When Franchisee Effort Affects Demand: An Application to the Car Radiator Market

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Consumers respond not only to the price and the product attributes, but also to the service effort provided by the seller. Empirically quantifying or measuring the service effort is difficult because it is often unobservable. This paper proposes an empirical framework of the role of service effort in demand, along with other traditional marketing mix instruments. The model allows us to measure the unobserved effort level without data on effort, which is hardly available in most empirical settings. The paper also presents an application to a unique data set obtained from a franchise in the car radiator market. This framework can be useful in examining various aspects of service-intensive industries. In particular, this study investigates a much-debated public policy question regarding resale price ceiling in franchising. A policy evaluation shows that resale price ceiling lowers franchisees' profit and weakens their incentive to exert effort, which reduces consumer welfare. However, I find that, overall, resale price ceiling is consumer welfare enhancing in the car radiator market due to the lower price generated by the price ceiling.

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1 Introduction

Companies have long acknowledged that consumers respond not only to the price and characteristics of a product, but also to the service effort that the seller provides.[1] The chief financial officer of Home Depot, whose first of 8 company core values states excellent customer service, remarked that "with knowledgeable (sales) associates, customers buy more,"[2] underscoring effort as a determinant of the market outcome. In the media industry, DirecTV's high customer retention rate was attributed to superior customer service provided by its more than 15,000 call center agents and installation technicians across the country.[3] Companies that recognize the importance of service allocate significant resources to improve the quality of service. For instance, General Motors recently offered up to $1.5 million to selected dealerships in California to enhance customer service by moving dealer locations, refurbishing dealer facilities, and developing a workshop with Disneyland to train its employees.[4]

Not surprisingly, there is an abundant academic literature regarding a firm's service effort. See Rust and Chung (2006) for an extensive review of papers in marketing literature that investigates strategies in managing and customizing a firm's service and the role of customer satisfaction in customer relationship and in a firm's profitability. While these studies present a useful conceptual framework of a firm's service effort and consumers' perception of it, there have not been many rigorous empirical studies of effort that detail customer benefit from the effort and a firm's incentive for and cost of exerting it. This is mainly because it is difficult to precisely measure effort as it is intangible and unobservable to researchers. Nonetheless, it is

[1]Studies that focus on consumers' perception and expectation of service tend to use the term "service" or "service quality." The term "effort" is generally used by the studies that emphasize incentives of the sales channels or the firm's profitability. In this paper, service, effort, and service effort are considered to be the same construct and are used interchangeably.

[2]Merrick, Amy. "Good Service Gone Bad: What makes one consumer happy may annoy another; It's easy for companies to cross that fine line." *Wall Street Journal.* (Eastern edition). Oct 30, 2006. pg. R.4

[3]Neel, K.C. "Putting the Customer First; Service Focus Key Element in DirecTV's Success." *Multichannel News.* (Special Report). Aug. 24, 2009. pg. 24.

[4]Hirsch, Jerry. "Chevrolet staffs to learn Disneyland-style customer service," *Los Angeles Times.* Oct. 17, 2011.

important to quantify the level of effort because service is not only observed by consumers, but also taken into account when consumers make purchasing decisions. An empirical model that recovers the unobservable effort level of a firm's sales channel (e.g., employees, sales agents, retail partners, franchisees, etc.) can open doors to studies regarding the effectiveness of marketing initiatives, of incentive schemes, and the role of public policy.

This paper presents an empirical framework that defines and micro-models the role of service effort in consumer demand and in a firm's profit. The proposed framework allows us to recover the unobserved effort level without any data on it, which is hardly available in most empirical settings. The model developed in this study does not exclude or contradict demand models used in the literature. Rather, it accommodates the demand model of differentiated goods so that the effect of price, product characteristics, and consumer heterogeneity can be studied in conjunction with the impact of service effort on demand. Once the model is specified, the paper demonstrates how the developed model can be applied to real-world data in franchising. I obtained unique field data from a franchise network in the car radiator market, which includes information on sales, consumers, and vertical arrangement (ownership structure and royalty rates). Using this data, I estimate the econometric model and recover the unobservable effort level given assumptions. The recovered effort is then checked for validity against field evidence.

This framework can be useful in examining various questions faced by service-intensive industries. In particular, this study investigates a much-debated public policy question in franchising industry. Resale price ceiling (or maximum resale price) is a practice in which the upstream firm (e.g. manufacturer, distributor, franchisor) prohibits the downstream firm (e.g., reseller, retailer, franchisees) from selling its product or service above a set price determined by the upstream firm. It had been illegal in the U.S. until the Supreme Court overturned its decision in 1997 after 30 years on the basis of benefit to the consumer. The policy evaluation using a counterfactual based on the estimation results shows that imposing a resale price ceiling (e.g., 5% below the current price on all product lines) lowers the franchisee's incentive to exert effort, thus reducing consumer welfare. However, I find that overall, the resale price ceiling is consumer welfare enhancing due to welfare gain from the lower price generated by the price ceiling.

The role of service effort in a firm's decision and in demand has been discussed extensively in the literature of distribution channel coordination. In the stylized model of the distribution channel with successive firms, the downstream firm is an independent business that determines price and the level of service effort (Tirole 1995, pg. 177-178). In marketing literature, Iyer (1988) investigates channel coordination in a setting where retailers compete with a mix of price and service. Raju and Zhang (2005) also incorporates "demand-stimulating" service in the study of the dominant retailer. In franchising literature, the franchisee's effort gained academic interests. Mathewson and Winter (1985) notes that decisions by the downstream firm, especially service effort, can be contracted, but monitoring and enforcing them costs too much, which partly explains the existence of franchise contracts. Lal (1990) finds that when both the franchisor's and the franchisee's effort affect demand, royalty is needed with monitoring on franchisees. Desai and Srinivasan (1995) investigates the relationship between the (un)observability of franchisees' effort and price contracts.

Studies on sales-force also have explicitly modeled effort. Hauser et al. (1994) studies customer satisfaction incentive schemes and develops an analytical model of effort provided by the firm's risk-averse employees. Misra and Nair (2011) and Chung et al. (2011) investigate sales-force compensation schemes and their impact on the sale agent's level of effort implied by the inter-temporal nature of the compensation schemes and sales data. These two empirical studies address the agency problem in sales-force contracts and examine implications of different contracts. The focus of this paper does not lay on labor contracts. This paper presents a demand model of effort along with other marketing mix variables by taking advantage of detailed franchise sales data that includes pricing information.

The remainder of this paper is organized as follows. First, the industry being studied is described in Section 2. Then, the econometric model with consumer utility, firm's effort, and profit function is specified in Section 3. Details on the data used for estimation are discussed in Section 4, followed by estimation strategy, identification of effort, and endogeneity issues in Section 5. Estimation results and validity checks on the recovered effort are presented in Section 6. Finally, Section 7 shows the results of a policy evaluation regarding resale price ceiling in franchising before concluding the paper.

2 Industry Description

In the auto repair industry, service centers - repair shops, body shops, dealerships, etc. - rarely carry much inventory since there are millions of different parts to repair a variety of auto makes/models/years/editions. These service centers rely instead on special distributors for parts delivery when the need arises (e.g., a vehicle owner brings in his/her car for repair). Distribution for car radiators is no exception. A car radiator is a heat exchanger that helps dissipate heat from the engine. It comes in different sizes, materials, fit, or other specifications, making it impractical for service centers to carry a large amount of inventory. For instance, different generations of the same make/model may have different radiators installed. I obtained data on car radiator sales from a car radiator distributor that operates in all major North American markets.[5] A typical order process in this radiator market is as follows: when a service center needs a new radiator (usually one at a time), it calls this company (and potentially competitors), obtains a quote on the price and a delivery time, and makes a purchase decision. This company carries some 2,200 product lines, with the top 71 product lines accounting for 50% of the total quantity sold. Each product line fits a particular set of car make, model, year, and edition. For instance, a radiator for a 1998 Honda CR-V will not fit a Mercedes. In other words, each product line is considered to be a separate market since products across product lines are not compatible.

The studied company has been around for 25 years, and in 2005 it switched from owning

[5] There are two types of radiator orders: repair and collision. Collision orders are done through an auto insurance claim and require a distributor to go through a bidding process to be a qualified distributor, which is not included in my data here. This paper focuses on repair business in which the distributor deals directly with service centers, where effort or service level matters the most.

all the warehouses to franchising most of them. Now it has more than 200 territories (15 franchisor-owned territories and the rest operated by more than 170 franchisees) with $120 million in revenue.[6] Each franchisor-owned or franchisee business operates in an exclusive territory defined by a cluster of zip codes that typically includes 750,000 to 1.5 million people with an average of 2,000 potential customers (i.e., service centers and auto part shops). Franchisor-owned locations are operated by professional managers and sales agents, whose performances are tightly monitored and rewarded through various compensation schemes. These locations are considered "transitory," meaning the franchisor wants to re-franchise them to new owners after transforming the business. Franchisee-owned outlets are independent, residual-claimant businesses that are required to transfer a certain amount of money back to the franchisor to stay as a part of the franchise network. A typical franchise contract entails a fixed fee to join the franchise and a periodic royalty payment to the franchisor based on a predetermined percentage of the revenue with a long-term contract duration. This distributor does not require a membership fee, but charges its franchisees a royalty of 6-10% of gross revenue.[7] The company's standard franchise agreement has an initial term of 20 years with a renewal option. By joining the franchise, franchisees gain access to the company's Customer Relationship Management (CRM) software, where they can purchase inventory from approved suppliers at the prices that the franchisor negotiated with manufacturers or suppliers through a bidding system. A typical franchise outlet is located in an industrial park with a small office attached to a warehouse. A location with $1 million annual revenue typically hires 3-4 employees to answer phone calls and deliver radiators to customers. In addition to setting the price of radiators, the franchisee owner(s) puts effort into building customer relationship, promoting business, and providing services to customers.

[6]The radiator business accounts for 55% of the company's revenue. Other heating and cooling auto parts such as air conditioning parts account for the rest.

[7]Although there is no fixed fee to join, becoming a franchisee requires an initial investment, such as setting up the office and purchasing initial inventory of more than $150,000. The royalty rate for a new franchisee increases over time. The current royalty rate is 10% on gross revenue with 20% (i.e., 2% of gross revenue) reinvested in local/national marketing. Interviews with franchisees show that they do not perceive the 2% any differently than the rest of the royalty payment.

The franchisor views franchisees' efforts in attracting new customers and providing various customer services as a critical business proposition in this industry. For instance, franchisees are expected to call or visit new/current customers in the territory to determine their needs and to let them know of new promotions or services. The franchisor provides guidelines and training programs to ensure that franchisees maintain a high level of customer service. For example, the franchisor recommends that franchisees keep a certain hours of operation and policies on part returns for misfit/failure, such as lifetime warranty and paying back labor hours for re-installation. Interviews with the franchisor and some franchisees revealed that all the details of effort or service are not enforceable; it is often up to the individual franchisee to decide how much effort to exert or to follow the franchisor's guideline for customer service. In this study, I include this unobservable, endogenous effort in the model.

3 Model

3.1 Illustrative Example

Before describing the full econometric model, I first start this section with a very simple model illustrating how service effort can be incorporated into demand and firm's profit. Suppose a monopoly firm selling a single product to consumers in a single-period market with linear demand that strictly decreases in price (p) and increases in service effort (e): $D(p, e) = 1 - p + e$. The firm then maximizes the following profit function over price and effort: $\pi(p, e) = [p - c]D(p, e) - \frac{\lambda}{2}e^2$. The first term is profit from selling the product with a constant marginal cost c, and the last term is the cost of exerting effort in a convex function with a parameter λ. Note that from the first-order conditions, the optimal level effort is expressed as $e^* = \frac{p^* - c}{\lambda}$. The equation implies that the optimal effort increases in the margin and decreases as putting effort becomes more costly. The model developed in this paper will preserve this intuition, which will be revisited in Section 3.3. Now I present the full econometric model of this paper by first specifying consumer utility.

3.2 The Demand Side

Consider a franchise with F franchise businesses (franchisor-owned or franchisees), each with its own mutually-exclusive territory. Franchise business f offers H product lines that are not compatible (i.e., non-competing) and are considered as separate markets. For each product line, consumer i either buys one from this franchise business or chooses the outside option.[8] Then consumer i gets the following utility if she buys a product of the product line h from franchise business f in time t. Otherwise she gets normalized mean zero utility:

$$u_{ihft} = \sum_k x_{hkft}\tilde{\beta}_{ik} + e_{ft} + \xi_{hft} + \epsilon_{ihft} \tag{1}$$

where $\tilde{\beta}_{ik} = \bar{\beta}_k + \sum_q a_{iq}\beta^o_{kq} + v_{ik}\beta^u_k$. First, a_{iq} denotes consumer i's q-th observed attribute, and v_{ik} represents unobserved attribute. The term x_{hkft} is product line h's k-th observed product characteristic. The common demand shock, ξ_{hft}, is observed by consumers, but not observed by the econometrician. The e_{ft} term captures the level of effort that franchise business f provides in time t. Effort is observed by consumers and incorporated into their decision making, but not by the econometrician. One can consider substituting proxies for this unobservable variable in the analysis, but they can only capture a fraction of the total effort exerted by definition. This paper addresses the lack of observability of effort by directly modeling it in the consumer utility and in the profit function as described below. The literature often refers to this effort as service quality, promotional effort, sales effort, managerial activities, and/or local advertising. Here I broadly define effort as a franchise business's endogenous input that increases consumer utility and effectively shifts demand curve upward. I assume that the franchise business's effort adds to consumer utility uniformly

[8] The outside option for the consumer is typically either buying from a competing firm or not buying at all. Note that a car cannot be driven without a radiator; hence, not buying means disposing of the car in this industry. It is reasonable to think that the probability of disposing of a car, which is typically worth thousands of dollars, may not significantly change in response to change in radiator prices, whose average is around \$100. In that case, outside option can be thought of as buying from a competitor.

across consumers (i.e., e_{ft} is per-consumer effort). The effort is also assumed to be uniform across product lines based on interviews with the franchisor and franchisees that firm's effort, such as customer interaction, local ads, or warranty service, is not product line specific.[9] Finally, ϵ_{ihft} is an idiosyncratic random term. The consumer utility can be re-written as the following:

$$u_{ihft} = \psi_{hft} + \mu_{ihft} + \epsilon_{ihft} \tag{2}$$

$$\psi_{hft} \equiv \psi_{hft}(X,\, e,\, \xi,\, \bar{\beta}) = \sum_k x_{hkft}\bar{\beta}_k + e_{ft} + \xi_{hft} \tag{3}$$

$$\mu_{ihft} \equiv \mu_{ihft}(X,\, a_i,\, v_i,\, \beta^o,\, \beta^u) = \sum_k\sum_q x_{hkft}a_{iq}\beta^o_{kq} + \sum_k x_{hkft}v_{ik}\beta^u_k \tag{4}$$

The termψ_{hft} is the mean utility that is common across individuals, and μ_{ihft} accounts for consumer heterogeneity in preference towards different product characteristics. Assuming ϵ_{ilft} is independently and identically distributed Type 1 extreme value, the probability of consumer i purchasing product line h from franchise business f in time t is given by the following expression:

$$f_{ihft}(\psi_{hft},\, X,\, a_i,\, v_i,\, \beta^o,\, \beta^u) \equiv \frac{exp(\psi_{hft} + \mu_{ihft})}{1 + exp(\psi_{hft} + \mu_{ihft})} \tag{5}$$

The predicted market share is then calculated by integrating it over all consumers:

$$s_{hft}(\psi_{hft},\, X,\, a,\, v,\, \beta^o,\, \beta^u) \;=\; \int \frac{exp(\psi_{hft} + \mu_{ihft}(a_i,\, v_i))}{1 + exp(\psi_{hft} + \mu_{ihft}(a_i,\, v_i))} P(da,\, dv) \tag{6}$$

[9]The model can easily modified to accommodate effort at the product line level by making changes to consumer utility and profit function.

3.3 The Supply Side

Franchise business f chooses price and effort level in time t to maximize the profit:

$$\begin{aligned} \max_{p_{ft},\, e_{ft}} \pi_{ft}(p,\, e;\, c,\, s,\, M,\, r,\, \theta) \;&= \textstyle\sum_{h=1}^{H} \left[p_{hft}(1-r_f) - c_{hft}\right] M_{hft} s_{hft}(\psi_{hft},\, X,\, a,\, v,\, \beta^o,\, \beta^u) \\ &\quad - \tfrac{\lambda}{2} M_{ft} e_{ft}^2 \end{aligned} \tag{7}$$

where p_{hft}, c_{hft}, $s_{hft}(\cdot)$, and M_{hft} are price, marginal cost, market share, and total market potential of product line h at franchise business f in time t, respectively. The term r_f denotes the franchise royalty rate at franchise business f: it is zero for franchisor-owned establishments and 6-10% for franchisees in the data. The p, c, s, M, r denote the vector representation of the aforementioned terms. The vector θ is a set of the parameters to be estimated. Note that the first term is the sum of monetary profit from selling $M_{hft}s_{hft}(\cdot)$ units of product h at a margin of $p_{hft}(1-r_f) - c_{hft}$ at business f in time t. The last term represents the cost of effort with a coefficient of $\lambda > 0$. Recall that effort exerted by the franchise business, e_{ft}, is defined at per-consumer level. The total effort is calculated by multiplying the total market potential, i.e., the total number of consumers, at franchise business f in time t, $M_{ft} \equiv \sum_{h=1}^{H} M_{hft}$, by the quadratic function of per-consumer effort.[10] The first-order conditions with respect to price and effort at f in time t are given by the following:

$$(1-r_f)s_{hft} + \left[p_{hft}(1-r_f) - c_{hft}\right] \frac{\partial s_{hft}}{\partial p_{hft}} = 0 \;\; \forall h = 1, ..., H \tag{8}$$

$$\sum_{h=1}^{H} \left[p_{hft}(1-r_f) - c_{hft}\right] M_{hft} \frac{\partial s_{hft}}{\partial e_{ft}} - \lambda M_{ft} e_{ft} = 0 \tag{9}$$

[10] The total cost of effort is assumed to be linear in the market potential size because franchise businesses hire more sales agents as the total market size grows. It also produces the level of effort that is very close to what the executives know and expect of franchisees. Other forms of cost functions, such as $M_{ft}^2 e_{ft}^2$, that assume much higher cost of effort for larger franchise businesses (i.e., larger M_{ft}) did not align with what the executives knew about their franchisees. For instance, the effort of the better and larger franchisees was measured to be very low mainly due to their large market potentials.

From Equation (8), the expression for the optimal price is given by $p^*_{hft} = \frac{c_{hft}}{1-r_f} - \frac{s_{hft}}{\partial s_{hft}/\partial p_{hft}}$. The intuition is straightforward: the optimal price is higher when the marginal cost is higher and/or the magnitude of price sensitivity ($\partial s_{hft}/\partial p_{hft}$) is smaller (i.e., demand is less elastic). The royalty rate, $0 < r < 1$, effectively creates a double marginalization problem by raising the transfer price to franchisees by $\frac{1}{1-r_f}$. Thus the optimal price is expected to be higher when the royalty rate is higher, which is consistent with other findings.[11] In the following section, this correlational relationship is statistically tested and confirmed.

From Equation (9), the optimal effort can be expressed as

$$e^*_{ft}(\cdot) = \frac{1}{\lambda}\sum_{h=1}^{H}\left\{[p_{hft}(1-r_f) - c_{hft}]\frac{\partial s_{hft}}{\partial e_{ft}}\right\}\frac{M_{hft}}{M_{ft}} \tag{10}$$

First, more effort is exerted when the cost of effort λ is lower. The rest of the right hand side of the equation can be considered as the weighted sum of $[p_{hft}(1-r_f) - c_{hft}]\frac{\partial s_{hft}}{\partial e_{ft}}$ across all product lines with the weight being the relative size of the market potential of the product line, $\frac{M_{hft}}{M_{ft}}$. The intuition is clear: the franchise business exerts more effort when the margin, $p_{hft}(1-r_f) - c_{hft}$, is larger and/or the marginal effect of effort on demand, $\frac{\partial s_{hft}}{\partial e_{ft}}$, is larger. Combining Equations (8) and (9), the optimal effort can be written as

$$e^*_{ft}(p,\, c,\, r,\, M;\, \psi,\, \beta^o,\, \beta^u,\, \lambda) = -\frac{1-r_f}{\lambda}\sum_{h=1}^{H} s_{hft}\frac{\partial s_{hft}/\partial e_{ft}}{\partial s_{hft}/\partial p_{hft}}\frac{M_{hft}}{M_{ft}} \tag{11}$$

Unlike the effort expression in Equation (10), this expression is written in terms of observed/simulated variables. The royalty rate and market potentials are observed. Market shares and the derivative terms can be obtained through simulation. Hence effort can be recovered once the cost coefficient λ is estimated.

[11] Blair and Lafontaine (1999), Schmidt (1994).

4 Data

This paper uses a unique set of data from a franchise network that contains information on demand, such as price, quantity sold and observed consumer attributes.[12] In addition, it has information on the vertical arrangement of each establishment (e.g., franchisor-owned or franchisees, royalty rates for franchisees) and proxies for effort, which will be discussed and used in validating recovered effort in Section 6.3. First, I use two sets of proprietary data - customer lookup (i.e., product inquiry) history and sales transaction data - to obtain two product characteristics, price and the probability of same-day delivery. These data sets include information on the top 71 product lines[13] (50% of total quantity sold) in repair business at the top 15 establishment in the U.S. (1 franchisor-owned, 14 franchisees)[14] between January 2009 and August 2011, aggregated to monthly levels. The customer lookup history records customers' product inquiries with customer ID, part number, and dates. It also contains inventory availability information for same-day delivery at the time of the lookup. If a radiator is available at the local franchise business warehouse, it can be delivered within a few hours, which consumers highly value. Otherwise it takes more than a day to ship it from the manufacturer, another supplier, or other franchisees. The probability of same-day delivery of a radiator is calculated by averaging this local warehouse availability of each part in each month. If the lookup is converted to a sale, then the sales transaction data keeps track of cost of goods and the final sales price of the sold radiator.[15]

The company also provided a complete list of potential customers (including those who never made any purchase), compiled and updated over the past decade. This list provides the

[12] The company provided data confidentially to the author. Neither the author nor UC Berkeley received financial aid from the company.

[13] Recall that each product line fits a particular set of car make, model, year, and edition.

[14] Top 15 franchise businesses are chosen for the highest total quantities sold in large markets (with at least 1,800 customers). A franchise business may own more than one exclusive territory. For instance, the franchisor runs 15 exclusive territories. Franchisees used in this study are located across the U.S.: Arlington, TX; Phoenix, AZ; Smyrna, GA; Austin, TX; Orange, CA; Kansas city, KS; Dallas, TX; Pomona, CA; Baltimore, MD; Omaha, NB; Houston, TX; Portland, OR; Winston Salem, NC; White Oak, TX; and Brooksfield, WI.

[15] Average conversion rate is about 25%.

joint distribution of observed consumer characteristics in each franchise f, such as consumer's type of business (repair shop, dealership, auto part shop, or others) and zip code, which I match to 2000 U.S. Census median household income.[16] Note that the income level is the attribute of the final consumers, i.e., customers of the service centers. It is assumed that the service center's price sensitivity is correlated with the income level of its customers. This list is utilized to account for consumer heterogeneity in preference towards price. In Equation (4), the first term captures the observed consumer attributes a from the list and the last the unobserved attribute v. The distribution of the unobserved consumer attribute v is assumed to be standard lognormal in each franchise business. Then random draws $(a,\, v)$ are taken in each franchise business for simulating the market share expression in Equation (6).[17]

Market potential is defined as the total demand for new car radiators for repair. The total annual car radiator market is estimated to be $900 M, which is divided by the average price of all the radiators in the data to obtain the total quantity, which is further adjusted for the top 71 product lines in repair business. This quantity is then divided into market potential for each line/business/time based on the proportion of the product inquiries in the customer lookup data.

5 Estimation and Identification

The estimation strategy is similar to that of Generalized Method of Moments (GMM) used in Berry, et al. (1995), with some modification to incorporate a firm's effort. The first set of moments matches the predicted market shares, $s_{hft}(\cdot)$, to the observed market shares in the data, s^N_{hft}:

$$s_{hft}(\psi(\theta),\, \theta) - s^N_{hft} = 0,\ \forall h,\ f,\ t \tag{12}$$

where θ is the set of parameters to be estimated. Berry(1994) shows that there is a unique

[16] Some studies use CPS as the assumed distribution of consumer attributes.
[17] The simulation sample size is 300.

value of ψ that matches these two market shares, which can be found using a contraction mapping as in Berry, et al. (1995). Additional moment conditions can be constructed by making assumptions on the demand shock ξ. For each product line h at franchise business f in time t, the unobserved demand shock ξ_{hft} is assumed to be uncorrelated with Z, a set of instrumental variables including exogenous variables:

$$E[\xi_{hft}(\theta) \,|\, Z_{hft}] = 0 \;\forall h,\; f,\; t \tag{13}$$

There are two variables - price and effort - in Equation (3) that are potentially correlated with the demand shock ξ, which may bias the estimates (endogeneity issue). First, the demand shock is not observable to the econometrician, but the firm observes it and takes it into account when it sets the price, making the two likely correlated. I use average sales tax rate of each location in the data and the state per-hour minimum wage[18] to instrument for radiator prices. Another potential source of endogeneity is in the expression for effort. Remember $\psi_{hft}(\theta) \equiv \sum_k x_{hkft}\bar{\beta}_k + e_{ft} + \xi_{hft}$ where $e^*_{ft}(\cdot) = -\frac{1-r_f}{\lambda}\sum_{h=1}^{H} s_{hft}\frac{\partial s_{hft}/\partial e_{ft}}{\partial s_{hft}/\partial p_{hft}}\frac{M_{hft}}{M_{ft}}$. Since s_{hft} and its derivatives are a function of ξ_{hft}, I cannot rule out correlation between e_{ft} and ξ_{hft} because e_{ft} is a weighted sum of market share and its derivatives of all product lines. If I can find an instrument that is only a function of product lines other than h, it should be structurally uncorrelated with $\xi_{h\cdot\cdot}$. I use the average probability of same-day delivery (exogenous variable) of other product lines at the business, $\frac{1}{H-1}\sum_{h'\neq h} x_{h'ft}$, as an instrumental variable. The correlation between this instrument variable and the effort term comes from the fact that the market share and its derivatives of product lines other than h are a function of the probability of same-day delivery, $x_{h'\cdot\cdot}$. Also, because all franchisee businesses use the same replenishment recommendation system in the CRM, the probabilities of same-day delivery at different locations, x_{hft} and $x_{hf't}$, are correlated, allowing the probability of same-day delivery of other product lines at other locations, $\sum_{h'\neq h}\sum_{f'\neq f} x_{h'f't}$ to be used as an additional instrumental variable.

[18] The historical state minimum wages are obtained from the U.S. Department of Labor website.

Denote the sample analog of the moment condition in Equation (13) as $\hat{m}(\theta)$, the optimal estimators are obtained in the following expression:[19]

$$\hat{\theta} = arg \min_{\theta \in \Theta} \hat{m}(\theta)' \hat{W}(\theta) \hat{m}(\theta) \tag{14}$$

where the weighting matrix $\hat{W}$ is a consistent estimator of $E[Z'Z]^{-1}$ in the first step and of $E[Z'\xi(\hat{\theta}_1)\xi(\hat{\theta}_1)'Z]^{-1}$ in the second step using the estimates from the first step, $\hat{\theta}_1$. Note that the effort e_{ft} is a function of $(\psi,\, \beta^o,\, \beta^u,\, \lambda) \subset \theta$, so it needs to be updated for newly found θ in each iteration of search. For every new set of θ in the outer loop, I first find $\psi(\theta)$ that satisfies market share moment condition in Equation (12) through the contraction mapping. Then effort is updated through Equation (11), which in turn is used to calculate $\xi(\theta,\, \psi,\, e,\, X)$. Standard errors of the estimates are calculated by finding the the analytical derivatives of $\hat{m}(\theta)$. More details on the GMM estimation can be found in the Appendix.

The identification of most parameters, i.e., macro parameters $\bar{\beta}$ and micro parameters β^o, β^u, is straightforward and similar to identifying conditions in Berry, et al (1995). The cost of effort λ is a new parameter added from micro-modeling effort, whose identification can be better understood in a simpler model. Consider the case of a single product line with homogeneous consumers (logit model). Then Equation (3) and (11) can be re-written as the following:

$$log(\frac{s_{ft}}{1 - s_{ft}}) \quad = \quad \sum_k x_{kft}\bar{\beta} + e_{ft} + \xi_{ft} \tag{15}$$

$$e_{ft} = -\frac{1}{\lambda \beta_{price}}[(1 - r_f)s_{ft}] \tag{16}$$

From data, effort is implied to be high when $(1 - r_f)s_{ft}$ is high. The cost of effort λ is identified in the following way: define $Y \equiv log(\frac{s}{1-s})$ and $X \equiv (1 - r)s$. Ignoring other terms,

[19] I follow 2-step GMM estimation in Hansen (1982).

$-\frac{1}{\lambda\beta_{price}}$ is simply the slope of the regression line passing through data points (Y, X). Since the price sensitivity β_{price} is identified from the market share change in response to price variation, the cost of effort λ can be separately identified by taking the inverse of the slope and dividing it by $-\beta_{price}$.

6 Results

6.1 Descriptive Statistics

Table 1 presents descriptive statistics:

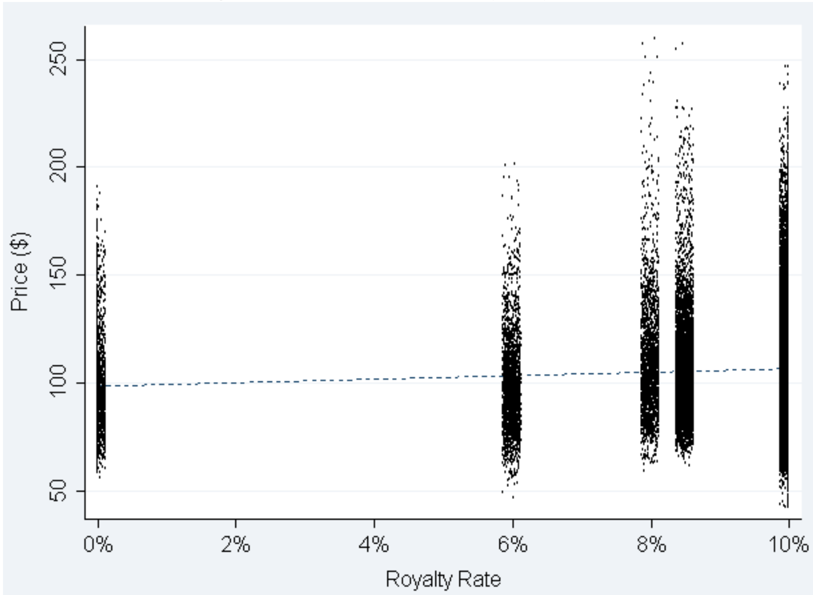
Table 1: Descriptive Statistics

	All Businesses		Franchisor-owned		Franchisees	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Same-day Delivery	0.34	0.13	0.34	0.07	0.34	0.13
Observed Market Share (%)	10.20	5.27	9.37	2.80	10.26	5.40
Cost of Goods ($)	59.23	16.37	59.59	15.91	59.21	16.40
Price Sold ($)	105.57	25.70	98.48	21.53	106.08	25.90

Note: This table summarizes monthly data from January 2009 to August 2011 for the top 71 product lines in repair business at the top 15 establishments in the U.S (34,080 data observations). Price Sold is the price the 15 franchise businesses change their consumers (i.e., service centers, auto part shops, etc.).

The average probability of same-day delivery is 34% and does not differ between franchisor-owned businesses and franchisees since they all share the same purchasing software in the CRM system. A part of the CRM system includes an inventory replenishment algorithm developed by an external company. Franchise businesses take inventory recommendations from the software and make their decision on the type/quantity/timing of inventory replenishment. The average market share for the top 71 product lines is 10.2% for the franchise businesses in this data, with that of franchisor-owned location slightly lower at 9.37%. The cost of goods (between $59 and $60) is similar between two ownership types. However, franchisees set noticeably higher price than the franchisor-owned establishment. This is in line with the result of the first-order condition in Equation (8), where the optimal price increases in royalty rate. Figure 1 shows the scatter plot of price and royalty rate:

Figure 1: Price vs. Royalty Rate



Note: Jitters are added to observations for expositional purposes.

Franchisor-owned locations bear no royalty, whereas franchisees have to pay the franchisor 6%, 8%, 8.5%, or 10% of their revenue as franchise royalty payment. The plot shows a general upward trend of price in increasing royalty rate. I statistically test this by running a simple regression of price on royalty rates with product line and time dummies. The regression result in Table 2 shows that 10% increase in the royalty rate is associated with $8.11 increase in the average price, confirming the correlation between the two variables implied by the first-order condition:

Table 2: Price vs. Royalty Regression Results

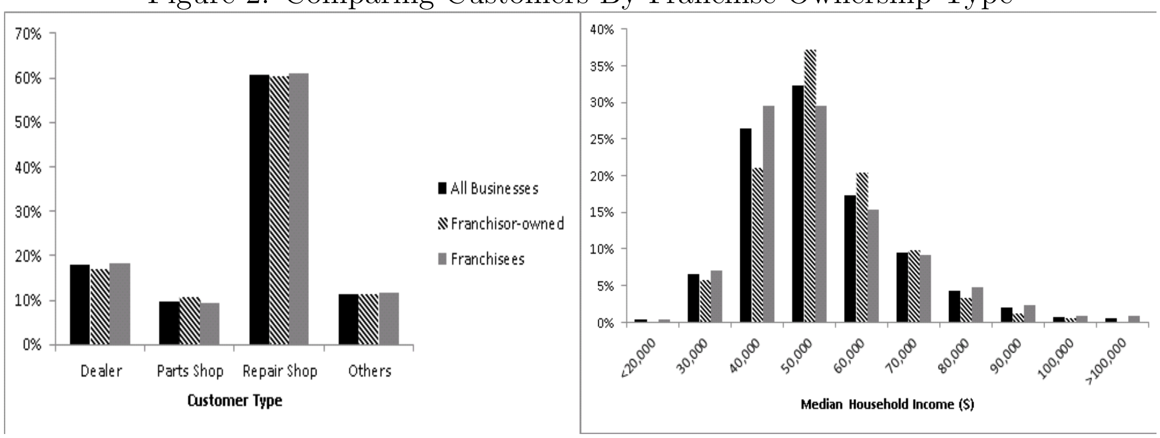
Royalty Rate	81.13***
	(2.13)
Constant	161.00***
	(1.16)
Dummies	
Product line	Yes
Month	Yes
Observations	34,080
F-stat	1432.24
R-squared	0.77

Robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Recall that the list of potential customers provides information on the type of consumers and median household income in the area matched to the zip code of the franchise businesses. Figure 2 summarizes the data and shows little difference in observed consumer attributes between franchisor-owned locations and franchisee locations. About 60% of the potential customers are repair shops. Close to 20% of customers are new/used car dealers, 10% are auto part shops, and the rest are junkyards, fleets, etc. The mean of median household income is slightly higher for franchisor-owned businesses ($47,475 vs. $47,163), but the overall income distributions do not seem to differ much.

Figure 2: Comparing Customers By Franchise Ownership Type



6.2 Parameter Estimates

Tables 3 presents parameter estimates. The second column shows the estimates of the full random coefficient model, and the first column lists those of a logit model with instrumental variables by setting $\beta^u = \beta^u = 0$ in the random coefficient model and removing consumer heterogeneity:

Table 3: Parameter Estimates

	Logit with IVs	Random Coefficients with IVs
Demand-side Parameters		
Constant	-2.838*** (0.288)	-1.259* (0.585)
Price ($00)	-2.137*** (0.265)	-18.615*** (1.177)
Same-day Delivery	1.855*** (0.122)	2.185*** (0.180)
Income ($00,000)		2.054*** (0.365)
Dealers		15.097*** (0.559)
Repair Shops		13.650*** (0.498)
Auto Part Shops		10.528 (21.964)
Unobserved		-0.009 (0.120)
Supply-side Parameter		
Cost of Effort (λ)	0.026*** (0.004)	0.017* (0.007)

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

Signs of the estimated parameters of price, same-day delivery, and cost of effort are as expected. The results imply that consumers value low price and a high chance of same-day delivery. A positive λ means that it is costly for franchise businesses to exert additional unit of effort or service for the consumer. In the random coefficient model, a positive coefficient on the income implies that consumers in the area with higher median household income are less price-sensitive. Estimates for consumer type dummies (dealers, repair shops, and auto part shops) indicate that auto dealers and auto repair shops are significantly less price-sensitive than other types of consumers. The coefficient for the unobserved consumer attribute is not statistically significant. The imputed average marginal cost based on these parameter estimates under random coefficient model is calculated to be \$61.56[20]. Recall that this company is a distributor, not a manufacturer. Its marginal cost mainly consists of the cost of goods, with the remainder arising from storing and delivering an additional unit, which is relatively small in this company. Given the average cost of goods at \$59.23 in the data (Table 1), the model estimate suggests that 96% of the imputed marginal cost is accounted by the cost of goods.

6.3 Effort Measure

Effort level e_{ft} can be recovered from the data by plugging the estimated parameters into Equation (11). If the model is correctly specified, the measured effort should reflect the real-world effort in some ways.[21] I first presented the average effort of all 15 establishments (Table 4) to the company chief marketing officer to see whether it is in line with his assessment of business: franchisee 47 is the best-run franchisee in the nation, but controlling for the market size, franchisee 123 has done more than franchisee 47. The recovered effort shows that both franchisees are in the top 3, with franchisee 123 exerting the most per-consumer effort. He also confirmed that the rest of the ranking, including the franchisor-owned location, looks accurate.

[20]The price elasticity is 2.77.

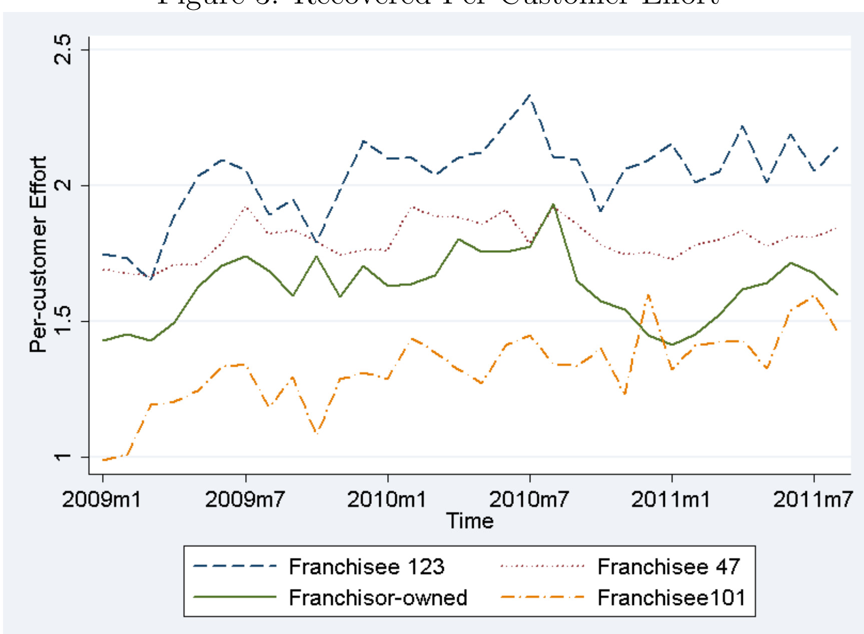
[21]The effort used in this section for validity check is recovered using the full random coefficient model.

Table 4: Average Effort Recovered by Company

Franchisee ID	Avg. Effort	Franchisee ID	Avg. Effort	Franchisee ID	Avg. Effort
123	2.035	40	1.632	209	1.556
94	1.899	57	1.627	146	1.519
47	1.800	Franchisor-owned	1.626	2	1.431
129	1.794	153	1.608	9	1.381
109	1.745	41	1.594	101	1.328

The franchisor's merger and acquisition history also helps to validate the effort measure. Between August 2010 and January 2011, the franchisor actively leveraged out under-performing franchisees and merged them into franchisor-owned operation. The effort time plot in Figure 3 captures this impact of merger and acquisitions:

Figure 3: Recovered Per-Customer Effort



The plot shows a significant drop in the franchisor-owned locations' combined effort level during the period of shoring up under-performing franchisees. This is because the overall average market share of franchisor-owned locations is dragged down by that of the under-performers acquired. The decrease in market share in the data is then interpreted as a drop in effort in the model, explaining the patterns in the plot.

Finally, a unique set of data on promotional activities helps validation of the recovered effort. Franchisee owners and sales agents are expected to visit and/or call customers on a regular basis. Sales visits entail finding out customer needs, learning about experience with the company if they previously ordered from the company, and providing them with promotional materials (magnets, candies, coupons, gift cards, etc.). Sales calls involve similar interactions. The company has provided data on the frequencies of these promotional activities at all franchise businesses over time.[22] If the sales visits and calls are good proxies for the unobservable effort, the econometrically recovered effort level is expected to be correlated with them. Regressions of the measured effort (i.e., effort per consumer) on the number of sales calls and/or the number of sales visits per market share (i.e., total number of customers) allow us to check the correlation between these variables:

Table 5: Effort Regression

Regressor(s)	Calls Only	Visits Only	Calls + Visits	Calls, Visits
Calls/Market Share	0.003*			0.004**
	(0.001)			(0.001)
Visits/Market Share		0.001		-0.0006
		(0.001)		(0.0008)
(Calls+Visits)/Market Share			0.001*	
			(0.0004)	
Constant	1.624***	1.628***	1.622***	1.630***
	(0.011)	(0.013)	(0.013)	(0.014)
Observations	480	480	480	480
R-squared	0.022	0.003	0.010	0.023

Robust standard errors in parentheses

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

Results show positive relationship between the recovered effort and the number of calls. The number of visits is not significantly correlated with the recovered effort. Note that the R-squared of these regressions are around 2% or below, meaning that only about 2% of the variation in recovered effort is explained by the variation in these two proxies. This may be attributed to the fact that the regression only captures the quantity of promotional

[22] These activities are recorded in the CRM. Franchisees and sales agents use the CRM to decide which customers to call or to visit in each day. The CRM even lets the users pick an area to visit and instantly maps the shortest route.

activities. The company executives pointed out that the quality of those activities is also very important, which is not captured in the proxies (regressors). The rest of the variation also may come from other unobservable customer service and effort such as honoring warranties, extended hours of operation, or other unobservable sales tactics. An important part of this study involves investigation of the impact of effort on consumer welfare, so capturing full effort is crucial. Assuming the model specification and assumptions of the utility and profit functions are correct, such low R-squared in the regression supports the approach of micro-modeling unobserved effort over relying on proxies, which would have captured only partial effort by definition. Having the demand model parameters estimated and the effort recovered allows us to run counterfactuals to predict consequences of marketing initiatives or public policies. In this study, the controversial case of resale price ceiling in franchising is investigated to understand how it impacts franchise business optimal effort and consumer welfare.

7 Policy Evaluation: Resale Price Ceiling

The International Franchise Association defines franchising as "the agreement or license between two legally independent parties which gives a franchisee the right to market a product or service using the trademark or trade name of the franchisor." The agreement can potentially dictate any aspects of business operation, but pricing agreement between a franchisor and its franchisees has often been the subject of legal scrutiny. Price fixing in horizontal channel is *per se* (i.e., inherently) illegal because of its antitrust nature that reduces consumer welfare.[23] Extending this judicial interpretation to vertical channel has been controversial, and recently the U.S. Supreme Court reversed its position on resale price ceiling (or maximum resale price) in vertical channel. When *Albrecht*, a newspaper carrier, brought a lawsuit against its publisher, the Herald Company, in 1968 for enforcing resale

[23] *United States v. Socony-Vacuum Oil Co. (1940),*

price ceiling on its carriers,[24] the Court ruled that resale price ceiling is inherently illegal. The Court's decision was partly based on a rationale that "maximum prices may be fixed too low for the dealer to furnish services essential to the value which goods have for the consumer or to furnish services and conveniences which consumers desire and for which they are willing to pay."[25] When a similar lawsuit was filed by *Khan*,[26] a gasoline station owner, in 1997, the U.S. Supreme Court overruled *Albrecht* and made resale price ceiling subject to a rule of reason after 30 years of academic criticism[27] arguing that resale price ceiling lowers price, hence benefiting consumers. This section examines these two competing views of resale price ceiling in vertical channel to investigate their impact on consumer welfare.

Suppose that the franchisor imposes a 5% discount on all the product lines:

Table 6: Counterfactual Result

	Current	5% Discount	Change
Market Outcome			
Avg. Price	\$106.08	\$100.78	-5.00%
Avg. Effort	1.64	1.48	-9.91%
Avg. Market Share	10.26%	10.91%	6.42%
Franchisee Profit			
Monetary Profit	\$8.03 M	\$7.63 M	-4.91%
Cost of effort	\$5.25 M	\$4.93 M	-6.03%
Net Profit	\$2.78 M	\$2.70 M	-2.78%
Royalty Payment	\$2.20 M	\$2.29M	4.08%

The counterfactual results in Table 6 show that franchise businesses reduce effort level by

[24] Blair and Lafontaine (2010) discusses why a franchisor wants to impose resale price ceiling on its franchisees in the first place: by expanding output through lowering price, the franchisor cannot increase the total channel profit by reducing the magnitude of double marginalization between two successive firms with market power and/or extract more royalty from franchisees by hurting their profitability.

[25] Albrecht 1968, pp. 152-53. The Court condemns resale price ceiling because it "schemes to fix maximum prices, by substituting the perhaps erroneous judgment of a seller for the forces of the competitive market, may severely intrude upon the ability of buyers to compete and survive in that market," which is a matter of contractual issue rather than an antitrust issue, as Blair and Lafontaine (2010) points out. This counterfactual concerns consumer welfare and focuses primarily on the antitrust aspect of resale price ceiling.

[26] State Oil Company v. Khan 1997. Khan was a gasoline station owner who bought gasoline from State Oil Company. The oil company set the wholesale price to change with the retail price Khan set so that Khan could not make more money even if it charged a higher price, making it effectively a resale price ceiling restraint. More details can be found in Blair and Lafontaine (1999).

[27] Blair and Lafontaine (1999), Blair and Lafontaine (2010), Blair and Lopatka (1998).

9.91% in response to 5% price discount.[28] The intuition comes from Equation (10), where optimal effort decreases with a lower margin. The average market size is predicted to increase by 6.42% due to price discount. Examining franchisees' profits also provide insight into a franchisor's potential incentive to impose resale price ceiling and franchisee's opposition towards it. By imposing 5% discount, franchisees' monetary profit, cost of effort decrease, and the net profit for franchisees decrease by varying degrees, but in essence the price discount decreases the franchisees' profit by 2.78%. The predicted royalty payment transfer to the franchisor, which is the franchisor's incentive for imposing resale price ceiling, is predicted to increase by 4.08% (from $2.20 M to $2.29 M)[29] Under the current revenue-based royalty scheme, the benefit of reduction in price goes to the franchisor in the form of royalty payment by sacrificing franchisees profit; this provides insight as to why some franchisees filed lawsuits against their franchisors or upstream firms for imposing resale price ceilings.

Change in consumer welfare is measured using change in compensating variation. Table 7 summarizes consumer welfare change under the counterfactual:

Table 7: Consumer Welfare Change

	Consumer Surplus Change
Due to Price	15.54 %
Due to Effort	-3.80%
Net	11.74 %

Results show that a 5% price reduction increases the net consumer welfare by 11.74%. This net increase can be decomposed into two components: price and effort. Reduction in price alone increases consumer welfare by 15.54%, and 3.8% of it is lost due to lower optimal effort by franchise businesses. Hence, imposing resale price ceiling in this market is consumer welfare enhancing, supporting the recent U.S. Supreme Court's ruling (*Khan*) on changing the status of resale price ceiling from *per se* illegal to rule of reason. However, the argument

[28]The counterfactual is run with the random coefficient model with IVs. Competitors do not react to the price change by this franchise in this model.

[29]Even if imposing resale price ceiling improves profitability, the franchisor may not want to implement it as it can potentially tarnishes the franchisor's reputation, which hampers recruitment of new franchisees.

of *Albrecht* - downstream firm lowering service or effort in response - should not be overlooked in quantifying benefit to the consumer. If one ignores the change of effort level in response to vertically imposed price ceiling in analyzing consumer welfare and calculates it solely based on price change, the welfare increase will be estimated to be 15.54% rather than 11.74%, leading to an overestimation. Hence, the firm's effort level change should be taken into account when vertical pricing is studied, particularly in analyzing consumer welfare in an industry where exerting effort it is an important decision variable of the firm.

8 Conclusion

Service effort has long been of interest to practitioners and researchers. The literature on a firm's effort (or service) is extensive and diverse; however, there have not been many empirical studies investigating the role of effort in consumer demand. This is because effort, unlike other marketing mix instruments, is not only unobservable to researchers, but also abstract in nature, which makes it difficult to quantify. This paper proposes an empirical framework of effort by micro-modeling it using a demand model of differentiated goods, along with other traditional marketing mix variables. The model defines unobservable service effort in the consumer utility and in the firm profit. In the model, the firm sets the optimal price and the level of effort after incurring a cost of exerting effort. The paper then applies it to a unique data set - sales transaction, customer information, and franchise arrangement - obtained from a franchise network in the car radiator market, where service effort by the franchisee is an important firm decision in determining the market outcome. The set of first-order conditions from the model then helps to recover the unobserved effort level. Once the effort is recovered, it is checked against field evidence for validation.

The estimated model is also applied to provide insight into a much-debated public policy question regarding the impact of resale price ceiling. The legality of resale price ceiling in vertical channels has been controversial. In 1968, the Supreme Court ruled resale price ceiling inherently illegal. The Court argued that the downstream firm might reduce the service effort that the consumer values if it were forced to lower the price by the price ceiling. After 30 years, the U.S. Supreme Court reversed its position and allowed resale price ceiling under reasonable circumstances on the basis of consumer welfare enhancing prospect from lower price.

A policy evaluation result shows that imposing resale price ceiling at 5% below the current price across all products reduces franchisees' profit. On the contrary, it increases consumer welfare by 11.74% despite welfare loss due to lower service effort exerted by the franchise businesses. This result supports the U.S. Supreme Court's recent decision allowing resale price ceiling. In measuring the size of consumer benefit, however, *Albrecht*'s argument on service reduction by the firm should be taken into account as calculating it without change in effort significantly overestimates the amount of consumer welfare gain.

Appendix

Data Cleaning

The original data contains sales transactions of the top 71 radiator product lines from all franchisor-owned and franchisee businesses. After subtracting 164,170 returned parts, there are 1.4 million sales transactions. Orders without a radiator and more than 3 items are dropped. Among the 2-item orders, if there is a promotion coupon, the coupon discount is subtracted from the sales price. Then orders with multiple quantities are split into single orders, which results in 1.08 million observations. After removing parts with missing information and dropping Canadian locations, data is aggregated to monthly levels in each location. Canadian locations are removed because they have different franchise contracts due to different legislation, tariff and border-crossing supply chains. Most product lines are not substitutable with one another. However, some of them are compatible according to the lookup data. If radiators are looked up for a particular type of car, and the data shows multiple product lines, the substitute products are grouped together.

Expressions for Market Shares

Derivatives are

$$\frac{ds_{hft}}{dp_{hft}} = \int f_{ihft}(a_{if}, v_{if})[1 - f_{ihft}(a_{if}, v_{if})]\frac{d(\psi_{hft} + \mu_{ihft}(a_{if}, v_{if}))}{dp_{hft}} P(da, dv)$$

$$\frac{\partial s_{hft}}{\partial e_{ft}} = \int f_{ihft}(a_{if}, v_{if})[1 - f_{ihft}(a_{if}, v_{if})]\, P(da, dv)$$

Assuming the q-th product characteristic is price and random coefficient on price only (i.e., r = 1),

$$\frac{d(\psi_{hft} + \mu_{ihft}(a_{if},\, v_{if}))}{dp_{hft}} = \beta_{Price} + a_{if}\beta^o + v_{if}\beta^u$$

Using simple frequency simulators, the above expression can be simulated by

$$\begin{aligned}\hat{s}_{hft}(\psi,\, \beta^o,\, \beta^u,\, \omega) &= \frac{1}{ns}\sum_{i=1}^{ns} f_{ihft}(a_{if},\, v_{if}) \\ &= \frac{1}{ns}\sum_{i=1}^{ns} \frac{exp(\psi_{hft} + \mu_{ihft}(a_{if},\, v_{if}))}{1 + exp(\psi_{hft} + \mu_{ihft}(a_{if},\, v_{if}))}\end{aligned}$$

Simulated derivatives are

$$\frac{d\hat{s}_{hft}}{dp_{hft}} = \frac{1}{ns}\sum_{i=1}^{ns} f_{ihft}(a_{if},\, v_{if})[1 - f_{ihft}(a_{if},\, v_{if})]\frac{d(\psi_{hft} + \mu_{ihft}(a_{if},\, v_{if}))}{dp_{hft}}$$

$$\frac{d\hat{s}_{hft}}{de_{ft}} = \frac{1}{ns}\sum_{i=1}^{ns} f_{ihft}(a_{if},\, v_{if})[1 - f_{ihft}(a_{if},\, v_{if})]$$

GMM

1. <u>(Initialization)</u> Set initial values for $(\beta^o,\, \beta^u,\, \lambda)$ and take ns draws of $(a_i,\, v_i)$ from the list of potential customers in each market f and standard normal distributions, respectively.

2. <u>(Outer Loop)</u> Minimize $m \equiv E[\xi \,|\, X,\, Z]$ over $(\bar{\beta},\, \beta^o,\, \beta^u,\, \lambda)$ through non-linear search.

   - Using contraction mapping as in BLP, find ψ_{hft} such that the observed market share is equal to the predicted market share: $s^N_{hft} = s_{hft}(\cdot)$
   - Update $e^*_{ft}(\beta^o,\, \beta^u,\, \lambda,\, \psi;\, p,\, c,\, r,\, M\,) = -\frac{1-r_f}{\lambda}\sum_{h=1}^{H} s_{hft}\frac{\partial s_{hft}/\partial e_{ft}}{\partial s_{hft}/\partial p_{hft}}\frac{M_{hft}}{M_{ft}}$
   - $\xi_{hft} = \psi - \sum_k x_{hft}\bar{\beta}_k - e^*_{ft}(\beta^o,\, \beta^u,\, \lambda,\, \psi;\, p,\, c,\, r,\, M\,)$

3. Repeat until it converges

Note that the asymptotic variance of GMM is $\frac{1}{HFT}\hat{V}$, where $\hat{V} = (\hat{d}'\hat{W}\hat{d})^{-1}$, $\hat{d} = \frac{\partial \hat{m}}{\partial \theta'}|_{\hat{\theta}} =$

$Z'\frac{\partial\hat{\xi}}{\partial\theta'}|_{\hat{\theta}}$. Standard errors can be found by taking the square root of the diagonal elements of the variance covariance matrix.

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