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Strategic Pricing Decisions: Cognitive and Organizational Influences on Competitive Interactions

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Strategic Pricing Decisions: Cognitive and Organizational Influences on Competitive Interactions

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Management

by

Scott Eugene Mitchell

Dissertation Committee:
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2015

DEDICATION

In memory of my grandmothers,

Elizabeth Lyon and Marcella Mitchell

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This dissertation is the culmination of five years of study. I would not have made it through the Ph.D. program without the help of dozens of people.

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ABSTRACT OF THE DISSERTATION

Strategic Pricing Decisions: Cognitive and Organizational Influences on Competitive Interactions

By Scott Eugene Mitchell

Doctor of Philosophy in Management

University of California, Irvine, 2015

Professor Philip Bromiley, Chair

This dissertation encompasses three papers that empirically examine ongoing competitive interactions in retail gas markets. Each paper takes a different empirical approach to examine how organizational and cognitive factors influence pricing decisions in this market.

The first essay examines how multi-unit franchisee ownership and corporate ownership influences competitive behavior reflected in pricing. I use a panel dataset of pricing decisions of multi-unit franchisees and company-owned gas stations to compare two competing mechanisms by which ownership form influences pricing, double marginalization and strategic delegation. I find that franchisees charge higher average prices, supporting the greater influence of double marginalization on price. Contrary to agency theoretic predictions, firm size and geographic dispersion have a *negative* influence on the price of multi-unit franchisee stations.

The second essay explains how spatial distance and competitor similarity influence firm identification of a relevant competitors. In contrast to prior studies that have used surveys to identify competitors managers saw as most important, I identify a firm's competitors by examining the competitive actions and responses of units using data that isolates the timing of price changes in the Los Angeles retail gas market. Consistent with predictions, I find that retail gas stations monitor a small number of rival stations. The results demonstrate that distance to a rival and similarity between competitors on price and the number of pumps at a station interact to

influence the weights assigned to competitors. The findings suggest that managers categorize competitors based on a smaller number of key dimensions than previously theorized.

The third essay takes a behavioral approach to examining competitive market factors that lead to systematic pricing errors using non-experimental data. While management researchers have studied the causes of suboptimal pricing decisions, previous research has emphasized experimental or aggregate corporate data rather than pricing and performance data from actual competitive interactions. I utilize a hand-collected, longitudinal dataset of prices and performance outcomes for 26 retail gas stations to determine a daily, station specific profit-maximizing price. These prices are then compared to the actual prices charged to assess the accuracy of station pricing decisions. I find that the number of competitors in a market have a positive influence on the accuracy of pricing decisions at low numbers of competitors but a negative influence at high numbers of competitors. Stations with a visible competitor that compete head-to-head set more accurate prices than stations without a competitor visible competitor.

ESSAY 1

OWNERSHIP FORM AND RETAIL GAS STATION PRICE COMPETITION: THE INFLUENCE OF MULTI-UNIT FRANCHISEES

ABSTRACT

This paper examines how multi-unit franchisee ownership and corporate ownership influences competitive behavior reflected in pricing. I use a panel dataset of pricing decisions of multi-unit franchisees and company-owned gas stations to compare two competing mechanisms by which ownership form influences pricing, double marginalization and strategic delegation. I find that franchisees charge higher average prices, supporting the greater influence of double marginalization on price. Contrary to agency theoretic predictions, firm size and geographic dispersion have a *negative* influence on the price of multi-unit franchisee stations.

INTRODUCTION

Standardization and coordination among units allow multiunit organizations to carry out strategic behaviors on a large scale (Baum & Greve, 2001; Greve, 2003). However, as multiunit organizations increase in size, they face difficulties coordinating and controlling units because individual unit decision makers may have incentives that deviate from an organization's profits (Caves & Murphy, 1976). As a result, the early literature on multi-unit, multi-market organizations focused on how firms use contracts that create different ownership forms (e.g., ownership or contract) at the unit level to align an agent's incentives with the chain's objectives (LaFontaine, 1992).

Recent research on multiunit organizations has examined competition between different ownership forms (Ater & Rigbi, 2015; Corts, 2001; Lafontaine, 1999; Vroom & Gimeno, 2007). However, empirical evidence regarding the effect of ownership form on competitive behavior is mixed. For example, franchisees systematically charge higher average prices than company owned units in some industries, but lower average prices in others (Lafontaine & Slade, 1997). While several environmental explanations have proposed to explain this discrepancy (e.g., differences in market concentration or industry growth), researchers have not yet fully examined how organizational factors interact with different ownership forms to influence competitive behavior. This paper focuses on how ownership form and two factors that limit the organizational control of units, firm size and geographic dispersion, interact to influence pricing decisions, a key strategic franchising behavior that is not governed by contracts with a chain. I focus on the influence of three sets of factors: ownership form (e.g. franchisee or company owned), organizational characteristics (e.g. size and geographic distance), and market characteristics that influence competition.

Consider three firms that operate under the same brand name. Firm A is a large franchisee with 20 geographically dispersed units. Given the dispersion of the units, the owner must decide what competitive decisions to delegate to store managers and how to evaluate and reward the managers. Firm B is also a franchisee, but the firm owns only one unit. This owner-operated unit faces almost no such delegation and evaluation decisions. Firm C is a chain of 20 company owned units controlled by store and district managers. Each of these firms must make parallel decisions regarding how to compete in a local market, delegate decision making, and reward decision makers.

This study draws from economic and organizational theories to examine how internal firm factors that constrain organizational control (Eisenhardt, 1985; Ouchi, 1979; Sengul, Gimeno, & Dial, 2012) moderate the influence of ownership form on firms' competitive behavior. I examine two competing explanations for the influence of ownership form on competitive behavior (double marginalization and strategic delegation) and propose that two firm factors, an organization's size and geographic dispersion, will modify the impact of ownership form on competitive behavior by reducing a firm's ability to strategically control units. I predict that the size and geographic dispersion of a firm will have a positive influence on the average prices charged by multi-unit franchisees because franchisee owned units become more like company-owned units as their firm grows.

This paper makes several contributions to understanding the influence of ownership form on competitive behavior. First, I demonstrate that ownership form influences a unit's competitive behavior independent from market and organizational factors validating and extending prior research on the impact of ownership form on competitive behavior (Barron & Umbeck, 1984; Hastings, 2004; Lafontaine & Slade, 1997; Shepard, 1993; Vroom & Gimeno, 2007). Second, I show that organizational factors that limit a manager's ability to monitor a local market have differential impacts on the competitive behavior of different ownership forms. The interaction effects between ownership form, firm size and geographic dispersion highlight the benefits of combining both economics and organizational perspectives to better understand firms' competitive behavior (Bromiley, Papenhausen, & Borchert, 2002; Cyert & March, 1963; Vroom & Gimeno, 2007). Finally, increasing our understanding of the competitive consequences of different ownership forms will allow firms to better design their organizations and enhance their organizational control capability, and thus better carry out their competitive strategy.

The rest of the paper proceeds as follows. I first describe the different theories regarding how ownership form, firm size, and unit geographic dispersion influence a unit's competitive behavior in isolation and in combination. This leads to hypotheses regarding the influence of organization form, firm size, and unit geographic dispersion on pricing strategy. I then test my hypotheses with daily price data for 446 retail gas stations in Riverside County, California during 6 months in 2012. While gasoline retailers compete in very localized markets with a homogeneous product, the sample offers substantial variety among the factors of interest - ownership form, organizational characteristics, and market factors that influence the level of competition. In the conclusion section, the paper uses supporting qualitative evidence from industry literature and interviews conducted with industry participants to further illuminate these issues.

THEORY AND HYPOTHESES

Ownership Form and Multi-Unit Organization Competitive Behavior

Multi-unit organizations, such as restaurants, hotels, gas stations and retail chains, operate in multiple markets through distinct units (Greve, 2003). These chain organizations represent a simple organizational form – they repeatedly apply a formula or recipe to geographically dispersed units (Winter & Szulanski, 2001). How the ownership of different economic activities is divided among multi-unit organizations has important implications for firm competitive behavior (Fama & Jensen, 1983). This early question of who will own which activities (Coase, 1937) continues to receive scholarly attention in this context (e.g. Parmigiani, 2007; Perryman & Combs, 2012), in part because multi-unit organizations often feature a mix of both wholly owned (company-owned) and contract (franchised) units. This mixture is a challenge to theories that predict the firms will adopt the most effective form.

Franchising is a common ownership form of multi-unit organizations. Franchisors own a product, process, or service and sell the right to the use of its brand name, operating routines, and product specifications to a franchisee (Perryman & Combs, 2012). Many chains use a mix of company and franchisee owned units. Such an arrangement allows the chain to balance uniformity with system wide adaptability (Bradach, 1998; Kaufmann & Eroglu, 1999; Sorenson & Sørensen, 2001). Franchising is a prominent feature of the US economy, accounting for 8.9 million jobs within 780,000 franchisee organizations ("International Franchise Association: FAQS About Franchising," 2015). The question of how differences between franchisor owned and franchisee owned units influences competitive behavior has long interested researchers (Bradach, 1998; Lafontaine & Slade, 1997).

I define *company-owned* units as units that are owned by a corporation that owns the brand name and are operated by a salaried employee. The corporation that owns company-owned stores will often also act as a franchisor, allowing others to own and operate units under their brand name. *Franchisee owned* units have a contract to operate under a brand name with a franchisor, but the franchisee owns the physical facilities. Franchisees often own multiple units. For example, Kalnins & Lafontaine (2004) note that 85% of units of the 5 largest fast food chains in Texas in 1995 were owned by franchisees that owned multiple units. *Multiunit franchisees* are thus defined as franchisees that own more than 1 unit. Table 1 summarizes the key terms and definitions used this paper.

Agency theory is the most commonly used theory to explain the existence of franchising (Combs, Ketchen, & Hoover, 2004; Lafontaine & Slade, 1997). An agency relationship exists when one party, the principal, delegates authority to another, the agent (Eisenhardt, 1989; Jensen & Meckling, 1976). Agents are assumed to be self-interested, with goals that diverge from the principal (Eisenhardt, 1989). As a result, principals must expend resources, known as agency costs, to make sure that agents act in a way that satisfies the principals' goals. Agency costs in multi-unit organizations focus on the vertical agency problem, which stems from the potential for agents to withhold effort or shirk when their behavior is not observed (Alchian & Demsetz, 1972; Combs et al., 2004). Since employees at company-owned units do not have their own wealth tied to unit performance, they may shirk their duties and focus on other activities that benefit them personally. The potential for shirking requires principals to closely monitor employees at company-owned units, which is costly.

The proposed solution to the vertical agency problem is to make the agent a residual claimant. Franchising makes franchisees the residual claimant by entering into a contract where the franchisee agrees to use the franchisor's brand name and operating procedures for a fee. The franchisee controls all competitive decisions not explicitly outlined in the contract with the franchisor. These contractual conditions apply to all franchised units in the chain. In contrast, managers in company-owned units face additional restrictions on how they operate their units. For example, a franchisee is free to add or change ancillary activities at a gas station (e.g. snack food, presence of a car wash, etc.). The manager of a company-owned store would need corporate approval and capital to make such changes.

The franchising arrangement greatly reduces franchisors' monitoring costs. Bradach (1998) noted that franchisors required franchisees to report only basic quarterly or annual cost and sales data to the franchisor. Franchisor area managers monitored an average of 65 franchisee owned restaurants for quality, visiting each restaurant just once per year. In contrast, company-owned area managers monitored an average of just 6 restaurants and provided daily oversight. These monitoring costs are at the heart of the agency theory prediction that firms will use franchisees in locations that are costly to monitor, such as rural or distant locations (Brickley & Dark, 1987; Fladmoe-Lindquist & Jacque, 1995; Norton, 1988).

Agency theoretic predictions of franchise ownership make the implicit assumption that franchisees provide direct oversight. However, franchisees often operate multiple units. Such franchisees must hire managers to monitor their numerous outlets, undermining the very incentives promoted by agency theory as a benefit of franchising (Garg, Rasheed, & Priem, 2005). Researchers have examined the location choices of multi-unit franchisees (e.g. Kalnins & Lafontaine, 2004; Perryman & Combs, 2012), however, the impact of multi-unit ownership by franchisees on competitive behavior has received significantly less attention.

As a starting point for building upon extant theory, I offer two competing hypotheses regarding the influence of differences in ownership form on competitive behavior. I then develop hypotheses that examine how two factors that influence monitoring costs, the number of units that a firm owns and the geographic dispersion of a unit, influence competitive behavior of the multi-unit franchisees. Empirically the ownership form hypotheses will be examined by comparing franchisee and company-owned unit competitive behavior to independent owners. Since the focus of this paper is on the influence of multi-unit franchisee ownership, I do not make any theoretical predictions regarding the influence of independent ownership on competitive behavior.

Strategic Delegation

Two mechanisms have been proposed to explain how franchise versus company ownership of a unit influences competitive behavior – strategic delegation and double marginalization. The first theoretical mechanism, strategic delegation, links ownership form to competitive behavior by suggesting that certain types of ownership forms can be used as a commitment device to maintain a higher, and therefore more profitable, price level.

The observation that a particular firm "leads" or sets prices in oligopolistic markets has led to a long history of research in economics on the requirements and competitive outcomes of price leadership (Bain, 1960; Markham, 1951; Nichol, 1930; Stigler, 1940). This literature broadly assumes that firms with large market shares set prices at an optimal level and smaller market share firms follow by price matching. If "fringe" or smaller market share firms attempt to set lower prices, the dominant firm will follow suit, destroying margins for all firms.

Price increases have the opposite effect. In geographically differentiated markets, modest price increases by all sellers can increase all sellers' profitability (Bulow, Geanakoplos, & Klemperer, 1985). Plummer, Sheppard & Haining (1998) demonstrate that all firms can earn high returns if all competitors behave appropriately even in markets with a relatively large number of competitors. If all competitors follow the price leader's lead and set a higher average price, all firms in a local market will benefit. Despite the appeal, achieving higher average prices in a market is difficult because individual sellers have strong incentives to increase profits by selling more volume at slightly lower prices than the other competitors. Competitors only follow a competitor's lead if the price commitment is both credible and lasting.

Strategic delegation theory proposes that one way to signal to competitors a commitment to a competitive action, such as price-leadership, is to delegate authority in a way that is both credible and long lasting (Fershtman, Judd, & Kalai, 1991; Schelling, 1960; Sklivas, 1987; Vickers, 1985). A company-owned store meets the conditions for price leadership. Company stores can price relatively higher simply because headquarters told them to (Vroom & Gimeno, 2007). Bradach (1998) referred to company ownership as the military model. Headquarters has direct control of company-owned store competitive actions. In contrast, franchisees lack the ability to credibly commit to setting higher prices in a market since price increases are easily withdrawn. While administrative orders from headquarters can stop a company-owned store from lowering prices, individual franchisees retain pricing authority so a franchisee can quickly lower prices when needed. Here, the strong incentives for the franchisee owner-operators increase the temptation to lower prices to increase sales. Although franchisors may influence the pricing decisions of franchisees by adjusting the royalty fees and supply costs, these are not directly tied to pricing (Shepard, 1993; Vroom & Gimeno, 2007). The absence of corporate oversight over retail pricing weakens a franchisee's ability to engage in credible price leadership. Therefore, the credible commitment through strategic delegation mechanism predicts that company-owned stores will set higher average prices.

H1a: Company ownership has a greater positive influence on price than franchise ownership.

Double Marginalization

The second theoretical mechanism that links ownership form to competitive behavior is double marginalization. Double marginalization was originally applied to discussions of vertical restraints (Shepard, 1993). Spengler (1950) explained that a vertically integrated monopolist will charge a lower price than two vertically adjacent monopolists because the downstream monopolist purchases goods at a margin above costs and then applies an additional margin to make a profit. The accumulation of margins results in a higher average price to the consumer for the vertically adjacent monopolist. In the absence of competition, the double marginalization process results in a higher end price than is optimal. While the discussion is normally posed as "vertically adjacent monopolists" and discussed in oligopolistic settings, the logic equally applies to situations where the two vertically adjacent businesses have some lesser degree of market power.

Double marginalization influences franchisees because the franchisor and the franchisee act as vertically adjacent monopolists. Franchise contracts require franchisees to purchase wholesale goods from a franchisor at a price set by the franchisor. For example, in the retail gas industry, refiners set the price of wholesale gas. A company-owned unit can set an optimal price for a local market by extracting rent at the pump. In contrast, a refiner selling gas to a franchisee dealer faces a monopoly-pricing situation and so will price above the competitive market price to increase the refiner's profits (Shepard, 1993; Slade, 1992). If the franchisee operates in a perfectly competitive market, this will result in a franchisee earning less overall profit than a company-owned unit would. However, if the franchisee faces an imperfectly competitive market, it will increase profits by monopolistic pricing. This accumulation of refiner and franchisee margins in the franchise relation results in higher average prices at franchisee units than company-owned units. All else equal, the theory predicts that franchisees charge higher prices than company-owned stores.

H1b: Franchisee ownership has a greater positive influence on price than company ownership.

Empirical evidence regarding the effect of double marginalization and credible commitment is mixed (Kalnins & Lafontaine, 2004), perhaps because the importance of each effect may depend on other characteristics of the unit's context or environment (Sengul et al., 2012). If both double marginalization and strategic delegation mechanisms operate in a context, then whether franchised or company-owned units price higher in a competitive situation depends on the *combination* of double marginalization and strategic delegation effects. Recent research has examined contingencies and contexts that cause variation in the effect of strategic delegation and double marginalization. Examining firms in the Texas hotel industry, Vroom & Gimeno (2007) found that franchised units with higher royalty rates charged higher prices, providing evidence for double marginalization. Higher franchisees fees are thought to lead to a distortion in the franchisee's optimal pricing position, disincentivizing the franchisee to cut prices to increase sales. After controlling for royalty rates, they found that company-owned units priced higher than franchisees in more concentrated markets, supporting the argument that company-owned units can credibly commit to price leadership via strategic delegation when it matters most.

Because double marginalization depends on the number of adjacent vertical stages in a firm's supply chain, its effect should not vary among franchisees *within* a chain. However, the influence of strategic delegation may be amplified by organizational factors that can cause variation in the competitive behavior of units within a chain. For example, Sengul et. al (2012) suggested that the use and influence of strategic delegation might vary with the effectiveness of organizational control systems and the cost of monitoring between the principal and agent. I argue that multi-unit franchisees are able to commit to higher average prices through strategic delegation in the same manner as company-owned units. Two factors that have been theorized to increase agent monitoring costs, the number and location of units owned by a multi-unit franchisee (Eisenhardt, 1985), create a hierarchical organization that reduce the benefits of the franchisor-franchisee relationship promoted by agency theory and result in higher average prices.

Organizational Size

Firm size is an important contingency in strategy research and has strong implications for strategic delegation in multi-unit firms. Prior research suggests both strategic benefits and costs associated with firm size. While larger companies may gain economies of scale and market power (Chen & Hambrick, 1995; Woo & Cooper, 1981, 1982), they may also suffer structural complexity and bureaucracy (Mintzberg, 1979). Large chain organizations are simultaneously cited for their ability to facilitate the replication of routines (Knott, 2003; Winter & Szulanski,

2001) and as a reason to use a franchise relationship to guard against agency theoretic concerns as a firm expands (Lafontaine & Slade, 1997).

Size influences the competitive behavior of both multi-unit franchisees and company-owned units by reducing a manager's ability to intensely monitor markets and coordinate pricing decisions. A manager's ability to monitor the relevant markets in detail decreases with the number of units the manager oversees. Large firms need to analyze and coordinate many markets and departments to implement a coherent response (Porter, 1980), which may limit their competitive action and response capability (Chen & Hambrick, 1995). This has important implications in oligopolistic markets where firms compete on price. As previously discussed, firms in oligopolistic markets have incentives to maintain a competitive price. Such incentives are used to explain the findings that small franchisees are often the first to cut prices below the local competition's prices to capture market share (Eckert, 2003). An owner-operator with one unit can focus exclusively on a single local market. The owner-operator does not need to coordinate or communicate a pricing strategy. In contrast, a firm with units in 10 markets must delegate decision-making to employees. The owner of a large firm must divide his or her attention to monitor all of their markets. Dealing with the organization's increased complexity forces units to create routines that slow down their action and response capabilities.

One of the primary arguments of agency theory is that the use of owner-operators gives franchisees incentives to monitor competitors and maintain a competitive price. The incentives promoted by the franchise relation are thought to benefit both the franchisee and franchisor. For example, in retail gas markets a franchisee has incentives to continually monitor competitors and cut prices to an optimal price approaching the marginal cost of gas in order to capture local market share (Noel, 2011). This dynamic also benefits the franchisor, which profits from supplying additional gasoline to the franchisee.

However, the use of multi-unit franchisees creates a hierarchical organization and diminishes the benefits promoted by agency theory. To monitor their own stores, multi-unit franchisees create an organizational structure that often resembles the structure of company-owned units (Bradach, 1998). This structure diminishes the incentives promoted by the franchise relation, reducing an owner's direct oversight and the incentive of on-site employees to intensely monitor their competitor's prices. Burger King corporate headquarters noted that as franchisees add stores, multi-unit franchisees go through a process of "[initial] intense personal involvement in stores to general management." Headquarters reported that as owner-managers add stores, they "Get[s] fed up with day-to-day detail" (McLamore, 1998, pg. 51). Bradach (1998) pointed out that as multi-unit franchisees grow in size, the organization begins to resemble a franchisor's operating structure. For example, multi-unit franchisee units often hire regional managers to monitor units and use incentive structures similar to company-owned units. These managers often move between the franchisor and large, multi-unit franchisees, reinforcing this effect.

In markets that are price competitive, a smaller retailer with one to two units can realize a short-term temporary gain in sales volume and profits by continually monitoring competitors and making small price cuts to steal market share. A large firm with many units realizes a smaller proportional increase in sales and wealth with such behavior. For example, if all stations in a market charge the same price, the smaller retailers have a greater incentive to cut prices to gain market share than retailers with a greater number of units. Additionally, the costs required to maintain the monitoring standards of owner-operators at multi-unit franchisee units further reduces the incentives to maintain prices at a level just below the competition. This smaller proportional increase in sales volume from price cuts and the increased difficulty monitoring additional markets has been used to explain why smaller retailers often lead price cuts and large retailers are the first to raise prices (Eckert, 2003).

The arguments suggest that as a franchisee's number of units grows, the franchisee deemphasizes day-to-day involvement and delegates competitive decision-making, reducing the benefits that agency theory claims for the form and resulting in higher average prices.

H2: Firm size has a positive influence on multi-unit franchisee prices.

Geographic Dispersion

The geographic distance between units in a firm decreases a firm's ability to control units. Geographic distance between units makes it more difficult for firms to learn about local markets (Minkler, 1992) and drives up monitoring costs (Lafontaine, 1992). Geographic distance from current operations and a lack of market knowledge has been cited as a reason to franchise rather than establish a company-owned unit (Oxenfeldt & Kelly, 1969), as operators with local market knowledge can better control costs, monitor the competition, or customize offerings (Brickley & Dark, 1987; Fladmoe-Lindquist & Jacque, 1995; Kalnins & Lafontaine, 2004; Lafontaine, 1992; Norton, 1988).

These benefits influence franchisor decisions when allocating new franchisee units; franchisors often award multi-unit franchisees adjacent locations because of monitoring concerns and the expertise franchisee possess in certain markets (Kalnins & Lafontaine, 2004). For example, they may have better knowledge of local demand (Norton, 1988) and consumer tastes (Minkler, 1992). Production and marketing efficiencies may arise from proximate locations

(Darr, Argote, & Epple, 1995). When explaining findings that franchisers award franchisees new units in areas that are geographically close to their current units, Kalnins & Lafontaine (2004) point to the franchisor's desire to "utilize franchisees' knowledge and capabilities as the basic function of multi-unit ownership."

A firm's local market knowledge and proximity to its own units lets the firm better coordinate pricing strategies. Minkler (1992) notes that clusters reduce monitoring costs since a monitor can travel among dense locations cheaply. However, monitoring units and the competitors becomes more difficult for multi-unit franchisees as the firm's geographic dispersion increases. Multi-unit franchisees are forced to hire employees to manage operations and face the same agency problems of incomplete information and concerns about agent behavior as company-owned units. It is difficult and costly to monitor and communicate information about operations. Since the justification for franchising is to provide incentives to the unit manager to remain competitive in a local market by effectively monitoring themselves and their competition, I expect that the dilution of the incentives promoted by multi-unit ownership will result in higher average prices at more geographically dispersed franchisee units.

H3: Geographic dispersion has a positive influence on multi-unit franchisee prices.

METHODS

Sample

Investigation of my research questions requires an empirical setting that includes observations of the pricing behavior of multi-unit organizations with different ownership forms. One such setting is the retail gas station industry. Retail gas stations offer a largely homogenous product and thus compete on price with their local competitors. The visibility of pricing decisions and the factors that influence price allows for an analysis of short-run competitive interactions. Price constitutes the most important aspect of short-run competition for retail gas stations. While other factors may influence pricing at the station level, such as location or ancillary services, they are costly to change in the short-run and can be effectively controlled for.

Gasoline is produced by a refiner and transported through pipelines to a distribution rack where it is delivered to stations through an intermediate supplier known as a jobber. The jobber distributes the gasoline to the retail gas stations. Jobbers deliver two types of gasoline: branded and unbranded. Branded gasoline has additives that are mixed into the gas prior to delivery at a station.

Stations that sell branded gas stations have four primary vertical contract types with the refiner: company owned and operated, commissioned agent stations, lessee dealer stations, dealer owned stations (Slade, 1998). At company owned and operated station, the refiner owns the station and the inventory, sets the pump price centrally, and hires employees to work at the station. In commissioned agent stations, commissioned agents enter into a long-term lease with a refiner to operate a station owned by the refiner. The refiner owns the gasoline inventory and sets the pump price centrally. The agent receives a small commission for the amount of gas sold and is responsible for purchasing the inventory and operating all ancillary services. The refiner is the residual claimant on all retail gas sales. The commission agent often pays the refiner a small percentage of non-gasoline revenues. For lessee-dealer stations, a refiner owns a station but enters into a long-term contract with a lessee to operate the station. The lessee purchases gas from the refiner at a wholesale price set by the refiner. The lessee sets the retail price and is the residual claimant. Dealer owned and operated stations enters into a long-term supply contact with the refiner. The station purchases gas from the refiner at a refiner determined wholesale price and sets the retail price.

Stations that sell unbranded gasoline are known as independent gas stations. The gas sold at such stations lacks major oil company branding. Independent station owners purchase gasoline from wholesalers at the best available price on the wholesale market and resell it at a price determined by the station owner. Unlike the branded station formats where the retail price of gas may be set by the refiner or influenced by the refiner through contract terms or wholesale prices, independent station owners can shop for the lowest wholesale price of gas and independently set the retail price of gas. In some cases, independent chains may use leasing contracts with a commission agent. In these cases, the independent chain owns the wholesale gas inventory and sets the price at the pump. The commission agent receives a small commission. For example, one station in my sample, 7-Eleven, pays 1.5 cents per gallon to the agent (St. George, 2012). A comparison of the station formats is summarized in Table 2. I discuss the construction of the variables identifying station formats in greater detail below.

The retail gas market is one of the few industries where contracts allow franchisees to operate multiple brands of the very same product. Retail gas station multi-unit organizations often operate as franchisees under several different brands. United Oil Co. in Southern California, for example, has over 90 stations, including 76 and Shell brands ("United Oil - Locations," 2015). In addition to these two brands, it operates two different unbranded, independent, gas station and convenience store chains. Thus, franchisees in the retail gas industry may operate stations across multiple brands that are both franchisee and independent stations. Contractual arrangements do not allow firms to mix gasoline among the branded stations. Contracts for branded stations lock in supply with a specific refiner, requiring stations to purchase a minimum amount of gasoline per year at a price determined by the refiner.

Data

The data was compiled from several sources. Daily price observations for regular unleaded gasoline, wholesale prices, brand and location data for 446 retail gas stations in Riverside County, CA from July to December of 2012 came from the Oil Price Information Service (OPIS). OPIS records station prices from credit card transaction reports, station reported data, and crowd sourced price data from GasBuddy.com to get a full picture of retail prices for each day. If OPIS observes multiple prices at a station during the day, it reports an average of the prices. OPIS reports wholesale prices for each station by recording the dealer tank wagon price at the nearest terminal for each brand. The dealer tank wagon price is the price available to franchisees in an area. Company owned stores are also assigned this price in the data set, though their true cost is unobservable. Independent stations can shop around for the lowest priced gasoline and were therefore assigned the lowest available wholesale price at the nearest applicable terminal. Station characteristics such as whether a station sells diesel fuel or has a carwash came from GasBuddy.com.

There were approximately 486 retail gas stations in Riverside County in 2011 according to the California Energy Commission. Riverside County features a mix of both urban and rural stations. The data in the final model on 414 of these stations captures 85% of the market.

Dependent Variable

Price Per Gallon. The dependent variable was the observed daily price of regular unleaded gasoline as reported by OPIS. Regular unleaded gasoline accounted for 86% of gasoline sold in the US in 2012 (United States Energy Information Administration, 2012). Customer price sensitivity, along with the variability and visibility of price and the relative stickiness of other strategic actions like brand and station amenities makes price a very powerful indicator of competitive interaction.

Independent Variables

Ownership Form. This study examines how company-owned and franchisee unit ownership influences competitive behavior. I grouped branded station formats into two groups based on the residual claimant at each station. Company-owned and operated stations and commission-agent stations are classified company-owned stores since the refiner sets the retail price and is the residual claimant. Lessee-dealer and dealer owned and operated stations are classified as franchisee stations since the station operator sets the price and is the residual claimant. Finally, all independent stations were classified as a third ownership form. The lack of a long-term vertical supply contracts creates different incentives for independent station owners than is discussed in my theory.

Indicator variables were created for company-owned and franchised stations, with independent stations as the base category. I used data from four sources to determine whether a unit was company-owned, franchised, or independent. First, the Riverside County Assessor Office provided property ownership data and owner contact. Second, the South Coast Air Quality Management District (AQMD) provided a list of all retail gas stations in Riverside

County with station name, brand and the contact names and information of the franchisee or operator. The owner responsible for all stations in California must have an operating permit from their AQMD. Data on corporate branding came from the Oil Price Information Service (OPIS) and station company names were obtained from the California Energy Commission (CEC). For stations with convenience stores, data on the operator of the convenience store was obtained from the California Department of Alcoholic Beverage Control (ABC) and the California State Board of Equalization (BOE). The six lists were cross-referenced to classify stations as company-owned and operated, franchised, or independent. Stations with conflicting ownership names were dropped from the sample.

Number of Stations Owned. Firm size was measured by the number of stations owned in Riverside County. The property ownership, AQMD, OPIS, CEC, ABC and BOE data were used to identify co-ownership among franchisees and company-owned stores. Small franchisees often operate under different business names. Station franchisees with shared business addresses, business names, or contact names were coded as one company. Conflicting data or a lack of data resulted in a loss of station ownership information for 40 stations (~9% of the sample).

Station Geographic Dispersion. Using station geographic coordinates from OPIS, geographic dispersion was measured by the average distance to a co-owned station for each station with a common owner. Station geographic coordinates were obtained from OPIS. The distance to each station the firm owns were summed and then divided by the number of other stations in the firm. Firms that own only one station have a dispersion value of 0.

Control Variables

I include several variables to account for other potential explanations of variation in price. First, I controlled for a focal station's *average competitor price* by creating a measure that captures the distance-weighted average price of the 5 closest competitors. Retail gas stations compete with one another in their local market but not with distant stations, allowing them to exhibit local market power. The degree of connection or influence between retail units in such geographically differentiated markets is thought to lessen quickly with distance (Chamberlin, 1948). Price changes at closer competitors should have a greater effect on a station's price level. I assume that distance has an approximately linear influence on the importance of a local competitor and weight the price of the 5 closest competitors by a variable equal to 5 minus the distance in miles the competitor is from a focal station. If a station did not have 5 competitors within 5 miles the remaining stations within the 5-mile radius were used to capture the average competitor price. Station latitude and longitude and competitor price data come from OPIS. While this measure does not directly measure market concentration, the distance weighted average price of competitors is a proxy for both local competitor's prices and market concentration.

I included a station's *wholesale price* of gasoline in *t* to control for the focal station's marginal price of gasoline. Daily station specific wholesale prices were obtained from OPIS. OPIS assigns each station type an appropriate daily wholesale price. Franchisees are assigned the "rack" wholesale price of gas for the appropriate brand at the nearest terminal. The rack price is the price available to all franchisees. Independent stations were assigned the best available unbranded price at the nearest terminal. Company owned stations are assigned the appropriate branded wholesale rack price. The true cost of wholesale gas for company owned stations is unobservable, as they pay a transfer price to the refiner.

I also included a number of station features that represent alternative explanations for variation in price. Indicator variables for a focal station's gasoline brand and convenience store brand were created from OPIS data. Indicators that note the presence of a convenience store, restaurant, truck stop, auto repair, a car wash, 24-hour service, and the number of pumps at a station were created from data obtained from GasBuddy.com. Such ancillary services may encourage station managers to price gasoline higher as a result of the presence or draw of such services (Barron, Umbeck, & Waddell, 2008; Eckert & West, 2004; Hosken, McMillan, & Taylor, 2008; Ning & Haining, 2003).

Estimation

The final model explains the daily price for each station. The model was estimated using random effects for stations. The use of a fixed effects specification does not allow for the examination of the hypothesized variables that do not vary within station. The functional form of the model can be written as:

$$\text{Price Per Gallon}_{it} = \alpha_i + \beta_1 \text{ Franchise}_i + \beta_2 \text{ Company Owned}_i + \beta_3 \text{ Firm Size}_i + \beta_1 \text{ Franchise}_i \text{ x Firm Size}_i + \beta_4 \text{ Station Dispersion}_i + \beta_5 \text{ Franchise}_i \text{ x Station Dispersion}_i + \beta_6 \text{ Gas Brand}_i + \beta_7 \text{ Average Price of Rivals}_{it} + \beta_8 \text{ Wholesale Price}_{-1} + \beta_9 \text{ Ancillary Service Indicators} + \varepsilon_{ij}$$

RESULTS

The final sample consisted of an unbalanced panel of 446 focal stations from July 1, 2012 to December 31, 2012, totaling 47,078 observations. The sample included 72 company-owned or operated stations, 297 franchised stations, and 43 independently owned stations. There are 298 firms represented in the sample. Over 50% of firms in the sample are single station franchisee owners. There are no single-station "company-owned" units as defined above. The largest and second largest firms in the sample, ExxonMobil Inc. and Chevron USA Inc., are franchisors with 30 and 27 company-owned stations in the sample. The largest franchisee owned firm in the sample is G&M Oil Co., which owns 26 stations in Riverside Count, 25 that are Chevron branded and one independently branded. Table 3 presents means and overall standard deviations and correlations for the data.

As expected, retail price is correlated highly with wholesale prices. Retail price also correlated highly with nearby competitors. Price has a slight positive correlation with indicators for both company and franchised stations.

Table 4 presents the results of the random effects regression analysis. Model 1 presents the model with only the control variables. Model 2 presents the model with indicator variables for ownership form. Model 3 presents the model with the measures for firm size and ownership form. Model 4 presents the model with the measures for station dispersion and ownership form. Model 5 presents the full model. Results discussed are for model 5 in Table 4 unless otherwise noted.

Hypothesis 1a and 1b present competing hypotheses for the effects of ownership form on station prices. The results of model 5 indicate that franchise ownership has a greater *positive* effect on price than company station ownership (b=0.0964, $p<.001$ vs. b=-0.1324, $p<.01$). All else equal, franchise stations price an average of 7 cents higher than similar company-owned stations, indicating support for double marginalization. At the mean values for all parameters, franchisee stations charged an average price of $3.92 per gallon while company-owned stations charged an average of $3.85 per gallon. I compared the values of these parameters using a univariate t-test between the two ownership forms confirmed that franchisees charged higher average prices ($\chi^2 = 30.21$, $p<.0001$).

The results do not support hypothesis 2. The main effect for firm size is positive and significant (b=.0006, p<. 1). However, the interaction between firm size and the indicator for a franchisee station is *negative* and significant (b=-.0097, p<.001). Holding all other variables at their means, stations at the mean multi-unit franchisee size of five stations charged $3.972 or 1.6 cents less than the average single station owner. Multi-unit franchisees with 12 stations, one standard deviation higher than the mean station size, charged an average of $3.946, or 2.6 cents less than the price at station at the mean franchisee size of 5 stations. Multi-unit franchisees at the 90th percentile of firm size charged an average price of $3.892 per gallon, or 8 cents less than the price charged by the mean multi-unit franchisee. Figure 1a depicts the relationship between the interaction of firm size and franchisee ownership on station prices.

The results do not support hypothesis 3. The main effect of a station's geographic dispersion has a positive effect on a station's price (b=0.0006, p<.1) but the interaction between geographic dispersion and the indicator for franchisee ownership is *negative* and significant (b=-0.001, p<.05). Franchised stations at the mean station dispersion of 23 miles charged an average price of $3.93 per gallon. Holding all other variables at their means, stations with a geographic dispersion one standard deviation higher (53 miles) charged an average price of $3.91. Stations at the 90th percentile of station dispersion (65 miles) charged an average price of $3.89. Figure 1b depicts the relationship between station dispersion and ownership form on station prices.

Of the control variables, wholesale price (*b*=0.9145, p<.001) and the average competitor price (*b*=.0366, p<.001) were both significant. All controls for station characteristics, with the exception of the number of pumps, the presence of restaurant, and the presence of a convenience store were statistically significant. Brand indicator variables were omitted from the output, however several major oil brands had a significant influence on price.

Robustness Checks

I performed several robustness checks of the data.

I examined alternative market definitions. I considered alternative market definitions that used the distance-weighted prices of stations within 2 miles of a focal station, the use of the average price of all stations within 2 miles without distance weighting, and the use of individual variables for the price of the 5 closest competitors. The findings were robust to the alternative geographic market definitions that account for competitor prices. I also ran the full model without the inclusion of Costco observations. While some independent stations emphasize low gas margins to drive convenience store sales, Costco and other hypermarket stations may use gas as a loss leader to increase store traffic. This strategy is difficult for most theory of retail gas pricing that assumes that gas stations try to profit on selling gas itself. The results for the hypotheses are similar with the omission of Costco stations.

DISCUSSION AND CONCLUSION

This study explores how the size and geographic dispersion of a multi-unit firm, which reduces its ability to control, monitor and coordinate pricing, interacts with ownership form to influence competitive behavior. Following double marginalization and strategic delegation theories, I developed agency theoretic arguments that link ownership forms with managerial incentives to price more aggressively and described how firm size and dispersion can moderate such relationships. The results do not support the hypotheses. The findings provide important implications for research on the link between ownership form and competitive behavior and for managers who compete against units with different ownership forms.

This paper contributes to the growing literature on the effect of ownership form on the competitive behavior of multi-unit organization firms. Consistent with other studies in retail gas settings (Lafontaine & Slade, 1997), I found that franchisee owned units tend to price higher than company-owned competitors. More importantly, I provide strong evidence that the effect of ownership form on competitive behavior varies with the size and geographic dispersion of the multi-unit organizations, but not in the direction expected by agency theory. This new theory and evidence enriches our knowledge of the link between ownership form and competitive behavior in three ways.

First, the contingent influence of firm size and geographic dispersion on franchisee stations helps to further our understanding of the underlying mechanisms driving the impact of ownership form on competitive behavior. The finding that franchise ownership is associated higher average prices than company ownership supports the findings of previous work on the influence of double marginalization in retail gas markets. However, the negative influence of the interactions between size and geographic dispersion on franchisee station price was a surprise and is counter to prior agency theoretic predictions that suggest that true owner-operators will be more competitive. Industry and academic literature often suggests that small franchisees are the first to cut prices during price cycles since they are incentivized to aggressively defend their market (Eckert, 2003). When discussing the challenges stations face when trying to increase margins, a multi-unit franchisee noted, “you’re at the mercy of your dumbest competitor. One of the mantras for many years has been: Gallons are forever, margins come and go” (Abcede & Vonder Haar, 2013). These findings and anecdotes suggest that multi-unit franchisees should charge a higher average price. However, my results suggest that multi-unit franchisees are even more price competitive than smaller franchisees. After controlling for the wholesale price of gas and competitive prices, the findings demonstrate that smaller franchisees charge a higher average price. One possible explanation is that single station owners are more conservative and less willing to engage in price wars. They face capital constraints and greater risk since they often have a significant portion of their personal wealth tied to their station. Multi-unit franchisees may also be more willing to use gasoline as a traffic driver for their convenience stores or other ancillary services. Future research can examine these potential explanations.

The finding that multi-unit franchisees charge a lower average price provides a potential new explanation for the widespread use of multi-unit franchisees. Prior research has discussed the difficulty and time consumed for franchisors searching for franchisees and has suggested that franchisors prefer to expand quickly instead of searching for new single-owner franchisees (Bradach, 1998). The finding that multi-unit franchisees charge lower average prices than an equivalent single-station owner is an additional benefit for franchisors in retail gas markets since they prefer higher volume and low-margin stations.

Second, the firm size and geographic dispersion contingencies I introduce are complementary to the market concentration contingency studied by Vroom and Gimeno (2007). While market concentration is external to the firm, firm size and geographic dispersion are internal organizational features relevant to organizational control. These new, internal factors help to further explain how competition between different ownership forms may vary across competitive contexts. Moreover, while market concentration influences a firm's incentive and motivation to credibly commit to higher prices, organizational size and geographic dispersion influence its capability of doing so. In this sense, the two new contingencies also fit into the Awareness-Motivation-Capability framework in the competitive dynamics literature (Chen, 1996) and show the value of integrating strategic delegation and organizational control research (Sengul et al., 2012).

Third, the paper supports the importance of integrating governance-based and capability-based theories for strategy research. While there is an immense amount of empirical work in both areas, the joint impact of ownership form and differing firm capabilities has received considerably less attention (Makadok, 2003; Williamson, 1999). The theory and findings show that the impact of different governance forms on firm behavior constrain a firm's capability to monitor and respond to local competition, or to control strategically (Eisenhardt, 1985; Ouchi, 1979). In this sense, the two lenses may be used in combination to better understand firm behavior.

Implications for Franchising Research and Practice

This study provides new insights for managers competing against different ownership forms of varying sizes and geographic dispersion. It highlights the challenges faced by multi-unit franchisees and the potential for variation in firm performance as a result of competition between different ownership forms. Within a firm, owners need to understand the implications of different ownership forms on the incentives and motivations of managers and employees. As discussed above, the negative influence of size and geographic dispersion on price suggests that more multi-unit franchisee owners may be advantageous to franchisors. Future inquiry focused on how the evolution of franchisor and franchisee ownership of units influences competitive behavior might further our understanding of the relationship between monitoring efficiency, ownership form, and competitive behavior.

Limitations and Future Research

This study has several limitations. First, a lack of observed sales volume information does not allow us to observe the performance implications of the theory. Future research can quantify how pricing practices of ownership forms and firm size and geographic dispersion influences performance. Second, while the theorizing depends on a change in pricing routines with larger firm sizes, I cannot directly measure routines for different firm sizes. Finally, while the use of a regional market provided a wide variety of competitive contexts, another region may face different competitive issues. Future research can examine competition between multi-unit organizations in other industries and locations.

Conclusion

Companies in all industries make choices about their ownership form and how to engage in competition. This study is a first attempt to examine how firm size and geographic dispersion moderate the influence multi-unit franchisee competitive behavior. Consistent with prior research, I find that franchisees charge a higher average price than company-owned units. However, contrary to agency theoretic predictions, I find that firm size and geographic dispersion have a negative influence on the franchisee retail gas station prices.

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Table 1.1: Key terms and definitions

Multi-Unit Organization	A chain organization that operates distinct units under the same brand name. Multi-unit organizations may be made of solely company-owned units, franchisee owned units, or a mix of the two.
Franchisor	A firm that owns a product, process, or service and sells the right to the use of its brand name, operating routines, and product specifications to another firm (a franchisee) for an ongoing fee.
Franchisee	A firm that has a contract to operate a unit under a brand name of another firm (a franchisor). The franchisee owns the unit's physical facilities.
Multi-Unit Franchisee	A franchisee that owns more than one unit.
Single-Unit Franchisee	A franchisee that owns one unit.
Company-Owned Unit	A unit that is owned by a franchisor and operated by a salaried employee.

Table 1.2: Retail gas station ownership forms and characteristics

	Company-Owned	Franchisee	Independent
Physical Station Owned By:	Refiner/ Franchisor	Franchisee	Independent Owner
Major Oil Company Branded:	Yes	Yes	No
Wholesale Prices Set By:	Stations sell the refinery's own gas	Refiner	Independent Wholesaler
Consumer Prices Set By:	Refiner	Franchisee or Lessee if Commission Agent	Station Owner
Supply Contracts:	Produce Their Own	Yes; 20-30 years initially, 1-3 years at renewal	No; Obtain best price from wholesaler
California Market Share[1]:	10%	80%	10%
Sample Market Share:	18%	71%	11%

[1] Source: California Energy Commission

Table 1.3: Summary statistics and correlation table

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7
1	Price	3.96	0.33	2.90	5.60	1						
2	Wholesale Price	3.04	0.27	2.50	4.44	0.86	1					
3	Average Competitor Price	10.95	5.56	0.00	21.89	0.08	0.13	1				
4	Convenience Store	0.96	0.19	0.00	1.00	0.08	0.02	-0.06	1			
5	Restaurant	0.11	0.31	0.00	1.00	0.02	0.00	-0.06	0.07	1.00		
6	Near Highway	0.79	0.40	0.00	1.00	0.01	0.00	0.25	-0.02	0.03	1.00	
7	Open 24 hours/day	0.42	0.49	0.00	1.00	0.01	0.01	-0.04	0.06	0.21	0.00	1.00
8	Diesel	0.56	0.50	0.00	1.00	0.05	0.00	-0.14	0.15	0.26	0.05	0.14
9	Auto Repair Shop	0.07	0.25	0.00	1.00	0.04	0.00	0.10	-0.01	0.04	0.07	-0.03
10	Truck Stop	0.02	0.15	0.00	1.00	0.00	0.00	-0.07	0.03	0.44	0.08	0.18
11	Car Wash	0.31	0.46	0.00	1.00	0.05	0.01	0.03	0.09	0.04	0.05	0.25
12	Number of Pumps	10.65	3.59	4.00	29.00	-0.02	0.00	-0.04	-0.09	0.19	0.12	0.28
13	Franchisee	0.62	0.49	0.00	1.00	0.04	0.02	0.00	0.12	-0.11	0.03	-0.04
14	Company-Owned	0.25	0.43	0.00	1.00	0.00	0.00	0.02	0.11	0.05	-0.05	0.05
15	Independent	0.08	0.27	0.00	1.00	-0.09	-0.03	-0.01	-0.43	0.03	0.01	0.01
16	Firm Size	9.87	11.50	1.00	30.00	0.02	0.00	0.07	0.08	0.00	-0.07	0.03
17	Geographic Dispersion	25.84	28.30	0.00	156.76	-0.04	-0.01	0.04	-0.12	-0.06	-0.02	-0.05
18	Single Station Owner	0.44	0.50	0.00	1.00	0.04	0.01	-0.05	0.12	0.07	0.04	0.08

		8	9	10	11	#	13	14	15	16	17	18
8	Diesel	1										
9	Auto Repair Shop	-0.07	1									
10	Truck Stop	0.08	0.13	1								
11	Car Wash	0.04	-0.01	-0.01	1							
12	Number of Pumps	0.24	-0.06	0.34	0.25	1						
13	Franchisee	0.06	0.09	0.03	0.02	#	1					
14	Company-Owned	-0.15	-0.05	-0.09	0.01	#	-0.73	1				
15	Independent	-0.03	-0.08	0.05	-0.11	0	-0.38	-0.17	1			
16	Firm Size	-0.17	-0.08	-0.05	-0.08	#	-0.49	0.74	-0.15	1		
17	Geographic Dispersion	-0.16	-0.08	-0.04	-0.13	0	-0.47	0.49	0.2	0.71	1	
18	Single Station Owner	0.14	0.06	0.05	0.08	0	0.38	-0.51	-0.04	-0.69	-0.81	1

Table 1.4: Random Effects Regression Results on Price Per Gallon

	Model 1		Model 2		Model 3		Model 4		Model 5	
DV: Price Per Gallon	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Wholesale Price	0.9143***	(0.003)	0.9150***	(0.003)	0.9145***	(0.003)	0.9141***	(0.003)	0.9145***	(0.003)
Average Competitor Price	0.0366***	(0.001)	0.0364***	(0.001)	0.0365***	(0.001)	0.0367***	(0.001)	0.0366***	(0.001)
Convenience Store	-0.0195	(0.035)	-0.0172	(0.035)	-0.0193	(0.035)	-0.0254	(0.035)	-0.0243	(0.035)
Restaurant	-0.0147	(0.018)	-0.0042	(0.018)	-0.0027	(0.018)	0.0027	(0.018)	0.0011	(0.018)
Near Highway	-0.1188***	(0.012)	-0.1194***	(0.012)	-0.1208***	(0.012)	-0.1193***	(0.012)	-0.1206***	(0.012)
Open 24 Hours	0.0229*	(0.010)	0.0230*	(0.010)	0.0288**	(0.010)	0.0227*	(0.010)	0.0274**	(0.010)
Diesel	0.0765***	(0.010)	0.0742***	(0.011)	0.0750***	(0.011)	0.0684***	(0.011)	0.0728***	(0.011)
Auto Repair Shop	-0.0485*	(0.019)	-0.0497**	(0.019)	-0.0632***	(0.019)	-0.0594**	(0.019)	-0.0634***	(0.019)
Truck Stop	0.1896***	(0.045)	0.1737***	(0.045)	0.1825***	(0.045)	0.1785***	(0.045)	0.1825***	(0.045)
Car Wash	-0.0156	(0.011)	-0.0145	(0.011)	-0.0216*	(0.011)	-0.0145	(0.011)	-0.0191+	(0.011)
Number of Pumps	-0.0024	(0.002)	-0.0016	(0.002)	-0.0023	(0.002)	-0.0015	(0.002)	-0.0023	(0.002)
Franchisee			0.0474**	(0.017)	0.0846***	(0.018)	0.0885***	(0.019)	0.0964***	(0.019)
Company-Owned			0.0207	(0.019)	-0.1372***	(0.041)	-0.0121	(0.022)	-0.1324**	(0.041)
Firm Size					0.0069***	(0.002)			0.0059***	(0.002)
Franchisee x Firm Size					-0.0117***	(0.002)			-0.0097***	(0.002)
Station Dispersion							0.0010**	(0.000)	0.0006+	(0.000)
Franchisee x Station Dispersion							-0.0024***	(0.000)	-0.0010*	(0.000)
Constant	0.8317***	(0.045)	0.8235***	(0.045)	0.8081***	(0.044)	0.7800***	(0.047)	0.7854***	(0.046)
Observations	47,078		47,078		47,078		47,078		47,078	
Number of FocalStation	446		446		446		446		446	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Figure 1.1: Riverside county sample gas stations

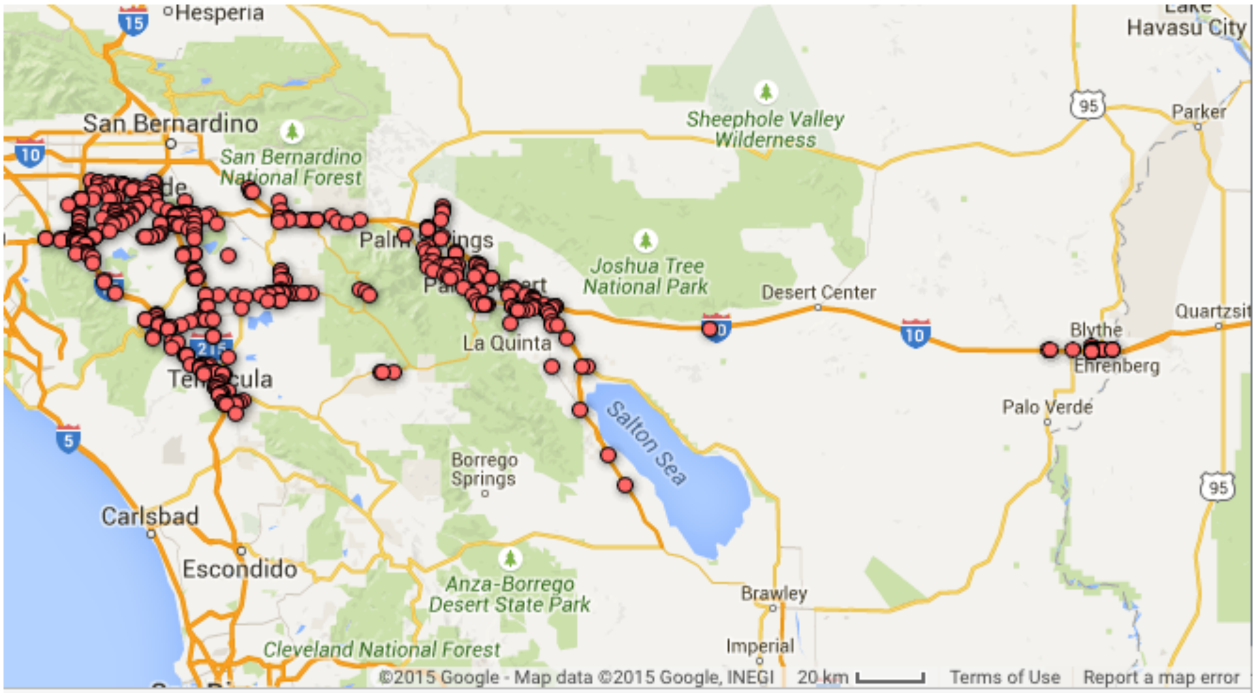


Figure 1.2: Predicted influence of multi-unit franchisee size on price

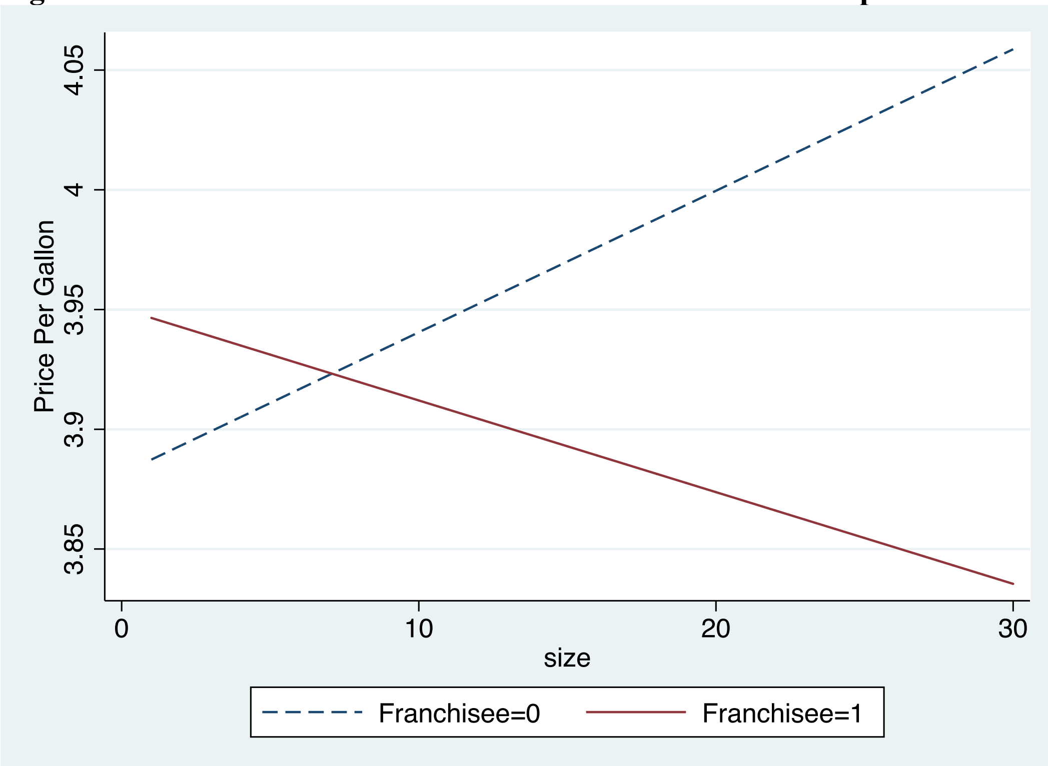
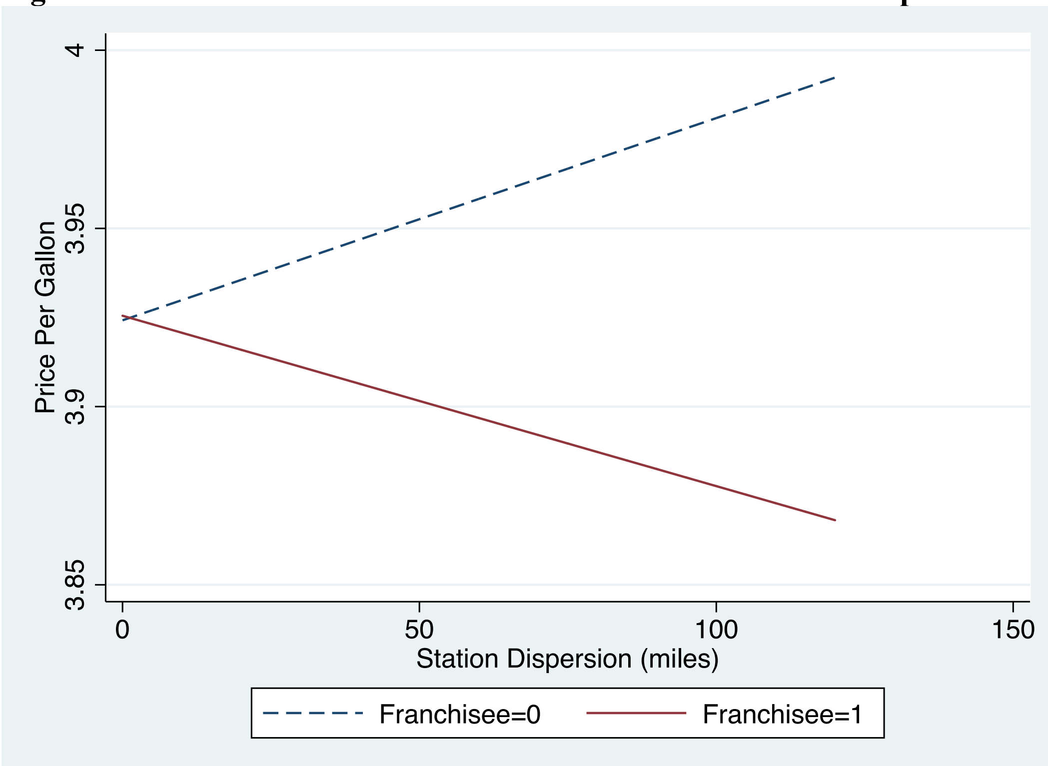


Figure 1.3: Predicted influence of multi-unit franchisee station dispersion on price



ESSAY 2

COMPETITOR IDENTIFICATION AND RETAIL GAS STATION COMPETITIVE INTERACTIONS

ABSTRACT

This paper explains how spatial distance and competitor similarity influence firm identification of a relevant competitors. In contrast to prior studies that have used surveys to identify competitors managers saw as most important, I identify a firm's competitors by examining the competitive actions and responses of units using data that isolates the timing of price changes in the Los Angeles retail gas market. Consistent with predictions, I find that retail gas stations monitor a small number of rival stations. The results demonstrate that distance to a rival and similarity between competitors on price and the number of pumps at a station interact to influence the weights assigned to competitors. The findings suggest that managers categorize competitors based on a smaller number of key dimensions than previously theorized.

INTRODUCTION

Why do firms aggressively react to the actions of some rivals while ignoring others? This questions has been of central importance to the understanding of competitive dynamics (Chen & MacMillan, 1992; Smith, Grimm, Gannon, & Chen, 1991). Recent work in competitive dynamics has sought to answer these questions by addressing the psychological and cognitive theories that may help to explain the patterns of actions and responses of firms (Chen, Kuo-Hsien, & Tsai, 2007; Livengood & Reger, 2010). While researchers have proposed several psychological and cognitive theories to complement competitive dynamics' awareness-motivation-capabilities perspective, this work remains largely untested empirically.

This paper combines research on the cognitive categorization of competitors and competitive dynamics to explain competitive behavior in retail gas markets. Specifically, this study examines the cognitive spatial boundaries of competition that managers in retail gas markets construct by deriving them from the competitive actions and reactions of stations.

Examining the boundaries of competition has been a popular area of study in both economics and management . Early Strategy research relied on aggregate, objective factors such as industry structure (Bain, 1956; Porter, 1980) and organizational attributes (Cool & Schendel, 1987; Hatten & Hatten, 1987; Hatten, Schendel, & Cooper, 1978) to identify competitors at the industry and strategic group levels. Later research on cognitive strategic groups sought to understand how managers devise competitive boundaries and select key competitors by examining their representations of the competitive environment. This research describes how organizations construct their own environments by interpreting their environment and acting on that interpretation as if it were true (McNamara, Deephouse, & Luce, 2003; Mcnamara, Luce, & Tompson, 2002; Porac, Thomas, & Baden-Fuller, 1989; Reger & Huff, 1993; Weick, 1979).

Faced with a complex environment, managers rely on social comparisons to identify a relevant set of rival firms that are most similar to their own (Cyert & March, 1963). The greater the similarity on a set of key attributes identified by management, the greater management perceives the competitive intensity of competition between the two firms (Baum & Lant, 2003a).

The identification of cognitive competitors underlies how a managers see the competition. Historically, studies concerned with how firms identify these cognitive competitors have relied on survey data that did not allow researchers to accurately assess the relative importance of competitors (e.g. Baum & Mezias, 1992; Porac et al., 1989). This study introduces a new approach to identifying cognitive competitors by examining retail gas station reactions to competitor price changes. I theorize that geographic proximity and the similarity of station specific features influence the perceived importance of a competitor. These hypotheses are tested using a panel dataset of hourly prices from 279 Los Angeles, CA gas stations from January 2014 to May 2014, or 635,147 station hours of observation. To identify the perceived relative importance of a competitor, I use the correlation coefficients of stations responding to a competitor price cut. Different time lags are used to allow for delays detecting competitor price changes. The data allows for the identification of the relative importance of competitors that influence a firm's price changes by identifying which competitors in a local market a focal station responds to most often. The results demonstrate that the similarity in geographic location and a small number of station features are important predictors of the relative importance of station's perceived competitors.

In summary, this paper introduces a new approach to identifying the percieved relative importance competitors of retail gas stations and goes on to develop and test a model of its determinants. The paper contributes an explanation for the patterns of competitive actions and reactions described by competitive dynamics research based on the importance of a cognitive competitor.

THEORETICAL BACKGROUND

Competitive Dynamics

The actions taken by a firm and its reactions to competitor actions determines a firm's economic performance (Porter, 1980; Smith et al., 1991). The field of competitive dynamics has explored the patterns and types of actions and reactions that firms make in a marketplace and how these influence firm performance. Competitive dynamics defines an action as a specific and detectable move, such as a new product or price change, to improve or defend a firm's competitive position. A reaction is an observable and discernible counteraction taken by a competing firm to defend or improve its competitive position (Chen, Smith, & Grimm, 1992).

Early research in competitive dynamics paid considerable attention to the performance outcomes and types of these actions and reactions, focusing on the intensity and the diversity of actions (Chen et al., 1992; Ferrier, Smith, & Grimm, 1999; Lee, Smith, Grimm, & Schomburg, 2000; Smith et al., 1991). Most of the research on the causes of competitive actions focused on firm-level constructs, such as economic incentives or TMT characteristics. Recently the focus has shifted to the underlying psychological and cognitive antecedents of these actions and reactions. Using the awareness-motivation-capability perspective (AMC), researchers have focused on how the subjective assessments and beliefs of managers influence competitive behavior (Chen, 1996; Chen et al., 2007).

The AMC perspective suggests that a competitor will not be able to respond to an action unless it is aware of the action, motivated to react, and capable of responding (Chen & Miller, 2012). The AMC perspective points to the underlying cognitive attention of managers as they interact with firms in their industry. Implicit in this is an assumption that managers and firms are limited information processors (March & Simon, 1958). Faced with a complex environment, individuals with limited attention react only to competitive actions they are aware of, motivated by, and capable of reacting to. Guiding this awareness and an understanding of one's capabilities are mental models of the firm and environment (Fiske & Taylor, 2013; Weick, 1979). These knowledge structures can have both benefits for information processing and lead to competitive blind spots (Walsh, 1995; Weick, 1979). For example, Livengood & Reger (2010) theorized that a firm's perceived identity domain may cause it to develop competitive blind spots and focus on defending markets and product spaces that are central to a firm's identity. They use the example of Volvo's reputation for safety as an identity domain, explaining that their reputation dominates its strategic actions and responses because of its continual reinvestment in safety features and awareness of rival threats in the product space.

Another powerful and important mental model is the understanding that managers have about identity of their competitors and the importance they assign to each competitor. To explain why managers act the way they do with competitors in retail gas markets, I focus on the formation of cognitive competitors.

Cognitive Categorization of Competitors

Research on the role of individual and collective cognition in determining the beliefs and actions of organizations has a long intellectual history (Selznick, 1957; Weick, 1979; Zucker, 1977). Cognitive strategic groups take a psychological approach to the identification of groups of competitors within an industry. Managers develop cognitive maps that evaluate the strengths and weaknesses of their firm and industry. They develop these cognitive maps through trial and error, observations of others, formal publications, and interactions with other industry members. The process results in a socially constructed understanding of the industry and what it takes to compete.

According to the cognitive perspective, managers observe other comparable firms to assess their own firms' competitive position and relative capabilities. Researchers, mainly drawing on the work of Simon and March (March & Simon, 1958; Simon, 1947), have noted that the environment that decision makers face is not purely exogenous. Uncertainties and complexities in the environment force managers to use simplifying heuristics to compare a potentially large number of firms and firm attributes. To manage such a task, managers use simple cognitive categories of competition to focus their limited attention capacity (Cyert & March, 1963; March & Simon, 1958; Ocasio, 1997; Simon, 1947). This information processing strategy enables boundedly rational managers to simplify the task of making sense of their complex competitive environment. Over time, competing managers' cognitive categories converge as their cognitive representations become intertwined with strategic choices and competitive interactions (Porac & Thomas, 1994; Porac et al., 1989). Thus, managers create their own percieved environment by classifying and simplifying the number of firms known to exist and defining their competitive set in a way that is small enough to monitor regularly.

The cognitive perspective has repeatedly found that managers develop simple, industry specific competitor categories and focus their attention on a small number of rivals. For example, Gripsrud and Gronhau (1985) found that grocery store managers in a Norwegian city perceived narrow competitive boundaries, with most managers identifying fewer than 5 rivals. Reger and Huff (1993) found that Chicago banks drew simple competitive distinctions on the basis of size and location. Porac and colleagues (1989; 1995) found that managers of Scottish knitwear firms created sharp and narrow competitive boundaries in a worldwide market. Porac and Thomas (1994) showed how grocery retailers in a small city defined cognitive competitors using simple categories like "supermarket" and "convenience store." Baum and colleagues (1997; 1992; 2003b) noted that three basic strategic features of hotels – geographic location, size and price – were fundamental to the competitor categorization process. Each of these studies rely on survey measures of firms to establish the identity of a firm's cognitive competitors. However, researchers have noted that surveys have the potential to be biased or inaccurately reflect reality (Podsakoff & Organ, 1986). Additionally, previous surveys have used a yes or no categorization scheme which does not allow the researchers to assess the factors that explain the relative importance of a cognitive competitor. This study uses data on competitive actions and reactions in the retail gas market to create a measure that captures the relative importance of cognitive competitors. I first provide some industry background and develop hypotheses drawn from previous industry and cognitive categorization research.

Cognitive Categorization in the Retail Gas Industry

Few industries have been subject to as much regulatory and academic scrutiny as retail gas stations. Over 75 empirical studies of retail gasoline were published between 2000 and 2012 (Eckert, 2013). One major stream of this research addresses the determinants of retail gasoline prices. Simplicities in production, distribution, and competition make the market an attractive one for researchers to analyze competition. Many studies cite the homogeneity of gasoline as a feature that makes it attractive for study (Barron, Taylor, & Umbeck, 2004). Additionally, most of the factors that are theorized to influence the price of gasoline at individual stations are observable to the researcher.

Gasoline is provided to retail gas stations by refineries or through independent distributors at various wholesale prices, often based on the contracts that a station has with a supplier. Gas stations have a number of contractual arrangements with suppliers. The incentives of station operators are thought to differ across stations according to the contractual arrangement with a station's supplier. Stations operate under four types of contractual arrangements. The first station type is the company owned and operated station. These stations are owned by a refiner and operated by a salaried employee who in some cases may receive a bonus based on the volume sold. The second type of station is a lessee dealer station. Refiners own the stations but lease them to a dealer who sets the price and owns the gasoline inventory. The third type of station is a franchisee owned station. These stations have a long-term supply contract with a refiner, are owned by independent dealers, and set the price of gas at their station. The fourth type of station is an independent, unbranded station. These stations do not have a long-term supply contract with a refiner, but instead purchase gasoline on the spot market and set the price of gas at their station. Brands often employ a mix of contractual arrangements, however, the majority of brands in California and the sample of this paper, Los Angeles, are franchisee owned and operated stations (~90%). Franchisees often own multiple stations in an area and operate stations under multiple brands.

While the gasoline sold at stations is largely homogeneous by state law, consumers may perceive product differences across brands due to the advertising of gasoline additives. Additionally, gas stations sell other products, such as car washes, convenience store goods, and automotive repair services. Some stations may be associated with grocery store or big box retailers. These services are thought to differentiate stations from one another in addition to their geographic location. However, in the short-run, price changes are the only competitive action available to stations. Station branding and amenities require large investments and time to change.

As described above, cognitive categorization theory suggests that firms select competitors based on similarity along factors that form the basis of competition. The research on retail gas stations focuses on five primary features that determine the price of retail gasoline: (1) local demographics and station location; (2) physical station characteristics; (3) brand and contractual arrangements; (4) station concentration, or the role of geographic space (Eckert, 2013). The largest amount of research has focused on the role of geographic proximity to competitors.

Competition in retail gas markets is primarily geographic. Since the product is homogenous, customers mobile, and prices visible, the distance to a competitor is thought to strongly influence a station's optimal price (Barron et al., 2004; Hosken, McMillan, & Taylor, 2008). The popular press claims that customers will travel long distances to save on gas (National Association of Convenience Stores, 2015). Manuszak and Moul (2009) find that customers near Chicago were willing to travel an additional mile to save 7 cents per gallon.

The recognition of geographical proximity as a key determinant of competition is at the basis of models of localized retail competition (Hotelling, 1929; Salop, 1979). The influence of distance between competitors on retail gas prices has been examined in a number of ways with some conflicting results. A popular area of research addresses the influence of market density or concentration of competitors on a station's price. While most studies that examine station counts in a local market find that station density in a market is negatively associated with a station's price (Barron et al., 2004; Shepard, 1993; Van Meerbeeck, 2003), several studies have found the opposite utilizing alternative local concentration measures (Hosken et al., 2008; Pennerstorfer, 2009). Studies have used differing definitions of local markets as well. Hastings (2004) noted that managers considered stations within 1 mile to be competitors while Barron *et al.* (2004) used a local market definition of 2 miles. I know of no studies that do not consider the closest station to a focal station to be the most influential, as most studies assume that the influence of competitor prices are weighted by the distance to a competitor in a linear or non-linear manner (e.g. Barron et al., 2004; Hastings, 2004; Lewis, 2008; Slade, 1987; Tappata, 2009; Verlinda, 2008).

While these studies address the influence of distance on price levels, they do not examine actual price changes or responses to price changes. With the exception of Atkinson, Eckert, and West (2009), studies of retail gas price movements at the station level use daily, weekly, or even monthly prices (e.g. Borenstein, Cameron, & Gilbert, 1997; Deltas, 2008; Noel, 2007; Verlinda, 2008). Atkinson et al. (2009), in a study of 27 gas stations in Guelph, Ontario, examined the "domino effect" of changing gas prices and found that price decreases ripple across a market like dominos but price increases do not. Studies of this "domino effect" of price changes find that rivalry decays with distance, but many of these studies rely on spatial econometric specifications of cross sectional prices and not studies of actual short-term price changes (e.g. Kalnins, 2003; Thomadsen, 2001).

The evidence suggests that geographic proximity increases the importance of a competitor in two ways. First, the nearest competitor may be the most important alternative for a firm's customers. If customers see a nearby station offers a lower price, that customer can easily choose to purchase gas at the lower price station. Studies of consumer search models in retail gas markets explain differences in station responses to wholesale price changes as the result of consumers' willingness to search lower prices. Researchers propose that the willingness of consumers to search depends on the magnitude of observed price changes, where larger price changes by a station encourage consumers to search out lower prices (Lewis, 2008; Tappata, 2009). Second, the nearest competitor is the easiest competitor for a manager to monitor for price changes. Managers also have search costs. Managers must monitor competitor prices by sending an employee to check prices in person or wait for a competitor's price to appear on an online website. The nearest competitor is the easiest and most important competitor to monitor to ensure that a station's price is in line with the competition. Studies that examine price changes at a daily level avoid considering such search costs by assuming that stations set the price of gas once a day optimally and know all relevant competitor prices. However, stations often change their prices throughout the day and the speed of response to a competitor price change varies by station. Atkinson et. al's (2009) study of the speed of response of 26 stations to one station's price cuts found that while some stations responded to the price change within hours, many stations took days. If managers are most concerned with the competitive actions of the closest station, we should observe competitive responses by managers to the nearest station most often. The importance weights assigned to nearby stations should be greater than more distant stations.

H1: Distance has a negative influence on the importance of a competitor.

A key finding of research on cognitive categorization is that the similarity of competitors plays a primary role in the identification of a cognitive competitor. Cognitive categorization processes allow managers to segment a large number of competitors on the basis of industry-specific factors. Managers identify rivals that are similar to themselves in to draw conclusions on how to conduct themselves in the marketplace.

The empirical literature on retail gas stations point out that while gas stations offer a homogenous product, associations exist between a station's price and a station's ancillary services, such as the presence of a car wash or service bay (Barron et al., 2004; Eckert & West, 2004; Hosken et al., 2008; Ning & Haining, 2003). Stations with ancillary services are theorized to have incentives to price gasoline higher as a result of the presence or draw of such services. A car wash, for example, is thought to be associated with a higher price of gasoline since drivers will visit a station to wash their car. The presence of these ancillary services provides a strong signal on which to identify how a station competes. Since competition among retail gas stations is localized, stations use different strategies to attract customers. Some stations choose to offer amenities, such as a car wash, that others in a local market do not have. Large stations may choose to offer a restaurant or convenience store or they may feature a large number of pumps that emphasize their gasoline business. I expect that station managers use these services as basic cues to categorize competitors in environments where there are multiple competitors of similar geographic distances. Following the literature on cognitive categorization, I predict that managers will be more likely to assign greater importance weights to competitors with similar station features.

H2: The similarity of station features positively influences the importance of a competitor.

A third dimension on which competitors in retail gas markets compare themselves is on price. A station’s price is directly linked to competitive actions, as it is the only short-term competitive action available to stations. The price a station sets provides an important signal of variation in market position. While stations sell a homogeneous product, wide price variation exists in retail gas markets. Some brands, such as Chevron or Shell, charge higher prices and achieve higher margins, while brands such as ARCO charge lower prices and appeal to budget conscious customers who want limited services. Small price changes by a station that is not price competitive with a neighboring station may be ignored while small price changes by a station that traditionally prices at the same level are likely to be quickly matched. I expect that stations in a local market that charge similar prices compete for the same customers, causing stations to pay greater attention to competitors in a market with similar prices.

H3: The similarity of competitor prices positively influences the importance of a competitor.

I expect that the distance to a competitor will negatively moderate the influence of price and station feature similarity on the importance of a competitor. While geographic proximity provides a clear indicator of importance, differentiation by competitors on the other dimensions that form the basis of competition makes it difficult for stations to easily assess the relative influence of a competitor on a station's sales. Competitor categorization theory predicts that a station with two competitors of equal distances will weight the competitor that is more similar on price and ancillary services as a more important competitor. However, when competitor stations are not an equal distance from a focal station, the importance of competitor similarity becomes more difficult to assess. The positive influence of the similarity of a station's prices and features on the importance of a cognitive competitor depends partially on the geographic proximity of competitors. I expect that distance will negatively moderate the influence of price and station feature similarity on the importance of a competitor. More distant competitors with similar station features and prices will have less influence than nearby stations with similar features and prices.

H4a: Distance negatively moderates the influence of station feature similarity on the importance of a competitor.

H4b: Distance negatively moderates the influence of price similarity on the importance of a competitor.

METHODS

Sample and data collection

To explore managerial perceptions of cognitive competitors, previous research has relied on ethnographic and manager survey data. However, while a "yes" or "no" identification scheme explains competitor selection, it does not allow for the assessment of the factors that determine the importance weights applied to cognitive competitors. Evidence suggests that survey data may not be an accurate representation of reality (Podsakoff & Organ, 1986). A number of studies have noted that the assumption that managers see their environment accurately is unlikely to be true (Clark & Montgomery, 1996). Additionally, managers may make errors in describing both their competitors' and their own actions. Managers tend to over-rate the aggressiveness of competitors' market actions (Prabhu & Stewart, 2001) and they tend to not sufficiently consider the decisions of other competitors (Zajac & Bazerman, 1991).

I attempt to identify the relative importance of competitors by using archival data on actual competitive interactions. My hypotheses were tested using a panel dataset of hourly price observations for 279 retail gas stations in Los Angeles, CA gas stations from January 2014 to May 2014, or 635,147 station hours of observation. The data was obtained from GasBuddy.com, a website where users crowd-source the price of gas at stations across the United States. GasBuddy has over 47 million users in North America. Consumers voluntarily post the location and prices of gasoline retailers. Community members are identified by a nickname and posts are time stamped to note when the prices were reported by a user. When a member reports prices to GasBuddy.com the prices are posted to the website immediately and members receive points that can be used in raffles for prizes such as gas gift cards. Membership is free and anonymous. Prices in the gas buddy database remain online for 24 hours. They are removed after 24 hours or until a new member reports a price for the station to keep the displayed prices current.

The GasBuddy.com data may exhibit several potential biases. First, while the timing of the price updates are time stamped, they depend on volunteer observations. Thus, stations may change prices or detect competitive price changes before the changes get reported to GasBuddy.com, causing the data to inaccurately identify the leaders of price changes in a market. For example, members reporting updated prices may simply report the new prices in the order that they encounter the stations on trips. Second, prices may be more likely to be reported more often and more quickly by members on heavily trafficked roads or at stations known to charge low prices. The setting of the study and timing and length of data collection helps to mitigate the influence of these potential biases. The large population and heavy traffic in Los Angeles County helps to reduce the potential that less trafficked stations are reported to GasBuddy.com less often. Los Angeles County had 7.7 million vehicles registered in 2014 (California Department of Motor Vehicles, 2015), making it one of the most heavily trafficked counties in America. Second, as I will discuss below, prices were collected at hourly intervals.

The hourly collection of prices and the long time frame of the data collection (6 months) helps to mitigate the concern that the timing of price reporting by members is not indicative of the leader and follower price changes.

Additional data to investigate the propositions has been collected from a variety of sources. Station features, such as the presence of a car wash, the number of pumps, or the presence of a convenience store, come from GasBuddy.com. Geolocation data was obtained from Google Maps. Station ownership information was collected from the Los Angeles County Assessor Office, the California Energy Commission, the California Franchise Tax Board, and the South Coast Air Quality Management Control District. The ownership information allows for the identification of co-ownership of stations in the sample.

The final sample includes hourly price observations for 279 stations from January 2014 – May 2014. A map of the stations used in the final sample can be seen in Figure 1.

Dependent Variable

Competitor Importance. I take advantage of the high frequency, longitudinal structure of the data to define each station's key competitors by identifying the frequency of price matching between rival stations in a local market. The dependent variable was constructed by capturing the separate correlation coefficients for all price increases and decreases in the Los Angeles market. Hourly time series data for all stations in the sample was used to create an indicator variable for every hour that a price increase and decrease was observed. A correlation matrix was then created to capture the correlation coefficient for all price increases and decreases between stations that occurred in the following three hours. Since it is likely that station managers do not immediately notice competitor price changes, the procedure was repeated for a lagged time interval of six hours. This process was then repeated for price increases. The data allows the researcher to conclude that station X lowers its price within 3 hours of station Y lowering its price for 50% of all price decreases by station Y. The measure is not a strict correlation coefficient, since the lagged measures identify only if a station responded to a price change within the three or six-hour window.

I report both the three and six hour time lags since the shorter time lag is less likely to capture spurious correlated price changes, but it decreases the amount of time available for stations to discover and respond to competitor price changes. Station pairs owned by the same firm and stations that made fewer than 12 price changes (two per month) were dropped from the analysis. The average station made 28 observed price changes during the 6 month time period. The most active station made 114 observed price changes.

I use a three-mile market definition to identify potential competitors. All station-pairs outside of a station's three-mile radius were dropped from the analysis. This is a slightly larger and more conservative estimate than the one or two mile radius researchers have previously used when describing how stations define their competitive market (Barron et al., 2004; Hastings, 2004).

Independent Variables

Distance. I account for the focal station's distance to a competitor by measuring the Euclidean distance between the two stations. Station latitude and longitude was geocoded with data from Google Maps.

Similarity of Station Features. Data that note the presence of a convenience store, restaurant, auto repair shop, and car wash were obtained from GasBuddy.com. I computed similarity as four indicator variables where 1 indicates that both stations had or did not have a convenience store, restaurant, auto repair shop or car wash. When the two stations differ on a feature, the value becomes 0.

Price Similarity. The observed hourly price of a gallon of regular unleaded gasoline was obtained from GasBuddy.com for both the focal station and a station's rivals. Since prices fluctuated over the period of observation, a mean average price may not accurately capture the similarity between two stations. Instead, each station's weekly average deviation from the market average price was measured for each week of observation. The average deviation from the weekly average price was then used to measure a station's weekly average price position. Following Baum & Lant (2003), the similarity or price differential between a station pair *i* and *j* was computed as:

$$Similarity_i^{Price} = \frac{1}{\sqrt{(Average\ Price\ Devation_i - Average\ Price\ Deviation_j\ )^2}}$$

Thus, larger values mean that stations offer a similar average price.

Control Variables

I control for several variables representing alternative explanations for competitor pair's level of importance. Indicator variables were used to account for the *brand* a focal station and a competitor station belong to. Brand affiliation has a strong influence on price levels as the result of differences in the wholesale price of gas charged by the refiner. There may be unobserved incentives or routines across brands that influence the competitive intensity of station owners.

Brand data was obtained from GasBuddy.com. Because my arguments focus on the effects of station feature similarity on competitor importance, I also control for the *proximity to a highway*. The proximity of a station to a highway is associated with higher overall price levels. An indicator variable was used to identify station pairs that were both within a half-mile of a highway exit.

Finally, I also control for unobserved firm effects by including indicator variables for each responding firm in the dataset. Station ownership information was obtained from the Los Angeles County Assessor Office, the South Coast Air Quality Management District, the California Energy Commission, the California Franchise Tax Board, and the California Department of Alcohol and Beverage Control. The five lists were cross referenced to identify station ownership. Stations with shared company names, owner names or company addresses were coded as one firm.

Model Specification

The theory proposes that differences in station and firm characteristics will influence competitor identification. The dependent variable aggregates the panel data to a single measure of competitor importance. The final data is a cross-sectional dataset that explains the frequency of competitor price matching for each station pair. Ordinary least squares regression was used to test the hypotheses. As noted above, firm indicator variables were included in the analysis but were omitted from the reported results.

RESULTS

Table 1 presents sample statistics and correlations. Table 2 and 3 report regression results for price decreases with three and six-hour time lags. Table 4 and 5 report regression results for price increases with three and six-hour time lags. Each table presents three models. The first examines only distance and the control variables. The second includes the station similarity measures. The third is the full model with the interactions between the station similarity measures and distance.

Overall, the results demonstrate that the use of a 6-hour time lag to capture the measure of competitive importance provides a stronger model fit. The six-hour time lag provides a slightly better model fit and the largest number of statistically significant results. The direction of the effects of the independent variables was largely consistent across both temporal measures. The coefficients reported below are for the full model using the six-hour time lag unless otherwise specified.

The results report support for Hypothesis 1. The distance between competitors has a negative and significant influence on the importance of a cognitive competitor in the reduced models for both increases and decreases. Holding all other variables at their mean values, a competitor one mile from a focal station is 1.7% less important than a station that is a half mile from a focal station. Using the results of the competitor importance for price increases, a competitor one mile from a focal station is 2.1% less important than a station a half mile from a focal station.

The results show limited support for Hypothesis 2, that the similarity of competitor station features positively influences the importance of a cognitive competitor. With the exception of auto repair shop similarity in model 11, similarity between competitors with a car wash, auto repair shop, and restaurant were insignificant across both temporal measures for price increases and decreases. However, the number of pumps at a station had a positive and statistically significant influence on the importance of a competitor for both temporal measures for price increases ($b=0.0997$, $p<.01$) and decreases ($b=0.1151$, $p<.001$).

The data supports Hypothesis 3. The similarity of prices between competitors has a positive influence on the importance of a cognitive competitor for both price decreases and increases ($b=0.0475$, $p<.001$ and $b=0.0209$, $p<.01$).

The results partially support Hypothesis 4a and 4b. Distance negatively moderates the magnitude of the influence of price similarity ($b=-0.0295$, $p<.001$) for price decreases and increases ($b=-0.0131$, $p<.05$). Competitor importance in a local market increases with price similarity across the board, but the increase is slightly less for more distant stations. Distance negatively moderates the magnitude of the influence of the number of pumps similarity for both for price decreases ($b=-0.0762$, $p<.05$) and increases ($b=-0.0309$, $p<.05$). Distance does not have a significant effect on the magnitude of influence of convenience store, restaurant, car wash, or auto repair shop similarity.

Among the control variables, USA Gasoline brands had significant and positive influences on the importance of a cognitive competitor for stations responding to price increases ($b=-0.0602$, $p<.01$), suggesting that USA Gasoline stations were more likely to respond to competitor price increases. ARCO and Chevron brands had significant and positive influences on the importance of a cognitive competitor for the stations initiating price decreases, suggesting that competitors were more likely to respond to price decreases by these brands.

DISCUSSION AND CONCLUSION

This research joins a stream of literature that models retail gas station behavior by combining insights from competitive dynamics and cognitive categorization theory. The paper contributes an explanation of the importance of a cognitive competitor based on the geographic proximity and similarity between stations on a number of dimensions that form the basis of competition. I use a new method to identify the perceived relative importance of competitors of retail gas stations by examining the competitive actions and responses of stations in their local market. Within this overview, this work offers several key insights.

Examining the competitive actions and reactions of managers allows for the isolation and identification of the cognitive competitors of units in a retail market. Previous work on the identification of cognitive competitors has relied primarily on survey data. This data is subject to bias and ignores the relative level of importance that managers place on competitors. Specifically, competitive decisions involve trade-offs. Boundedly rational managers must rely on pricing routines and select how often and when to respond to competitor actions. This study is a first step in linking the findings of competitive dynamics on the speed and types of competitor responses with the cognitive antecedents of such competitive actions. I believe that the availability of the measure gives it the potential to facilitate future empirical studies on the causes, consequences, and timing of competitive actions.

The findings support the assumptions made by traditional economic analyses of retail gas markets on the influence of geographic proximity. Stations are more likely to respond quickly to price changes by a near competitor than one farther away. However, the results demonstrate that even in highly competitive markets, managers segment their competitors on dimensions other than geographic space. This finding sheds additional light on the outcomes of the cognitive categorization process. A central assumption of the cognitive perspective is that managers categorize potential competitors along simple competitive dimensions to select a small group of key competitors managers consistently monitor (McGee & Thomas, 1986). The cognitive perspective has said less about how managers prioritize scanning their key competitors and how the selection of their competitors influences competitive behavior. The findings of this study support the assumption that managers categorize competitors along simple competitive dimensions, yet they propose a much simpler cognitive categorization scheme than previous industry research suggests. While stations in the sample have an average of 7.6 stations within a 2.5 mile radius, the average station responds within a six hour time period to price cuts of only 4 stations. This study suggests that just three key dimensions – distance, the number of pumps (a proxy for station size and market share), and price – predict the intensity of competition between key competitors. Future research can examine how survey measures that have examined the selection of cognitive competitors differ from measures that explain how firms interact with their competitors.

An increase in the availability of data on retail gas prices has led to a large increase in the scholarly attention on retail gas markets. Additionally, high price levels in California and across the nation have led to attention from the public and popular press on the competitive behavior of retail gas stations. Yet, with the exception of Atkinson et. al. (2009), I have found no other studies that examine the exact timing or diffusion of price changes in retail gas markets. My results lead to slightly different conclusions than previous studies of the determinants of retail gas prices. The results may reflect important theoretical distinctions. Studies of the influence of geographic space between competitors on retail price levels focus on the influence of *all* stations in a geographic space (Barron et al., 2004; Hastings, 2004; Lewis, 2008; Verlinda, 2008). This study focuses on price changes, not relative price levels, but the results demonstrate that stations have a much more selective definition of their competitor set and that geographic distance between stations is not the sole determinant of prices. Managers may still be aware of other local stations' prices, but they pay attention to a smaller and more selective number of competitors based on similarity in price, the number of pumps and distance than economics and industry research has traditionally described.

These findings have several implications for managers and regulators. First, as just discussed, traditional economic definitions of retail competitive boundaries may not accurately capture the attention of managers. Stations selectively ignore competitors within their local market and instead focus an identified set of similar key competitors. Stations that want to avoid fierce price competition can analyze their competitors on these key dimensions to try to find more profitable price positions and actions. For example, stations that compete with stations that differ on average price or the number of pumps may be able to capture higher margins or more volume without a reaction from some local competitors. Second, the findings that station feature similarity influences competition has important implications for the location, branding, and amenity choices made at retail gas stations. While price changes are the only short-run competitive action stations can change, differentiation on a number of non-price dimensions can lead to less contested market segments. Stations compete more intensely with similar stations, while stations that differentiate themselves on price, size, and distance are able to make competitive actions that are either not responded to as quickly or ignored. Thus, owners looking at new station locations or owners that want to alter stations can differentiate themselves on these dimensions to lessen the intensity of competition with other stations. Third, the results emphasize the importance of regular pricing surveys by managers. The evidence suggests that it took stations at least three hours to respond to price cuts and increases by rival stations. Understanding the lag time between a station's price cut and a rival's response has the potential to lead to more profitable competitive actions.

The results presented have several limitations. While the findings correspond to literature on cognitive competitors that claims that managers segment the market based on a few key dimensions, I do not have direct evidence that managers monitored stations based on these dimensions. While I offer an explanation for competitive behavior based on firm and competitor factors, this study does not demonstrate the influence of such competitive behavior on firm performance. Future research can combine the findings with performance data to explore this issue. The setting of the study, the Los Angeles retail gas market, may also have sample specific features that limit the generalizability of the findings. Future research can examine the findings in other settings and industries. While the measure of competitive importance uses actual competitive actions and reactions, the measure is a proxy for cognitive competitors. Prior work that compares managers' mental models to their actual competitive actions suggests that managers do not always correctly report their behavior (Clark & Montgomery, 1996). Future research can compare managers' perceptions of competitor importance to the measure of competitor importance used in this study. Finally, while the long time frame with which the study occurred helps to improve the validity of the measure of competitor importance, it limits the findings that can be drawn from specific competitive situations. Future research can examine specific shocks or time periods using similar data.

While this study examines the timing of price changes to derive a measure of competitor importance, future research can explore the temporal component of such competitive actions.

The study does not address the motivational component of the AMC perspective. Future research can explore other psychological constructs around motivation to see if they influence their awareness of the competition and competitive actions.

Conclusion

The results demonstrate the ability to measure the perceived importance of a competitor using the competitive actions and reactions of retail gas stations. I find that stations segment the market based on a smaller number of key dimensions than previous research suggests. Geographic proximity, the number of pumps, and the similarity of a station's price have a positive influence on the importance of a competitor. The geographic proximity of a competitor negatively moderates the influence of similarity on the number of pumps and price. The findings open the door to transforming the study of cognitive competitors from a construct that explains managerial perceptions to a subject that explains competitive behavior.

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Figure 2.1: Los Angeles sample stations

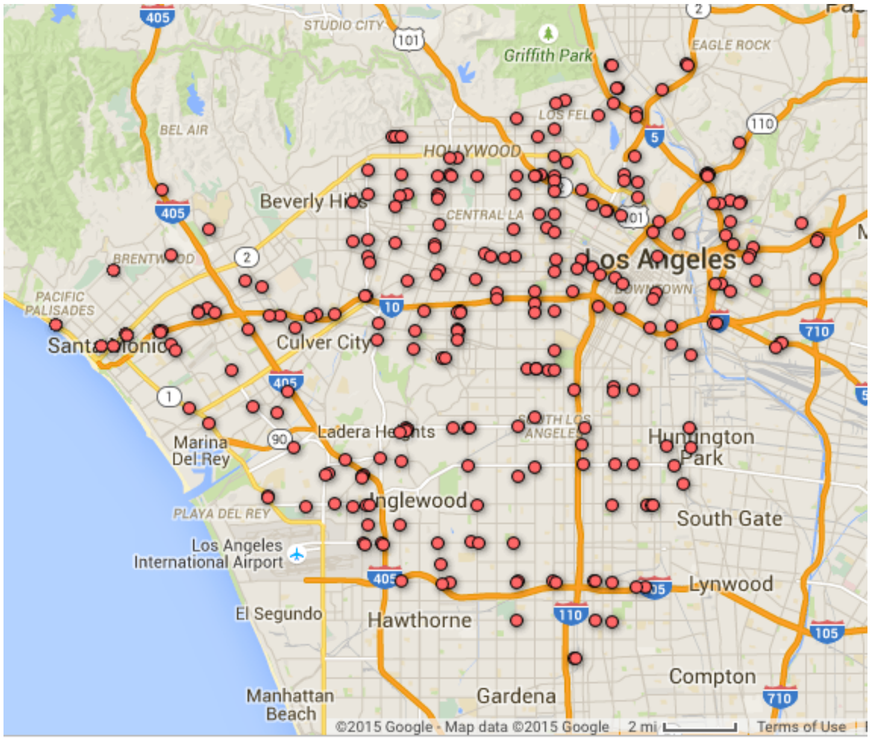

Table 2.1: Summary statistics and correlation table

		Mean	S.D.	Min	Max	1	2	3	4	5	7	8	9	10	11
1	Decreases - 3 Hours	0.04	0.08	0.00	1.00	1.00									
2	Decreases - 6 Hours	0.05	0.09	0.00	1.00	0.82	1.00								
3	Increases - 3 Hours	0.06	0.08	0.00	1.00	0.24	0.23	1.00							
4	Increases - 6 Hours	0.08	0.09	0.00	1.00	0.23	0.24	0.85	1.00						
5	Distance	1.90	0.75	0.03	3.00	-0.17	-0.15	-0.16	-0.14	1.00					
6	Car Wash Similarity	0.80	0.40	0.00	1.00	0.00	0.00	0.04	0.03	0.02	1.00				
7	Convenience Store Similari	0.83	0.38	0.00	1.00	-0.02	-0.03	-0.01	-0.01	-0.01	-0.08	1.00			
8	Number of Pumps Similarit	0.32	0.14	0.08	0.50	0.06	0.06	0.07	0.07	-0.01	-0.01	-0.03	1.00		
9	Restaurant Similarity	0.94	0.24	0.00	1.00	-0.01	0.00	-0.01	-0.01	-0.01	0.01	-0.08	0.07	1.00	
10	Auto Repair Shop Similarity	0.68	0.47	0.00	1.00	-0.01	0.01	0.00	0.00	-0.02	-0.04	0.08	-0.03	-0.02	1.00
11	Price Similarity	62.88	644.38	0.91	2480.87	0.07	0.06	0.03	0.01	-0.01	-0.02	-0.02	-0.02	-0.06	0.00
12	Highway Proximity Similar	0.59	0.49	0.00	1.00	0.03	0.02	0.02	0.03	-0.04	0.05	0.01	0.04	0.05	-0.07
13	ARCO	0.14	0.35	0.00	1.00	0.00	0.03	-0.01	-0.01	0.00	0.07	-0.04	0.02	-0.08	0.01
14	Chevron	0.20	0.40	0.00	1.00	0.01	0.01	-0.01	0.01	0.01	0.04	0.09	0.02	-0.04	-0.02
15	Mobil	0.13	0.33	0.00	1.00	-0.02	-0.02	0.01	0.03	0.00	-0.07	0.05	0.01	0.04	0.03
16	Shell	0.12	0.32	0.00	1.00	0.01	-0.01	0.02	0.01	-0.01	-0.14	0.07	0.00	0.00	0.04
17	USA Gasoline	0.03	0.17	0.00	1.00	0.01	0.01	0.01	0.01	-0.01	0.04	0.03	0.05	0.03	0.04
18	Valero	0.05	0.22	0.00	1.00	0.02	0.00	0.04	0.03	0.02	0.00	0.02	0.05	0.03	-0.05
19	76	0.18	0.39	0.00	1.00	0.00	0.00	-0.01	-0.02	-0.02	0.03	-0.14	-0.02	0.05	-0.02
20	Independent Brand	0.12	0.32	0.00	1.00	-0.02	-0.01	-0.03	-0.04	0.03	0.02	-0.04	-0.11	-0.02	-0.03

		12	13	14	15	16	17	18	19	20	21
11	Price Similarity	1.00									
12	Highway Proximity Similarity	0.00	1.00								
13	ARCO	-0.02	-0.01	1.00							
14	Chevron	0.00	0.00	-0.20	1.00						
15	Mobil	-0.02	0.00	-0.15	-0.19	1.00					
16	Shell	0.02	-0.03	-0.15	-0.18	-0.14	1.00				
17	USA Gasoline	-0.01	0.05	-0.07	-0.09	-0.07	-0.06	1.00			
18	Valero	0.01	0.01	-0.09	-0.12	-0.09	-0.08	-0.04	1.00		
19	76	0.02	-0.01	-0.19	-0.24	-0.18	-0.17	-0.08	-0.11	1.00	
20	Independent Brand	-0.01	0.01	-0.15	-0.18	-0.14	-0.13	-0.06	-0.08	-0.17	1.00

Table 2.2: Competitor identification results – three period lagged price decreases

	Model 1		Model 2		Model 3	
	Coef.	SE	Coef.	SE	Coef.	SE
Distance	-0.0175***	(0.001)	-0.0177***	(0.002)	0.0022	(0.010)
Car Wash Similarity			-0.0010	(0.004)	0.0105	(0.009)
Convenience Store Similarity			-0.0036	(0.004)	-0.0063	(0.010)
Number of Pumps Similarity			0.0287**	(0.011)	0.1066***	(0.027)
Restaurant Similarity			0.0017	(0.007)	0.0033	(0.016)
Auto Repair Similarity			-0.0021	(0.003)	-0.0015	(0.008)
Price Similarity			0.0122***	(0.000)	0.0054***	(0.000)
Distance x Car Wash Similarity					-0.0059	(0.004)
Distance x Convenience Store Similarity					0.0013	(0.005)
Distance x Number of Pumps Similarity					-0.0411**	(0.013)
Distance x Restaurant Similarity					-0.0009	(0.007)
Distance x Auto Repair Similarity					-0.0005	(0.004)
Distance x Price Similarity					-0.0356***	(0.000)
Highway Similarity	0.0015	(0.002)	0.0015	(0.003)	0.0020	(0.003)
Initiating Stations:						
ARCO	-0.0022	(0.006)	-0.0001	(0.008)	0.0002	(0.008)
Chevron	0.0016	(0.006)	0.0047	(0.008)	0.0051	(0.008)
Mobil	-0.0059	(0.006)	-0.0062	(0.008)	-0.0063	(0.008)
Shell	0.0016	(0.006)	0.0013	(0.008)	0.0018	(0.008)
USAGasoline	0.0056	(0.008)	0.0014	(0.010)	0.0008	(0.010)
Valero	0.0067	(0.007)	0.0061	(0.009)	0.0069	(0.009)
76	0.0003	(0.006)	-0.0026	(0.008)	-0.0027	(0.008)
Independent	-0.0046	(0.006)	-0.0013	(0.008)	-0.0021	(0.008)
Responding Stations:						
ARCO	-0.0150	(0.014)	-0.0209	(0.017)	-0.0215	(0.017)
Chevron	-0.0111	(0.012)	-0.0212	(0.015)	-0.0224	(0.015)
Mobil	-0.0166	(0.016)	-0.0292	(0.021)	-0.0324	(0.021)
Shell	-0.0093	(0.013)	-0.0083	(0.015)	-0.0098	(0.015)
USAGasoline	-0.0090	(0.013)	-0.0188	(0.016)	-0.0209	(0.016)
Valero	0.0048	(0.021)	-0.0019	(0.024)	-0.0022	(0.024)
76	-0.0043	(0.012)	-0.0104	(0.014)	-0.0118	(0.014)
Independent	-0.0202+	(0.012)	-0.0315*	(0.014)	-0.0345*	(0.014)
Constant	0.0771***	(0.013)	0.0779***	(0.018)	0.0421	(0.027)
Observations	5,092		3,288		3,288	
R-squared	0.087		0.120		0.124	

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 2.3: Competitor identification results – six period lagged price decreases

	Model 4		Model 5		Model 6	
	Coef.	SE	Coef.	SE	Coef.	SE
Distance	-0.0171***	(0.002)	-0.0173***	(0.002)	-0.0080	(0.013)
Car Wash Similarity			-0.0027	(0.005)	0.0118	(0.011)
Convenience Store Similarity			-0.0009	(0.005)	-0.0048	(0.012)
Number of Pumps Similarity			0.0378**	(0.013)	0.1151***	(0.032)
Restaurant Similarity			0.0031	(0.008)	-0.0146	(0.020)
Auto Repair Similarity			0.0010	(0.004)	-0.0029	(0.010)
Price Similarity			0.0171***	(0.000)	0.0475***	(0.000)
Distance x Car Wash Similarity					-0.0075	(0.005)
Distance x Convenience Store Similarity					0.0020	(0.006)
Distance x Number of Pumps Similarity					-0.0411**	(0.016)
Distance x Restaurant Similarity					0.0091	(0.009)
Distance x Auto Repair Similarity					0.0018	(0.005)
Distance x Price Similarity					-0.0295***	(0.000)
Highway Similarity	0.0004	(0.003)	-0.0007	(0.003)	-0.0001	(0.003)
Initiating Stations:						
ARCO	0.0078	(0.008)	0.0156	(0.009)	0.0156+	(0.009)
Chevron	0.0059	(0.007)	0.0155+	(0.009)	0.0160+	(0.009)
Mobil	-0.0012	(0.008)	0.0028	(0.010)	0.0027	(0.009)
Shell	0.0034	(0.008)	0.0057	(0.010)	0.0061	(0.010)
USA Gasoline	0.0095	(0.010)	0.0083	(0.013)	0.0079	(0.012)
Valero	0.0048	(0.009)	0.0076	(0.011)	0.0083	(0.011)
76	0.0073	(0.007)	0.0097	(0.009)	0.0097	(0.009)
Independent	0.0024	(0.008)	0.0113	(0.010)	0.0106	(0.010)
Responding Stations:						
ARCO	-0.0025	(0.017)	-0.0173	(0.021)	-0.0184	(0.021)
Chevron	-0.0095	(0.015)	-0.0213	(0.018)	-0.0224	(0.018)
Mobil	-0.0023	(0.020)	-0.0192	(0.025)	-0.0225	(0.025)
Shell	0.0111	(0.015)	0.0037	(0.018)	0.0023	(0.018)
USA Gasoline	0.0138	(0.016)	-0.0026	(0.019)	-0.0043	(0.019)
Valero	0.0132	(0.025)	0.0120	(0.029)	0.0120	(0.029)
76	0.0202	(0.014)	0.0107	(0.016)	0.0094	(0.016)
Independent	-0.0060	(0.015)	-0.0241	(0.017)	-0.0268	(0.017)
Constant	0.0699***	(0.016)	0.0637**	(0.022)	0.0485	(0.032)
Observations	5,092		3,288		3,288	
R-squared	0.103		0.129		0.137	

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 2.4: Competitor identification results – three period lagged price increases

	Model 7		Model 8		Model 9	
	Coef.	SE	Coef.	SE	Coef.	SE
Distance	-0.0167***	(0.002)	-0.0145***	(0.002)	0.0194	(0.011)
Car Wash Similarity			0.0032	(0.004)	0.0137	(0.010)
Convenience Store Similarity			-0.0030	(0.004)	-0.0015	(0.010)
Number of Pumps Similarity			0.0373**	(0.012)	0.1156***	(0.029)
Restaurant Similarity			-0.0094	(0.007)	0.0165	(0.017)
Auto Repair Similarity			0.0051	(0.003)	0.0117	(0.009)
Price Similarity			0.0092**	(0.000)	0.0236***	(0.000)
Distance x Car Wash Similarity					-0.0055	(0.005)
Distance x Convenience Store Similarity					-0.0008	(0.005)
Distance x Number of Pumps Similarity					-0.0412**	(0.014)
Distance x Restaurant Similarity					-0.0132+	(0.008)
Distance x Auto Repair Similarity					-0.0037	(0.004)
Distance x Price Similarity					-0.0136*	(0.000)
Highway Similarity	0.0011	(0.002)	0.0031	(0.003)	0.0032	(0.003)
Initiating Stations:						
ARCO	-0.0014	(0.007)	0.0027	(0.008)	0.0036	(0.008)
Chevron	-0.0018	(0.007)	0.0046	(0.008)	0.0051	(0.008)
Mobil	0.0024	(0.007)	0.0062	(0.008)	0.0064	(0.008)
Shell	0.0060	(0.007)	0.0092	(0.009)	0.0092	(0.009)
USA Gasoline	0.0097	(0.009)	0.0097	(0.011)	0.0098	(0.011)
Valero	0.0164*	(0.008)	0.0144	(0.010)	0.0151	(0.010)
76	0.0008	(0.007)	0.0017	(0.008)	0.0019	(0.008)
Independent	-0.0039	(0.007)	0.0034	(0.008)	0.0031	(0.008)
Responding Stations:						
ARCO	-0.0155	(0.015)	-0.0118	(0.019)	-0.0113	(0.019)
Chevron	-0.0076	(0.013)	-0.0103	(0.016)	-0.0111	(0.016)
Mobil	-0.0008	(0.017)	-0.0126	(0.022)	-0.0139	(0.022)
Shell	0.0192	(0.013)	0.0211	(0.016)	0.0201	(0.016)
USA Gasoline	0.0429**	(0.014)	0.0467**	(0.017)	0.0458**	(0.017)
Valero	0.0052	(0.022)	0.0156	(0.026)	0.0178	(0.026)
76	0.0202+	(0.012)	0.0202	(0.015)	0.0201	(0.015)
Independent	-0.0054	(0.013)	-0.0011	(0.015)	-0.0028	(0.015)
Constant	0.0525***	(0.014)	0.0356+	(0.019)	0.0285	(0.028)
Observations	5,092		3,288		3,288	
R-squared	0.136		0.145		0.150	

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 2.5: Competitor identification results – six period lagged price increases

	Model 10		Model 11		Model 12	
	Coef.	SE	Coef.	SE	Coef.	SE
Distance	-0.0157***	(0.002)	-0.0149***	(0.002)	0.0088	(0.012)
Car Wash Similarity			0.0046	(0.005)	0.0129	(0.011)
Convenience Store Similarity			-0.0048	(0.005)	-0.0114	(0.011)
Number of Pumps Similarity			0.0413**	(0.013)	0.0997**	(0.032)
Restaurant Similarity			-0.0158*	(0.008)	0.0034	(0.019)
Auto Repair Similarity			0.0072+	(0.004)	0.0158	(0.010)
Price Similarity			0.0072*	(0.000)	0.0209**	(0.000)
Distance x Car Wash Similarity					-0.0044	(0.005)
Distance x Convenience Store Similarity					0.0034	(0.005)
Distance x Number of Pumps Similarity					-0.0309*	(0.015)
Distance x Restaurant Similarity					-0.0098	(0.009)
Distance x Auto Repair Similarity					-0.0046	(0.005)
Distance x Price Similarity					-0.0131*	(0.000)
Highway Similarity	0.0011	(0.003)	0.0034	(0.003)	0.0036	(0.003)
Initiating Stations:						
ARCO	0.0027	(0.007)	0.0032	(0.009)	0.0039	(0.009)
Chevron	0.0076	(0.007)	0.0119	(0.009)	0.0122	(0.009)
Mobil	0.0106	(0.007)	0.0121	(0.009)	0.0123	(0.009)
Shell	0.0106	(0.007)	0.0093	(0.009)	0.0093	(0.009)
USA Gasoline	0.0168+	(0.010)	0.0187	(0.012)	0.0187	(0.012)
Valero	0.0208*	(0.008)	0.0211*	(0.011)	0.0216*	(0.011)
76	0.0032	(0.007)	0.0047	(0.009)	0.0048	(0.009)
Independent	-0.0029	(0.007)	0.0008	(0.009)	0.0005	(0.009)
Responding Stations:						
ARCO	-0.0243	(0.016)	-0.0228	(0.020)	-0.0223	(0.020)
Chevron	-0.0165	(0.014)	-0.0240	(0.017)	-0.0247	(0.017)
Mobil	0.0013	(0.019)	-0.0137	(0.024)	-0.0150	(0.024)
Shell	0.0250+	(0.014)	0.0240	(0.017)	0.0231	(0.017)
USA Gasoline	0.0637***	(0.015)	0.0609**	(0.019)	0.0602**	(0.019)
Valero	-0.0039	(0.024)	-0.0038	(0.029)	-0.0030	(0.029)
76	0.0213	(0.013)	0.0160	(0.016)	0.0158	(0.016)
Independent	-0.0138	(0.014)	-0.0212	(0.017)	-0.0225	(0.017)
Constant	0.0550***	(0.015)	0.0527*	(0.021)	0.0080	(0.031)
Observations	5,092		3,288		3,288	
R-squared	0.183		0.184		0.187	

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

ESSAY 3

THE PRICE SEEMS RIGHT: EXPLAINING SUBOPTIMAL STRATEGIC PRICING DECISIONS

ABSTRACT

While management researchers have studied the causes of suboptimal pricing decisions, previous research has emphasized experimental or aggregate corporate data rather than pricing and performance data from actual competitive interactions. This research takes a behavioral approach to examining competitive market factors that lead to systematic pricing errors using non-experimental data. I utilize a hand-collected, longitudinal dataset of prices and performance outcomes for 26 retail gas stations to determine a daily, station specific profit-maximizing price. These prices are then compared to the actual prices charged to assess the accuracy of station pricing decisions. I find that the number of competitors in a market have a positive influence on the accuracy of pricing decisions at low numbers of competitors but a negative influence at high numbers of competitors. Stations with a visible competitor that compete head-to-head set more accurate prices than stations without a competitor visible competitor.

INTRODUCTION

"It's [pricing] not an exact science"

- Steve Kehler, Gas Station Owner (Wilen, 2008)

Large literatures in economics, behavioral decision theory, marketing, and strategy have developed to explain pricing decisions at the individual, business unit, and corporate levels. This work has revealed a great deal about how people make strategic pricing decisions in experimental situations and how action and reaction patterns between competitors in an industry influence firm performance. However, few studies in strategy have examined how managers and employees make actual strategic pricing decisions and how pricing practices influence firm performance.

This paper applies behavioral approaches explain how stations deviate from optimal pricing positions in retail gas markets. In many markets, price setting is the primary form of short-run competition. Pricing decisions in retail gas markets are the only short-run strategic option that stations have to improve performance. Retail gas stations sell a largely homogenous product. The other factors that form the basis of competition – location, brand, and station amenities – are long-term, fixed investments. A station's pricing decision is therefore the most important short-run strategic consideration.

Traditional economics research on the pricing behavior of retail gas stations assumes that stations set daily optimal prices. This research characterizes pricing decisions as a daily profit-maximizing game. The quantity of gasoline sold at each station is assumed to be a function of a station's posted price and the price of the prices posted at rival stations (Slade, 1986). Stations are assumed to set prices at the profit-maximizing own and rival price combinations each day to sell the quantity demanded by consumers. However, a considerable amount of management research has documented how organizational and cognitive factors can cause firms to make suboptimal competitive decisions that lead to differences in firm performance.

This study examines factors that influence sub-optimal strategic pricing decisions on a day to day basis. I use a behavioral approach to develop theory that explains how managers deviate from rational models of decision-making. I test this theory in a longitudinal analysis of 26 retail gas stations in Orange County, CA. One reason for the lack of prior work on how managers deviate from optimal or profit-maximizing pricing decisions is the difficulty of obtaining performance data at the appropriate level of analysis. The most commonly used sources of performance data in management research aggregate at least to the line of business level, which makes it difficult to assess the performance implications of product pricing decisions. This study introduces performance data at the unit level to question the assumption that retail gas stations price optimally. To assess the accuracy of station pricing decisions, I compare the station's actual daily posted prices to a theoretically optimal price that I derive from that station's demand curve. I define high accuracy as a price that is close to the daily theoretically optimal price. Low accuracy deviates from the daily optimal price. A random effects specification is then used to analyze how pricing accuracy shifts in response to the theorized factors.

In summary, this paper introduces a new measure of the accuracy of firm pricing decisions and develops and tests a model of the determinants of pricing accuracy. The empirical findings demonstrate that managers systematically deviate from profit-maximizing pricing.

THEORY AND HYPOTHESES

The traditional economic model of the firm assumes that management seeks to maximize profit. Such analysis assumes firms set optimal price. For example, an optimal pricing decision under such an assumption would price to result in a volume of sales that maximizes the difference between the firm's total revenue and total cost. This requires the decision maker have a complete knowledge of the firm's and the competition's demand functions. A significant body of research has demonstrated that this assumption is unrealistic.

Findings indicate firms often don't quickly update prices in response to wholesale or competitor price changes. Menu costs, for example, have been the subject of much research to explain the failure of firms to instantly adjust prices (Ball and Romer, 1990; Levy, 2007; Mankiw, 1985), as traditional economic theory suggests that exogenous market shocks should be immediately passed on to consumers. A number of researchers have paid particular attention to the managerial and organizational costs of such price adjustments (Dutta, Zbaracki, and Bergen, 2003; Rotemberg, 2005; Zbaracki *et al.*, 2004; Zbaracki and Bergen, 2010). These authors emphasize that organizational complexities and significant managerial time and attention is required to make price changes, which can influence time lags in the price adjustment process.

A long line of research examining how managers actually set prices demonstrates that the pricing process departs quickly from traditional economic theory. Hall and Hitch's (1939) investigation into pricing noted that a striking feature of firms was that their pricing policies did not aim to maximize profits, but instead they applied rules of thumb that "charged prices based on full average cost" or a traditional or convenient price that had proved acceptable in the past (p. 18-19). Cyert & March (1963) devoted a chapter to price determination routines at a department store accurately predict actual pricing and purchasing decisions. Zbaracki & Bergen

(2010), emphasized the political factors and managerial effort required to assess and change prices in an ethnographic study of a price change within one firm.

Blinder et al. (1998) surveyed a number of CEOs in an attempt to discover the most relevant theories for the causes of price stickiness. When asked why executives did not change prices more often, respondents commonly cited that frequent price changes would antagonize customers, firms preferred to vary non-price elements and firms tacitly agree to stabilize prices with customers and competitors. When asked why firms did not raise their prices in advance of anticipated cost increases, respondents cited the fairness of such action or concern about antagonizing customers, their lack of confidence in their forecasts and the fear that competing firms won't raise prices. The authors conclude that such responses demonstrate the numerous ways that managers deviate from traditional economic theory.

Prior research on the process of setting prices has revealed that the relevant factors for each pricing decision can vary from situation to situation, even in the same industry or firm (Zbaracki and Bergen, 2010). The numerous factors that must be taken into account when making pricing decisions has forced organizations to enact decision-making procedures to compensate for the bounded cognitive abilities of decision makers (March and Simon, 1958). Decision makers use a number of cognitive heuristics or shortcuts, which can systematically bias decision outcomes (Tversky and Kahneman, 1974). The heuristics and biases research in psychology emphasizes the limitations of heuristics, although other scholars argue that fast and frugal heuristics have benefits (DeMiguel, Garlappi, and Uppal, 2009; Gigerenzer, 2008; Taylor, Bennell, and Snook, 2009).

Studies demonstrate that these heuristics or shortcuts can systematically influence individual decision processes, and they are elicited by influences inherent in many organizational decision settings (e.g., McNamara and Bromiley, 1997). For example, Shapira & Shaver (2014) demonstrate that managers often confound marginal profits with changes in average profit. Average profit becomes a strong anchor for managers, causing them to forgo positive net present value investments. Organizations may enact decision rules that are embedded in routines to replace the idiosyncratic heuristics decision makers may otherwise use (Cyert and March, 1963). These decision rules and routines reduce the need to continually solve the same problems and increase the reliability and the predictability of decision outcomes. Examples include pricing to earn a target rate of return, cost plus pricing, or price matching to maintain market share. These decision rules make it easier for managers to make repeated strategic decisions. In order to explore how these decisions depart from a theoretically optimal decision outcome, I examine how managers make strategic pricing decisions in retail gas markets.

Pricing in Retail Gas Markets

Despite a large number of studies documenting the pricing behavior of retail firms under different market conditions, few studies examine the how managers deviate from optimal or profit-maximizing pricing decisions with real world data. One reason for this is that firms often differentiate their products, making it difficult to assess the substitutability of the products. Another reason is the lack of data on pricing decisions and performance outcomes at a high enough frequency and a low enough level of analysis to allow researchers to link pricing decisions with performance outcomes. The challenge is finding a setting where (i) sellers offer a homogeneous good, (ii) pricing is the primary strategic option, (iii) performance outcomes are observable at a high enough frequency to link pricing decisions with performance outcomes, and

(iv) the information available to managers setting prices is available to the researcher. The retail gas market offers such a setting.

Retail gas markets are an ideal area for the study of pricing decisions since managers make daily decisions on how to price their product. Station managers make repeated pricing decisions and can receive daily feedback on the performance outcomes of such decisions. Retail gas prices are *the* critical short-run strategic decision for stations. Prices are posted for consumers and the competition to easily see. However, a wide range of individuals and organizations in many different settings make the pricing decisions. For example, franchisees that own 1-2 stations owned roughly 80% of California gas stations in 2012 (California Energy Commission, 2012). While there is some corporate pricing guidance for these franchisees, franchisees have the power to set prices at their stations at the prices they determine. Thus, the retail gas market is an ideal setting to examine factors that lead managers to deviate from a profit-maximizing price.

Retail gas stations compete with one another in local geographic markets. Since the product is homogeneous, customers are mobile, and the prices are visible, the distance to a competitor is thought to be the most important factor in determining a station's profit-maximizing price (Barron, Umbeck, and Waddell, 2008; Hosken, McMillan, and Taylor, 2008). Often, to assess competitor prices, station employees have to physically drive to nearby competitors to survey prices. Employees then relay prices back to a pricing manager or owner who determines the daily price. Industry literature suggests that stations repeat this at intervals that range from 2-3 times per week to several times per day (Hastings, 2004; *Miller Oil Improves Response Times*, 2014; Omer, 2013; Pilcher, 2001).

Economic models that predict retail gas prices assume that the quantity of gasoline sold at each station depends on its posted price and the price of and distance to rival stations. Such models assume that in each period the station managers set a profit maximizing price that takes into account the pricing strategies of other sellers and the expected level of demand.

Of the many factors that could cause managers to deviate from this model and fail to set a daily optimal price, I focus on the influence of competitive factors which have been the focus of previous research on the causes of price variation in retail markets and that can be tested with archival data. I apply a behavioral explanation for how the number of stations in a market and the visibility of competitors can cause stations to deviate from an optimal price.

Number of competitors

Theoretical and empirical evidence suggests that the number of competitors in a market will have an inverted U-shaped influence on the accuracy of pricing decisions. In economic theory, as the number of competitors in a market increases, the ability of a firm to extract higher profits decreases since customers can more easily find an alternative firm with a lower price. The density of competitors should lead to lower and less dispersed prices. Empirical evidence finds mixed support for this prediction. Studies of price dispersion in retail gas markets find that price variation decreases as the number of competitors in a market increases (Barron, Taylor, and Umbeck, 2004; Lewis, 2008). However, some theoretical and empirical studies have come to the opposite conclusion, finding high price variation in highly competitive markets (Dahlby and West, 1986; Sorensen, 2000). While a market with more densely populated sellers should associate with a more competitive market, scholars developed models where more densely populated sellers results in *greater* price dispersion (Rosenthal, 1980; Samuelson and Zhang, 1992; Stiglitz, 1987). These models note that the counter-intuitive results occur because increased search costs result in incomplete information on the part both customers and firms (Stigler, 1961), the inability of firms to adjust prices quickly due to menu costs (Fishman, 1992), and greater demand uncertainty in markets with a greater number of competitors (Dana Jr, 1999).

To make optimal pricing decisions, managers must correctly infer how a rival's price and the distance to that rival impact a station's sales. At low levels of competition, station managers have less information about how to weight the impact of a competitor's price and the distance, making it more difficult to set a daily optimal price. For example, a station with 4 competitors within one mile can be relatively certain that a 20% increase in the price of gas will have a negative effect on profits as consumers can more easily search and travel to nearby competitors. A station manager with only 1 competitor, however, needs to have a better understanding of the station's demand curve to draw the same conclusion.

At low levels of competition, increasing the number of competitors in a market makes it easier to gauge an appropriate price to charge. However, at high levels of competition, observing competitive behavior becomes more complex and difficult. Managers in retail markets have to physically drive to the competition to survey prices, making it more costly to search for up to date competitor price information. Stations often collect competitor price data at routine intervals. At high levels of competition, the potential for undetected competitive price cuts increases and it becomes more difficult to assess the causal implications of a competitor's actions. This suggests that the number of competitors have an inverted U-shaped influence on the accuracy of pricing decisions

H1: The number of competitors in a market has an inverted U-shaped influence on the accuracy of pricing decisions.

Visibility of competitors

A visible competitor influences managerial attention in ways that might produce deviations from an optimal price position. I expect that managers overweight the importance of visible competitor actions to the detriment of their own potential profit.

A body of research suggests that the managerial time and effort required to monitor competitors can lead firms to have a myopic view of their competition. One of the key contributions of Cyert and March's (1963) behavioral theory of the firm is the idea that organizations conduct a limited search for information. Cyert and March characterize search as simple-minded, in that decision makers search in the neighborhood of the problem symptom to find a satisfactory alternative. Such a search process leads to the risk that managers may make myopic choices when important information requires additional search beyond the neighborhood of the problem.

Academic and practitioner literatures have discussed the search routines of gas station managers (Atkinson, Eckert, and West, 2009; Hastings, 2004). Managers typically check the prices at stations within one to two miles of their station three to seven days a week. A manager will then set prices or relay prices back to a central pricing office for analysis. However, when a competitor is visible from another station's property, that station's price is readily available to station managers all day. A visible station serves as a real-life example of an availability bias (Tversky and Kahneman, 1974). Industry literature often discusses the simple search routines of stations with a visible competitor. One station manager noted to a local paper, "I almost always set my price by what the Stop & Shop next door is selling their gas for (Omer, 2013)". A Canadian station manager described his price matching strategy with a station across the street, explaining that “We're just going to compete with them, no matter what price it is (CBC News, 2009).” Visible competitors pay close attention to one another and change their behavior accordingly, often without considering other competitors in a market. Their constant focus on a small fraction of their relevant competitors is likely to cause deviations from an optimal pricing position.

Empirical evidence on pricing decisions of stations on adjacent corners supports this theory. Scholars have noted that while stations across the street from one another may change the price differential with which they price, they rarely change their rank order. The lowest price station on a corner generally remains the lowest priced station at all times (Chandra and Tappata, 2011). However, similar stations that are *not* visible to one another frequently change their rank order based on when they update prices, changes in underlying wholesale costs and competitor prices. The findings have been used to test consumer and manager search theories since visibility means essentially zero search costs.

If station managers price optimally, they should consider the full set of relevant local competitors when making daily pricing decisions. In practice, the presence of a visible competitor means that managers are likely not performing a full search of local competitor prices when a visible competitor makes a price change or when underlying wholesale prices prompt the need for a change, causing stations to overweight the influence of the visible competitor. This suggests that visible competitors negatively influence on the accuracy of pricing decisions.

H2: Visible competitors negatively influence the accuracy of pricing decisions.

DATA AND METHODS

The analysis was completed in two stages. The first stage analysis uses a sales volume equation for each station to capture the price elasticity of demand and the cross-price elasticities of a station's competitors. I then use the estimated parameters to calculate an optimal price for each station for each day in the dataset and compare this optimal price to the actual prices charged by a station to create a measure of a station's pricing accuracy. The second stage analysis uses a random-effects analysis to examine how the number of competitors and the visibility of competitors influence the accuracy of station prices.

Stage One: Model Specification

I begin by determining a profit-maximizing, optimal price for each station in the sample using a model of the volume sold as a function of the price of a focal station, the price and distance of a station's 5 nearest competitors, and indicator variables for each day of the week to account for differences in demand. Slade (1986) and Barron, Umbeck, and Waddell (2008) use a similar model.

$$q_i = a + b(p_i) + \sum_{j=1}^{4} c\left(w_j p_j\right) + \sum_{k=1}^{7} d\, D_k + \varepsilon \tag{1}$$

where:
q_i = the quantity of gas sold at station *i*
p_i = price of gas at station I
p_j = price of gas at the 4 closest rival stations
w_j = inverse of distance to rival station (miles)
D_k = Indicator variables for the day of the week

Retail gas stations compete with one another in their local market but not with distant stations, allowing them to exhibit local market power (Chamberlin, 1948). The degree of connection or influence between stations is thought to lessen quickly with distance until it becomes zero. A number of recent papers in economics have analyzed the importance of spatial differentiation on competitor gas prices (see Eckert, 2013 and Hosken, McMillan, and Taylor, 2008 for recent surveys) under the assumption that geographic proximity may influence the extent to which customers switch to other stations given a change in a station's relative price. Following Barron *et al.* (2008) I assign a weight *w* to closer stations by assuming that the importance of a competitor's price is approximated by a linear function of distance. The weight assigned to the price of each competitor is equal to two minus the distance in miles that the competitor is from the focal station in order to weight closer stations in order to weight closer stations more heavily. Researchers have previously noted that stations often define their local market as a two-mile radius (Hastings, 2004).

Investigation of the first-stage sales equations for each station required daily sales volume data. The data for this study was collected by visiting 26 stations in Orange County, California at the same time each day. By state law, stations are required to have visible meters that record the number of gallons sold at each pump each day. These meters were read at the same time each day on consecutive days to calculate the number of gallons sold during the 24 hour period. Stations were selected based on their proximity to the author's residence, the presence of functioning and easily accessible volume meters, and to ensure variation in brand. Collecting one day of sales volume required visiting stations for two consecutive days. A number of days were missed at random during the data collection period due to personal factors. The final sample of sales data consists of 100 days of sales data collected between September, 2014 and

March, 2015. Daily prices for the focal station, competitor stations prices and geographic coordinates were obtained from the Oil Price Information Service (OPIS). The geographic coordinates were used to calculate the Euclidean distance between each station.

Table 3 presents summary statistics and zero-order correlations. I used a fixed-effects regression analysis to model the first stage sales equation. Table 1 presents the regression result of this analysis. The coefficients for the focal station's price and the rival station prices represent each station's price elasticity of demand and the competition's cross-price elasticity of demand. A station's own price elasticity or coefficient explains how the quantity of gas sold changes in response to a change in price while the competitor cross-price elasticities explain how a station's sales volume changes in response to a competitor price change. Table 1 reports two models. Model A estimates cross-price elasticities for the nearest 4 stations individually. However, the very high correlation between competitor prices makes it difficult to estimate individual cross-price elasticities, as reflected by the large number of insignificant and negative competitor cross-price elasticities. Model B reports the alternative approach that uses the mean distance weighted price for all stations within 2 miles of a station. To capture this average market price, I summed the distance weighted competitor prices and divide by the number of stations to obtain an alternative index of the price of competitors as done by Barron et. al. (2008). The combined weighted cross-price elasticity is thus with respect to the changes in the mean distance weighted price of all competitors and not a single competitor. Since the underlying theory of localized competition concerns the impact of a focal station's change in price on sales, both measures capture the reaction or response of consumers to changes in relative prices.

The coefficients in both Model A and B are in the expected directions. Own-station price elasticities are negative while the competitor cross-price elasticities are positive. As noted above, due to collinearity, the cross-price elastiticities for competitors 2 to 4 in Model A do not have significant coefficient results. The indicator variables for the days of the week were each significant. Gasoline sales were significantly higher on Thursdays, the traditional day of the week with the highest sales. The use of logged prices produced similar results.

The coefficients for the focal station's price and the rival station prices were then used in each individual station's profit function to determine a station specific profit-maximizing price for each day in the sample. Following, Slade (1986) and Barron *et al*. (2008), I assume that each station sets a price in each period that maximizes profits based on the station's demand curve that was derived in equation 1. I derive the station's daily profit-maximizing price using equation 2, which calculates a station's daily maximum profit as the total markup multiplied by the amount of gasoline sold. By using the estimates of the parameters in equation 1, it is possible to solve the equation to determine the profit-maximizing price.

(2)

$$\max \pi_i = margin\ x\ volume$$

$$\max \pi_i = (p_i - mc_i)\ x\ q_i$$

$$\max \pi_i = (p_i - mc_i)\ \ x\ \ (a + b(p_i) + \sum_{j=1}^{4} c\left(w_j p_j\right) + \sum_{k=1}^{7} d\, D_k)$$

$$\frac{\partial \pi}{\partial p_i} = a + 2bp_i - bmc_i + \sum_{j=1}^{4} c\left(w_j p_j\right) + \sum_{k=1}^{7} d\, D_k$$

$$p = \frac{a - bmc + \sum_{j=1}^{4} c\left(w_j p_j\right) + \sum_{k=1}^{7} d\, D_k}{-2b}$$

where:
mc = the marginal cost of gasoline (wholesale price + taxes)

Table 2 lists the calculated average profit-maximizing prices and average prices charged during the period of observation. In general, the actual prices charged at stations were higher than the calculated profit-maximizing price. The average profit-maximizing prices vary greatly across the sample ($2.99 to $3.69). Figure 1 graphs the average profit-maximizing prices, the average actual prices charged, and each station's daily wholesale price of gasoline during the period of observation. Stations do not always price higher than the profit-maximizing price. On average, stations charged *lower* than optimal prices when average prices were near $4.00 per gallon, but *higher* than optimal prices while prices were near $3.00 per gallon. A fire at the Torrance, CA ExxonMobil refinery caused the increased wholesale gas prices on February 18th, 2015.

Stage Two: Model Specification

The second stage analysis uses the calculated optimal daily price for each of the 26 stations to examine the theorized factors that influence pricing errors. To model such within-station effects I use panel data collected over the course of the period of the data collection. The final sample includes observations for 26 stations over approximately 200 days, or 4,910 total observations. Table 3 presents the summary statistics and zero-order correlations for all variables.

Dependent Variable

Pricing Accuracy. The accuracy of a firm's pricing was measured as the absolute value of the difference between the actual posted price and the optimal, profit-maximizing price for gas for each day calculated in equation 2. High values represent less accurate pricing. Low values represent more accurate pricing decisions. The daily price of regular unleaded gasoline for the focal station was obtained from the Oil Price Information Service (OPIS) and was checked against prices recorded during station visits.

Independent Variables

Number of Competitors. Prior research on retail gas markets has used different definitions of the relevant market. Hastings (2004) concluded that a one-mile radius was the typical market definition of Los Angeles area gas station managers from interviews with station managers. Barron et. al. (2008) used a two-mile definition when using data from a large retailer. I utilized both measures by counting the number of stations within one and two-mile radius of the focal station.

Visibility of Competitors. I identified stations with a visible competitor by visiting each station and recording the presence of a visible competitor from a station's property with an indicator variable.

Control Variables

I control for several variables representing alternative explanations for a station's deviation from a profit-maximizing price. First, given the importance of the daily wholesale price of gas and competitor prices in determining prices, I control for the daily station *wholesale price* of gas and the *average competitor price*. OPIS supplied daily station specific wholesale prices and competitor prices. The presence of station amenities were included since alternative revenue streams may influence a station to charge more or less than a profit-maximizing price. GasBuddy.com was used to create indicator variables that note the presence of a *convenience* *store, restaurant, auto repair shop,* and a *car wash.* Finally, indicator variables for each *day of the week* were included to account for shifts in demand.

Model Specification and Robustness Checks

The theory proposes that the number of competitors and the visibility of competitors influence the accuracy of prices charged at a station. To model the influences of such factors on individual stations, I used a random effects model as it allows for the inclusion of variables that do not vary across time. Given that the hypothesized explanatory variables did not vary over time within stations, fixed effects estimates were not feasible. Additionally, a Hausman test rejects the fixed effects specification in favor of the random effects alternative (χ^2 (15) = 0.14, $p < 0.7034$).

RESULTS

Table 4 presents regression results on pricing accuracy. Overall, I can strongly reject the null hypothesis that all of the regression coefficients equal zero (Model 2: $F(4,910) = 321.5$, $p<.001$). The hypothesized model offers a limited but clear ability to explain the differences in pricing accuracy of stations (Model2: between $R^2 = .4399$).

Model 2 presents the results for the one-mile market definition for the number of competitors. The number of competitors within one mile has a positive and statistically significant influence on pricing accuracy ($b = 0.062$, $p < 0.01$) while the squared value for the number of competitors within one mile has a negative and statistically significant influence on pricing accuracy ($b = -0.013$, $p < 0.01$), consistent with Hypothesis 1. Model 3 presents similar results for the number of competitors in a market using a two-mile market cutoff. The number of competitors within two miles has a positive and statistically significant influence on pricing accuracy ($b = 0.044$, $p < 0.05$) while the squared value for the number of competitors within two miles has a negative and statistically significant influence on pricing accuracy ($b = -0.004$, $p < 0.05$). Figure 2 graphs the predicted influence of the number of competitors on pricing accuracy using the two-mile cutoff.

I do not find support for Hypothesis 2, that visible competitors positively influence the direction of pricing error. Stations with a visible competitor have a *negative* and statistically significant influence on the accuracy of pricing decisions ($b = -0.05$, $p < 0.05$) in Model 2 and ($b = -0.062$, $p < 0.05$) in Model 3. The results suggest that stations with visible competitors price 5 to 6 cents closer to the optimal price than stations without a visible competitor.

Among the control variables, both the average competitor price and the wholesale price of gas for each station significantly influence the accuracy of firm pricing decisions in both Model 2 and 3. The average competitor price has a negative ($b = -0.194$, $p < 0.01$ in model 3) influence on the accuracy of firm pricing decisions while the wholesale price of gasoline has a positive influence on the accuracy of pricing decisions ($b = 0.14$, $p < 0.01$ in model 3). The presence of a convenience store had a negative and strongly significant influence on the accuracy of pricing decisions ($b = -0.177$, $p < 0.001$), however, only two stations in the sample did not have a convenience store. The presence of an auto repair shop had a positive and statistically significant influence on the accuracy of pricing decisions ($b = 0.05$, $p < 0.05$). While the use of a measure of absolute value does not allow me to examine if stations use gasoline as loss leaders for these alternative revenue streams, the results support the conclusion that these amenities alter station pricing behavior. The presence of a car wash or a restaurant at a station did not significantly influence on the accuracy of pricing. Finally, I observed a statistically significant positive influence for Thursday. Thursday is traditionally the busiest day of the week at gas stations and in the sample. The positive and statistically significant effect for Thursday ($b = -0.013$, $p < 0.05$) suggests that stations do not fully take advantage of the increased demand on this day. All other days of the week did not significantly influence the accuracy of pricing decisions.

DISCUSSION AND CONCLUSION

Broadly speaking, this paper contributes an explanation for the heterogeneity of firm performance in retail markets based on competitive pricing decisions, a construct often examined under the implicit or explicit assumption of rationality. The work offers three major insights.

First, examining retail gas station pricing decisions compared to a theoretically optimal price point allows for the examination of managerial judgments of strategic pricing decisions in a market where pricing is the primary short-run determinant of firm performance. This study is a first step in understanding what factors influence managers to depart from rational models of pricing. The findings demonstrate that station behavior is hardly optimal. A number of stations in the sample deviate greatly from a theoretically optimal price. For example, three stations Valero, Shell, and Chevron branded stations on average priced at least 50 cents *above* the theoretically optimal price. These three stations shared two common features. First, they are located near or directly across the street from a significantly cheaper ARCO. Second, each of the stations featured an amenity that the ARCO stations did not have. The Valero features an auto repair shop, the Chevron a very large convenience store, and the Shell a car wash. Managers at these stations may not be able to compete with the cheaper ARCO branded gasoline and may have chosen to instead focus on the draw that their amenity brings.

Second, the significant and negative influence of a visible station suggests that an optimal pricing decision may be much simpler than previously theorized. Traditional economic theories of retail price competition assume that all stations compete with one another, but near stations are more important than distant stations. The results suggest that stations with a direct, visible competitor create extremely local markets. The stations compete so directly that nearby competitors, even those on the other side of the highway, have little influence on station profits. Economic theory that weights competitors simply by distance may be missing an important component of rivalry.

Finally, the inverted U-shape results for the influence of the number of competitors on the accuracy of station pricing decisions demonstrates that a greater number of competitors in a market does not make it easier to set profit-maximizing prices in a linear fashion. Stations with a moderate level of competition had a more difficult time making judgments of an optimal price. The accuracy enhancing effect of a visible competitor agrees with these findings. Stations with few local competitors can clearly identify their competitors. However, at moderate numbers of competitors, managers have greater difficulty identifying the most important competitors and assessing causality to competitor actions. At high numbers of competitors the market becomes denser, making it easier to identify relevant competitors.

I am aware of only three prior studies that have collected sales volume data from gas stations. Slade (1986, 1992, 1998) collected data from 13 Vancouver gas stations for 100 days and calculated station price elasticities. She found that stations of different ownership formats responded to price shocks in differing ways. Barron, Umbeck, and Waddell (2008) collected data from one chain with 54 locations throughout California and calculated price elasticities for each station in the chain. They found that stations located in denser markets lost a greater percentage of sales to price increases than those in less dense markets. Wang (2009) analyzed the price elasticities at 8 Australian gas stations to explain the price sensitivity of consumers. The relative void of prior work on retail gas sales volume data demonstrates the difficulty of obtaining such data. This study's sample size of 27 stations is twice as large as the previous multi-firm analysis and is the first to attempt to explain differences in optimal and actual prices.

The results presented here have several limitations. First, the results are dependent on the method used to measure a firm's optimal daily price. While I have chosen to measure a firm's daily optimal price based on prior economic theory, alternative models might find different results. Second, the small sample size and setting of the study offer restrictions on the generalizability of the findings. Moreover, although I offer an explanation for short-term pricing decisions, this study does not take into account longer-term pricing strategies that may influence the pricing decisions over the period observed.

These considerations raise a number of potential avenues for future research on this topic. Future research can examine a broader set of stations in other settings. The significant variation in station pricing accuracy warrants a deeper study of the influence of location choices on firm strategic decisions. The graph of station actual and optimal prices in figure 1 shows that firms priced lower than a theoretically optimal price during periods of high prices and higher than a theoretically optimal point during periods of low prices. Future research can examine additional price cycles to identify factors influence station mispricing during these periods. A significant body of research in retail gas markets has noted that price responses to underlying wholesale costs are asymmetric (Tappata, 2009). Prices rise faster than they fall. The data and measure of pricing accuracy offer additional opportunities to examine the causes and performance outcomes of this behavior. Finally, retail gas stations operate under several different ownership formats and are owned by firms that feature different levels of vertical integration. Future research can examine if firm factors have a significant influence on pricing behavior and accuracy.

From a practical standpoint, the results raise a number of concerns for managers. First, the results demonstrate that stations that understand their own price elasticity of demand and their competitors' price elasticity of demand will experience significant performance improvements. Understanding these factors requires formal empirical analysis. The results of my first stage regression analysis suggest that a number of stations in the sample would experience significant performance benefits from formal pricing models. Industry literature and my interviews with station managers suggest that many stations do not use formal quantitative pricing techniques and instead rely on industry rules of thumb. For example, a number of station owners have made calls to change the industry's pricing heuristics from a markup based not on cents, but on a percentage of wholesale costs (Abcede and Vonder Haar, 2013). The station owners explain that the long standing industry heuristic of marking up gas by 10 to 12 cents does not account for inflation and station profits do not increase when wholesale prices increase and a station's financial risk increases. Despite the appeal, significant industry inertia is difficult to overcome. Second, the wide variation in optimal prices demonstrates the importance of station location choices. While my results do not make location suggestions, the wide variation in prices for different stations within a relatively close area suggest that a number of stations are able to extract significantly higher prices.

Conclusion

Setting the price of a good is a basic, yet difficult task. Understanding why managers deviate from an optimal price position has important implications for both theory and practice.

This research is a first attempt to model and explain pricing errors at retail gas stations using a behavioral approach. The results demonstrate that the number of competitors in a market has an inverted U-shaped influence on the accuracy of pricing decisions. The presence of a visible competitor positively influences the accuracy of pricing decisions.

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Table 3.1: Stage one station fixed effects sales volume regression results

DV: Gallons of Unleaded Sold	Model A	Model B
Focal Station Price	-1,305.798*	-1,458.060**
	(531.164)	(474.096)
Average Competitor Price		1,632.416***
		(472.823)
Competitor Price 1	1,211.740*	
	(560.115)	
Competitor Price 2	538.618	
	(485.563)	
Competitor Price 3	389.556	
	(472.944)	
Competitor Price 4	-669.396	
	(567.754)	
Mon	386.043***	379.230***
	(98.061)	(92.278)
Tue	563.277***	555.840***
	(96.117)	(90.733)
Wed	704.718***	702.007***
	(97.733)	(92.495)
Thu	1,147.757***	1,133.833***
	(107.718)	(101.642)
Fri	242.432+	216.601+
	(123.871)	(115.951)
Sat	-807.407***	-808.638***
	(109.370)	(103.775)
Constant	2,225.520***	2,012.525***
	(289.598)	(235.069)
Observations	2,541	2,524
R-squared	0.741	0.747

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1
Station and month fixed effects
omitted from output

Table 3.2: Comparison of station optimal and actual posted prices

Station	Average Posted Price	Average Optimal Price	Average Pricing Accuracy
7- Eleven	3.70	3.44	-0.25
76	3.63	3.50	-0.14
ARCO #1	3.01	3.30	0.29
ARCO #2	3.28	3.32	0.04
ARCO #3	3.24	3.33	0.09
ARCO #4	3.13	3.31	0.18
ARCO #5	3.67	3.29	-0.38
ARCO #6	3.63	3.42	-0.21
Chevron #1	3.32	3.51	0.19
Chevron #2	3.45	3.56	0.11
Chevron #3	2.99	3.57	0.58
Chevron #4	3.55	3.58	0.03
Chevron #5	3.55	3.58	0.03
Chevron #6	3.26	3.58	0.32
Chevron #7	3.33	3.59	0.26
Mobil #1	3.47	3.54	0.07
Mobil #2	3.54	3.59	0.05
Shell #1	3.39	3.47	0.07
Shell #2	3.03	3.54	0.51
Shell #3	3.58	3.56	-0.02
Shell #4	3.47	3.46	-0.01
Shell #5	3.31	3.53	0.23
USA Gas #1	3.62	3.38	-0.24
USA Gas #2	3.47	3.34	-0.13
USA Gas #3	2.99	3.35	0.36
Valero	2.96	3.49	0.53
Total	**3.43**	**3.47**	**0.04**

Table 3.3: Summary Statistics and Correlation Table

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11
1	Pricing Accuracy	0.16	0.13	0.00	0.79	1.00										
2	Number of Competitors - One Mile	2.15	1.59	0.00	5.00	0.07	1.00									
3	Number of Competitors - Two Miles	5.69	2.78	1.00	10.00	-0.09	0.73	1.00								
4	Visible Competitor	0.23	0.42	0.00	1.00	-0.06	0.29	0.29	1.00							
5	Focal Station Posted Price	3.47	0.55	2.26	4.49	-0.19	-0.07	-0.07	0.01	1.00						
6	Wholesale Pricet	2.41	0.55	1.24	3.88	-0.20	-0.03	-0.03	0.02	0.96	1.00					
7	Convenience Store	0.96	0.19	0.00	1.00	-0.15	0.27	0.27	0.11	0.03	0.02	1.00				
8	Car Wash	0.15	0.36	0.00	1.00	-0.03	-0.04	-0.07	-0.23	0.04	0.02	0.09	1.00			
9	Restauran	0.15	0.36	0.00	1.00	-0.05	-0.04	-0.03	0.02	0.02	-0.03	0.09	0.11	1.00		
10	Auto Repair Shop	0.27	0.44	0.00	1.00	0.15	0.43	0.16	0.49	0.01	-0.01	0.12	-0.02	-0.02	1.00	
11	Average Competitor Price	3.52	0.54	2.39	4.39	-0.23	-0.05	-0.01	-0.02	0.98	0.96	-0.03	-0.01	0.00	-0.04	1.00
12	Competitor Price 1	3.52	0.55	2.26	4.40	-0.23	-0.09	-0.04	-0.07	0.97	0.95	-0.03	-0.02	0.04	-0.06	0.99
13	Competitor Price 2	3.52	0.55	2.36	4.49	-0.21	-0.04	-0.02	0.04	0.96	0.95	-0.01	-0.01	-0.04	-0.02	0.99
14	Competitor Price 3	3.50	0.56	2.26	4.49	-0.24	-0.01	0.03	-0.01	0.96	0.95	-0.04	-0.01	0.00	-0.02	0.99
15	Competitor Price 4	3.52	0.55	2.26	4.37	-0.18	0.00	0.02	0.01	0.95	0.94	-0.03	0.03	0.06	0.03	0.97
16	Monday	0.14	0.35	0.00	1.00	-0.02	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.01
17	Tuesday	0.15	0.35	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Wednesday	0.14	0.35	0.00	1.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01
19	Thursday	0.14	0.35	0.00	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Friday	0.14	0.35	0.00	1.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
21	Saturday	0.14	0.35	0.00	1.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Sunday	0.14	0.35	0.00	1.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01

		12	13	14	15	16	17	18	19	20	21	22
12	Competitor Price 1	1.00										
13	Competitor Price 2	0.97	1.00									
14	Competitor Price 3	0.97	0.96	1.00								
15	Competitor Price 4	0.96	0.96	0.96	1.00							
16	Monday	-0.01	-0.01	-0.01	-0.01	1.00						
17	Tuesday	0.00	0.00	0.00	0.00	-0.17	1.00					
18	Wednesday	0.01	0.02	0.02	0.02	-0.16	-0.17	1.00				
19	Thursday	0.00	0.00	0.00	0.00	-0.17	-0.17	-0.16	1.00			
20	Friday	0.00	0.00	0.00	0.00	-0.17	-0.17	-0.16	-0.17	1.00		
21	Saturday	0.00	0.00	0.00	-0.01	-0.17	-0.17	-0.16	-0.17	-0.17	1.00	
22	Sunday	-0.01	-0.01	-0.01	0.00	-0.17	-0.17	-0.16	-0.17	-0.17	-0.17	1.00

Table 3.4: Stage two random effects regression results on pricing accuracy

DV: Pricing Accuracy	Model 1 Controls	Model 2 One Mile	Model 3 Two Miles
Number of Competitors		0.062**	0.044*
		(0.022)	(0.021)
Number of Competitors^2		-0.013**	-0.004*
		(0.004)	(0.002)
Visible Competitor		-0.050*	-0.062*
		(0.023)	(0.026)
Wholesale Price	0.059+	0.122*	0.140**
	(0.035)	(0.056)	(0.052)
Average Competitor Price	-0.114*	-0.171*	-0.194**
	(0.052)	(0.067)	(0.063)
Convenience Store	-0.108***	-0.188***	-0.177***
	(0.016)	(0.016)	(0.019)
Auto Repair Shop	0.054	0.045*	0.049*
	(0.041)	(0.022)	(0.023)
Car Wash	0.033	-0.043	-0.017
	(0.055)	(0.029)	(0.024)
Restaurant	-0.023	-0.029	-0.046
	(0.021)	(0.027)	(0.030)
Monday	-0.002	-0.001	-0.003
	(0.003)	(0.003)	(0.003)
Tuesday	0.001	0.005	0.004
	(0.003)	(0.003)	(0.003)
Wednesday	0.003	0.004	0.003
	(0.004)	(0.004)	(0.004)
Thursday	0.010*	0.014**	0.013*
	(0.005)	(0.005)	(0.005)
Friday	0.007+	0.006+	0.005
	(0.003)	(0.004)	(0.004)
Saturday	-0.004	-0.006	-0.007
	(0.005)	(0.005)	(0.005)
Constant	0.059+	0.062**	0.590***
	(0.035)	(0.022)	(0.150)
Observations	4,910	4,910	4,910
Number of Stations	26	26	26

Robust standard errors in parentheses

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.1$

Figure 3.1: Station average, optimal and wholesale prices

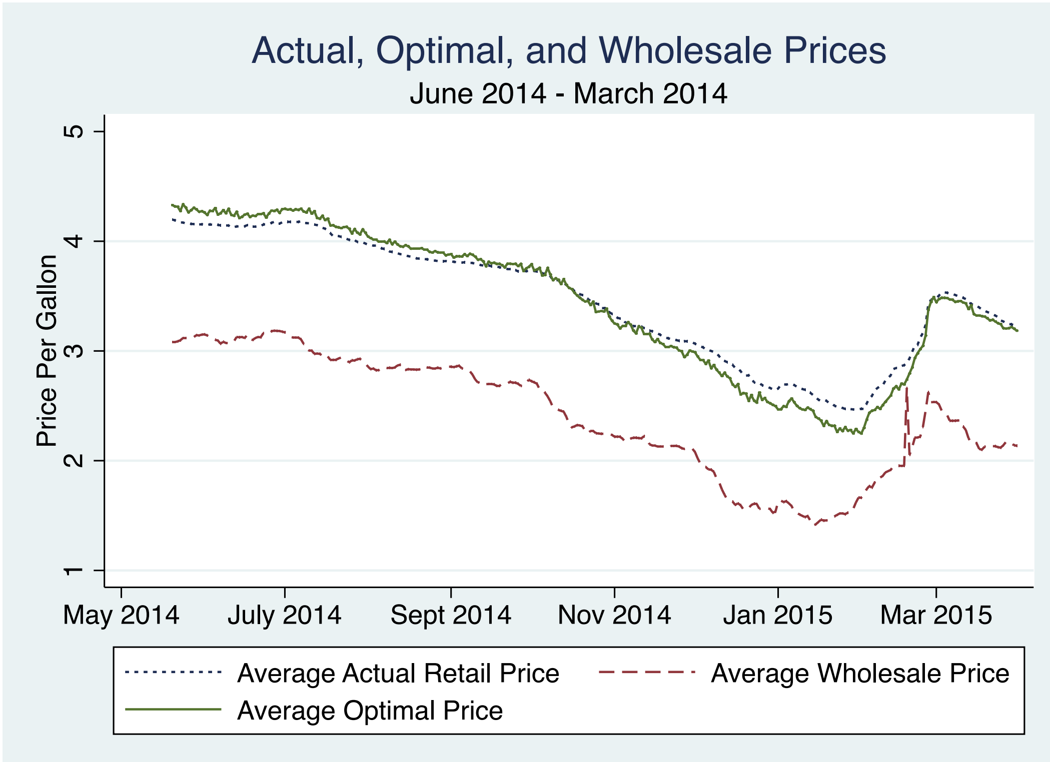

Figure 3.2: Predicted influence of the number of competitors on pricing accuracy