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

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A Dissertation presented to the Graduate Faculty
of the University of Virginia in Candidacy for the Degree of
Doctor of Philosophy

Department of Economics

University of Virginia
May 2014

Abstract

I model consumer demand for new cars, and pricing and advertising decisions of automobile manufacturers and dealers. I estimate the model with detailed car transaction and local advertising data, and I recover consumer preferences and firm surplus. On the demand side, the consumer purchase decision depends on the distance between dealers and consumers and advertising spending by both dealers and manufacturers. On the supply side, both dealers and manufacturers make a price-cost markup which is the result of a double marginalization pricing externality, and there is a public goods advertising externality. Advertising is under-provided from the perspective of total vertical surplus compared to the optimal decisions of an integrated vertical structure. I recover manufacturer and dealer surplus in a similar way to the previous literature that only models pricing decisions of firms. Dealer and manufacturer surplus depends not only on price-cost markups, but also on advertising spending. I find that dealers earn 8% more surplus on average than manufacturers, in contrast to about 16% more in a specification without advertising decisions.

The automobile dealer-manufacturer relationship is highly regulated by U.S. states. I use the estimation results to predict how dealer and manufacturer decisions would change after changes to two dealer franchise regulations. In a first counterfactual, I find that if a dealer-manufacturer pair is allowed to coordinate decisions, advertising more than doubles and prices fall by 15% on average for the coordinated firm. However, the average price falls by 20% if advertising is held constant. In a second counterfactual, I simulate the effect of forced dealer exit. Brand advertising falls substantially, which harms the remaining dealers, even though they face less competition.

Acknowledgements

I could not have written this dissertation without the support and guidance of my advisors at the University of Virginia. I will forever be indebted to Simon Anderson, Federico Ciliberto, and Steven Stern for generously offering their time and expertise to assist me with every stage of my research. I am extremely proud to call myself a student of these three outstanding teachers.

Much of the research in this dissertation was done while receiving financial support from the Bankard Fund for Political Economy and the Quantitative Collaborative. I am also grateful to UVA alumni Karen and Brad Radulovacki, who generously provided summer research support through the UVA Economics Department. I would also like to thank the Virginia Department of Motor Vehicles for providing me with data and UVACSE, especially Ed Hall, for invaluable computational support.

I am grateful to other members of the University of Virginia Economics Department that provided me with particularly valuable support, advice, or guidance over the last six years, including Leora Friedberg, David Mills, Nathan Larson, and Charlie Holt. I benefited, both professionally and personally, from relationships with many of the friends I met in the UVA graduate program, including Patten Mahler, Michael Schreck, Ignacio Martinez, Catherine Alford, and Daniel Fried.

I want to thank my parents, Leonard and Barbara, who have always supported me without question and encouraged me in my academic and non-academic pursuits. Their dedication to their family and careers has always served as an inspiration.

Lastly, I would like to thank my wife and the love of my life, Betsy, who has stood by me constantly with tremendous support. I truly believe that this accomplishment would not have been possible without her encouragement, advice, and love.

This dissertation is dedicated to the University of Virginia Office of Undergraduate Admission

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Chapter 1

Introduction

It is common for retailers and manufacturers of the same product to engage in promotional effort. Naturally, promotion by one level of a vertical structure benefits the other; for example, retail advertising shifts consumer demand and positively affects manufacturer surplus. However, promotional incentive concerns arise within vertical relationships, akin to the well-studied pricing incentive problem of double marginalization. If the retailer considers only its own marginal benefit of promotion decisions, then a public goods externality exists and promotion is under-provided from the perspective of joint manufacturer-retailer surplus. As in the case of the double marginalization externality, the promotion public goods externality may have significant consequences for consumer welfare and firm surplus. Although promotion plays a large role in many industries, structural empirical models of vertical relationships do not account for promotion decisions.

I empirically study promotion decisions within the context of new car dealer and manufacturer local market advertising. In this market, pricing and promotional incentive problems arise for two reasons. First, both car dealers (retailers) and manufacturers spend significant resources on advertising in local markets. For example, in 2010, new car dealers spent an average of $335,000 on promotion, about half of accounting profits on average; and car manufacturers spent a total of more than $2 billion in local market advertising expenditures.[1] Second, strict state regulations govern dealer-manufacturer interactions. These regulations inhibit the ability of manufacturers and dealers to resolve price and promotional incentive issues. For example, dealers and manufacturers cannot contract on retail prices, quantity, or advertising spending. Also, manufacturers cannot sell directly to consumers, and their ability to terminate existing dealer relationships is restricted. The result is that the vertical relationship is well approximated by the textbook two-stage game in which manufacturers set linear wholesale prices, and dealers make retail pricing decisions in response. Because these regulations promote vertical inefficiencies, they have been recently criticized for harming consumer welfare and potentially contributing to the weakness of the U.S car manufacturing industry.[2]

Estimating the economic power of firms from structural models of supply and demand has a long tradition in the industrial organization literature, including the seminal studies of Bresnahan (1987), Berry, Levinsohn, and Pakes (1995) (BLP), and Nevo (2001). These and many related studies typically ignore the distinction between manufacturing and retailing. Implicit in the interpretation of results is the assumption that retailers (or manufacturers) are passive agents that make no strategic decisions.

[1]Dealer data from the National Association of Automobile Dealers December 2010 Dealership Financial Profile and includes all costs associated with advertising: `http://www.nada.org/Publications/NADADATA/dealership_profile/`.Manufacturer data come from my own calculations based on data from Kantar Media and includes only costs associated with the purchase of advertising space.

[2]For two recent examples of criticisms from U.S. government policy-makers, see Bodisch (2009) a 2001 speech made by Federal Trade Commission chairman Thomas Leary, `http://www.ftc.gov/speeches/leary/learystateautodealer.shtm`. Also see Lafontaine and Morton (2010) for a broader overview.

However, recent empirical studies have extended structural methods to examine vertical relationships. For the most part, these studies assume that manufacturers and retailers compete by choosing prices, for example, Villas-Boas (2007), Brenkers and Verboven (2006), and Bonnet and Dubois (2010). Other studies model pricing decisions along with an additional strategic variable, such as the set of products offered for sale (Crawford and Yurukoglu (2012) and Ho (2009)), but not promotional or selling effort.

I make three primary contributions to the literature. First, I estimate a model of demand for new cars using complete new car transaction data and local market advertising data in the state of Virginia. Second, I contribute to the structural empirical literature on vertical relationships by estimating a model where firms choose prices and promotion effort, and I show how incorporating promotion decisions change estimated firm surplus and policy predictions. I use the demand estimates and the model to recover dealer and manufacturer surplus in the tradition of previous studies such as BLP and Nevo (2001). Third, through a set of counterfactual exercises, I quantify the pricing and advertising incentive problems in this industry and evaluate the effect of dealer-manufacturer regulations on welfare.

I estimate a random coefficients logit model of demand for new cars using complete transaction level purchase data in the state of Virginia. Consumers in the model have preferences over prices, car characteristics, distances to dealers, and dealer and brand advertising. Dealer advertising increases demand for all cars at a particular dealer, and brand advertising affects the quality of all products of the same make/model sold in a local market. To my knowledge, I am the first to study this industry using data on the population of transactions in a market. These data reveal a complete sense of the substitution patterns of consumers and competition between individual car dealers.

The data include the entire population of new car transactions in the state of Virginia, the locations of consumers and dealers, and actual transaction prices. I combine these data with local market advertising expenditures of both dealers and manufacturers. The estimation results imply that consumers have a strong distaste for traveling in order to purchase new cars. I also find that both dealer and brand advertising positively affect demand, but there is substantial heterogeneity among consumers in their taste for advertising. Many consumers are not affected by advertising.

On the supply side, I present a model of manufacturer and dealer behavior. In the model, manufacturers set wholesale prices and brand advertising each quarter. Dealers react by setting retail prices and dealer advertising. Double marginalization exists because both the dealer and manufacturer make separate pricing decisions, which results in a price-cost markup for both firms. There is also an advertising public goods externality: since dealers and manufacturers make separate decisions, the dealer (manufacturer) does not take into account the marginal benefit of advertising to the manufacturer (dealer). The advertising externality implies advertising is under-provided compared to the optimal decision of an integrated vertical structure. The fact that consumers dislike traveling in order to purchase cars implies that the geographic differentiation of dealers affects dealer competition. Two geographically close dealers are much closer substitutes, and thus much closer competitors, than two more distant dealers. Because of this, dealers only compete against a relatively close subset of rival dealers instead of all the dealers in their media market, for example, Richmond and all of the surrounding counties.

After estimating demand, I recover cost functions of firms using the model of firm behavior and quantify the division of surplus between dealers and manufacturers. Villas-Boas (2007) and Villas-Boas and Hellerstein (2006) show how to solve for and identify cost functions in empirical models of vertical structures. I build on their work by modeling a second choice variable for both upstream and downstream firms and show how to solve the model analytically to recover the cost structure of dealers and manufacturers. Costs have closed-form solutions and are computed in a similar way to previous empirical models of differentiated products. I define the division of surplus as dealer average profits over manufacturer average profits per product (including advertising costs). I find that dealers earn about 8% more surplus than manufacturers per car sold on average. I contrast this measure with the ratio of markups (dealer to manufacturer) per product, estimated from a model without advertising decisions, which implies dealers make 16% more surplus on average than manufacturers. Also, the division of surplus varies much more across brands after accounting for advertising decisions. Variation in estimated surplus reflects the advertising incentives within the vertical relationship that are not captured in a model without advertising.

The new car market is heavily regulated at the state level. One regulation that has received recent attention from academics, policy makers, and the media is the requirement that cars be sold through an independent network of licensed franchises. Manufacturers may not sell directly to consumers, nor can they own a controlling stake in any dealers' operations. This separation in decision-making leads to double marginalization and the advertising externality discussed earlier. To address the effect of this regulation, I use the estimated model to simulate vertical coordination between dealers and manufacturers. I allow one dealer-manufacturer pair to coordinate at a time, and then solve for retail prices and dealer advertising in the retail sub-game. I find that dealer advertising increases by 150% on average, suggesting that the advertising externality in this industry is quite large. I also find that retail prices fall drastically, by about 15% on average. A decline in retail prices as a result of solving the double marginalization problem is often cited as a reason to allow vertical coordination/mergers.[3] However, I find that when firms can also adjust their advertising levels, the price benefit of coordination weakens. On average, across different manufacturer-dealer pairs, prices are 30% higher when firms also adjust advertising levels after coordination takes place.

In most states, including Virginia, regulations make it very difficult for manufacturers to close dealer franchises.[4] In 2009, Chrysler and General Motors proposed closing more than 3,000 dealers. They used their impending bankruptcy proceedings as a legal way around the state laws regulating dealer terminations. I use the model to simulate the effect of hypothetical Chrysler dealer closings in 2007 and evaluate claims made by Chrysler and GM about the anticipated market effects. I predict that Chrysler would substantially decrease brand advertising in local markets after closing dealers. The decrease in brand advertising harms the remaining dealers, outweighing any positive competitive effects from the exit of rivals.

In the next chapter, I review both the related theoretical and empirical literature. In chapter 3 I describe the industry. In chapter 4 I introduce the empirical model. In Chapter 5 I describe the data and present some descriptive analysis of the market. I detail the estimation of the model in chapter 6 and results are presented in chapter 7. Chapter 8 provides a discussion of the policy implications of my results and counterfactual exercises. Chapter 9 concludes.

[3] Arguments against vertical mergers, such as market foreclosure, are not explicitly in the model. However, the results of one of my counterfactual exercises suggest that foreclosure might not be a concern.

[4] This particular regulation has its roots in the *Dealer's Day in Court Bill* of 1956.

Chapter 2

Literature Review

This research is closely related to four mostly separate literatures: empirical models of vertical relationships, empirical models of advertising, theoretical models of vertical relationships, and empirical studies of the automobile industry. In this section, I describe the most relevant papers.

2.1 Theoretical Models of Vertical Relationships

There is a rich literature that studies the economics of vertical relationships, including a long tradition of focusing on selling effort between vertically related firms. Typically, these papers are concerned with how to resolve price and effort/service externalities in vertical relationships using vertical restraints.

The most commonly examined vertical externality in the literature is double marginalization. To illustrate double marginalization, consider a simple economy with a monopolist manufacturer and retailer. The manufacturer sells goods to the retailer for a linear price, who then sells the goods to consumers. Both have some degree of market power and both charge a price markup over marginal cost. The retailer does not take into account the effect of its price decision on the marginal profit of the manufacturer. The final retail price of the good is higher than a single, integrated firm would choose. Total consumer surplus is lower, and direct consequence of the higher price, and total firm surplus is lower than if a single integrated firm made all pricing decisions.[1] As I will describe below, this externality extends naturally to oligopolistic competition and to non-price competition. Much of the theoretical literature is concerned with analyzing contractual arrangements, termed "restraints in the literature," that resolve the double marginalization problem. Common examples of restraints suggested in the literature include fixed fees, two-part tariffs, and retail price maintenance.[2]

To provide some context for a review of the literature, I preview the model of firm behavior I use to describe the automobile industry. Manufacturers and dealers compete in two stages. In the first stage, all manufacturers compete against each other by simultaneously setting wholesale prices and brand level advertising in local markets. In the second stage, dealers compete against each other by simultaneously setting retail prices and dealer advertising. Manufacturers have full information about dealers, and the equilibrium concept is sub-game Nash perfection. This set-up is a very standard case in the theoretical literature, and it applies particularly well to the automobile industry because state regulations restrict the ability to use anything other than linear wholesale prices, or otherwise control the pricing and advertising decisions of dealers. The assumption of linear prices and non-cooperative behavior between dealers and manufacturers implies a double marginalization pricing externality, as

[1] Two seminal references on double marginalization and the theory of vertical relationships are Spengler (1950) and Rey and Tirole (1986).

[2] See Mathewson and Winter (1984) for a detailed analysis of many common vertical restraints.

well as a public goods advertising externality akin to double marginalization.

Rey and Vergé (2008) review much of the literature on vertical relationships and provide a general treatment of vertical restraints and selling effort in vertical relationships. They conclude that standard results about restraints that resolve double marginalization no longer hold when selling effort is introduced along with price setting behavior. For example, retail price maintenance can no longer induce the retailer to sell the first-best quantity from the perspective of total firm surplus, but a two part tariff can still achieve the first best outcome. My treatment of selling effort, or in my case advertising, differs from Rey and Vergé (2008), as they consider a marginal cost of effort and I consider advertising from a fixed cost perspective.

Mathewson and Winter (1984) consider a monopolist selling to many spatially differentiated retailers. Retailers must inform consumers of a product's existence. Once a consumer has seen an advertisement, he or she knows their valuation for the product and can purchase the product for the price. They also find that there is an advertising externality, and a simple price maintenance contract by the manufacturer is not sufficient to resolve both a pricing and advertising externality.

Perry and Porter (1990) model a single manufacturer selling to downstream firms spatially competing on a Salop circle. The retailers set prices and provide a service that increases consumers willingness to pay for the good. With linear prices, there is an externality and retailers can provide either too little or too much service from the perspective of total firm surplus and total welfare. This is the same public goods externality that arises in my model. Furthermore, the authors find that retail price maintenance does correct the externality, and retailers continue to under-provide service. Combinations of price maintenance and a fixed fee can correct the service externality. The main takeaway is that results about vertical restraints and economic efficiency do not generalize to situations when more than prices are being decided in the vertical relationship. They propose contracts that achieve the joint profit maximizing equilibrium, and find that price maintenance and territorial restrictions are substitutes.

Winter (1993) considers a setting where a monopolist manufacturer sells through multiple retailers. The retailers compete by setting price and a “service” variable. Service acts to decrease the transportation cost in a linear spatial model. Naturally, retailers are biased towards price competition, so too little service is provided from the manufacturers point of view. However, the manufacturer can use a price floor to limit price competition and induce more service for the product.

There is a group of more recent marketing papers that explore sales effort, or advertising decisions, in vertical relationships using a Hotelling line framework. Iyer (1998) finds that retailers tend to provide too little service in a framework where a monopolist sells to multiple retailers who compete on a Hotelling line. He finds that if variation in consumer tastes are high enough, the manufacturer will offer different contracts to different retailers, or alternatively, the manufacturer can offer a menu of contracts to retailers and the retailers will self select themselves into different contracts. Shaffer and Zettelmeyer (2004) model two manufacturers selling through a single retailer that faces a linear demand. They show that when advertising decreases the substitution between the products (by decreasing “transportation” costs similar to the mechanism in Winter (1993)), manufacturers are better off compared to a zero advertising world, but when the advertisements are only seen by low valuation consumers, manufacturers are worse off. This is in contrast to my model, where I treat advertising as persuasive. See the discussion below in Chapter 2.3 for a dichotomy of alternative mechanisms for advertising in consumer demand.

2.2 Empirical Models of Vertical Relationships

There is a growing literature on empirical models of vertical relationships in both industrial organization and quantitative marketing. Two different paradigms are used to model the interactions of vertically related firms in the literature: non-cooperative games, the approach I take, and cooperative games. In the non-cooperative game approach, one type of firm, typically manufacturers, make take it or leave it offers to the other type of firm, typically retailers. This framework can potentially imply incentive problems, like double marginalization. This is a natural framework for industries where there are many retailers compared to manufacturers, or a bargaining setting is implausible, or both. The cooperative game framework is most natural is settings there there are a similar number of upstream and downstream firms, or there is a good reason to believe that a specific bargaining mechanism exists between firms. For example, this is the framework generally used to model hospital-insurer interactions because there is documentation of contract bargaining in this industry, and there are relatively few firms.

In probably the most relevant paper, Villas-Boas (2007) uses the non-cooperative framework to model the interactions between grocery retailers and yogurt manufacturers. The author estimates consumer demand for yogurt and then infers the costs of grocery stores and yogurt manufacturers from various models of retailer-manufacturer price setting behavior, including manufacturer Stackelberg with linear prices, retailer Stackelberg with linear prices, manufacturer marginal cost pricing (with a fixed fee), retailer marginal cost pricing, and various degrees of manufacturer or retailer collusion. The author tests these models against each other using non-nested model testing procedure and finds that the models that attribute greater pricing power to the retailer fit the data better. My research is related to Villas-Boas (2007) along two dimensions. First, it may be the case that the ability to advertise could be a source of relative pricing power for the retailer not explained by the models. In other words, a different model might fit the data better, for instance the manufacturer Stackelberg model, if both pricing and advertising decisions are incorporated. Second, she develops a procedure to calculate markups in vertical relationships that is nested in the BLP and Nevo (2001) framework of empirical models of product differentiation competition. I extend this framework by showing how to calculate markups when both manufacturers and retailers choose a second strategic variable, in my case advertising.

There is a growing literature that uses the methods and insights of Villas-Boas (2007) to empirically examine vertical relationships. Bonnet and Dubois (2010) test for the presence of non-linear tariffs in bottled water retailing and find that a model with a two part tariff rationalizes the data better than linear wholesale pricing. In their model of two part tariffs, they assume the manufacturer prices at marginal cost and then charges the retailer a fixed fee at the end of a certain time frame. Bonnet et al. (2013) consider how vertical restraints influence cost pass-through in the German coffee industry. They find that price maintenance increases pass-through rates. In an application to international trade, Goldberg and Hellerstein (2007) examine the sources of incomplete exchange rate pass-through in the US beer market. Meza and Sudhir (2010) study private labels and extend the framework to deal with chains of stores and deviations from Nash-Bertrand pricing in a conduct parameter framework. Villas-Boas (2009) look at the welfare effects of wholesale price discrimination in a grocery product.

Other examples of non-cooperative models of vertical relationships can be found in the quantitative marketing literature. An early example of a paper that uses similar methods is Sudhir (2001). In that paper, the author also, like Villas-Boas (2007) considers multiple models of vertical interaction and multiple models of demand, however between a single retailer and multiple manufacturers in the grocery industry. Using data from two grocery categories, he finds that logit demand and a manufacturer Stackelberg pricing model fit the data better than a multiplicative demand model and collusive behavior by the manufacturers.

More generally, the empirical investigation of vertical relationships has been an active area of research and involves a mix of empirical strategies. Many studies infer an effect of organizational form on some outcome variable, while other papers explicitly model the behavior of vertically related firms and estimate firm surplus. However, much of the structural work in this area only considers price decisions between firms, or discrete decisions like contracting outcomes between parties. There are a range of industries where vertical issues have recently been examined, such as airlines (Forbes and Lederman (2009) and Forbes and Lederman (2010)), hospitals (Ciliberto (2006), Ho (2009) , Brand et al. (2012)), cable television (Crawford and Yurukoglu (2012)), groceries (Bonnet, Dubois, and Simioni (2006) and Kadiyali, Chintagunta, and Vilcassim (2000). Lafontaine and Slade (2007) provide a thorough review of the empirical literature on vertical relationships. They present mixed evidence from the literature on the effect of vertical integration on firm performance/quality, but slightly more conclusive evidence that integration benefits consumer welfare.

There are two studies that are particularly related to my work. Mortimer (2008) studies vertical coordination in the video rental industry by examining how a change from linear price to revenue sharing contracts in affected profits and consumer welfare. She estimates substantial benefits for upstream firms, downstream firms, and consumers from revenue sharing contracts. Ho (2009) uses a model of demand for hospital services and a cooperative bargaining game of contracting decisions between hospitals and insurance companies to estimate hospital and insurance surplus. She concludes that higher quality hospitals have an incentive to invest in cost saving technology (relative to insurance companies) because they capture the benefit of these investments in the form of price markups, whereas lower quality hospitals do not have this investment incentive. There is a similar mechanism in my model, where high quality car dealers have greater incentives to spend more on advertising.

2.3 Empirical Models of Advertising

There is an established literature in industrial organization that is concerned with empirically examining the effects of advertising on consumer demand, and quantifying the effect of advertising on competition between firms. I estimate elasticities of demand with respect to advertising in the automobile market, and also show that advertising is an important competitive concern for firms not just horizontally among rivals, but also vertically.

Advertising's effect on consumer demand can be classified into two broad categories, persuasive and informative. Along with many other papers, I treat adverting as persuasive. There are a number of earlier examples of structural models of persuasive advertising. Roberts and Samuelson (1988) estimate a dynamic model of advertising in the cigarette industry. They test between two potential effects of advertising on industry competition, segment promotion and business stealing. They find that advertising's primary role is to steal business from rivals. In other words, greater industry advertising does not lead to significantly greater total industry sales. Ackerberg (2003) uses a dynamic learning model of yogurt sales to distinguish between the persuasive and informative effects of advertising. He finds that the primary role of advertising in this market is to inform consumers about new products, although the informational benefit is low, and so advertising is wasteful in terms of total surplus. In static model of demand, Nevo (2001) treats advertising as persuasive in the breakfast cereal market and finds economically and statistically significant elasticities of advertising, however he does not control for the likely endogeneity of advertising. Shum (2004) treats advertising in a persuasive role and interacts the effect of advertising with whether the consumer has purchased the product before. He finds that advertising is effective at getting consumers to change brands. Anderson et al. (2012) estimate a structural model of advertising decisions by pharmaceutical firms. Advertising is persuasive, but can either positively persuade a consumer to purchase a product, or negatively attack a rival product.

While Ackerberg (2003) separately distinguishes between a persuasive and informative effect of advertising, most papers a single role for advertising is assumed. For example, Erdem and Keane (1996) study grocery purchase decisions in a dynamic model. Advertising informs consumers about product characteristics by decreasing the uncertainty a consumer has about the value of the true product characteristic. Sovinsky Goeree (2008) estimates a model of purchase behavior in the new PC market using aggregate and micro-level data on PC sales and advertising exposure. Advertising acts to inform consumers of a product's existence. Each consumer makes a static, discrete choice facing an individual choice set, where the products in the choice set are a function of whether or not the consumer has been exposed to advertising.

2.4 The Automobile Dealer Manufacturer Relationship

There is a sparse literature on the new car dealer-manufacturer relationship. Bresnahan and Reiss (1985) find that markups between dealers and manufacturers is proportional across the product line. More recently Busse, Silva-Risso, and Zettelmeyer (2006) use transaction level data to infer pass-through rates of dealer versus consumer oriented sales incentives. Their results imply that dealers take advantage of information asymmetries between the two types of sales incentives. Using aggregate sales data from Europe, Brenkers and Verboven (2006) predict welfare gains from a change in the way manufacturers sell through dealers in Europe.

There has been some recent work on auto industry policy issues relating to both the recent financial crisis, and to auto retailing regulations more generally. Lafontaine and Morton (2010) provide an overview of manufacturer and dealer issues relating to the recent U.S. automobile manufacturer financial crisis. They also suggest that many state auto industry regulations contributed to the financial weakness of U.S. automobile manufacturers, and regulations may adversely effect consumer welfare. Albuquerque and Bronnenberg (2012) use transaction data to investigate the impact of the recent decrease in auto demand on the car industry.[3] They estimate a structural model of demand, supply, and entry/exit among a set of dealers and provide an argument for GM and Chrysler to close dealers based on fixed distribution costs per dealer. I contribute to their work simulating how advertising decisions change competition after dealer closures. Recently, the Department of Justice advocated eliminating state bans on direct sales to consumers. They predict that direct sales

[3]Their data covers a sample of dealers in the San Diego, California metropolitan area.

would reduce distribution costs and better match consumer preferences with car production. Although my model is not able to address production and inventory issues, my results suggest consumers would benefit from direct sales through lower prices

Chapter 3

Industry Background

In this section I present industry background that motivates the model and counterfactual exercises.[1] There are nearly 500 new car dealers in Virginia, selling every major car brand.[2] Dealers are traditional franchises, and they have what are essentially perpetual contracts to sell cars from manufacturers. Manufacturers must offer their full-line of cars to any dealer that it has established a franchise relationship with. Dealers can only sell new cars from manufacturers with which they have franchise contracts, so dealer entry is ultimately a decision of the manufacturer. Traditionally dealers sold only a single brand at each location, it has become more common for a single location to be a franchise for multiple brands. Dealers buy cars directly from the manufacturer and then sell to consumers. This means that every car on a dealership lot is either owned out right, or financed by the dealer through a bank.

[1] 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 has been president of the National Automobile Dealer Association was particularly useful. An understanding of the historical regulatory framework is due to McHugh (1956)

[2] "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.

State regulations tightly govern the new car market.[3] Traditionally, dealers and dealer associations have had significantly more influence in state legislatures than manufacturers, leading to regulations that are viewed as favoring dealers. Modern regulations date back to the *Dealers' Day in Court Bill of 1956* passed by the U.S. Congress. The bill centered around the ability of manufacturers to terminate dealer franchise relationships; it protected dealers legally and made it difficult for a manufacturer to end or fail to renew a dealer franchise contract without just cause. Since then state laws have expanded to included those that regulate not only dealer termination, but almost every other interaction between manufacturers and dealers. For example, manufacturers generally are prohibited from using tools such as quantity forcing, price maintenance, two part tariffs, service or quality provisions, or investment requirements, such as advertising or showroom quality.[4] In practice, if a manufacturer wants to close a dealer it must offer the dealer a buyout which the dealer could freely choose to accept or reject. For example, General Motors spent more than $1 billion on dealer buyouts when it closed its Oldsmobile line.[5]

A striking feature of the new car market is the difference in dealer network sizes across manufacturers. American car manufacturers, most notably GM, Ford, and Chrysler, have many more dealers than foreign manufacturers. Dealers affiliated with American car manufacturers sell many fewer cars than dealers associated with

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[3]For a thorough review on the current regulatory environment see Lafontaine and Morton (2010) and Canis and Platzer (2009).

[4]Since these tools generally resolve externalities in the vertical relationship, there is some question to why dealers lobbied for them in the first place. Initial legal analysis of the "Dealers Bill" of 1956 suggests that dealers felt like they had zero bargaining power, and so surplus from the relationship was unfairly in favor of manufacturers. There is also some sense in which franchise contracts may have included terms that were not enforceable, and the nature of the burden of proof for enforcement favored manufacturers. See, for example McHugh (1956) and Fulda (1956)

[5]See James Surowiecki, *Dealer's Choice*, The New Yorker, September 4, 2006, `http://tinyurl.com/5fgjjh`.

foreign brands. This is partly because many dealer termination regulations were enacted after American brands had established dealer franchise networks and before foreign brands entered the market. Lafontaine and Morton (2010) establish this fact in detail and describe the dynamics of dealer networks. In order to avoid dealer termination penalties, GM and Chrysler used their recent financial problems and potential bankruptcies as an opportunity to downsize dealer networks. In fact, U.S. car manufacturers have been shrinking dealer networks for the past half century, but can typically only through attrition because state laws restrict the termination of dealer relationships. During bankruptcy those manufacturers proposed about three thousand dealer terminations, but only a few hundred for each brand actually closed after the proposal prompted court and legislative challenges at the state and federal level.

Manufacturers and dealers spend significant resources advertising in local markets. Manufacturers either advertise directly in local markets and/or organize dealer advertising associations to coordinate regional and local brand advertising. Dealer associations are typically funded by manufacturers, sometimes explicitly through advertising "fees" posted as a line item on invoice prices to dealers. Participation in such associations is not mandatory, but conversations with dealers suggest that participation is nearly universal, especially in larger markets. Dealers can contribute their own funds for the dealer association, but this behavior is relatively rare. Instead, dealers use their own funds to pay for dealer specific advertising which is an independent decision apart from the dealer association in terms of advertising funds and content. Manufacturers cannot require dealers to advertise. In some cases dealers use creative material provided by the manufacturer, but it is not clear whether this is provided gratis by the manufacturer.

Manufacturers and dealers associations advertise the "brand," and dealers advertisements typically focus less on the brand and more on qualities specific to the dealer. In the model I present later, I assume that brand advertising affects consumers differently than dealer advertising does.[6] Manufacturer and dealer association brand advertising tends to communicate messages about brand, features, and desirability. Xu et al. (2013) studies advertising content for trucks, and finds that local market ads by manufacturers and dealer associations have very similar mixes of price and brand content. Dealer association advertising tends to cater more to local populations, for instance featuring local celebrities or sports teams, but still emphasizes the brand. In some cases the manufacturer advertisements have higher production quality, but in many cases the same creative content is used by manufacturers and dealer associations. Dealer advertisements typically have a lower production quality and stress features such as service, buying experience, selection, and getting a "good deal." Although prices are advertised, individual price negotiation is prominent in this industry: advertised prices do not reflect actual prices paid.

In most states, manufacturers cannot sell directly to consumers. Recently, these regulations have received attention because Tesla Motors, an electric car manufacturer, has been selling cars in many states directly to consumers through internet orders. In some cases the Tesla sales model works through a "loophole" in current state regulations; in other cases it is unclear whether Tesla's sales operations are legal. Dealer associations are lobbying state legislatures to take action and rewrite regulations to be clear about cases like Tesla's. State legislators in New York, North Carolina, Texas, and Virginia, have introduced legislation to make it harder for con-

[6] I have watched examples of advertisements provided by my advertising data source and there are clear quality and message differences.

sumers to purchase and register cars not bought from franchised dealers, even through phone or internet orders.[7]

There are many other laws that regulate the relationship between manufacturers and dealers are common across most states. Manufacturers cannot use vertical restraints in dealer franchise contracts. Such as price maintenance, quantity forcing, and fixed fees. Manufacturers cannot terminate a sales relationship with a dealer except under special circumstances. There are limits to how close a new dealer can locate near an existing dealer of the same brand. Typically a dealer's exclusive territory extends in a twenty mile radius. Manufacturers cannot wholesale-price discriminate between dealers in the same state, and in practice do not price discriminate across entire regions. Lafontaine and Morton (2010) provide a thorough discussion of state dealer franchise regulations, and detailed documentation in an online appendix.

[7]See "Tesla vs. the auto dealers of America," MSNBC, June 28, 2013, `http://tinyurl.com/mrzaxha`; "Local Dealers Pan Tesla's On-line Sales, Apply Legislative Pressure," ABC World News, September 12, 2013, `http://tinyurl.com/kf6qd8w`, and "State battles yield mixed results. A federal approach might be next," Automotive News, September 9, 2013, `http://tinyurl.com/m7w8ntv`.

Chapter 4

Empirical Model

4.1 Demand

In this section I describe the demand for new cars. Each period, consumers make a discrete choice among differentiated products. I define a product as a car make/model from a particular dealer. Consumers, indexed $i = 1..N$, decide which of the $j = 1..J_t$ products to purchase in their home market, where $t = 1..T$ indexes markets. A market is a particular geographic location, in this case a metropolitan area, at a particular time. Consumers can only purchase products located in their geographic market. The consumer also has the option of no purchase, denoted as $j = 0$.

Consumer i's indirect utility for a new car j in market t is a function of observed car characteristics, x, prices, p, a function $g(a, A; \boldsymbol{\phi})$ of exposure to local dealer and brand advertising,a and A respectively, and a function $f(\mathcal{D}; \boldsymbol{\lambda})$ of the distance from the consumer location to the product location, $\mathcal{D}$. Indirect utility of product j for consumer i in market t is

$$u_{ijt} = \beta_i x_{jt} + \alpha_i p_{jt} + f(\mathcal{D}_{ijt}; \boldsymbol{\lambda}) + g(a_{r_j t}, A_{z_j t}; \boldsymbol{\phi}) + \xi_{jt} + \epsilon_{ijt}, \tag{4.1.1}$$

where β_i is a vector of consumer specific preferences for car characteristics, α_i represents a consumer specific preference for price, $\boldsymbol{\lambda}$ and $\boldsymbol{\phi}$ are preference parameters for distance and advertising , and ξ_j represents a product-market specific preference that is known to the households and firms, but unobserved in the data. The index convention r_j maps product j to dealer r, and the z_j maps product j to car model z. The term ϵ_{ijt} is i.i.d., follows the Type I extreme value distribution, and represents unobservable household specific tastes. I assume that utility from not purchasing is only a function of an unobserved consumer specific preference: $u_{i0t} = \epsilon_{i0t}$. Households choose the option with the highest indirect utility.

4.1.1 Price and product characteristics

Consumers have preferences over product price and product characteristics. Preference for price is distributed truncated Normal, where the scale parameter is a function of consumer i's income, Υ_i:

$$\alpha_i \sim \begin{cases} TrN(\alpha^L, \sigma^p, (-\infty, 0]) & \text{if } \Upsilon_i \in [0, 50000) \\ TrN(\alpha^M, \sigma^p, (-\infty, 0]) & \text{if } \Upsilon_i \in [50000, 100000) \\ TrN(\alpha^H, \sigma^p, (-\infty, 0]) & \text{if } \Upsilon_i \in [120000, \infty), \end{cases} \tag{4.1.2}$$

I allow for individual specific preferences for product characteristics. Letting $k = 1..K$ index characteristics, consumer i's preference for characteristic k is

$$\beta_{ik} = \bar{\beta}_k + \tau_{ik}\sigma_k^x,$$

where τ_{ik} is distributed standard normal, and represents unobserved individual preferences for product characteristic k. As noted in BLP and subsequent related studies, this specification allows for realistic substitution patterns that do not suffer from the independence of irrelevant alternatives problem. A consumer with a strong positive preference for a particular characteristic, for example horsepower, will more likely substitute to products with high horsepower before products without high horsepower, all else equal.

4.1.2 Distance

To capture the idea that households may prefer to purchase cars from nearby dealers over dealers that are farther away I allow indirect utility for product j to be a function of the distance, $\mathcal{D}_{ij}$ between the consumer home and the location of the dealer that sells the product. I define the function $f()$ as,

$$f(\mathcal{D}_{ijt}; \boldsymbol{\lambda}) = \lambda_1 \mathcal{D}_{ijt} + \lambda_2 \mathcal{D}_{ijt}^2 + \lambda_3 H_1 \mathcal{D}_{ijt} + \lambda_4 H_2 \mathcal{D}_{ijt},$$

where λ_1 and λ_2 are preferences for distance and distance squared respectively, and λ_3 and λ_4 capture preferences for distance interacted with household characteristics, H_1 and H_2. I include travel time to work and a measure of population density as household characteristics that influence preferences for distance.[1] This formulation of spatial demand that included distance in the utility function is a common treat-

[1]For population density I use the land area of the household's Census Tract. Tracts are designed to have similar populations, so land area is highly correlated with population density.

ment in the literature, including Davis (2006), Thomadsen (2005), and Houde (2012), among others. Allowing for distance in the utility function creates spatial competition between dealers which implies that dealers with fewer geographic competitors have more market power, holding other things constant. Household preferences for distance have strong implications for cross-price elasticities between competitors of varying distances. Previous studies have found very strong effects of distance on demand across a variety of industries. In the automobile industry, Albuquerque and Bronnenberg (2012) find an effect of distance that is slightly stronger, but of a similar magnitude, than what I find.

4.1.3 Advertising

Advertising enters utility through the function $g(a, A; \boldsymbol{\phi})$. I limit the analysis to television and print advertising and aggregate them into a single variable of advertising expenditures measured in dollars. Advertising is classified into two types: (1) *dealer* advertising, a, and (2) *brand* advertising, A.[2] Brand advertising is model/make specific, and can represent either advertising for the entire brand or for the specific model. The two types of advertising have (potentially) different and linearly separable effects on utility: dealer advertising influences the utility for every product at that dealer, and brand advertising influences the utility for every product of that brand/model.[3]

Households may respond to advertising differently, and may also be exposed to different levels of advertising. To capture this, I allow for consumer specific preferences

[2] When reasonable, I use lower case letters to denote variables associated with dealers and uppercase letters to denote variables associated with manufacturers.

[3] It is sometimes the case that dealer advertising is specific to a particular brand, even if the dealer sells more than one brand. When this happens, I make the strong assumption that this advertising perfectly "spills over" to the other cars sold by the dealer.

for advertising. This could either represent heterogeneity in tastes for advertising, or heterogeneity in exposure to advertising, however, for the remainder of the paper I refer to this as an unobserved preference for advertising. The following is the functional form for advertising preferences:

$$g(a_{r_j t}, A_{z_j t}; \boldsymbol{\phi}) = \phi_i^{\text{dealer}} log(\underline{a} + a_{r_j t}) + \phi_i^{\text{brand}} log(\underline{A} + A_{z_j t}), \tag{4.1.3}$$

where,

$$\phi_i^{type} \sim TrN(\bar{\phi}^{type}, \sigma^{type}, [0, \infty]),$$
$$type \in \{dealer, brand\}\,.$$

The term z_j denotes the car model z associated with product j, and r_j denotes the dealer r associated with product j. The parameters $(\bar{\phi}^{\text{dealer}}, \bar{\phi}^{\text{brand}})$ are parameters that describe the scale of advertising preferences in the population, and $(\sigma^{\text{dealer}}, \sigma^{\text{brand}})$ describes consumer heterogeneity in advertising preferences.[4] The parameters $\underline{a}$ and $\underline{A}$ represent minimum levels of advertising resulting from normal business operations in a given market.[5]

I allow for separate effects of dealer and brand advertising few many reasons. First, typically these advertisements convey different types of messages about the

[4] Technically, $\bar{\phi}$ is the mean of the parent normal distribution, and σ is the standard deviation of the parent normal distribution.

[5] In practice, this is not observed and I do not estimate it. As an approximation, I use advertising rate data from Clear Channel to predict the value of a medium size billboard in each of the four markets and set this value as the minimum advertising level, the idea being that this approximates the value of a storefront with a sign. The minimum level of advertising could also include informal advertising like word of mouth.

product. Second, brand advertisements typically have a higher level of production quality, and so may have a different effectiveness in shifting consumer demand per dollar of media spending. On the other hand, dealer advertising may be better at reflecting local idiosyncrasies in preferences, and so may have a better effectiveness.[6] I allow consumers to differ in their preference for advertising, and for a given consumer advertising parameters are perfectly correlated.[7]

4.2 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 (the dealer-sub-game), dealers observe the manufacturer decisions and simultaneously make retail pricing and advertising decisions. Each firm has complete information about its rival firms, and I assume there exits a sub-game perfect Nash equilibrium in prices and advertising. [8]

First I introduce notation to help deal with different combinations of dealers and brands. Manufacturers sell multiple car models through multiple dealers, and dealers sell multiple models from (possibly) multiple manufacturers. Recall that a product is a dealer/make/model combination. Let m_j denote the manufacturer m associated with product j, where manufacturers are indexed $1 \dots M$. Let r_j denote the dealer r associated with product j, where dealers are indexed $r = 1 \dots R$. Also, recall that z_j denotes the car model z associated with product j, where models are indexed $1 \dots Z$.

[6]For a similar separable treatment of advertising in indirect utility, see Anderson et al. (2012).

[7]The perfect correlation assumption is more reasonable than a zero correlation assumption, and the aggregate nature of the data limits my ability to identify a correlation parameter.

[8]I take dealer-manufacturer relationships as exogenous, so I do not model the matching of dealers to manufacturers or dealer entry/exit.

The reason I index models as well as products is because manufacturers make decisions at the model level, not the product level. For example, a Toyota Camry from Mike Brown's Auto Mall maps to $\{m, r, z\} = \{$Toyota, Mike Brown's Auto Mall, Camry$\}$.

Both manufacturers and dealers sell multiple products. Let the set of products sold by manufacturer m in market t be $\mathcal{J}^M_{mt}$. Let the set of products sold by dealer r be $\mathcal{J}^R_{rt}$. Also, let the set of all products of the same model z be Ω_{zt} and the set of models from manufacturer m be $\mathcal{Z}_{mt}$.

I solve the price and advertising game backwards, starting with the decisions of the dealers. The goal is to recover the unobserved costs of dealers and manufacturers. With costs in hand, I calculate producer surplus, and conduct counterfactual exercises.

Dealers make one retail price decision for each product and a single advertising decision, taking as given the wholesale price and manufacturer advertising decisions. A particular dealer faces the following profit maximization problem:

$$\max_{\boldsymbol{p_t}, a_r} \pi_{rt} = \mathcal{M}^t \sum_{j \in \mathcal{J}^R_{rt}} (p_{jt} - W_{jt} - c_{jt}) s_{jt} - a_{rt} + a_{rt}\psi_{rt},$$

where $\mathcal{M}^t$ represents the size of the potential market for market t, c_j represents marginal cost/revenues of distribution for product j, and ψ_r represents unobserved constant marginal profits from advertising. For example, unobserved revenue could be sales from trucks, used cars, or other dealer services. Unobserved costs could be production costs of advertising. The term c_j represents additional constant marginal costs (or revenues) of selling cars beyond the wholesale price, W. This could represent either costs of distribution, or additional revenue from the sale of a car such as future warranty service and other future business. Therefore, the total price-cost markup for the dealer for a single product is $p_{jt} - W_{jt} - c_{jt}$.

All dealers simultaneously make price and advertising decisions.For a particular dealer, the solution involves one pricing first order condition for each product sold and one advertising first order condition.[9] The price first order condition for product j is

$$s_j + \sum_{k \in \mathcal{J}^R_{r_j}} (p_k - W_k - c_k) \frac{\partial s_k}{\partial p_j} = 0, \tag{4.2.1}$$

and the advertising first order condition is

$$\mathcal{M} \sum_{j \in \mathcal{J}^R_{r_j}} (p_j - W_j - c_j) \frac{\partial s_j}{\partial a_r} - 1 + \psi = 0. \tag{4.2.2}$$

Define T^R as 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 ∇^s_p be a matrix containing all of the first partial derivatives of shares with respect to retail prices, with general element $\nabla^s_p(g, h) = \frac{\partial s_g}{\partial p_h}$. Also define ∇^a as a row vector with general element $\nabla^a(g) = \frac{\partial s_g}{\partial a_{r_g}}$. Following Bresnahan (1987) and Nevo (2001), I solve for dealer markups by stacking all of the pricing FOCs defined by equation (4.2.1),

$$(\boldsymbol{p} - \boldsymbol{W} - c) = -(T^R * \nabla^s_p)^{-1} \boldsymbol{s},$$

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 equation (4.2.2) and recover ψ directly.

[9]For the remainder of this chapter, I drop the time/market subscript t for clarity.

Although optimal price and advertising decisions cannot be solved for analytically, the FOCs from equations (4.2.1) and (4.2.2) implicitly define functions for equilibrium choices of price and advertising, given the decisions of manufacturers: $\boldsymbol{p}^{\star}(\boldsymbol{W}, \boldsymbol{A})$ and $\boldsymbol{a}^{\star}(\boldsymbol{W}, \boldsymbol{A})$.[10] Equilibrium prices and ads imply a level of equilibrium shares, $s^{\star}(\boldsymbol{p}^{\star}(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{a}^{\star}(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{A})$, given manufacturer decisions. Notice that brand advertising affects shares directly because consumer utility is a function of brand advertising, and indirectly through dealer decisions.

4.3 Automobile Manufacturers

Manufacturers make wholesale price and advertising decisions in the first stage with full information about how these decisions change equilibrium shares, $s_j^{\star}$, in the retail sub-game. In a *particular market*, manufacturers solve the following problem:

$$\max_{\boldsymbol{w}, \boldsymbol{A}} \Pi_m = \mathcal{M} \sum_{j \in \mathcal{J}_m^M} (W_{z_j} - C_{z_j}) s_j^{\star} - \sum_{z \in \mathcal{Z}_{mt}} A_z + \sum_{z \in \mathcal{Z}_{mt}} A_z \Psi_z.$$

The term C_{z_j} represents marginal costs of production for model z. A manufacturer can choose to spend different amounts on advertising for a particular model z in different media market t. The term Ψ_z represents unobserved constant marginal costs/revenues of advertising for model z. Notice that W_z is not market specific. This is because the wholesale price, by law, must be the same for every dealer in the state of Virginia. Here I present the model as if there is only a single market to ease the burden of notation; however, it is still the case that every wholesale price must be the same for each dealer within a market. I consider the many markets case later.

[10]Demand, s_j is a non-linear function of prices and advertising.

All of the estimation results presented in Chapter 7 are from the model that includes the cross market restrictions on wholesale price.

4.3.1 Only pricing decisions

First, I abstract away from advertising decisions by both dealers and manufacturers and derive expressions for manufacturer markups from pricing behavior only. This analysis is nearly identical to the analysis in Villas-Boas (2007), and has been employed in other empirical studies of vertical relationships. The pricing-only analysis will make it easier to understand the analysis with advertising decisions later, which I present in the next subsection.

The number of pricing decisions the manufacturer makes is equal to the number of distinct models, where the set of distinct models sold by manufacturer m is denoted as $\mathcal{Z}_m$. The number of advertising first order conditions is also equal to the number of models in a market.[11] The following defines the pricing FOCs of a manufacturer for model z:

$$\sum_{k\in\Omega_z} s_j + \sum_{f\in\mathcal{Z}_m} (W_f - C_f) \sum_{k\in\Omega_f} \frac{\partial s_k(\boldsymbol{p}(\boldsymbol{W}))}{\partial W_z} = 0,$$

where recall that Ω_z represents the set of products of model z. The first term is the sum of the shares for all of the products for that model. The second term is the markup of each model sold by the manufacturer multiplied by the sum of the response of demand with respect to wholesale price of model z across all products of each model. This is a typical pricing first order condition for a multi-product firm,

[11] Unlike pricing decisions, manufacturers can set different advertising levels for the same model in different markets

except I have the constraint that all products of the same model must have the same wholesale price. The manufacturer thus aggregates over products of the same model across dealers when making the pricing decision.

To set wholesale prices, the manufacturer anticipates how equilibrium shares respond to changes in wholesale prices through retail price adjustments:

$$\frac{\partial s_k^\star}{\partial W_z} = \frac{\partial s_k^\star}{\partial p_1}\frac{\partial p_1}{\partial W_z} + \cdots + \frac{\partial s_k^\star}{\partial p_J}\frac{\partial p_J}{\partial W_z}.$$

A change in the wholesale price, W_z, will result in a change in all retail prices. The sum of these effects on demand is the total effect of the change in wholesale price.

I recover the pass-through of wholesale price to retail price, $\frac{\partial p_j}{\partial W_z}$, by applying the implicit function theorem to the *retail* pricing first order conditions, equation (4.2.1). Consider the system of implicit equations $Q(\boldsymbol{p}, \boldsymbol{W})$, where the jth element is the pricing FOC of product j:

$$Q^j(\boldsymbol{p}, \boldsymbol{W}) = s_j + \sum_{k \in \mathcal{J}^r} (p_k - W_k - c_k)\frac{\partial s_k}{\partial p_j} = 0. \tag{4.3.1}$$

Consider a marginal change in the first wholesale price, W_1. The vector of retail price derivatives with respect to the first wholesale price (or retail price pass-through of wholesale price), $\nabla^p_{W_1}$, is the solution to the following system of equations,

$$Q_p \nabla^p_{W_1} = Q_{W_1},$$

where Q_p and Q_{W_1} are a matrix and vector (respectively) of derivatives, with general element $Q_p(i,j) = \frac{\partial Q^j}{p_i}$, and $Q_{W_1}(j) = \frac{\partial Q^j}{\partial W_1}$.

Assuming a Nash equilibrium in prices exists, manufacturer markups are

$$(\boldsymbol{W} - \boldsymbol{C}) = (T^M * \nabla_W^{p\prime} \nabla_p^s)^{-1} \tilde{\boldsymbol{s}}^\star,$$

where ∇_p^s notates the matrix of partial derivatives of shares with respect to retail price and T^M is the ownership matrix for manufacturers defined similarly to T^R. Here, $\tilde{\boldsymbol{s}}^\star$ denote shares aggregated across products to the model level. For example, $\tilde{\boldsymbol{s}}^\star$ is: $\tilde{s}_1^\star = \sum_{j \in \Omega_1} s_j$.

4.3.2 Pricing and advertising decisions

I extend the above analysis to the case where dealers and manufacturers make pricing and advertising decisions. To my knowledge, this is the first that an empirical model of vertical relationships has incorporated both pricing and a second strategic variable. First, I derive expressions for manufacturer markups and marginal costs using the manufacturer pricing FOCs. Second, I derive expressions for unobserved advertising cost/revenue, Ψ, using the manufacturer advertising FOCs.

Manufacturers anticipate that changes in wholesale prices lead to changes in retail prices *and* changes in dealer advertising. For example, consider an increase in wholesale price leads to a less than one-for-one increase in retail price. The dealer sells less and makes a lower markup per car, so it has a lower incentive to advertise.[12] There is also competition to consider, as rival dealers will have pressure to change prices and advertising in response. The sum of these effects depends on the parameters of demand and the structure of local markets.

A single pricing first order condition for a manufacturer is,

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

$$\sum_{j\in\Omega_{zt}} s_j + \sum_{f\in\mathcal{Z}_{mt}} (W_f - C_f) \sum_{k\in\Omega_{ft}} \frac{\partial s_k(\boldsymbol{p}(\boldsymbol{W},\boldsymbol{A}), \boldsymbol{a}(\boldsymbol{W},\boldsymbol{A}), A)}{\partial W_z} = 0, \tag{4.3.2}$$

where now I write retail prices and dealer advertising as a function of wholesale prices and manufacturer advertising. Shares are also directly affected by manufacturer advertising (the third argument) because brand advertising directly enters consumer utility.

A change in wholesale price now 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 shares:

$$\frac{\partial s_k^\star}{\partial W_z} = \Bigg[\underbrace{\frac{\partial s_k}{\partial p_1}\frac{\partial p_1}{\partial W_z} \cdots \frac{\partial s_k}{\partial p_J}\frac{\partial p_J}{\partial W_z}}_{\text{effect through dealer prices}} + \underbrace{\frac{\partial s_k}{\partial a_1}\frac{\partial a_1}{\partial W_z} \cdots \frac{\partial s_k}{\partial a_R}\frac{\partial a_R}{\partial W_z}}_{\text{effect through dealer ads}} \Bigg] \tag{4.3.3}$$

The expression here for the derivative of shares with respect wholesale price is different from the last subsection, where I assumed dealers and manufacturers only choose prices, due to the second set of terms labeled *effect through dealer ads*. The manufacturer anticipates the response of dealer advertising to changes in wholesale price (and manufacturer advertising) and knows how these changes in dealer advertising will change sales. This is a second margin of pass-through: the advertising pass-through of wholesale price.

To understand how the advertising pass-through influences manufacturer markups, I use the implicit function theorem on the price *and* advertising FOCs of the dealer, similarly to how I used the pricing FOCs to construct expressions for price pass-through in the previous section.

Next, consider a vector of the implicit equations of dealer advertising FOCs with the following general element for the rth dealer as,

$$K^r = \sum_{j \in \mathcal{J}_r^R} \mathcal{M}(p_j - c_j)\frac{\partial s_j}{\partial a_r} - 1 + \psi_r = 0$$

where I define matrices of derivatives of the FOCs as K_p, K_a, and K_{W_1} with general elements $K_p(r, j) = \frac{\partial K^r}{\partial p_j}$, $K_a(r, r') = \frac{\partial K^r}{\partial a'_r}$, and $K_{W_1}(r) = \frac{\partial K^r}{\partial W_1}$.

To recover the total effect of a wholesale price change on dealer pricing I again apply a multivariate version of the implicit function theorem. I define the following block matrix with dimension $(J + R) \times (J + R)$,

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

where Q_a is the derivative of the pricing FOCS, equation (4.3.1), with respect to dealer advertising.[13] Next, I construct a block matrix with dimension $(J + R) \times Z$:

$$\mathcal{H} = \begin{pmatrix} Q_{W_1} & \cdots & Q_{W_Z} \\ K_{W_1} & \cdots & K_{W_Z} \end{pmatrix}.$$

This matrix holds the derivatives of all the dealer FOCs (including advertising) with respect to wholesale price.

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

[13]The dimension here is the total number of dealer FOCs in the market

$$\mathcal{G}\nabla^p_W = \mathcal{H},$$

where the first J rows of ∇_W are the price pass-through terms, and the last R rows are the advertising pass-through terms.

Using equation (4.3.2) and the notation for pass-through just introduced, manufacturer markups are expressed as

$$(\boldsymbol{W} - \boldsymbol{C}) = -1 * (T^M * \nabla^{p\prime}_W \begin{pmatrix} \nabla^s_p \\ \nabla^s_a \end{pmatrix})^{-1} \tilde{\boldsymbol{s}}^\star \qquad (4.3.4)$$

where ∇_a the matrix of the derivative of shares with respect to dealer advertising.

Brand advertising by the manufacturer is at the model level, and therefore affects all products of the same model regardless of the dealer. In this sense, brand advertising "raises all boats" with respect to the dealers. The number of advertising decisions equals the number of products multiplied by the number of local markets.[14] The manufacturer advertising first order condition for model z in local market t is

$$\sum_{k \in \mathcal{J}} (W_{z_k} - C_{z_k}) \frac{\partial s_k(\boldsymbol{p(W, A)}, \boldsymbol{a(W, A)}, A)}{\partial A_{zt}} - 1 + \Psi_{zt} = 0. \qquad (4.3.5)$$

The partial derivative of shares with respect to manufacturer advertising implies that the manufacturer anticipates changes in dealer price and advertising effort $(\boldsymbol{p}, \boldsymbol{a})$ given changes in own brand advertising:

[14] I am ignoring here a more general equilibrium effect of national advertising. National advertising choice is a function of demand and dealer behavior in all 50 states. Modeling this would be difficult with data from one state and may add little value to the key insights of vertical relationships in local markets.

$$\frac{\partial s_k(\boldsymbol{p}(\boldsymbol{W},\boldsymbol{A}),(\boldsymbol{a}(\boldsymbol{W},\boldsymbol{A}))}{\partial A_{zt}} = \Bigg[\underbrace{\frac{\partial s_k}{\partial p_1}\frac{\partial p_1}{\partial A_{zt}}\cdots\frac{\partial s_k}{\partial p_J}\frac{\partial p_J}{\partial A_{zt}}}_{\text{effect through dealer prices}} + \underbrace{\frac{\partial s_k}{\partial a_1}\frac{\partial a_1}{\partial A_{nz}}\cdots\frac{\partial s_k}{\partial a_R}\frac{\partial a_R}{\partial A_{zt}}}_{\text{effect through dealer ads}}\Bigg]$$

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_{zt} is straightforward after solving for markup's in equation (4.3.4) and recovering $\frac{\partial s}{\partial A}$'s.

4.3.3 Manufacturer behavior across markets

In this appendix, I present the model of manufacturer price and advertising decisions that includes the cross market restriction that wholesale prices are the same for each dealer. Manufacturer m solves the following problem.

$$\max_{\boldsymbol{w},\boldsymbol{A}} \sum_{t=1}^{4}\Big[\Pi_{mt} = \mathcal{M}\sum_{j\in\mathcal{J}_m^M}(W_{z_j} - C_{z_j})s_j^{\star} - \sum_{z\in\mathcal{Z}_{mt}} A_{zt} + \sum_{z\in\mathcal{Z}_{mt}} A_{zt}\Psi_{zt}\Big]$$

A single pricing first order condition for a manufacturer is,

$$\sum_{t=1}^{4}\Big[\sum_{j\in\Omega_z} s_{z_j} + \sum_{f\in\mathcal{Z}_m}(W_f - C_f)\sum_{k\in\Omega_f}\frac{\partial s_k(\boldsymbol{p}(\boldsymbol{W},\boldsymbol{A}),\boldsymbol{a}(\boldsymbol{W},\boldsymbol{A}),A)}{\partial W_z}\Big] = 0$$

where since W_z is not market specific, the firm must consider how a change in wholesale price effects sales (and retailer behavior) in all markets.

Dealers in separate markets do not compete against each other, so the pass through of wholesale price to retail decisions looks exactly like it does in the earlier section on dealer decisions. For a given market t, the effect of a change of wholesale price on shares is

$$\frac{\partial s_k^\star}{\partial W_z} = \sum_{j \in \mathcal{J}_t} \frac{\partial s_k}{\partial p_j}\frac{\partial p_j}{\partial W_z} + \sum_{r \in \mathcal{R}_t} \frac{\partial s_k}{\partial a_r}\frac{\partial a_r}{\partial W_z},$$

where $\mathcal{R}_t$ is the set of dealers in market t.

The derivation of pass-through terms is also the same as earlier in the Chapter. Again, this is because dealers do not compete with other dealers outside their market.

The vector valued equation that defines manufacturer markups is the following:

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

In the single market case, ∇_p^s is a $J_t x Z$ matrix. Now, it is a JxZ matrix, where J_t is the number of products in market t, and J is the number of products across all markets. The same applies for ∇_a^s, which now includes an element for each dealer in all markets. Also, $\tilde{\boldsymbol{s}}^\star$ is the same of market shares for each model: $\tilde{s}_z^\star = \sum_{t=1}^4 \sum_{j \in \Omega_{zt}} s_j$. The ownership matrix, T^M is unchanged from previously.

The first order condition for manufacturer m advertising of model z is

$$\sum_{t=1}^{4} \Big[\sum_{k \in \mathcal{J}} (W_{z_k} - C_{z_k}) \frac{\partial s_k(\boldsymbol{p}(\boldsymbol{W}, \boldsymbol{A}), \boldsymbol{a}(\boldsymbol{W}, \boldsymbol{A}), A)}{\partial A_z} - 1 + \Psi_{zt} \Big] = 0.$$

Even though car model level advertising decisions are market specific, the advertising decision is dependent across markets because wholesale price is not market specific. Again, pass-through rates can be calculated as in the previous subsection because dealers do not compete across markets.

Chapter 5

Data and Descriptive analysis

5.1 Data

I combine data from three main sources: new car transactions and dealer information, local market advertising expenditure data, and new car characteristics and wholesale prices. I also use data from the Census to supplement the transaction data.

5.1.1 Transaction and car characteristics data

I obtain automobile sales data for the state of Virginia from the Virginia Department of Motor Vehicles for January 1, 2007 to September 31, 2011. The data are at the transaction level, and for each purchase I see the make/model of car bought, date of transaction, price paid, identity of the selling dealer, (usually) the nine-digit zip code of the buyer and county/town/city of the buyer.[1]

I define the product market for new cars by restricting the sample along a number

[1] The location of the buyer is where the car is to be garaged after purchase for local tax purposes. About 3% of transactions are listed as out of state purchases.

of dimensions. I limit my sample to cars, SUVs and vans.[2] I drop cars with a manufacturer suggested retail price above \$70,000. I also drop transactions with recorded prices below half of the average price and above 150% of the average for each model in each time period. I also drop very small dealers who sell less than 10 cars per brand each quarter on average and I also drop dealers not in one of the four largest media markets in Virginia (as defined by Nielsen) in order to match dealers with advertising data. The four markets are (in descending order of population) Northern Virginia, Hampton Roads, Richmond, and Roanoke/Lynchburg. I display the number of household in each media market in Table 3. On the consumer side, I restrict the sample to transactions from buyers in the four largest media markets. I present the number of transactions over time in the sample in Table 1. There is a significant dip during the "Great Recession," and a subsequent rebound in 2010. I do not present 2011 data because I only observe transactions for part of this year.

The data contain detailed information about buyer and seller locations including the street address of each seller and usually the nine-digit zip code for each buyer, although for some cases I only see the five-digit zip code. I geocode these data in order to construct distances between purchases.[3] Figure 1 is a graph of the empirical density of transaction distance from the sample. Most consumers do not make purchases very far from home. The distribution is heavily skewed. I present transaction distance moments in Table 2. The median purchase distance is about eight miles. Furthermore,

[2] I ignore trucks for a few reasons. First, it is common in the literature to consider the market for cars different than the market for trucks. Second, the format of the data makes it difficult to accurately aggregate transaction information for trucks to the model level. Third, even if it were easy to aggregate truck transactions to the model level, trucks tend to have much more variation than cars in trim characteristics within a model, and so model level aggregations may be problematic. It is not clear what percentage of sales trucks account for from my data because there are other vehicles that I also preclude from the sample, like motorcycles and commercial vehicles.

[3] I calculate straight line distances (distance "as the crow flies") using a great-circle method, or.

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.

Data on car characteristics and wholesale pricing is from IntelliChoice, a consumer car buying resource. I display moments of these data in Table 2. The car characteristics I observe include horsepower, physical size and weight, miles per gallon, passenger capacity, and body style. I also observe the wholesale cost of the car, the list price, destination charges, and dealer "hold-back".[4] Following the literature, I aggregate car trims up to the model level. I use the base trim to define the characteristics of a model unless my contact at Intellichoice provided me with information that suggests another trim level should be used.[5] I aggregate the wholesale price of a car because I have wholesale price data for all possible trim levels of a model. I use the median wholesale price across trims when I estimate the model.

Some automobile manufacturers commonly offer wholesale price discounts to their franchised dealers. I hand collect this information from Automotive News, a web source for industry news and data, to supplement the wholesale price data from IntelliChoice. Wholesale price discounts are fairly common for some manufacturers and nearly non-existent for others. I also use consumer rebate information provided to me by IntelliChoice to construct retail prices net of special offers.

[4]Hold-back is a payment made to the dealer when a car is sold - effectively a constant discount on the wholesale price that is not applied until the car leaves the lot.

[5]For example many compact sedans have base trims that have only 2-doors and a manual transmission, when in reality the most common trims have 4-doors and automatic transmissions. I use the later in these cases.

5.1.2 Advertising data

Advertising data come from Kantar Media and include quarterly 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 and television advertising as the measure of advertising expenditures.[6] Brand advertising is the sum of advertising from the manufacturer and advertising from the dealer associations.

In Table 3, I display quarterly dealer and brand advertising across different media markets in Virginia. For example, dealers advertise nearly $30,000 per quarter on average in Richmond, and total dealer advertising in Richmond is about $1.9 million per quarter. Brands spend, on average, about $71,000 per quarter in Richmond. Figure 2 displays average quarterly local market advertising for various brands for Richmond, Virginia Beach, and Roanoke/Lynchburg.[7] The red bars represent average quarterly advertising per market for each brand. The blue bars represent average quarterly dealer advertising expenditures. There is substantial variation in advertising expenditures across brands. There is also variation in the ratio of dealer to brand advertising across brands.

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[6] I do not use data on national advertising expenditures. The distinction between local market advertising and national level advertising is, for example, the difference between a local market television spot (typically sold through the provider, like Comcast) and a national television spot (typically purchased as part of a package from the television network). The local spot will only run on the providers feed in a particular market, whereas the national spot will be placed on every television feed in the nation, although both advertisement could be seen during the same television program.

[7] I omit the Northern Virginia area from this graph because it has a substantially larger population than the other three markets, and the brand advertising decisions reflects products outside of my defined market area: Maryland, Washington DC, West Virginia and Delaware.

5.1.3 Demographic data

I use tract level data from the 2010 American Community Survey to simulate households in the state of Virginia. The Survey uses Census data to provide estimates of income and other demographic information for every Census Tract. I use data on tract population, income, the geographic size of the tract (this is to control for population density) and travel time to work. Since the demographic data is from a single year, I do not capture changes in demographics over time, however, the sample period of five years is relatively short.

5.2 Descriptive Analysis

5.2.1 Advertising

Next, I examine how advertising co-varies with other features of the data. The analysis provides suggestive evidence of the role of advertising in the automobile industry and provides support for the key mechanisms in the structural model.

First, I present a linear regression of log dealer sales on log advertising in Table 4. The first column includes market dummies, and the second column includes market and brand dummies. As expected, log-sales is positively associated with both dealer and manufacturer advertising. If interpreted as a causal relationship, this association likely overstates the "effect" of advertising on sales because unobserved demand shocks are likely positively correlated with advertising decisions. In the estimation, I account for this endogeneity concern, however, it is useful to make a comparison between these results and the results of the structural model.

In the structural model the advertising parameters, ϕ^{dealer} and ϕ^{brand}, are approximately elasticities and their magnitudes can be compared to the regression results in Table 4. To see this for the case of dealer advertising, re-write the probability of purchase as

$$s_{ij} = (\underline{a} + a_{r_j})^{\phi^{dealer}}$$
$$\times \frac{exp\big(d_{ij} + \beta_i x_j + \alpha_i p_j + \phi_i^{dealer} log(\underline{a} + a_j) + \phi_i^{brand} log(\underline{A} + A_{z_j}) + \xi_j\big)}{1 + \sum_{k\mathcal{J}} exp\big(d_{ik} + \beta_i x_k + \alpha_i p_k + \phi_i^{dealer} log(\underline{a} + a_k) + \phi_i^{brand} log(\underline{A} + A_{z_k}) + \xi_k\big)}$$

The parameter ϕ^{dealer} represents approximately how much a percentage change in the probability of purchase comes from a percentage change in dealer advertising, as long as dealer advertising does not change the numerator much and $\underline{a}$ is relatively small. This likely holds because there are typically close to 600 products in the choice set, so small changes in one dealer's advertising will not result in large changes to the numerator, and $\underline{a}$ is about one-tenth of average dealer advertising.

Next, I present evidence of the link between dealer advertising and two features of the dealer's profit maximization problem: market power and dealer size/scale. The model implies that there is a positive relationship between a dealer's ability to charge price-cost markups and advertising effort. To see this, consider the expression for a dealer's marginal benefit of advertising, the leftmost term in Equation (4.2.2),

$$\mathcal{M} \sum_{j \in \mathcal{J}^R_{r_j}} (p_j - W_j - c_j) \frac{\partial s_j}{\partial a_r}$$

The greater is $(p_j - W_j - c_j)$, the greater the marginal benefit of advertising, the more advertising by a dealer.[8]

[8]There is a potential complementarity between prices and advertising from a single dealer's

There are many things in the data that are reasonably correlated with a dealer's ability to charge markups. I examine how these factors co-vary with advertising expenditures. In Table 5 I present the results from a tobit regression of dealer advertising on factors that the model implies are associated with a dealer's decision to advertise.[9] There is a negative association between the number of same brand rivals faced by the dealer in its market and the level of advertising. Dealers with more rivals face greater price competition and charge lower prices. Greater competition implies that the marginal benefit of an advertisement is lower than a dealer with fewer rivals, all else equal. There is a positive association between between dealers that carry at least one foreign brand car and advertising, conditional on other factors. During the time period of the data foreign cars have a reputation of being higher quality which in the model implies the ability to charge higher prices, resulting in a larger marginal benefit of advertising.[10]

The model also implies that a dealer's scale of business is related to advertising. To see this, consider the right side of Equation (4.2.2). Even if a dealer charges a large markup, optimal advertising is low if it does not sell very many cars. If a dealer offers more cars for sale the sum in the marginal benefit of advertising equation becomes larger, and all else equal, optimal advertising is greater. As seen in the results of the tobit regression, the number of brands a dealer sells is positively associated with advertising. Also, dealers that sell luxury cars tend to sell many fewer cars (because

perspective: more advertising makes the product more attractive, which in turn gives the dealer and the manufacturer the ability to charge higher prices, depending on how quickly wholesale price rises with dealer advertising. The strategic (with respect to rival dealers) complementarity of both prices and advertising reinforces this effect.

[9] I use a tobit specification because advertising is left censored; about 20% of dealers do not advertise in any given quarter.

[10] In the structural model, higher quality takes the form of either more desirable observed characteristics, or higher unobserved mean utility.

consumers are price sensitive and so the density of potential customers is small) than dealers who sell non-luxury cars. The dummy for whether a dealer exclusively sells luxury brand(s) is negatively associated with advertising. Even though these luxury dealers may have higher markups, the scale of their business is driving the decision not to advertise.

5.2.2 All-units discounts in automobile retailing

Automobile manufacturers cannot use contracts to explicitly control the pricing and advertising choices of dealers. However, they could use non-contractual mechanisms in order to encourage certain pricing and advertising choices by dealers. One such mechanism that has been documented in the popular press involves a quantity forcing mechanism such as an all-units discount. For example, a manufacturer announces at the beginning of a month that if its dealers sell a certain amount of cars, they will receive a bonus for each car sold.[11]. Although no contract is written, it is reasonable to believe that in a dynamic setting, the manufacturer has the incentive to honor its commitment at the end of the month.

Kolay, Shaffer, and Ordover (2004) analyze contracted all-units discounts. They show that this restraint can eliminate double marginalization. Furthermore, an all-units discount is a type of quantity forcing restraint, and quantity forcing has been shown to resolve pricing and effort externalities, like the advertising externality in my model, in vertical relationships, for example, see Rey and Vergé (2008). Since I do not model all-units discounts, this could cause me to overstate the effect of double

[11]Recently, National Public Radio production *This American Life* aired a story titled "129 Cars" about this practice. See `http://www.thisamericanlife.org/radio-archives/episode/513/129-cars`

marginalization in the model.

The goal, from the manufacturers point of view, of an all-units discount is to force the dealer to sell cars at dealer marginal cost. The dealer will do this if it is compensated after the target quantity is met. In the data, I observe the difference between actual selling price and the wholesale cost of the car. I present summary statistics of the difference between selling price and wholesale cost in Table 6. Unfortunately I do not know the exact wholesale price for every car. Because of this, I report the difference using the wholesale price of the lowest trim of car, a middle wholesale price that is the median of all the trims available, and the wholesale price of the highest trim. The takeaway from Table 6 is that dealers sell cars for prices well over wholesale. However, this difference does ot tell the whole story. It does not include other marginal costs beside wholesale costs, or other "kick-backs" from the manufacturer, including monthly wholesale promotions.

One anecdote often cited concerning all-units quantity discounts in automobile retailing is that dealers under-price cars near the end of the month because they are trying to just meet the quantity target. I do not find any evidence for this in my data. In fact, I find the exact opposite. I graph average price of cars over days in a month in Figure 3. Average prices are almost $1,000 higher at the end of the month than at the beginning of the month. To confirm this result, I run a regression with price on the left hand side and the day of the month on the right hand side. I present the results from two versions of this regression in table 7. Column (1) is the regression just described, and the regression in column (2) includes make, model, and year fixed effects. Both regressions confirm that prices rise over the month.

Chapter 6

Estimation

I estimate the demand model presented in section (4.1) using the car transaction and advertising data discussed above. After estimating the utility parameters, I derive the cost functions of firms using the behavioral assumptions of the model presented in Chapter 4, and I solve for the following parameters: dealer marginal cost, manufacturer marginal cost, dealer marginal other profit from advertising, manufacturer marginal other profit from advertising. 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 have used individual level data on purchases and have combined the original BLP macromoments with micromoments that take advantage of all the available information in the data. Examples of this include Berry, Levinsohn, and Pakes (2004), Petrin (2002), Sovinsky Goeree (2008), and Crawford and Yurukoglu (2012). I follow this recent literature. Next, I describe the details of estimation.

6.1 Market definition and product aggregation

I separate the state of Virginia into four separate markets. A geographical market consists of every dealer and household in a single media markets, 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 mode product characteristics for trim levels and options offered. Without this aggregation the choice set would be unreasonably large.[1] Although I observe individual transaction prices, I do not observe the prices consumers would have received for other products, so I assume households are make decisions based on the average price for a particular product. This allows me to ignore a more complicated negotiation process that generates the data which would complicate the model without adding anything to the role of advertising in vertical relationships.[2]

In order to construct market shares from the data I must make an assumption about the size of the potential market. I make the common assumption in the literature that households leave the market for some time after they purchase a car. For the market size, I use the total number of households in each market, divided by five.

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

[2] Recently, the topic of price negotiation in this industry has received some attention in the literature, see Morton, Silva-Risso, and Zettelmeyer (2011).

6.2 Consumer Choice

The probability that consumer i in market t chooses product j is

$$s_{ijt} = \frac{exp(\delta_j + \mu_{ij})}{1 + \sum_{k \in \mathcal{J}_\sqcup} exp(\delta_k + \mu_{ikt})}, \tag{6.2.1}$$

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

$$\delta_j = \bar{\beta} x_j + \xi_j \tag{6.2.2}$$

$$\mu_{ijt} = \tau_i \sigma^x + \alpha_i p_j + d_{ij} + g_{ijt} \tag{6.2.3}$$

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. Next, I present the simulation details and a description of how I construct the moment conditions.

6.3 Macromoments

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 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, $\boldsymbol{\delta(\theta)}$, that are the implicit solution to

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

where S^{data} is the vector of observed market shares and $s(\boldsymbol{\delta(\theta)})$ is the corresponding vector of predicted shares.[3] $\theta = \{\theta_1, \theta_2\}$ 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.[4] 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.[5] Instead, I sample every Census Tract four times, and weight each draw by Tract population divided by four. Conditional on the Census Tract, I simulate household demographics and the unobserved characteristics, such as preference for car characteristics and advertising, from their empirical distributions or the distributions assumed in the model.[6]

[3]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, especially for "reasonable" guesses of the parameter values.

[4]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.

[5]I found serious bias in $\boldsymbol{\delta}$ in practice for small numbers of simulations.

[6]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)). Geweke (1988) shows that if antithetic acceleration is used during simulation the loss of precision is proportional to the inverse of the sample size, which implies the parameter variance-covariance matrix does not need to be adjusted for simulation bias.

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 weight of each draw. The terms δ and μ are defined in equations (6.2.2) and (6.2.3).

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:

$$\delta_j(s_{jt}, \theta_2) = \sum_k x_{jk}\bar{\beta}_k + \xi_j.$$

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

$$G^{(1)}(\theta_2) := E[\xi \mid Z] \tag{6.3.1}$$

I discuss details of the instruments and identification below.

6.4 Micromoments

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 disutility of distance traveled and the income specific preferences for price.

After recovering δ (as described above), 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 location (which I observe in the data).[7]

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.[8] 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,

[7]In practice, I use a sample of 10,000 individuals from the transaction data.

[8]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).

6.5 Identification

The model of supply implies that both prices and advertising are correlated with unobserved quality, ξ. I exclude prices and advertising from Z and include instruments that are correlated with pricing and advertising decisions, but likely uncorrelated with unobserved product quality. To identify the price coefficient I rely on the standard argument in the literature that the characteristics of other products are correlated with pricing decisions although uncorrelated with the structural error. As instruments I use the characteristics of other cars of the same style (mid-size, SUV, etc.), within a 20 mile radius. I also include the number of nearby dealers (within a 10 and 20 mile radius) and the product characteristics of all cars within 10 miles. The rationale for interacting the typical instruments with geography is that competition with rivals dissipates over space, so I capture important restrictions placed on the geographic nature of competition in the supply model.

A number geographic variables are correlated with advertising decisions. 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 market size is correlated with advertising. To capture this, I include functions of the population of the closest city, the distance to the nearest city center, and an interaction of these terms. For example, total city size is an important factor in the decision to advertise for the manufacturer (see Table 3). Dealer advertising has less to do with total market population, and more to do with population density close to the dealer because consumers are not willing to travel far to purchase. This is the rationale for also interacting city size with distance from the city center.

It is also clear from the advertising first order conditions that a dealer that sells more models and brands will, all else equal, find it optimal to advertise more, so I include this as an instrument. To identify the effect of manufacturer advertising I include in Z the number the dealers in a particular market for that brand. More dealers leads to greater market coverage for the manufacturer, which implies a higher marginal benefit of advertising. Additionally, I construct a measure of the price of advertising in each local market using data on total expenditures and number of units for TV Spot advertising and include this as an instrument.

The main overarching assumption I rely on is that functions of geography and dealer entry and location decisions are not correlated with contemporaneous unobserved product quality, after controlling for product characteristics and location and time effects. There is very little entry of dealers in the industry, and when there is entry it is often a new brand entering at an existing dealer location. Also, to the extent that local demographics and population change over time, initial decisions about entry may not reflect current demographics, population, and preferences for cars.

Chapter 7

Estimation Results

7.1 Consumer preferences

In this section I present results of the demand estimation from various specifications of utility. First I present a simplified version of the model. Second, I present results from the full model specified in Chapter 4.

In Table 8, I display the results from a restricted version of the model presented in Chapter 4, where I only allow consumers to differ by one characteristic, their geographic location. I make this simplification in order to clearly illustrate the co-variation in the data, especially the importance of instrumenting for prices *and* advertising. The estimation occurs in two stages. In the first stage, I use non-linear GMM to match predicted shares to observed shares, and to match predicted distance traveled to actual distance traveled. I match shares by using the BLP contraction mapping and recover mean product qualities. Next I search for the distance parameter that minimizes a GMM objective function. lastly, I use a linear regression to regress the product qualities recovered in the first stage on car characteristics, price, and advertising.

In column (1) of Table 8, I restrict preference for distance to zero, and do not instrument for price and advertising. Many of the coefficients are somewhat reasonable, although the price coefficient is unreasonably close to zero.[1] Notice the low value for the constant. This is likely because, in this specification, rural dealers are no different than urban dealers. To rationalize low sales at rural dealers, the estimation routine gives them low unobserved quality. Including the distance of individuals addresses the issue by allowing rural dealers to have low shares because of low nearby population, not product quality. [2] In Columns (2)-(4) I allow individuals to vary in their geographic location to dealers. Column (2) provides estimates without instrumenting for prices or advertising. Column (3) displays estimates after controlling for the endogeneity of prices. The results in column (4) control for endogeneity in both advertising and prices. The instruments seem to do a good job fixing the price endogeneity problem. The coefficients on advertising also seem more reasonable when instruments are included. In particular, the parameter on dealer advertising is much lower than in column (1), and lower than the estimate from the simple regression presented earlier in Table 4.[3]

In all specifications I include a quadratic time trend, style dummies, and location dummies. The time trend is intended to pick up macroeconomic trends during my

[1] As a rough check on price coefficients, a coefficient of -0.6 implies an average price elasticity close to -1.

[2] Not shown is a specification of column (1) with dealer fixed effects, which results in reasonable estimates of the utility parameters. This is because dealer fixed effects account for location attributes like population density. However, since the fixed effect does not vary across individuals, the true spatial nature of competition is not accounted for, creating cross-price elasticities that are not functions of spatial proximity

[3] In all three columns I include dummies for the style of car, zip-code dummies, and a quadratic time trend. The zip-code dummies capture unobserved heterogeneity in dealer locations. The time trend captures broader macroeconomic trend during this time period.

sample. These parameters are generally significant and are of the expected signs. Including style dummies implies that the variation identifying mean parameters comes from within car style. Styles include can, compact, mid-size sedan, large sedan, SUV, and wagon. I also include a luxury dummy on those brands which are generally considered luxury cars. The location dummies capture unobserved quality of geographic locations where many dealers co-locate. I use the zip code of the dealer, and only include geographic locations (zip codes) with multiple dealers.

Next, I present the full model parameter estimates from the utility function described in Chapter 4, the results of which are in Table 9. The results are qualitatively similar to the simpler specification. However, in the full model I allow for consumer heterogeneity along multiple dimensions.

Distance. Consumers dislike traveling to purchase cars. Consumers with longer travel times to work dislike distance less, and consumers from more rural areas are more sensitive to distance. Consequently, cross price elasticities between products at dealers located far from each other are smaller than dealers located near each other. In Table 10 I present elasticities for selected group of cars in the Richmond market in the first quarter of 2007. 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. 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. We would expect, for the same car, cross elasticities to be smaller between areas “2” and “3” than between any other combination. For example, a price increase by Honda Accord 2 leads to greater substitution to Honda Accord 1 than Honda Accord 2. The pattern is similar for the Ford Fusion. Also, notice that the Ford Fusion 1 and the Ford Escape 1 are closer substitutes for the Honda Accord 1 than is the Honda Accord 3. The elasticity of demand with respect to distance (averaged across individuals and products) is about -0.92, which mean that 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 demand by a little less than 1%.

Price. Table 10 displays own and cross price elasticities for a select group of cars in the Richmond market. Own price elasticities are generally consistent with, or slightly more elastic than related studies of the automobile market. For example, the average price own price elasticity for the entire sample is -4.2, compared to Albuquerque and Bronnenberg (2012) who find an average price elasticity of -4.1 with a similar model using a 20% sample of transactions the San Diego area for 2004-2006. Additionally, I estimate that lower income households (<$50k) are more price sensitive than medium and higher (<$120k) income households. Notice that the two highest priced cars in Table 10 are each other's closest substitutes. High income consumers are less price sensitive, so they substitute to other high quality cars, even though the price is high.

Advertising. Both dealer and brand advertising have a positive effect on utility. On average, consumers value an increase in dealer (brand) advertising from $10,000 to $20,000 at about $60 ($47) in terms of the price of the car, and $54 ($43) for an increase from $20,000 to $30,000. There is substantial variation across households in their preference for advertising. Given the functional form assumption of preferences, this implies there is a mass of consumers that are not affected by advertising. Sovinsky Goeree (2008) also finds substantial heterogeneity in advertising effectiveness using micro level data on advertising exposure in the personal computer industry.

Similar to results from the simple specification, I find a higher parameter on dealer advertising than manufacturer advertising. At first glance, this may seem to be inconsistent with the fact that, on average, brands advertise more than dealers. But manufacturers sell many more cars than a single dealer in a local market, and so typically have a higher marginal benefit of advertising, even though the marginal utility of an brand advertisement is smaller.

In a similar model of demand using data on truck sales, Xu et al. (2013) find that price advertising by dealer associations is more effective than price advertising by manufacturers. Their story is that the more local an ad's sender, the more credible the information in the ad. It is possible that this story extends to why dealer ads are more effective than brand ads in my setting. However, these estimates do not imply that a dollar of advertising is necessarily more effective in the hands of a dealer. From the manufacturer standpoint, a dollar of dealer advertising only benefits the cars at a single dealer, whereas a dollar of brand advertising helps all the cars in a local market.

7.2 Supply

I calculate markups, marginal costs, and unobserved marginal advertising profits using the demand estimates and the model of pricing and advertising presented in Chapter 4. Table 11 includes summary statistics of product markups and costs for dealers and manufacturers across brands. The results presented are for the Richmond market for 2007-2011. Markups for manufacturers are at the model level (ie Ford Fusion) because wholesale prices are restricted to be the same between dealers.

In total, mean dealer markups are $6,233 on average. In contrast, manufacturer markups are \$5,352 on average (where averages are not weighted by sales). Markups tend to be higher for more expensive cars, and there is more variation across brands for dealers. Marginal cost to the manufacturer represent about 62% of the retail price of a car on average.

Comparison to Previous Studies. I compare the supply estimates to other studies of the automobile industry. Albuquerque and Bronnenberg (2012) is the only other paper that I am aware of that uses transaction data to estimate firm surplus. My results are similar to theirs for dealer markups and dealer costs. However, I estimate much smaller manufacturer markups, which could be because I include the population of manufacturers, where they only have a sample of manufacturers. My finding that distributional costs to dealers, c_j, can be (and often are) negative is consistent with Albuquerque and Bronnenberg (2012). There are a few potential reasons for this, and they all likely contribute. First, dealers might price new cars expecting future revenues. The most significant future revenue is car service/maintenance. In particular, warranty service is paid for by the manufacturer and can usually only be provided by a licensed dealer. Second, there are issues with the measure of wholesale price. I do not observe the exact wholesale prices for the set of cars sold, but only an aggregate measure. I use the median wholesale price across trims, which may overstate wholesale prices and in turn cause a bias in the distribution costs, c_j. Third, I am not incorporating information on dealer rebates. These rebates can be quite large, anywhere from \$500 to \$10,000 per sale.[4]

It is a little more difficult to compare my results to previous studies that use ag-

[4]According to NADA, service department revenues represented 14% of total revenues in 2010, and warranty revenues are about 10% of service revenues (http://tinyurl.com/azf6jey). Information on dealer rebates is from Automotive News, an industry data and analysis resource.

gregate data at the make/model level such as BLP, Petrin (2002), and Brenkers and Verboven (2006). Also, BLP and Petrin (2002) do not model the vertical structure, and they interpret their results as the costs and markups of manufacturers. They implicitly assume retailers do not make strategic decisions. However, if both dealers and manufacturers have market power, these studies are actually estimating an aggregate measure of retail markups, and, as noted by Brenkers and Verboven (2006), the costs they estimate are the total costs of the entire vertical structure. There are no summary statistics for markups or marginal costs in BLP, but I can compare specific models between their study and mine; however, the comparison might be weak because of changing products over the time between our data. I tend to find slightly larger dealer markups than the markups in BLP. BLP find that "manufacturer" marginal costs are a much higher percentage of the final price than I do, which is expected given that they do not split marginal costs between dealers and manufacturers.[5] As in BLP, Petrin (2002) does not present complete summary statistics for markups or marginal costs, but I can compare my results for selected models. Petrin (2002) finds markups that are similar, but overall slightly lower, than the retail markups I find. Importantly, Petrin (2002) uses cost estimates to conduct a policy exercise where he removes a product from the product set and re-calculates prices. Estimates of marginal costs are important for this type of exercise, and over-estimation of manufacturer costs might bias the results. In a study using data across various European countries, Brenkers and Verboven (2006) focus on the vertical relationship between retail and manufacturer sectors. They cannot separately estimate marginal costs for each sector because they do not observe wholesale price data. Comparing

[5]Also, the price they use is the manufacturer suggested price. This is typically much higher than actual retail prices, so their estimate of marginal cost in terms of revenue is likely understated.

our numbers is not useful, since we use data from two different countries.

Distance and Prices. The demand results imply that distance is important for consumer choice, but how does this translate into competition between firms? I resolve the model for prices in the dealer sub-game assuming different counterfactuals about the effect of distance. First, I cut in half the distance from consumers to all dealers; second, I assume that there is no preference for distance in the model (effectively reducing the distance to each dealer to zero). Table 12 presents the results from the exercise. Mean prices decrease by around \$100 when distances are reduced by half, and by \$250 if distance does not matter at all. As distance becomes less important, dealers start to compete more directly with each other because consumers are now willing to substitute to more distant dealers.

7.3 Advertising and the division of surplus

Next, I present evidence that non-price choices are important for characterizing the division of surplus between dealers and manufacturers. One way to describe the relationship between dealers and manufacturers is to compare the price-cost markups by each firm.[6] However, this does not account for potentially important non-price decisions of firms, such as advertising. Although markups may look like they favor dealers, if dealers are doing the bulk of advertising then the division of surplus might favor the manufacturer.

I define the division of surplus within the vertical structure as the ratio of dealer

[6] For example, Villas-Boas (2007) calculates the division of surplus in the yogurt industry using the same model as mine with respect to pricing. Albuquerque and Bronnenberg (2012) calculate markups with a similar model of pricing for auto dealers and manufacturers. Ho (2009) uses a price bargaining model to calculate the division of surplus between hospitals and insurers.

to manufacturer average profits (including advertising expenses) for each product sold. Define η_j to be the ratio of average profit per car for a particular product using estimates from my model that incorporate advertising decisions,

$$\eta_j = \frac{(p_j - W_j - c_j) + (a_{r_j}\psi_r - a_{r_j})(\frac{q_j}{q_{r_j}})}{(W_j - C_j) + (A_{z_j}\Psi_z - A_{z_j})(\frac{Q_j}{Q_{z_j}})}. \tag{7.3.1}$$

Compare this to $\hat{\eta}_j$, the ratio of dealer to manufacturer markups,

$$\hat{\eta}_j = \frac{(p_j - c_j)}{(W_j - \hat{C}_j)}. \tag{7.3.2}$$

where $\hat{C}$ is an estimate of manufacturer marginal costs calculated from a model of supply where manufacturers do not account for the pass-through of wholesale prices to dealer advertising. Since advertising is not product specific (it is either dealer specific or model specific), I weight advertising by sales for each product. The term q_j represents units sold for product j, q_{r_j} represents total units sold by dealer r, and Q_{z_j} represents total units sold for model z by the manufacturer across all dealers.

Results for the division of surplus are displayed in table 13. Although total brand advertising is greater than dealer advertising, dealers advertise more per car sold in local markets than manufacturers, which is why the mean of η is smaller than the mean of $\hat{\eta}$. The magnitude of difference reflects the extent to which advertising per car is relatively important compared to price-cost markups. On average, dealers earn about 8% more the surplus from new car sales than manufacturers. Contrast this to 15% for the case without advertising.

Table 13 also displays the measure of the division of surplus across the best selling foreign and domestic brands in the Richmond market for the entire sample period.

There are rather large differences in the division of surplus across brands. These differences are mainly driven by differences in advertising between dealers and manufacturers. A model that does not account for advertising in this industry would miss substantial variation across brands in the division of surplus. For example, compare Chevrolet to Hyundai. In the case of Chevrolet, most of the advertising is done at the brand level. But in the case of Hyundai, dealers do a substantial amount of advertising.

7.4 The marginal benefit of dealer advertising

At both the dealer and the manufacturer level I allow for the marginal benefit of and ad from selling new cars to be different from the observed marginal cost of an ad. For dealers, this is captured as marginal *other* profit from advertising, ψ, in equation (4.2.2). Given that I estimate the demand model without restrictions from the supply equations, the extent to which the marginal benefit and cost of advertising diverge can tell me something about the fit of the model. For example, if the computed marginal benefit of advertising from the demand estimates is always equal to the observed marginal cost (one), then the demand estimates and the supply model completely explain advertising behavior.

There are both revenue and cost components of ψ. On the revenue side, new car sales represent a little less than half of revenue for a dealership.[7] Other revenue comes from new truck sales, used car and truck sales, and the service department. There is no reason to believe dealer advertising does not benefit these other business

[7]Information about dealership line of business are taken from the National Automobile Dealer Association website: `http://www.nada.org/Publications/NADADATA/dealership_profile/`

lines. There are other costs associated with advertising besides the cost of buying media time/space, for example production costs. Also, to the extent that the dealer faces credit constraints, there is opportunity cost of using a dollar for advertising instead of something else. For instance, there might be less advertising than than expected at a dealer if the dealer is starting a showroom renovation project, employing more seasonal staff, or engaging in direct promotional activities not captured in the advertising data such as enhanced showroom selling materials or community outreach. In addition, advertising is typically purchased in bundles in order to take advantage of quantity discounts. This could create lumpiness in advertising over time.

Figure 4 displays a histogram the computed marginal benefit of advertising from new car sales for dealers using demand estimates, conditional on dealer advertising greater than zero. Specifically, this is the leftmost term from equation (4.2.2):

$$\mathcal{M} \sum_{j \in \mathcal{J}^R_{r_j}} (p_j - W_j - c_j) \frac{\partial s_j}{\partial a_r}$$

The median of the distribution is close to one half, and 78% of dealers have marginal benefit less than one. Lower marginal benefits (below one) suggest that dealers advertise more than just the benefit from new cars implies. Values above one suggest that there are net costs of advertising that the model does not explicitly capture, or in other words too little advertising when compared to model predictions.

Chapter 8

Policy Implications

8.1 Vertical coordination

The new car market is heavily regulated at the state level. One regulation that has received attention recently from academics, policy makers, and the media is the law stipulating that cars be sold through an independent network of licensed franchises. The details of these regulations vary slightly across states, but generally manufacturers are prohibited from selling directly to consumers, or owning controlling stakes in dealer operations.[1] However, a classic efficiency argument in favor of vertical coordination is that it resolves the double marginalization externality and leads to lower retail prices. In this section, I discuss institutional details of dealer franchise regulations and provide anecdotal evidence of the effect of vertical coordination. Finally, I present results from a counterfactual exercise that simulates the effects of vertical coordination.

U.S. antitrust authorities have weighed in on the effects of dealer-manufacturer

[1] There are some exceptions, like in the case of the bankruptcy of a dealer.

regulations. Rogers (1986) studies these state restrictions on vertical restraints, including bans on manufacturer direct-to-consumer sales. He concludes that state policies restricting vertical arrangements harm consumers. This conclusion is echoed in a 2001 speech made by Federal Trade Commission chairman Thomas Leary.[2] In a more recent analysis, Bodisch (2009) advocates eliminating state bans on direct sales. He predicts that direct sales would reduce distribution costs and better match consumer preferences with car production. It is unclear, though, federal antitrust agencies can play a role in the dealer franchise debate because dealer franchise regulations fall under state action antitrust immunity.

The issue of direct-to-consumer sales and vertical coordination has recently emerged because of the actions of Tesla Motors, a luxury electric car company from California. Tesla has been de facto selling directly to consumers by allowing customers to phone-order cars from "galleries." Dealer Associations see Tesla as a threat. In multiple states, they have pushed legislation that further restricts the sales of cars to consumers by any means other than the established franchise system.

In addition to the prohibition against direct-to-consumer sales, state laws prevent manufacturers from using vertical restraints in contracts with dealers. This is important because vertical restraints are a means by which the manufacturer solves incentive problems that arise in vertical relationships. They may coordinate decisions with the dealer even though they cannot sell directly to consumers.[3] Such contractual tools include price maintenance, quantity forcing, and minimum advertising requirements.

These prohibitions against direct-to-consumer sales and contracted restraints raise

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

[3]See Rey and Vergé (2008) for an overview of the economics of vertical restraints.

incentive issues which, in turn, raise questions about efficiency. The dealer fails to internalize the effect of its decisions on the surplus of the manufacturer. The pricing incentive problem implies that prices are too high from the point of view of the total vertical structure. The advertising externality implies that advertising is too low from the point of view of the total vertical structure.

How would the market for new cars change if manufacturers could coordinate with dealers, either by owning dealers and selling directly to consumers, or by writing contracts that coordinate dealer-manufacturer decisions? How great are the price and advertising inefficiencies from double marginalization and the public goods advertising externalities? Direct quasi-experimental variation of coordination is not possible in order to test the effects of changing regulation because there exists little variation in regulations across states. However the recent behavior of Tesla Motors furnishes anecdotal evidence of the effect of coordination. Tesla sells electric cars directly to consumers. Consumers can test drive the car at a Tesla "gallery," and then order the car for delivery over the internet. Tesla's advertising-to-sales ratio as documented in annual reports is similar to that of other luxury vehicles, even though its market coverage is many times smaller. This implies that Tesla's marginal benefit of advertising is greater than that of a manufacturer in a traditional dealer franchise relationship.[4]

Tesla claims its organizational structure is an advantage that positively affects its sales. From the Tesla Motors 2013 Annual Report:

> We believe that by owning our own sales and service network we can offer a compelling customer experience while achieving operating efficiencies and capturing sales and service revenues incumbent automobile manufacturers do not enjoy in the traditional franchised distribution and service model. Our customers deal directly with our own Tesla-employed sales and service staff, creating what we believe is a differentiated buying experience from the buying experience consumers have with franchised automobile dealers and service centers.

[4]Information on Tesla Motors' marketing activities is from various 10K statements.

Tesla's statement about high levels of sales effort illustrates the effects of coordination. The incentive for advertising and sales effort are greater for Tesla because the coordinated firm makes pricing and advertising (and in Tesla's case, service) decisions based on the marginal benefit to the total vertical structure.[5]

8.1.1 Counterfactual Exercise

Using the estimation results and the model of firm behavior, I simulate the behavior of a coordinated firm in order to predict the outcome were dealers and manufacturer allowed to coordinate. I do this for two reasons. First, allowing firms to vertically coordinate is a way to quantify the pricing and advertising externalities already discussed. Second, I predict how competition were to change if a manufacturer were to be allowed to take control of a dealer and sell directly though its own "factory outlet."

Specifically, I take a single dealer and calculate the total marginal costs within the vertical structure for all of the products it sells: $mc_j^{\text{total}} = c_j + C_j$. I then simulate the dealer sub-game using the new marginal cost for that one dealer, while keeping the cost structure the same for the other dealer-manufacturer pairs. I do this exercise one at a time for all dealers in the market. I assume that non-advertising dealers continue not to advertise after coordination. I make this assumption because I cannot infer the unobserved marginal revenue from advertising, ψ_r, for these firms. I also assume nothing changes in the manufacturer sub-game.

I separate the effect of coordination on prices and advertising. To understand the effect on prices, I simulate the model, holding everything constant except retail

[5]This concept has been documented in other industries as well. Hoy, Jain, and Wilkens (2012) present a model of internet advertising auctions that explains differences in willingness to pay for internet advertising by Apple and Microsoft.

prices. To understand the effects on advertising, I hold everything constant except dealer advertising. Lastly, I allow both retail prices and dealer advertising to adjust to the new vertical structure. The last simulation approximates the market outcome if a single dealer were allowed to write a contract with the manufacturer to resolve the pricing and advertising externalities. Alternatively, the simulation replicates the existence of manufacturer-owned stores for those dealers that sell products from a single manufacturer.

I conduct the coordination experiment for every dealer in the Richmond market in the second quarter of 2007. The results are presented in Table 14. Both the pricing externality and the advertising externality are large. The median coordinated dealer-manufacturer pair lowers retail prices by 14.5%, and raises dealer advertising by 150%. Figure 5 displays a histogram of percent changes in dealer advertising after coordination for those dealers that originally advertise.

A classic defense of vertical mergers is the beneficial effects on retail prices. As expected, coordination leads to a decrease in equilibrium prices for the coordinated firm; however, prices do not fall as much as they would if firms are also not allowed to choose new levels of advertising. Prices fall by 20.5% on average if firms do not adjust advertising spending. The reason for this is that increased advertising makes products more attractive to consumers, which gives the firm more market power. The results suggest policy makers should be careful when assessing the price benefits of a vertical merger if the firm can also adjust advertising, promotion, or quality.

8.1.2 Dealer competition

One claim that automobile dealers make in defense of the current system of franchise regulations is that consumers benefit from dealer competition in the form of lower retail prices. They argue that an alternative system of direct-to-consumer sales by manufacturers would concentrate market power and lead to higher prices. However, my demand estimates suggest that consumers dislike traveling to purchase a car, potentially creating mini geographic monopolies for each dealer (with respect to their own brands), resulting in little competition between dealers who sell the same brand even in the current system. I test this hypothesis by recalculating retail prices assuming collusion between dealers. Specifically, I allow dealers who sell the same brand to internalize the cross substitution effect of pricing decisions, effectively creating a brand cartel in a local market.[6] The extent to which counterfactual prices are higher than actual prices gives credence to dealers' claims that the current independent franchised dealer system benefits consumers. With collusion, the average price of a car increases by only $86. This suggests that their dealers already command significant market power. One thing driving this result is the estimates of the effect of distance on demand. If consumers are not willing to travel far to purchase, then consumer substitution across distance is very small, giving each dealer high market power over their brands.

[6] I hold advertising and manufacturer decisions constant. Its not immediately clear how allowing for advertising to adjust influences the results. On one hand advertising and prices are strategic complements, so we should expect higher levels of advertising and even higher prices under collusion. On the other hand, advertising is wasteful because it steals business from other dealers, so we should expect less advertising and downward pressure on prices.

8.2 Advertising and dealer terminations

In 2009, Chrysler and General Motors each published lists of dealers that they intended to terminate relationships with, totaling about 3,000 dealers across the country. Generally, state laws prevent the termination of dealer franchise contracts, but the bankruptcy proceedings of both car manufacturers provided a potential legal reason to violate state dealer regulations. As of 2013, Chrysler and GM have terminated many, but not all, of the selling relationships with the originally proposed list of dealers.

Chrysler and GM were asked to report on their activities to Congress because they received government funding (mostly in the form of loans). Local and national dealer associations lobbied state and national legislators to prevent dealer terminations, and in the end end were successful in moderating the number of terminations. A summary of the dealer termination issue as it relates to the U.S. federal government is in a report on the Troubled Asset Relief Program, the program that funded the provision of government loans to GM and Chrysler (Barofsky, 2010). When requested to provide a report on potential cost savings to the U.S. Congress, the two largest "cost" savings GM cited were higher wholesale prices and lower local advertising assistance.[7] Importantly, GM and Chrysler also claimed that one benefit of closing dealers is that the remaining dealers would be "stronger," and thus able to provide a higher level of service to customers.

Here, I provide analysis of the effects of dealer network size on advertising and welfare. First, I discuss the effects predicted by the model. Second, I find evidence of these effects in the data. Third, I use the structural model to predict the effects of

[7]Here I do not consider wholesale price changes because my data are for one state, whereas wholesale price decisions are made on a regional and national level.

Chrysler closing dealers in the Richmond market.

There are two main effects in the model when a manufacturer shrinks its dealer network. First, there is a scale effect of sales on the manufacturer. The manufacturer will sell fewer cars, all else equal, because it has fewer retail locations. This decreases the marginal benefit of advertising for the manufacturer, and the manufacturer will decrease advertising. A decrease in manufacturer brand advertising has a negative effect on dealers. The second effect is a dealer competition effect. Remaining dealers, all else equal, are better off because they face less competition. Dealers have an incentive to charge higher prices, and both dealers and manufacturers have a higher marginal benefit of advertising and so advertise more.

I look at how advertising co-varies with the size of dealer networks in the data. I construct a variable, *ad ratio*, which is equal to the ratio of brand advertising over mean dealer advertising (for dealers selling that brand in a given market). This variable captures the relative advertising effort of the manufacturer compared to its network of dealers in each market. Using OLS, I regress *ad ratio* on the size of the dealer network and market dummies. The results are displayed in Table 15. An observation for column (1) is make-market-quarter, and an observation for column (2) is averaged over all quarters. There is a significant positive association between a brand's *ad ratio* in a market and the number of dealers selling that brand of car in a market. The point estimate suggests that each extra dealer is associated with a three-fold increase in brand advertising relative to mean dealer advertising.

Overall, the co-variation between *ad ratio* and the number of dealers is consistent with what the model predicts. Both the scale effect and the dealer competition effect predict that the numerator of *ad ratio* goes up as the number of dealers increases. The dealer competition effect predicts that the denominator goes down as the number of dealers goes up. However, it is not possible to separately identify the two effects from one another or to understand how firm welfare changes. To gain a better understanding of the effects of dealer terminations, I use the model to simulate dealer closings by Chrysler in the Richmond area in 2007.[8] I run two simulations. In the first simulation, I close the two Chrysler dealers in Richmond that consistently do not advertise and have the lowest sales. In the second simulation, I close all Chrysler dealers except the best-selling dealer. I call this dealer the *Flagship* dealer.

The results of the simulation exercises are in table 16. As Chrysler terminates dealers, brand advertising falls. This results in a significantly lower cost (more than halving the advertising cost for the second case) to the manufacturer. However, a key assumption of GM and Chrysler (see Barofsky (2010)) is that a smaller dealer network would make remaining dealer(s) stronger, so that they would be able to invest in sales effort, such as advertising, without manufacturer support:

> The companies' leaders stated that a smaller network would result in greater sales per dealership, which would make the dealerships more profitable and thus enable them to invest in their facilities to meet GM and Chrysler standards and retain top-tier sales and service staffs

According to my findings, this is not the case. After the simulated closings, the remaining dealers are not significantly more profitable. In fact, advertising and sales for the flagship dealer decrease slightly. The dealer competition effect is very low because the elasticity of substitution between far away dealers is low. Consumers substitute to closer dealers of different brands before they substitute to farther dealers of the same brand. The dealers that remain open suffer from Chrysler decreasing its brand advertising.

[8] I choose 2007 because it is the time period before the financial crisis and Chrysler bankruptcy proceedings.

In conclusion, dealer terminations provide a cost savings to manufacturers through decreased local advertising support. But there is very clear evidence why dealer associations are opposed to allowing manufacturers to terminate dealer relationships, even beyond the obvious reason: even the remaining dealers may be worse off because of decreased manufacturer brand advertising.

Chapter 9

Conclusion

9.1 Summary of findings and discussion

Recent structural empirical models of vertical relationships do not model the promotion decisions of firms. However, there are many industries where promotion decisions are made by both retailers and manufacturers. I provide evidence that modeling the promotion decisions of vertically related firms is important for two reasons. First, estimates of relative surplus between manufacturers and dealers differs when advertising is included. Second, policy changes can induce large changes in advertising.

I find that dealers capture about 8% less surplus relative to manufacturers than from a specification without advertising decisions. The structure of different vertical relationships (for instance, multi vs. single branded dealers, number of same-brand locations) creates different incentives for dealer and manufacturer advertising across brands. Estimates of surplus vary across brands, more so than in a specification without advertising. For example, Hyundai dealers capture 49% of the surplus on average, and Chevrolet dealers capture about 56% of the surplus average from selling cars.

The inability of dealers and manufacturers to coordinate decisions (for example, by writing Pareto improving contracts) creates pricing and advertising externalities within vertical relationships. Prices are significantly higher than a coordinated firm would set, and dealer-level advertising is significantly under-provided in the vertical structure. I quantify these externalities by simulating coordination between dealer-manufacturer pairs. Median prices are 14.5% lower for a coordinated firm, and median dealer advertising is 150% higher. This evidence explains why dealer associations have lobbied for regulations that ban manufacturers from selling directly to consumers: a coordinated firm can offer products at a significantly lower price, and with much higher advertising. However, prices are not as low as in a specification that does not account for advertising decisions. Policy-makers should use caution when judging the effects of a vertical merger by simply considering retail price changes. If enough advertising (or other retail service for that matter) is provided after the merger, it could reverse the beneficial price effects of a vertical merger.

U.S. manufacturers have been reducing the size of dealer networks for many decades. At the heart of these decisions is a claim by the manufacturers that remaining dealer should be better off, and that they should provide more services like advertising. In a counterfactual, I close Chrysler dealers in a market. Brand advertising decreases substantially, which trumps any benefits from reduced competition and leaves the remaining dealers worse off. A state regulation, this time prohibiting dealer terminations, is likely the result of rent-seeking behavior by dealers. The more dealers in a market, the more brand advertising support, and without much cost of greater price competition.

To be sure, the new car industry is not the only industry where non-price decisions within vertical relationships are an important consideration. Other industries where advertising is prominent by both retailers and manufacturers include groceries, retail clothing/accessories, and personal technology. Understanding how advertising is provided within all these vertical relationships is important to understanding which firms hold economic power, and the effect of regulatory or business policies.

9.2 Future Work

There are many directions for related future related work. First, the estimates of consumer dis-utility of distance are quite large. But the distance between a consumer and a product might not capture all of the relevant non-monetary travel costs associated with purchasing a car. For example, it is possible that consumers travel to many different dealers in order to solicit price quotes, and then use those quotes to bargain with the closest dealer. If this is the case, then I likely overstate the cost associated with distance. In future work, I could consider a model of the individual data generating process for prices, which may include both search and bargaining mechanisms.

Second, there are still open questions about the effects of state regulations in the automobile industry. Although the current study focuses mostly on dealers and consumers, one open question has to do with the effects of termination regulation on US manufacturers. US manufacturers had already set up dense dealer networks by the time regulations that prohibited dealer terminations were passed. Foreign competitors entered after these regulations were passed, and could therefore make choices about dealer networks without US manufacturer reaction. What disadvantage does this give US manufacturers. How would dealer networks be different if US manufacturers could best respond to foreign competition? What effect does this have on consumer welfare? Some or all of these questions might be answered with a dynamic model of dealer entry and location, which would require additional information on historical entry decisions by manufacturers.

Third, the model I present implies that manufacturers might optimally choose lower wholesale prices to encourage dealer advertising. If wholesale prices in the data are lower than a pricing only Manufacturer Stackelberg model would imply, then the researcher may reject that model in favor of a model that implies more retailer power. In fact, this is exactly what Villas-Boas (2007) finds. It would be interesting to see if, in her application to grocery stores, or in other settings, the Manufacturer Stackelberg model is rejected when both pricing and advertising decisions by the retailer are modeled.

Chapter 10

Appendix

10.1 Tables

Table 1: Virginia New Car Sales Over Time

Year	2007	2008	2009	2010
Quantity	186,598	168,633	149,020	169,792

Statistics from selected sample of new automobile transactions, 2007Q1-2011 Q3, Virginia Department of Motor Vehicles.

Table 2: Virginia New Car Transactions, Descriptive statistics

	Mean	Q25	Median	Q75
Purchase Distance	13.3	4.3	8.1	17.9
Distance past closest dealer	9.2	1.8	4.3	14.6
Horsepower	192	150	175	240
MPG-hwy	28.3	25	28	32
Cubic inches	8393	7353	8051	9231
Passenger Seats	5.2	5	5	5
Domestic Brand	0.262	-	-	-
Price	\$27,335	\$20,185	\$25,159	\$32,075

Note: From the selected sample of new automobile transactions, 2007Q1 - 2011 Q3, Virginia Department of Motor Vehicles. See text for selection details. Price is in 2006 dollars.

Table 3: Quarterly Advertising by Market (000's dollars)

	Dealer Advertising		Brand Advertising		
Market	2010 Households	Mean	Total	Mean	Total
Richmond	553,950	29.7	1,909	70.8	2,060
VA Beach	709,880	24.3	2,147	130.7	3,831
Roanoke/Lynchburg	461,220	7.4	417	31.3	651
N. Virginia/DC [a]	2,335,040	18.1	2,571	898.6	28,283

Note: Advertising expenditures are in thousands of dollars.
[a] N. Virginia/DC media market includes southern Maryland and parts of Delaware and West Virginia. Dealer advertising represents only dealers in Virginia, but population and brand advertising is for the entire DMA.

Table 4: Dealer Sales and Advertising

	Log Dealer Sales	Log Dealer Sales
Log Dealer Advertising	0.194	0.126
	(0.011)	(0.008)
Log Brand Advertising	0.106	0.013
	(0.008)	0.006
Constant	1.243	3.951
	(0.163)	(0.171)
Brand Dummies		✓
Market Dummies	✓	✓
Time Trend	✓	✓
Observations	2456	2456

Note: Regression of log sales on log advertising. An observation is a brand-dealer-quarter. Sales are total brand sales at a given dealer in a given quarter. SEs in parentheses.

Table 5: Dealer Advertising Tobit Regression

	Dealer Advertising
# of Brands Sold	7849.4
	(1103.6)
# of Rivals	-1864.1
	(231.3)
Luxury	-21132.9
	(2299.8)
Foreign	11288.2
	(1923.0)
Time Trend	-198.5
	(153.0)
Observations	6664

Note: Standard errors in parentheses.

Table 6: Difference between transaction price and wholesale price

	Q25	Median	Q75
Low	2940.55	5144.495	8408.84
Middle	-460	1843	4614.542
High	-5207	-1884.255	1168.06

Note: Summary statistics of the difference between observed transaction price and wholesale for for three different levels of wholesale price.

Table 7: Difference between transaction price and wholesale price

	(1)	(2)
Day	24.85	1.83
Constant	26884.22	41639.74
Fixed Effects	×	✓
R^2	0.001	0.854
N	819.060	819,060

Note: All parameter estimates are significant at the 1% level.

Table 8: Demand estimates, simple model

	(1)	(2)	(3)	(4)
Distance	-	2.982	2.982	2.982
	-	(0.082)	(0.082)	(0.082)
Dist. Squared	-	-29.431	-29.431	-29.431
	-	(0.082)	(0.082)	(0.082)
Constant	-15.046	-12.030	-12.466	-12.552
	(0.126)	(0.114)	(0.117)	(0.129)
Acceleration	0.984	-0.001	2.719	3.525
	(0.227)	(0.049)	(0.291)	(0.232)
Size	0.774	-0.682	2.372	3.214
	(0.274)	(0.113)	(0.339)	(0.279)
MPG	0.772	0.995	0.360	0.118
	(0.054)	(0.019)	(0.069)	(0.055)
Seats	0.070	0.088	0.092	0.092
	(0.006)	(0.006)	(0.006)	(0.006)
Price	-0.331	-0.078	-0.821	-1.050
	(0.061)	(0.069)	(0.079)	(0.062)
Dealer Ads	0.385	-	-	0.074
	(0.026)	-	-	(0.026)
Brand Ads	-0.080	-	-	0.021
	(0.008)	-	-	(0.008)

Note: Distance parameters are from a first stage non-linear GMM. Other parameters are from a second stage linear GMM. All specifications include style and zip-code dummies and a time trend. Advertising is $log(1 + \text{advertising})$. Distance is in 00's miles and price is in 000's of 2006 dollars.

Table 9: Full model demand parameter estimates

Variable	Parameter	Estimate	Standard Error
Distance	λ_1	3.458	0.354
Distance^2	λ_2	-24.687	2.233
Dist×TravelWork	λ_3	0.217	0.035
Dist×Density	λ_4	-0.074	0.007
Advertising	ϕ^{dealer}	0.073	0.001
	σ^{dealer}	0.039	0.000
	ϕ^{brand}	0.054	0.002
	σ^{brand}	0.030	0.000
Price	α^L	-3.925	0.121
	α^M	-2.425	0.037
	α^H	-3.038	0.048
	σ^p	0.670	0.005
Acceleration	β_1	4.472	0.058
Size	β_2	6.154	0.154
MPG	β_3	-0.380	0.024
	σ_3	0.241	0.022
Seats	β_4	-0.472	0.009
	σ_4	0.382	0.283
US Brand	β_5	-0.432	0.015
	σ_5	0.321	0.002
Constant	β_0	-9.561	0.157

Note: Preference estimates include car style dummies, dummies for the zip-code of the dealer, and a time trend. Estimates are from two-step GMM estimation. Standard errors are calculated directly.

Table 10: Cross price elasticities between select products

Make/Model/Loc.	Honda Accord	Honda Accord	Honda Accord	Ford Fusion	Ford Fusion	Ford Ford	Ford Escape	BMW 3-series
Accord 1	-4.0675	0.0088	0.0044	0.0004	0.0023	0.0015	0.0012	0.0079
Accord 2	0.0082	-4.1024	0.0035	0.0004	0.0022	0.0013	0.0010	0.0076
Accord 3	0.0096	0.0084	-4.0673	0.0004	0.0022	0.0015	0.0012	0.0080
Fusion 1	0.0088	0.0084	0.0041	-4.0513	0.0024	0.0015	0.0012	0.0078
Fusion 2	0.0080	0.0084	0.0036	0.0004	-3.9359	0.0015	0.0011	0.0071
Fusion 3	0.0082	0.0079	0.0038	0.0004	0.0023	-3.8343	0.0011	0.0064
Escape 1	0.0090	0.0085	0.0043	0.0004	0.0024	0.0015	-4.2542	0.0096
3-series 1	0.0081	0.0085	0.0038	0.0004	0.0021	0.0012	0.0013	-4.4523

Note: For products sold in the Richmond area during 2007Q2

Table 11: Summary Statistics, Firm Behavior

	Dealer			Manufacturer		
Brand	Mean Price	Mean Markup	Mean Lerner Index	Mean Markup	Mean Marginal Cost	Mean Lerner Index
ACURA	38,270	7,352	0.19	6,060	27,780	0.18
AUDI	47,639	9,021	0.19	7,260	30,128	0.20
BMW	52,946	9,829	0.19	7,905	32,102	0.20
BUICK	33,376	6,522	0.20	5,481	21,604	0.20
CADILLAC	46,110	8,669	0.19	6,797	31,913	0.18
CHEVROLET	27,779	5,966	0.23	5,147	16,980	0.25
CHRYSLER	27,337	5,759	0.22	5,002	17,166	0.23
DODGE	25,645	5,670	0.22	4,849	15,365	0.24
FORD	28,440	6,061	0.22	5,235	16,615	0.25
GMC	40,570	7,408	0.19	6,162	23,356	0.21
HONDA	24,537	5,517	0.23	5,002	14,516	0.26
HYUNDAI	24,047	5,424	0.23	4,815	14,277	0.27
JEEP	27,186	5,916	0.22	5,088	16,064	0.25
KIA	21,390	5,124	0.25	4,480	12,370	0.28
LEXUS	50,843	9,302	0.19	7,556	33,741	0.19
LINCOLN	45,695	8,314	0.18	6,597	31,862	0.18
MAZDA	24,983	5,583	0.23	4,862	15,223	0.25
MERCEDES-BENZ	53,032	9,855	0.19	7,842	36,148	0.18
MERCURY	27,352	5,811	0.22	4,974	17,740	0.22
MITSUBISHI	24,392	5,448	0.23	4,733	13,688	0.26
NISSAN	28,981	6,080	0.22	5,291	17,248	0.25
PONTIAC	23,554	5,510	0.24	4,730	14,485	0.25
SAAB	32,900	6,692	0.20	5,658	28,455	0.17
SATURN	27,414	5,793	0.22	5,030	17,640	0.23
SUBARU	24,941	5,624	0.23	4,865	15,411	0.24
SUZUKI	19,696	4,912	0.26	4,335	12,231	0.27
TOYOTA	28,547	6,068	0.22	5,411	16,172	0.26
VOLKSWAGEN	25,982	5,764	0.22	4,982	16,548	0.24
VOLVO	35,200	7,045	0.20	5,834	25,597	0.19
Total	29,611	6,233	0.22	5,352	18,093	0.24

Note: For the 2007Q1-2011Q3 in Richmond, Virginia. For selected brands.

Table 12: The effect of distance on price competition

	Data	Half Distance	No Distance
Mean Prices	28,649	28,556	28,396

Note: Computed average prices for different values of the distance parameters. Computed for the Richmond market, 2007Q1.

Table 13: Mean Division of Surplus by Make

	$\hat{\eta}$	η
Chevrolet	1.12	1.27
Chrysler	1.15	1.09
Ford	1.16	1.08
Honda	1.11	1.06
Hyundai	1.12	0.98
Toyota	1.13	1.10
All Brands	1.16	1.08

Note: Dealer to manufacturer surplus as defined in the text. Calculated from supply results from the Richmond market, 2007-2011.

Table 14: Median percentage change of decisions after coordination

	Price	Dealer Advertising
Price Only	-20.5%	–
Advertising Only	–	87%
Both	-14.5%	150%

Note: Results from counterfactual simulation. I allow dealer's to coordinate with their manufacturer, one dealer at a time. I hold constant manufacturer decisions.

Table 15: Relative Brand Advertising[a]

	(1)	(2)
# of Dealers	3.47	2.91
	(1.04)	(0.78)
Constant	-22.98	-7.31
	(9.75)	(5.37)
Market Dummies	Yes	Yes
Observations	1815	123

[a] Standard errors in parentheses. Ad ratio is brand advertising over median dealer advertising for dealer who sell that brand. Column (1) observation is a brand-market-quarter. Column (2) observation is a brand-market.

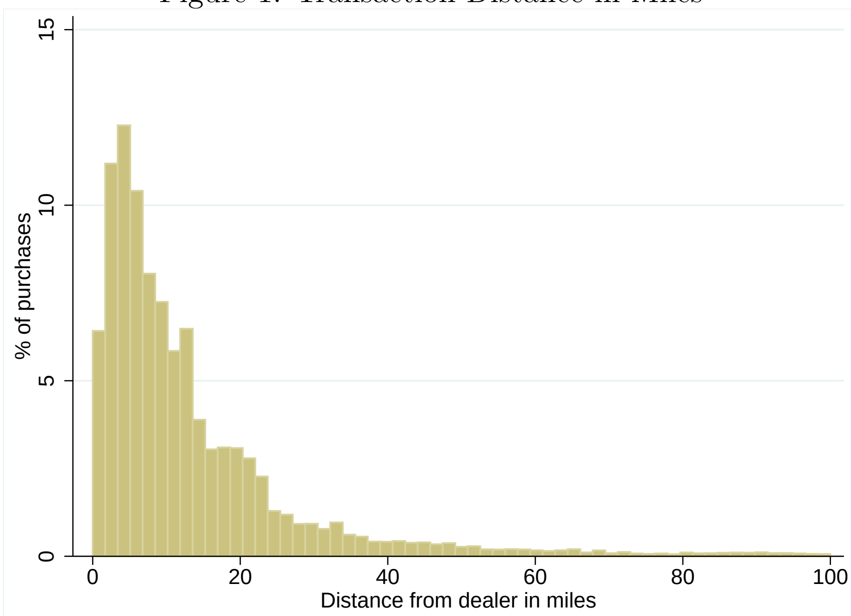
Table 16: Effect of Chrysler Dealer Closings

	Original Structure	Close Two Dealers	Close Four Dealers
Number of Dealers	5	3	1
Brand Advertising	404,390	371,499	192,289
Total Sales	170	143	87
Manufacturer Variable Profits	870,094	736,586	589,300
Manufacturer Profits	465,704	365,087	397,011
Flagship Dealer			
Sales	89	89	87
Advertising	116,873	116,871	116,850
Average Price	26,655	26,654	26.654

Results from simulation exercises for 2007 Q2 in Richmond. In the second column I close two Chrysler dealers that never advertise; in the third column I close all but the best selling dealer.

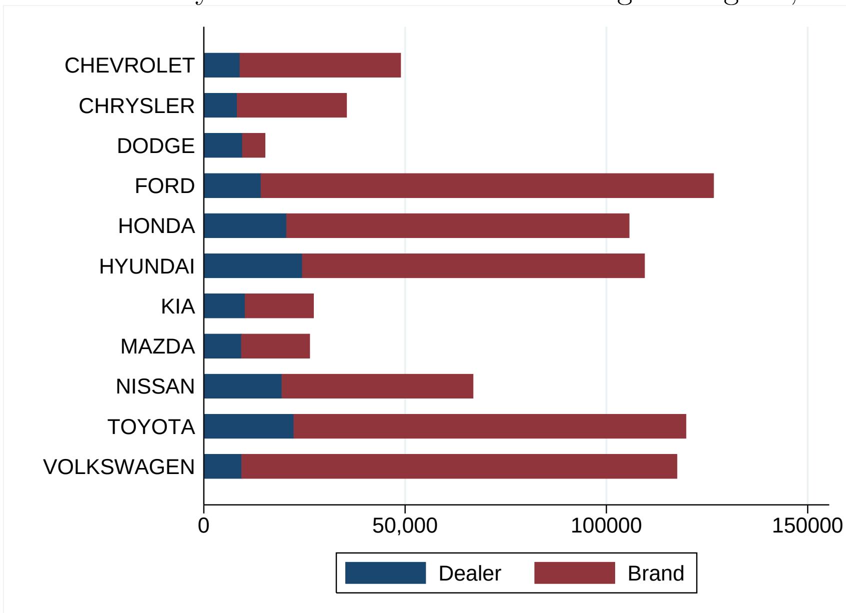
10.2 Figures

Figure 1: Transaction Distance in Miles



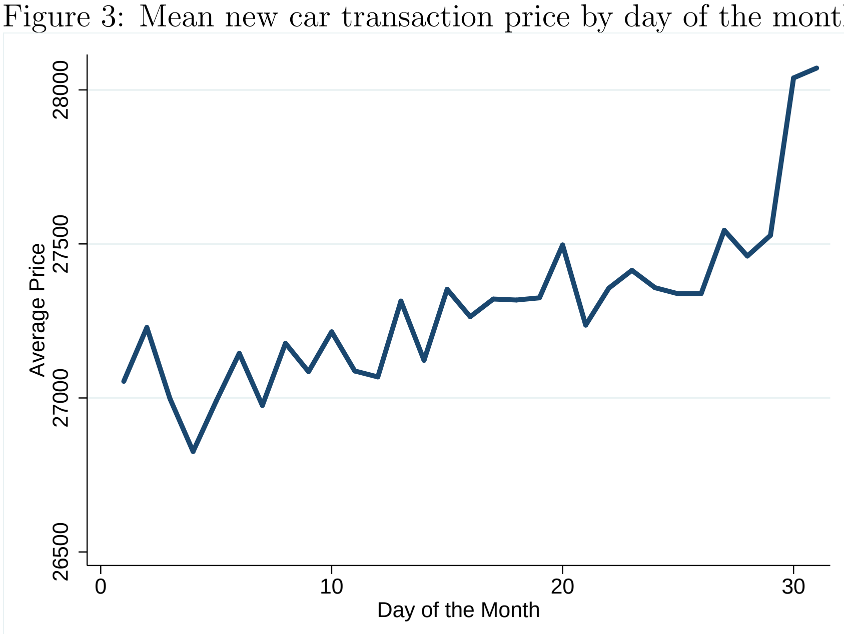
Note: Histogram of transaction distances for new cars, 2007Q1-2011Q3. Data from Virginia Department of Motor Vehicles.

Figure 2: Mean Yearly Dealer and Brand Advertising in Virginia, 2007-20011



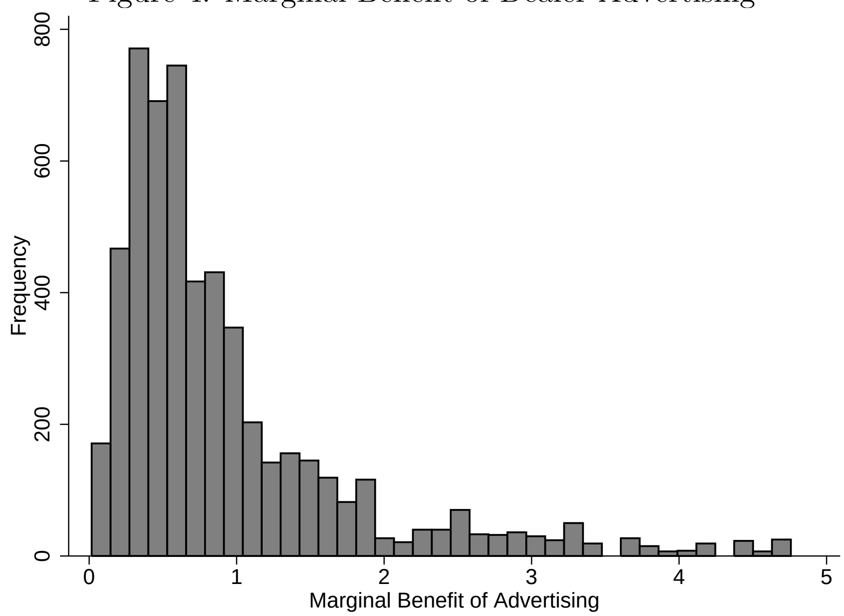
Note: For VA Beach, Richmond and Roanoke/Lynchburg.

Figure 3: Mean new car transaction price by day of the month



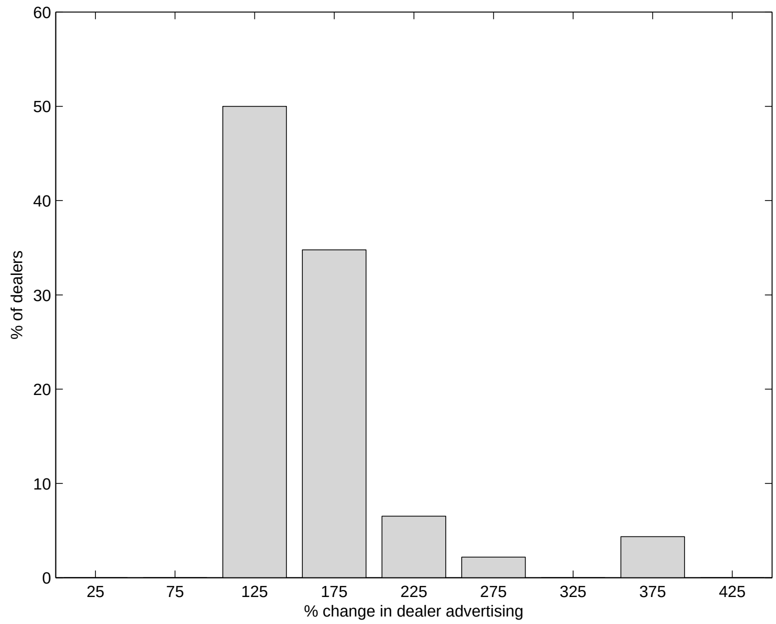
Note: For state of Virginia, 2007-2011.

Figure 4: Marginal Benefit of Dealer Advertising



Note: Computed dealer marginal benefit of advertising for all dealers in Richmond from 2007Q1-2011Q3.

Figure 5: Percent change in dealer advertising for coordinated firms



Note: Results from counterfactual exercise. Percent change in dealer advertising when a single dealer coordinates decisions with its associated manufacturer(s). Manufacturer decisions are held constant. For Richmond, 2007Q2.

Bibliography

Ackerberg, Daniel A. 2003. "Advertising, learning, and consumer choice in experience good markets: an empirical examination." *International Economic Review* 44 (3):1007–1040.

Albuquerque, P. and B. Bronnenberg. 2012. "Measuring the impact of negative demand shocks on car dealer networks." *Marketing Science* 31 (1):4–23.

Anderson, Simon, Federico Ciliberto, Jura Liaukonyte, and Regis Renault. 2012. "Push-me pull-you: Comparative advertising in the OTC analgesics industry." .

Barofsky, Neil. 2010. *Factors Affecting the Decisions of General Motors and Chrysler to Reduce Their Dealership Networks*. DIANE Publishing, Office of the Special Inspector General for the Troubled Asset Relief Program, United States Government.

Berry, Steven, James Levinsohn, and Ariel Pakes. 1995. "Automobile Prices in Market Equilibrium." *Econometrica* 63 (4):841–890.

———. 2004. "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market." *Journal of Political Economy* 112 (1):68–105.

Bodisch, Gerald R. 2009. "Economic Effects of State Bans on Direct Manufacturer Sales to Car Buyers." *Deparment of Justice Economic Analysis Group Competition Advocacy Paper* .

Bonnet, Céline and Pierre Dubois. 2010. "Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance." *The RAND Journal of Economics* 41 (1):139–164.

Bonnet, Celine, Pierre Dubois, Sofia B. Villas Boas, and Daniel Klapper. 2013. "Empirical Evidence on the Role of Nonlinear Wholesale Pricing and Vertical Restraints on Cost Pass-Through." *The Review of Economics and Statistics* 95 (2):500–515.

Bonnet, Cline, Pierre Dubois, and Michel Simioni. 2006. "Two-Part Tariffs versus Linear Pricing Between Manufacturers and Retailers: Empirical Tests on Differentiated Products Markets." CEPR Discussion Papers 6016, C.E.P.R. Discussion Papers.

Brand, Keith, Christopher Garmon, Gautam Gowrisankaran, Aviv Nevo, and Robert Town. 2012. "Mergers when Prices are Negotiated." *mimeo* .

Brenkers, Randy and Frank Verboven. 2006. "Liberalizing a Distribution System: The European Car Market." *Journal of the European Economic Association* 4 (1):pp. 216–251.

Bresnahan, Timothy F. 1987. "Competition and Collusion in the American Automobile Industry: The 1955 Price War." *The Journal of Industrial Economics* 35 (4):457–482.

Bresnahan, Timothy F. and Peter C. Reiss. 1985. “Dealer and Manufacturer Margins.” *RAND Journal of Economics* 16 (2):253–268.

Busse, Meghan, Jorge Silva-Risso, and Florian Zettelmeyer. 2006. “1000 Cash Back: The Pass-Through of Auto Manufacturer Promotions.” *The American Economic Review* 96 (4):pp. 1253–1270.

Canis, Bill and Michaela Platzer. 2009. “U.S. Motor Vehicle Industry Restructuring and Dealership Terminations.” Tech. rep., Congressional Research Service.

Ciliberto, Federico. 2006. “Does Organizational Form Affect Investment Decisions?” *The Journal of Industrial Economics* 54 (1):63–93.

Crawford, Gregory S. and Ali Yurukoglu. 2012. “The Welfare Effects of Bundling in Multichannel Television Markets.” *American Economic Review* 102 (2):643–85.

Davis, Peter. 2006. “Spatial Competition in Retail Markets: Movie Theaters.” *The RAND Journal of Economics* 37 (4):pp. 964–982.

Erdem, Tülin and Michael P Keane. 1996. “Decision-making under uncertainty: Capturing dynamic brand choice processes in turbulent consumer goods markets.” *Marketing science* 15 (1):1–20.

Forbes, Silke and Mara Lederman. 2009. “Adaptation and Vertical Integration in the Airline Industry.” *The American Economic Review* 99 (5):pp. 1831–1849.

———. 2010. “Does Vertical Integration Affect Firm Performance: Evidence from the Airline Industry.” *RAND Journal of Economics* 41 (4):765–790.

Fulda, Carl H. 1956. "Automobile Dealer Franchise Act of 1956: A Dissent, The." *Antitrust Bull.* 2:367.

Geweke, John. 1988. "Antithetic acceleration of Monte Carlo integration in Bayesian inference." *Journal of Econometrics* 38 (1-2):73–89.

Goldberg, Pinelopi K and Rebecca Hellerstein. 2007. "A framework for identifying the sources of local-currency price stability with an empirical application." *National Bureau of Economic Research Working Paper 13183* .

Hansen, Lars Peter. 1982. "Large sample properties of generalized method of moments estimators." *Econometrica: Journal of the Econometric Society* 50:1029–1054.

Ho, Katherine. 2009. "Insurer-Provider Networks in the Medical Care Market." *American Economic Review* 99 (1):393–430.

Houde, Jean-Francois. 2012. "Spatial Differentiation and Vertical Mergers in Retail Markets for Gasoline." *American Economic Review* 102 (5):2147–82.

Hoy, Darrell, Kamal Jain, and Christopher A. Wilkens. 2012. "Coopetitive Ad Auctions." *CoRR* abs/1209.0832.

Iyer, G. 1998. "Coordinating Channels Under Price and Nonprice Competition." *Marketing Science* 17 (4):338–355.

Kadiyali, Vrinda, Pradeep Chintagunta, and Naufel Vilcassim. 2000. "Manufacturer-Retailer Channel Interactions and Implications for Channel Power: An Empirical Investigation of Pricing in a Local Market." *Marketing Science* 19 (2):127–148.

Kolay, Sreya, Greg Shaffer, and Janusz A Ordover. 2004. "All-units discounts in retail contracts." *Journal of Economics & Management Strategy* 13 (3):429–459.

Lafontaine, Francine and Fiona Scott Morton. 2010. "Markets: State Franchise Laws, Dealer Terminations, and the Auto Crisis." *Journal of Economic Perspectives* 24 (3):233–50.

Lafontaine, Francine and Margaret Slade. 2007. "Vertical integration and firm boundaries: the evidence." *Journal of Economic Literature* 45:629–685.

Mathewson, G Frank and Ralph Albert Winter. 1984. "An economic theory of vertical restraints." *Rand Journal of Economics* 15 (1):27–38.

McHugh, Donald P. 1956. "Automobile Dealer Franchise Act of 1956, The." *Antitrust Bull.* 2:353.

Meza, Sergio and K Sudhir. 2010. "Do private labels increase retailer bargaining power?" *Quantitative Marketing and Economics* 8 (3):333–363.

Mortimer, Julie H. 2008. "Vertical contracts in the video rental industry." *The Review of Economic Studies* 75 (1):165–199.

Morton, Fiona Scott, Jorge Silva-Risso, and Florian Zettelmeyer. 2011. "What matters in a price negotiation: Evidence from the U.S. auto retailing industry." *Quantitative Marketing and Economics* 9 (4):365–402.

Nevo, Aviv. 2001. "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica* 69 (2):307–342.

Perry, Martain K and Robert H Porter. 1990. “Can resale price maintenance and franchise fees correct sub-optimal levels of retail service?” *International Journal of Industrial Organization* 8 (1):115–141.

Petrin, Amil. 2002. “Quantifying the Benefits of New Products: The Case of the Minivan.” *Journal of Political Economy* 110:705–729.

Rey, Patrick and Jean Tirole. 1986. “The Logic of Vertical Restraints.” *American Economic Review* 76:pp. 921–939.

Rey, Patrick and Thibaoud Vergé. 2008. “Economics of Vertical Restraints.” In *Handbook of Antitrust Economics*, chap. 9. MIT Press, 353–390.

Roberts, Mark J. and Larry Samuelson. 1988. “An Empirical Analysis of Dynamic, Nonprice Competition in an Oligopolistic Industry.” *RAND Journal of Economics* 19 (2):200–220.

Rogers, Robert P. 1986. “The Effect of State Entry Regulation on Retail Automobile Markets.” *Bureau of Economics staff report to the FTC* .

Shaffer, Greg and Florian Zettelmeyer. 2004. “Advertising in a Distribution Channel.” *Marketing Science* 23 (4):619–628.

Shum, Matthew. 2004. “Does advertising overcome brand loyalty? Evidence from the breakfast-cereals market.” *Journal of Economics & Management Strategy* 13 (2):241–272.

Sovinsky Goeree, Michelle. 2008. “Limited Information and Advertising in the US Personal Computer Industry.” *Econometrica* 76 (5):1017–1074.

Spengler, Joseph J. 1950. "Vertical integration and antitrust policy." *The Journal of Political Economy* :347–352.

Stern, Steven. 1997. "Simulation-Based Estimation." *Journal of Economic Literature* 35 (4):2006–2039.

Sudhir, K. 2001. "Structural analysis of manufacturer pricing in the presence of a strategic retailer." *Marketing Science* 20 (3):244–264.

Thomadsen, Raphael. 2005. "The Effect of Ownership Structure on Prices in Geographically Differentiated Industries." *RAND Journal of Economics* 36 (4):908–929.

Train, Kenneth and Clifford Winston. 2007. "Vehicle Choice Behavior and the Declining Market Share of U.S. Automakers." *International Economic Review* 48 (4):1469–1497.

Villas-Boas, Sofia and Rebecca Hellerstein. 2006. "Identification of supply models of retailer and manufacturer oligopoly pricing." *Economics Letters* 90 (1):132–140.

Villas-Boas, Sofia Berto. 2007. "Vertical Relationships between Manufacturers and Retailers: Inference with Limited Data." *Review of Economic Studies* 74 (2):625–652.

———. 2009. "An empirical investigation of the welfare effects of banning wholesale price discrimination." *The RAND Journal of Economics* 40 (1):20–46.

Winter, Ralph. 1993. "Vertical Control and Price Versus Non-price Competition." *Quarterly Journal of Economics* 108 (1):61–76.

Xu, Linli, Kenneth C. Wilbur, Sivaramakrishnan Siddarth, and Jorge M. Silva-Risso. 2013. "Price Advertising by Manufacturers and Dealers Associations." *working paper* .