Advertising in Vertical Relationships: An Equilibrium Model of the Automobile Industry[*]

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Abstract

I develop and estimate a model of pricing and advertising decisions of new car manufacturers and dealers. The model highlights a selling effort externality between dealers and manufacturers, which leads to estimated manufacturer markups that are about half compared to estimates from a model without endogenous advertising decisions in the vertical relationship. I quantify the welfare effects of state regulations that restrict wholesale contracts by simulating the adoption of a franchise fee contract. I predict a 10% decrease in prices and an 8% increase in dealer advertising. The results imply substantial gains in consumer welfare compared to current linear price contracts.

1 Introduction

Retailers and manufacturers commonly engage in selling effort for the same product. Selling effort makes the good more attractive to consumers, which benefits both retailers and manufacturers. However, vertical externalities arise that resemble double price marginalization if retailers and manufacturers do not coordinate investments in selling effort. For example, if the retailer does not consider the manufacturer's marginal benefit of effort then a public goods externality exists, and effort is underprovided from the perspective of the manufacturer. As in the case of the double marginalization externality, sales effort externalities within vertical relationships may have significant consequences for producer and consumer welfare.

I empirically study the role of sales effort in vertical relationships in the context of the advertising decisions of new car dealers and manufacturers. Both new car dealers and manufacturers make substantial investments in advertising, making advertising an important aspect of competition.[1] This is a relevant setting to study vertical relationships because the new car dealer-manufacturer relationship is heavily regulated in the United States, and these regulations have drawn the attention of academics, policymakers, and industry participants. One regulation that is ubiquitous among states involves the level of vertical control manufacturers have over the decisions of dealers. By law, manufacturers are required to sell cars through independent franchised dealers. They are also restricted in their the ability to include non-linear tariffs in selling contracts, even though these types of contracts can theoretically alleviate double marginalization and effort externalities in vertical relationships.[2] Policymakers and academics have suggested that new car dealer regulations, and especially those that restrict vertical coordination, are detrimental to consumer welfare.[3]

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[1]For example, adage.com, an advertising industry consulting firm, reports the automotive industry was the most heavily advertised industry in 2013, with manufacturers collectively spending approximately $9 billion and dealers collectively spending nearly $6 billion on advertising.

[2]This type of effort externality is commonly referred to as downstream, or double-sided moral hazard. For example see Tirole (1988) and Lafontaine and Slade (2007). Although the externality I discuss is akin to double-sided moral hazard, moral hazard implies agents face uncertainty which is not present in the model I present later, so I abstain from using this term.

[3]See Lafontaine and Morton (2010) for an overview.

To understand the effects of vertical decision making between dealers and manufacturers, I estimate a structural model of new car demand and supply. I specify a static, discrete choice model of consumer demand, and a model of dealer and manufacturer behavior, where the dealer and manufacturer each choose two actions, advertising and price. The demand model incorporates two potentially important features of the new car market. First, I assume that consumers incur a disutility for traveling from their residence to the dealer to purchase a car. Utility over distance gives rise to spatial demand and spatial competition among dealers. Second, dealer and manufacturer advertising affect the consumer purchase decision, and I allow these effects to differ by type of advertiser. Importantly, advertising is endogenous in the demand estimation because it is an optimal decision of the firms. I estimate the causal effect of advertising on consumer demand using novel instruments based on local dealer geography and the competitiveness of local advertising markets.

I model supply as a two-stage full information game between manufacturers and dealers. In the first stage, manufacturers simultaneously set wholesale prices and brand advertising levels, anticipating dealers' responses. In the second stage, dealers observe the first stage decisions and simultaneously set dealer advertising and retail prices. I use the model to infer marginal costs within the vertical structure as in Villas-Boas (2007), as well as parameters of an advertising cost function for both dealers and manufacturers. The model incorporates two incentive problems between dealers and manufacturers: double marginalization which implies retail prices are too high from the perspective of total welfare, and an advertising effort externality. For example, when a dealer decides advertising spending it does not consider the marginal benefit of advertising to the manufacturer, so the dealer under-supplies advertising from the perspective of the manufacturer.

I estimate that the average manufacturer price-cost markup is $2,151. I compare manufacturer markups to an estimate from a model that does not incorporate optimal advertising of dealers and manufacturers. The model without advertising overstates manufacturer markups by more than double. The reason for this is that my model captures a mechanism whereby manufacturers optimally encourage dealer advertising by charging low wholesale

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prices. The implication is that wholesale prices are rationalized by higher marginal costs in my model compared to the no-advertising model. The magnitude of the difference between both models depends on the shares of the retailer, the pass-through of wholesale price to advertising, and the estimated demand elasticity of dealer advertising, which are all objects I recover from estimation. I also compute that the ratio of dealer-to-manufacturer surplus is twice as high as is implied by the alternative model. Intuitively, the optimal advertising decisions of firms provide information about firms' marginal benefit of advertising, which, in turn, is information that better informs estimates of surplus.

I use the model to quantify the distortions created by the double marginalization and advertising marginalization vertical externalities. These externalities exist in the model primarily because manufacturers charge dealers linear wholesale prices. State regulations require that manufacturers sell cars through independent franchises at linear wholesale prices. However, non-linear pricing contracts, such as a two-part tariff, can theoretically ameliorate double marginalization and effort externalities.[4] I use the model to predict dealer pricing and advertising if manufacturers and dealers adopted a franchise fee, or two-part tariff, contract. In the counterfactual contract, manufacturers charge a wholesale price equal to their marginal cost and recover rents from the dealers in the form of a yearly franchise fee.

First, I predict the effects of a single dealer adopting the franchise fee contract. Since the new contract resembles vertical integration for a single dealer-manufacturer pair, this exercise is meant to predict how competition would change if a manufacturer opened up a company "outlet" that competes against traditional franchised dealers. I find that this coordinated dealer charges lower prices, spends more on advertising, and steals a significant market share from rivals due to the amelioration of the two externalities. This result provides intuition for the apprehension of industry participants for allowing firms like Tesla to compete against traditional franchised dealers.[5]

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[4]For example, in a bilateral monopoly non-linear wholesale prices can achieve higher surplus for producers and consumers, although integration may not lead to higher producer surplus in the case of bilateral oligopolies; see Tirole (1988) and Lin (1988).

[5]Tesla is an electric car company based out of California that circumvents franchise regulations in many states, selling cars directly from the manufacturer.

Second, I predict the effects of all dealers adopting a franchise fee contract with manufacturers. I predict that average retail price would fall by 10.28% and dealer advertising would increase by 8.28%. Both of these effects are due to the amelioration of the price and advertising marginalization externalities. A lower bound for the increase in consumer welfare due to the contract change is $75 million yearly in the medium sized market I study (Richmond, Virgina). Overall, my results suggest that the size of vertical externalities in this industry are large, and the regulations that prevent coordination have a substantial impact on market outcomes.

The model bridges earlier theoretical work on selling effort inefficiencies in vertical relationships (e.g. Telser, 1960; Mathewson and Winter, 1984; Winter, 1993) with more recent work on both the importance of adverting in differentiated goods markets (e.g. Sovinsky Goeree, 2008; Ackerberg, 2003) and the empirical understanding of vertical relationships and vertical inefficiencies (e.g. Villas-Boas, 2007; Hortaçsu and Syverson, 2007; Lee, 2013; Conlon and Mortimer, 2015). Telser (1960) is the first to study externalities of non-price decisions, or retail service, in vertical relationships. In particular, Telser (1960) argues that retailers may not optimally provide the service desired by the manufacturer, and retail price maintenance can be used to encourage retailers to provide product-specific services. Mathewson and Winter (1984) and Winter (1993) both consider a theoretical setting where a monopolist manufacturer sells a good through multiple retailers. As in my setting, they find that retailers do too little service, or advertising, from the perspective of the manufacturer.

There is a growing empirical literature that analyzes the effects of contracts in vertical relationships using structural models, including Villas-Boas (2007), Mortimer (2008), Bonnet and Dubois (2010), Crawford and Yurukoglu (2012), and Lee (2013). All of these studies only consider pricing decisions within the vertical relationship.[6] Mortimer (2008) studies how the adoption of a revenue sharing contract improves efficiency in the vertical relationship. Crawford and Yurukoglu (2012) and Lee (2013) quantify the effects of vertical integration

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[6]In earlier work, Bresnahan and Reiss (1985) estimate a model of the automobile dealer-manufacturer relationship in rural towns and find that markups between dealers and manufacturers are proportional across the product line. However, they do not consider the role of advertising, or spatial competition.

on welfare to disentangle efficiency and foreclosure effects. One study that focuses non-price decisions is Conlon and Mortimer (2015), who estimate a model of retail service effort but hold prices fixed. They disentangle an efficiency effect of vertical integration from a foreclosure effect. I focus on efficiency issues only, but I allow prices and selling effort to be endogenous in the model. In my setting, exit regulations limit the role of foreclosure.

I also contribute to an extensive literature on the automobile industry. There is a growing literature that uses newly available micro data from surveys (Berry, Levinsohn, and Pakes, 2004; Langer, 2011; Xu et al., 2014; Wakamori, 2015) and administrative records (Nurski and Verboven, 2012; Albuquerque and Bronnenberg, 2012; Moraga-González, Sándor, and Wildenbeest, 2015) to estimate consumer demand in the automobile industry. Albuquerque and Bronnenberg (2012) estimate dealer and manufacturer markups to analyze the effect of large demand shocks, and Nurski and Verboven (2012) analyze the effect of exclusive dealing in Europe on dealer and manufacturer profits. Xu et al. (2014) estimate a model of manufacturer and dealer association price advertising for trucks using detailed survey data. In contrast to Xu et al. (2014), I consider dealer advertising as well, and I model the supply side to understand the effect of state regulations and an alternative contract.

Examining the auto manufacturer and dealer relationship has long been an interest U.S. policy authorities. Recently, these regulations have attracted more attention because of (i) the financial trouble of US manufacturers during the 2009 recession and (ii) the emergence of Tesla, which has successfully worked around state regulations and offers cars for sale direct from the manufacturer. For example, the Federal Trade Commission in Rogers (1986) study state restrictions on vertical restraints, including a ban on direct to consumer sales, and conclude that state policies restricting vertical arrangements are harmful to consumers. The Department of Justice in Bodisch (2009) advocates eliminating state bans on direct sales. The FTC also urged state legislators to re-examine dealer franchise regulations through letters of comment.[7] Lafontaine and Morton (2010) provide a thorough overview of state franchise laws and suggest that these laws have contributed to the decline of US automobile

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[7]See http://tinyurl.com/oubuqeq, http://tinyurl.com/owgu2rb, and http://tinyurl.com/nlhyq27.

manufacturing.

2 Industry Background

There are nearly 500 new car dealers in Virginia, selling every major car brand.[8] Dealers are traditional franchises and hold essentially perpetual contracts to sell cars from manufacturers.[9] Manufacturers must offer their full-line of cars to any dealer that it has an established franchise relationship with. Dealers own their inventory outright, or finance it through a bank, having purchased it from the manufacturer. Dealers can only sell new cars from manufacturers with which they have franchise contracts, so dealer entry is ultimately a decision of the manufacturer. In Virginia, dealers range in size, selling as little as less than a dozen cars to as many as a few hundred cars per month. Nearly three-quarters of dealers sell more than one brand, and one-third sell cars from more than one parent company. Moreover, dealers tend to own more than one dealership location, and some dealers themselves have significant brand recognition.

New car dealers and manufacturers spend more on advertising than any other industry, totaling about $15 billion in 2012. Including national and local advertisements, manufacturers accounted for about 65% of this spending, but spending is more even between dealers and manufacturers in local markets.[10] The distinction between national and local advertising is the identity of who sells the advertising spot and whether the advertisement is seen only locally, or nationally. For example, some television ads are sold by NBC Comcast for national broadcast, and some are sold by a local affiliate, like NBC - New York. Typically, the same creative content is used for local and national advertisements. As in many other industries, manufacturers provide dealers with local advertisement support, or "market development

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[8]Much of the knowledge presented in this section is derived from interviews with various industry insiders. One interview with a dealer who owns multiple dealerships, sits on many dealer association boards, and is a former president of the National Automobile Dealer Association was particularly useful. An understanding of the historical regulatory framework is due to McHugh (1956). Lafontaine and Morton (2010) and Murry and Schneider (2015) provide detailed discussions of various aspects of this industry.

[9]"Dealership" is the common term for the physical location of a dealer's selling operations. However, throughout the paper, I adopt the term "dealer" to refer both to the person and the location of sales.

[10]Aggregate advertising statistics from adage.com.

funds." This local support often happens though dealer associations, which are organizations of dealers who decide on common advertising campaigns. These dealer associations are typically funded by manufacturers. Participation in such associations is not mandatory, but tends to be close to universal, especially in larger markets where there can be a significant amount of advertising funds available to spend.

Dealers pay for dealer specific advertising which is an independent decision from the manufacturer and dealer association. Manufacturers cannot require dealers to advertise, but in some cases provide dealers with creative content. Manufacturers and dealers associations tend to advertise the brand, and dealers typically focus less on the brand and more on qualities specific to the dealer. Dealer advertisements typically have a lower production quality and stress features such as service, buying experience, selection, and getting a "good deal." Although price advertising is not uncommon, advertised prices do not necessarily reflect transaction prices because individual price negotiation is prominent in this industry.

Individual state governments in the United States adopted numerous laws regulating car sales and the relationships between dealers and manufacturers during the second half of the 20th century.[11] Traditionally, dealers and dealer associations had significantly more influence in state legislatures than manufacturers, and resulting regulatory environment is viewed as favoring dealers. Regulations date back to the federal *Dealers' Day in Court Bill of 1956*, which requires manufacturers to prove "just cause" to terminate a dealer franchise relationship, giving a legal protection for dealers. Since then, states have adopted their own, stronger, laws regulating dealer termination, as well as other aspects of the dealer-manufacturer relationship. These laws are nearly ubiquitous among all fifty states.

One such ubiquitous regulation is a provision that new cars must be sold through dealers who are independent franchises of manufacturers. Additionally, manufacturers are prohibited from using contractual tools such as quantity forcing, price maintenance, two-part tariffs, service or quality provisions, investment requirements for advertising or showroom quality,

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[11]For a thorough review on the current regulatory environment see Lafontaine and Morton (2010) and Canis and Platzer (2009). Also, the FTC has a series of comments that summarize recent developments in laws concerning direct-to-consumer sales: `http://tinyurl.com/oubuqeq`, `http://tinyurl.com/owgu2rb`, and `http://tinyurl.com/nlhyq27`.

or franchise fees. Together, these regulations effectively ban direct-to-consumer sales or contractual forms of vertical integration.[12] Since these tools can theoretically resolve externalities, like double marginalization, in the vertical relationship, there is some question to why dealers lobbied for them in the first place. Legal analysis of the "Dealers Bill" of 1956 from the time suggests that dealers felt like they had little bargaining power, and so surplus from the relationship was unfairly in favor of manufacturers. Also, dealers were terminated in large numbers in the 1940s and 1950s, so the regulations may have been reactionary. Additionally, franchise contracts at the time included terms that were dubiously enforceable, and the nature of the burden of proof for enforcement favored manufacturers. For detailed history of the "Dealers Bill" see McHugh (1956) and Fulda (1956). Recently, these regulations have received attention because Tesla Motors, an electric car manufacturer from California, has sold cars directly to consumers in many states by either exploiting regulatory loopholes or taking advantage of ambiguous wording in the regulations. Since 2010, Tesla has been involved in numerous legal and legislative battles involving state automobile franchise regulations.

3 Demand and Supply of New Cars

In this section, I specify the model of consumer choice for automobiles and firm behavior. The framework allows for many important features in the industry including geographic variation in consumer locations, differentiation between dealers, multi-product manufacturers, multi-brand dealers, and intra-brand competition of dealers. Competition among dealers and manufacturers occurs in two stages. First manufacturers simultaneously set wholesale prices and local brand advertising.Second, dealers simultaneously set retail prices and dealer

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[12]Quantity discounts outside of the franchise contract occur in this industry and have the potential to relieve vertical externalities. However, these discounts would have to perfectly target downstream demand to achieve the first best advertising solution by forcing the retailer to set price equal to marginal cost. I observe accounting markups in the data, and they are not near zero. I also do not observe dealers giving large price breaks at the end of months, which might be consistent with a model of quantity discounts with uncertainty. Also, conversations with a large multi-franchisee dealer suggest they might not play a large role from the perspective of dealer pricing policy.

advertising.

3.1 Demand

Each year, consumers make a discrete choice among differentiated car models at dealers in the market where they reside. The consumer also has the option of not purchasing a new car. Consumer i's indirect utility for a new car j from dealer r at time t is a function of a vector of observed car characteristics, $\boldsymbol{x}_{jt}$, dealer specific price of the car, p_{jrt}, a function $g(a_{rt}, A_{jt}; \boldsymbol{\phi}_{it})$ of the level of dealer and brand advertising, a_{rt} and A_{jt} respectively, and a function $f(\mathcal{D}_{irt}; \boldsymbol{\lambda}_{it})$ of the distance from the consumer location to the dealer location, $\mathcal{D}_{irt}$.[13] The outside option is indexed $jr = 0$. Indirect utility of the consumer is:

$$u_{ijrt} = \boldsymbol{x}_{jt}\boldsymbol{\beta}_i + \alpha_i p_{jrt} + f(\mathcal{D}_{irt}; \boldsymbol{\lambda}_{it}) + g(a_{rt}, A_{jt}; \boldsymbol{\phi}_{it}) + \xi_{jrt} + \epsilon_{ijrt}, \qquad (3.1)$$

where $\boldsymbol{\beta}_i$ is a vector of consumer specific preferences for car characteristics, α_i represents a consumer specific preference for price, $\boldsymbol{\lambda}_{it}$ and $\boldsymbol{\phi}_{it}$ are vectors of preference parameters for distance and advertising, and ξ_{jt} represents a product-dealer-time specific preference that is known to the consumers and firms but unobserved in the data. The variable ϵ_{ijrt} is distributed i.i.d. type I extreme value and represents unobserved idiosyncratic consumer tastes. I assume that utility from not purchasing is a function of an unobserved consumer specific preference: $u_{i0t} = \epsilon_{i0t}$. Consumers choose the option with the highest indirect utility.

Consumers have heterogeneous preferences over price and product characteristics. I assume preference for price has the following functional form: $\alpha_i = -exp(\bar{\alpha} + \alpha^{inc}\Upsilon_i + \sigma^p\nu_i^p)$, where Υ_i represents consumer income, ν_i^p is distributed i.i.d standard normal, and σ^p represents the degree of unobserved heterogeneity in price preference across consumers.

I allow for individual specific preferences for product characteristics. For example, preferences for miles per gallon have the following form: $\beta_i^{mpg} = \bar{\beta}^{mpg} + \sigma^{mpg}\nu_i^{mpg}$, where ν_i^{mpg}

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[13]I omit a market index, n in the discussion of demand because I assume that consumers only purchase from dealers in the market where they reside. However, manufacturer advertising is market specific and wholesale prices are not, so I will introduce notation for markets when describing manufacturer advertising choices below.

is distributed standard normal and σ^{mpg} is a parameter to be estimated that represents the standard deviation of preferences for miles per gallon. I allow every car characteristic to have preferences with this formulation, which is the standard formulation for unobserved heterogeneity in differentiated products demand systems.

3.1.1 Distance

To capture the idea that consumers may prefer to purchase cars from nearby dealers over dealers that are farther away, I assume indirect utility is a function of the distance between the consumer's residence and the location of the dealer, $\mathcal{D}_{irt}$. The distance function has the following functional form:

$$f(\mathcal{D}_{irt}; \boldsymbol{\lambda}) = \lambda_1 \mathcal{D}_{irt} + \lambda_2 \mathcal{D}_{irt}^2 + \lambda_3 H_{i(1)} \mathcal{D}_{irt} + \lambda_4 H_{i(2)} \mathcal{D}_{irt}, \tag{3.2}$$

where $\boldsymbol{\lambda}$ is a vector of preferences to be estimated, and $H_{(1)}$ and $H_{(2)}$ are consumer characteristics: travel time to work and a measure local population density. This formulation of spatial demand is common in the literature, for example, see Davis (2006). Allowing for distance in the utility function creates spatial competition and affects the cross elasticities of dealers who are geographically disperse. It also implies that the effective potential market sizes can vary between dealers because some dealers are located in densely populated areas, while other dealers are located in less populated areas.

3.1.2 Advertising

I assume advertising enters indirect utility. I aggregate expenditures on television, radio, and print advertising into a single variable, separately for dealer advertising, a_{rt}, and manufacturer advertising, A_{jt}. I assume that the two types of advertising have, potentially, different effects on utility. Dealer advertising influences the utility for every product at that dealer, and manufacturer advertising influences the utility for every product of that brand or model

across dealers.[14]

I allow for consumer specific preferences for advertising. This could either represent heterogeneity in tastes for advertising or heterogeneity in exposure to advertising. The following is the functional form for advertising preferences:

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\begin{aligned}
g(a_{rt}, A_{jt}; \boldsymbol{\phi}_i) = & \phi_i^{dealer} log(1 + a_{rt}/\mathcal{M}) \\
& + \phi_i^{brand} log(1 + A_{jt}/\mathcal{M} + A_{jt}^{national}/\mathcal{M}^{national}),
\end{aligned}
\tag{3.3}
$$

where $\mathcal{M}$ represents market size. The advertising parameters have the following specification: $\phi_i^{type} = \bar{\phi}^{type} + \nu_i^{type} \sigma^{type}$, where ν_i^{type} is a standard normal random variable. The parameters $(\bar{\phi}^{dealer}, \bar{\phi}^{brand})$ represent the mean of advertising preferences in the population, and $(\sigma^{dealer}, \sigma^{brand})$ capture consumer heterogeneity in advertising preferences.

I measure the advertising exposure of an individual for a product as the advertising expenditures per capita. I divide expenditures by population to account for differences in the market for advertising across geographical markets. For example, in larger cities an advertisement is seen by more potential consumers, so advertising will command a higher price. The same amount of advertising expenditure in different markets could reach drastically different number of consumers. Adjusting advertisement expenditures by population is a way to approximately control for the equilibrium outcomes of the supply and demand of advertising across markets, and this is a common way to measure advertising in the literature. For example, Gordon and Hartmann (2016) impute a measure of advertising exposure that is market specific and is intended to control for differences in dollars per impression across markets. Also, Tuchman (2016) uses a measure of advertising scaled by population, termed Gross Rating Points.[15]

In the model, manufacturer advertising affects the utility for all of the manufacturer's

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[14]In practice, an advertisement can include multiple cars or brands. I provide more details about how I construct the advertising variables below in Section 4.

[15]In other work that models individual utility from advertising, Ackerberg (2003) and Sovinsky Goeree (2008) use a measure of the direct advertising exposure of consumers because they have micro data on individuals advertising exposure.

products at all of the dealers in its dealer network. However, dealer advertising only directly affects the utility of products sold at that particular dealer. I allow for separate effects of dealer and brand advertising for the following reasons. First, typically these advertisements convey different types of messages about the product. Second, manufacturer ads typically have a higher level of production quality, and so may have a different effectiveness in shifting consumer demand per dollar of advertising spending. On the other hand, dealer advertising may be better at reflecting local idiosyncrasies in preferences, and so may be more effective.[16]

3.1.3 Aggregate Product Shares

I assume that ϵ_{ijrt} is distributed i.i.d. Extreme Value Type I, which leads to the familiar logit individual choice probabilities. To obtain aggregate shares, I integrate individual choice probabilities over the distribution of observed and unobserved individual characteristics. I use s_{jrt} to denote the market share of car model j from dealer r. This follows BLP and the subsequent related literature. I provide details in Appendix A.1.2.

3.2 Automobile Dealers

I model the supply of new cars by manufacturers and dealers as a full information two stage game. In the first stage, manufacturers simultaneously set wholesale prices and brand advertising levels. In the second stage, dealers observe the manufacturer decisions and simultaneously make retail pricing and advertising decisions. Each firm has complete information about rivals, and I assume there exits a sub-game perfect Nash equilibrium in prices and advertising. In this section, characterize dealers' and manufacturers' optimal pricing and advertising decisions. I show how to recover unobserved retail, production, and advertising costs of dealers and manufacturers.

Both manufacturers and dealers sell multiple products and some dealers link with multiple

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[16]Other studies that model advertising directly in indirect utility include Ackerberg (2003), Dubé, Hitsch, and Manchanda (2005), Gordon and Hartmann (2016), and Anderson et al. (2016). Alternatively, some studies have treated advertising as informative, including Ackerberg (2003) and Sovinsky Goeree (2008). In my setting, unlike the latter two papers, products are not frequently being introduced, so there is likely not a large information component to advertising.

manufacturers. Let the set of models sold by dealer r be $\mathcal{J}_r^R$. Let the set of models sold by manufacturer m in market n be $\mathcal{J}_{mn}^M$. Let the set of dealers associated with manufacturer m in market n be $\mathcal{R}_{mn}$.[17]

I solve the price and advertising game backwards, starting with the decisions of the dealers. Each dealer makes one retail price decision for each car model they offer and a single advertising decision, taking as given the wholesale price and manufacturer advertising decisions. A particular dealer faces the following profit maximization problem:

$$\max_{\boldsymbol{p_t}, a_r} \pi_{rn} = \mathcal{M}_n \sum_{j \in \mathcal{J}_r^R} (p_{jr} - W_j - c_{jr})s_{jr} - c^{ad}(a_r; \psi_r), \tag{3.4}$$

where $\mathcal{M}_n$ is the size of market n where the dealer is located, W_j is the wholesale price charged by the manufacturer, c_{jr} is the constant marginal cost/revenues of retail distribution, s_{jr} is the market share of the car from a particular dealer, and $c^{ad}(a_r; \psi_r)$ is the cost of advertising. Although not explicitly notated, the market share is directly a function of all the endogenous variables: prices and both types of advertising.

I assume the dealer faces convex advertising costs. This is a common assumption in the advertising literature that captures the idea that successive advertisements may "reach" the same person multiple times, and reaching new customers becomes increasingly difficult; for example, see Grossman and Shapiro (1984) and Anderson et al. (2016). Specifically, I assume the cost of advertising is

$$c^{ad}(a_r; \psi_r) = \psi_r \frac{a_r^2}{2}, \tag{3.5}$$

where ψ is a dealer specific advertising cost parameter.

All dealers simultaneously make price and advertising decisions. For a particular dealer, the solution involves one pricing first order condition for each car model offered and a single advertising first order condition. The price first order condition for car model j offered at

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[17]I suppress the time subscript t in the rest of this section for notational clarity.

dealer r is

$$s_{jr} + \sum_{k \in \mathcal{J}_r^R} (p_{kr} - W_k - c_{kr}) \frac{\partial s_{kr}}{\partial p_{jr}} = 0, \tag{3.6}$$

and the advertising first order condition for dealer r is

$$\frac{\mathcal{M}_n}{a_r} \sum_{k \in \mathcal{J}_r^R} (p_{kr} - W_j - c_{kr}) \frac{\partial s_k}{\partial a_r} - \psi_r = 0. \tag{3.7}$$

Let T^R be the dealer ownership matrix, with general element $T^R(g, h) = 1$ if product g and h are sold by the same dealer, and zero otherwise. Let ∇_p^s be a matrix containing all of the first partial derivatives of shares with respect to all retail prices. Following BLP, I solve for the vector of all dealer markups by stacking all of the pricing FOCs defined by equation (3.6),

$$(\boldsymbol{p} - \boldsymbol{W} - \boldsymbol{c}) = -(T^R * \nabla_p^s)^{-1} \boldsymbol{s}, \tag{3.8}$$

where $\boldsymbol{s}$ denotes the vector of product shares and the notation "$*$" refers to element-by-element multiplication. Once markups are recovered, I plug them into the system of equations defined by equation (3.7) and recover advertising costs, ψ, directly.

3.3 Automobile Manufacturers

I assume manufacturers simultaneously set wholesale prices and model/brand advertising in a first stage with full information about rival manufacturers and dealers. These wholesale prices and advertising choices constitute take-it-or-leave-it offers to the dealers. In practice, regulations impose that manufacturers set the same price for all dealers in a single state. This coupled with the fact that each manufacturer has dozens to hundreds of dealers per state motivate the timing structure of the game. Although optimal dealer price and advertising decisions cannot be solved analytically, the FOCs from equations (3.6) and (3.7) implicitly define functions for equilibrium choices of price and advertising given the decisions of manufacturers: $\boldsymbol{p}^\star(\boldsymbol{W}, \boldsymbol{A})$ and $\boldsymbol{a}^\star(\boldsymbol{W}, \boldsymbol{A})$. These equilibrium prices and ads imply a level of equilibrium shares given manufacturer decisions, $s^\star(\boldsymbol{p}^\star(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{a}^\star(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{A})$. Notice

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that manufacturer advertising affects shares directly because consumer utility is a function of manufacturer advertising, as well as indirectly through the optimal response of dealer decisions. Wholesale prices affect shares indirectly through dealer decisions.

Manufacturer m chooses a single wholesale price W for each of its models j across all markets n. The manufacturer also chooses a market specific brand advertising level for each model. The following defines the manufacturer profit maximization problem:

$$\max_{\boldsymbol{W},\boldsymbol{A}} \Pi_m = \sum_n \left[\mathcal{M}_n \sum_{j \in \mathcal{J}_{mn}^M} \sum_{r \in \mathcal{R}_{mn}} (W_j - C_j) s_{jr}^\star - \sum_{j \in \mathcal{J}_{mn}^M} C^{ad}(A_{jn}; \Psi_{jn}) \right], \qquad (3.9)$$

where C_j represents constant marginal costs of production for model j and $C^{ad}(A_{jn}; \Psi_{jn})$ is the cost of advertising. Notice that a manufacturer can choose to spend different amounts on advertising for a particular model in different media markets, but W_j is not market specific because wholesale prices, by law, must be the same for every dealer in the state of Virginia. I assume that manufacturers face convex advertising costs: $C^{ad}(A_{jn}; \Psi_{jn}) = \Psi_{jn} A_{jn}^2 / 2$.

In the model, manufacturers anticipate changes in wholesale price lead to both changes in retail price *and* changes in dealer advertising. For example, consider an increase in wholesale price that leads to a less than one-for-one increase in retail price. The dealer would sell less and make a lower markup per car, generating less incentive to advertise, which in turn reinforces the lower retail price.[18] Also, rival dealers change prices and advertising in response to changes in wholesale prices and manufacturer advertising. The sum of these effects depends on the parameters of demand and the market structure of local markets. A single wholesale pricing first order condition for model j is,

$$\sum_n \left[\sum_{r \in \mathcal{R}_{mn}} s_{jr} + \sum_{f \in \mathcal{J}_{mn}^M} (W_f - C_f) \sum_{r \in \mathcal{R}_{mn}} \frac{\partial s_{fr}^\star(\boldsymbol{p}(\boldsymbol{W},\boldsymbol{A}), \boldsymbol{a}(\boldsymbol{W},\boldsymbol{A}), \boldsymbol{A})}{\partial W_j} \right] = 0. \qquad (3.10)$$

Here, I am explicit about the fact that equilibrium retail prices and dealer advertising are a function of wholesale prices and manufacturer advertising.

To solve equation 3.10 for unobserved costs, I need to compute $\frac{\partial s}{\partial W}$. A change in wholesale

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[18]In the model, all of these effects happen simultaneously.

price directly affects the retail price decisions of dealers, as well as the advertising decisions of dealers. Both of these effects influence how a change in wholesale price changes equilibrium shares of a single product in a market:

$$\frac{\partial s^{\star}_{fr}}{\partial W_j} = \underbrace{\sum_{s \in \mathcal{R}} \sum_{z \in \mathcal{J}} \frac{\partial s_{fr}}{\partial p_{zs}} \frac{\partial p_{zs}}{\partial W_j}}_{\text{effect through dealer prices}} + \underbrace{\sum_{s \in \mathcal{R}} \frac{\partial s_{fr}}{\partial a_s} \frac{\partial a_s}{\partial W_j}}_{\text{effect through dealer ads}}, \tag{3.11}$$

where the first set of terms are the typical wholesale price pass-through to retail prices, and the second set of terms are the additional advertising pass-through of wholesale price. This second term is how my model differs from the canonical empirical model of vertical relationships, for example Villas-Boas (2007). A challenge is computing wholesale cost pass-through, $\frac{\partial p}{\partial W}$ and $\frac{\partial a}{\partial W}$, which I explain next.

3.3.1 Recovering Pass-through

I recover the pass-through of wholesale price to retail price, $\frac{\partial p_{fr}}{\partial W_j}$, and advertising, $\frac{\partial a_r}{\partial W_j}$, by applying the implicit function theorem to the *retail* pricing and advertising first order conditions. Villas-Boas (2007) and Sudhir (2001) recover pass-through this way this for retail prices only, whereas I show how this naturally extends to two retail choices, prices and advertising.

Consider a matrix Q containing the system of equations, where the ith equation is the retail pricing FOC of product j at dealer r:

$$Q(i) = s_{jr} + \sum_{k \in \mathcal{J}^R_r} (p_{kr} - W_k - c_{kr}) \frac{\partial s_{kr}}{\partial p_{jr}} = 0. \tag{3.12}$$

Using this system of equations, I define the following matrices of derivatives of Q that have the following general elements: $Q_p(h, i) = \frac{\partial Q^i}{p_h}$, $Q_a(r, i) = \frac{\partial Q^i}{a_r}$ and $Q_{W_1}(i) = \frac{\partial Q^i}{\partial W_1}$. Note that the h index in the term $Q_p(h, i)$ indexes both models and dealers, which I do to avoid a three-dimensional matrix notation. Alternatively, I could define a product as a model-dealer combination, but that notation is much harder to follow when describing the rest of the

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model.

Additionally, consider the matrix of dealer advertising FOCs, K, with general element for the rth dealer:

$$K(r) = \frac{\mathcal{M}}{a_r} \sum_{k \in \mathcal{J}_r^R} (p_{kr} - W_k - c_{kr}) \frac{\partial s_{kr}}{\partial a_r} - \psi_r = 0. \tag{3.13}$$

I define matrices of derivatives of the advertising FOCs as K_p, K_a, and K_{W_1} with general elements $K_p(r, i) = \frac{\partial K^r}{\partial p_{jr}}$, $K_a(r, r') = \frac{\partial K^r}{\partial a_{r'}}$, and $K_{W_1}(r) = \frac{\partial K^r}{\partial W_1}$, where, just as above, the i index in $K_p(r, i)$ indexes a model-dealer combination.

To recover the total effect of a wholesale price change on dealer pricing I apply a multivariate version of the implicit function theorem. To do this, define the following block matrix.

$$\mathcal{G} = \begin{pmatrix} Q_p & Q_a \\ K_p & K_a \end{pmatrix}, \tag{3.14}$$

where this matrix holds the derivatives of all dealer price and advertising first order conditions with respect to all retail prices and advertising. The dimension of this matrix is a square matrix with length equal to the number of all model-dealer combinations (the number of pricing first order conditions, as in Villas-Boas, 2007) plus the number of dealers (the number of advertising first order conditions).

Next, I construct a block matrix for the wholesale price derivatives:

$$\mathcal{H} = \begin{pmatrix} Q_{W_1} & \cdots & Q_{W_J} \\ K_{W_1} & \cdots & K_{W_J} \end{pmatrix}, \tag{3.15}$$

where this matrix holds derivatives all dealer price and advertising first order conditions with respect all wholesale prices. The length of this matrix is the same length as $\mathcal{G}$, and the width is the number of distinct car models (the number of wholesale prices). Recall wholesale prices must be the same across dealers.

The matrix of wholesale price pass-through, ∇_W, is the solution to the following system

of equations:

$$\mathcal{G}\nabla_W = \mathcal{H}. \tag{3.16}$$

The first $\mathcal{I}$ rows of ∇_W are the price pass-through terms, which I term ∇_W^p, where $\mathcal{I}$ is the total number of products offered at all dealers. The last $\mathcal{R}$ rows are the advertising pass-through terms, notated ∇_W^a, where $\mathcal{R}$ is the total number of dealers.

Non-advertising dealers. About ten percent of dealers do not advertise in any given year, which implies their advertising first order condition are at a corner. I cannot use their FOCs to construct advertising pass-through in the manner described above. Formally, this means I cannot recover ψ for non-advertising dealers. I assume the pass through of advertising for these dealers is zero because I do not have any additional information about these dealers' willingness to advertise given changes in W. The consequence is that I cannot say anything about how these dealers' advertising might change in a counterfactual. An alternative approach would be to put a distributional assumption on ψ and estimate parameters of that distribution simultaneously with demand estimation, for example as in Sovinsky Goeree (2008) and Anderson et al. (2016). However, recovering the supply side parameters for my model is much more computationally expensive than those papers, and nesting the supply side in the estimation routine would be computationally infeasible.

3.3.2 Recovering Manufacturer Costs

I recover manufacturer marginal costs by inverting the wholesale price first order condition, equation 3.10, and plugging in the pass-through terms recovered above. Markups can be expressed in matrix form as

$$(\boldsymbol{W} - \boldsymbol{C}) = - * (T^M * \left(\nabla_W^{p\,\prime}\nabla_W^{a\,\prime}\right) \begin{pmatrix} \nabla_p^s \\ \nabla_a^s \end{pmatrix})^{-1}\tilde{\boldsymbol{s}}^{\star}, \tag{3.17}$$

where $\tilde{\boldsymbol{s}}^{\star}$ in the above equation is a vector of *model* market shares (summed over dealers), with element, $\tilde{s}_j^{\star} = \sum_n \sum_{r \in \mathcal{R}_{mn}} s_{jr}$. By writing markups this way I am incorporating the constraint

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that wholesale prices must be equal across dealers and markets. To recover marginal costs I need data on wholesale price, which I have.[19] After computing the pass-through terms, the only unobserved term left is C.

3.3.3 Recovering Manufacturer Advertising Costs

Advertising by the manufacturer is at the model-market level, and therefore affects all products of the same model in a single market, regardless of the dealer. In this sense, brand advertising "raises all boats" with respect to the dealers. The number of total advertising decisions equals the number of models multiplied by the number of local markets. The manufacturer advertising first order condition for model j in local market n is

$$\sum_n \left[\mathcal{M}_n \sum_{k \in \mathcal{J}_m} \sum_{r \in \mathcal{R}_{mn}} (W_k - C_k) \frac{\partial s_{kr}^\star(\boldsymbol{p}(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{a}(\boldsymbol{W}, \boldsymbol{A}), A)}{\partial A_{jn}} - \Psi_{jn} A_{jn} \right] = 0. \qquad (3.18)$$

Note that even though car model level advertising decisions are market specific, the advertising decision is dependent across markets because wholesale price is not market specific.

The partial derivative of shares with respect to manufacturer advertising implies that the manufacturer anticipates changes in dealer price and advertising given changes in manufacturer advertising:

$$\frac{\partial s_{kr}^\star}{\partial A_{jn}} = \underbrace{\sum_{h \in \mathcal{J}_m^M} \sum_{s \in \mathcal{R}_{mn}} \frac{\partial s_{kr}}{\partial p_{hs}} \frac{\partial p_{hs}}{\partial A_{jn}}}_{\text{effect through dealer prices}} + \underbrace{\sum_{s \in \mathcal{R}_{mn}} \frac{\partial s_{kr}}{\partial a_s} \frac{\partial a_s}{\partial A_{jn}}}_{\text{effect through dealer ads}} + \underbrace{\frac{\partial s_{kr}}{\partial A_{jn}}}_{\text{direct effect}}. \qquad (3.19)$$

When the manufacturer changes its advertising, all dealers will respond with changes in prices and advertising, which in turn changes equilibrium shares. The sum of these effects is the total effect of a change in manufacturer advertising on quantity demanded. Recovering Ψ_{jn} is straightforward after solving for markups in equation (3.17) and recovering the pass-through of manufacturer advertising in an analogous way I recovered the pass-though of

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[19]See Villas-Boas and Hellerstein (2006) for a discussion of identifying features of profits in models of vertical relationships.

wholesale prices above.

3.4 Discussion of the Model − Advertising Externalities

The model captures two advertising externalities: a vertical public goods externality familiar from the theoretical literature, such as in Telser (1960) and Mathewson and Winter (1984), and a horizontal business-stealing externality that comes from the nature of the non-cooperative game played by rivals in each sub-game.

The vertical externality implies that there is too little advertising by the dealer from the manufacturer's perspective and too little advertising by the manufacturer from the dealer's perspective. This is clear, for example, from the dealer advertising first order condition, equation 3.7, which does not directly include the payoffs of the manufacturer. As long as demand is increasing in dealer advertising, then the dealer is doing too little advertising from the perspective of the manufacturer, holding prices constant. Each firm would prefer to introduce a contract that coordinates the advertising decisions and appropriates the rents from the new market outcomes. I discuss a particular franchise fee contract in Section 6 that would accomplish this outcome. However, it is useful to note that in complex oligopoly environments like the automobile industry, vertical coordination does not necessarily imply greater total producer surplus, in contrast to simpler bilateral monopoly environments where vertical coordination leads to higher total consumer and producer surplus. For example, see Lin (1988) for a model of oligopoly and vertical integration where vertical integration does not achieve higher total producer surplus.

On the other hand, advertising at each vertical level acts to steal business from rivals, creating a Prisoner's Dilemma in advertising among horizontal rivals. For example, if rival dealers could collude on advertising they would jointly decide to lower advertising. This is analogous to standard pricing externality in Nash Bertrand pricing games. Since vertical coordination would imply greater advertising for the integrated firm and advertising is a strategic complement, vertical coordination can exacerbate the horizontal externality. In this sense vertical disintegration "softens" downstream competition over advertising, compared

with a completely vertically integrated industry. The size of these two externalities is an empirical question which I address by simulating a two-part tariff contract between dealers and manufacturers that leads to vertical coordination of advertising and pricing decisions.

4   Description of Data

I obtain automobile sales data for the state of Virginia from the Virginia Department of Motor Vehicles for January 1, 2007 to December 31, 2011. The data are at the individual transaction level. For each car purchase, I observe the make/model of car bought, date of transaction, transaction price, the identity of the selling dealer, and the nine or five digit zip code of the buyer. I limit the sample to cars, SUVs, and non-commercial vans sold to and from consumers and dealers in the four largest media markets in Virginia: Northern Virginia, Virginia Beach, Richmond, and Roanoke/Lynchburg. I also limit the sample to cars with a manufacturer suggested retail price below $70,000. I merge the transaction data with data on car characteristics and wholesale prices provided to me from Intellichoice.com. I include the following car characteristics in the model: a measure of acceleration that is equal to horsepower divided by car weight, physical size as described as the length times height in inches, EPA miles per dollar rating (MPG / price per gallon), and the body style (eg sedan, SUV, etc). A summary of variable definitions is in Table 10. I aggregate the transactions data to define a product as a car model sold from a particular dealer. I use the base, 4-door, model trim characteristics as the product characteristics for a particular model. To construct the price of a product, I take the average price for a make/model from a dealer in a year. The final sample consists of 21,177 product level observations across four markets and 5 years. I present descriptive statistics in Table 1.

I geo-code the location of dealers and buyers in order to construct purchase distances. Figure 1 illustrates the empirical density of transaction distances in the sample. Most consumers do not make purchases very far from home, and the distribution is heavily skewed. I present transaction distance statistics in Table 1. The median purchase distance is about eight miles. Furthermore, median transaction distance past the closest dealer is only about

four miles. As expected, transaction distances are much shorter in urban and suburban areas than rural areas (not shown in the table).

Figure 1: Density of Transaction Distance
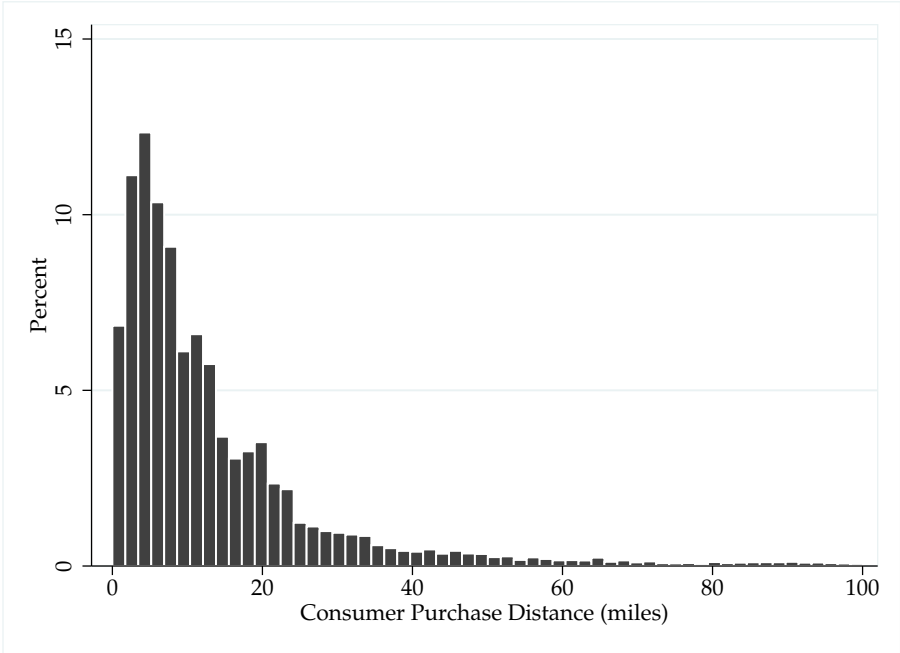
I merge the transactions data with information on dealer and manufacturer advertising from Kantar Media Intelligence. I observe yearly advertising expenditures for automobile dealers, manufacturers, and dealer associations in the four largest media markets in Virginia. The data are broken down by type of media, and I use the sum of print, radio, and television advertising as the measure of advertising expenditures. Manufacturer brand advertising is the sum of manufacturer and dealer association advertising. For dealer advertising, I assign the total amount spent on dealer advertising in a year to each product sold from that dealer. For example, if "Jim Bob Chevrolet" spends $20,000 on advertising in 2008, every car offered by that dealer has $a_j = 20,000$. Brand advertising is more complicated because I observe advertisements that mention more than one car model. For example, Volkswagen might have an advertisement that mentions both the Jetta and the Golf. I also observe advertisements that simply mention the brand without reference to particular models. I

follow Sovinsky Goeree (2008) and partially attribute the amount spent on multi-product ads to each of the products mentioned by equally distributing the advertising dollars among those products mentioned.[20] For example, if Volkswagen spends \$10,000 on a Jetta/Golf ad, I attribute \$5,000 to each the Jetta and the Golf. If Volkswagen spends \$10,000 on an ad that mentions the entire line of products, I attribute \$2,000 to each product, assuming Volkswagen offers five different car models in total.

I present product-level descriptive statistics from the advertising data in Table 1. Average yearly dealer advertising is \$78,576, and average local brand level advertising for a given product is \$278,139. Average national advertising for a model is \$4.3 million. There is substantial variation in advertising across models. There are also substantial differences in dealer advertising, both among dealers of the same brands and across brands.

Lastly, I merge the geo-coded transaction data to local demographics from the 2010 American Community Survey. I use these data to simulate from the empirical distributions of the following individual characteristics at the zip-code level: income, population density, and travel time to work. I also use the ACS data to compute the number of potential consumers.

5 Estimation and Results

I estimate the demand model using the Method of Simulated Moments, following closely Berry, Levinsohn, and Pakes (2004) and Petrin (2002). I use three different types of moments to estimate the model parameters. First, I force the market shares predicted by the model to equal the market shares in the data, which exactly identifies unobserved product quality, ξ_{jr}. Second, I make the assumption that $\boldsymbol{\xi}$ is mean zero conditional on a set of instruments, $E[\xi \mid Z] = 0$, where Z represents the instruments. There are three endogenous variables in consumer demand, price, dealer advertising, and manufacturer advertising, so I construct instruments for all three variables. Third, I construct micro-moments based on the individual

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[20]Sovinsky Goeree (2008) has much more detailed advertising data and estimates parameters of this assignment function instead of equally assigning ads across products.

transactions data. For example, I match the mean travel distance in the data to the mean travel distance predicted by the model. I do not use restrictions from the supply model to estimate the demand parameters. Details of how I construct the moments and other estimation details can be found in Appendix A1. Below, I first discuss identification and the instruments, second I present estimates of demand and supply, and third I discuss important implications of the estimates, including comparison of the results to a model that does not incorporate optimal advertising decisions.

5.1 Identification and Instruments

There are three endogenous variables in the utility function: prices, dealer advertising, and manufacturer brand advertising. I include brand, time, and car style dummies in the utility function to control for common demand realizations within these groups. However, it is still likely that there are unobserved demand factors, ξ, that correlate with prices and both types of advertising. I construct multiple instruments to deal with the endogeneity issue. In general, as is the case in most of the literature, the validity of the instruments depend on the assumption that market structure is exogenous with respect to product-level unobserved quality. It is useful to describe the price and advertising instruments separately, although they are all used simultaneously in estimation.

For prices, I use versions of the instruments suggested in BLP that are based on competition. Specifically, for a particular car and a particular car characteristic, I construct the squared difference between that car's product characteristic and the average characteristic of cars available at dealers within a 20-mile radius. I also use the squared difference from the average characteristic for cars of the same style (e.g. mid-size sedan, SUV, etc.) available within 20 miles. Not only are these instruments useful at identifying the price parameter, but they also help identify the random coefficients because they measure the competitiveness, or substitutability, among products in a local geographic area. The fact that these instruments are based on dealer specific locations generates useful variation in competition within a market usually not captured by the BLP instruments.

To identify the effect of dealer advertising, I rely on the fact that the first order conditions for dealer advertising imply that some notion of local market size correlates with advertising. This is because advertising expenditures enter profits as a fixed cost, so advertising spending should be greater for dealers with greater the total revenue, other things equal. To capture local market size, I construct a variable that is the population within a 5-mile radius of each dealer. I also construct a measure of advertising price, which varies across time and markets, from the Kantar advertising data. To identify the effect of manufacturer advertising, I include the national advertising spending of the manufacturer. Conditional on a brand effect, national advertising is likely uncorrelated with local brand specific demand shocks.

In Appendix A.1.4 I report regressions of the three endogenous variables on all of the exogenous variables. These results are in Table 11. Most of the BLP instruments are significant in the price regression, and all of the advertising instruments are statistically significant in the advertising regressions. I also report the estimates of a simplified version of the demand model that does not include any unobserved or observed consumer heterogeneity, except ϵ, in Table 12. I estimate this model using linear GMM, as in Berry (1994). I estimate this simplified version of the model for three reasons: to examine covariation between product shares and the exogenous variables, to understand the effect of the instruments on coefficients of the endogenous variables, and to provide good starting values for the estimation of the full model.

There are some aspects of my data that are different from other related studies. First, I have very detailed transaction level sales data that match consumers with actual purchases and the distance traveled to make the purchase. Variation in distance and choice probabilities identifies the distance preference parameter. Co-variation of consumer's Census Tract attributes and purchase distance identifies the demographic preferences in the distance function. These micromoments are described in more detail in Appendix A.1.3, and are analogous to the score of a multinomial logit likelihood function, as explained in Berry, Levinsohn, and Pakes (2004).

Second, I use advertising data that is more aggregate than some other studies. For

example, Sovinsky Goeree (2008) uses individual exposure data and I only have data on aggregate advertising spending by firms. Identification of the advertising parameters in my model is akin to the identification of an endogenous product attribute. Covariation in advertising (more specifically, those instruments which correlate with advertising) and sales identifies the mean advertising parameters, and the random coefficients on advertising are identified by the standard arguments for random coefficients, that is by co-variation in choice sets across markets and time. Because of the different nature of our two datasets, compared to this study, Sovinsky Goeree (2008) identifies many features of advertising preferences, whereas I am limited to a mean and variance parameter for each type of advertising.

Also, Sovinsky Goeree (2008) estimates the supply and demand simultaneously, which leads to an issue when firms have zero advertising. If advertising is zero in the data, then the advertising first order condition does not hold with equality and the unobserved costs of advertising (ψ and Ψ in my model) are not identified. Sovinsky Goeree (2008) uses a generalized residual concept to complete the model. Because I estimate demand without supply-side restrictions, advertising zeros are not an issue in estimation. However, this is an issue when I back out firm advertising costs (ψ and Ψ) and simulate counterfactuals. I cannot back out advertising costs for firms who do not advertise, and I hold their advertising at zero in counterfactuals. However, I can back out marginal costs, c and C, for dealers and manufacturers with zero advertising.

5.2 Results: Demand

Next, I discuss results from demand estimation. The results are presented in Table 2.

Car Characteristics   The coefficients on acceleration and car size are positive and statistically significant (bottom panel of Table 2). The average consumer dislikes US brand cars. The coefficient on miles-per-dollar is close to zero, however I estimate substantial variation in the taste for miles-per-dollar. There is a relatively significant amount of consumer heterogeneity in preferences for acceleration and US brands as well. These results, including the

miles per gallon result, are not inconsistent with other studies of automobile demand in the literature.

Price   I display the estimated density of own price elasticities in Figure 2. There is substantial variation in elasticities. The average price elasticity of demand is about -4.9, which is similar to other results in the literature, in particular Albuquerque and Bronnenberg (2012) and Nurski and Verboven (2012) who also use fairly granular demand data. As seen in Table 2, higher income consumers are less elastic, and there is substantial heterogeneity in sensitivity to price across consumers. These results translate directly into the estimated markups and costs, which I discuss in the next section.

Distance   Consumers are very sensitive to travel distance (top panel in Table 2). Consumers with longer travel times to work are willing to travel further to purchase a car, and consumers that live in dense areas are willing to travel less to purchase a car. The average elasticity of demand with respect to distance is between -1.1 and -1.8 depending on the market and year. For example, a 1% increase in distance to a product for all consumers (or the equivalent increase in the cost of distance) leads to a decrease in product shares by between 1.1% and 1.8%. Consequently, cross price elasticities between products at dealers located far from each other are smaller than dealers located near each other. I present own and cross price elasticities for selected group of cars in the Richmond market in the first quarter of 2007 in Table 3. An element of the table is the percent change in demand of the row product given a percent change in the price of the column product. Three different geographic selling areas are represented in the table. Area "1" is approximately 15 miles from areas "2" and "3", and the later two areas are approximately 25 miles from each other. If distance is important then cross elasticities should be smaller between areas "2" and "3" than between any other combination.[21] For example, a price increase by Honda Accord 3 leads to greater substitution to Honda Accord 1 than Honda Accord 2. The pattern is similar for the Ford

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[21]Of course cross elasticities also depend on other things besides distance, including the density of consumers between each dealer.

Figure 2: Own Price Elasticity of Demand
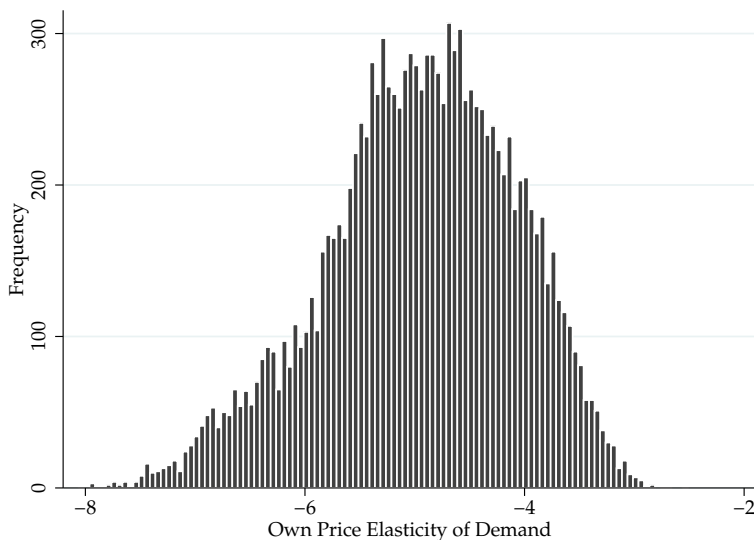
Fusion. Also, notice that the Accord 3 is a closer substitute to the Fusion 3 than the Fusion 1 or 2. The Jetta 1 and Camry 1 are closer substitutes to Accord 1 than the other Accords.

Advertising The advertising parameters are presented in the second panel in Table 2. Both dealer and brand advertising have a meaningful effect on utility. On average, consumers value a 10% increase from the mean of dealer advertising by about $74. Consumers value a 10% increase from the mean of manufacturer advertising by about $42. There is also substantial variation across consumers in their preference for advertising, which is in line with results from the literature, for example, Sovinsky Goeree (2008). The fact that dealer advertising is more effective than brand advertising is consistent with Xu et al. (2014), who argue that the more "local" the sender of an ad, the more effective it should be. They estimate a similar finding in the "light truck" market.

5.3 Results: Market Power and Costs

I compute marginal costs $((c_{jr}, C_j))$, markups, and parameters of the advertising cost functions (ψ_r, Ψ_j) using the demand estimates and the supply model presented in Section 4. I display estimated dealer markups and marginal costs in Table 4. Average dealer markups

are \$5,590 per car. An important feature of my data is that I observe the wholesale price charged by the manufacturer to the dealer, including any national level sales incentives to dealers. Because of this, I can estimate a marginal retailing cost to the dealer (c_{jt}) which is separate than the wholesale price of the car. This cost can be positive or negative, as the dealer realizes both costs and additional revenues associated with the sale of a new car. Examples of costs are salesperson and inventory costs. Examples of additional marginal revenue from car sales include future revenues from warranty repairs, oil changes, other services, or the opportunity cost of moving a car from inventory. If the net cost is negative (i.e. a net revenue), this implies that the dealer is charging a lower price than the observed wholesale cost and demand elasticities from the model would imply; in other words, they have net marginal revenues from selling cars, not including the wholesale cost. The dealer charges this lower price to sell more units to realize this extra marginal revenue from each sale. On average I estimate this cost to be about -\$1,000 per car, with substantial variation across cars and brands. Albuquerque and Bronnenberg (2012) also estimate that dealers have net marginal retailing revenue from selling cars, although their estimate is substantially larger than mine. They claim that dealer net marginal revenues are consistent with the fact that dealers make over half of their profits from business activities other than new cars sales, and this claim is substantiated in Hanssens et al. (2012).

I present the estimated markups and costs for manufacturers in Table 5. Because I have data on wholesale prices, I can estimate markups and marginal costs for both levels of the vertical relationship.[22] I estimate that average manufacturer markups are \$2,151 per car model. Cars sold from different dealers will have different demand and different own price elasticities, but the manufacturer must charge the same wholesale price to every dealer, so the manufacturer's markup is model specific as opposed to model-dealer specific.

I compare the supply estimates to other studies of the automobile industry. There are limited studies of the automobile industry that also make the distinction between dealer

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[22]An observation in the manufacturer table (Table 5) is a car model in a given year. In the dealer table (Table 4) an observation is a car model from a particular dealer. This is why the average wholesale costs are different.

and manufacturer surplus. Albuquerque and Bronnenberg (2012) estimate a slightly larger average dealer markup, $6,220 versus $5,590. Both numbers are consistent with estimates using detailed accounting data provided in Hanssens et al. (2012). However, Albuquerque and Bronnenberg (2012) estimate much larger manufacturer markups. In part, this is because I model optimal advertising decisions of dealers and manufacturers, so the system of first order conditions that define manufacturer markups are different between my model and Albuquerque and Bronnenberg (2012). I discuss this in more detail below. Nurski and Verboven (2012) make the distinction between retailers and manufacturers, but they do not report price-cost markups at each level. Other studies that estimate markups in the new automobile industry do not make the distinction between retail and manufacturer surplus, for example, Berry, Levinsohn, and Pakes (1995), Petrin (2002), and Brenkers and Verboven (2006). Brenkers and Verboven (2006) note that if both retailers and manufacturers have market power, then the markups these studies estimate is the retail markup, and the estimated costs are the sum of costs in the vertical structure.

5.4 Manufacturer Market Power in Alternative Models

My model builds on previous models of vertical relationships, for example Villas-Boas (2007), by incorporating the optimal non-price decisions of upstream and downstream firms. Because of this, the manufacturer wholesale price first order conditions in my model are different than the first order conditions in a model with only pricing decisions. When choosing wholesale price, the manufacturer takes into account the effect of changes in wholesale price on optimal retail prices chosen by dealers (the typical wholesale cost pass-though) as well as the effect of changes in wholesale price on the optimal advertising decisions of dealers. Dealers marginal benefit of advertising is directly a function of its markup, so the effect of raising wholesale price will decrease the marginal benefit of advertising for the dealer, thus leading to lower dealer advertising. Dealer advertising benefits the manufacturer, so the manufacturer has an incentive to provide dealers with a marginal benefit of advertising in the form of higher markups.

To give more intuition for the difference between my model and an alternative model without advertising decisions, I present a simple example of a single product monopolist manufacturer selling to a single product monopolist retailer. Using the notation introduced in Section 3, manufacturer markups and marginal costs are estimated from the following equation:

$$s + (W - C)\frac{\partial s(p(W, A), a(W, A), A)}{\partial W} = 0, \tag{5.1}$$

where I am being clear that dealer prices and advertising are functions of manufacturer wholesale prices and advertising. The researcher estimates s and $\frac{\partial s(p(W,A),a(W,A),A)}{\partial W}$. W is data, so C is recovered directly.

The distinction between my model and one with just pricing decisions is the derivative of shares with respect to wholesale prices. In the alternative model, for example that of Villas-Boas (2007), the derivate is:

$$\frac{\partial s}{\partial W} = \frac{\partial s}{\partial p}\frac{\partial p}{\partial W}, \tag{5.2}$$

and in my model this derivative is a function of the optimal choice of advertising by the dealer:

$$\frac{\partial s}{\partial W} = \frac{\partial s}{\partial p}\frac{\partial p}{\partial W} + \frac{\partial s}{\partial a}\frac{\partial a}{\partial W}. \tag{5.3}$$

I estimate that $\frac{\partial s}{\partial p}$ is negative and the wholesale cost pass-through to retail price, $\frac{\partial p}{\partial W}$, is positive. I also estimate that $\frac{\partial s}{\partial a}$ is positive and the cost pass-through to advertising, $\frac{\partial a}{\partial W}$, is negative.[23] Therefore, in the model with advertising decisions demand is more elastic with respect to wholesale price, and manufacturer markups (costs) are lower (higher).

The previous equation highlights the role of the tension between vertically related firms in the model. The dealer engages in advertising, a relationship specific investment that is valuable to the manufacturer. There is tension in the vertical relationship because the dealer does not internalize the effect of changes in dealer advertising on manufacturer profit. Given

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[23]All of these terms can be recovered using the demand estimates and the model. I describe the procedure in Section 3.

the institutional setting, there is a lack of tools available to the manufacturer to provide incentives for the dealer to advertise, so one way to encourage advertising is by charging a lower wholesale price.

I compare my estimates of manufacturer marginal costs to estimates from a model that does not include advertising decisions. The results are presented in Table 6. I estimate that manufacturer price cost markups are $2,151 on average (first row). This is comparison a model without optimal dealer advertising where average manufacturer markups are $5,420. This is a substantial difference. I estimate that median yearly manufacturer variable profits are $5.6 million. In the model without advertising median yearly variable profits are $12.3 million.

5.5 Comparing Manufacturer and Dealer Surplus

Typically in the literature, the relationship between a retailer and manufacturer is expressed as the relative size of price-cost markups. For example, Villas-Boas (2007) and Albuquerque and Bronnenberg (2012) express the division of surplus this way in the yogurt and automobile industries, respectively. However, comparing surplus within the vertical relationship using the relative markups ignores the contribution towards surplus of costly non-price decisions, like advertising. For example, although estimated markups may look like they favor dealers, if dealers invest proportionally more in advertising than manufacturers then the division of surplus might be more equal than the comparison of markups suggest. Also, as I have shown above, the estimates of manufacturer markups themselves depends on the optimal advertising decisions of dealers.

I consider the division of surplus within the vertical structure as the ratio of dealer average profits to manufacturer average profits, where average profits include costs of advertising.[24]

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[24]Dealers and manufacturers have additional fixed costs that I do not consider, so "average profits" is somewhat of a misnomer. But my definition captures the relevant decisions of the firms in the model, just as the ratio of markups would capture relevant decisions in a model with only pricing decisions.

I define η_{jr} as the ratio of surplus for each model offered by a particular dealer,

$$\eta_{jr} = \frac{(p_{jr} - W_j - c_{jr}) - \frac{\psi_{r_{jr}} a_{r_{jr}}^2 / 2}{q_{jr}}}{(W_j - C_j) - \frac{\Psi_{nj} A_{nj}^2 / 2}{Q_{nj}}}, \tag{5.4}$$

where q_{jr} represents total sales of a particular model from a particular dealer and Q_{nj} represents total sales of the model in a given market. Since dealer advertising is dealer specific, not car specific, the above equation reflects the fact that I am weighting the cost of advertising equally among products at a dealer.

I contrast η to a measure of the division of surplus from an alternative model that does not include optimal advertising decisions:

$$\hat{\eta_{jr}} = \frac{(p_{jr} - W_j - c_{jr})}{(W_j - \hat{C}_j)}, \tag{5.5}$$

where $\hat{C}$ is an estimate of manufacturer marginal costs calculated from the alternative model and corresponds to the markups presented in Table 6.

I display averages for the ratio of surplus across brands in Table 7. First, focusing on the first column, I estimate that dealers earn 2.39 times as much surplus per car as manufacturers on average. There is significant variation within brands and across brands. In particular, dealers for the largest foreign brands (Honda and Toyota) earn less surplus relative to the manufacturer than the three largest domestic brands (Chevrolet, Ford, Chrysler).

There are two sources for differences in the division of surplus across brands. First, price-cost markups across different cars are estimated to be different. However, this doesn't appear to be driving the differences between brands, as I estimate similar mean markups for dealers and manufacturers across the five brands presented in Table 7. Second, the amount and cost of dealer and manufacturer advertising is different across brands. US brand dealers advertise less than their non-US counterparts and US manufacturers are the biggest advertisers in my sample. Also, the estimated cost parameters for advertising, ψ and Ψ, differ across brands. In total, US manufacturers bear more of the cost of advertising compared to their dealers

than non-US manufacturers, whose dealers tend to bear the cost of local market advertising.

I contrast the ratio of surplus calculated from my model to the ratio of markups calculated from a model without dealer and manufacturer advertising decisions. The ratio of surplus from the alternative model implies that dealers and manufacturers earn similar surplus from each car sold, with an average dealer to manufacturer ratio across brands of 1.11. There is also much less variation across brands in the alternative model.

The results for the division of surplus are broadly consistent with the recent troubles of US car manufacturers during the 2009 financial crisis. US manufacturers experienced more financial turmoil than non-US manufacturers during 2009 and 2010, with Chrysler and GM both receiving US government backed loans to avoid insolvency. Both GM and Chrysler lobbied US Congress to suspend state dealer termination laws so they could terminate roughly 3,000 dealers, or about a quarter of their entire dealer network. In congressional testimony (see Barofsky, 2010) GM and Chrysler claimed that remaining dealers in a smaller retail network would be stronger and put in more selling effort. Viewed through the lens of my model, this would mean US manufacturers could lower their advertising because their dealers would increase advertising when faced less intra-brand competition.[25]

6   Policy Implications of an Alternative Vertical Contract

In the United States, manufacturers are required to sell cars to consumers through independent franchised dealers. Manufacturers are also prohibited from using vertical restraints, like price maintenance, two-part tariffs, or advertising quotas, in their franchise contracts even though these restraints can theoretically help alleviate vertical externalities.[26]   How much

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[25]Using national advertising and dealer data, Murry (2016) shows the pattern in advertising by US and non-US brands holds across the country, and it is correlated with local market structure and the historical adoption of franchise termination laws.

[26]Manufacturers in this industry do provide incentives for dealers to advertise through so-called cooperative advertising schemes. For example, General Motors will match advertising spending up to 0.5 percent of revenue for each dealer, provided the dealer advertising meets certain requirements. However, take-up of advertising cooperative matching funds in this industry is low – industry reports claim that dealers utilize

would prices fall if double marginalization were eliminated, and how large is the advertising externality? Understanding the extent of vertical externalities in the industry, and how firm behavior would change in a counterfactual world, is a relevant public policy question. For example, Rogers (1986) concludes that state policies restricting vertical arrangements harm consumers, and in 2001 the former Federal Trade Commission Chairman Thomas Leary made similar made statements consistent with this finding.[27] In a recent analysis by the DOJ, Bodisch (2009) advocates eliminating state bans on direct sales and the FTC made public comments on this issue in 2015 and 2016.[28] The issue of direct-to-consumer sales and vertical coordination has recently emerged in the public policy and legislative arenas because of the emergence of Tesla Motors, a luxury electric car company from California. Tesla sells cars directly to consumers in many states by exploiting loopholes in regulations. Dealers, manufacturers, and industry groups have filed lawsuits against Tesla, and many state legislatures have either proposed or succeeded in strengthening dealer franchise regulation.

Using the model, I simulate an alternative vertical contract that would theoretically alleviate vertical externalities. Specifically, I assume that the manufacturer can implement a franchise fee contract, or two-part tariff, with the dealer that has the following form: the manufacturer charges a wholesale price equal to its marginal cost, $W_{jt} = C_{jt}$, and levies a fixed franchise fee each year on the dealer. The new profit function of the dealer is:

$$\max_{\boldsymbol{p_t}, a_{rt}} \pi_{rtn} = \mathcal{M}_{tn} \sum_{j \in \mathcal{J}_{rt}^R} (p_{jrt} - C_{jt} - c_{jrt}) s_{jri} - \psi_{rt} \frac{a_{rt}^2}{2} - \sum_{m \in \text{man.}} \Gamma_{rt}^m, \tag{6.1}$$

where Γ_{rt}^m is the franchise fee that the dealer pays to each manufacturer, m, that it sells.

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only 10-15 percent of potential cooperative advertising dollars. However, co-op advertising is a vertical tool used by manufacturers to resolve the vertical advertising externality. In the model, co-op advertising is captured in the estimated cost of advertising for dealers, ψ. Dealers that participate will face lower advertising costs and will have a lower estimated ψ all else equal. However, data on which dealers use co-op advertising and how much they use is not available, so I am unable to model any transfer of funds between manufacturers and dealers. Because of this, my results from simulating an alternative vertical contract may overstate increases in advertising for some dealers.

[27]See http://www.ftc.gov/speeches/leary/learystateautodealer.shtm.

[28]Federal antitrust agencies are likely powerless to change public policy in this area because dealer franchise regulations fall under state action antitrust immunity, which prevents them from being subject to federal antitrust authority.

The new profit function for the manufacturer is:

$$\Pi_{mt} = \sum_n \left[\sum_{r \in \mathcal{R}_{mnt}} \Gamma_{rt} - \mathcal{M}_n \sum_{r \in \mathcal{R}_{mnt}} \sum_{j \in \mathcal{J}_{mnt}^M} C_j s_{jrt} - \sum_{z \in \mathcal{Z}_{mnt}} \Psi_{znt} \frac{A_{znt}^2}{2} \right]. \qquad (6.2)$$

The manufacturer derives revenues from the franchise fee but has to pay production and advertising costs. This particular vertical contract aligns the dealer's marginal pricing and advertising incentives with the manufacturer, thus resolving the pricing and advertising double marginalization externalities.[29] Another reason to choose this contract as a benchmark is that the informational requirement to the manufacturer is small. To align marginal incentives the manufacturer simply needs to know its marginal cost. Of course, exact knowledge of dealer profits is necessary to extract the maximal surplus from dealers from the franchise fee.

The franchise fee contract I propose leaves the manufacturer with zero residual claims and zero marginal incentive to advertise. To align manufacturer advertising incentives, Holmstrom (1982) suggests using a third party contract that transfers the good between the manufacturer and dealer. He shows that there exists a contract that provides the correct incentives for dealer effort (in my case advertising), manufacturer effort, and retail prices, and replicates the vertically integrated solution in a bilateral monopoly.[30] In the counterfactual, I make the assumption that the new franchise fee contract leaves manufacturers' incentives to advertise the same as in the baseline linear wholesale price case. This could be the case with a particular third party contract, as in Holmstrom (1982), and is convenient in the sense that it allows me to characterize the extent of the dealer's advertising externality separately from the manufacturers' advertising externality.

I execute two different counterfactual simulations, both for the Richmond, Virginia market in 2007. In both counterfactuals, I calculate the new equilibrium retail prices and dealer

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[29]For example, see Chapter 4 in Tirole (1988).

[30]Complete vertical integration is not well defined in my setting because there is both downstream and upstream oligopoly, and the links between both levels overlap in the sense that dealers sell multiple manufacturers. Integration involving all manufacturers would require a restructuring of the dealers who sell multiple brands in an ad hoc way.

advertising implied by the model. In the first counterfactual, I simulate the new contract for a single dealer. I do this one by one for every dealer, in each case allowing all competitors to best respond. This exercise has two purposes. First, allowing a single deviation is a way to isolate the pricing and advertising externalities present in the model. Second, this exercise simulates how competition would change if a single manufacturer took control of a dealer and sold directly through a "factory outlet" type of store popular in other industries, while still competing against traditional dealers in the market. This is precisely the behavior of Tesla Motors, and the counterfactual speaks to how competition would change if traditional manufacturers followed Tesla's lead.

In the second counterfactual, I simulate the new equilibrium when every dealer in the market adopts the new contract at the same time. This counterfactual simulates the effect of overhauling state regulations to allow non-linear price contracts, and it captures the total effect of the vertical externalities caused by the current linear pricing arrangement.

The results of the two counterfactual exercises are presented in Table 8. First, I focus on the case of a single dealer adopting the contract, the left panel in Table 8. Prices of the "coordinated" dealer fall by 8.64% on average, advertising increases by 74.39% on average, and sales more than double on average. These results highlight how large the pricing and advertising marginalization externalities are in the vertical relationship. If a single dealer-manufacturer pair can eliminate these externalities, it gains a huge advantage over its competitors. The price decrease comes from the fact that there is no profit margin by the manufacturer, so wholesale prices are lower for the dealer. Lower price leads to greater demand. Greater demand and larger profit margins lead to a greater marginal benefit for advertising and greater equilibrium advertising. All of these effects reinforce each other, leading to substantially more quantity sold by the dealer who adopted the franchise fee contract. Not shown is that the market share of rival products decreases by 8% on average. These results provide intuition for why traditional players in the automobile industry have resisted new forms of firm organizational structure that offer direct-to-consumer sales, like Tesla.
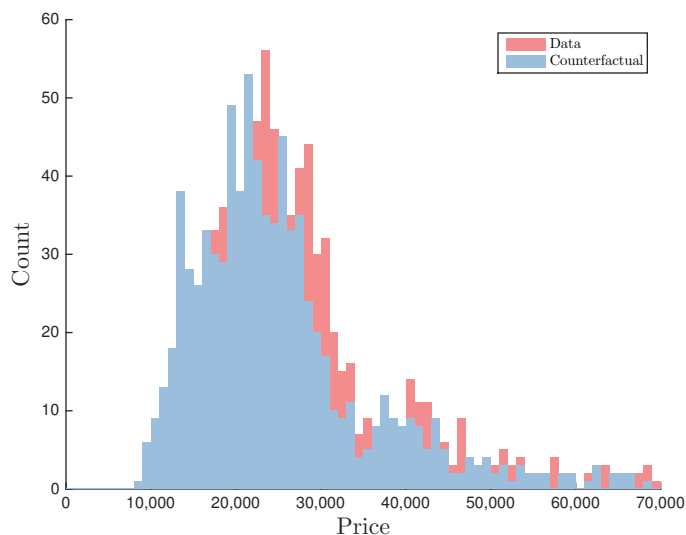
Figure 3: Retail Prices Before and After Franchise Fee Contract

Note: Histogram of prices before and after franchise fee contract adoption by all dealer-manufacturer pairs. Counterfactual details described in text.

Next, I discuss the case where all dealers adopt a franchise fee contract. Average retail prices fall by 10.28% and dealer advertising increases by 8.28% on average. I display the before and after distribution of prices in Figure 3. Prices fall by more than in the single dealer case because of price competition, which is also why advertising and quantity sold do not increase as much.[31]

I calculate a lower bound to the potential gain in consumer welfare from the franchise fee contract by calculating the price savings that consumers who bought cars in the data would realize in the counterfactual world where they purchase and all dealers adopt the franchise fee contract.[32] There were 30,434 cars sold in the Richmond market in 2007 and the franchise fee contract decreases retail prices by about $2,500 on average. I take the set of consumers who purchased a car before the contract change and give them each a rebate equal to the retail price change after the contract, which implies consumers gain about $75 million

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[31]Both counterfactuals depend crucially on estimated manufacturer markups because this is the markups wedge between production costs and dealer wholesale price in the linear wholesale price contract. To the extent that the model without endogenous advertising overstates manufacturer markups, the benefits of alleviating double marginalization would be overstated.

[32]Note that since prices decease and advertising increases in the counterfactual, these consumers would still purchase.

in surplus. The results of adopting the franchise fee contract suggest that there are huge consumer welfare gains from allowing firms to alleviate distortions from vertical externalities in this industry.[33]

According to Wards Automotive, there were about 7.5 million new car sales across the U.S. in 2007 (excluding light trucks) and the market I study, Richmond, accounts for about 0.04 percent of national new car sales. I extrapolate the lower bound of consumer welfare gain for Richmond ($75 million) to the whole country. The total savings for existing consumers is approximately $18 billion. This estimate is conservative because it does not capture the welfare of new consumers due to the changes in prices and advertising. Seemingly moderate changes in prices due to the franchise fee contract (10% decrease on average) translate into large increases in consumer welfare.

Lastly, I examine the effects of the franchise fee contract on producer surplus in the scenario where all dealers adopt a franchise fee contract. The results are presented in Table 9. Dealer marginal profits increase with the new contract, which is a direct consequence of the lower wholesale price. However, dealer advertising costs increase, which is a consequence of a higher marginal benefit of advertising and the amelioration of the vertical advertising externality. By design of the contract, manufacturer marginal profits are zero, and my assumption in the counterfactual is that manufacturer advertising does not change. Interestingly, total producer surplus with the franchise fee contract is 20% lower than the original linear price contract. This result may seem counterintuitive because the classic theory of vertical restraints suggests that total producer surplus increases after the implementation of two-part tariffs, for example, see Rey and Tirole (1986). However, this logic does not always hold in models of oligopoly. Lin (1988) shows that in oligopoly markets the effect on producer surplus of vertical integration depends on the elasticity of demand and the competitiveness of the downstream market. For example, if the effect of lower prices predominantly steals

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[33]This is a lower bound because there are other channels through which consumer welfare can increase; namely, the predicted 6,756 additional consumers who purchase a car. However, I do not do a true consumer surplus calculation because advertising enters directly into the utility function and I do not want to attribute welfare gains directly to increased advertising. For example, I do not claim that those consumers who purchased cars before the new contract are better off after the new contract just because the car they purchased has more advertising.

business from rival dealers (some of which sell the same brand in the case of automobile dealers) rather than expands the market, then the franchise fee contract may not lead to an increase in total vertical profits. However, total producer surplus under the franchise fee contract is greater than manufacturer surplus under the linear contract, so manufacturer surplus could be higher if manufacturers levy the correct franchise fees on their dealers.

7 Conclusion

In this paper, I develop and estimate a model of pricing and advertising decisions of new car dealers and manufacturers. I show how a model without endogenous advertising decisions can over-estimate manufacturer profits. I estimate the model using detailed transactions data from the state of Virginia and find that the bias in manufacturer markups is substantial: estimated manufacturer markups are $2,150 per car, about half as much as a model that does not endogenize advertising decisions in the vertical relationship. The estimation results are based on novel instruments to identify the causal effect of advertising in the demand estimation.

The relationship between new car dealers and manufacturers is heavily regulated by US states. One regulation that has received attention is that manufacturers cannot sell directly to consumers or use non-linear pricing contracts to coordinate decisions within the vertical relationship. I simulate the adoption of a franchise fee contract that theoretically alleviates the double marginalization and advertising public goods externalities present in the model. In one simulation, I allow a single dealer to adopt the new contract, replicating a situation where a single integrated firm (like a factory outlet) engages in inter and intra-brand competition against non-coordinated firms. I find that the dealer with the new contract gains a significant advantage regarding pricing, advertising, and market share. In a second simulation, I allow every dealer-manufacturer pair to adopt the franchise fee contract. The result is that average retail price falls by 10.28% and average dealer advertising increases by 8.28%. I calculate substantial gains in consumer welfare from the franchise fee contract. This

result provides supportive evidence to policy-makers and academics who have long argued that many franchise regulations in this industry are harmful to consumers.

There are many industries where both upstream and downstream firms engage in promotion, or selling effort, for example, retail grocery (packaged goods and store), computers (chips and computers), phones (operating system and handset) among others. This paper is the first to capture the empirical effects of these decisions on firm surplus and to show that estimates of upstream profits are sensitive to downstream selling effort. Understanding how advertising, or some other selling effort, is provided within these vertical relationships is important to understanding which firms hold economic power and the effect of regulatory or business policies.

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Appendix

A.1 Estimation Details

I estimate the demand model presented in section 3.1 using the car transaction and advertising data discussed in section 4. I follow the previous literature on demand for differentiated products by minimizing a GMM objective function of simulated moment conditions. The moment conditions originally proposed by BLP for these types of models are at the product level. More recently, like in this study, researchers supplement the poduct level moments with moments constructed from individual level data on purchases. For example, see Berry, Levinsohn, and Pakes (2004) and Petrin (2002). In this appendix I discuss the details of estimation. First, I discuss details of the data, second I describe how deamnd is calculated, and lastly I present the moments used to estimate the demand parameters.

A.1.1 Market definition, product aggregation, and variable definitions

I separate the state of Virginia into four separate markets. A geographical market consists of every dealer and household in a single media market, as defined by The Nielsen Company. I do not allow consumers to purchase outside of their market and I do not allow firms to sell outside of their market.

Each consumer's choice set includes every product available in the market. I aggregate over trim levels and options of cars to the model level. For instance I combine the Honda

Accord EX and the Accord LX into a single product. To define a product's characteristics I use the base model's product characteristics for trim levels and options offered. Without this aggregation the choice set would be unreasonably large.[34] Although I observe individual transaction prices, I do not observe the prices consumers would have received for other products, so I assume consumers make decisions based on the average price transacted for a car at a dealer in a given year. In this sense, I ignore a more complicated negotiation process that generates the data.

To define the geographical market, I merge publicly available data from Nielsen on Designated Market Areas (DMAs) with the Census data from Virginia. I use DMAs to ensure that a market includes all consumers with access to local television stations for a given market. I define the market size as the total number of households in each market.

A.1.2 Consumer Choice

The probability that, in a given market, consumer i at time t chooses product j is

$$s_{ijt} = \frac{exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k \in \mathcal{J}_t} exp(\delta_{kt} + \mu_{ikt})}, \tag{A-1}$$

where δ includes all terms in the utility function that are not individual specific, and μ contains all individual specific utility terms.

$$\delta_{jt} = \bar{\beta}x_{jt} + \xi_{jt} \tag{A-2}$$

$$\mu_{ijt} = \alpha\Upsilon_i + \sigma^p\epsilon_i^p + \sigma_k^x\epsilon_{ik}^p + f(\mathcal{D}_{ijt}; \boldsymbol{\lambda}) + g(a_{r_jt}, A_{z_jt}; \boldsymbol{\phi}) \tag{A-3}$$

The share of households that purchase a particular automobile, s_{jt}, is derived by summing up over individuals. Some individual attributes are unobserved, so during estimation I use simulation to integrate over the distribution of unobserved preferences and demographic characteristics. I use the 2010 ACS from American Fact Finder to simulate from the distribution of demographic characteristics and aggregate consumer into US Census Tracts. Next, I present the simulation details and a description of how I construct the moment conditions.

A.1.3 Moments

There are two types of product level macromoments: moments that match aggregate shares, and moments that are derived from a distributional assumption on unobserved product

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[34]This aggregation is standard in similar studies of this industry, see Train and Winston (2007) and Berry, Levinsohn, and Pakes (2004)

quality. First, following BLP, I restrict the aggregate product shares predicted by the demand model to exactly match the observed product shares in the data. Using the contraction mapping suggested in BLP, I solve for the mean utility parameters, $\boldsymbol{\delta}(\boldsymbol{\theta})$, that are the implicit solution to

$$S^{data} - s(\boldsymbol{\delta}(\boldsymbol{\theta})) = 0,$$

where S^{data} is the vector of observed market shares and $s(\boldsymbol{\delta}(\boldsymbol{\theta}))$ is the corresponding vector of predicted shares from the model.[35] $\theta = \{\theta_1, \theta_2\}$ represents the vector of parameters and is partitioned into parameters that enter δ and μ respectively.

I use simulation to compute aggregate market shares. First, I draw a person from a Census Tract, then I conditional on each draw, I simulate unobserved preferences and demographic characteristics using the empirical distribution for demographic characteristics at the Tract level.[36] One difficulty is sampling from the geographic distribution of consumers. Because population densities are quite spread out and I use a relatively small unit of geography, taking a random sample of locations may lead to poor geographical coverage and require many simulations to reduce simulation bias.[37] Instead, I sample every Census Tract four times, and weight each draw by one-fourth Tract population. Conditional on the Census Tract, I simulate household demographics and the unobserved characteristics.[38]

Specifically, simulated market shares are

$$s_{jt} = \sum_{h}^{H} \frac{exp(\delta_j(\theta_1) + \mu_{hjt}(\theta_2))}{1 + \sum_{k \in \mathcal{J}_t} exp(\delta_k(\theta_1) + \mu_{hkt}(\theta_2))} \omega_h$$

where h is indexes simulation draws and ω is the population weight of each draw. The terms δ and μ are defined in equations (A-2) and (A-3).

After inverting demand using the BLP contraction mapping, I follow BLP by solving for the product specific demand unobservable as the residual of the following ordinary least squares regression:

$$\delta_{jt}(s_{jt}, \theta_2) = \sum_{k} x_{jkt} \bar{\beta}_k + \xi_{jt}.$$

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[35]BLP show that there is a unique δ vector that solves this system of equations. There is a recent literature that criticizes the use of the BLP contraction mapping on computational grounds and suggests other methods. In my setting, the contraction mapping converges quite quickly for a given time period at a relatively strict tolerance, around 10 iterations.

[36]To construct market shares for the macromoments I *do not* use individual data. This step is analogous to BLP and other studies that only have aggregate data on market shares.

[37]I found estimates of $\boldsymbol{\delta}$ unstable in practice for small numbers of simulations without stratifying across geography.

[38]At this step I use antithetic acceleration to reduce variance due to simulation error when integrating over the distribution of demographics and unobserved household characteristics: see Stern (1997).

I use macromoments that set the expected value of $\boldsymbol{\xi}$ to zero, conditional on a set of instruments, Z,

$$G^{(1)}(\theta_2) := E[\xi \mid Z] \tag{A-4}$$

I supplement the standard product level BLP moments with micromoments derived from data on individual purchase decisions. These moments are most useful at identifying the parameters related to demographic characteristics, for example the dis-utility of distance traveled and the income specific preferences for price.

After recovering δ, I simulate *individual* purchase probabilities in the following way,

$$s_{ij}(\theta_2) = \frac{1}{R}\sum_{r=1}^{R} s_{ij}^r(\theta_2) = \frac{1}{R}\sum_{r=1}^{R} \frac{exp(\delta_j + \mu_{ij}^r(\theta_2))}{1 + \sum_{k \in \mathcal{J}} exp(\delta_k + \mu_{ik}^r(\theta_2))},$$

where I draw from the joint density of individual household demographics and unobserved preferences, conditional on Census Tract.[39]

Consider the residuals for each household, $y_{ij} - \hat{s}_{ij}$, where y_{ij} is a dummy of whether or not the household i purchases product j, and $\hat{s}_{ij} = \frac{s_{ij}}{1-s_{i0}}$ represents the choice probabilities *conditional* on purchase.[40] I interact this residual with data to form moments, for example household purchase distance, $\sum_j \sum_r (y_{ij} - \hat{s}_{ij}^r)d_{ij}$, or distance interacted with a demographic characteristic, $\sum_j \sum_r (y_{ij} - \hat{s}_{ij}^r)d_{ij}H_{1ij}^r$. Define $\mathcal{X}_{ij}$ as the vector of all the exogenous data entering the individual specific portion (μ_{ij}) of the utility function, for example distance traveled or distance traveled multiplied by travel-time-to-work. In general, the micromoments I construct take the following form:

$$G^{(2)}(\theta) = \sum_i \sum_j \sum_r (y_{ij} - \hat{s}_{ij}^r(\theta_2))\mathcal{X}_{ij}^r = 0$$

I stack the micromoments and macromoments and then minimize their weighted distance by choosing θ_2:

$$\theta_2^\star = arg\min_{\theta_2} G(\theta_2)'\Gamma G(\theta_2)$$

where,

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[39]In practice, I use a sample of 10,000 individuals from the transaction data. Also, I see an individual's nine digit zip code, not Census Tract. I assign to each individual the Census Tract which has the closest center to the nine digit zip code.

[40]I make this adjustment following BLP (2004) because the individual level data is selected conditional on purchase.

$$G(\theta_2) = \begin{pmatrix} G^{(1)}(\theta_2) \\ G^{(2)}(\theta_2) \end{pmatrix},$$

and Γ is a positive definite weighting matrix. I follow the two step procedure described by Hansen (1982) in order to obtain efficient estimates using the optimal weighting matrix. The weighting matrix is a block diagonal matrix, where the first block includes the weights for the macromoments, and the second block includes weights for the micromoments. For the first stage, I use the two-stage least squares weighting matrix, $(Z'Z)^{-1}$, for the product level moments and the identity matrix for the individual moments. I calculate standard errors directly using the expressions for asymptotic variance from Hansen (1982). In order to ensure that I have found the global minimum of the objective function, I start the estimation routine from 10 different randomly selected initial parameter values. Except in the case of the distance, advertising, and price parameter, I use a starting value from a simplified version of the model that I estimate ahead of time where the only dimension of heterogeneity is distance traveled.

A.1.4 Price and Advertising Instruments

I report "first stage" regressions of price and advertising on the exogenous variables. Although I estimate the model using GMM, so there is no first stage per se, it is useful to understand how the endogenous variables are correlated with the instruments. I use multiple instruments for prices and advertising. First, I use the squared distance of each product characteristic from the mean of the product characteristics for other cars at dealers within 20 miles. For example, *AccelIV1* is the squared distance of the car's acceleration from the mean acceleration for all cars available at dealers within 20 miles distance. Second, I use the squared distance of each product characteristics from the mean product characteristic for other cars of the same style (eg sedan, SUV, etc) available at dealers within 20 miles. These are analogous to BLP instruments, but they capture more variation in the competitive environment within a market.

To identify the effect of dealer advertising, I use the population within 5 miles of each dealer, *DealerPop* and a proxy for the price of advertising in a market, *AdPrice*. To identify the effect of manufacturer advertising, I use the level of national advertising for a brand, *NationalAds*. National advertisements are plausibly uncorrelated with local demand shocks, and I include make dummies to capture brand level demand shocks.

I present regressions of the endogenous variables on the instruments in Table 11. Most of the BLP style instruments are significant in the price regression. The advertising instruments are significant in the advertising regressions. Also, the minimum eigenvalue statistic is 58.91,

which is above the critical value for three endogenous regressors.

A.2 Counterfactual Details

I simulate the model with an alternative franchise fee contract. The new price and advertising equilibrium is defined by a complicated non-linear system of equations. To deal with the dimensionality, I use a nested procedure. The outside nest uses Jacobi iteration over the advertising FOCS.[41] For each guess of the new advertising equilibrium, I use a function iteration method to solve for *all* equilibrium retail prices, which iterates over the pricing first order conditions:

$$\boldsymbol{p}^{h+1} = \boldsymbol{c} + \boldsymbol{W} + \frac{-\boldsymbol{s}(\boldsymbol{p}^h)}{D\boldsymbol{s}(\boldsymbol{p}^h)} \tag{A-5}$$

The benefit of this procedure is that for each Jacobi step, the problem is a simple one dimensional non-linear equation: the solution to a single advertising FOC holding all other advertising constant. The price contraction mapping in the inner nest is extremely well behaved and converges quickly at each step. I repeat the Jacobi iterations over the entire system of advertising FOCs until the solution to the advertising FOCS no longer changes, defined by some tolerance. The Jacobi method is not guaranteed to work, but in this application it works well because the system of advertising FOCs is diagonally dominant; in other words, the off-diagonal elements of the Jacobian are generally much smaller than the diagonal elements. The procedure is summarized as follows:

1. make a guess for a single dealer advertising term, a_1

2. given that guess, solve the pricing FOCs for all products

3. calculate the single advertising FOC for a_1, $K(1)$, see equation (3.13)

4. update a_1 using Broyden's Method

5. repeat steps 1-4 until convergence to find a_1^{new}

6. follow steps 1-5 for a_2 through a_R, for each step using the *original* vector of $\boldsymbol{a}$

7. repeat steps 1-6 using the new vector of $\boldsymbol{a}^{new}$ from the new solutions from step 4.

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[41]For another example of Guass-Jacobi iteration technique to solve for equilibria see Pakes and McGuire (1994), which uses the Jacobi method to solve a dynamic investment problem.

Appendix References

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Tables

Table 1: Virginia New Car Transactions Descriptive Statistics

	Mean	SD	Q25	Median	Q75
Transaction Level Data					
Purchase Distance	13.3	14.7	4.3	8.1	17.9
Distance past closest dealer	9.2	8.1	1.8	4.3	14.6
Price	29,960.86	11,466.85	22,293.38	27,422.11	34,406.92
Product Level Data					
Acceleration	0.57	0.13	0.49	0.54	0.62
Size	0.69	0.10	0.61	0.67	0.76
Miles Per Dollar	0.12	0.03	0.10	0.11	0.13
Domestic Brand	0.50	0.50	0	1	1
Dealer Advertising	78,576	144,044	0	15,661	92,658
Local Man. Ads	278,139	698,573	0	28,464	243,680
National Manufacturer Ads	4,364,438	9,428,416	80,831	1,163,500	3,497,800
Total Sales of New Cars					
Year	2007	2008	2009	2010	2011(Q1-Q3)
Total Quantity Sold	178,722	161,936	143,570	162,798	137,047

Note: From the selected sample of new automobile transactions, 2007Q1 - 2011 Q3, Virginia Department of Motor Vehicles. See text for sample selection details. Price is in 2006 dollars. Total sales are the sales included in my sample after the sample selection described in the text. Acceleration: 10*horsepower/weight. Size: Length*height/1000 in inches. Miles per dollar: MPG / gallon price. Ad expenditures in dollars.

Table 2: Utility Paramter Estimates

Category	Variable	Parameter	Estimate	Standard Error
Distance	Distance	λ_1	-30.258	2.091
	Distance^2	λ_2	0.223	0.054
	Dist×TravelWork	λ_3	0.530	0.040
	Dist×Density	λ_4	-0.254	0.045
Advertising	Dealer	ϕ^{dealer}	0.410	0.076
		σ^{dealer}	0.446	0.142
	Manufacturer	ϕ^{brand}	0.324	0.074
		σ^{brand}	0.178	0.0435
Price	Mean	$\bar{\alpha}$	1.227	0.307
	Income	$\alpha^{Inc.}$	-0.317	0.083
	s.d.	σ^p	0.491	0.125
Characteristics	Acceleration	β_1	0.582	0.011
		σ_1	0.126	0.039
	Size	β_2	0.663	0.014
		σ_2	0.005	0.002
	Mile/$	β_3	-0.002	0.016
		σ_3	0.479	0.168
	US Brand	β_4	-2.040	0.142
		σ_4	0.450	0.163
	Constant	β_0	3.2920	0.101

Note: The utility function includes car style dummies, year dummies, and brand dummies (estimates not reported). Simulated Method of Moments estimation described in the appendix. Standard errors are calculated directly.

Table 3: Cross price elasticities between select products

Product	Honda Accord1	Honda Accord2	Honda Accord3	Ford Fusion1	Ford Fusion2	Ford Fusion3	VW Jetta1	BMW 3-series1	Toyota Camry
Accord 1	-4.9162	0.0284	0.0178	0.0032	0.0081	0.0079	0.0196	0.0201	0.0369
Accord 2	0.0269	-4.7692	0.0083	0.0024	0.0103	0.0038	0.0076	0.0298	0.0177
Accord 3	0.0510	0.0252	-4.8924	0.0028	0.0055	0.0090	0.0150	0.0177	0.0638
Fusion 1	0.0354	0.0275	0.0106	-4.8364	0.0092	0.0048	0.0091	0.0180	0.0226
Fusion 2	0.0368	0.0497	0.0087	0.0038	-4.5501	0.0055	0.0103	0.0256	0.0192
Fusion 3	0.0489	0.0247	0.0195	0.0027	0.0075	-4.3908	0.0165	0.0129	0.0424
Jetta 1	0.0645	0.0264	0.0172	0.0027	0.0075	0.0088	-4.7123	0.0174	0.0374
3-series 1	0.0268	0.0418	0.0082	0.0022	0.0075	0.0028	0.0070	-6.2496	0.0159
Camry 3	0.0484	0.0245	0.0291	0.0027	0.0055	0.0090	0.0149	0.0156	-4.8107

Note: For products sold in the Richmond area during 2007Q1. Area 1 is approximately 15 miles from area 2 and 3. Areas 2 and 3 are approximately 25 miles from each other. An element of the table is the percent change in demand of the row product given a percent change in price of the column product.

Table 4: Summary Statistics, Dealer Supply

Brand	Mean Retail Price	Mean Wholesale Price (W_{jt})	Mean Markup	Mean Marginal Retail Cost (c_{jt})	Mean Lerner Index
BMW	55,191	46,483	8,192	516	0.15
BUICK	32,733	28,209	5,827	-1,303	0.18
CHEVROLET	29,709	24,790	5,779	-861	0.21
CHRYSLER	28,244	24,402	5,397	-1,555	0.20
DODGE	25,655	22,080	5,147	-1,572	0.20
FORD	28,882	24,166	5,567	-851	0.20
HONDA	24,787	21,995	5,176	-2,384	0.21
PONTIAC	23,318	20,553	4,963	-2,199	0.22
TOYOTA	29,748	23,839	5,635	275	0.20
VOLKSWAGEN	26,833	23,590	5,220	-1,978	0.20
VOLVO	34,418	32,217	5,799	-3,598	0.17
Total (all brands)	29,760	25,302	5,590	-1,132	0.20

Note: Table displays average prices of cars (from the data) and the average estimated markups and retail costs, across brands. "Total" includes all brands, including smaller brands not listed. Markup is defined as retail price minus wholesale price minus marginal retail cost. Lerner Index is the markup divided by price: $\frac{p_{jt}-W_{jt}-c_{jt}}{p_{jt}}$. An observation is a car model offered offered at a particular dealer.

Table 5: Summary Statistics, Manufacturer Supply

Brand	Mean Wholesale Price (W_{jt})	Mean Markup	Mean Marginal Cost (C_{jt})	Mean Lerner Index
BMW	50,338	2,032	48,305	0.04
BUICK	28,434	3,347	25,087	0.12
CHEVROLET	26,562	1,917	24,645	0.08
CHRYSLER	24,839	2,417	22,422	0.10
DODGE	24,336	1,972	22,364	0.08
FORD	24,764	1,388	23,376	0.06
HONDA	22,301	1,843	20,458	0.08
HYUNDAI	21,731	1,292	20,440	0.06
PONTIAC	20,664	2,787	17,878	0.14
TOYOTA	24,869	1,637	23,232	0.07
VOLKSWAGEN	23,819	1,509	22,309	0.07
VOLVO	32,079	1,515	30,565	0.05
Total (all brands)	29,750	2,151	27,599	0.08

Note: Table displays average wholesale price (from the data), average estimated markups, and average estimated production costs of cars across brands. "Total" includes all brands, including smaller brands not listed. Markup is defined as wholesale price minus product cost, $W_{zt} - C_{zt}$. Lerner Index is the markup divided by price: $\frac{W_{zt}-C_{zt}}{C_{zt}}$. An observation is at the make/model/year level.

Table 6: Comparison of Manufacturer Markups
Between Alternative Models

Model	Mean	Q25	Median	Q75
Price and Advertising	2,150	1,447	1,980	2,691
Prices Only	5,420	4,436	5,033	6,039

Note: This table displays summary statistics for manufacturer markups for two different supply model. The first row is the model presented in Section 3, where retailers and manufacturers are assumed to optimally choose prices and advertising. The second row is for a model where dealers and manufacturers choose only prices.

Table 7: Ratio of Dealer to Manufacturer Surplus

	With Advertising, η				Without Advertising, $\hat{\eta}$			
	Mean	Q25	Median	Q75	Mean	Q25	Median	Q75
Chevrolet	3.26	2.76	3.20	3.67	1.13	1.04	1.10	1.18
Chrysler	1.85	1.87	2.22	2.56	1.16	1.09	1.14	1.21
Ford	3.21	3.18	3.83	4.54	1.10	1.02	1.07	1.15
Honda	1.09	2.13	2.67	3.13	1.02	0.96	1.00	1.07
Toyota	1.56	1.31	2.39	3.99	1.01	0.96	1.00	1.05
All Brands	2.39	1.94	2.72	3.64	1.11	1.04	1.09	1.16

Note: Dealer to manufacturer surplus as defined in the text. η is the ratio of average profits, including advertising costs, calculated from the model presented in Section 3. $\hat{\eta}$ is the ratio of markups from a model without optimal advertising decisions.

Table 8: Results from Introducing Franchise Fee Contract

	Single Dealer Adopts Contract				All Dealers Adopt Contract			
	Mean	Q25	Median	Q75	Mean	Q25	Median	Q75
% Change in Prices	-8.64	-11.11	-7.91	-5.44	-10.28	-13.01	-9.70	-6.68
% Change in Dealer Advertising	74.39	46.53	63.39	93.60	8.28	4.06	8.06	16.10
% Change in Quantity Sold	129.11	76.71	115.09	169.7910	21.16	1.37	16.77	33.65

Note: Results from counterfactual simulation show the percent change in prices, advertising, and quantity sold. First panel: a single dealer adopts franchise fee contract, separately, one at a time. Results displayed are for the affected dealer only. Second panel: all dealers adopt franchise fee contract. Manufacturer advertising held constant in both scenarios. Results for the Richmond market in 2007.

Table 9: Effect of Franchise Fee Contract on Producer Surplus

	Dealer		Manufacturer		
	Variable Profits	Advertising Costs	Variable Profits	Advertising Costs	Total Surplus
Linear Wholesale Contract	138.8	18.4	54.9	0.6	174.8
Franchise Fee Contract	158.1	21.4	0	0.6	136.1
Difference	+19.3	+3.0	-54.9	0	-38.7

Note: In millions $. Results from counterfactual simulation show producer surplus before and after all dealers adopt franchise fee contract. Manufacturer advertising held constant under the new contract. Results for the Richmond market in 2007.

Table 10: Car Characteristics Definitions

Acceleration	$10 \times$ Horsepower / Car Weight
Size	Wheelbase length *height in inches, divided by 1,000
Miles per Dollar	Miles per Gallon Highway / Dollars per gallon
US Brand	Buick, Cadillac, Chevy, Chrysler, Dodge, Ford, Jeep Lincoln, Mercury, Pontiac, Saturn
Styles	Van/Other, Compact, Midsize, Large, SUV, Wagon

Table 11: First Stage Regressions

Dependent Variable	Price	Dealer Advertising	Manufacturer Advertising
AccelIV1	0.0753	-0.0118	-0.0128
	(0.0080)	(0.0067)	(0.0074)
SizeIV1	0.0582	0.0035	-0.0052
	(0.0037)	(0.0032)	(0.0035)
MPGIV1	-0.0295	0.0027	0.0031
	(0.0054)	(0.0046)	(0.0050)
USBrandIV1	-0.0199	0.2009	-0.3440
	(0.0482)	(0.0406)	(0.0444)
AccelIV2	-0.0465	0.0129	0.0085
	(0.0085)	(0.0072)	(0.0078)
SizeIV2	-0.0454	0.0022	-0.0017
	(0.0075)	(0.0063)	(0.0069)
MPGIV2	0.0756	0.0061	0.0133
	(0.0071)	(0.0060)	(0.0065)
USBrandIV2	0.1474	0.0846	0.0839
	(0.0391)	(0.0330)	(0.0361)
DealerPop	-1.0344	3.1882	2.0712
	(0.2789)	(0.2352)	(0.2572)
AdPrice	0.0001	-0.0005	0.0007
	(0.0000)	(0.0000)	(0.0000)
National Ads	-0.2272	-0.0189	1.1729
	(0.0379)	(0.0319)	(0.0349)
Acceleration	0.3894	0.0088	0.0088
	(0.0056)	(0.0047)	(0.0051)
Size	0.4011	-0.0012	-0.0091
	(0.0051)	(0.0043)	(0.0047)
MPG	0.1561	-0.0029	-0.0115
	(0.0058)	(0.0049)	(0.0054)
USBrand	-0.6373	-0.0618	-0.1131
	(0.0501)	(0.0422)	(0.0462)
Luxury	-0.0001	0.0039	-0.0013
	(0.0083)	(0.0070)	(0.0077)
Constant	3.2333	0.3863	-0.1556
	(0.0421)	(0.0355)	(0.0388)
Observations	21,177	21,177	21,177

Note: "First stage" regressions to illustrate how the instruments are correlated with the endogenous variables. Car make, year, and car style dummies included in the regressions. An observation is a make/model/dealer/year, eg a Honda Accord from Jim Price Honda in 2008. Standard errors in parenthesis.

Table 12: Parameter Estimates: Simple Model

Dependent Variable	$log(s_{jrt}) - log(s_{0t})$
Acceleration	0.2786
	(0.0436)
Size	0.3732
	(0.0381)
MPG	-0.0183
	(0.0225)
USBrand	-1.7235
	(0.1607)
Luxury	0.0279
	(0.0264)
Price	-1.1283
	(0.0842)
Dealer Ads	2.8148
	(0.1457)
Manufacturer Ads	0.6979
	(0.0447)
Constant	3.2333
	(0.0421)
Observations	21,177

Note: GMM estimation of simplified model a la Berry (1994). Car make, year, and car style dummies included in the regression. An observation is a make/model/dealer/year, eg a Honda Accord from Jim Price Honda in 2008. Standard errors in parenthesis. Instruments for price and advertising described in text and presented in Table 11.