to pay for environmental status.

3 Identification and Econometric Strategy

3.1 Hypothesis and Identification

Our hypothesis is that demand for visible environmental public goods is driven, in part, by social status-seeking desires. In general, this hypothesis is not testable because it is challenging to separate out or account for a variety of unobservables that are also likely to influence demand. However, in the case of the Toyota Prius, it is possible to identify the environmental status value separately from other confounding factors. Hence, we refocus our hypothesis to the following testable hypothesis:

Hypothesis: There is a status-seeking component to the demand for the Toyota Prius.

Our identification of the status-seeking value of the Toyota Prius is grounded in the observation that of all available hybrid vehicles, the Toyota Prius is the only visually unique hybrid, as all other hybrids are derived from a visually identical conventional engine vehicle.[6] Consider, for example, the Honda Civic hybrid as being representative of all non-Prius hybrids: the only feature identifying the Honda Civic hybrid from a conventional Honda Civic is the label on the rear of the vehicle stating that the model is a hybrid. Passers-by do not generally recognize the Civic hybrid as being a hybrid; hence, the Civic hybrid does not provide much opportunity for a status-seeking consumer to satiate their desires to signal their environmental consciousness. All else being equal, a status driven consumer will not purchase the Honda Civic hybrid, and will instead choose to purchase the Toyota Prius.

This insight provides the justification for considering differences in prices of the Toyota Prius relative to other hybrids, holding constant differences in mechanical, safety, and luxury specifications, as well as unobservable brand effects (e.g., loyalty, reputation). Considering a variety of plausible motives driving purchases of hybrid vehicles - social status, altruism, warm-glow, guilt, and fuel efficiency - we contend that each motive, with the important exception of status signaling, can be satisfied via consumption of *any* hybrid (Prius or non-Prius). Consider, for example, an altruistic consumer who wishes to purchase a hybrid vehicle in order to contribute to improved environmental quality. Physical vehicle characteristics and tastes being held equal, such a consumer would be indifferent between purchasing a Prius or any non-Prius hybrid, as the visual uniqueness of the Prius is of no general value to this consumer. The same is true for any possible motive, except for status signaling. Therefore, controlling for the demand drivers common to all hybrids (i.e., common to both Priuses and non-Priuses), provides an important means of differencing out status-signaling demand from other drivers of hybrid demand.

We emphasize the generality of this identification strategy, as our use of hybrids as a control group for unobservable factors influencing demand for the Prius is in no way restricted to the several factors listed above. Indeed, our use of hybrids as a control is capable of accounting for *any* unobservable factors that may confound identification of the Prius status signal, so long as these unobservable factors are common to all types of hybrids. After accounting for both observable and unobservable factors influencing the demand for the Toyota Prius, we argue that any statistical evidence that the Toyota Prius continues to command a relatively higher price is evidence of a statistically significant social status signaling value.

3.2 Econometric Strategy

Our empirical model is a quasi-experimental hedonic pricing model for automobiles given a vector of control variables that account for differences in the observed market prices of different cars. Quasi-experimental econometric methods have begun to receive considerable attention in the hedonic pricing literature (Parmeter & Pope 2013). While hedonic methods have been used to extract the implicit price of a single attribute from the overall price of a commodity (Rosen 1974, Taylor 2003, Palmquist 2005, Parmeter & Pope 2013), one potential shortcoming is that the standard model is unable to generally account for unobserved factors that may influence prices. Quasi-experimental methods are able to control for certain unobserved factors by comparing a treatment group to a control group, where the control group is able to account for unobserved factors that are exogenous

[6]The one exception is the Honda Insight, which was the first hybrid electric passenger vehicle introduced in the US consumer market. This two-seater vehicle proved to be very unsuccessful and Honda stopped production after a few years. There are no Honda Insights in our sample.

to treatment and common to both treatment and control groups. Under this assumption, a quasi-experimental hedonic approach can be a powerful method for controlling for both observable and unobservable factors influencing the commodity price.

A standard hedonic regression model defines the price of the automobile, P_i, to be a function of a vector of vehicle attributes, X_i, for some conditional mean response $g(\cdot)$ and observation index $i = 1, 2, \ldots, n$. In general, the functional form of the hedonic price function is unknown, and typically believed to be nonlinear (Parmeter & Pope 2013). In practice, $g(\cdot)$ is often assumed to be parametric with parameter vector β:

$$\begin{aligned} P_i &= g(X_i) + \epsilon_i \\ &= g(X_i; \beta) + \epsilon_i \end{aligned} \tag{1}$$

in which ϵ_i is a mean zero error. A common specification of $g(X_i; \beta)$ is to specify the dependent variable in logs and the independent variables in linear and additively separable levels

$$\ln P_i = X_i \beta + \epsilon_i \tag{2}$$

so that the parameter β is a constant percentage change in the price of the vehicle for a particular attribute, while allowing for non-constant marginal prices for the different attributes (Boyle, Poor & Taylor 1999, Heintzleman & Tuttle 2012). In this specification, estimates of the marginal willingness to pay for each attribute is recovered by multiplying the estimated coefficients, $\widehat{\beta}$, by P_i. An additional advantage of this specification is that estimation of the hedonic price function is straightforward using least squares.

We consider a quasi-experimental version of the semi-log specification in (2) as our primary specification, defining X_i to be a vector of standard vehicle characteristics including mechanical specifications, safety features, luxury attributes, fuel efficiency rating, odometer reading, year built, and indicators for vehicle make (we provide complete details below). Define D_P as a binary indicator for the Toyota Prius and D_H as an analogous indicator for *all* hybrids, including the Toyota Prius. Then, we formulate our model as

$$\ln P_i = \beta_0 + \beta_1 D_P + \beta_2 D_H + \beta_3 X_i + \epsilon_i. \tag{3}$$

β_1 captures the price effect of a Toyota Prius relative to other cars, holding constant any characteristics common to all hybrids. Given our identification strategy and use of the general hybrid indicator to account for any (non-status) demand drivers common to all hybrid vehicles, β_1 defines the status signaling value of the Prius. Hence, our primary focus is on the estimate of β_1, and a standard t-test of the null hypothesis that $\beta_1 = 0$ provides a formal statistical test of our primary hypothesis. Of independent interest is the parameter β_2, as this parameter captures the non-status value of a hybrid, holding constant the observables defined in X_i. That is, an estimate of β_2 provides a measure of the bundled value of other, non-status, behavioral hybrid demand drivers. In addition to testing the individual significance of both β_1 and β_2, a comparison of the relative magnitudes of these parameters provides insight into the relative strength of the social status signaling value compared to the value of all other hybrid demand drivers.

One important aspect of hedonic modeling that deserves some attention is the definition of the market in which to conduct the empirical study (Parmeter & Pope 2013). In our case, there are two plausible ways to define the market: a national market and a local (or regional) market. One view is that vehicle prices are essentially national prices. Manufacturer Suggested Retail Prices are set nationally. Further, unlike in the housing market, the value of any vehicle is not likely to vary regionally as the value is typically determined only by vehicle-specific factors, and not additionally by local or regional factors. Hence, there is no particular reason to believe that identical cars will have different equilibrium market prices in different parts of the country. In this view, a nationally defined market is appropriate.

An alternative view is that consumers are likely to search within the nearest metropolitan area for vehicles, but are not likely to look across different states or outside their closest metropolitan area. This conjecture implies that there may be regional or local differences in the equilibrium market value of otherwise identical vehicles that can be exploited to obtain more precise estimates of the parameters in the model. In this case, the appropriate size of the market for cars is the regional or local metropolitan level. As we discuss in Section 4, one advantage of our dataset is that we have access to the core-based statistical area location of each observation that can be exploited to estimate approximately city-level regressions. Hence, we begin our analysis at the national level to obtain a preliminary set of regression results, and then refine our analysis by considering both census division and core-based statistical area regressions. Indeed, one additional advantage of considering multiple markets is that we can compare estimates across markets to investigate heterogeneity in the signaling value of the Prius.

Finally, we acknowledge that a potential shortcoming of the model specified in (3) and the description of our identification strategy in general is that we have not yet addressed any potential confounding factors that are Prius specific. As stated, our controls are only able to account for unobservable factors that are common to all hybrids. We defer this discussion until Section 7 in which we consider the general robustness of our results as well as explore the possibility of remaining confounding factors that may lead to a bias in our primary estimates.

4 Data

The data comes from three different sources: the 2009 National Household Travel Survey (NHTS) conducted by the United States Department of Transportation Federal Highway Administration, the 2002-2009 Wards Automotive Annual Yearbooks Model Car US Specifications and Prices tables (WARDs), and the Kelly Blue Book online vehicle pricing database (KBB). Each observation in our final dataset represents a vehicle from the NHTS survey, supplemented by vehicle price and technical specification data obtained from both WARDs and KBB. Both the NHTS (2001 version) and WARDs data were used previously by, for example, Bento, Goulder, Jacobsen & von Haefen (2009).

4.1 National Household Travel Survey

Our primary data source is the vehicle file from the 2009 NHTS survey (version 2.1).[7] The survey reports the make, model, year, and odometer reading for each vehicle owned by each household

[7]This data is available online at the Data Center website of the National Highway Travel Survey located at http://nhts.ornl.gov/download.shtml.

included in the survey. We obtained from the United States Department of Transportation Federal Highway Administration confidential zip code information for each household in the survey, which we use in conjunction with the KBB database to gather local market specific prices for each automobile in our sample.

The initial NHTS vehicle file consists of 309,163 vehicles. Given the focus of this paper, we restrict our sample to standard passenger vehicles keeping only those vehicles denoted as automobiles by the NHTS. This eliminates vehicles such as vans, SUVs, trucks, motorcycles, etc. The NHTS provides the official vehicle make and model codes as defined by the National Automotive Sampling System. Since these codes allow us to merge the NHTS dataset with other vehicle information from KBB and WARDs, we remove any vehicle with a missing make or model code. Since the KBB relies upon the vehicle specific odometer readings along with the make, model, and year to determine market price, we also drop any observations that report missing odometer readings or abnormal responses such as negative values, readings less than 100 miles on cars older than two years, or readings greater than 300,000 miles.

We restrict our sample to vehicles with model years 2002-2009, since the oldest hybrid vehicle in the data is from 2002, to ensure that the sample of conventional engine vehicles corresponds to the hybrid electric vehicles. In addition, we further eliminate any observations with missing information for the NHTS hybrid indicator. It is critical for our analysis that we know the hybrid status of each vehicle in our sample. For instance, if a household reports owning a Honda Civic but does not indicate whether the vehicle is a hybrid, we are unable to distinguish between the Honda Civic Hybrid and the traditional Honda Civic, so we eliminate that observation from our final sample. Additionally, a known drawback of the hybrid indicator in the NHTS survey is that a hybrid is defined by the NHTS as any alternative fuel vehicle. For instance, the Ford Crown Victoria appears in the NHTS dataset as a hybrid vehicle, however the WARDs database reports that the Crown Victoria was only produced as a flex-fuel vehicle and not a hybrid electric vehicle. Therefore, we use the manufacturing information from the WARDs yearbook jointly with the NHTS survey response indicating fuel-type in order to remove any natural gas, diesel, or flex-fuel vehicles from our dataset.

4.2 WARDs Automobile Specifications

One limitation of the NHTS survey is that it does not contain detailed information on the technical specifications of each vehicle. It is essential in our hedonic price equation to control for attributes such as vehicle size, engine power, and other performance features, as these attributes contribute to the overall price of the car. Hence, we turn to the WARDs automotive guides for detailed vehicle specifications on all vehicles remaining in our NHTS sample.

The WARDs annual yearbooks list detailed technical specifications for every vehicle produced and sold in the United States in a given year. The lists of vehicles provided in these tables are extensive. For example, in 2008 there are 11 different Toyota Camry options, including the Camry hybrid. These models differ by engine type, transmission type, and interior trim packaging. Since the NHTS survey does not specify which particular version of each make-model-year combination is reported, we follow Bento et al. (2009) and assume that all households with a traditional gasoline engine own the base model for each make-model-year combination. We define the base model to be the model with a standard transmission and the lowest MSRP reported in WARDs. Specifically, in the Toyota Camry example, we assume that all households owning a 2002 conventional engine Camry own a Camry with an in-line 4-cylinder gasoline engine and a 5-speed manual transmission. We then obtain detailed specifications on mechanical, luxury, and safety features for each vehicle in the dataset.

Along with vehicle specifications, we extract vehicle market segmentation measures from the annual WARDs market segment tables. WARDs divides the automobile market into twelve different segments based upon vehicle size and luxury classification. We restrict our sample of vehicles to those in the first seven market segments that are not deemed to be luxury class vehicles. This removes brands such as Lexus, BMW, Mercedes, and extreme performance vehicles such as the Chevrolet Corvette, or Dodge Thunderbird.[8] Over time the specific criteria adjust slightly; as body and trim styles evolve, some vehicles change segment. For instance, the Toyota Prius was initially classified as a Middle Specialty vehicle (Segment 6), but as the size and price point changed the Prius was re-classified from 2005 onward as an Upper Middle Class vehicle (Segment 5).

We match the information from WARDs with the information provided by the NHTS. We remove any unmatched observations between the WARDs base model vehicle specification information with the NHTS vehicle information. These unmatched observations represent inconsistencies between the vehicle data reported in the NHTS survey and the manufacturer information reported in WARDs. For example, NHTS reports a 2008 Chrysler Sebring hybrid while WARDs does not report this make-model-year combination. Hence, we exclude this vehicle from our dataset.

4.3 Kelly Blue Book

In order to estimate a hedonic price equation, we need observation specific prices for each car in our sample. We cannot use MSRP values reported in WARDs, since MSRPs are nationally suggested retail prices. First, our dataset contains fewer than 100 unique make-model-year combinations, which is likely too small a sample to reliably conduct our analysis. Second, restricting our sample to unique make-model-year combinations would render our sample of Prius hybrids to only 8 observations (one for each year in 2002-2009). Finally, restricting our focus to MSRP prices would automatically restrict our hedonic market definition to a single national market, not allowing us to exploit variations in local market conditions that may help identify variations in environmental preferences in different areas of the country. Hence, MSRP values would not allow us to reliably implement our hedonic framework, and would ignore much of the wealth of information contained in the NHTS survey. Instead, we turn to the KBB that provides current resale values for each car in our dataset, which allows us to use detailed information on odometer readings as well as household zip codes to identify unique, local market specific prices.

In using the KBB resale values to measure the equilibrium market price of a vehicle, we make two assumptions. First, we presume that any signaling value that exists in the retail price of a brand

[8] WARDs defines these first seven market segments as Lower Small Car (e.g., Honda Fit, Toyota Echo), Upper Small Car (e.g., Honda Civic, Toyota Corolla), Small Specialty Car (e.g., Toyota Celica), Lower Middle Car (e.g., Ford Fusion, Hyundai Sonata), Upper Middle Car (e.g., Honda Accord, Toyota Camry), Middle Specialty Car (e.g., Chevrolet Monte Carlo, Mazda Miata), and Large Car (e.g., Buick LeSabre, Toyota Avalon). For example, in 2007 the WARDs criteria from market grouping was defined as follows: Segment 1 - low price (< \$13,000) and small (< 170 inches); Segment 2 - middle price (\$13,500 - \$17,999) and small (< 180 inches); Segment 3 - odd style cars (< \$21,000 and < 180 inches); Segment 4 - low price (\$17,000 - \$18,999) and mid-size (180-190 inches); Segment 5 - mid-price (\$18,000 - \$26,999) and mid-size (185-190 inches); Segment 6 - odd style with high-price (\$21,000 - \$29,999) and mid-size (< 190 inches); Segment 7 - most price ranges but larger size (> 195 inches).

new Prius also exists in the resale market. The desire to signal environmental consciousness is not unique to new car owners, and a used Prius may be a viable option for consumers wishing to signal their environmental consciousness without purchasing a brand new vehicle. Further, differences in new and used car prices reflect physical depreciation in the used car, however the visual uniqueness that affords the Prius a status signal as a hybrid car does not depreciate. Conditioning on our hedonic controls should account for any differences between new and used car prices, and should not affect our ability to identify and estimate the Prius status signal.

Second, we recognize that current market resale values may be sensitive to external factors, such as current or recent gasoline prices. While this is a valid concern, sensitivity of market prices to current gasoline prices is not unique to hybrids or the Prius, and any possible manifestation of this effect in our data will affect the used car price for all fuel efficient vehicles, not just the hybrids. One important control variable in our regressions is the miles per gallon rating on each vehicle. If current gasoline prices are an important factor in determining recent market values of the vehicles in our dataset, such an effect would be in part captured by the miles per gallon variable. In the worst case, if current gasoline market trends did disproportionately affect hybrids in our sample, this effect would be captured by our hybrid control indicator, and would not hamper our ability to identify and estimate the status signaling value of the Prius. That is, there is no particular reason to believe that this issue would affect our estimate of the signaling value of the Prius.

We also use the KBB to return several additional vehicle attributes, for instance, trim features such as cruise control, air conditioning, airbags, and standardized estimates of vehicle fuel efficiency (miles per gallon). The WARDs database provides estimates for fuel efficiency, however the WARDs estimates do not account for the change in measurement standards that occurred in 2008. In that year, the Environmental Protection Agency adjusted the standards for measuring fuel efficiency to incorporate changes in average speed, air conditioning usage, and exterior temperatures. In light of this change, we utilize the fuel efficiency information reported in the KBB which is measured in post-2008 miles per gallon standards and is consistent across all model years (including years prior to 2008).

KBB captures the current market value for all vehicles and specifications. As part of their routine operations, the KBB data is regularly updated to incorporate changes in market trends. Therefore it is important to note that our KBB data were retrieved during the week of April 26, 2013 to ensure consistent market prices. We eliminated any vehicles that were missing either price or fuel efficiency information from the KBB. We then merged the KBB information with the WARDs and NHTS vehicle data and eliminated any unmatched vehicles. We are left with a total sample of 36,167 cars, of which 1,847 are hybrid electric vehicles, and 1,222 of the hybrids are Toyota Prius hybrids.

4.4 Data Summary

4.4.1 Visual Description

Figure 1 provides a visual summary of the location of all the vehicle observations in our dataset, and Figure 2 illustrates the location of all the Prius hybrids and non-Prius hybrids. It is clear from Figure 1 that the majority of our data comes from the east coast and several large areas sampled in the midwest, Texas, and California, and that at a national level our sample is not random. When conducting a national level analysis, we use survey sampling weights provided by the NHTS in order to correct for oversampling in some regions. It is important to note that the NHTS survey is collectedly randomly at a core-based statistical area level.

Figure 2 shows a clustering of hybrids in several prominent areas, such as San Francisco, San Diego, Washington D. C., and New York City. It is also apparent that at a core-based statistical area level of analysis, many areas (e.g., Seattle) may not have sufficient observations, particularly hybrid or Prius observations, to conduct a reliable analysis. Therefore, we combine a national level analysis with a regional level analysis to ensure that our results are robust.

4.4.2 Regression Controls

Identifying a Prius premium that can be reliably attributed to status signaling hinges upon a complete set of hedonic controls that render all cars in our sample statistically equivalent, with the exception of any premium unique to all hybrids and/or specific to the Prius. While both the WARDs and KBB sources returned a wealth of measures on vehicle attributes, many of these measures are highly correlated reflecting the fact that many features come bundled together by the auto manufacturer. For example, many performance or luxury features come bundled in a performance or luxury package, and are not generally available separately. Including all of these measures in our regression simultaneously leads to multicollinearity problems, causing many regressors to take unexpected signs and significance (Espey & Nair 2005). To address this issue, we pared down our set of controls to carefully account for important dimensions of vehicle value, while sidestepping any multicollinearity issues that might compromise our analysis. Our procedure for selecting which variables to include is done both conceptually by eliminating many measures that seem redundant based on common vehicle attribute packages, as well as examination of variance inflation factors as statistical reassurance that our model specification is not riddled with a high degree of multicollinearity.[9]

The dimensions that are important to account for with our set of hedonic controls include general depreciation, engine power and performance, vehicle size, vehicle safety rating, luxury attributes, and fuel efficiency performance (Espey & Nair 2005, Bento et al. 2009). We control for general depreciation by including controls for the year the car was built and the current odometer mileage from the NHTS survey. Since all cars in our sample are relatively new, all cars are assumed to be in 'very good' condition.[10] We control for engine power and performance via horsepower, and car size with cargo space. Including other measures such as torque or curb weight leads to a high degree of multicollinearity and instability of our regressions. Our safety measures include an indicator for anti-lock braking system (ABS) and an indicator for side airbags. Our set of controls for luxury features include indicators for air conditioning, alloy wheels, CD player, and cruise control.

We measure fuel efficiency as the highway miles per gallon rating obtained from KBB. We do not use the city miles per gallon rating as city miles per gallon is perfectly grouped by hybrid status

[9]In general, we interpret variance inflation factors above 10 to be a sign of relatively severe multicollinearity, and factors between 5 and 10 to be signs of potential multicollinearity. Variance inflation factors less than 5 reflect no significant degree of multicollinearity.

[10]KBB defines a car to be in 'very good' condition as "minor wear or visible defects on the body and interior but is in excellent mechanical condition, requiring only minimal reconditioning. It has little to no paint and bodywork and is free of rust. Its clean engine compartment is free of fluid leaks. The tires match and have 75% or more of tread. It also has a clean title history, with most service records available, and will pass safety and smog inspection."

and so does not provide any additional measurement. Furthermore, city and highway miles per gallon are highly correlated, so including the highway miles per gallon is sufficient for measuring fuel efficiency. Our analysis of multicollinearity indicated that miles per gallon may be highly correlated with hybrid vehicle status, clearly reflecting the generally high miles per gallon ratings of most hybrid cars. As a result, we explore regression models that include and exclude the highway miles per gallon rating. Despite the potential for moderate multicollinearity, we prefer to include miles per gallon as an explicit measure that is no doubt an important determinant of vehicle prices. Fuel efficiency values are likely captured to a large extent by the general hybrid indicator in models that exclude the miles per gallon rating.

We include indicators to control for unobservables that are common to different vehicle makes (brands). It is well known that Honda and Toyota have well-established reputations for producing reliable cars that may significantly influence demand (e.g., consumer loyalty or general reputational benefits). Further, if there are any Toyota reputational advantages enjoyed by the Prius, our inclusion of a Toyota brand dummy will control for these effects. We include a single indicator for the Toyota Camry to control for any consumer effects that are unique to the Camry for two reasons. Toyota claims the Toyota Camry to be the best selling car in America for 15 out of the last 16 years, and that 90 percent of Toyota Camrys sold over the last decade are still on the road.[11] No other vehicle has enjoyed such long-lasting attention, which no doubt has led to Camry-specific reputational effects or model loyalty. Second, we find that in our data, the distribution of vehicle prices for the Toyota Camry, particularly the Toyota Camry hybrid, is substantially skewed to the left relative to the overall price distribution in our sample. Preliminary regression results indicate that the Camry has a statistically significant influence on our results, and failure to account for general reputational benefits unique to the Camry leads to a bias in our estimates. Finally, in our national level regressions we include core-based statistical area indicators to control for unobservable regional effects. Indicators specific to all vehicle models and market segments are highly collinear with our existing controls; in other words, any unobservable effects believed to exist within each specific model (not including the Camry) or within a particular market segment is already accounted for via our control variables. Hence, we do not include model or market segment indicators in our regression model, except for the indicator for the Toyota Camry.

As described above, our key control variable is an indicator for hybrid status, that takes a value of unity for *any* hybrid, including the Prius, and zero otherwise. This indicator captures any general hybrid effects that may include, but is not restricted to include, demand motives such as altruism, warm-glow, or guilt. Our primary indicator of interest, through which we measure and test the hypothesis that the Toyota Prius has value as an environmental status symbol, is a binary indicator that takes a value of unity for Toyota Prius, and zero otherwise. Given our set of controls, any significant price premium unique to the Toyota Prius is a reflection of the signaling value of the Prius.

4.4.3 Statistical Summary

Table 1 contains a summary of the data. We report the sample-weighted mean and standard deviation for each of the variables in our dataset for the total sample of observations, the sample

[11] Toyota provides a detailed list of Camry awards online at http://www.toyota.com/camry/awards.html (accessed August 2013).

of Toyota Prius hybrids, and the sample of all hybrids including the Toyota Prius. In total, we have 36,167 observations, and of the 1,847 hybrid vehicles, 1,222 are Toyota Prius hybrids. Specifically, our group of hybrid vehicles includes the Toyota Prius, Honda Civic hybrid, Honda Accord hybrid, Toyota Camry hybrid, Nissan Altima hybrid, and Saturn Aura.[12]

The average 'very good' price recovered from the Kelly Blue Book for the total sample of observations is $8,161.55. The average price for Toyota Prius hybrids is $13,304.10 and the average price of all hybrids is $13,865.52. The all hybrids sample has, on average, a higher price than the Prius hybrids sample because the all hybrids sample includes Toyota Camry hybrids, which relative to all other hybrids in our sample have a substantially higher price and so pull the average price for the group upwards.

Table 1 shows that the average car in our sample has about 47,999 miles, which is higher than the average number of miles on both the Prius hybrids (34,664 miles) and all hybrids (32,979 miles). The median car in our sample was built in 2005, whereas the median car in both samples of hybrids was constructed in 2007. Hence, in our sample, at least at the median, hybrids are slightly newer than conventional engine cars. The average car in our sample achieves about 30 miles per gallon on the highway, while the average Prius achieves nearly 45 miles per gallon on the highway and the average hybrid achieves about 43 miles per gallon on the highway. Conversely, our samples of hybrids have substantially less horsepower than our full sample; Prius hybrids have the lowest horsepower at only 75 horsepower at the mean (variation across Prius observations comes from temporal differences). We further see that our sample of hybrids average the least cargo space. It is clear from our sample averages that one way in which hybrids achieve higher fuel efficiency is through lower horsepower and less cargo space (i.e., they are generally smaller and less powerful).

Table 1 shows that while just under half of our sample has ABS, nearly all hybrids have ABS. Similarly, a substantially larger share of hybrids have side airbags, compared to only 32 percent of our total sample. We see that air conditioners are common for most cars, regardless of hybrid status (although hybrids do have a slightly larger share), but that a relatively low share of cars have alloy wheels, compared to a relatively high percentage of hybrids. Most hybrids have a CD player and cruise control, as do a smaller share of cars in our total sample. However, we see that about half of the cars in our sample have a CD player and cruise control, which suggests that these features are still common in the average car. It is clear that, on average, hybrids have enhanced safety and luxury features relative to conventional engine cars, primarily because our sample of hybrids are relatively newer. That the hybrid vehicles have, on average, more safety and luxury attributes underscores the importance of control variables in our hedonic regression to ensure that any Prius or hybrid premium we might identify is not biased upwards by omitted vehicle attributes that are correlated with higher vehicle prices.

In terms of make, model, and market segment indicators, the table shows a wide distribution of vehicles. We only report frequencies for vehicle makes and model that represent over 5 percent of our total sample. The most common vehicle makes are Toyota, Honda, Chevrolet and Ford, with 18, 13, 12, and 11 percent of all cars in our sample. The most popular models in our sample are the Toyota Camry (about 9 percent) and Honda Accord (about 7 percent). Of the hybrid vehicles, Toyota represents nearly 82 percent of the hybrid observations, while Honda makes about

[12]Our data does not include any purely electric vehicles (e.g., Chevy Volt) since these vehicles did not enter the market until after 2009, the year of our NHTS survey.

17 percent, Nissan constitutes approximately 1 percent. The two most prominent non-Prius hybrid vehicle models are the Toyota Camry hybrid and the Honda Civic hybrid. Finally, Segments 2 and 5 (Upper Small Car and Upper Middle Car) represent the largest market segments in our total sample. Hybrids exist within several different market segments, most prominently within Segments 2 and 5.

5 Empirical Results

5.1 National level regressions

We first consider regressions using our entire sample defined over a national level market. Each national level regression is specified as the semi-log model in (3), and uses the survey sampling weights and includes fixed effects for each core-based statistical area.[13] We report regression results in Table 2.

The first model is a regression of the log of the price of each observation on our vector of hedonic controls and unobservable effects. That is, we omit our hybrid and Prius indicators in order to explore the relationship between automobile price and our controls without controlling for any environmental behavioral demand drivers. We find that each of the variables in the regression is statistically significant, and generally take the expected sign. For instance, cars with higher odometer mileage have lower equilibrium prices, while cars that are newer, have higher fuel efficiency, and have higher horse power command higher equilibrium prices. Our results show that larger cars, as well as cars with more safety and luxury features have higher equilibrium prices. The R^2 for this model is relatively high at 0.8648, and indicates that our hedonic controls account for much of the variation in vehicle prices. The variance inflation factors for this model (not shown in the table), as well as all other models reported in Table 2, are relatively low. Hence, our model summary shows that our set of controls is able to capture much of the variation in prices, while the variance inflation factors do not signal concern from multicollinearity.

To provide a bit more clarity into the relative sizes of these effects, we report in Table 3 the average implied marginal willingness to pay for each control variable reported in Table 2. Table 3 reports that each additional mile recorded on the odometer reduces the price of the car by about 4 cents, whereas being one year newer increases the marginal value by about \$925. ABS and alloy wheels have relatively high values, indicating that these measures successfully proxy for general safety and luxury features (packages).

The second model reported in Table 2 adds the general hybrid indicator to the model. Recall that this indicator is defined to indicate *any* hybrid, including the Toyota Prius, and therefore captures any general demand drivers that are common to all hybrids. We first report that the hybrid indicator coefficient is relatively large and highly statistically significant, indicating that these unobservable hybrid demand drivers account for a relatively large share of vehicle price. As reported in Table 3, the implied marginal willingness to pay for a hybrid is on average \$2,236, or approximately 16 percent of the average price for the hybrids in our sample.[14] We find that inclusion of the hybrid indicator does not substantially alter the coefficient estimates for most of the

[13]Standard least squares regressions without using survey sampling weights yield qualitatively consistent results.

[14]Table 1 shows that the average price for hybrids in our sample is about \$13,866, from which we calculate the hybrid premium of \$2,236 is approximately $2236/13866 = 0.1613$ or about 16 percent.

other control variables, with the exception of highway miles per gallon that becomes statistically insignificant. It is clear that, in addition to other behavioral motives such as altruism or warm-glow, the hybrid indicator captures, in part, the attractiveness of more fuel efficient vehicles.

Column 3 in Table 2 adds our Prius indicator, which is shown to be positive and statistically significant. Table 3 reports that the average implied marginal willingness to pay for the Prius is approximately $587. Our general hybrid indicator remains highly significant, but decreases slightly in magnitude with a lower implied marginal willingness to pay of about $1,954 or 14 percent of its average value. The highway miles per gallon variable remains statistically insignificant. These results indicate three important findings. First, a positive and significant Prius coefficient indicates a statistically significant social status signaling value unique to the Toyota Prius (of $587). Hence, this result constitutes formal evidence in support of our primary hypothesis. Second, the continued significance of the hybrid indicator adds credence to our identification strategy in that we continue to find evidence of non-status demand drivers. In other words, results from Model 3 indicate that our finding of a significant hybrid effect in Model 2 was not driven entirely by social status signaling value in the Prius. Third, the relative magnitude of the Prius and hybrid indicator coefficients indicates that the social status signaling value of the Prius is relatively lower than the general added value of a hybrid. This makes sense because the demand components captured by the hybrid indicator are more general, while the status value measured by the Prius indicator is considerably more specific. To add a bit more perspective on these estimated values, a $587 Prius premium translates into approximately 4.5 percent of the average value of a Prius. Further, we note that our estimates are generally consistent with the estimates of Sexton & Sexton (2013), albeit slightly smaller in magnitude.

Models 4 through 6 consider several robustness checks relative to our preferred Model 3. In Model 4 we drop the highway miles per gallon variable; in Model 5 we drop the general hybrid indicator; and in Model 6 we drop the Prius indicator but add a specific indicator for Honda Civic hybrid. The purpose of Model 4 is to get a sense of the interaction between hybrid status and fuel efficiency in terms of their effects on the price of a car. As indicated by the insignificance of fuel efficiency in Model 2, hybrid cars may be generally synonymous with higher fuel efficiency. In other words, evidence that our hybrid indicator is sufficient to capture the effects of fuel efficiency on the price of a car indicates that consumers who desire more fuel efficient cars generally seek a hybrid. Model 4 shows that removing the fuel efficiency variable does not alter the magnitude of our Prius or hybrid indicator (or any other control variable). Hence, the general hybrid indicator appears to be sufficient for capturing demand for increased fuel efficiency.

Removing the general hybrid indicator in Model 5 yields two interesting results: the Prius indicator coefficient greatly increases in magnitude, and highway miles per gallon increases in magnitude and becomes statistically significant. These results have two important implications. First, the increase in the Prius coefficient indicates that unobservable hybrid demand drivers (e.g., altruism, warm-glow, or guilt) that were initially captured by the hybrid coefficient are now captured in part by the Prius indicator. Recall that our general hypothesis was that the Prius commands value as a status signal *in addition to* value from more general hybrid behavioral motives. The increase in the Prius coefficient after removing the hybrid indicator confirms this intuition as the Prius coefficient now captures both the status signaling effect and part of the general hybrid effect. Second, the significance of highway miles per gallon indicates that the Prius is not sufficient to completely capture the demand for higher fuel efficient vehicles. This means that, while Prius consumers are no doubt attracted by higher fuel efficiency, it is apparent that demand for higher fuel efficiency is common to all hybrids and that Prius ownership is driven by factors in addition to fuel efficiency. In general, the differences between Models 3 and 5 generally confirm our general intuition about differences in demand drivers for the Prius and hybrids in general.

Our final national level regression swaps in a Civic hybrid indicator in place of our Prius indicator. The second most widely sold hybrid vehicle is the Honda Civic hybrid, however one main difference between the Civic hybrid and Prius that is relevant to our regressions is that the Civic hybrid is not able to signal environmental consciousness. Moreover, from a statistical perspective, the combination of the Prius and Civic hybrid make up, to a large extent, our general hybrid indicator (about 83 percent of the hybrid indicator consists of either the Prius or Civic hybrid). For these two reasons, it is only natural to consider the individual effects of Civic hybrid on the price of a car, net of any general hybrid or fuel efficiency effects. As shown in Table 2, the Civic hybrid indicator has a negative and significant coefficient with implied negative marginal value of $1,194. This result means that, conditional on unobserved hybrid effects, fuel efficiency, and general mechanical, safety, and luxury attributes, the Honda Civic hybrid is a relatively less expensive car. This is intuitive for two reasons. First, as is provided implicitly in our status-signaling identification strategy, there is no reason to expect the Civic hybrid to command any price premium that is not driven by general hybrid demand or fuel efficiency. Second, according to U.S. News car rankings and reviews, aside from higher fuel efficiency the Honda Civic hybrid is not generally an attractive vehicle.[15] For these reasons, we take the results in Model 6 as further evidence of the general robustness of our hedonic specification.

In brief summary, the national level regressions reported in Tables 2 and 3 indicate two important findings. First, there is a statistically significant signaling value of the Toyota Prius of about $587, or 4.5 percent of the average value of the Prius. Second, there are large and statistically significant demand drivers for hybrids in general, accounting for about 16 percent of the value of the average hybrid. We believe these effects generally include behavioral motives such as, but not limited to, altruism, warm-glow, or guilt. There is also evidence that fuel efficiency plays an important role in general hybrid demand. Before delving into deeper discussion of these main results, we first turn to regression results from hedonic models estimated over substantially smaller automobile markets.

5.2 Regressions by census division

We first consider the 9 census divisions as our market area.[16] We recognize that census divisions are still relatively large areas, however using the census divisions allows us to explore potential

[15] This report was accessed online (accessed July 2013) at http://usnews.rankingsandreviews.com/cars-trucks/Honda_Civic-Hybrid/2012/.

[16] The 9 census devisions are defined as follows: Pacific - Alaska, California, Hawaii, Oregon and Washington; Mountain - Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah and Wyoming; West North Central - Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota; East North Central - Illinois, Indiana, Michigan, Ohio and Wisconsin; West South Central - Arkansas, Louisiana, Oklahoma and Texas; East South Central - Alabama, Kentucky, Mississippi and Tennessee; South Atlantic - Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia and Washington D. C.; Middle Atlantic - New Jersey, New York and Pennsylvania; and New England - Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island and Vermont.

heterogeneity across different markets without dropping too many observations (see the core-based statistical area regressions in the next section). Results for the Prius and hybrid indicators for the census division regressions are reported in Table 4, and are specified as in Model 3 of Table 2.

Prior to estimating regressions at the census level, we make the following caveat. It is clear from Figure 2 that two census area regressions in particular are inherently less reliable because of sparse hybrid and Prius observations. These areas include the Mountain division in which most of the hybrid and Prius observations are clustered in Arizona, and the East South Central division in which most hybrid observations come from Tennessee. While there is no reason to exclude these divisions from our analysis, it is clear that relative to other census divisions these divisions may have relatively less power in identifying both the hybrid and Prius effects. Moreover, this issue is not easily resolved using the sampling weights, which are defined as sampling corrections for the national sample as a whole. Nevertheless, the census divisions, in general, provide an important level of analysis for further exploring the behavioral demand components of hybrid cars.

Table 4 reports that in nearly each of our census division regressions the Prius indicator is positive and statistically significant. We find that the Prius signaling effect is insignificant only for the East South Central division. The implied Prius signaling premium ranges significantly across census divisions from \$391 to \$1012. Table 4 also shows that the hybrid indicator is statistically significant in each census level regression, with the implied marginal willingness to pay ranging from \$954 to \$2,833. While these estimates show some heterogeneity across census divisions, these estimates are generally consistent with the national level estimates reported in Table 2. Further, we continue to find, based on the reported R^2 measures, that our hedonic model provides a good fit to the data within each census division.

5.3 Regressions by core-based statistical area

To address the possibility that national or census division markets are too large to provide accurate information, we focus on eleven different core-based statistical areas that contain the largest groupings of hybrids and Prius hybrids.[17] To define each area, we selected all observations located within each CBSA region, dropping any observations outside of any CBSA. CBSA's with fewer than 20 Prius or 40 general hybrid observations are excluded from this analysis. We again run identical regression specifications for each CBSA region, excluding survey weights from these models as CBSAs are randomly sampled by the NHTS survey.

Before presenting these results, we mention that restricting our analysis to these eleven CBSAs eliminates many Prius and hybrid observations. This creates potential for both indicators, but particularly the Prius indicator since the hybrid indicator includes both Prius and non-Prius hybrids, to lack sufficient power to accurately estimate the Prius or hybrid premium.

We report our CBSA level results for the Prius and hybrid indicators in Table 5. We see that, in general, the point estimates for both indicators match our estimates from previous regressions. These point estimates are significant in each CBSA for the hybrid indicator, and for Houston, Los Angeles, San Diego and San Francisco for the Prius indicator.[18] Unfortunately, because of

[17] These areas include Dallas, Houston, Los Angeles, Miami, New York City, Phoenix, Sacramento, San Diego, San Francisco, San Jose and Washington D. C.

[18] The Prius indicators in the Houston and Los Angeles regressions are both significant at the 15 percent level with p-values 0.14 and 0.12 respectively. Given our restricted sample sizes, it seems warranted to consider statistical significance at a level greater than 5 percent.

the limited sample size for some CBSAs, we are unable to estimate the Prius signaling value with enough precision to identify a statistically significant effect in all regressions.

Despite the difficulties in precisely estimating the Prius premium across CBSAs, we find that our general results are robust with point estimates and significance generally commensurate with previously reported regressions. Our point estimates imply that the Prius commands a significant signaling value somewhere in the range of $666 to $1,019, while hybrids in general earn a premium in the range $1,539 to $2,770. Hence, we find that despite the size of hedonic market we assume for our regression models, we continue to find strong statistical evidence that (i) behavioral demand drivers positively and significantly influence demand for hybrids in general, and (ii) that the Toyota Prius has a positive and significant social status signaling value of approximately $587.

6 Additional Regressions and Robustness Checks

6.1 Environmental status signal across green and brown cities

Our first set of additional regression results compares estimates of the Prius status signal across relatively green and brown communities. There is much discussion in the literature that the value of the Prius status signal is likely to be larger in relatively greener communities (e.g., Kahn 2007, Sexton & Sexton 2013). We follow Sexton & Sexton (2013) and consider four green and four brown cities coming from either Colorado or Washington. Specifically, Sexton & Sexton (2013) define green cities to be cities with a relatively high share of democratic voter support for President Obama in the 2008 election, and relatively brown cities to be those with relatively low democratic voter support for President Obama. This results in two green and two brown cities in each state.

Sexton & Sexton (2013) define green cities in Colorado to be Denver and Boulder while brown cities in Colorado are Longmont and Loveland. Green cities in Washington are Seattle and Spokane, and brown cities in Washington are Richland and Yakima. To obtain data on each of these cities, we artificially assume that all of our observations belong to households residing in the central business district zip code of each of these cities.[19] We use these zip codes to obtain green and brown city market prices for each of the cars in our dataset from KBB.

Table 6 reports the regression results from city-specific regressions for each of the green and brown cities. Several facts are readily clear from these results. First, our general finding that the Toyota Prius has a status signaling value is robust. Our estimates in Table 6 reveal that this status signal is approximately $650 to $700, which is not much different from our previously reported results. Second, the hybrid indicator is highly significant as well, confirming our previous results that hybrids in general command a premium of approximately $2,000. Finally, it is clear that there is not a statistically significant difference in Prius signaling value (or hybrid premium) across green and brown communities.

This finding is initially unexpected, but it is not without intuition. One of the primary results in Sexton & Sexton (2013) is that there is a disproportionate share of Prius hybrids in relatively greener communities. Hence, while it may be true that there is potential for the Prius to command a higher signaling value in relatively greener communities, *ceteris paribus*, this relatively higher signaling value leads to a relatively larger number of Prius hybrids. If the value of the status signal of the Prius is decreasing with the prevalence of the Prius, then we would not necessarily expect

[19] Choice of zip code within each city does not influence the results reported in this subsection.

to find that the *equilibrium* signaling value of the Prius is higher (or lower) in a relatively greener community. Hence, these results are not at odds with the findings of Sexton & Sexton (2013), and provide important insight into the relative market equilibria of environmental status signals across green and brown communities. We further emphasize that our primary estimates, including the relative magnitude of the Prius and hybrid effects, continue to be robust across both green and brown communities.

6.2 Alternative parametric specifications

Our next set of regressions include a handful of specifications that are designed to explore the robustness of our model to measurement of vehicle prices, as well as parametric hedonic specification. In particular, we consider semi-log regressions using different measures of vehicle price from KBB - specifically the 'excellent', 'good', and 'fair' price rating - to explore potential depreciation effects on the Prius status signal. Our expectation is that our Prius status signaling estimate does not vary significantly with KBB price measure since we have no reason to believe that the status signaling ability of the Prius depreciates. We also estimate our benchmark regression model both in levels and double logs. It is typically argued that the basic levels specification is not flexible enough to obtain reliable hedonic estimates, however it is a useful robustness check of our primary model. Results from these regressions are reported in Table 7.

The top panel of the table considers alternative market prices based on the KBB definitions of vehicles listed as being in excellent, good, or fair condition. If our Prius indicator was identifying any mechanical features of the Prius that might potentially depreciate, we would expect to see sensitivity in the estimate of the Prius coefficient to measures of KBB price. It is clear from the table that our Prius status signaling estimate is stable across different KBB price measures, and is qualitatively consistent with our previous results. These results indicate that our status signaling estimate is not subject to any depreciation, which is consistent with our intuition that β_1 identifies a status signaling effect unique to the Prius.

The bottom panel provides two alternative parametric hedonic specifications: a levels model, and a log-log model. We find that our estimate of the Prius status signal is negative and insignificant in the levels model, and the hybrid premium is larger than in our benchmark regressions and is highly significant. The coefficient estimates in the log-log model are slightly larger than in our preferred semi-log specifications, but are qualitatively consistent in that both the Prius signaling value and hybrid premium are statistically significant and relatively close in magnitude to our previous estimates. Our finding that the Prius status signal is insignificant in the levels model confirms the words of caution common in many empirical hedonic discussions that the standard levels specification is overly restrictive in functional form (e.g., Boyle et al. 1999).

6.3 Semiparametric hedonic regression specification

Our final regression is designed to incorporate flexibility into our hedonic specification, to ensure that our results are not driven by any statistical modeling assumptions embedded in the semi-log specification. Our main concern is that, while the semi-log specification is more flexible than the benchmark linear model, the imposed linearity and additive separability of the regressors is overly restrictive causing us to inconsistently estimate the Prius status signal. To address this concern, we consider a semiparametric generalization of (3) given by

$$P_i = \beta_0(X_i) + \beta_1 D_{Pi} + \beta_2 D_{Hi} + \epsilon_i. \tag{4}$$

The model in (4) is the partial linear semiparametric regression of, for example, Robinson (1988). In (4), the intercept coefficient is a generalized functional coefficient that takes the hedonic conditioning set as its arguments, while the parameters β_1 and β_2 bear similar interpretation to those given in (3) and are taken to be constants. Notice that in (4) we no longer measure vehicle price in logs, as this transformation is no longer necessary for incorporating flexibility into the model.[20]

We choose this specification for the following reasons. First, $\beta_0(X_i)$ is unrestricted in functional form, and as such is a fully general hedonic specification that is immune to functional form misspecification issues that may exist in parametrically specified functions. As such, this specification addresses concerns recently raised in the hedonic literature that the hedonic pricing function may not be easily parameterized (Parmeter et al. 2007, Parmeter & Pope 2013). Second, (4) allows the Prius and Hybrid premia to enter as constant, parallel shifts in the hedonic pricing function. An example illustrates our intuition: consider the negative relationship between odometer reading and vehicle price. This same relationship exists for both Prius and conventional vehicles. Yet, given this relationship, we expect that the price of the Prius is higher than the conventional engine type because of the uniqueness of the Prius as a status signal. Hence, we postulate a parallel shift in the negative relationship between odometer reading and vehicle price on account of the Prius signal that preserves the relationship between odometer reading and vehicle price. That is, we do not expect that the the basic hedonic relationship is fundamentally different for Prius and hybrids, relative to conventional engine vehicles. We thus extrapolate this intuition into the full hedonic model, allowing for the hedonic pricing function of each vehicle to be fully nonparametric and general via $\beta_0(X_i)$, while allowing for parallel adjustments given the behavioral demand drivers captured by both β_1 and β_2.

Our semiparametric model yields estimates of the Prius status signal of about \$951 and the hybrid premium of about \$4,356. Both of these estimates are statistically significant at a 5 percent level with standard errors 62.5279 and 39.7688, respectively. While these estimates are relatively larger than those from our benchmark semi-log parametric estimates, they are consistent with the range of parametric estimates described previously. The increase in magnitude of these effects indicates that neglected nonlinearities and interactions in the hedonic pricing function may lead to a downward bias in our Prius and hybrid premia, but that this bias did not qualitatively alter our estimates. Each of the other hedonic estimates are generally consistent with the parametric estimates, at the average. We interpret these estimates to indicate that, while different specifications yield different sized estimates, our general range of estimates is robust, and that functional form misspecification is not likely driving our results qualitatively.

[20] A standard nonparametric kernel estimator for (4) is given in Robinson (1988) or Li & Racine (2007), and uses a conditional mean transformation to first recover a consistent estimate of β_1 and β_2, and then a consistent estimate of $\beta_0(X_i)$ in a final step. We use a local constant least squares estimator for all nonparametric estimates, select bandwidths using least squares cross-validation, and use a wild bootstrap based on 399 replications to obtain standard errors of each estimate. See Robinson (1988) and Li & Racine (2007) for further technical details, or Parmeter, Henderson & Kumbhakar (2007) for a nonparametric estimator in a hedonic regression context.

7 Discussion

We have presented a series of regressions that have shown a large and significant price premium of hybrids relative to conventional gasoline engine vehicles, as well as a positive and significant price premium unique to the Toyota Prius. Conditional on our hedonic controls, we interpret these estimates to indicate that there are strong demand components for hybrid vehicles that account for approximately 14 percent of the value of the average hybrid (calculation based on Model 3 in Table 2), and that the Toyota Prius has a social status signaling value of approximately $587, or 4.5 percent of its value.

Our identification of these effects rests on two assumptions. First, our hedonic controls are able to account for physical differences or brand differences across vehicles that contribute to differences in vehicle price. These controls essentially render any premium identified by our hybrid or Prius indicators attributable to behavioral demand drivers. Second, the only difference in demand drivers between the Prius and hybrids in general is the visual uniqueness that associates a Prius with environmental consciousness. This implies that we can use a general hybrid indicator as a control to partial out general behavioral demand components.

Our intuition, as well as econometric results, confirm these arguments. However, one issue that we have not yet explored is *Prius-specific* demand drivers that (i) are not currently controlled for via the existing control variables in the model, and (ii) may potentially confound our estimate of the Prius status-signal. In this section, we explore what these potential Prius-specific confounding factors may be, as well as their potential confounding effects on our estimates.

7.1 Prius reputation

The first potential factor we consider is the possibility that the Prius has a reputation of being the most popular and/or dependable hybrid vehicle. Hybrid-electric technology is relatively new, and most hybrid consumers may be first-time hybrid buyers. This potentially increases the uncertainty around the hybrid car-buying decision, as consumers with relatively little knowledge or experience with hybrid technology are choosing whether to invest a large sum into a new technology. A Prius reputation of being the longest hybrid in (generally available) existence, or the general popularity of the Prius among consumers, may reduce this uncertainty, making the Prius a relatively safer investment. Such an effect may be manifested in the equilibrium market price for the Prius, and may confound our status-signal estimates. Heutel & Muehlegger (2012) present a model of hybrid vehicle adoption and demonstrate that hybrids that are perceived to be of higher quality have relatively higher market penetration rates. Further, they show that there are important spillover effects towards all hybrids in general, and that these reputational effects dissipate over time. One further advantage of using current KBB market prices is that any reputational effects that may have been manifested in past market prices for new Prius hybrids (i.e., the MSRPs), but that dissipate over time as Prius and/or hybrid uncertainty diminishes, are not likely to be manifested in our data.

Reputation stemming from the length of existence of the Prius may arise from a general notion that technology improves both over time and with increased demand, or simply that time will tell whether Prius technology is reliable. This reputation may be Prius-specific, or may affect all hybrids jointly. In the first case, the consumer may believe that, relative to other hybrids, the

Prius is likely to be more technologically reliable as Toyota has been refining the Prius technology for a longer period of time and in response to higher demand, and that there has not been any widely reported failure of hybrid-electric technology. In this case, our inclusion of a Toyota brand dummy in all of our regressions will capture this effect.

An alternative view is that any reliability reputation earned by the Prius spills over onto all other hybrid-electric vehicles, regardless of make. This is not unreasonable, and Heutel & Muehlegger (2012) show that there are large effects of Prius adoption on non-Toyota hybrid adoption rates. Consumers may not be able to differentiate Prius hybrid-electric technology from general hybrid-electric technology put in other hybrid-electric vehicles. To be more specific, uncertainty in early years regarding Prius hybrid technology may not stem from mistrust of Toyota's ability to produce a hybrid-electric. Rather, consumers may be generally uncertain about battery life and/or the integration of a gasoline and electric engine into a single system. Both of these constitute large innovations in the automobile engine, and no doubt generate uncertainty in a general sense. Over a decade without report of widespread hybrid-electric technological failure, consumers may begin to believe that hybrid electric technology is reliable. Moreover, it is conceivable that consumers are aware that Toyota's competitors (e.g., Honda) are fully aware of the technological specifications of the Toyota hybrid-electric technology, so that there is no reason to believe that Toyota-specific technology is any more reliable than that of their competitors. In this case, our Prius status-signaling estimates are not confounded because such general hybrid reputational effects are captured by our general hybrid indicator.

While we recognize that there are plausible reputational effects that may influence the market price for the Prius, we argue that based on our identification strategy and previous research that these effects are not likely contaminants of our environmental status signaling estimates.

7.2 Marketing effects

A second potential confounding factor of our Prius status signal is aggressive marketing of the Prius by Toyota. Sexton & Sexton (2013) document Toyota marketing as a potential confounding factor as nearly half of the hybrids sold in the United States in 2010 were Prius hybrids, but that Toyota marketing (and brand loyalty, but we control for this with a Toyota indicator in our regressions) is not sufficient for explaining the Prius premium.

We contend that the potential for Toyota marketing to confound our status-signal estimates is somewhat nuanced. Clearly, aggressive marketing campaigns are effective at increasing consumer awareness of the Prius, which in turn increases demand. Narayanan & Nair (2013) provide empirical evidence of social contagion effects increasing the demand for the Prius. As consumers are more aware of the Prius and its technology, perceived uncertainty regarding the Prius and its technology decreases. Further, advertisement campaigns boost the general popularity of the Prius, which further reduces any general uncertainty. Hence, Toyota marketing efforts can have two effects. First, Toyota marketing can increase the generally perceived reliability of the Prius. This effect was discussed in the previous subsection. The second effect is that marketing efforts can increase the popularity of the Prius, which in turn can influence its status signaling value.

The theoretical social status literature (e.g., Corneo & Jeanne 1997) has distinguished between different types of status-seeking, each type bearing different implications on the effects of Prius popularity on its signaling value.[21] Regardless of the direction of the effect of popularity on the Prius status signal, these consequences of Prius marketing are not confounding factors in our status signal estimates. Indeed, Narayanan & Nair (2013) describe social contagion as general peer-referenced consumption, which is not necessarily different from social status signaling. To provide a somewhat exaggerated but nevertheless illustrative example, if Toyota never produced aggressive marketing advertisements for the Prius, it is possible that the Prius would not have become synonymous with hybrid-electric technology, and may not serve as a clear signal of environmental consciousness.

7.3 Prius as a signal of wealth

The Prius may also serve as a signal of wealth, in addition to signaling environmental consciousness. Consumers are aware that, in addition to being a hybrid, the Toyota Prius is relatively more expensive than some other vehicles of the same class. Hence, a consumer of a mid-size sedan who purchases a Prius may, in addition to receiving utility from showing environmental consciousness, receive utility from driving a more expensive vehicle.

Is it possible that Prius consumers use the Prius as a signal of wealth? There are two potential types of Prius consumers: those who purchase the Prius for non-environmental status reasons, and those who do. For the first type of consumer, we argue that the Prius is not the most expensive or luxurious type of hybrid. The Camry hybrid, Accord hybrid, and particularly the Lexus hybrid, are generally perceived to be more luxurious hybrids than the Prius. Any Prius consumer who is *not* interested in signaling environmental status, but is also interested in signaling wealth would not likely purchase a Prius as their environmental desires can be fully satiated via *any* type of hybrid and their wealth status can be more clearly signaled through a more luxurious hybrid. Therefore, it is not likely that non-environmental status seeking hybrid consumers who are also interested in signaling wealth would choose the Prius.

As we have argued, environmental status-seeking consumers have no choice but to purchase the Prius in order to satiate their desires of environmental status signaling. If these consumers are also interested in signaling wealth, then it is possible that our Prius environmental status signaling estimate is confounded. Recent research has shown that this is not likely a concern (Kahn 2007). First, he shows that there is no correlation between average household income and Green Party share, and that voter support for environmental legislation within census tract increases with Green Party share but *decreases* with income. Second, he provides evidence that environmentalists are more likely to purchase hybrid vehicles. (While he is generally agnostic about what drives this demand, he mentions that social status is one plausible motive.) Hence, he does not find any evidence that suggests that environmental attitudes are correlated with wealth. Therefore, we do not believe that our Prius status signaling estimates are contaminated by Prius demand driven by the desire to signal wealth.

[21] Corneo & Jeanne (1997), for example, refer to both ‘conformism’ and ‘snobbism’ as different manifestations of social status. In the first case, increased popularity of the Prius would increase the value of the Prius as a status signal. In the latter case, increased popularity would decrease the signaling value.

8 Concluding Remarks

Recent years have seen a surge in consumer demand for environmentally friendly products, typically purchased at a higher price compared to conventional alternatives. Such demand has piqued the interest of environmental economists, adopting behavioral theories such as altruism, egoism, guilt, or social status as explanation for such behavior. Empirical evidence in support of these motives is, however, somewhat rare.

We consider the Toyota Prius as a conspicuous environmental public good, and seek to econometrically measure the signaling value of the Prius. We develop a novel quasi-experimental hedonic model of automobile prices that is capable of identifying the status-signaling value of the Toyota Prius in the presence of unobservable behavioral factors that would otherwise bias regression estimates. Our model is further able to separately identify and estimate the non-status behavioral demand for hybrid-electrics. This empirical strategy provides an important contribution to both the general economic literature on identification of behavioral demand drivers, in addition to the environmental economic literature focusing directly on hybrid vehicles, consumer choice, and environmental policy.

Using a unique database on automobile prices and characteristics, we estimate that the Toyota Prius has a status signaling value to consumers of, on average, \$587. Hybrids, in general, have a premium over non-hybrids of approximately \$1,954. Our regression results are largely robust to a variety of econometric regression specifications, designed both as robustness checks of our primary specification and as confirmation of the reliability of our status signaling value identification strategy. These results imply that the status signaling value makes up approximately 4.5 percent of the value of the Toyota Prius, and the hybrid premium accounts for about 14 percent of the average price of a hybrid. We carefully explore a variety of Prius-specific factors that may potentially confound our estimates, from which we conclude that our status signaling estimates are both credible and robust.

Our empirical results have several implications that are relevant to economists and policymakers. First, we provide a robust set of estimates of (i) the status signaling value of the Prius; (ii) the estimate of the marginal value of a hybrid, in general; and (iii) estimates of the relative value of the Prius status signal to a bundle of behavioral demand drivers. Second, our results are qualitatively consistent with the findings of Narayanan & Nair (2013) that suggest that policymakers interested in increasing consumer adoption of hybrid vehicles may want to exploit the status signal as a means of nurturing widespread consumer interest in hybrids (or at least the Prius).

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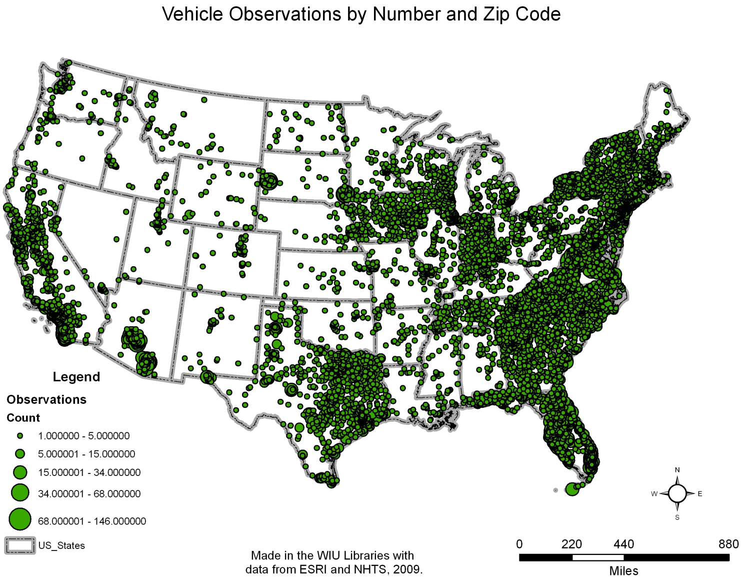
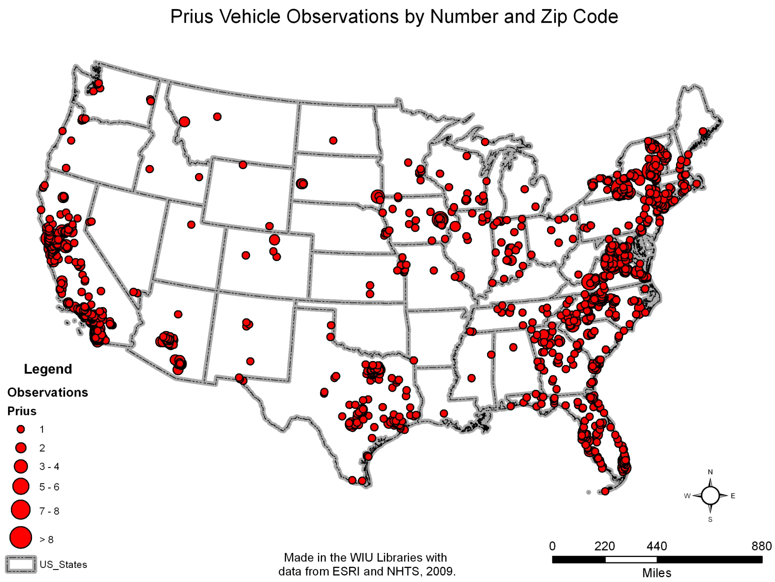


Figure 1: Location of all observations by zip code.



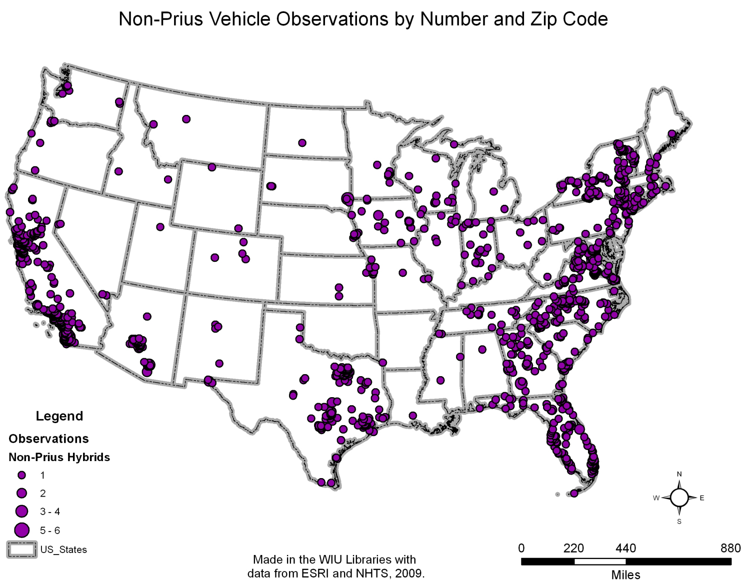


Figure 2: Location of Prius hybrids (top panel) and non-Prius hybrids (bottom panel) by zip code.

Table 1: Descriptive statistics.

Variable	Total Sample Mean	Total Sample Std. Dev.	Toyota Prius Mean	Toyota Prius Std. Dev.	All Hybrids Mean	All Hybrids Std. Dev.
Price	8161.5504	3711.0124	13304.0982	2853.9237	13865.5249	3782.2382
Mileage	47999.3202	35695.1129	34664.2955	28502.4313	32978.5200	27834.7084
Year built	2005	-	2007	-	2007	-
Performance						
Highway MPG	30.3335	4.1882	44.7509	0.9670	42.9610	4.2090
Horsepower	154.5982	34.8376	75.1709	2.0714	93.0052	35.9803
Size						
Cargo space	16.6459	8.9803	15.0097	1.1671	13.7324	2.1974
Safety						
ABS	0.4276	-	0.9983	-	0.9866	-
Side airbags	0.3218	-	0.4838	-	0.6429	-
Luxury						
Air conditioner	0.8572	-	0.9983	-	0.9986	-
Alloy wheels	0.1873	-	0.9983	-	0.8653	-
CD player	0.5823	-	0.9362	-	0.7212	-
Cruise control	0.4810	-	0.9409	-	0.9590	-
Make						
Chevrolet	0.1204	-	0.0000	-	0.0000	-
Buick	0.0541	-	0.0000	-	0.0000	-
Nissan	0.0695	-	0.0000	-	0.0067	-
Ford	0.1125	-	0.0000	-	0.0000	-
Honda	0.1325	-	0.0000	-	0.1673	-
Toyota	0.1873	-	1.0000	-	0.8249	-
Model						
Accord	0.0674	-	0.0000	-	0.0240	-
Camry	0.0862	-	0.0000	-	0.1334	-
Civic	0.0600	-	0.0000	-	0.1433	-
Market						
Segment 2	0.3095	-	0.0000	-	0.1433	-
Segment 4	0.0968	-	0.0000	-	0.0000	-
Segment 5	0.4132	-	0.8618	-	0.7611	-
Segment 7	0.0828	-	0.0000	-	0.0000	-
Observations	36167		1222		1847	

1. We report the median year built instead of the mean.
2. We include a summary of make, model, and market indicators for those groups with at least 5 percent share of observations.
3. Mean and standard deviation summaries are calculated using survey sampling weights.

Table 2: Semi-log regression results for national level regressions.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	**-208.9535**	**-216.8587**	**-217.1263**	**-216.9968**	**-212.9897**	**-215.5319**
	4.1836	4.1348	4.1330	3.9387	4.1388	4.1770
Prius	-	-	**0.0687**	**0.0685**	**0.2191**	-
	-	-	0.0174	0.0174	0.0195	-
Civic hybrid	-	-	-	-	-	**-0.1397**
	-	-	-	-	-	0.0169
Hybrid	-	**0.2617**	**0.2287**	**0.2275**	-	**0.2751**
	-	0.0180	0.0174	0.0120	-	0.0176
Mileage	**-0.00001**	**-0.00001**	**-0.00001**	**-0.00001**	**-0.00001**	**-0.00001**
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Year built	**0.1083**	**0.1124**	**0.1125**	**0.1124**	**0.1103**	**0.1117**
	0.0021	0.0021	0.0021	0.0020	0.0021	0.0021
Highway MPG	**0.0106**	0.0000	-0.0002	-	**0.0057**	0.0015
	0.0016	0.0019	0.0019	-	0.0017	0.0020
Horsepower	**0.0031**	**0.0032**	**0.0032**	**0.0032**	**0.0033**	**0.0032**
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cargo space	**0.0010**	**0.0007**	**0.0006**	**0.0006**	**0.0008**	**0.0007**
	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
ABS	**0.0699**	**0.0508**	**0.0478**	**0.0479**	**0.0527**	**0.0482**
	0.0069	0.0072	0.0073	0.0072	0.0072	0.0072
Side airbags	**-0.0853**	**-0.0788**	**-0.0761**	**-0.0762**	**-0.0740**	**-0.0778**
	0.0079	0.0078	0.0078	0.0078	0.0078	0.0078
Air conditioner	**0.0336**	**0.0279**	**0.0295**	**0.0296**	**0.0362**	**0.0312**
	0.0092	0.0084	0.0084	0.0085	0.0088	0.0084
Alloy wheels	**0.1429**	**0.1127**	**0.1094**	**0.1094**	**0.1203**	**0.1145**
	0.0068	0.0073	0.0074	0.0074	0.0072	0.0073
CD player	**0.0162**	**0.0276**	**0.0274**	**0.0273**	**0.0199**	**0.0272**
	0.0060	0.0060	0.0060	0.0060	0.0059	0.0060
Cruise control	**0.0352**	-0.0024	-0.0056	-0.0054	0.0098	-0.0004
	0.0077	0.0081	0.0084	0.0085	0.0083	0.0082
R^2	0.8648	0.8691	0.8694	0.8694	0.8669	0.8697

1. Sample size is 36167 for each regression.
2. Each regression contains indicators for make (reference group is Ford), CBSA effects, and the Toyota Camry.
3. Standard errors are reported below each coefficient.
4. Survey sampling weights were used in estimation of each regression.
5. Statistically significant coefficients at the 5 percent level are highlighted in bold.

Table 3: Implied MWTP from the semi-log national level regressions.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Prius	-	-	587.2312	585.6736	1872.0997	-
Civic hybrid	-	-	-	-	-	-1193.7863
Hybrid	-	2236.0902	1953.6704	1943.5780	-	2350.1490
Mileage	-0.0441	-0.0442	-0.0442	-0.0442	-0.0441	-0.0442
Year built	924.9718	959.9634	961.0909	960.5110	942.6556	954.0717
Highway MPG	90.2414	0.1656	-1.5336	-	48.5552	12.7833
Horsepower	26.1196	27.0334	27.5606	27.6292	28.1683	27.5729
Cargo space	8.5140	5.7446	5.4757	5.5340	6.5415	6.1055
ABS	597.1596	434.1431	408.6867	409.3301	450.3663	411.4633
Side airbags	-729.2003	-673.3859	-649.9388	-650.8107	-631.9772	-664.5897
Air conditioner	287.2362	238.7677	251.8987	252.5389	309.5821	266.3926
Alloy wheels	1220.9287	962.5086	934.5086	934.5530	1027.6121	977.8674
CD player	138.0181	236.0834	233.6788	233.1909	169.8379	232.2837
Cruise control	300.3204	-20.6645	-47.9390	-46.3193	84.1251	-3.8167

Table 4: Semi-log regression results by census division.

	Prius Dummy - β_1			Hybrid Dummy - β_2				
Census Division	Estimate	Standard Error	Mean MWTP	Estimate	Standard Error	Mean MWTP	Sample Size	R^2
Pacific	**0.0919**	0.0199	824	**0.2250**	0.0184	2017	5030	0.8769
Mountain	**0.0894**	0.0435	767	**0.2003**	0.0384	1718	2082	0.8665
W. N. Central	**0.1164**	0.0502	945	**0.1874**	0.0433	1521	1998	0.8833
E. N. Central	**0.1046**	0.0516	844	**0.2573**	0.0422	2077	1960	0.8806
W. S. Central	**0.0608**	0.0307	530	**0.2561**	0.0237	2234	4994	0.8690
E. S. Central	0.0112	0.0945	93	**0.3434**	0.0758	2833	813	0.8865
S. Atlantic	**0.0457**	0.0184	391	**0.2355**	0.0154	2016	13380	0.8660
Mid Atlantic	**0.0859**	0.0296	716	**0.2256**	0.0257	1880	5028	0.8737
New England	**0.1214**	0.0579	1012	**0.1145**	0.0642	954	882	0.8933

1. Each regression contains a full set of control variables, including indicators for make (relative to Ford) and Toyota Camry.
2. Statistically significant estimates at the 5 percent level are highlighted in bold.

Table 5: Semi-log regression results by CBSA division.

	Prius Dummy - β_1			Hybrid Dummy - β_2					
CBSA	Estimate	Standard Error	Mean MWTP	Estimate	Standard Error	Mean MWTP	% Prius	Sample Size	R^2
Dallas	0.0368	0.0517	327.2567	**0.2384**	0.0402	2117.4651	2.28	1448	0.8744
Houston	0.1124	0.0766	1018.8629	**0.2824**	0.0538	2560.5197	2.35	894	0.8643
Los Angeles	0.0716	0.0462	666.0513	**0.2504**	0.0412	2330.9775	7.81	1012	0.8733
Miami	-0.0361	0.0681	-330.3648	**0.3027**	0.0524	2769.6144	2.64	1021	0.8619
New York	0.0176	0.0556	156.9726	**0.2158**	0.0452	1920.2561	2.20	1270	0.8767
Phoenix	0.0637	0.0594	558.3036	**0.2009**	0.0523	1762.4367	3.39	1120	0.8567
Sacramento	0.0835	0.0906	728.5781	**0.2864**	0.0664	2498.1485	7.46	268	0.9216
San Diego	**0.0994**	0.0406	882.0982	**0.2100**	0.0371	1863.7967	6.38	1364	0.8757
San Francisco	**0.1015**	0.0511	943.4104	**0.1655**	0.0503	1538.5282	14.42	527	0.8948
San Jose	-0.0278	0.0761	-266.0229	**0.2659**	0.0726	2543.2042	13.15	213	0.9173
Washington D.C.	0.0204	0.0654	172.0682	**0.2176**	0.0499	1839.8589	4.73	592	0.8916

1. Each regression contains a full set of control variables, including indicators for make (relative to Ford) and Toyota Camry.
2. We only report results for CBSA divisions with at least 20 Prius observations and 40 all hybrid observations.
3. Statistically significant estimates at the 5 percent level are highlighted in bold.

Table 6: Semi-log regression results by Green/Brown community division.

	Prius Dummy - β_1			Hybrid Dummy - β_2				
City	Estimate	Standard Error	Mean MWTP	Estimate	Standard Error	Mean MWTP	Sample Size	R^2
Green Cities								
Boulder, CO	**0.0816**	0.0091	673.9329	**0.2423**	0.0079	1999.9524	36548	0.8917
Denver, CO	**0.0869**	0.0092	716.2300	**0.2471**	0.0080	2036.6508	35609	0.8910
Seattle, WA	**0.0803**	0.0092	661.6184	**0.2403**	0.0079	1979.5368	36056	0.8914
Spokane, WA	**0.0776**	0.0091	639.6564	**0.2369**	0.0079	1952.0427	36369	0.8916
Brown Cities								
Longmont, CO	**0.0837**	0.0092	690.7705	**0.2434**	0.0080	2009.8104	36003	0.8917
Loveland, CO	**0.0868**	0.0092	715.9695	**0.2440**	0.0080	2012.6589	36058	0.8912
Richland, WA	**0.0787**	0.0091	648.4243	**0.2371**	0.0079	1953.8454	36723	0.8918
Yakima, WA	**0.0824**	0.0092	678.9099	**0.2434**	0.0079	2004.9572	36146	0.8913

1. Each regression contains full set of control variables and indicators for market segment, make, and model.
2. Statistically significant estimates at the 5 percent level are highlighted in bold.

Table 7: Regression results of robustness checks for sensitivity to vehicle depreciation and parametric hedonic specification.

	Prius Dummy - β_1			Hybrid Dummy - β_2			
Model	Estimate	Standard Error	Mean MWTP	Estimate	Standard Error	Mean MWTP	R^2
KBB Prices							
Excellent	**0.0591**	0.0176	513.2509	**0.2625**	0.0125	2278.5307	0.8536
Good	**0.0691**	0.0175	576.3354	**0.2248**	0.0121	1875.6384	0.8693
Fair	**0.0889**	0.0198	680.9859	**0.2025**	0.0128	1550.2115	0.8635
Hedonic Setup							
Levels	-401.9843	211.4546	-	**3249.7410**	189.0624	-	0.8798
Log-Log	**0.1429**	0.0243	1221.1202	**0.2703**	0.0149	2309.4415	0.8192

1. Each regression contains full set of control variables and indicators for market segment, make, and model.
2. Statistically significant estimates at the 5 percent level are highlighted in bold.