Conspicuous Conservation: The Prius Effect and Willingness to Pay for Environmental Bona Fides*

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June 30, 2011

> "The wish to become proper objects of this respect, to deserve and obtain this credit and rank among our equals, may be the strongest of all our desires." - Adam Smith

1 Introduction

Veblen explained in 1899 that "in order to gain and hold the esteem of man it is not sufficient merely to possess wealth or power. The wealth or power must be put in evidence, for esteem is awarded only on evidence" (?). Since then, a considerable literature has explored the concept of conspicuous consumption and its implications in various settings, with particular focus on purchases that signal prestige, luxury and exclusivity.[1] While consumption of luxurious automobiles, jewelry and apparel surely still afford a certain social status in the 21st Century, evolving social norms suggest esteem can be attained through the demonstration of certain kinds of austerity–specifically austerity that minimizes the environmental impact of consumption. Amid heightened concern about environmental damage and global climate change, costly private contributions to environmental protection increasingly confer status once afforded only through ostentatious displays of wastefulness. Consumers may, therefore, undertake costly actions in order to signal their type as environmentally friendly or "green." The status conferred upon demonstration of environmental friendliness is sufficiently prized that homeowners are known to install solar panels on the shaded sides of houses so that their costly investments are visible from the street. We call this behavior "conspicuous conservation."

*The authors thank the University of California Giannini Foundation and the Energy Biosciences Institute for funding support. Correspondence should be directed to Steven Sexton at ssexton@berkeley.edu

[1]See for instance: Leibenstein [1950], and more recently Frank [1985], Basu [1987], Braun and Wicklund [1989] and Ireland [1998]. More generally, other studies, including Akerlof [1980], Bernheim [1994], Stephen et al. [1992], Cole et al. [1992], Fershtman and Weiss [1993], Glazer and Konrad [1996] explore the impact of status consciousness on economic behavior.

Car ownership choices are among the most visible consumption decisions households make. Since the introduction of the Toyota Prius in the U.S. in 2001, a growing number of vehicle models have been introduced with features that reduce environmental impacts, particularly greenhouse gas emissions. They include small and light cars with conventional engines (like the SmartCar), alternative fuel cars (like the Chevrolet flex-fuel fleet), and hybrid cars (like the Prius, Honda Civic Hybrid, and others). Until the reintroduction of the Honda Insight in 2010, the Prius was the only model that at once provided the standard features consumers are accustomed to in modern vehicle design (climate control, four doors, luggage space, etc.), environmental amenities, and a design unique to the model.[2]

Today Prius is the clear leader among 24 different hybrid models available in the U.S.; 48% of the 290,271 hybrid cars sold in the U.S. in 2009 were Priuses. The success of the Prius can certainly be attributed, in part, to an aggressive and innovative marketing effort by Toyota and to the equity in the Toyota brand. However, national marketing effort does not explain our result that ownership increases in green communities disproportionately relative to other hybrid cars, conditional on the green attributes of the models. Nor does it explain our results that ownership of comparable hybrids, such as the Toyota Camry Hybrid, does not increase proportional to the Prius in these communities after conditioning on green attributes. Likewise, the Civic Hybrid achieves a green rating that is nearly identical to the Prius from a number of sources, including the American Council for an Energy Efficient Economy's "Green Book," yet we show that the Civic is underrepresented in green locales.

We attribute these differences to the unique design of the Prius, and, thus, its ability to signal environmental bona fides. Toyota executives reportedly instructed their designers to develop something unique, regardless of the quality of the styling. Prius design has been described as utilitarian as it seeks to maximize on aerodynamics. Still, its design made it unique among the class of green cars that also provide the comfort and performance characteristics to which consumers in the U.S. have become accustomed. When Toyota updated the Prius in 2009, it kept the outside styling virtually the same. The Honda Civic Hybrid and other hybrid models, in contrast, share body styling with the other trims in the model class that have conventional drive types. The Hybrid trims of these models typically carry only a badge on the side or rear of the vehicle indicating their type. The Prius has, therefore, historically provided the most powerful signal of the owner's affinity for the environment of any vehicle in the U.S.

In this paper, we test for the presence of a conspicuous conservation effect in vehicle purchase decisions and estimate the willingness to pay for the "green halo" generated by signaling green type with a Prius purchase. To do this, we

[2]The Honda Insight was first introduced in 1999, two years before the Prius and four years before the current generation of Prius. Still, it was a two-door subcompact car that sacrificed on amenities available in most passenger cars at the time. The Insight was re-introduced in 2010 as a four-door sedan, joining the class of four-door hybrids with unique model names and designs.

observe that the value of the signal is increasing in the predisposition of one's neighbors toward environmental protection. All else equal, then, a Prius is more valuable in communities with a strong green ethos like Boulder, Colorado than in communities with greater heterogeneity in attitudes toward the environment, like, for instance, Greeley, Colorado. Thus, while shares of all green car models are expected to be greater in green communities than "brown" communities simply due to the relatively greater concentration of environmentally conscious consumers, to the extent individual green purchases are motivated, at least in part, by efforts to signal type, then Prius share should be disproportionately greater than other green models in these communities because of its unique capacity to signal green type.

Using observed variation in model ownership rates across communities in Colorado and Washington, we identify a statistically and economically significant conspicuous conservation effect. We relate these findings to a growing literature on green markets and private provision of public goods. Results suggest private provision of environmental preservation need not rely on altruism in the traditional sense, but can instead be elicited from consumers who seek economic and non-economic returns from status achieved by signaling green type.

We are unaware of any prior research that empirically tested for conspicuous conservation effects, though the concept has drawn popular media attention, particularly with respect to the Prius (Bedard 2007-07, Maynard and Bunkley 2007-07-04, Samuelson 2007-07-25, Cloud 2009-06-03). The New York Times reported in 2007 on survey results in which 57% of Prius buyers said their main reason for choosing the Prius was becuase "it makes a statement about me" (Maynard and Bunkley 2007-07-04).

This paper proceeds in Section 2 with a brief review of the theories related to conspicuous consumption and green markets in order to motivate the concept of conspicuous conservation. The self-interested motivations for private provision of public goods is also related to the vast literature on altruism. We next present a stylized model of "green" signaling. Section 4 presents our econometric model and data, while Section 5 contains results. Section 6 estimates the willingness to pay for the green halo. The final section concludes.

2 Status Seeking and Conspicuous Conservation

Economists since **?** have sought to explain anomalies in consumption behavior, like upward sloping individual demands and "non-additive" market demands, by appealing to the notion that status is acquired or retained by individuals who engage in costly signaling to differentiate their types (Leibenstein [1950], Frank [1985], Ireland [1998], Glazer and Konrad [1996], Ireland [2001], Barclay and Willer [2007]). Much of this work has focused on ostentation as a signal of affluence and has provided a theoretical basis to understand consumer demand for luxury goods that are functionally equivalent to less costly alternatives. Ireland [1998] and Bernheim [1994], for instance, were concerned with "bizarre" premia for designer fashions and high expenditures on cars.

Relatively more recent is the treatment of private provision of public goods in status-signaling models. Glazer and Konrad [1996] argued status-seeking behavior explained anomalies in charitable contributions that were not explained by conventional theory, like high rates of giving and low rates of anonymous contributions. But like much of the economics literature on status-seeking, they hypothesized charitable giving was intended to signal wealth when conspicuous consumption was unobservable or subject to imitation.

Economists have only within the past decade begun to consider the implications of status seeking when individuals attempt to signal their selflessness, a phenomenon the psychology literature has termed competitive altruism (Hawkes et al. [1993], Roberts [1998], Barclay and Willer [2007] and Van Vugt et al. 2007). Though it inspires behavior consistent with other-regarding preferences and utility from the "warm glow of giving," motivations that are familiar to economists as pure altruism and impure altruism, respectively, (e.g. Becker [1974] and Andreoni [1989, 1990]), competitive altruism is distinct from standard notions of altruism in economics in that it is self-interested in the traditional sense. A competitive altruist contributes to the public good in order to attain status that can generate economic rewards and intrinsic value (Hardy and Van Vugt [2006] and Van Vugt et al. [2007].

Benabou and Tirole [2006] defined a reputational motivation, in addition to intrinsic and extrinsic motivations, in order to explain the decline in prosocial behavior when it generates extrinsic rewards or when it moves from the public sphere to the private domain (see Frey and Oberholzer-Gee [1997] and Frey and Jegen [2001] for surveys). The crowdout of intrinsic motivations by extrinsic rewards (and punishments) has been documented in a number of contexts. Schoolchildren were shown to collect less charity when they were given performance bonuses (Gneezy and Rustichini [2000b]), and parents became more delinquent in terms of on-time retrieval of their children from childcare centers when fines were imposed for late pick-ups (Gneezy and Rustichini [2000a]). Provision of prosocial behavior also declines when it is removed from the public sphere and increases when it is made public. Funk [2010] showed, for instance, that voter participation did not increase in Switzerland with the introduction of mail voting and that voting rates declined in small communities, despite the reduction in the time-inclusive costs of voting. Similarly, when individual voter participation is shared with neighbors, participation rates increase [Gerber et al. 2008].

As preferences for environmental protection and, particularly, climate change mitigation, have become stronger and more prevalent, the market for green products that jointly provide private benefits and public goods has grown (Kotchen 2006), as has research on consumer's willingness to pay for such products. Surveys show as many as one third of consumers are willing to pay a premium for products with green characteristics, such as renewable residential energy, organic foods, and eco-labelled household products. Most evidence of willingness to pay for environmental benefits in consumption decisions is obtained from stated-preference methods (e.g. surveys and contingent valuation methods), and hence are subject to hypothetical bias (Cummings et al. 1995, 1997 and Blumenschein et al. 1997. Much of the evidence from revealed preference is subject to alternative explanations, such as demand for energy efficienct appliances due to variable cost savings and demand for organic foods due to perceived health benefits.

To our knowledge there is no research that formally tests for the presence of conspicuous conservation in green markets, though Griskevicius et al. [2007] and Griskevicius et al. [2010] demonstrated the importance of social norms in motivating conservation. A number of studies have shown that social pressure induces environmentally-preferred behaviors: homeowners reduce energy consumption after receiving reports that compare their usage to neighbors (Allcott 2009, Ayres et al. 2009), and hotel guests reduce demand for clean towels when they are told the majority of their peers have done likewise [Goldstein et al. 2008].

Akerlof and Kranton [2010] articulated how individuals self-select into social categories that encompass ideals of how one should behave. They defined the utility of individuals as increasing in their conformance to the norms of their chosen identities and decreasing in deviations from those norms. Identity, they argued, explains persistent gender biases in the workplace, like the over-representation of women in nursing and of men in firefighting. Identity can also explain heterogeneous preferences for vehicles. Grubb and Hupp [1968] and Grubb and Stern [1971] identified symbolic meanings associated with vehicles, while Sirgy [1985] and Ericksen [1997] showed that symbolism influences vehicle purchase decisions. Heffner et al. [2006] observed that in vehicle choices, individuals communicate interests, beliefs, values, and social status.

During extensive interviews with early hybrid vehicle adopters in California, Heffner et al. [2007] found that symbolism was important to hybrid owners. One interview subject said his Prius "made a statement" to others and that the Civic Hybrid communicated symbolism less effectively than the Prius. The authors reported that most of the individuals they interviewed had "only a basic understanding of environmental issues or the ecological benefits of HEVs (hybrid electric vehicles)," but "bought a symbol of preserving the environment that they could incorporate into a narrative of who they are or who they wish to be."

In a related context, behavioral economists have suggested that homeowners will over-invest in solar panels and under-invest in other green home improvements, like additional insulation and window caulking, because the former are conspicuous and the latter are not. Dastrop et al. [2010] showed that the housing price premium for residential solar installations is increasing in the greenness of neighbors.

3 Theoretical Foundations

Intrinsic motivation may explain positive willingness to pay for green product characteristics. But it does not explain the success of the Prius relative to the Civic Hybrid and other top-green-rated cars. Much as the paucity of anonymous charitable giving that Glazer and Konrad observed suggested the presence of status-seeking motives, so too does the relative success of highly visible green investments demand an alternative to conventional altruism explanations. We propose green signaling as such an explanation.

The success of green signaling hinges on two conditions. First is the observability of costly conservation effort, which may be reflected by willingness to pay premia for green product characteristics or by willingness to accept lower quality for products that generate less environmental damage in production or end-use than conventional products. Second is partial or full revelation through signaling that permits green types to distinguish themselves from others. In wealth signaling models, consumption of luxury items permits separation because declining rates of marginal substitution make high expenditures on ostentation (at the expense of other consumption) more tolerable to the affluent (Bernheim 1994).

Likewise, in a model of environmental signaling, tolerance of price premia and/or lower objective quality for green goods is increasing in the strength of preferences for the environment. One who derives utility from reductions in greenhouse gas emissions will sooner settle for the utilitarian design, cloth seats, and loss of performance of a Prius than one who is indifferent to climate change mitigation. Thus, the cost of sending the green signal may be lower for those who are predisposed to support environmental protection. Moreover, the benefits of signaling may be greater to members of this cohort as they attach greater utility to being perceived by peers to have established environmental bona fides. They may also gain greater utility from pure altruism and warm glow.

In order to better define the signaling problem and motivate the econometric model that follows, we present a stylized model of vehicle choice. Consumers live in communities indexed by $i = 1, \dots, N$. Consumers in a community i are distributed according to their preferences for environmental protection, θ, according to the density function $f_i(\theta)$ defined over the support $[a, b]$. The expected value of θ in community i is $\bar{\theta}_i = \int_a^b \theta f_i(\theta) d\theta$. We define $\bar{\theta}_i$ as the "greenness" of a community.

Consumers have utility functions of the form $U = X + d + s$, where X is a composite commodity, d is driving services and s is status. Moreover, status is a function of both intrinsic rewards, m, and extrinsic rewards, k: $s(m, k)$. Intrinsic rewards are a function of a consumer's own environmental preference, whereas extrinsic rewards are a function of the greenness of the consumer's community: $s = m(\theta) + k(\bar{\theta}_i)$.

Consumers maximize utility with respect with respect to consumption of the composite commodity and choice of vehicle to purchase, with the option to purchase no vehicle at all. For our purposes, automobile types can be restricted to a two-point distribution $\{C, T\}$ where C denotes a "conventional" vehicle and T denotes a Toyota Prius. Each vehicle type j is characterized by the triple (y_j, z_j, P_j) for $j = C, T$, where y_j denotes the driving services yielded from vehicle type j, z_j denotes the "greenness" of the vehicle, and P_j its price. We assume consumers are fully informed about the characteristics of each vehicle type. Moreover, we assume $y_C > y_T > 0$ and $z_T > z_C = 0$.

To complete the specification of the model, let $m(\theta) = z_j\theta$ and $k(\bar{\theta}_i) = z_j\bar{\theta}_i$. Thus, the consumer's problem in community i is to choose whether to purchase a vehicle of type C or T or no vehicle at all in order to maximize:

$$U = X - P_j + y_j + z_j\theta + z_j\bar{\theta}_i$$

[3]

Then, there exists in community i a consumer who is indifferent between vehicle types C and T. The strength of environmental preference (or the magnitude of θ) for this consumer is:

$$\theta_i^* = \frac{(P_T - P_C) + (y_C - y_T)}{z_T} - \bar{\theta}_i.$$

The market share of Prius among all potential car buyers in community i is:

$$S_i^T = \frac{\int_{\theta^*}^{b} f_i(\theta)d\theta}{\int_a^b f_i(\theta)d\theta}. \tag{1}$$

It is clear that θ^* is decreasing and S_i^T is increasing in the perceived greenness of the Prius and the environmental consciousness of community i. On the other hand, θ^* is increasing and S_i^T is decreasing in the price differential between Prius and a conventional car and differential in driving services yielded between the Prius and a conventional car.

4 Empirical Methods

Our empirical analysis focuses on the link established in (1) between Prius market share and community greenness. The empirical design controls for the other determinants of S^T indicated in (1). In order to test empirically for the presence of status seeking in vehicle choice and to estimate willingness to pay for the "green halo" associated with hybrid vehicle ownership, we exploit spatial variation in vehicle model market share and in preferences for conservation and environmental protection in the states of Colorado and Washington.[4] Important to the empirical strategy of this paper is the insight that the value of the Prius signal, i.e the halo effect, is increasing in the greenness of the community in which the owner resides. The benefits to signaling one's green type should be greater the more one's peers are concerned about the environment. Kahn [2007] documented the clustering of Prius and Hummer ownership and showed that communities in California with more registered Green or Democrat party

[3]One could alternatively specify y_T to be a decreasing function of θ_i so that the cost of Prius ownership is declining in the greeness of the consumer.

[4]These states were chosen becuase of the availability and affordability of vehicle registration data and because of spatial variation in political preferences, which we use to measure community greenness.

members are home to more Priuses. Communities with more Republicans have more Hummers.

Were there no status-seeking motivations for hybrid demand or were the Prius indistinct relative to other green cars, we would expect to see ownership patterns like those described by Kahn, with hybrid cars enjoying greater market share in green communities. But a similar pattern should exist for all hybrid models, with their market shares equally covarying with measures of community environmentalism. If, instead, Prius owners also derive utility from the halo effect that is unique to a Prius, then, conditional on vehicle characteristics, the greater value of the halo in greener communities should cause Prius ownership to increase disproportionately in those areas relative to other hybrids like the Civic.

Following Kahn [2007] and Kahn and Vaughn [2009], we measure the relative greenness of communities using election data. As has been observed in a number of settings, political ideology is highly correlated with environmental ideology. Republican household energy consumption is less responsive to peer comparisons and may increase, whereas Democrat households decrease consumption on average (Costa and Kahn 2010); households in highly Democratic and Green communities pay higher premia for solar panels (Dastrop et al. 2010); per capita energy consumption has been trending upwards in majority Republican states but relatively flat in majority Democrat states; and public opinion surveys show Republicans are more than three times as likely as Democrats to think that the seriousness of global warming is exaggerated in the news media (Loewenstein 2009).

Green party affiliation could also be an important indicator of the strength and prevalance of preferences for environmental protection. Strategic voting, however, limits the Green party share of the electorate. Many environmentalists participate in Democratic politics to ensure their votes have the greatest impact on election and primary election outcomes. Consequently, we focus on Democratic Party electoral data for the bulk of this analysis, relying on records regarding voter party registration in Colorado and election results in Washington to develop our measures of market greenness[5].

We define markets at the zip code level, the smallest geographical breakdown for which car share data are available. Two related econometric specifications. are considered. The first is a reduced-form fixed-effects model that is effectively a regression-based difference in difference (DD) model with partial treatment. To motivate the full DD model, we first illustrate a two-by-two DD model in which we consider the market shares for the Prius and the Civic Hybrid in a green market and in a "brown" market. This 2x2 design assumes that the unique design of the Prius makes it a purchase that signals green status and that the Civic Hybrid is a perfect control for all attributes of the Prius except that it lacks a design that enables the owner to signal his green type. Its use further assumes green and brown markets are identical apart from preferences

[5]Washington has an open primary system, so there is no party registration requirement to participate in elections there.

over the environment. Environmental preferences can be thought of as the policy parameter in the context of the treatment effects literature. Then the DD estimate of the conspicuous consumption effect on market shares is given by:

$$\hat{\delta} = (S_G^T - S_B^T) - (S_G^H - S_B^H),$$

where S is market share and subscripts T and H denote Prius and Civic, respectively, and subscripts G and B denote green and brown markets, respectively.

Accepting the difficulty of identifying markets that are otherwise identical apart from greenness, and in order to exploit observations across a number of markets, we augment the 2x2 model to consider a regression-based 2xN model, incorporating all zip codes (in the N-dimension), and use market fixed effects to condition on market characteristics other than the policy variable. We estimate:

$$S_{ij} = \xi V_i + \gamma D_j + \beta D_j * VOTE_i + \varepsilon_{ij} \tag{2}$$

where, for $j \epsilon \{\text{Prius}, \text{Civic}\}$, the V_i are market fixed effects, D_j is a Prius indicator, $VOTE_i$ is a measure of the greenness of the market (i.e. the strength of the policy), and ε_{ij} is an idiosyncratic error. The coefficient of interest is β, which represents the change in Prius market share due to a one-unit change in $VOTE$.

Finally, we specify a full model that incorporates many car models and controls for model heterogeneity with model fixed effects and for heterogeneous effects of green car characteristics according to market preferences for the environment by interacting a measure of model greenness, $GREEN_i$, with $VOTE_j$. This serves to control for the Prius attributes apart from the unique design that could cause its demand to increase disproportionately in green markets relative to other models. Specifically, we consider:

$$s_{ij} = \delta_i D_i + \xi_j V_j + \gamma GREEN_i * VOTE_j + \beta PRIUS_i * VOTE_j + \varepsilon_{ij}, \tag{3}$$

where interest again centers on the estimate of β.

Additionally, one might be concerned about model-specific regional effects, such as marketing effort by car manufacturers and dealerships, which may be positively correlated with the greenness of the region. In particular, one may be concerned that Toyota and Toyota dealers market the Prius more heavily in green communities. Based on conversations with Toyota marketing executives, we believe these concerns are minimal. Toyota marketing is undertaken at national, regional and dealer levels. Colorado and Washington are each fully encompassed within their respective marketing regions, so regional marketing is not a concern. In addition, the Toyota executives indicated that Prius success in specific markets, like Portland, Oregon, is largely independent of marketing effort. Data on model-specific marketing by dealers is unavailable. Nevertheless, in order to control for such effects, we defined dealer marketing areas by mapping each zip-code to the nearest Toyota dealership using "as the crow flies" distance.

We then included separate fixed effects for each product in each marketing area by interacting the product dummies with dealer dummies.[6]

Finally, we address concerns related to omitted variables bias arising from variation in the relative demand for different vehicle attributes by different demographic groups in two ways. First, because marketing data indicate that hybrid car ownership is positively correlated with income and education, which are themselves highly correlated, and because both may be correlated with Democratic vote share in our data, we allow for median household income to have a unique effect on the market share for each product. We do this by interacting the product dummies with median household income. In addition, while it is unclear whether the Toyota Prius should be in relatively higher demand in suburban areas or in cities, the high concentration of democratic vote share in urban areas in our data suggests population density may also confound the conspicuous conservation effect. Therefore, we also allow population density to have a unique effect on the market share of each product by interacting product dummies with population density.

We further address concerns about confounding effects by replicating the analysis for cars that are similar to the Prius except for the unique design of the Prius. If the Prius is in higher demand in areas with high Democratic vote shares because of vehicle characteristics apart from the unique design, then we should find similar effects by replacing the Prius dummy with indicators for comparable vehicles. In other words, we should see a similar effect for the Civic Hybrid. If, however, the unique design of the Prius is causing it to be over-represented in green communities relative to other green cars, then we would expect to find no positive effect for the interaction of other model dummies and vote share. If consumers predisposed to by a green car are more likely to buy Priuses in green communities because of conspicuous conservation, then the model-vote interaction for the other green models will be negative.

Our second empirical model draws on the literature on econometric estimation of demand parameters in discrete choice, differentiated product settings, particularly the work of Berry et al. [1995], Berry et al. [2004] and Petrin [2002] who adapt discrete choice multinomial logit models for use with aggregate, market-level data rather than observations on individuals' choices. A central concern in these models is the endogeneity of price, which arises because price is likely to be correlated with vehicle attributes that are unobservable to the econometrician and thus are relegated to the model error. We use the control-function approach of Petrin and Train [2010] to account for endogeneity. Specifically, we estimate a nested logit model where products are grouped into predetermined, exhaustive, and mutually exclusive sets, according to their vehicle type - car, truck, mini-van, or SUV. By grouping the observations in this way we decomposed the error term into an i.i.d. shock plus a group-specific component. This implies that correlation among brands within a group is higher

[6]This analysis includes all 19 dealerships in Colorado. In Washington, we combined marketing areas for dealerships in the same cities or, in some instances, for proximal dealerships in nearby cities in order to improve the tractability of the econometric model. From the 30 dealerships in Washington, we created 18 marketing areas.

than across groups and allows for more reasonable substitution paterns than a simple logit model.

Berry [1994] derived a simple expression for the mean utility levels and showed that demand perameters for price and product characteristics could be estimated from a linear instrumental variables regression of the differences in log market shares on product characteristics, price, and the log of within group share:

$$ln(S_j) - ln(S_0) = \chi_j \beta - \alpha p_j + \sigma ln(S_{j/g}) + \varepsilon_j \quad (4)$$

where S_j is the share of product j in the market, S_0 is the share of the outside good in the market, χ_j is a matrix of product characteristics and demographic variables, and $S_{j/g}$ is the within group share of product j. We incorporate an outside option in two ways. In the first specification, we consider the market to be all workers 16 years or older. In the second, we consider the market to be all residents. In the equation above, both p_j and $S_{j/g}$ are endogenous and thus require instrumental variables. To properly IV for the within group share we used mean product characteristics for the other products within each product's group [Berry 1994]. These mean values should be exogenous to the model but correlated with the group share variable ($S_{j/g}$). Instead of using traditional IV methods to correct for the endogeniety of price, we used a control-function approach as described in (Petrin 2010). The idea behind the control function approach to engodenous variables is to derive a proxy variable that conditions on the part of the dependant variable that is correlated with the error term. If this is done correctly, then the remaining variation in the endogenous variable will be independent of the error and standard estimation approaches will be consistent. This model proceeds in two steps. First we regress the remaining endogenous variable, price (p_j) on observed product cost characteristics. The residuals of this regression are retained and then used to calculate the control function. In the second step, the choice model is estimated with the control function entering as an extra explanatory variable and with instrumental variables entering for $S_{j/g}$. Logit analysis relies exclusively on data from Colorado.

4.1 Data

Data on all registered vehicles in the states of Colorado and Washington were obtained from the state's respective vehicle licensing departments. For Colorado, 3.9 million vehicle identification number (VIN) records were matched to one of 511 5-digit zip codes. For Washington, 4.2 million VIN records were matched to one of 412 5-digit zip codes. A third-party, proprietary data set was used to decode the VINs in order to obtain the make, model, and year of the car in each vehicle record, as well as the other characteristics used in this analysis, including the U.S. Environmental Protection Agency's fuel economy ratings. We defined products by iteration of make and model (i.e., model generation). In order to reduce dimensionality, we did not treat each model year as a distinct product but rather grouped models across years so long as model design was unchanged.[7]

We generated the average characteristics of each "product" and dropped products with Manufacturer Suggested Retail Prices (MSRP) greater than $100,000. In order to further reduce dimensionality, we restricted attention to all models manufactuerd by Acura, Cadillac, Chevrolet, Ford, GMC, Honda, Lexus, Mercury, and Toyota–356 products in total. These brands manufactured all but a few of the hybrid vehicle models available in the U.S. by 2010. Census 2000 data were used to incorporate consumer heterogeneity into the discrete choice specifications. Our measure of market greenness in Colorado is voter party registration data obtained from the Colorado Secretary of State. Washington state voters do not register with parties, so vote share for respective party candidates in the 2008 Presidential election was used as the measure of market greenness. Green car ratings are used to condition for car characteristics that could have a heterogeneous effect on market share that varies with market greenness. For this rating, we used the American Council for an Energy Efficient Economy (ACEEE) "Green Book", which grades all models in the U.S. on a 100-point curve according to their environmental impacts, with tailpipe emissions ratings, fuel economy, and curb weight being the most important inputs into the grades.[8]

Summary statistics are reported in Table 1. Figure 1 shows Democrat party share of registered voters in Colorado by zip code along with Prius locations (Each green dot denotes five Priuses). Likewise, Figure 2 shows 2008 vote share for the Democrat party candidate by zip code in Washington and Prius locations. Consistent with the findings of Kahn [2007], Priuses are clustered in the more Democratic areas.

5 Results

Results from estimation of the fixed effects models in (2) and (3) reveal a statistically and economically significant conspicuous conservation effect that, based on preferred specifications, accounts for 32.9% of Prius market share on average in Colorado, and 10.1% of Prius market share on average in Washington. Table 2 reports results from estimation of the '2 x N' model in (2). Results from two specifications of (3) are reported in Table 3. We estimate (3) with product-marketing area interactions (top panel) and with product-specific median income and product-specific population density effects (bottom panel). The latter are our most robust estimates.

The coefficient on the interaction between the Prius indicator and the vote share variable is positive and significant at the 99% level in each estimate. These estimates suggest economically significant conspicuous conservation effects on Prius market share. The magnitude of the conspicuous conservation effect is

[7] For instance, the 2010 Toyota Camry is the sixth generation of Camry ever produced. The sixth generation was first introduced in 2007. We group Toyota Camry's from model years 2007-2010 as one product.

[8] For more information about ACEEE Greenbook ratings, see http://www.greenercars.org/greenbook_method.htm

Table 1: Summary Statistics

	Colorado		Washington	
	Mean	Std. Dev	Mean	Std. Dev.
Hwy MPG	22.27	7.61	23.54	8.11
City MPG	17.17	7.09	18.12	7.74
Green Score	31.05	7.45	33.61	7.45
MSRP	30,733.4	10,696.8	30,596.2	11,715.4
Length	199.64	26.41	190.19	14.95
Width	74.17	11.93	72.38	10.98
Height	67.43	8.61	64.33	8.49
Wheelbase	118.8	19.07	110.76	9.12
Curb Weight	4,295.89	1,156.61	3,910.33	996.14
Dem Share	0.30	0.11	0.54	0.14
Pop Density	1,513.75	2,405.63	1,724.24	2,716.32
Median Income			45,302.9	13,338.5
No. of doors	3.70	0.70		
Van share	0.06	0.24		
Car share	0.47	0.50		
SUV share	0.30	0.46		
Truck share	0.17	0.38		
Population	15,934.87	14,980.34		
Household size	2.57	0.25		
Age	36	4.79		
Family size	3.05	0.25		
Carpool share	0.13	0.05		
Public transit rider share	0.02	0.03		
Commute45	0.32	0.15		
Commute30	0.36	0.12		
College	0.36	0.12		
Grad school	0.07	0.05		

Figure 1: Prius Ownership and Democrat Party Share of Registered Voters in Colorado (One green dot denotes 5 Priuses)

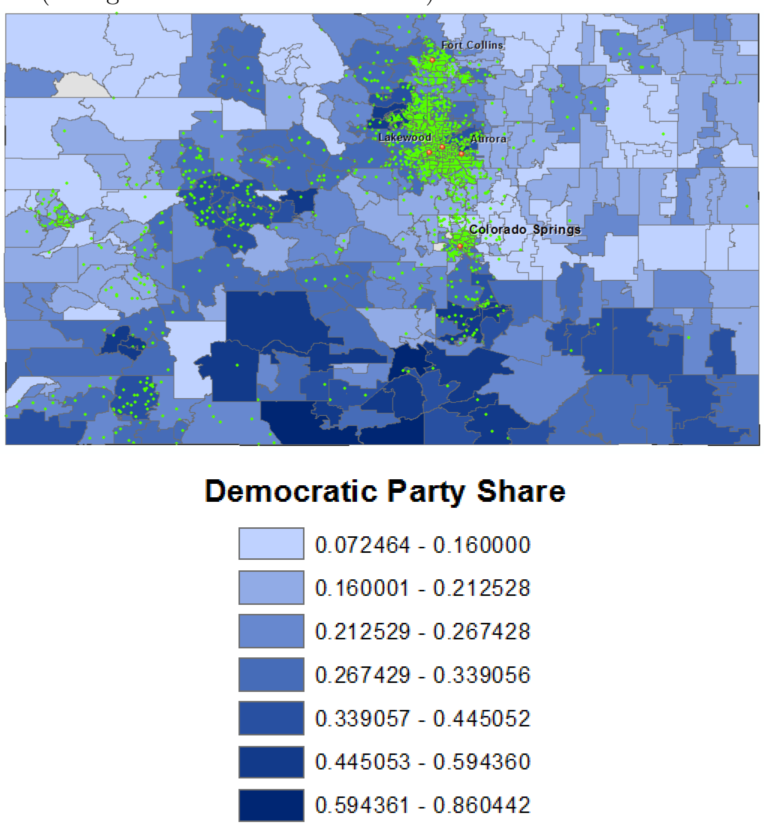


Figure 2: Prius Ownership and Democrat Candidate Vote Share in Washington
(One green dot denotes 5 Priuses)

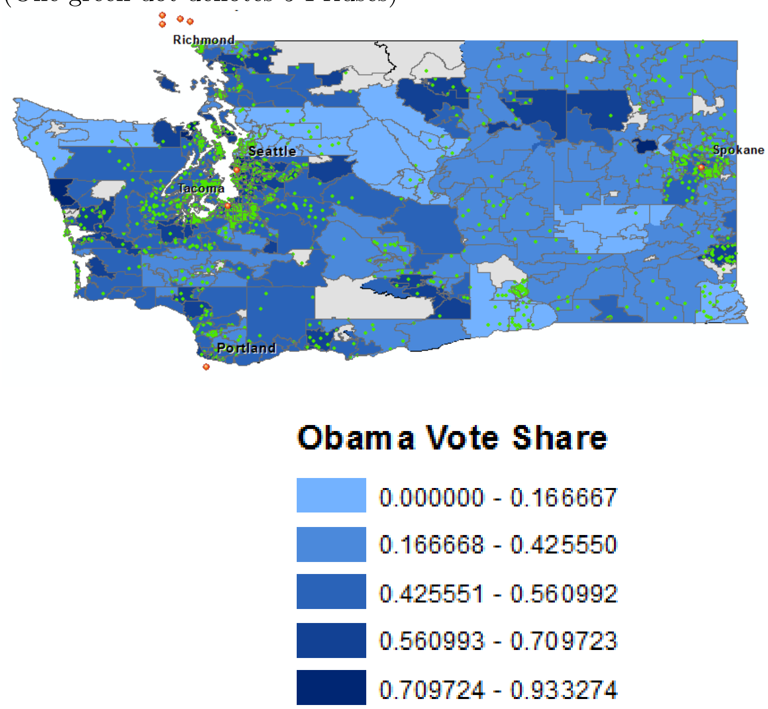


Table 2: Fixed Effects Results: '2 x N' Model (for Colorado)

	(1) Democrat	(2) Green
PRIUS*VOTE	0.0094***	1.01385***
	(0.0007)	(0.1163)
	[47.55]	[37.6]

Robust standard errors in parentheses
Mean conspicuous consumption effect as percent of share in brackets
*** p<0.01, ** p<0.05, * p<0.1

calculated as a percent of Prius share by multiplying the estimated coefficients by the mean party share across zip codes in Colorado and Washington, respectively, dividing by the Prius share in each state, and converting to a percent.

We also conducted a series of falsification checks by sequentially replacing the Prius indicator and vote share interactions in (3) with interactions of a Civic Hybrid indicator and vote share and a Toyota Camry Hybrid indicator and vote share. Because the Civic Hybrid and Camry Hybrid do not have unique designs, we expect the coefficient on these interactions to be non-positive. If market share for these models were independent of Prius market share, we would expect the coefficients to be insignificant. As reported in Table 4, however, the estimated coefficients on the interaction variables are negative and statistically significant, indicating the absence of a conspicuous conservation effect, and, moreover, Prius is likely being substituted in place of Civic and Camry Hybrids in these areas due to the intrinsic value of the green halo signalled uniquely by the Prius.

The regression results shown in Table 5 are mean parameter estimates for the vehicle demand system estimated by the nested logit specificantion in (4) using Colorado data. The coefficients are for the most part consistent across both market definitions and consistent with economic theory. For example, the price variable, MSRP is negative in both models indicating that higher prices reduce consumer's mean utility. In both models we were able to control for a number of demographic variables including average household size, median income, percent of the population who take public transportation and who carpool, and the percent of the population who have a daily commute in excess of 45 minutes. The coefficient of primary interest in is the interaction of the Prius dummy variable with the share of democratic voters. It is positive and significant in both models, re-enforcing the results in Table 2 and indicating that the mean utility for a Prius vehicle is greater in more democratic zip codes. The coefficient estimates for SUV and mini vans are positive, indicating that mean utility levels are higher for both types of vehicles conditional on select demographics. Similarly, mean utility levels are lower in zip codes that have more public transportation users and carpoolers.

Table 3: Fixed Effects Results: Full Model

	(1) Colorado	(2) Washington
	Product-specific Marketing Effects	
PRIUS*VOTE	0.0052***	0.0113***
	(0.0024)	(0.0023)
	[24.3]	[18.4]
	Product-specific Marketing, Income, and Population Density Effects	
PRIUS*VOTE	0.0052***	0.0062***
	(0.0014)	(0.0026)
	[32.9]	[10.1]

Robust standard errors in parentheses
Mean conspicuous consumption effect as percent of share in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Model Validation Results

	(1) Colorado	(2) Washington
	Honda Civic Hybrid	
CIVIC_HYB*VOTE	-0.0046***	-0.0047***
	(0.0009)	(0.0013)
	[-87.3]	[-90.4]
	Toyota Camry Hybrid	
CAMRY_HYB*VOTE	-0.0036***	-0.0028*
	(0.0012)	(0.0014)
	[-45.5]	[-44.4]

Robust standard errors in parentheses
Mean conspicuous consumption effect as percent of share in brackets
*** p<0.01, ** p<0.05, * p<0.1

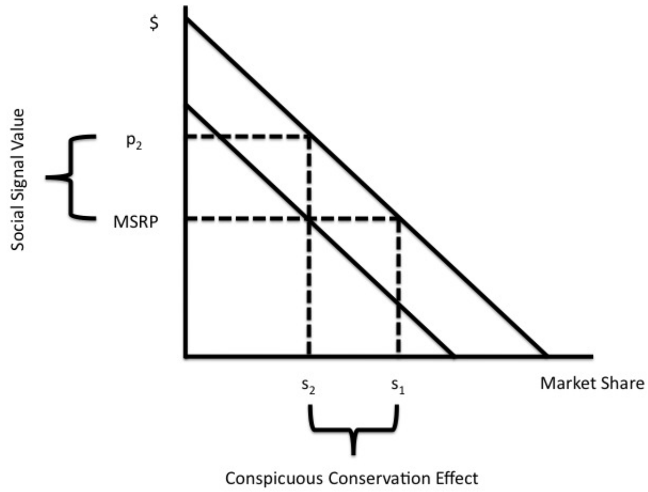
Table 5: Nested Logit Estimation Results

	(1)	(2)
PRIUS*VOTE	2.5189***	2.3428***
	(0.2942)	(0.2862)
VOTE	-2.5497***	-3.5474***
	(0.0549)	(0.0804)
MPG	0.0014**	0.0012**
	(0.0004)	(0.0005)
MSRP	-0.00002	-0.00007***
	(-0.00001)	(0.00001)
MSRP Income^2	-0.000006*	0.0000007
	(-0.0000005)*	0.0000005
Engine Size	0.3856***	0.3652***
	(0.0124)	(0.0128)
Vehicle Type 2	0.2376***	0.2312***
	(0.0090)	(0.0123)
Vehicle Type 4	0.4162***	0.3845***
	(0.0472)	(0.0586)
P07001	2.441024***	1.5910***
	(0.0647)	(0.0493)
P013001	0.0580***	0.1251***
	(0.0020)	(0.0023)
P033001	-1.8849***	0.1456**
	(0.0805)	(0.0726)
P053001	-0.00003***	-0.00003***
	(0.0000011)	0.000001
Work	-.2355***	0.0913***
	(0.0439)	(0.0328)
Carpool	-0.5269***	0.0226
	(0.1065)	(0.1713)
Public Transportation	2.6071***	-1.9988***
	(0.2690)	(0.2877)
Commute > 45 min	1.7710***	1.8574***
	(0.0312)	(0.0363)
college	4.5936***	4.0875***
	(0.1058)	(0.1243)
female	-1.6487***	-3.5398***
	(0.2098)	(0.2095)
residual from MSRP	0.00002***	0.000021***
	(0.000001)	(0.000001)
Within Group Share	-3.3477***	-3.0374***
	(0.2942)	(0.3086)

Bootstrap standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 3: Prius demand with and without the status signal



6 Estimating the Value of the Green Halo

In order to derive estimates of the mean willingness to pay for the status signal afforded by Prius ownership, we assume a locally linear Prius demand and treat the conspicuous conservation effect as a demand shifter. We determine what magnitude of right shift in Prius demand would, for given price, generate an equilibrium market share equal to our model estimate of actual market share and then estimate the share without the green halo by subtracting that estimated effect from the observed share. This simple approach is illustrated in Figure 1, where the estimated market share is denoted by s_1 and the estimated market share in the absence of the conspicuous conservation effect is s_2. The value of the social signal is given by $p_2 - \text{MSRP}$.

We fit the locally linear demand equation using estimated price elasticities of demand for individual vehicle models from the literature. Table 6 reports estimated mean willingness to pay for the Prius Halo in Colorado and Washington for each estimate of the percentage share effect of conspicuous conservation and for each of three own price demand elasticities obtained from the literature. To our knowledge there are no elasticity estimates for the Prius or for individual hybrid models. We rely, therefore, on estimated elasticities for similar models. Specifically, Mannering and Hani [1985] estimated a Toyota Corolla elasticity of 1.59, while Mannering and Winston [1985] estimated a Corolla elasticity of 1.7. Honda Accord elasticities were estimated to be 2.0 and 4.8 by Mannering and Hani [1985] and by Berry et al. [1995], respectively. Because of the uniqueness of the Prius, we expect its price elasticity falls in the low end of this range.

Table 6: Estimated Mean Willingness to Pay for the Prius Halo (in dollars)

	Price Elasticity		
Percent Change in Share	-1.6	-2.0	-4.8
10.1 (WA)	1,291.34	1,033.07	430.45
32.9 (CO)	4,208.53	3,366.83	1,402.84

Using preferred specifications from the bottom panel of Table 3, we estimate that the mean willingness to pay in Colorado (where the mean Democratic party share is 0.303) is between \$1,402.84 and \$4,208.53. In Washington, where the Democratic vote share was 0.53, we estimate the mean willingness to pay is between \$430.45 and \$1,291.34. These results are reported in Table 6.

Spatial variation in green intensity implies that the willingness to pay for the Prius halo is greater in some communities than in others. Table 7reports for each of the three price elasticities the difference from state-mean willingness to pay for two cities with high Democratic registration shares and two cities with low Democratic registration shares in Colorado and two cities with high Obama vote share and two cities with low Obama vote share in Washington. Table 7 also reports the difference from mean willingness to pay as a percent of mean willingness to pay for each city. In Denver, for instance, the value of green signaling (and hence the conspicuous conservation effect) is estimated to be more than twice the state mean. The signal is worth as much as \$5,000 more in Denver than the average Colorado community. Likewise, it is worth as much as \$3,400 more in Boulder. In less green communities, like Longmont and Loveland, however, the value of the green signal is worth as much as \$300 and \$700 less than the state mean, respectively. In Seattle, the signal is worth 54% more than the Washington state mean (as much as \$698), whereas in Richland, its worth 27% less than the state mean (as much as \$350). The Prius halo is worth as much as \$5,700 more in Denver than in Loveland and as much as \$1,000 more in Seattle than in Richland.

Throughout this paper, we assume that the instantanesou arbitrage condition precludes Toyota executives from varyin Prius price across communities in order to capture the full signaling value. Were Toyota to attempt to charge differential prices, consumers who reside in green communities could simply purchase their Priuses in brown communities. However, Table 7 reveals that if Prius demand were the same across communities conditional on the green signaling value and if Toyota were to internalize the mean signaling value into Prius price, then the benefit of Prius ownership in some communities would be exceeded by the price.

Table 7: City Comparison of Conspicuous Conservation Effect

		Price Elasticity		
	% Diff. in WTP	-1.6	-2.0	-4.8
Colorado				
Denver	120.75	5,082.13	4,065.71	1,694.04
Boulder	81.22	3,418.13	2,734.51	1,138.38
Longmont	-7.74	-325.87	-260.69	-108.62
Loveland	-17.63	-741.86	-593.49	-247.29
Washington				
Seattle	54.10	698.66	558.92	232.89
Spokane	22.54	291.07	232.85	97.02
Yakima	-7.17	-92.55	-74.03	-30.85
Richland	-27.59	-356.28	-285.02	-118.76

7 Conclusion

Using market-level data on vehicle ownership in Colorado and Washington, we have empirically identified a significant conspicuous conservation effect related to Toyota Prius demand. Such effects have been the subject of theory and discussion, but to our knowledge have not heretofore been tested empirically. Our results suggest that, depending on their location, consumers are willing to pay up to several thousand dollars to signal their environmental bona fides through their car choices. Competitive altrium, i.e. the social signaling motive, may, therefore, provide a strong impetus toward private provision of public environmental goods via purchase of impure public goods in the green market.

While much of the literature on conspicuous consumption emphasized the wastefulness of spending to signal wealth, conspicuous conservation may improve social welfare. It suggests that private actions can substitute, to some extent, for government policies to yield social-welfare-improving environmental outcomes in the presence of market failures that under-value environmental amenities. However, the social welfare implications of conspicuous conservation depend upon substitution effects with respect to conservation effort. The social signaling motive can distort private incentives and generate conservation investment that is individually rational but not social welfare maximizing. For instance, economists have begun to question whether homeowners over-invest in residential solar power because of its conspicuousness and under-invest in home insulation improvements, energy efficient heating and cooling systems, and window sealing because of the relative inconspicuousness of these investments. Policy makers, then, may wish to reconsider subsidies for consicuous green cars and residential solar panels in order to allign private incentives with behaviors that are in the public interest. This means subsidies should be targeted toward inconspicuous conservation in order to achieve an optimal mix of conservation effort. However, policy makers should be mindful of the potential to crowd out intrinsic motivation with extrinsic rewards like taxes and subsidies. Because conspicuous-conservation goods enable their purchasers to signal their willingness to sacrifice to enhance the environment, the public subsidy of such goods diminishes the value of such goods as social signals. Subsidies may, therefore, have the perverse effect of reducing demand for conspicuous conservation.

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