Asymmetric Search and Loss Aversion: Choice Experiment on Consumer Willingness to Search in the Gasoline Retail Market

Carolina Castilla
Agricultural, Environmental and Development Economics
The Ohio State University
312 Agricultural Administration
2120 Fyffe Rd.
Columbus, OH 43210
Email: castilla.3@buckeyemail.osu.edu

and

Timothy Haab
Agricultural, Environmental and Development Economics
The Ohio State University
224 Agricultural Administration
2120 Fyffe Rd.
Columbus, OH 43210
Email: haab.1@osu.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2010 AAEA,CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010

Asymmetric Search and Loss Aversion: Choice Experiment on Consumer Willingness to Search in the Gasoline Retail Market[1]

Carolina Castilla and Timothy Haab

May, 2010

Abstract:

Price search enables consumers to overcome information asymmetries, it can lead to a reduction in price dispersion and it can increase consumer surplus, but search is costly. In this paper, an internet survey is conducted among a random sample of 490 drivers in the State of Ohio to answer the question, when are consumers more likely to search? The internet survey affords us the opportunity to impose exogenous price changes in a random sample of gasoline consumers to examine the decision-making process behind intended search decisions. Results indicate that among the respondents who faced prices below their expected price, only 12% chose to search, whereas 45% searched when prices were above. Results suggest that asymmetric search can be explained by prospect theory, in the sense that consumers evaluate current prices compared to a reference price, and as a consequence they value price increases differently from price decreases. Our findings indicate that in the gasoline retail market, consumers are allowing retailers to extract consumer surplus by exhibiting loss aversion because this behavior deters search when the probability of finding a lower price is highest.

Key words: price search, choice experiment, search cost, gasoline market.

JEL Classification: D83, D03

[1] Acknowledgements: This project was funded by NSF-0524924: BE/MUSES: A Multiscale Statistical Framework for Assessing the Biocomplexity of Materials Use - The Case of Transportation Fuels.

1. Introduction

Price search enables consumers to overcome information asymmetries that arise as a result of being unable to observe the entire set of prices, it can lead to a reduction in price dispersion (Lewis, (2008); Tapata, (2009)) and it can increase consumer surplus, but search is costly. In this paper, we use an internet survey conducted among a random sample of 490 drivers in the State of Ohio to examine when consumers are more likely to search, and provide evidence indicating the decision making process behind asymmetric search is consistent with loss aversion. Our findings indicate that in the gasoline retail market, consumers are allowing retailers to extract consumer surplus by searching asymmetrically because this behavior deters search the consumer observes a high price quote, i.e. when the probability of finding a lower price is higher relative to somewhat lower prices.

There are two features that must be present in a market in order for search to be profitable: there must be price dispersion, or else the opportunities to find a different (lower) price would be diminished, and consumers must be unable to perfectly classify retailers as high or low priced (Sorensen, (2001)). In the gasoline retail market, price dispersion can be partially attributed to the unique characteristics of the industry, and partially to the lack of consumer search (Tappata, (2009): Lewis, (2008); Hastings, (2004); Shepard, (1993)). Price differences start right before gasoline is delivered to the gas station, when the refiner aggregates an additive to the fuel corresponding to its brand. At the gas station level the potential for product differentiation is further increased by decisions such as location, capacity, presence of a convenience store, car wash service, repair facilities and methods of payment available (Tappata, 2009; Lewis, 2008). Additionally, there are different contractual arrangements between retail outlets and refiners which imply differences in the degree of vertical integration (Tappata, 2009; Deck and Wilson, 2008). Product differentiation makes it difficult for consumers to identify low priced retailers even when they are able to observe the entire set of prices, thus making it profitable to search.

Consumer search can further contribute to price dispersion because it is costly, but also because consumer search intensity is asymmetric, i.e. consumers search more when prices rise compared to when they fall. Using data from an on-line gas price aggregation site, gasbuddy.com, Lewis and Marvel (2010) find that negative price shocks (price increases) trigger search. They report that when gasoline prices increase, search intensity increases, but when prices fall search response is smaller. As a result, price dispersion decreases when prices rise because, given more consumers are searching, the penalty firms face from deviating from the market norm is higher (consumers will purchase from another retailer if prices are too high), and price dispersion increases when prices fall (Lewis and Marvel, (2010)). When prices fall, consumer surplus decreases because, by not searching, consumers are giving up potential gains from search. Lewis and Marvel (2010) state this behavior should be accorded the status of a stylized fact.

While the Lewis and Marvel results are compelling, they are perhaps limited due to the use of web-based search sites. Responses to our survey of Ohio drivers shows that only 5% of respondents search online for gasoline prices, while 67.5% search as they drive by, suggesting that asymmetric search could be a feature of online searchers which are not necessarily representative of the gasoline consumer population. Further, search decisions are endogenous; that is, whether a consumer chooses to price-shop or not depends on her expectations about the distribution of prices, which in turn depend on the intensity of search. Without exogenous price variation it cannot be determined if asymmetric search is consumers' response to pricing strategies or a behavioral issue. Finally, the use of aggregate search data does not allow the examination of how search rules are formed. The internet survey affords us the opportunity to exogenously impose price changes on consumers searching for gas prices and observe their intended search behavior.

The survey consists of a choice experiment on willingness to search, where individuals face a hypothetical scenario where they are driving in their car and they need to purchase gasoline.

Individuals are first asked for the price they expect to pay per gallon of gasoline. Next they are asked 2 sequential questions where they have to choose between purchasing gasoline at a gas station or to keep driving for one mile in search of a lower price, but incurring a search cost. At the hypothetical gas station, the consumer is given a price quote corresponding to the price he would pay if he chooses to purchase gasoline at that station. The price quote is randomly assigned to one of four treatments: 2.5% below, 5% below, 2.5% above or 5% above the price the consumer stated he expected to pay. The baseline group is the case where the price at the hypothetical gas station is equal to the consumer's expected price.

Results indicate that among the respondents who faced prices below their expected price, only 12% choose to search, whereas 45% search when prices are above, confirming Lewis and Marvel (2010) asymmetric search findings. The probability that a person chooses to search decreases as the difference between the expected and observed price increases, however, it decreases more when prices are 2.5% above expectations than when they are 5% higher. When faced with lower posted prices, however, there are no significant differences in the slope on the probability of search with respect to price differentials. It is shown that results are consistent with loss aversion; consumers evaluate current prices compared to a reference price, and as a consequence they value price increases differently from price decreases.

The paper is organized as follows: in Section 2 we describe the choice experiment; Section 3 contains the survey description and descriptive results; in Section 4 we explain the empirical strategy; Section 5 presents the econometric results; in Section 6 we describe an alternative search model. In Section 8, we present some concluding remarks.

2. Choice Experiment Design

The choice experiment design is based upon a sequential search model, and we find evidence to support it because 67% of consumers in our sample search as they drive by. Sequential search consists of obtaining one price quote at a time and then based upon the information available decide whether the expected benefits (or reduction in purchasing costs) exceed the cost of an additional draw. In the sequential search model, the optimal rule is characterized by a reservation price that makes the consumer indifferent between purchasing at the lowest price drawn so far and obtaining an additional draw. There are differences in the expectation formation mechanism across models, which yield different search rules and reservation prices (Rothschild, (1973, 2001); Reinganum, (1979); Lewis, (2005); Yang and Ye, (2008)). However, it is not our interest to examine how consumers form their expectations, thus in the design we assume this away by asking respondents for the price they expect to pay for a gallon of gasoline, and use it as an anchor in the subsequent questions.

The survey posed respondents with a hypothetical scenario, were they were told to assume they were driving in their car and had to purchase gasoline. Respondents were first asked for the price they expected to pay for a gallon of gasoline. Then they were given a price quote for free framed as the price they observe in the first gas station they see. The price quote is randomly assigned to one of four treatments: 2.5% below, 5% below, 2.5% above or 5% above the price the consumer stated he expected to pay. The baseline is the case where the price at the hypothetical gas station is equal to the consumer's expected price. After observing the price quote, and being reminded of the price they told us they expect to pay, respondents were given 2 choices: (a) would you buy gasoline at that gas station, or (b) would you keep driving to the next gas station that is one mile down the road. There is a search cost associated with driving to the next gas station: the

gasoline spent driving, plus the time it takes to get there[2]. If the respondent did not choose to keep driving to the next gas station, he moves on to the next section; if he chose to keep driving, then he must answer a follow up question where he observes a new price (which is also randomized in the same fashion) and he must choose between the same two alternatives, plus the option to recall the price observed at the previous gas station, incurring the same cost.

In a sequential search model, the search rule compares the expected gains from acquiring an additional price quote, to the search cost. Consider the case in our survey where a consumer is driving in his car and has to purchase one gallon of gasoline. At the first hypothetical gas station (j), consumer i can observe the first price quote for free, thus the expenditure from purchasing one gallon of gasoline at the posted price is $X(p, c) = p_{i,j}$, where the search cost (c) is equal to zero. The consumer has the alternative to keep driving to obtain an additional price quote but he does not know for certain what the price at the next gas station (gas station k) will be. In this case the expenditure per gallon of gasoline is uncertain and thus his expected expenditure is: $E[X(p, c)] = E[p + c_i]$. Even though the framing of the search cost is varied in the survey, all consumers are told that the next gas station is one mile down the road, such that the search cost is deterministic, and thus $E[X(p, c)] = E[p_{i,k}] + c_i$.

The consumer's objective is to minimize his gasoline expenditure, but searching for lower prices is costly and incurring the cost of driving for one mile may or may not be worth it because he does not know what the price in the next gas station will be. For this reason, the consumer only

[2] In the design, we told the consumer that the next gas station was one mile down the road, but provided him with different amounts of information regarding the monetary value of the search cost. Consumers were randomly assigned to one of the following search cost treatments: 1) the monetary value of the gasoline spent driving for one mile considering their car's mileage per gallon, 2) the 5 minutes it would take them to get to the next gas station or 3) both. The remaining respondents are used as a baseline group and are not given an explicit cost treatment. This segment of the choice experiment is not the focus of this paper, thus, we control for total search costs, without elaborating on search cost treatments.

searches if the expenditure at the current retailer given the posted price is greater than the expected expenditure at the next gas station, therefore the search rule is given by:

$$X_j(p,c) = p_{i,j} > E\left[p_{i,k}\right] + c_i = E[X_k(p,c)] \quad (1)$$

Re-arranging,

$$E\left[p_{i,k}\right] - p_{i,j} < -c_i \quad (2)$$

When the consumer observes a price in the first gas station that is above her expected price, it could mean that the entire price distribution has shifted upwards. In our survey, the consumer was given no indication that the prices at the hypothetical gas stations were a result of a shift in the distribution. If the distribution hasn't shifted, however, this retailer constitutes a high price draw, so there exists the possibility of finding a lower price. When the posted price at the hypothetical gas station is below the consumer's expected price, given that the distribution has not shifted, it constitutes a low price draw, and the consumer will be more likely to take it because he will be less likely to find an even lower price. The following implications can be derived from the search rule:

Implication 1: *As the difference between expected and posted price increases, search intensity decreases, until no search is observed when the price differential equals or exceeds the search cost.*

When the posted price is below the consumer's expected price, there are no gains from search and no search would be observed. Conversely, when posted prices are above the expected price, search intensity will be positive, and increasing in the gains from search.

Implication 2: *The probability of search is decreasing in the difference between expected and posted price.*

A price that is 5% above expectations is closer to the upper tail of the distribution than a price draw 2.5% above, implying that the probability of finding an even lower price draw than the 5% increase is higher. Likewise, a price that is 5% below expectations is closer to the lower tail than a price 2.5% below, implying that the probability of finding a subsequent price draw below the 5% reduction is

lower. Thus, the probability of search is expected to decrease linearly as the difference between expected and posted prices increases.

3. Empirical Strategy

The goal of the paper is to estimate the effect of price differences on the probability of search, which is derived from the search rule in (2). Let $X(p,c) = p + c_i + \varepsilon_i$, where $p_{i,j}$ is the price quote observed at the current retailer, $E[p_{i,k}]$ is the price the consumer expects to pay, c_i is the search cost, and let $\varepsilon_i \sim iid(0,\sigma^2)$ be unobserved heterogeneity in consumers' expenditure. Then $E[X(p,c)] = E[p + c_i]$ because $E[\varepsilon_i]$ =0.

Let y_i be the consumer's observed choice which is based on the search rule:

$$y_i = \begin{cases} 1 & if \;\; E[p_{i,k}] - p_{i,j} + \varepsilon_i < -c_i \\ 0 & if \;\; E[p_{i,k}] - p_{i,j} + \varepsilon_i \geq -c_i \end{cases} \tag{3}$$

De los Santos (2008) shows that search costs vary by socio-demographic characteristics, such as education, age, income and gender. Further, Sorensen (2001) notes that frequency of purchase can be regarded as measuring the number of times the information gained from a price search can be used before that information "expires." Therefore, other things being equal, the benefit per search is highest for consumers with high purchasing frequency. As mentioned earlier, c is equal to the sum of the monetary value of the time spend searching (5 minutes in this case) (T) and the value of the gasoline spent driving to the next gas station for one mile (G). Thus we allow the search cost to be equal to the sum of the gasoline and time spent driving to the next gas station, plus a function of socio-demographic characteristics and purchasing habit, such that $c_i = \beta z_i + \theta(T+G)_i$. The probability that a consumer searches is given by:

$$P[y_i = 1] = P\left[E\left[p_{i,k}\right] - p_{i,j} + \varepsilon_i < -\beta z_i - \theta(T+G)_i\right]$$

$$= P\left[\varepsilon_i < -\left[E\left[p_{i,k}\right] - p_{i,j}\right] - \beta z_i - \theta(T+G)_i\right] \quad (4)$$

Where z_i contains socio-demographic characteristics and purchasing habits, and β are the corresponding parameter values. If it is further assumed that the unobserved heterogeneity is normally distributed, $\varepsilon_i \sim N(0, \sigma^2)$, then after converting it to standard normal, the probability becomes:

$$P[y_i = 1] = \Phi\left[\frac{\varepsilon_i}{\sigma} < \frac{1}{\sigma}\left[E\left[p_{i,k}\right] - p_{i,j}\right] - \frac{\beta}{\sigma} z_i - \frac{\theta}{\sigma}(T+G)_i\right]$$

$$P[y_i = 1] = \Phi\left[\frac{\varepsilon_i}{\sigma} < -\alpha\left[E\left[p_{i,k}\right] - p_{i,j}\right] + \pi_2 z_i + \pi_3 (T+G)_i\right] \quad (5)$$

In the design, the time cost is specified to be 5 minutes, so the cost of gasoline and the time cost are in different units of measurement. To construct the search cost variable, we first compute the time cost as the monetary value of 5 minutes evaluated at the midpoint of the income category of the respondent, considering he works 40 hours a week for 52 weeks per year. The gasoline cost equals the monetary value of driving for one mile given the price they paid per gallon of gasoline last time they filled-up adjusted by the mileage per gallon of their day-to-day vehicle.

4. Survey and Descriptive Results

4.1 Survey Description

An internet survey was conducted among a random sample of 490 drivers over the age of 18 in the State of Ohio in 2009 to examine the decision-making process behind consumers' search decisions. In consumer search models, search decisions are endogenous; that is, whether a consumer chooses

to price-shop or not depends on her expectations about the distribution of prices, which in turn depend on the intensity of search. The internet survey affords us the opportunity to exogenously impose prices on consumers searching for gas prices and observe their intended search behavior. The survey was conducted through Knowledge Networks using a random sample from their panel of drivers in the State of Ohio. This is an online research panel that is representative of both the online and offline populations in the U.S[3]. The survey is balanced by age, gender and income; it consists mainly on white/non-Hispanic respondents and high school graduates, consistent with the ethnicity and education distribution of the Ohio population according to the Current Population Survey. It had a response rate of 98% on the search and risk variables, with no significant within survey attrition.

To qualify for the survey each panel member must be an adult (18 +) resident in the state of Ohio, provide an estimate of the mileage per gallon of their day-to-day vehicle, and provide the amount of money they paid per gallon the last time they filled up. Once assigned to the survey, individuals received a notification email letting them know there was a new survey available, and reminders were sent to non-respondents after that. After the data was collected, a post-stratification process was used to adjust for any survey non-response and non-coverage due to sample design[4]. To encourage participation Knowledge Networks offers modest incentives, such as entering special raffles or sweepstakes with both cash and other prizes won. The survey was in the field for 10 days and took each individual an average of 30 minutes to complete.

[3] The panel members are randomly recruited by telephone and by self-administered mail and web surveys, and households are provided with Internet access and hardware if needed. The panel is not limited to current Web users or computer owners, and includes households with both listed and unlisted phone numbers, telephone and non-telephone households, as well as cell-phone only households.

[4] Specifics on the post-stratification process are available upon direct request from the authors.

Table 1:
Willingness to Search Questions framed in 4 different ways

Question #	Wording
Question 1	Keeping in mind you have told us you think you can get gas right now for $[E(P)] per gallon, imagine you are driving in your car and that you need to buy gas. The first station you see has a price of $[X]. The next gas station is one mile down the road.
No Search Costs	*(**X** is randomly assigned +5%, +2.5%, 0%, -2.5%, -5%; **E(P)** is the expected price the consumer reported initially)* What would you do? a. I would buy gas at the current gas station b. I would keep driving towards the next gas station that is one mile down.
Question 2	Keeping in mind you have told us you think you can get gas right now for $[E(P)] per gallon, imagine you are driving in your car and that you need to buy gas. The first station you see has a price of $[X]. The next gas station is one mile down the road. Based on the price of gas you paid most recently and the gas mileage you told us your day to day car gets, driving one mile to the next gas station will cost you $[Gas Cost].
Only Gas Cost	*(**X** is randomly assigned +5%, +2.5%, 0%, -2.5%, -5%; **E(P)** is the expected price the consumer reported initially; **Gas Cost** is equal to the cost of driving one mile at the reported millage per gallon and price paid last time)* What would you do? a. I would buy gas at the current gas station b. I would keep driving towards the next gas station that is one mile down the road which will cost $[Gas Cost].
Question 3	Keeping in mind you have told us you think you can get gas right now for $[E(P)] per gallon, imagine you are driving in your car and that you need to buy gas. The first station you see has a price of $[X]. The next gas station is one mile down the road. Getting there will take you 5 minutes.
Only Time Cost	*(**X** is randomly assigned +5%, +2.5%, 0%, -2.5%, -5%; **E(P)** is the expected price the consumer reported initially)* What would you do? a. I would buy gas at the current gas station b. I would keep driving towards the next gas station that is one mile down the road and take 5 minutes to get
Question 4	Keeping in mind you have told us you think you can get gas right now for $[E(P)] per gallon, imagine you are driving in your car and that you need to buy gas. The first station you see has a price of $[X]. The next gas station is one mile down the road. Getting there will take you 5 minutes. Based on the price of gas you paid most recently and the gas mileage you told us your day to day car gets, driving one mile to the next gas station will cost you $[Gas Cost]
Both Search Costs	*(**X** is randomly assigned +5%, +2.5%, 0%, -2.5%, -5%; **E(P)** is the expected price the consumer reported initially; **Gas Cost** is equal to the cost of driving one mile at the reported millage per gallon and price paid last time)* What would you do? a. I would buy gas at the current gas station b. I would keep driving towards the next gas station that is one mile down the road which will cost $[Gas Cost] and take 5 minutes to get there

Respondents were first asked questions on the vehicles they drive, such as mileage per gallon, and the price they paid per gallon last time they purchased gasoline. Next they were asked a set of questions related to their expectations on the price per gallon, including the price they expect to pay, as well as the minimum and maximum price they think they would pay if they purchased gasoline at

that time. Next respondents were faced with a hypothetical scenario described in the previous section. The first question is presented in Table 1. At the end of the survey, subjects were asked questions on their actual gasoline purchasing habits, such as how they search for prices, their purchasing frequency and brand loyalty, followed by a section of 7 questions on risk preferences. In a sequential search environment where consumers are driving around in search for prices, going back to a previously visited retailer is not optimal, and so individual risk aversion could make the consumer take an early price even when he expects lower prices to be available.

4.2 Descriptive Results

Search is defined as an indicator variable that takes the value of 1 if the individual answered that he would continue driving to the next gas station looking for a lower price when asked the willingness to search question, and 0 if he chose to purchase gas at the posted price. First, I examine if there are ex-ante differences in expectations about prices or search costs between searchers and non-searchers. Searchers have, on average, a higher expected price than non-searchers, though the differences are not statistically significant. Further, there are no significant differences across searchers and non-searchers on search costs or risk aversion.

Table 2:
Expected Price, Cost and Risk Average Differences by Search

	Non-Searchers		Searchers		Diff.
	N	Mean	N	Mean	
Expected Price	352	1.89 (0.226)	124	1.87 (0.165)	0.02 (0.067)
Gas+Time Cost	352	2.51 (1.445)	124	2.54 (1.535)	0.15 (0.267)
Risk Aversion	352	35.4 (22.25)	124	34.6 (21.87)	2.31 (5.314)

Note: Standard erros in parentheses.
*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.

Descriptive results on search by price change treatment are presented in Table 3. When the observed prices are above the reported expected price, 45% of the respondents choose to search when prices are 5% higher and 42% when prices are 2.5% higher; whereas when the posted price is below the expected price, only 17.7% search when the price is 2.5% lower and 5.9% when it is 5% lower. Observing search when prices are equal to the expected price or lower suggests that respondents could be either making their search decisions based upon an alternative reference price. This argument can be discarded because in the willingness to search question the expected price they provided was anchored.

There are two important issues to keep in mind: first, respondents were faced with a hypothetical scenario in which they were not actually incurring the cost of driving towards the next gas station. Second, in the wording of the question respondents were told they are driving in their car and realize they have to purchase gasoline, thus there is no way to control if they think that driving is not costly because they are already planning on going towards the direction of the next gas station. Nonetheless, consumers considering search costs are very close to zero does not explain why consumers search when observing posted prices below their expected price. In the results section this is further examined.

Table 3:
Search Intensity by Price Change Treatment

Search	Up (+5%)		Up (+2.5%)		No Change		Down (+2.5%)		Down (+5%)	
	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.
0	53	54.1	55	56.7	70	83.3	79	82.3	95	94.1
1	45	45.9	42	43.3	14	16.7	17	17.7	6	5.9
Total	98		97		84		96		101	

Recall that if the respondent chose to keep driving to the next gas station in the first question, he was answered a follow up question that asked him to assume he had arrived to the next gas station. The price at the second gas station was randomly assigned to be between 2.5% or 5% above or

below the posted price in the first gas station. After being reminded of the price he expected to pay and given the new price, he was asked to choose between: (a) purchasing gasoline at that new gas station; (b) driving back to the previous station incurring a cost that is consistent with the one specified in the first question; or (3) to keep driving to the next gas station that is one mile down the road, incurring the same cost as before.

The follow up question was intended to examine whether respondents would recall a previously observed price, which is inconsistent with optimizing behavior, and found that less than 16% of consumers that search on the first question choose to drive back, 63% of whom observed a price higher at the second gas station. The 16% recall figure, though lower in our survey than what is found in the experimental literature (25% or so), suggests that consumers can be experiencing regret out of letting go of a lower price, or that they take the new higher price as a piece of information that changes their beliefs about the possibility of finding a lower price.

5. Econometric Results

In order to answer the question, when are consumers more willing to search?, we estimate reduced-form Probit regressions to obtain the effect of the change in the difference in expectations and posted prices on the probability of search. We are also interested in testing for differences in the probability of search across price-change treatments.

Let the difference between expected and posted prices be $PC = \frac{E[p_i]-p_i}{E[p_i]} \times 100$ and let $\Delta p = \{1\ if\ PC = 5, 2\ if\ PC = 2.5, 3\ if\ PC = 0, 4\ if\ PC = -2.5, 5\ if\ PC = -5\}$. Define the price change operator as:

$$I_m = \begin{cases} 1 & if \quad \Delta p = m \\ 0 & if\ \Delta p \neq m \end{cases} \qquad \text{where} \quad m = \{1,2,3,4,5\} \qquad (6)$$

The equation to be estimated is:

$$P[y_i = 1] = \Phi\left[\frac{\varepsilon_i}{\sigma} < -\sum_{m=1}^{5} \alpha_m \left[E\left[p_{i,k}\right] - p_{i,j}\right] * I_{m,i} + \pi_2 z_i + \pi_3 SC + \pi_6 H_i + \pi_7 PF\right] \quad (7)$$

where: $p_{i,j}$ is the price observed at the hypothetical gas station; $E\left[p_{i,k}\right]$ is the price the respondent expects to pay; z_i is a matrix of socio-demographic characteristics including gender, age, education level dummy variables, risk aversion and income evaluated at the midpoint of the reported income category; SC_i is the search cost, i.e. the sum of the monetary value of the gasoline and the time spent driving to the next gas station; H_i is a matrix of indicators of gasoline purchasing habits such as the octane level, brand and store loyalty, if they are in a discount program, concern about gasoline prices, and the type of vehicle they drive; PF_i is a matrix containing indicator variables of frequency of purchase, where the base category are consumers that purchase gasoline twice a week or more. Details on how all variables are computed are in Appendix II. Results are summarized in Table 4, excluding the controls which can be found in Appendix IIIb[5].

Table 4 contains results for 4 different specifications of equation (7). Specification (1) corresponds to the estimate of the search rule without controlling for price treatments, specification (2) accounts for positive and negative price changes, and specification (3) and (4) control for degrees of price changes and how this interacts with risk preferences. Results indicate that on average consumers are significantly more likely to be willing to search as the expected gains from search increase. When testing for differences in the probability of search across price-change treatments, estimates suggest symmetry, i.e. for the same level of change in the difference between expected and posted price, the change in the probability that a consumer searches is equal regardless of whether he faced a price that was above or below her expectations. However, when different levels of price-changes are allowed, the change in the probability of search when consumers observed posted prices

[5] Since the first level of randomization was at the search cost level, all estimates are computed using clustered standard errors at the search cost level.

5% above their expectations is higher (less negative) compared to the change when posted prices were 2.5% above. On the other hand, when posted prices are below expectations, the slope in the probability of search with respect to the difference between expected and posted price is statistically equal between the respondents that observed prices 5% and 2.5% below their expectations. It must be noted that none of the slope coefficients are statistically equal to the slope when the posted price matches the expected price.

The results on the effect of price differences when prices are above expectations are robust to controls and specifications, however, the results when prices are below are unstable. This is caused by there being 17 respondents who search when prices are 2.5% below, and 6 respondents when prices are 5% below, which is a small number of observations to properly identify the magnitude of the effect. In Appendix I, I present evidence indicating the average expected price is not statistically equal across price treatments. In particular, the expected price of the respondents that received the minus 2.5% and minus 5% treatments is lower than the average expected price of the baseline group. This implies that the absolute difference between expected and posted price is smaller. However, in order to guarantee proper randomization, in the design we computed posted prices as a proportional increase or decrease relative to expected prices, such that ex-ante differences in expected prices should not affect our estimates of the change in the probability of search.

Most of the control variables do not significantly influence willingness to search (income, age, education). Consistent with Sorensen (2001), as purchasing frequency decreases, consumers are less likely to be willing to search. The reference category corresponds to respondents that purchase gasoline twice a week or more. As is shown in Appendix III, respondents that purchase gasoline once a week are less likely to search than the reference category, and those that purchase once a month are even less likely, and so on. The controls on degree of concern regarding gasoline prices are statistically significant; as respondents are more concerned about gasoline price fluctuations they are significantly

more likely to search. Brand loyalty and store loyalty are not significant, though those consumers that receive fuel discounts are significantly more likely to search. This indicates that respondents that are already looking for ways to reduce their gasoline expenditure search more, and this is corroborated by consumers that purchase regular unleaded gasoline being weakly more likely to search.

Table 4:

Estimates of the Probability of Search[a/], *Marginal Effects*

	(1)	(2)	(3)	(4)
Price Difference [b/] *(Expected Price - Posted Price)*	-0.233*** (0.020)	-	-	-
Up * Price Difference *(Up=1 if Price +5% or +2.5%)*	-	-0.284*** (0.111)	-	-
Down * Price Difference *(Down=1 if Price -5% or -2.5%)*	-	-0.396*** (0.034)	-	-
I(5%) * Price Difference *(I(5%)=1 if Price +5%)*	-	-	-0.271*** (0.102)	-0.339*** (0.111)
I(2.5%) * Price Difference *(I(2.5%)=1 if Price +2.5%)*	-	-	-0.501*** (0.122)	-0.625*** (0.135)
I(-2.5%) * Price Difference *(I(-2.5%)=1 if Price -2.5%)*	-	-	0.001 (0.139)	-0.261*** (0.088)
I(-5%) * Price Difference *(I(-5%)=1 if Price -5%)*	-	-	-0.189** (0.067)	-0.338*** (0.029)
Total Search Cost [b/] *(Gasoline Cost + Time Cost)*	-0.879 (0.957)	-0.867 (0.965)	-0.946 (1.007)	-0.931 (1.040)
Risk (*0=do not like risk, 10= fully prepared*)	-0.000 (0.000)	-	0.000 (0.000)	-
Risk * Up (*Up=1 if Price +5% or +2.5%)*	-	-0.000** (0.000)	-	-0.001*** (0.000)
Risk * Down (*Down=1 if Price -5% or -2.5%)*	-	0.003*** (0.001)	-	0.003** (0.001)
Tests for Differences in Price Change Interactions [c/]				
Up * Price Diff. = Down* Price Diff.	-	0.93	-	-
I(5%) *Price Diff. = I(2.5%) *Price Diff.	-	-	36.87***	75.95***
I(-5%) * Price Diff. = I(-2.5%) * Price Diff.	-	-	7.31***	1.62
I(-5%) * Price Diff. = I(-2.5%) * Price Diff. = 0	-	-	58.91***	314.52***
N	476	476	476	476
R^2	0.217	0.230	0.228	0.243

a/ Regression results include all control variables. Full results are presented in Appendix III.

b/ Price differences and Search Costs in US$.

c/ Test statistics are presented.

Note: Standard Errors clustered at the search cost treatment level in Parentheses.

*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.

The first implication of the general search rule described in Section 2, indicates that no search should be observed among consumers that observe prices equal or below the expected price because independently of the search cost, there are no gains from search. This holds, even if consumers are considering search costs are very close to zero, either because they are presented with a hypothetical scenario, because the gas station is on the way to get somewhere else, or even if they consider search costs are incurred each time they go out to sample multiple gas stations in search for lower prices. The possibility that they are considering an alternative reference price can be discarded because in each question the expected price they reported was anchored, i.e. they were reminded of the price they told us they expected to pay. The second implication of the general search rule is that the probability of search is decreasing in the difference between expected and posted prices. The results on both, search intensity where we find positive search when prices are below expectations, and the different changes in the probability of search for different price-change treatments are inconsistent with the sequential search rule.

Even though respondents were not given any indication that the distribution of prices had changed when they were provided the first price in the hypothetical gas station, and since we cannot control for changes in beliefs, there exists the possibility that respondents took the posted price to update their expectations on the price they could find. If respondents used Bayes' rule to update their expectations they would consider the posted price as a signal that the distribution of prices has shifted, and use it to form a posterior expectation of what the price would be in the next gas station.

When respondents face prices above expectation, it would be possible to obtain a pattern in the probability of search consistent with our results only if consumers update their expectations faster when the posted price is 5% above expectations compared to when it is 2.5% above. Such that the difference between the posterior expectation on prices (updated) and the posted price would be smaller for consumers observing a price 5% above compared to those observing a price

2.5% above their prior beliefs (ex-ante expectations). However, as in the sequential search rule without updating, even if respondents are using the new information to update their expectations no search should be observed when prices are below ex-ante expectations. Moreover, we anchored the price they reported they expected to pay in the framing of the question, so it is unlikely that used the new prices to update their expectations.

6. Alternative Search Model based on Prospect Theory:

There is an alternative explanation that is consistent with our results. Prospect theory postulates that consumers value current prices compared to a reference price, in this case the price they reported they expect to pay, and as a consequence they will value positive price variations differently from negative price variations. An integral part of prospect theory is the notion that the consumer does mental accounting to deal with changes with respect to a reference point. Hence, an increase in price relative to the consumer's reference price in the consumer mental account is experienced as a loss, therefore making it more likely for the individual to search in order to compensate for that loss. Conversely, a price decrease relative to the consumer's reference price is viewed as a gain, thus deterring search.

Following Koszegi and Rabin (2006), assume that the consumer derives utility from finding a good deal, i.e. she derives utility from how the posted price compares to her reference price, such that utility is of the following form:

$$U_i(p, c) = v\left(r_i - p_{i,j} - c_i\right) + \varepsilon_i$$

Where r_i is the reference price, $p_{i,j}$ is the price observed at gas station *j*, and c_i is the search cost, ε_i accounts for individual heterogeneity, and $v(\cdot)$ has the properties of the value function in

Kahneman and Tversky (1979) such that it is concave in gains (v"<0) and convex in losses (v">0). In her decision to search, the consumer then compares the utility he can derive from purchasing at the price at the first gas station, which in our case is given to her without incurring any search cost, with the expected utility of searching for a lower price, where she has to incur a cost. The consumer then searches if the utility derived from the current posted price is lower than the expected utility in the gas station *k*:

$$U_i(p,c) = v(r_i - p_{i,j}) < Ev(r_i - p_{i,k} - c_i) = EU_i(p,c) \quad (8)$$

In our design we anchored the price the individual expected to pay as the reference price, so we can assume $r_i = E[p_i]$, and if we allow for unobserved heterogeneity in the utility function to be distributed $\varepsilon_i \sim N(0, \sigma^2)$, the search rule is:

$$U_i(p,c) = v(E[p_i] - p_{i,j}) + \varepsilon_i < E[v(E[p_i] - p_{i,k} - c_i) + \varepsilon_i] \equiv Ev(E[p_i] - p_{i,k} - c_i) = EU_i(p,c) \quad (9)$$

The probability that the consumer searches is then given by:

$$P[search = 1] = \Phi[\varepsilon_i < -v(E[p_i] - p_{i,j}) + Ev(r_i - p_{i,k} - c_i)] \quad (10)$$

The change in the probability of search for a unit change in the difference between the reference price and the posted price is given by:

$$\frac{\partial P[search=1]}{\partial [E[p_i] - p_{i,j}]} = \phi[-v(E[p_i] - p_{i,j}) + Ev(r_i - p_{i,k} - c_i)][-v(E[p_i] - p_{i,j})] \quad (11)$$

Evaluating the marginal effect of a change in the difference between reference price and the posted price $[E[p_i] - p_{i,j}]$ at four different price-level changes (a 2.5% and a 5% increase, and a 2.5% and a 5% decrease), yields the following implications.

Implication 3: *In the realm of losses, the change in the probability of search is higher when the posted price is 5% above expectations, relative to when it is 2.5% above.*

In the realm of losses, when $E[p_i] - p_{i,j} < 0$:

$$\frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(2.5\%) = \phi\left[-v\left(E[p_i]-p_{i,j}(2.5\%)\right)+Ev(r_i-p_{i,k}-c_i)\right]\left[-v\left(E[p_i]-p_{i,j}(2.5\%)\right)\right]$$

$$< \phi\left[-v\left(E[p_i]-p_{i,j}(5\%)\right)+Ev(r_i-p_{i,k}-c_i)\right]\left[-v\left(E[p_i]-p_{i,j}(5\%)\right)\right] = \frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(5\%)$$

This is follows from $E[p_i]-p_{i,j}(2.5\%) > E[p_i]-p_{i,j}(5\%)$, which implies that $v\left(E[p_i]-p_{i,j}(5\%)\right) < v\left(E[p_i]-p_{i,j}(2.5\%)\right)$, such that $\phi\left[-v\left(E[p_i]-p_{i,j}(5\%)\right)\right] < \phi\left[-v\left(E[p_i]-p_{i,j}(2.5\%)\right)\right]$, and $v'\left(E[p_i]-p_{i,j}(5\%)\right) < v'\left(E[p_i]-p_{i,j}(2.5\%)\right)$ due to convexity assumption in the realm of losses.

Implication 4: *In the realm of gains, the change in the probability of search is higher when the posted price is 2.5% below expectations, relative to when it is 5% below.*

In the realm of gains, when $E[p_i]-p_{i,j} > 0$:

$$\frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(-2.5\%) = \phi\left[\varepsilon_i < -v\left(E[p_i]-p_{i,j}(-2.5\%)\right)+Ev(r_i-p_{i,k}-c_i)\right]\left[-v\left(E[p_i]-p_{i,j}(-2.5\%)\right)\right]$$

$$< \phi\left[\varepsilon_i < -v\left(E[p_i]-p_{i,j}(-5\%)\right)+Ev(r_i-p_{i,k}-c_i)\right]\left[-v\left(E[p_i]-p_{i,j}(-5\%)\right)\right] = \frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(-5\%)$$

This follows from $E[p_i]-p_{i,j}(-2.5\%) < E[p_i]-p_{i,j}(-5\%)$, which implies that $v\left(E[p_i]-p_{i,j}(-5\%)\right) > v\left(E[p_i]-p_{i,j}(-2.5\%)\right)$, such that, holding everything else constant, $\phi\left[-v\left(E[p_i]-p_{i,j}(-5\%)\right)\right] < \phi\left[-v\left(E[p_i]-p_{i,j}(-2.5\%)\right)\right]$ and $v'\left(E[p_i]-p_{i,j}(-5\%)\right) < v'\left(E[p_i]-p_{i,j}(-2.5\%)\right)$ due to the concavity assumption in the realm of gains.

In our design, we implicitly assume that $v(\cdot)$ takes the following form:

$v\left(E[p_i]-p_{i,j}\right) = \sum_{m=1}^{5}\alpha_m\left[E[p_{i,k}]-p_{i,j}\right] * I_{m,i}$ where $I_m = \begin{cases}1 & if\ \ \Delta p = m\\ 0 & if\ \Delta p \neq m\end{cases}$ and $m = \{1,2,3,4,5\}$

We find that in the realm of losses, $\frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(2.5\%) < \frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(5\%)$, which is consistent with the prospect theory postulates. In the realm of gains, however, we find that $\frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(-2.5\%) = \frac{\partial P[search=1]}{\partial[E[p_i]-p_{i,j}]}\Big| p_{i,j}(-5\%)$ which is not what Implication 4 indicates. The lack of statistical differences in this case can be attributed to two factors: first, as mentioned before the

number of individuals that chose to search when they received the treatment of a 5% decrease in price is very small (6) which can explain why the results are unstable on that side of the curve. Second, the prospect theory value function in the realm of gains is flatter, so there exists the possibility that the difference from a 2.5% to a 5% decrease in price is not large enough to generate significant changes in the slope, which translates into insignificant differences in the change probability of search.

Further, specification (4) in Table 4 presents estimates differentiating how risk aversion affects the probability of search when prices are above and below expectations. As the value of the risk[6] variable decreases risk aversion increases. The coefficient of the interaction between risk and the price change indicator is negative when posted prices are above expectations, and positive when posted prices are below, both statistically significant. For the same degree of risk aversion, when experiencing losses (i.e. when the posted price is higher) a consumer is significantly less willing to take a gamble and search relative to both, when she experiences gains (i.e. when posted prices are lower) and when the posted price matches expectations. These results are also consistent with loss aversion; risk seeking in gains and risk averse in losses.

7. Conclusions

An internet survey was conducted among a random sample of drivers in the State of Ohio. We found evidence to support the sequential search setting, given that 67% of respondents stated that they search as they drive by. We use a randomized posted price design relative to the price respondents expected to pay at the time of the survey to achieve exogenous price variation in order

[6] The risk variable is a continuous indicator that takes values between 0 and 10, where 0 indicates the respondent does not like to take risk, and 10 indicates he is fully prepared to take risk.

to examine the decision making process behind search decisions. Furthermore, we anchored the consumer's expected price in the hypothetical search questions to guarantee that respondents were not making search decisions based upon an alternative reference price.

Results indicate that among the respondents who faced prices below their expected price, only 12% choose to search, whereas 45% search when prices are above. In a sequential set setting, no search should be observed among consumers that observe prices equal or below the expected price because independently of the search cost, there are no gains from search. Results further indicate that the probability of search decreases as the difference between the expected and observed price increases, however, it decreases more when prices are 2.5% above expectations than when they are 5% higher. When faced with lower posted prices, however, there are no significant differences in the slope on the probability of search with respect to price differentials. The probability of search is predicted to decrease as the difference between expected and posted prices increases, but the relationship is expected to be linear.

We provided an explanation to our results based on prospect theory by assuming consumers derive utility from finding a good deal, and allow the utility function to be consistent with the Kahneman and Tversky (1979) value function. In the realm of losses, due to the convexity assumption, the marginal utility of obtaining a price slightly below the price they observe is lower when the posted price is 5% above the reference price, thus the probability of search decreases less when the price is 5% compared to when it is 2.5% above expectations. In the realm of gains (when prices are below) however, due to the concavity assumption, the marginal utility of obtaining an even lower price is higher when prices are 2.5% below the reference price than when they are 5% below, thus the probability of search decreases more when prices are 5% below than 2.5%.

References

Deck, Cary. A and Bart J. Wilson. 2008. "Experimental Gasoline Markets". *Journal of Economic Behavior & Organization* 67, pp. 134–149.

De los Santos, Babur. 2008. "Consumer Search on the Internet." NET Working Paper #08-15.

Johnson, Ronald. 2002. "Search Costs, Lags and Prices at the Pump". *Review of Industrial Organization* 20, pp. 33–50.

Hastings, Justine. 2000. "Vertical Relationships and Competition in Retail Gasoline Markets: An Empirical Evidence from Contract Changes in Southern California" *Competition Policy Center*. Paper CPC00-010.

Kahneman, Daniel and Tversky, Amos. 1979. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica*, 47(2), pp. 263-291.

Koszegi, Botondd and Rabin, Matthew. 2006 A Model of Reference-Dependent Preferences. *Quarterly Journal of Economics*, CXXI(4), pp. 133 – 1165.

Lewis, Matthew. 2008. "Price Dispersion and Competition with Differentiated Sellers", *The Journal of Industrial Economics*, 56, pp. 654-678.

Lewis, Matthew and Marvel, Howard. 2010. "Why do consumers search?" The Ohio State University, Working Paper.

Reinganum, Jennifer F. 1979. "A Simple Model of Equilibrium Price Dispersion." *The Journal of Political Economy*, 87(4), pp. 851-858.

Rothschild, Michael. 1973. "Models of Market Organization with Imperfect Information." *The Journal of Political Economy*, pp. 1283 – 1306.

Rothschild, Michael. 2001. "Searching for the Lowest Price when the Distribution of Prices is Unknown." *The Journal of Political Economy*, pp. 689 – 711.

Shepard, A. 1991. "Price Discrimination and Retail Configuration," Journal of Political Economy, 99, pp. 30–53.

Stigler, George J. 1961. "The Economics of Information." *The Journal of Political Economy*, 69(3), pp. 213-225

Sorensen, Alan. 2001. "An Empirical Model for Heterogeneous Consumer Search for Retail Prescription Drugs". *National Bureau of Economic Research*, Working Paper 8548.

Tappata, Mariano. 2009. "Rockets and Feathers: Understanding Asymmetric Pricing." *RAND Journal of Economic,s* 40(4), pp. 673-687.

Yang, Huanxing and Lixin, Ye. 2008. "Search with Learning: Understanding Asymmetric Price Adjustments," *RAND Journal of Economics*, 39(2), pp. 547-564

Appendix I: Survey Statistics

Table 5:
Apendix I, Price Treatment Distribution by Search Cost Treatment

Price Treatment	No Cost		Gas Cost		Time Cost		Gas+Time Cost		Total
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Plus 5%	23	21.10	26	21.67	25	20.16	24	19.35	98
Plus 2.5%	17	15.60	35	29.17	16	12.90	30	24.19	98
No Change	18	16.51	18	15.00	31	25.00	17	13.71	84
Minus 2.5%	25	22.94	23	19.17	23	18.55	25	20.16	96
Minus 5%	26	23.85	18	15.00	29	23.39	28	22.58	101
Total	109		120		124		124		477

Table 6:
Appendix I, Expected Price Differences by Price Treatment

Price Treatment	Mean	Plus 5%	Plus 2.5%	No Change	Minus 2.5%	Minus 5%
Plus 5%	1.89 (0.021)	-	-	-	-	-
Plus 2.5%	1.86 (0.020)	0.02 (0.028)	-	-	-	-
No Change	1.84 (0.020)	0.04 (0.027)	0.01 (0.025)	-	-	-
Minus 2.5%	1.90 (0.021)	-0.01 (0.029)	-0.03 (0.027)	-0.05** (0.027)	-	-
Minus 5%	1.92 (0.024)	-0.03 (0.034)	-0.06* (0.033)	-0.08** (0.033)	-0.02 (0.034)	-

Note: Standard erros in parentheses.
*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.

Table 7:
Appendix I, Total Search Cost Differences by Cost Treatment

Search Cost Treatment	Mean	No Cost	Gas Cost	Time Cost	Both Costs
No Cost	2.52 (0.128)	-	-	-	-
Gas Cost	2.47 (0.125)	0.04 (0.181)	-	-	-
Time Cost	2.44 (0.129)	0.07 (0.189)	0.02 (0.187)	-	-
Both Costs	2.64 (0.132)	-0.12 (0.193)	-0.17 (0.192)	-0.19 (0.197)	-

Note: Standard erros in parentheses.

*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.

Table 8:
Tests on Individual Characteristics by Price Treatment

Variable	Plus 5%		Plus 2.5%		No Change		Minus 2.5%		Minus 5%	
	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.
Education										
Less than High School	10	9.9	7	7.0	9	10.6	7	7.1	9	8.6
High School Degree	37	36.6	30	30.0	27	31.8	39	39.4	29	27.6
Some College	32	31.7	28	28.0	29	34.1	26	26.3	31	29.5
Bachelor Degree or Higher	22	21.8	35	35.0	20	23.5	27	27.3	36	34.3
Total	101	100.0	100	100.0	85	100.0	99	100.0	105	100.0
Ethnicity										
White	87	86.1	89	89.0	69	81.2	81	81.8	96	91.4
Black	9	8.9	7	7.0	7	8.2	8	8.1	4	3.8
Other, Non-Hispanic	0	0.0	0	0.0	1	1.2	2	2.0	0	0.0
Hispanic	2	2.0	1	1.0	3	3.5	4	4.0	1	1.0
2+ Races, Non-Hispanic	3	3.0	3	3.0	5	5.9	4	4.0	4	3.8
Total	101	100.0	100	100.0	85	100.0	99	100.0	105	100.0
Gender										
Male	50	49.5	48	48.0	38	44.7	46	46.5	62	59.1
Female	51	50.5	52	52.0	47	55.3	53	53.5	43	41.0
Total	101	100.0	100	100.0	85	100.0	99	100.0	105	100.0
Income Category										
Less than $5,000	2	2.0	1	1.0	1	1.2	1	1.0	2	1.9
$ 5,000 - $ 9,999	3	3.0	3	3.0	3	3.5	4	4.0	1	1.0
$ 10,000 - $ 14,999	3	3.0	3	3.0	3	3.5	6	6.1	2	1.9
$ 15,000 - $ 24,999	8	7.9	6	6.0	5	5.9	7	7.1	10	9.5
$ 25,000 - $ 34,999	11	10.9	13	13.0	10	11.8	9	9.1	8	7.6
$ 35,000 - $ 49,999	30	29.7	19	19.0	19	22.4	15	15.2	12	11.4
$ 50,000 - $ 74,999	21	20.8	26	26.0	21	24.7	24	24.2	27	25.7
$ 75,000 - $ 99,999	12	11.9	15	15.0	14	16.5	19	19.2	23	21.9
$ 100,000 - $ 149,999	7	6.9	11	11.0	8	9.4	9	9.1	19	18.1
$ 150,000 or more	4	4.0	3	3.0	1	1.2	5	5.1	1	1.0
Total	101	100.0	100	100.0	85	100.0	99	100.0	105	100.0

Appendix II

Definition of Variables

Variable	Definition
Expected Price	Answer to the questions: You previously told us that the last time you bought gas, you paid about $[P] per gallon. Do you think this is the price you would pay for gas right now if you shopped around? If they answered no, then they were asked the following quesstion: What do you think you would currently pay per gallon *([P] is the price they paid the last time they purchased gasoline)*
Gas Cost	(Millage per gallon of the car day-to-day vehicle) * (Price paid last time)
Timce Cost	(5 / 60) * (Midpoint of Income Category / 2080). Where 2080 is the annual worked hours, corresponding to working 40 hours per week for 52 weeks.
Search Cost	Sum of the monetary value of the gasoline spent to drive one mile adjusted by the day-to-day vehicle mileage per gallon plus the monetary value of the time spent driving for 5 minutes (Gas Cost + Time Cost).
Frequency of Purchase	Answer to the question: Approximately how often do you buy gas? 1) Twice a week; 2) Once a week; 3) Every other week; 4) Once a month or less.
Age	Age
Education	Categorical variable of the level of education of the respondent: 1) Incomplete high school; 2) High school degree; 3) Some college; 4) Bachelor's degree or more.
Gender	Dummy variable equal to 1 if male.
Loyalty	Categorical variable in respose to the questions: Do you usually buy gas from the same location? If answered No, then they were posted the following question: Do you usually buy gas from the same provider, for example, Shell, Mobile, etc?
Risk Aversion	People can behave differently in different situations. How would you rate your willingness to take risks in financial matters? where the value 0 means: "Don't like to take risks," and the value 10 means: "Fully prepared to take risks,.
Octane Level	Dummy variable equal to 1 if they purchase regular unleaded.
Fuel Discount	Dummy variable equal to 1 if they answered yes to the following question: When you buy gas, do you receive any fuel discounts, for example due to incentive schemes such as Giant Eagle Fuel Perks, Kroger Fuel Saver Rewards or Speedway Speedy Rewards programs?
Concern with Gas Prices	Categorical variable equal to 1 if they responded they are not concerned with gasoline price fluctuations, 2 if they are somewhat concerned, 3 if they are very concerned, and 4 if they are extremely concerned.
Car type	Categorical variable equal to 1 if the respondent's day-to-day vehicle is a 2 door coupe, 2 if it is a 4-door coupe, 3 if it is a pickup truck, 4 if it is other, 5 if it is a sports or luxury car, 6 it is is an SUV or Mini Van.

Appendix IIIa:

Estimates of the Probability of Search[a/], *Marginal Effects*

	Total Search Costs					With Search Cost Treatment Effects				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Expected Gains	-0.233***					0.229***				
(Posted Price - Expected Price)	(0.020)	-	-	-	-	(0.008)	-	-	-	-
Up * Price Difference		-0.284***					0.279***			
(Up=1 if Price +5% or +2.5%)	-	(0.111)	-	-	-	-	(0.101)	-	-	-
Down * Price Difference		-0.396***					0.396***			
(Down=1 if Price -5% or -2.5%)	-	(0.034)	-	-	-	-	(0.023)	-	-	-
5% * Price Difference			-0.271***	-0.339***	-0.352***			0.261***	0.332***	0.351***
(5%=1 if Price +5%)	-	-	(0.102)	(0.111)	(0.094)	-	-	(0.091)	(0.098)	(0.081)
2.5% * Price Difference			-0.501***	-0.625***	-0.599***			0.475***	0.610***	0.569**
(2.5%=1 if Price +2.5%)	-	-	(0.122)	(0.135)	(0.165)	-	-	(0.098)	(0.108)	(0.146)
d5% * Price Difference			0.001	-0.261***	-0.380*			0.010	0.275***	0.390**
(d2.5%=1 if Price -2.5%)	-	-	(0.139)	(0.088)	(0.193)	-	-	(0.139)	(0.083)	(0.194)
d5% * Price Difference			-0.189**	-0.338***	-0.214*			0.196**	0.343***	0.227**
(d5%=1 if Price -5%)	-	-	(0.067)	(0.029)	(0.111)	-	-	(0.074)	(0.034)	(0.110)
Total Search Cost [b/]	-0.879	-0.867	-0.946	-0.931	-0.965					
(Gasoline Cost + Time Cost)	(0.957)	(0.965)	(1.007)	(1.040)	(1.030)	-	-	-	-	-
Gas Cost	-	-	-	-	-	-0.078	-0.075	-0.077	-0.069	-0.073
						(0.094)	(0.093)	(0.098)	(0.098)	(0.096)
SC 3						-0.094***	-0.098***	-0.086***	-0.091***	-0.093***
(SC3=1 if Time Cost)	-	-	-	-	-	(0.013)	(0.013)	(0.016)	(0.014)	(0.016)
SC 4						0.012	0.001	0.036	0.035	0.032
(SC4=1 if Time+Gas Cost)	-	-	-	-	-	(0.047)	(0.038)	(0.032)	(0.028)	(0.032)
SC 2 * Gas Cost						-0.004	-0.020	-0.012	-0.036**	-0.037**
(SC2=1 if Gas Cost)	-	-	-	-	-	(0.019)	(0.016)	(0.021)	(0.015)	(0.016)
SC 4 * Gas Cost						-0.059	-0.056	-0.090***	-0.104***	-0.098***
(SC4=1 if Time+Gas Cost)	-	-	-	-	-	(0.046)	(0.039)	(0.028)	(0.029)	(0.027)
Risk	-0.000		0.000			0.000		0.000		
(0=do not like risk, 10= fully prepared)	(0.000)	-	(0.000)	-	-	(0.000)	-	(0.000)	-	-
Risk * Up		-0.000**		-0.001***			-0.000*		-0.001***	
(Up=1 if Price +5% or +2.5%)	-	(0.000)	-	(0.000)	-	-	(0.000)	-	(0.000)	-
Risk * Down		0.003***		0.003**			0.003**		0.003**	
(Down=1 if Price -5% or -2.5%)	-	(0.001)	-	(0.001)	-		(0.001)	-	(0.001)	-
Risk * 5%					-0.002***					-0.002***
(Up=1 if Price +5%)	-	-	-	-	(0.000)	-	-	-	-	(0.000)
Risk * 2.5%					-0.001**					-0.001*
(Up=1 if Price 2.5%)	-	-	-	-	(0.000)	-	-	-	-	(0.000)
Risk * (-2.5%)					0.005**					0.005**
(Up=1 if Price -2.5%)	-	-	-	-	(0.002)	-	-	-	-	(0.002)
Risk * (-5%)					0.000					0.000
(Up=1 if Price -5%)	-	-	-	-	(0.002)	-	-	-	-	(0.002)
N	476	476	476	476	476	476	476	476	476	476
R^2	0.217	0.230	0.2284	0.2426	0.2459	0.224	0.237	0.234	0.248	0.252

a/ Regression results include all control variables. Full results are presented in Appendix III.

b/ Price differences and Search Costs in US$.

Note: Standard Errors clustered at the search cost treatment randomization level in Parentheses.

*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.

Appendix IIIb:

Control Variable Results of Estimates of the Probability of Search[a/], *Marginal Effects*

	Total Search Costs					With Search Cost Treatment Effects				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Frequency 2	-0.108***	-0.109***	-0.120***	-0.117***	-0.118***	-0.114***	-0.114***	-0.123***	-0.119***	-0.120***
(=1 if Once a Week)	(0.015)	(0.016)	(0.023)	(0.018)	(0.018)	(0.005)	(0.009)	(0.012)	(0.007)	(0.009)
Frequency 3	-0.118***	-0.116***	-0.119***	-0.119***	-0.121***	-0.128***	-0.126***	-0.128***	-0.127***	-0.129***
(=1 if Twice a Month)	(0.025)	(0.024)	(0.025)	(0.022)	(0.023)	(0.027)	(0.028)	(0.026)	(0.025)	(0.027)
Frequency 4	-0.121**	-0.118**	-0.119**	-0.121**	-0.122***	-0.121**	-0.118**	-0.118**	-0.120**	-0.120**
(=1 Once a Month or less)	(0.045)	(0.037)	(0.041)	(0.035)	(0.035)	(0.046)	(0.041)	(0.042)	(0.039)	(0.039)
Income	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
(*midpoint of Income Category*)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.002	-0.001	-0.002	-0.002	-0.002	-0.001	-0.001	-0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Educ 2	0.051	0.032	0.043	0.025	0.020	0.039	0.019	0.032	0.013	0.009
(=1 if High school diploma)	(0.052)	(0.049)	(0.055)	(0.046)	(0.042)	(0.059)	(0.058)	(0.062)	(0.055)	(0.051)
Educ 3	0.077	0.076	0.066	0.063	0.062	0.072	0.070	0.063	0.059	0.059
(=1 if some college)	(0.086)	(0.082)	(0.082)	(0.079)	(0.077)	(0.089)	(0.086)	(0.085)	(0.083)	(0.082)
Educ 4	0.100	0.091	0.079	0.072	0.072	0.092	0.083	0.072	0.064	0.065
(=1 if Bachelors or more)	(0.096)	(0.085)	(0.089)	(0.080)	(0.077)	(0.101)	(0.092)	(0.095)	(0.087)	(0.085)
Gender	0.016	0.013	0.012	0.005	0.008	0.020	0.016	0.015	0.009	0.012
(=1 if male)	(0.025)	(0.025)	(0.018)	(0.019)	(0.018)	(0.022)	(0.022)	(0.016)	(0.017)	(0.015)
Store Loyalty	-0.072	-0.083*	-0.070	-0.080	-0.084	-0.067	-0.077	-0.065	-0.076	-0.079
(=1 if buys at same location)	(0.051)	(0.057)	(0.057)	(0.057)	(0.058)	(0.046)	(0.050)	(0.052)	(0.050)	(0.051)
Brand Loyalty	-0.018	-0.030	-0.021	-0.031	-0.037	-0.016	-0.029	-0.021	-0.033	-0.038
(=1 if buys from same provider)	(0.042)	(0.044)	(0.047)	(0.040)	(0.040)	(0.041)	(0.042)	(0.044)	(0.035)	(0.037)
Regular Unleaded	0.111	0.113*	0.112*	0.112*	0.115*	0.105	0.110*	0.108*	0.109*	0.113*
(=1 if buys regular unleaded)	(0.045)	(0.041)	(0.038)	(0.040)	(0.041)	(0.053)	(0.048)	(0.044)	(0.045)	(0.046)
Fuel Discount	0.049***	0.042***	0.058***	0.056***	0.055***	0.048***	0.040***	0.056***	0.052***	0.051***
(=1 if receives fuel discounts)	(0.012)	(0.013)	(0.013)	(0.012)	(0.012)	(0.010)	(0.012)	(0.010)	(0.008)	(0.009)
Concern 1	-0.208***	-0.202***	-0.204***	-0.200***	-0.200***	-0.208***	-0.203**	-0.203***	-0.200***	-0.200***
(=1 if not concerned)	(0.031)	(0.035)	(0.029)	(0.034)	(0.034)	(0.028)	(0.030)	(0.024)	(0.026)	(0.025)
Concern 2	-0.277***	-0.292***	-0.275***	-0.286***	-0.291***	-0.283***	-0.297***	-0.279***	-0.290***	-0.295***
(=1 if somewhat concerned)	(0.038)	(0.029)	(0.036)	(0.029)	(0.025)	(0.051)	(0.043)	(0.046)	(0.041)	(0.037)
Concern 3	-0.137**	-0.140**	-0.130**	-0.127**	-0.132**	-0.136**	-0.139**	-0.128**	-0.126***	-0.130**
(=1 if very concerned)	(0.046)	(0.048)	(0.047)	(0.048)	(0.046)	(0.050)	(0.052)	(0.050)	(0.051)	(0.049)
Car Type 1	0.009	0.009	0.004	0.001	0.000	0.010	0.009	0.004	-0.001	-0.000
(=1 if 2-door coupe)	(0.085)	(0.071)	(0.082)	(0.075)	(0.078)	(0.084)	(0.071)	(0.079)	(0.073)	(0.077)
Car Type 3	-0.057	-0.056	-0.062	-0.056	-0.056	-0.048	-0.047	-0.055	-0.047	-0.046
(=1 if Pickup Truck)	(0.078)	(0.090)	(0.074)	(0.086)	(0.086)	(0.081)	(0.093)	(0.076)	(0.089)	(0.088)
Car Type 4	0.068	0.080	0.067	0.081	0.080	0.058	0.072	0.056	0.072	0.071
(=1 if Other)	(0.099)	(0.068)	(0.086)	(0.075)	(0.078)	(0.100)	(0.070)	(0.085)	(0.074)	(0.078)
Car Type 5	0.131	0.134	0.134	0.139	0.134	0.127	0.134	0.131	0.143	0.137
(=1 if sports or luxury car)	(0.109)	(0.102)	(0.092)	(0.098)	(0.105)	(0.115)	(0.107)	(0.096)	(0.102)	(0.110)
Car Type 6	-0.028	-0.021	-0.029	-0.027	-0.026	-0.019	-0.012	-0.021	-0.020	-0.017
(=1 if Mini-Van or SUV)	(0.040)	(0.039)	(0.037)	(0.035)	(0.036)	(0.038)	(0.037)	(0.036)	(0.034)	(0.035)
N	476	476	476	476	476	476	476	476	476	476
R^2	0.217	0.230	0.2284	0.2426	0.2459	0.224	0.237	0.234	0.248	0.252

a/ Regression results include all control variables. Full results are presented in Appendix III.

b/ Price differences and Search Costs in US$.

Note: Standard Errors clustered at the search cost treatment randomization level in Parentheses.

*** p-value< 0.01, ** p-value < 0.05, * p-value< 0.1.