Yu Ma, Kusum L. Ailawadi, Dinesh K. Gauri, & Dhruv Grewal

An Empirical Investigation of the Impact of Gasoline Prices on Grocery Shopping Behavior

The authors empirically examine the effect of gas prices on grocery shopping behavior using Information Resources Inc. panel data from 2006 to 2008, which track panelists' purchases of almost 300 product categories across multiple retail formats. The authors quantify the impact on consumers' total spending and examine the potential avenues for savings when consumers shift from one retail format to another, from national brands to private labels, from regular-priced to promotional products, and from higher to lower price tiers. They find a substantial negative effect on shopping frequency and purchase volume and shifts away from grocery and toward supercenter formats. A greater shift occurs from regular-priced national brands to promoted ones than to private labels, and among national brand purchasers, bottom-tier brands lose share, midtier brands gain share, and top-tier brand share is relatively unaffected. The analysis also controls for general economic conditions and shows that gas prices have a much larger impact on grocery shopping behavior than broad economic factors.

Keywords: grocery expenditure, gas price effect, macroeconomic factors, retail format choice, promotions, private label

Macroeconomic conditions influence consumers' attitudes, shopping behavior, and consumption. Although these conditions are not controllable by manufacturers and retailers, understanding how they affect consumers and how consumers respond to them is critical in guiding effective managerial actions. This issue currently occupies center stage as the world economy tries to emerge from the most severe economic crisis in decades.

A small but rich body of literature in marketing examines the impact of macroeconomic factors. One stream of research describes how firms change advertising, innovation, and other "proactive" marketing activities during a recession and assesses the effectiveness of these actions (Deleersnyder et al. 2009; Frankenberger and Graham 2003; Srinivasan, Rangaswamy, and Lilien 2005). Another stream studies the effect of business cycles and consumer confidence on sales of durable goods (Allenby, Jen, and Leone 1996; Deleersnyder et al. 2004; Kumar, Leone, and Gaskins 1995) and private labels (Lamey et al. 2007). Both streams of research are typically conducted at an aggregate level, with industry-, firm-, or product category–level sales data. Yet change in consumer behavior is at the root of why these macroeconomic variables affect sales and firm performance. Therefore, it is important to conduct a more disaggregate analysis (Deleersnyder et al. 2004) and understand how consumers react to changes in macroeconomic factors (Grewal, Levy, and Kumar 2009).

An underlying theme in the literature is the notion that consumers' response to macroeconomic factors is a function of not just their ability to buy (as measured by current and expected future income) but also their willingness to buy (as measured by attitudes, sentiment, and so on) (Katona 1975). Conventional wisdom maintains that macroeconomic factors and consumer sentiment have an impact on durable goods sales because purchases of such products are discretionary and can be postponed when willingness to buy is low whereas nondurable products, such as groceries, are less affected because they cannot be postponed (Deleersnyder et al. 2004; Lamey et al. 2007).

The focus of the current research is on a macroeconomic factor that is qualitatively different from business cycles and consumer sentiment and has been prominent in recent years—namely, the price of gasoline. Since 2006, the price of a gallon of regular gasoline has varied widely, from lows of just over $2.00 to highs of more than $4.00. Gasoline demand is fairly inelastic (Brons et al. 2008; Greening et al. 1995), so expenditure on gas goes up in accordance with its price. A U.S. household earning a median income spent 11.5% of that income on gas in July 2008, up from 4.6% in 2003 (*The Wall Street Journal* 2008). When the price of gas increases sharply, consumers have less dispos-

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able income, feel significant financial hardship, become more price conscious, and must find ways to reduce spending in other areas (Du and Kamakura 2008; Jacobe 2006). Consistent with this, Hamilton (2008) notes in his recent review of oil and the economy that the key mechanism whereby energy price shocks affect the economy is through a disruption in spending on goods and services other than energy.

Thus, the impact of gas prices on consumer shopping behavior derives not just from psychological willingness to buy but also from the immediate economic ability to buy. Grocery products individually cost little relative to overall income. However, after housing and transportation, they form the largest percentage of U.S. households' annual expenditures. For example, expenditure on food at home for the average household was 5.6% of total income after taxes in 2007, exceeding other expense categories such as apparel, entertainment, and health care (Bureau of Labor Statistics 2007). Furthermore, grocery shopping is done frequently, generally more than once a week, so there is plenty of opportunity to make adjustments in purchases. Therefore, expenditures on grocery products provide a substantial and flexible means to adjust spending in response to unexpected changes in discretionary income. In summary, grocery products may be relatively immune to general economic conditions and business cycles, but this is not likely to be the case with rising gas prices.

However, there is little systematic research on the impact of gas prices on consumers' shopping behavior. An exception is the work of Gicheva, Hastings, and Villas-Boas (2010); using Consumer Expenditure Survey data (Bureau of Labor Statistics 2007), they find that expenditures on food outside the home decrease by 56% and expenditures on food purchased at grocery stores increase slightly with a 100% increase in gas price. They also use sales data in four food categories from a California grocery chain to show that consumers substitute away from regular shelf-price products and toward promotional items to save money on overall grocery expenditures.

The objective of our research is to provide a comprehensive analysis of the impact of gas prices on consumers' grocery shopping behavior. Consumers can alter how much they purchase, how often they purchase, and how much they spend on their purchases, which in turn is a function of what they buy and where they buy it. We not only quantify the impact on households' shopping frequency, total purchase volume, and spending but also examine the avenues they use to save money on grocery shopping, such as shifting from one retail format to another, from national brands to private labels, from regular-priced products to promotional purchases, and from higher-priced national brands to lower-priced ones. Such an analysis is important not only for researchers and policy makers but also for manufacturers and retailers, which must determine the best way to respond to and perhaps preempt changes in shopping behavior in an era of "peak oil" and sustained volatility in energy prices. As we discuss in the next section, the answers are not obvious.

We conduct our analysis using a household panel data set from Information Resources Inc. The data set captures grocery shopping information across multiple retail formats of approximately 1000 panelists from a major U.S. metropolitan area. The data are from January 2006 to October 2008 and span panelists' purchases of almost 300 product categories. We supplement these data with gas prices in the same metropolitan area obtained from the Department of Energy Information Administration Web site. Some unique features of these data make them especially useful for our research. First, we cover not just a few product categories but rather the vast majority of consumer packaged goods products purchased by consumers. Second, we cover both the traditional grocery store and drugstore channels and the regular and supercenter stores of mass merchants (including Wal-Mart) and warehouse clubs. Third, substantial variation in gas prices occurred during the period of our data. Fourth, we control for general economic conditions to isolate and contrast the impact of gas prices.

We organize the remainder of this article as follows: In the next section, we present the conceptual framework for our model and analysis, drawing on relevant literature whenever possible. Then, we discuss our data and methodology. Following this, we present our empirical results and discuss the implications of our findings for researchers and managers.

Conceptual Development

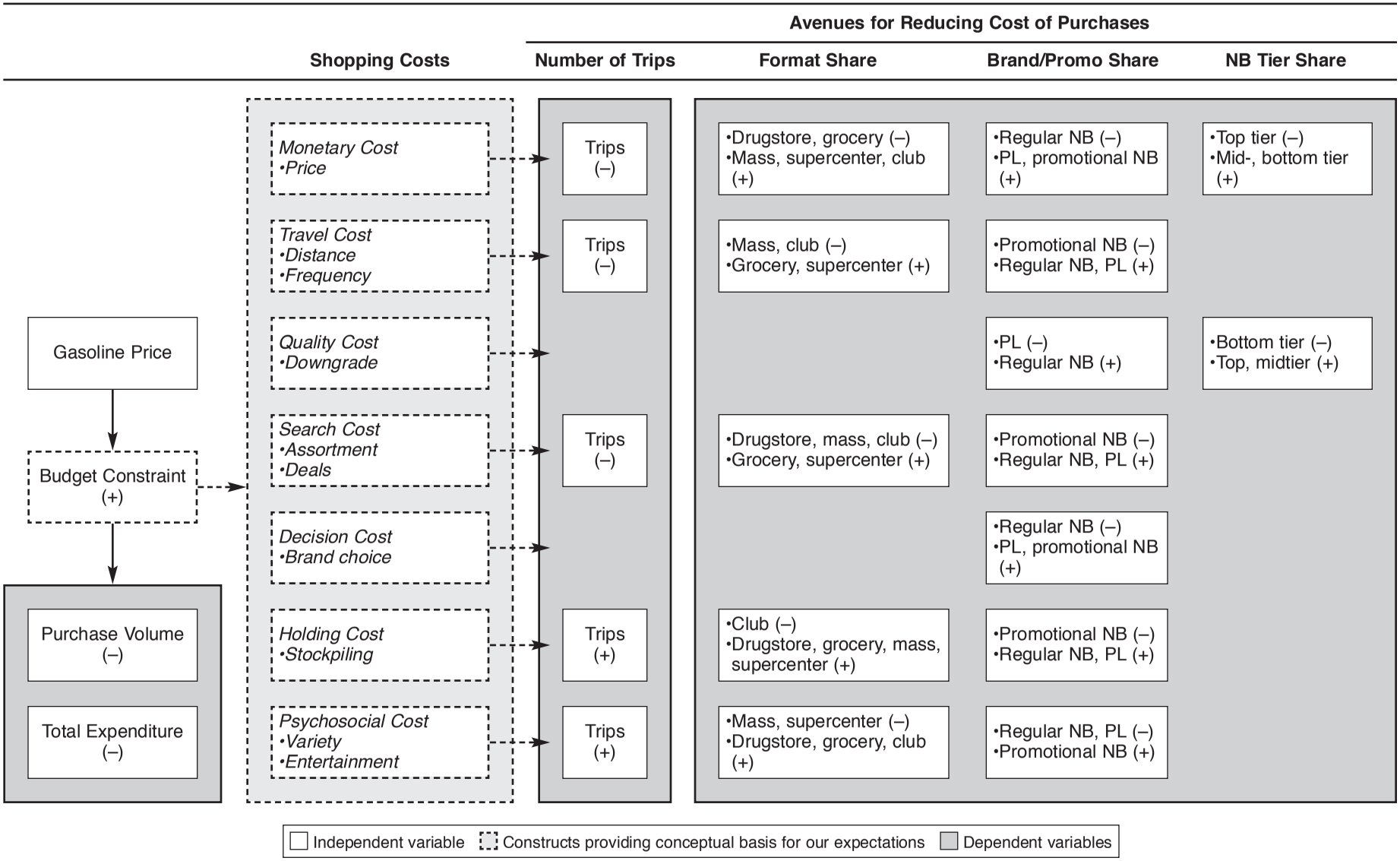
Overview

Figure 1 depicts the framework that guides our expectations and analysis. Gas prices affect consumers' budget constraint because an increase in gas prices directly reduces the income available for other purchases, given the relative inability to reduce gas consumption in the short run. The budget constraint requires consumers to reduce their total spending. They can do this by lowering their purchase volume (consumption) and/or by reducing the cost of their purchases. Cost can be reduced by shifting to less expensive retail formats, private label products or national brands on promotion, and/or lower-price-tier national brands (Griffith et al. 2009). In addition, consumers can adjust the number of shopping trips they make.

However, consumers' shopping utility is not just a function of the quantity of products purchased and their monetary cost. Although the monetary cost may be most salient in the face of gas price–induced budget constraints, consumers also experience other costs and benefits of shopping, such as the opportunity cost of time spent in travel and search (Bell, Ho, and Tang 1998; Blattberg et al. 1978; Marmorstein, Grewal, and Fishe 1992), other utilitarian benefits of quality and decision simplicity, and psychosocial benefits of self-expression and entertainment (Ailawadi, Neslin, and Gedenk 2001; Chandon, Wansink, and Laurent 2000; Urbany, Dickson, and Kalapurakal 1996). Figure 1 includes the major elements of total utility identified in prior research but represents them as costs for exposition simplicity.

As gas prices increase and tighten consumers' budget constraint, there is pressure to cut monetary costs by searching for lower prices. However, the reduction in monetary

FIGURE 1
Guiding Framework



Notes: NB = national brand, and PL = private label.

costs must be traded off against possible increases in other costs. Travel costs refer to the distance and how frequently the consumer must travel for shopping, quality costs are driven by whether the consumer downgrades to a less preferred brand, search costs are driven by how easy it is to find preferred products and deals, decision costs refer to how easy it is to decide what to buy, holding costs are driven by whether shopping is done in bulk, and psychosocial costs refer to how much enjoyment the shopping activity provides.

We do not directly observe all these costs, but they provide an important conceptual basis for our work (for a similar conceptual development in other contexts, see Geyskens, Gielens, and Dekimpe 2002; Narasimhan, Neslin, and Sen 1996). In the following discussion, we consider the tradeoffs among these costs in developing expectations about how gas prices affect consumers' overall shopping as well as the allocation of their purchases to different formats, promotions, and brands. Note that we control for general economic conditions through the gross domestic product (GDP) growth variable, which is a widely accepted measure of economic health.[1] Our expectation, based on prior research and conventional wisdom, is that the impact of this variable is weaker than that of gas price.

Effect of Gas Prices on Overall Shopping

Total purchase volume. The lower disposable income resulting from higher gas prices puts pressure on consumers to buy and consume less. Because consumers are also trying to save money by eating at home more often than at restaurants (Gicheva, Hastings, and Villas-Boas 2010) and spending more time at home (Mouawad and Navarro 2008), there is a positive substitution effect for food products. Across all grocery products, however, we expect a negative effect of gas prices on total purchase volume.

Total dollar spending. Total spending comprises purchase volume and the cost of the purchases. To the extent that consumers reduce purchase volume, spending should decrease as well. Consumers should also try to reduce the cost of their purchases, especially because retail prices tend to go up as energy costs rise. We examine the avenues by which the cost of purchases may be reduced subsequently.

Shopping trips. The most direct result of higher gas prices should be to reduce travel costs as much as possible. This implies a reduction in the number of shopping trips. However, consumers with low search costs can shop frequently to make better use of promotions, thus saving money (Gauri, Sudhir, and Talukdar 2008; Putrevu and Ratchford 1997; Urbany, Dickson, and Kalapurakal 1996). Gauri, Sudhir, and Talukdar (2008) find that households can obtain savings of up to 68% if they engage in either temporal (over time) or spatial (across stores) search, and they can increase those savings to 76% if they search across both stores and time. Furthermore, consumers must trade off the reduced travel cost against the psychosocial value from shopping and the higher inventory holding cost they incur if they shop less frequently. Thus, as Figure 1 shows, we cannot predict whether gas prices will have a negative or positive effect on the number of shopping trips for the average household.

Avenues for Reducing Shopping Expenditure

Effect of gas prices on retail format choice. Average price levels are lower in mass stores, supercenters, and warehouse clubs than in drugstores and grocery stores, and there is considerable, though not complete, overlap in the product categories carried by different formats, making it feasible for consumers to shift their spending from one format to another (Luchs, Inman, and Shankar 2007). Therefore, monetary costs should drive consumers to shift from drugstores and grocery stores to the former formats. However, consumers must trade off this benefit against other costs. Mass stores, supercenters, and warehouse clubs are not as densely located as drugstores and grocery stores, and their assortment is not as deep as grocery stores, thus increasing travel and search costs. Apart from membership fees, warehouse clubs require consumers to buy in bulk, increasing their inventory holding costs. However, supercenters and warehouse clubs offer one-stop shopping, which can reduce the number of shopping trips and travel costs.[2] With special displays and frequently changing layouts, especially in peripheral parts of drugstores and grocery stores, and "treasure hunts" for frequently changing assortment in some warehouse clubs, these formats may offer more entertainment and exploration appeal than mass store and supercenter formats.

Prior research has shown that all these costs are relevant to format choice. For example, Bell, Ho, and Tang (1998) show that consumers consider the sum of fixed (e.g., traveling to and from the store) and variable (product prices and quantities in the basket) costs of shopping when making their store choice. Similarly, Bhatnagar and Ratchford (2004) argue that format choice is a function of consumers' costs of travel, inventory holding, and so forth. Figure 1 shows the net impact of gas price on format choice. Given the countervailing effects of the different costs, the net impact of gas price on the share of each format is clearly an empirical question.[3]

Effect of gas prices on brand and promotion choice. National brands are sold at retail prices that are 20%–30% higher than private labels (Ailawadi and Harlam 2004), and penetration of private labels has increased substantially in the past decade, with most retailers offering private label products in a wide range of categories (Kumar and Steenkamp 2007). This makes shifting from national brands

[1]We obtained similar results with the Conference Board's Composite Index of Coincident Indicators, which combines four individual factors: payroll employment, personal income, industrial production, and manufacturing and trade sales.

[2]We distinguish between traditional mass stores, which have less square footage and carry a smaller assortment of categories, and the larger supercenter format, whose assortment is broader and includes perishable food products.

[3]Consumers could also shop more at convenience stores because they are conveniently located, often together with a gas station. However, we do not include this format in our analysis, because it accounts for less than 1% of total spending in our data.

to private labels an easy way for households to save money on their grocery shopping. Value-conscious consumers can also save money by searching for promotions, and both private labels and promotions reduce decision costs by making it easy for consumers to decide what to buy (Ailawadi, Neslin, and Gedenk 2001; Chandon, Wansink, and Laurent 2000).

However, the temporal and spatial search for promotions and the pressure to stock up on deals increase travel, search, and inventory holding costs. (Private labels do not increase these costs because of their everyday low prices.) However, despite the emergence of "premium" private labels, in general U.S. consumers perceive a quality cost in downgrading to private labels, whereas they may be able to buy preferred brands on promotion. In addition, promotions offer psychosocial benefits, while private labels do not. Overall, therefore, we expect a negative effect of gas prices on regular-priced national brand share and a positive effect on private label and promotional purchases of national brands. An empirical question, however, is whether the positive impact is greater for promotions or private labels.

Effect of gas prices on national brand price tier share. Despite private labels' price advantage, national brands still have a unit market share of more than 75% across consumer packaged goods categories (Private Label Manufacturers Association 2009), in support of Sethuraman's (2000) finding that consumers are willing to pay a significant premium for national brands even if a private label is of equivalent quality. Consumers can save money by switching from high- to mid- and low-price-tier national brands even if they are not willing to switch to private labels. This suggests a positive effect of gas prices on lower-tier share and a negative effect on top-tier share.

However, consumers incur a quality cost in switching away from high-tier national brands to low-tier ones. Those to whom monetary savings are important and quality cost is not are likely to switch to private labels, leaving the more quality conscious consumers to buy national brands. The literature on asymmetric price and context effects shows that consumers of low-tier national brands are more likely to switch to private labels while higher-tier national brands are more insulated (Blattberg and Wisniewski 1989; Geyskens, Gielens, and Gijsbrecht 2010; Pauwels and Srinivasan 2004; Sethuraman, Srinivasan, and Kim 1999). Thus, despite the conventional wisdom that top-tier brands hurt when times are tight, we cannot predict the effect of gas prices on bottom-, mid-, and top-tier shares among national brand purchasers.

Role of Demographic Variables

Although economic costs are likely to be more salient than psychosocial ones in the face of a significant budget constraint, it is reasonable to expect heterogeneity in how consumers make trade-offs among the various costs in Figure 1. Two overarching consumer characteristics that determine these costs and consequent shopping behaviors are financial constraints and time constraints (Ailawadi, Neslin, and Gedenk 2001; Blattberg et al. 1978; Fox, Montgomery, and Lodish 2004; Luchs, Inman, and Shankar 2007; Marmorstein, Grewal, and Fishe 1992; Urbany, Dickson, and Kalapurakal 1996). Financially constrained consumers are more likely to emphasize monetary and travel costs, and time-constrained consumers are more likely to emphasize travel, search, and decision costs. To preserve parsimony and strong theoretical grounding, we select three key demographic variables that are directly relevant to financial and time constraints: household income, presence of children, and presence of at least one household head who does not work outside the home. Income drives financial constraints, and the latter two variables drive time constraints.[4]

We expect that these demographic variables have main effects on the various aspects of purchase behavior we study and also may moderate the impact of gas prices. For example, lower-income households are more likely to engage in savings behaviors (e.g., smaller supermarket and drugstore shares, greater private label and promotion shares, smaller top-tier national brand share) and also may be more sensitive to gas price increases. In contrast, time-constrained households may be less likely to engage in search and more attracted to one-stop shopping (i.e., lower promotion share, higher supercenter share). We follow Ailawadi, Neslin, and Gedenk (2001) and Fox, Montgomery, and Lodish (2004) in including demographics to account for heterogeneity but do not develop explicit hypotheses about their effects.

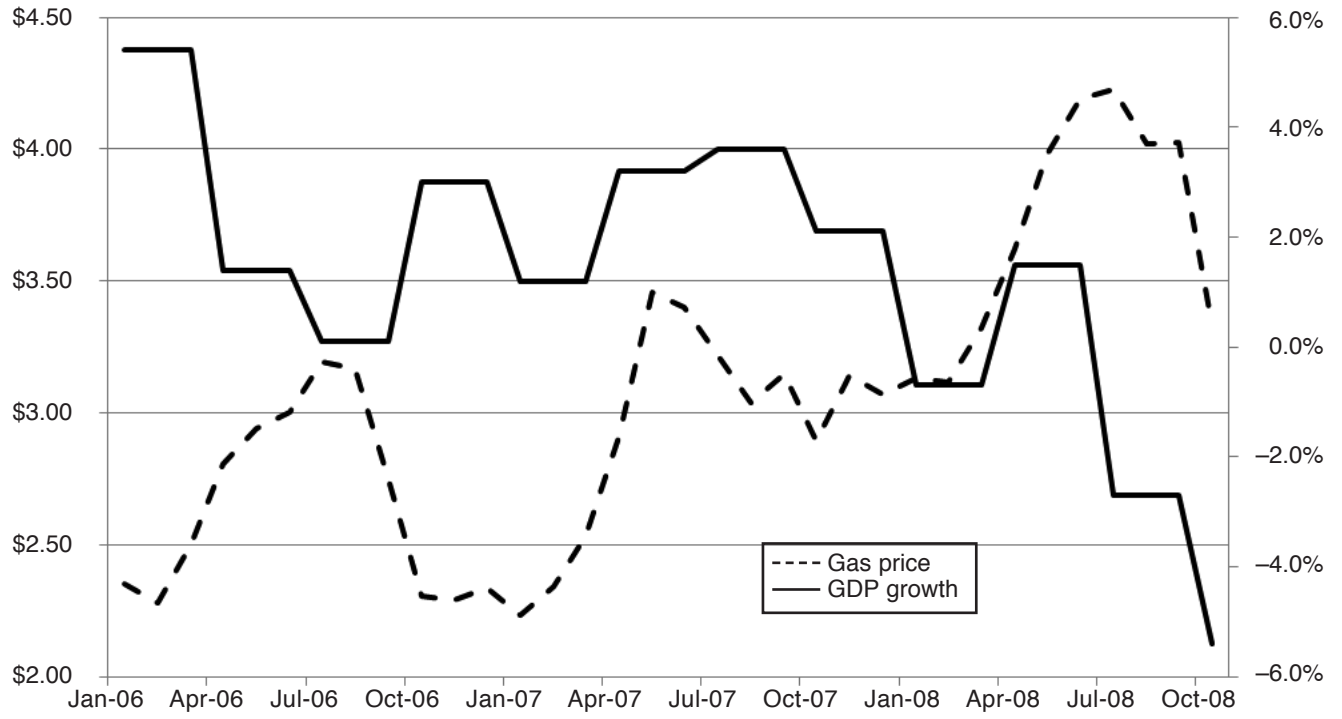
Data

We obtained an Information Resources Inc. panel data set from a major metropolitan area for this study. The data capture household-level shopping and spending of 1389 panelists across stores and formats, including all items bought in 297 categories tracked by the firm. Purchases are tracked over 147 weeks between 2006 and 2008. For each household, we also obtained information on key demographic variables, including household income, household size, age, and employment status. Finally, we obtained gasoline prices in the metropolitan area during the same period from the Department of Energy Information Administration Web site, and we obtained quarterly GDP growth rate figures from the Bureau of Economic Analysis Web site. Figure 2 depicts both gas prices and GDP growth during the period of our study.

Table 1 provides the descriptive statistics. Our unit of analysis is a household and month (e.g., Fox, Montgomery, and Lodish 2004). The average household spends $270 per month across 9.31 shopping trips. Note that total purchase volume is also measured in dollars. This is because the vastly different units across categories (e.g., pounds, gallons, square feet) cannot be aggregated in a meaningful way. We use an average category price per unit volume to aggregate purchase volume, so the resultant variable is in dollar units. However, variations in this variable occur only because of volume changes, not price changes, so we can

[4]These demographics are also related to other characteristics. For example, households with children have greater needs, and those who do not work outside the home are more likely to be older and retired.

FIGURE 2
Gas Prices and GDP Growth Rates



Notes: Mean (SD) of gas price is $3.07 ($.58), and mean (SD) of GDP growth is 1.19% (2.29%).

assess the impact of gas prices on purchase volume by modeling variation in this variable. Table 1 also summarizes marketing-mix differences across formats and how households allocate their purchases across formats, brands, and promotions.

Method

In line with Figure 1, we specify and estimate models for four sets of shopping decisions. The first set pertains to overall shopping and includes three dependent variables—number of shopping trips, purchase volume, and total expenditure per month. The second set pertains to how consumers allocate their total purchase volume across five different retail formats, the third set pertains to the share of regular versus promotional national brands and private label in their total purchase volume, and the fourth set pertains to their share of top-, mid-, and bottom-price-tier national brands.

Each model contains three groups of explanatory variables. The first group accounts for heterogeneity in preferences among households using demographic variables and the household's value of the dependent variable during a two-month initialization period (Briesch, Chintagunta, and Fox 2009; Bucklin, Gupta and Han 1995). The second group includes the macroeconomic variables of central interest to our research: gasoline price and GDP growth rate. We allow for heterogeneity in response to these variables by interacting them with the demographic variables.

The final group contains the control variables that also drive households' shopping, including distance traveled for shopping and the key retailer marketing-mix variables (i.e., net price, assortment size, and percentage of assortment devoted to private label). We compute the variables in this group at different levels of aggregation as appropriate for each set of models, using household-specific weights obtained from an initialization period. Detailed definitions of the variables for each set of models appear in the Appendix.

Because retailers may adjust their marketing mix according to local demand shocks and gas prices, we control for potential endogeneity in the three marketing-mix variables by using their values from markets other than the focal market as instruments (for examples of similar instruments, see Chintagunta, Kadiyali, and Vilcassim 2006; Nevo 2001).

Total Trips, Purchase Volume, and Dollar Spending

We provide the model specifications for the three total monthly shopping variables subsequently. We specify all three equations in log-log form because households vary widely in the magnitudes of these dependent variables. and this specification provides coefficients in percentages rather than absolute terms.[5] The only variables not in log form are the two dummy variables (AtHome and Kids) and the GDP variable, which can take on negative values.

[5]The fit of the log-log specification was as good as or better than the linear specification, particularly in holdout sample comparisons.

TABLE 1
Descriptive Statistics

Variable	Mean					
	Overall	Drugstore	Grocery Store	Mass Store	Supercenter	Club
Price index	1.00	1.01	1.15	.99	.96	.89
Assortment index	1.00	.54	2.72	.97	.60	.17
Private label % of assortment	19.95	20.58	21.77	14.85	16.06	12.84
Top-tier % of national brand assortment	20.10	20.12	20.28	18.69	17.38	18.33
Midtier % of national brand assortment	36.38	36.76	36.36	36.59	36.11	36.51
Bottom-tier % of national brand assortment	43.52	43.12	43.36	44.72	46.51	45.16
Regular-priced national brand share (%)	57.70	48.34	51.78	73.16	73.44	79.66
Promoted national brand share (%)	18.76	22.98	23.86	7.56	6.79	1.88
Private label share (%)	23.54	28.69	24.36	19.28	19.77	18.46
Top-tier national brand share (%)	10.14	14.73	8.87	11.80	10.89	8.27
Midtier national brand share (%)	32.65	32.82	32.62	31.49	32.25	31.30
Bottom-tier national brand share (%)	57.21	52.44	58.51	56.71	56.86	60.43
Monthly trips (n)	9.31	1.28	5.85	1.33	.38	.47
Monthly spending ($)	269.93	19.89	180.83	32.32	12.25	24.64
Monthly purchase volume ($)	260.19	21.19	171.98	32.08	12.00	22.94
Distance to households (miles)	3.11	1.20	3.44	3.65	11.95	5.52
Overall share (%)	—	8.14	66.10	12.33	4.61	8.82
Share: households with no head at home	—	6.40	66.29	13.28	5.09	8.94
Share: households with ≥ 1 head at home	—	10.06	65.88	11.28	4.09	8.68
Share: households with > average income	—	5.97	64.69	12.54	4.79	12.00
Share: households with < average income	—	10.02	67.31	12.15	4.46	6.07
Share: households with no children at home	—	9.60	66.97	11.38	4.11	7.93
Share: households with children at home	—	4.54	63.94	14.67	5.85	11.00

$$
\begin{aligned}
(1)\ \ln(\text{Numtrps}_{ht}) &= \beta_1^1 + \beta_2^1 \ln(\text{Numtrps}_{h0}) + \beta_3^1 \ln(\text{Inc}_h) \\
&+ \beta_4^1 \text{AtHome}_h + \beta_5^1 \text{Kids}_h + [\beta_6^1 + \beta_7^1 \ln(\text{Inc}_h) \\
&+ \beta_8^1 \text{AtHome}_h + \beta_9^1 \text{Kids}_h] \times \ln(\text{GPrice}_t) \\
&+ [\beta_{10}^1 + \beta_{11}^1 \ln(\text{Inc}_h) + \beta_{12}^1 \text{AtHome}_h \\
&+ \beta_{13}^1 \text{Kids}_h] \times \text{GDP}_t + \beta_{14}^1 \ln(\text{Dist}_h) \\
&+ \beta_{15}^1 \ln(\text{NPrice}_{ht}) + \beta_{16}^1 \ln(\text{AssrtSize}_{ht}) \\
&+ \beta_{17}^1 \ln(\text{PctPL}_{ht}) + \varepsilon_{ht}^1,
\end{aligned}
$$

$$
\begin{aligned}
(2)\ \ln(\text{Dolspnd}_{ht}) &= \beta_1^2 + \beta_2^2 \ln(\text{Dolspnd}_{h0}) + \beta_3^2 \ln(\text{Inc}_h) \\
&+ \beta_4^2 \text{AtHome}_h + \beta_5^2 \text{Kids}_h + [\beta_6^2 + \beta_7^2 \ln(\text{Inc}_h) \\
&+ \beta_8^2 \text{AtHome}_h + \beta_9^2 \text{Kids}_h] \times \ln(\text{GPrice}_t) \\
&+ [\beta_{10}^2 + \beta_{11}^2 \ln(\text{Inc}_h) + \beta_{12}^2 \text{AtHome}_h \\
&+ \beta_{13}^2 \text{Kids}_h] \times \text{GDP}_t + \beta_{14}^2 \ln(\text{Dist}_h) + \\
&+ \beta_{15}^2 \ln(\text{NPrice}_{ht}) + \beta_{16}^2 \ln(\text{AssrtSize}_{ht}) \\
&+ \beta_{17}^2 \ln(\text{PctPL}_{ht}) + \varepsilon_{ht}^2, \text{ and}
\end{aligned}
$$

$$
\begin{aligned}
(3)\ \ln(\text{Purvol}_{ht}) &= \beta_1^3 + \beta_2^3 \ln(\text{Purvol}_{h0}) + \beta_3^3 \ln(\text{Inc}_h) \\
&+ \beta_4^3 \text{AtHome}_h + \beta_5^3 \text{Kids}_h + [\beta_6^3 + \beta_7^3 \ln(\text{Inc}_h) \\
&+ \beta_8^3 \text{AtHome}_h + \beta_9^3 \text{Kids}_h] \times \ln(\text{GPrice}_t) \\
&+ [\beta_{10}^3 + \beta_{11}^3 \ln(\text{Inc}_h) + \beta_{12}^3 \text{AtHome}_h \\
&+ \beta_{13}^3 \text{Kids}_h] \times \text{GDP}_t + \beta_{14}^3 \ln(\text{Dist}_h) + \\
&+ \beta_{15}^3 \ln(\text{NPrice}_{ht}) + \beta_{16}^3 \ln(\text{AssrtSize}_{ht}) \\
&+ \beta_{17}^3 \ln(\text{PctPL}_{ht}) + \varepsilon_{ht}^3,
\end{aligned}
$$

where

Numtrps_{ht} = number of shopping trips made by household h in month t,
Dolspnd_{ht} = total grocery spending in dollars by household h in month t,
Purvol_{ht} = total purchase volume by household h in month t measured in constant dollars,
Numtrps_{h0} = average number of trips per month by household h in initialization period,
Purvol_{h0} = average purchase volume per month by household h in initialization period,
Dolspnd_{h0} = average dollar spending per month by household h in initialization period,
Inc_h = annual income of household h,
AtHome_h = 1 if at least one household head is at home (not working) and 0 if otherwise,
Kids_h = 1 if household h has children less than 18 years of age at home and 0 if otherwise,
GPrice_t = average price per gallon of regular gas in month t,
GDP_t = annualized real GDP growth rate in the quarter of month t,
Dist_h = distance traveled by household h for shopping,
NPrice_{ht} = net price facing household h in month t,
AssrtSize_{ht} = assortment size facing household h in month t, and
PctPL = percentage of assortment size facing household h in month t that is private label.

Share Allocation Models

The share models are of the following form:

$$
\begin{aligned}
(4)\ \ln(\text{Share}_{jht}) &= \beta_1^j + \beta_2^j \ln(\text{Share}_{jh0}) + \beta_3^j \ln(\text{Inc}_h) \\
&+ \beta_4^j \text{AtHome}_h + \beta_5^j \text{Kids}_h + [\beta_6^j + \beta_7^j \ln(\text{Inc}_h) \\
&+ \beta_8^j \text{AtHome}_h + \beta_9^j \text{Kids}_h] \times \ln(\text{GPrice}_t) \\
&+ [\beta_{10}^j + \beta_{11}^j \ln(\text{Inc}_h) + \beta_{12}^j \text{AtHome}_h \\
&+ \beta_{13}^j \text{Kids}_h] \times \text{GDP}_t + \beta_{14}^j \ln(\text{RelDist}_{jh}) \\
&+ \beta_{15}^j \ln(\text{RelNPrice}_{jht}) + \beta_{16}^j \ln(\text{RelAssrtSize}_{jht}) \\
&+ \beta_{17}^j \ln(\text{RelPctPL}_{jht}) + \varepsilon_{ht}^j,
\end{aligned}
$$

where subscript j refers to the jth alternative within each set (one of five retail formats, regular or promotional national brand or private label, one of three national brand price tiers) and distance and the marketing-mix variables for an alternative are computed relative to the weighted average across all alternatives in the set to account for cross-effects parsimoniously. We categorize national brands as bottom, mid-, or top tier depending on whether their average retail prices are in the lowest, middle, or top third of the national brand price distribution. All other variables are as defined previously.

Format shares have a significant number of zero values in our data because not all households shop at all five formats every month. Therefore, we use a two-tiered model in which a probit governs the zero–nonzero format choice and a regression of log share determines the magnitude of nonzero format share (Ailawadi and Harlam 2009; Wooldridge 2002). Because the percentages of zero values for the brand/promotion and national brand tier shares are small (generally between .5% and 5% of the observations), a two-tiered model is not needed for these models.

Consistent with the overall shopping models, we use a log-log formulation. The independent variables in all share models are as shown in Equation 3. Note that the relative marketing-mix variables are defined appropriately in each case—that is, relative to the weighted average of all formats for the format share models, relative to the weighted average of national brands and private label for the brand/promotion share models, and relative to the weighted average of the three price tiers for the national brand tier share models. We include the RelPctPL variable only in the format share models because it is not relevant in the others, and the distance variable is relative only for format share models because it does not vary across alternatives for the other share models.

Results

We specify some overarching points and then report specific results. First, we account for potential endogeneity of marketing-mix variables in all the models, using the instrumental variables noted previously. The first-stage regressions confirm that the instruments are strong; the R-squares are in the range of .40 to .80, and the F-statistics far exceed cutoffs recommended in the econometrics literature. Second, we mean-center gas price, GDP growth, and income so that we can interpret the coefficients of the gas price and GDP growth variables as their respective effects on the dependent variable for households with no head at home, no children, and average income. Third, we checked for multicollinearity and did not find it to be a concern. Table 2 shows the correlation matrix for the variables in the overall shopping models. The highest correlation among the independent variables is between AssrtSize and PctPL. Correlations of main variables with their interactions are substantial, as we expected, but none are high enough to be of concern. We also checked variance inflation factors, and none are greater than 5. Fourth, we perform three F-tests for the role of demographics in each model to test the joint significance of their main effects, interactions with gas price, and interactions with GDP growth, respectively.[6] We include these effects only when the corresponding F-tests are significant. Fifth, the initialization period values of dependent variables that capture unobserved heterogeneity are highly significant and positive in all the models, thus confirming that preferences are relatively stable.

Effect of Gas Price on Shopping Behavior

Overall shopping. Table 3 presents the estimates of our overall shopping models. For the coefficient for gas price, we find that monthly number of shopping trips, expenditure, and purchase volume all decrease significantly as gas prices increase. The coefficient can be interpreted as an elasticity; that is, for a 100% increase in gas prices, the average household reduces these three variables by approximately 20%, 6%, and 14%, respectively.

Retail format shares. Table 4 summarizes the results of the format share models. Because grocery store format share is zero for less than 3% of the observations, it is not meaningful to estimate a probit visit model for that format. For all other formats, we report both probit and log-share model results.

As gas prices increase, consumers shift to one-stop shopping formats; that is, they visit drugstores and mass stores less often and supercenters more often. High-income households are particularly likely to shift from mass stores to supercenters. Because the probit model coefficients cannot be directly interpreted as effects on visit probability, we use them to compute the change in predicted visit probability when gas price increases by 100% from $2.00 to $4.00 per gallon; all other model variables are held at their means. We find that the predicted visit probability decreases from 53.8% to 49% for drugstores and from 58.8% to 54% for mass stores, while it increases from 13.9% to 18.5% for supercenters.

The impact of gas price on the share of spending at each format, given that the format is visited, is also consistent with consolidation of shopping to offset travel costs. As gas prices increase, households visit drugstores and mass stores less often, but when they do visit these formats, the share of their total spending at these formats goes up by 38.2% and

[6]We also tested for interactions of gas price with distance and net price. Because these interactions were significant and negative only in the shopping trip model, we do not include them here.

TABLE 2
Correlations Between Shopping Model Variables

	Num-trps	Dol-spnd	Purvol	Dist	NPrice	Assrt-Size	PctPL	GPrice	GDP	Income	Kids	At Home	GPrice × Income	GDP × Income	GPrice × Kids	GDP × Kids	GPrice × At Home	GDP × At Home
Numtrps	1																	
Dolspnd	.51	1																
Purvol	.54	.95	1															
Dist	−.02	.03	.05	1														
NPrice	−.02	−.02	−.06	−.01	1													
AssrtSize	.01	.02	.00	−.12	.13	1												
PctPL	.03	−.05	−.09	−.19	.21	.83	1											
GP	−.03	−.02	−.06	−.01	.12	−.07	.20	1										
GDP	.01	−.01	.02	.01	−.12	.02	−.18	−.45	1									
Income	−.11	.12	.07	.00	−.05	−.05	−.11	−.00	−.00	1								
Kids	−.08	.16	.18	.07	−.11	−.04	−.12	−.01	.01	.22	1							
At home	.10	−.03	−.01	−.01	.05	−.02	.05	.00	−.00	−.28	−.17	1						
GP × income	−.01	−.01	−.01	.00	−.01	−.00	−.01	.00	−.00	.00	−.01	.00	1					
GDP × income	.01	.01	.01	−.00	−.00	−.00	−.00	−.00	.00	−.01	.01	.00	−.45	1				
GP × kids	−.02	−.01	−.03	−.01	.07	−.04	.10	.54	−.24	−.01	−.01	.00	.18	−.08	1			
GDP × kids	.01	−.00	.02	−.00	−.07	.01	−.09	−.24	.53	.01	.01	−.00	−.08	.18	−.45	1		
GP × at home	−.02	−.02	−.04	−.01	.08	−.05	.15	.69	−.31	.00	−.00	.00	−.20	.09	.27	−.12	1	
GDP × at home	.01	−.00	.02	.01	−.09	.01	−.13	−.31	.69	.00	.00	−.00	.09	−.20	−.12	.27	−.45	1

Notes: All variables are in log form except GDP and dummy variables.

TABLE 3
Overall Shopping Model Estimates

Variable	Log Number of Trips	Log Total Spending	Log Total Purchase Volume
Intercept	3.870**	.870	.336
	(6.70)	(1.41)	(.53)
Log gas price	–.201**	–.057*	–.144**
	(–8.82)	(–2.37)	(–5.81)
GDP growth	.002	–.009**	–.005**
	(1.29)	(–5.52)	(–3.04)
Log distance	–.026**	–.009*	–.006
	(–7.13)	(–2.49)	(–1.48)
Log net price	–.265**	–.105**	–.189**
	(–7.38)	(–2.80)	(–4.89)
Log assortment	–.203**	.094*	.122**
	(–5.65)	(2.43)	(3.06)
Log % private label	.681**	–.324*	–.484**
	(5.18)	(–2.28)	(–3.30)
Log income	–.022**	.021**	–.004
	(–5.23)	(4.76)	(–.83)
At home	.020**	.016**	.020**
	(2.62)	(3.12)	(3.30)
Children	–.087**	.033**	.059**
	(–13.12)	(4.79)	(8.33)
Heterogeneity variable	.690**	.569**	.561**
	(151.38)	(114.58)	(108.99)
N	32178	32178	32178
Adjusted R^2	.429	.343	.329

*$p < .05$.
**$p < .01$.
Notes: Coefficient estimates are reported with t-statistics in parentheses.

21.8%, respectively. Households with children reduce their share of spending at grocery stores by 8.7% and shop more often at supercenters, increasing their share of spending there by 50%. Higher-income households also increase their share of spending at supercenters conditional on a visit.

To compute the net effect of gas price on the unconditional share of each format, we compute both the predicted visit probability and the predicted conditional share at a gas price of $2.00, holding all other model variables at their means. The product of the two provides the predicted unconditional share at a gas price of $2.00. By doing the same thing at a gas price of $4.00, we can compute the change in predicted unconditional share of each format when gas price increases by 100% from $2.00 to $4.00. As a percentage of the average share of the format (Table 1), these changes are –3.6%, +10%, +5%, and +24.9% for grocery store, drugstore, mass store, and supercenter formats, respectively.[7]

Brand and promotion shares. The first three columns of Table 5 show estimates of the national brand/private label/promotion share models. Consistent with our expectations, an increase in gas price decreases the share of regular-priced national brands. For the average income household with no head at home, when gas price increases by 100%, the share of regular-priced national brands decreases by 11.9%, the share of promoted national brands increases by 28.8%, and there is no significant change in private label share. That the private label does not make gains in this group may be partly due to the shift of households from grocery stores, which have more private label assortments, to supercenters, which have fewer private label assortments (see Table 1). We do find an almost 10% increase (.128 – .031 = .097) in private label share among households with at least one head at home, and these households constitute 48% of the panel. Such households shop more at drugstores, which have a fairly large private label assortment (see Table 1). These households also are more prone to buy private labels anyway (see the main effect of "At home" on private label share in Table 5), and higher gas prices seem to reinforce this savings behavior.

Surprisingly, high-income households are more likely than others to shift from regular-priced national brands to promotional purchases. This is contrary to what we would expect from their financial constraints, but it is important to note that low-income households already have lower shares of regular-priced national brands and higher shares of promotional national brands and private labels (see the main effect of income), so when gas prices increase, high-income households have more "room" to shift.

National brand tier shares. The last three columns of Table 5 show estimates of the national brand tier share models. As we expected, higher gas prices increase the share of middle-tier national brands. Furthermore, they do not affect the share of top-tier brands, and they actually decrease the share of bottom-tier brands. For a 100% increase in gas price, bottom-tier share of the average household's national brand purchases decreases by 9.6%, while midtier share increases by 5.7%.

Heterogeneity in gas price effect across demographic groups. Interactions of demographic variables with gas price are not significant for the most part, showing that the gas price effect is not dramatically different across demographic groups. When there is a difference, it is generally due to the presence of children and household income. The effect of children is largely consistent with the notion that such households have higher requirements but are more constrained by time. Therefore, the negative effect of gas price on shopping trips is more pronounced for these households. These households also switch more than others to supercenters because they are attracted by one-stop shopping.

The effect of income is largely consistent with fewer financial constraints. High-income households can afford to make larger dollar outlays, so they shop less frequently, spend more, spend more at warehouse clubs, and are more likely to shift to supercenters when gas price increases. They are also more likely to shift from regular-priced national brands to promotional ones as gas price increases, but as we noted previously, they have more room to shift because they buy more regular-priced and fewer promotional national brands overall. They are also heavier buyers of top-tier national brands, so it makes sense that they take

[7]In share points, the 3.6% decrease in grocery share is larger than the 24.9% increase in supercenter share, given the much larger average share of the grocery format.

TABLE 4
Format Share Model

	Grocery Store	Drugstore		Mass Store		Supercenter		Club	
Variable	**Log Share**	**Probit**	**Log Share**	**Probit**	**Log Share**	**Probit**	**Log Share**	**Probit**	**Log Share**
Intercept	–.192***	1.432***	–.985***	1.334***	–1.059***	.918***	–.973***	1.170***	–.185**
	(–32.87)	(15.75)	(–11.04)	(43.15)	(–35.33)	(20.53)	(–13.59)	(14.23)	(–2.43)
Log gas price (GPrice)	–.010	–.173**	.382***	–.209***	.218***	.178**	.178	–.000	.003
	(–.36)	(–2.34)	(5.19)	(–2.87)	(2.71)	(2.04)	(1.17)	(0)	(.04)
GDP growth	.005***	–.005	–.010**	.004	–.008**	–.014***	–.026***	.008	–.015***
	(3.38)	(–1.18)	(–2.29)	(1.04)	(–1.96)	(–2.87)	(–3.09)	(1.50)	(–2.73)
Log relative distance	–.006	–.021**	.060***	–.088***	.051***	–.194***	–.107***	–.077***	.023
	(–.90)	(–2.42)	(6.25)	(–9.06)	(4.62)	(–20.64)	(–6.48)	(–6.57)	(1.63)
Log relative net price	–1.023***	–.313	–.554**	–.352*	1.214***	.512**	1.628***	–.133	.206
	(–4.77)	(–1.51)	(–2.53)	(–1.92)	(5.80)	(2.47)	(5.17)	(–1.17)	(1.50)
Log relative assortment	.129***	–.028	.414***	.048	–.171**	.004	.017	.055	.495***
(3.36)	(–.41)	(5.85)	(.75)	(–2.30)	(.07)	(.13)	(.82)	(7.18)	
Log relative % private label	–2.169***	–.421	–1.931***	.318	1.029***	.032	.428	.353	–.507*
	(–13.02)	(–1.49)	(–6.81)	(1.23)	(3.51)	(.14)	(.90)	(1.44)	(–1.87)
Log income	–.003	–.140***	–.069***	–.024*	–.038***	.038***	–.050**	.254***	.176***
	(–.55)	(–11.23)	(–5.39)	(–1.95)	(–2.86)	(2.64)	(–2.00)	(16.69)	(9.91)
At home	–.037***	.018	.047***	.006	–.087***	–.014	–.047	.073***	.000
	(–5.98)	(1.14)	(2.63)	(.36)	(–5.06)	(–.78)	(–1.49)	(4.00)	(.02)
Kids	.033***	–.096***	–.173***	.052***	.009	.065***	.058*	–.099***	.009
	(4.75)	(–5.47)	(–8.23)	(2.98)	(.49)	(3.24)	(1.73)	(–5.00)	(.45)
Log GPrice × log income	–.000			–.159**	.014	–.001	.252**		
	(–.01)			(–2.34)	(.19)	(–.01)	(1.85)		
Log GPrice × at home	–.044			.057	–.021	.041	.133		
	(–1.27)			(.64)	(–.22)	(.39)	(.77)		
Log GPrice × kids	–.087**			.022	.100	.260**	.501***		
	(–2.33)			(.23)	(.96)	(2.39)	(2.75)		
Log heterogeneity variable	.164***	.419***	.286***	.349***	.261***	.326***	.198***	.403***	.141***
	(13.62)	(56.71)	(32.17)	(59.68)	(36.69)	(45.88)	(18.29)	(64.50)	(19.61)
N	31,286	32,178	16,274	32,178	17,725	32,178	6287	32,178	8657
Adjusted R^2	.209	.306	.174	.264	.146	.249	.148	.404	.158

*$p < .10$.
**$p < .05$.
***$p < .01$.
Notes: All shares are shares of total purchase volume. Coefficient estimates are reported with t-statistics in parentheses.

TABLE 5
Brand, Promotion, and Tier Share Models

Variable	National Brand Regular Log Share	National Brand Promo Log Share	Private Label Log Share	Bottom-Tier National Brand Log Share	Middle-Tier National Brand Log Share	Top-Tier National Brand Log Share
IIntercept	–.313**	–1.054**	–.404**	–.269**	–.809**	–.371**
	(–67.44)	(–70.98)	(–12.08)	(–49.56)	(–97.02)	(–7.16)
Log gas price (GPrice)	–.119**	.288**	–.031	–.096**	.057**	.017
	(–6.21)	(5.88)	(–.88)	(–8.80)	(3.48)	(.54)
GDP growth	.003**	–.001	–.001	.000	–.001	.006*
	(2.77)	(–.37)	(–.64)	(.02)	(.52)	(2.64)
Log distance	–.005*	.062**	–.022**	.013**	–.009**	–.028**
	(–2.01)	(10.16)	(–5.09)	(6.39)	(–3.04)	(–4.97)
Log relative net price	.423**	.356	.198**	.365**	–.513**	.047
	(2.87)	(.90)	(4.14)	(17.60)	(–13.03)	(1.34)
Log relative assortment size	–.574**	–.507*	.370**	.183**	–.104	2.272**
	(–6.63)	(–2.24)	(8.43)	(2.78)	(–1.14)	(22.51)
Log income	.046**	–.032**	–.085**	–.028**	.046**	.101**
	(14.18)	(–3.85)	(–14.35)	(–10.26)	(11.42)	(13.46)
At home	–.015**	–.009	.055**	.004	–.005	–.001
	(–3.52)	(–.84)	(7.19)	(1.20)	(–.99)	(–.10)
Kids	.000	–.071**	.049**	.029**	–.023**	–.062**
	(0)	(–5.95)	(5.81)	(7.35)	(–4.09)	(–5.72)
Log GPrice × log income	–.036*	.197**	.041			
	(–2.01)	(4.28)	(1.23)			
Log GPrice × at home	–.009	–.070	.128**			
	(–.38)	(–1.15)	(2.93)			
Log GPrice × kids	.026	–.096	–.073			
	(1.02)	(–1.45)	(–1.56)			
Log heterogeneity variable	.424**	.401**	.477**	.402**	.265**	.281**
	(53.78)	(72.86)	(54.10)	(40.01)	(41.39)	(32.79)
N	32,137	29,937	31,553	32,092	32,014	30,748
Adjusted R^2	.252	.176	.277	.206	.115	.148

*$p < .05$.
**$p < .01$.
Notes: All shares are shares of purchase volume. Coefficient estimates are reported with t-statistics in parentheses.

advantage of promotions on these top brands to reduce their cost.[8]

Effects of Other Variables on Shopping Behavior

GDP growth rate. The overall shopping results in Table 3 show that the GDP growth coefficient is not significant for shopping frequency and is negative for expenditure and purchase volume. The negative sign is surprising but may reflect a small substitution effect as consumers travel and eat out more when economic conditions are good and therefore buy less for home consumption. Recall that this variable is not in log form, so the coefficient is the percentage change in the dependent variable for a unit increase in GDP growth. For a one percentage point increase in GDP growth, the decreases in expenditure and purchase volume are small (.9% and .5%, respectively). In elasticity terms, a 100% increase in GDP growth from its average of 1.29% (see Table 1) is associated with 1.1% and .65% decreases in expenditure and volume, respectively.

In line with our expectations, the impact of this variable is substantially smaller than the impact of gas price across all the other models. Indeed, there are only a few significant effects in Tables 4 and 5. As GDP growth rises, households increase their share of purchases at grocery stores and reduce shares at other formats, especially supercenters. Consistent with economic theory, as GDP growth increases, households slightly increase their share of regular-priced and top-tier national brands.

Control variables. In general, the effects of the control variables, when significant, are intuitive. We begin with the impact of distance. It has a negative effect on shopping frequency and spending (Table 3). That is, households consolidate their shopping into fewer trips when they must travel farther, and they conserve spending to offset higher travel costs. Table 4 confirms that the farther the relative distance to a format, the less likely a household is to visit that format (Ailawadi, Pauwels, and Steenkamp 2008; Fox, Montgomery, and Lodish 2004). Distance also induces some shopping consolidation in that the farther the drugstore or mass store format, the greater is the share of spending in those formats conditional on a visit. The supercenter format suffers because of its locational disadvantage in that households that are farther away not only visit it less often but also spend less there. Finally, Table 5 shows a negative

[8]Our key results are robust and remain substantively unchanged with a linear formulation. Two differences worth noting are that, in the linear formulation, the small gas price effect on total spending becomes insignificant and the insignificant gas price effect on warehouse club visit probability becomes a small, but significant, positive effect.

effect of distance on private label share and a positive effect on promotional national brand share. Consumers also reduce mid- and top-tier brand shares and increase bottom-tier brand shares when they must travel farther to shop. This may be to offset driving cost, but it could also be because the retail formats that are farthest away (warehouse clubs) have a lower-than-average top-tier assortment and a higher-than-average bottom-tier assortment (Table 1).

The effect of net price is not always negative. Net price has the expected negative effect on shopping trips, purchase volume, and expenditure. With a couple of exceptions, it also has the expected negative effect in the format share models, though it is not always significant. This is consistent with the mixed effect of price in prior research (e.g., Fox, Montgomery, and Lodish 2004). The positive effect for regular national brand and private label shares is consistent with previous findings that the price differential between private labels and national brands may be too big and that private labels can benefit from reducing the differential (Ailawadi, Pauwels, and Steenkamp 2008; Hoch and Banerji 1993).

Finally, the impact of assortment is noteworthy. It is negative for shopping frequency; we presume that consumers need fewer shopping trips to find what they need when assortment is large. Both spending and purchase volume increase with the variety of choices offered by a bigger assortment. In addition, we find that the more the private label is emphasized in the total assortment, the more frequently households shop, and the lower is their purchase volume and spending. Consistent with prior research (e.g., Ailawadi, Pauwels, and Steenkamp 2008), this suggests that emphasizing private labels too much is not good for retailers.

As we expected, in general the relative size of a format's assortment increases its share, with the exception being the mass store format. As grocery stores and drugstores increase their emphasis on private labels, households lower their visits and share of spending there, but the opposite is true for mass stores. This is consistent with different expectations and objectives in shopping trips made to different formats (Fox and Sethuraman 2006). Consumers want variety at the local grocery store and drugstores and lower-priced private labels when they visit a mass store. Table 5 shows that assortment size has the expected positive effect for bottom- and top-tier national brands and for private labels, but surprisingly, it has a negative effect for regular and promoted national brand share. The latter is consistent with prior findings that sales actually improve when retailers prune assortment strategically (Broniarczyk, Hoyer, and McAlister 1998).

Demographic variables. The main effects of demographics on shopping behavior are largely in line with intuition. Table 3 shows that income has a negative effect on the number of shopping trips and a positive effect on spending. Both effects make sense because the financial constraints of low-income households encourage them to search more and therefore make more trips; according to basic economic theory, high-income households can afford to spend more. Table 4 shows that high-income households make fewer visits to drugstores and mass stores and also have lower shares in these formats conditional on a visit. They also visit supercenters and warehouse clubs more often and have higher warehouse club share conditional on a visit, perhaps because they can afford the budget outlay required for bulk shopping. Finally, Table 5 shows that, consistent with basic economic theory, high-income households have higher shares of regular-priced national brands and middle- and top-tier national brands and lower shares of promotional and bottom-tier national brands and private labels.

Households with at least one nonworking household head make slightly more trips, consistent with fewer time constraints, and their volume and spending are also slightly greater (Table 3). They spend less at grocery and mass stores and more at drugstores (Table 4). This may have less to do with their time constraints (or lack thereof) and more to do with the probability that they are older and/or retired, a prime target market for drugstores. They buy fewer regular-priced national brands, but surprisingly, they buy more private labels, not more promotional national brands, despite their fewer time constraints. This finding may be related to their preference for drugstores, which carry a higher percentage of private label products than supercenters and warehouse clubs (Table 1).

In general, the impact of children is intuitive. Households with children make fewer shopping trips, presumably because of time constraints, but their total expenditure and purchase volume are higher because of the greater needs of large families. They visit and spend less at drugstores, which is consistent with the older, female target market of drugstore chains. In contrast, they spend more at grocery stores, mass stores, and supercenter formats. They are time constrained, and they need to save money on their large shopping baskets, so they prefer formats that balance convenience (grocery store) with affordability (mass store and supercenter). Also in line with intuition, time-constrained households with children buy more private labels and fewer national brands on promotion.

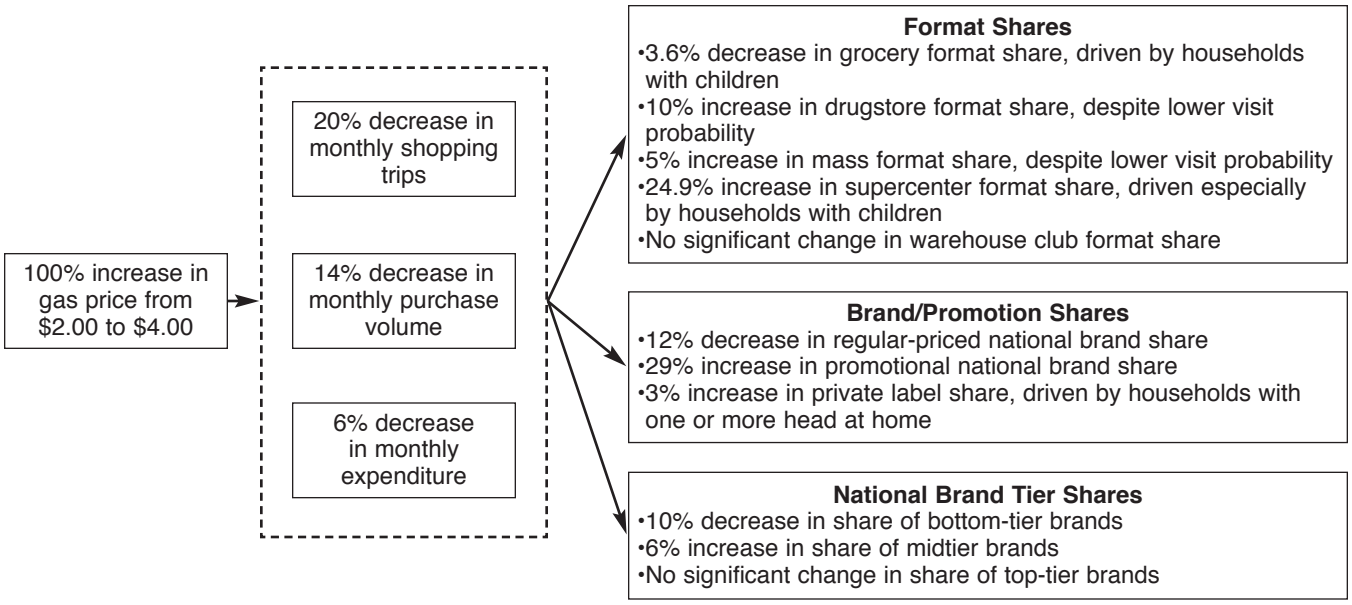
Discussion

Macroeconomic conditions have major effects on consumer behavior and, therefore, on firm performance. This research provides a comprehensive, disaggregate analysis of how and how much consumers change their grocery shopping behavior in response to gas price, a macroeconomic variable that is increasing in importance. In quantifying the effect of gas price, we control for general macroeconomic conditions as reflected in the GDP growth rate. On the one hand, our work complements aggregate research on the impact of macro factors, and on the other hand, it builds on the large body of research on consumer grocery shopping behavior, which examines a host of variables, such as price, promotions, assortment, and competitive factors, but in general does not incorporate macroeconomic factors.

Gas Price Effect

We summarize the estimated average magnitude of the gas price effect on each component of shopping behavior in Figure 3. For easy interpretation, the magnitudes are in terms of elasticities, that is, the percentage change in a com-

FIGURE 3
Summary of Average Gas Price Effect



Notes: Percentage changes in shares are from the average share of each option. Therefore, in share points, the 3.6% decrease in grocery share is larger than the 24.9% increase in supercenter share, given the much larger average share of the grocery format.

ponent of shopping behavior for the average household, attributable to a 100% increase in gas price (e.g., from $2.00 per gallon to $4.00 per gallon). We summarize the effect of gas price as follows: Households consume less and consolidate their shopping as rising gas prices take a bigger bite out of their wallet, but they preserve their preference for high-quality brands, searching for them on promotion to save money. Next, we highlight the aspects of these results that are either surprising or contrary to conventional wisdom and discuss their implications.

We found that an increase in gas prices reduces shopping frequency and purchase volume, and though this may not seem surprising, it is important for at least two reasons. First, although prior research has established a strong effect of macroeconomic factors, such as recessions and lower consumer confidence, on sales of durable goods, consumer packaged goods products are considered more habitual and necessary, less conducive to purchase postponement, and, therefore, less vulnerable (Deleersnyder et al. 2004; Katona 1975). Second, evidence shows that consumers travel less and eat at home more as gas prices rise, so there is a positive substitution effect that should increase food purchases. Indeed, Gicheva, Hastings, and Villas-Boas (2010) report a positive effect of gas price on expenditure in four food categories. Despite these phenomena, we document a substantial reduction especially in overall purchase volume when we include a comprehensive array of grocery products and control for other variables. Apart from the general decrease in purchase volume, which hurts both manufacturers and retailers, manufacturers of impulse products may be especially hurt by lower shopping frequency as impulse purchase opportunities decrease. In addition, consumers will stockpile, so manufacturers and retailers should offer frequent promotions to generate shopping trips and increase the opportunities for consumers to select their offering.

In general, the impact of gas prices on where consumers shop is intuitive: They consolidate their shopping. Driven largely by households with children, supercenters, the quintessential one-stop shopping format, benefit at the expense of traditional grocery stores. Although consumers visit drugstores and mass stores less, they buy a larger share of their requirements there when they do visit, and the net impact is slightly positive. Manufacturers need to consider the shift in consumer choice as they negotiate prices and trade deals with the different formats. They may need to offer more promotional funds to the traditional formats to keep them competitive while engaging the supercenter channel with different, possibly larger-size stockkeeping units that higher-income and larger households are willing to buy.

Consistent with economic theory, higher gas prices make households shift away from regular- to promotional-priced national brands. The shift toward private labels is much smaller. Indeed, there is no significant impact on private label share except among households with one head at home. This is a surprising finding given the attention in the business press to private label growth, and its implications are important. Retailers should realize that continuing to emphasize private labels at the expense of national brands, unless it is accompanied by credible quality improvements and strong marketing and differentiation (Ailawadi, Pauwels, and Steenkamp 2008), may not increase share even in tight times. Promotions are an effective retention tool as gas prices increase, so balancing a robust private label with attractive promotions on national brands is more likely to be effective. Manufacturers should also realize that

hunkering down in tough times by cutting promotions and allowing prices to rise will lead to share losses (see Deleersnyder et al. 2004). Furthermore, given prior research on the asymmetry of consumer shifts (Lamey et al. 2007), consumers lost during tough times may not return when financial constraints are eased.

Equally important is our finding that higher gas prices do not hurt the share of top-tier brands among consumers who continue to purchase national brands. Rather, it is the share of bottom-tier brands that drops, while midtier brands gain. This finding is contrary to the conventional wisdom that top-tier brands suffer when times are tough but is consistent with research on context effects; private labels are much more likely to take share away from bottom-tier brands than from top-tier ones. Thus, manufacturers should tread carefully in introducing lower-priced extensions of their high-equity brands. Unless they can significantly cut costs and preserve margins at the substantially lower price needed to combat private labels, they may find that the lower-tier introductions are not effective in retaining customers and may end up hurting their overall brand equity. It would be worthwhile to monitor the performance of "basic" versions of national brands that companies such as Procter & Gamble have begun introducing (Bryon 2009).

In summary, the most direct way consumers can offset higher gas prices is by using less gas, but the economics literature has convincingly shown that gasoline demand is fairly inelastic. Our results show that travel cost plays a role in consumer shopping shifts, but it is far from the sole determinant. On the one hand, shopping frequency decreases substantially as gas prices increase. Distance is an important control variable in our models and shows the expected negative sign. Furthermore, the one-stop shopping supercenter format increases share as gas prices rise. On the other hand, supercenters are generally farther away, and consumers buy more on promotion as gas prices increase, despite the need to search at different times and in different stores. In addition, sensitivity to distance does not become stronger with gas price increases, except in the shopping trip model. Overall, therefore, our results underscore the importance of considering not just monetary cost but also the full spectrum of other economic costs and, to a lesser extent, the psychosocial aspects of shopping in understanding consumer shopping response to macroeconomic factors such as gas price.

Limitations

We note some limitations of our work that we hope researchers can address. First, we estimate the impact of gas price on each component of shopping behavior separately. However, it is likely that consumers' shopping decisions are interdependent or follow a hierarchical structure (e.g., they first decide on their budget and where to shop and then decide what to buy). We leave this to further research to test more integrated models.

Second, although we allow for heterogeneity in the gas price effect across key demographic groups, there may be heterogeneity in response among consumers that these demographic variables do not capture. For example, consumers with different psychographic and shopping profiles may react differently. Generating such profiles and studying differences in their response are fruitful directions for additional research.

Third, although we control for economic conditions with the well-accepted GDP growth variable and find similar results to the Conference Board Composite Index of Coincident Indicators, other macroeconomic variables may affect shopping behavior and should be examined, especially when the data span longer periods. Similarly, we account for key marketing-mix variables, but other retail factors, such as service and convenience (Ailawadi and Keller 2004; Berry, Seiders, and Grewal 2002; Gauri, Trivedi, and Grewal 2008), influence consumers' format and store choice. To the extent that these factors are stable, we control for them through the heterogeneity variable. However, further research should examine whether the influence of these factors changes with the macroeconomic environment.

Conclusion

The significant effect of gas price we document herein makes it important to incorporate this factor explicitly into consumer shopping behavior models when it exhibits substantial variance. We also contrast the effects of gas price and general economic health on grocery shopping and find that the former is much stronger. Although we examine the short-term impact, it is important to understand whether these changes persist over the long run and whether they reverse when gas price goes down again. Furthermore, it is important to understand the extent to which shopping behavior changes are driven by psychological factors rather than the direct budgetary constraints that higher gas prices impose. Gas prices and general economic conditions are likely to have very different effects on consumer sentiment and attitudes, which in turn affect consumers' psychological willingness to buy. Finally, we show that gas price is just one important macroeconomic variable outside the control of managers that influences consumer shopping. Other macroeconomic variables, such as home values and tax rates, might also affect consumers' willingness and/or ability to buy. We hope that our work stimulates further research in this important domain.

Appendix
Variable Definitions

We aggregate all variables from the category to the format and market level using household-specific category and format shares in the initialization period as weights.[9] We use the first two months as the initialization period.

Variables for Format Share Models

Distance$_{hj}$. Distance to retail format j for household h is calculated as

[9]The exception is net price of a category, which we aggregate up from stockkeeping unit and brand levels using market shares in the initialization period as weights.

$$\sum_{n=1}^{N} \text{dist}_{hjn} \text{ts}_{hjnt0},$$

where dist_{hjn} is the distance from the closest store of retailer n in format j to household h and ts_{hjnt0} is the share of retailer n in retail format j for household h in the initialization period.

RelDist$_{hj}$. Distance to format j for household h relative to weighted average distance to all formats is calculated as

$$\frac{\text{Distance}_{hj}}{\sum_{j=1}^{5} \text{Distance}_{hj} \text{ts}_{hjt0}},$$

where ts_{hjt0} is household h's share of format j in the initialization period.

NPrice$_{hjt}$. Net price is calculated as

$$\sum_{c=1}^{C} \frac{\text{NPrice}_{jtc}}{\text{NPrice}_{t0c}} \text{cs}_{ht0c},$$

where Nprice_{jtc} is net price of category c in format j in month t and cs_{ht0c} is share of total spending by household h in the initialization period on category c.

RelNPrice$_{hjt}$. Net price of format j in month t for household h, relative to weighted average net price of all formats, is calculated as

$$\frac{\text{NPrice}_{hjt}}{\sum_{j=1}^{5} \text{NPrice}_{hjt} \text{ts}_{hjt0}}.$$

AssrtSize$_{hjt}$. Assortment size of format j for household h in month t is calculated as

$$\sum_{c=1}^{C} \text{AssrtSize}_{jtc} \text{cs}_{ht0c},$$

where AssrtSize_{jtc} is the number of distinct stockkeeping units of category c in the quarter of month t in retail format j.

RelAssrtSize$_{hjt}$. Assortment size of format j for household h relative to weighted average assortment size of all formats is calculated as

$$\frac{\text{AssrtSize}_{hjt}}{\sum_{j=1}^{5} \text{AssrtSize}_{hjt} \text{ts}_{hjt0}}.$$

PctPL$_{hjt}$. Percentage private label in assortment of format j for household h in quarter of month t is calculated as

$$\sum_{c=1}^{C} \text{PLPct}_{jtc} \text{cs}_{ht0c},$$

where PLPct_{jtc} is the percentage of the total assortment that is private label in category c of format j in the uarter of month t.

RelPctPL$_{hjt}$. Percentage private label in assortment size of format j for household h relative to weighted average percentage private label in all formats is calculated as

$$\frac{\text{PLPct}_{hjt}}{\sum_{j=1}^{5} \text{PLPct}_{hjt} \text{ts}_{hjt0}}.$$

Variables for Brand/Promotion Share Models

Distance$_{h}$. Average distance to stores for household h is calculated as

$$\sum_{n=1}^{N} \text{Distance}_{hj} \text{fs}_{hjt0},$$

where Distance_{hj} is as defined previously and fs_{hjt0} is the share of total trips to retail format j by household h in the initialization period.

NPrice$_{hkt}$. Net price is calculated as

$$\sum_{c=1}^{C} \frac{\text{NPrice}_{kct}}{\text{NPrice}_{ct0}} \text{cs}_{ht0c},$$

where NPrice_{kct} is net price of brand type k in category c in month t and cs_{ht0c} is as defined previously. Note that k = 1 is national brands and k = 2 is private label.

RelNPrice$_{hkt}$. Relative net price is calculated as

$$\frac{\text{NPrice}_{hkt}}{\sum_{k=1}^{2} \text{NPrice}_{hkt} \text{ts}_{hkt0}},$$

where ts_{hkt0} is household h's share of brand type k in the initialization period.

AssrtSize$_{hkt}$. Assortment size of brand type k for household h in month t is calculated as

$$\sum_{c=1}^{C} \text{AssrtSize}_{ktc} \text{cs}_{ht0c},$$

where AssrtSize_{ktc} is the number of distinct stockkeeping units of brand type k in category c in the quarter of month t.

RelAssrtSize$_{hkt}$. Assortment size of brand type k for household h relative to weighted average assortment size of both brand types is calculated as

$$\frac{\text{AssrtSize}_{hkt}}{\sum_{k=1}^{2} \text{AssrtSize}_{hkt} \text{ts}_{hkt0}}.$$

Variables for National Brand Tier Share Models

These are calculated the same as previously, except that k = 1, 2, and 3, respectively, for bottom-, mid-, and top-tier national brands.

Variables for Overall Shopping Models

Distance$_h$. This is calculated as defined previously.

NPrice$_{ht}$, AssrtSize$_{ht}$, and PctPL$_{ht}$. These are calculated as follows:

$$\sum_{j=1}^{5} \text{NPrice}_{hjt}\text{ts}_{hjt0},$$

$$\sum_{j=1}^{5} \text{AssrtSize}_{hjt}\text{ts}_{hjt0}, \text{and}$$

$$\sum_{j=1}^{5} \text{PctPL}_{hjt}\text{ts}_{hjt0},$$

where NPrice_{hjt}, AssrtSize_{hjt}, PctPL_{hjt}, and ts_{hjt0} are as defined in the format share models.

Purchase Volume$_{ht}$. Total purchase volume by household h in month t is calculated as

$$\sum_{c=1}^{C} q_{htc}\text{NPrice}_{t0c},$$

where q_{htc} is total equivalent units of category c purchased by household h in month t and NPrice_{t0c} is net price of category c in the initialization period.

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