PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

www.phoenix-center.org

PHOENIX CENTER POLICY PAPER SERIES

Phoenix Center Policy Paper Number 48:

The Price Effects of Intra-Brand Competition in the Automobile Industry: An Econometric Analysis

T. Randolph Beard, PhD
George S. Ford, PhD
Lawrence J. Spiwak, Esq.

(March 2015)

© Phoenix Center for Advanced Legal and Economic Public Policy Studies, T. Randolph Beard, George S. Ford and Lawrence J. Spiwak (2015).

Phoenix Center Policy Paper No. 48
The Price Effects of Intra-Brand Competition in the Automobile Industry: An Econometric Analysis

T. Randolph Beard, PhD*
George S. Ford, PhD†
Lawrence J. Spiwak, Esq.‡

(© Phoenix Center for Advanced Legal & Economic Public Policy Studies, T. Randolph Beard, George S. Ford and Lawrence J. Spiwak (2015).)

Abstract: Cars are expensive and most consumers know to shop dealers for the best prices. Yet, there is little to no empirical evidence on the price effects of intra-brand competition among different dealer franchises for the same automobile model. In this PAPER, using large samples of transactions for ten of the most popular new cars purchased in the state of Texas for the years 2011, 2012, and 2013, we estimate the effects of intra-brand competition on new car prices. Intra-brand competition is measured as the distance (in miles) to the nearest same-brand dealer. Significantly, for all but one automobile model we consider in our empirical analysis, we find that intra-brand competition does, in fact, lower new car prices for consumers. For the popular Honda Accord, for example, increasing the distance between Honda dealerships by thirty miles raises the price paid by consumers by about $500. Given that retail margins on auto sales are quite small (about 6% on average), the price reductions resulting from intra-brand competition are substantial relative savings for new-car consumers. Moreover, we find that the price effects of intra-brand competition are relatively strong compared to inter-brand competition—at the sample means, moving an intra-brand dealer one mile closer reduces prices by the equivalent of an increase in 35 inter-brand rivals.

---

* Senior Fellow, Phoenix Center for Advanced Legal & Economic Public Policy Studies; Professor of Economics, Auburn University.

† Chief Economist, Phoenix Center for Advanced Legal & Economic Public Policy Studies.

‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies. The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center or its staff.

TABLE OF CONTENTS:

I. Introduction 2
II. Background 4
III. Literature Review 7
IV. Empirical Model 9
A. Statistical Model 14
B. Results 15
1. Ordinary Least Squares 16
2. Robust Regression 18
3. Finite Mixture Model 19
C. Summary 21
V. Conclusion 22

I. Introduction

Outside of buying a home, an automobile will be the most expensive item ever purchased by many Americans. Annual transportation expenditures (17.6% of total) are second only to housing costs (33.5% of total) for the average consumer, exceeding food costs by 40% and healthcare expenditures by 150%.[1] As we all know from personal experience, buying and maintaining a car is a significant challenge.

Fortunately, the automobile industry is today workably competitive by almost any standard, thereby keeping prices low and quality high. Rivalry in the industry exists at two levels: inter- and intra-brand competition. Inter-brand competition occurs between different manufacturers such as Ford, Toyota, Honda, and others, with each offering differentiated products that attempt to satisfy the varied preferences of consumers. Intra-brand competition, in contrast, occurs among dealers of the same brand and thus tends to emphasize price. Intra-brand rivalry can be fierce: for example, Toyota's website returns seventeen (17) dealers for the city of Houston, Texas.[2]

---

[1] *Consumer Expenditures 2013*, Economics News Release, Bureau of Labor Statistics (September 9, 2014) (available at: http://www.bls.gov/news.release/pdf/cesan.pdf).

[2] *See* http://www.toyota.com/dealers.

In the U.S., competition among dealerships is made more interesting and arguably more intense by the fact that dealerships are independent franchisees of the manufacturers. Manufacturers do not own dealerships and are mostly prohibited from doing so by state laws.[3] The franchise system has probably led to a greater number of dealerships—especially for domestic brands—than would a more vertically-integrated structure. In turn, the large numbers of same-brand dealers in many local markets may lead to intense price competition.

Despite this important structural feature of the retail automobile industry, we are unable to find any formal empirical analysis of the price effects of intra-brand competition. In an effort to shed light on this important issue, in this PAPER we conduct regression analysis on large samples of transactions for ten of the most popular cars sold in the state of Texas during the years 2011, 2012 and 2013. Given the strengths and weaknesses of the data we use, econometric methods applied include ordinary least squares, robust regression, and finite mixture models. We measure intra-brand competition as the distance (in miles) to the closest intra-brand rival. While inter-brand competition, measured as the number of new or used car dealerships within a thirty-mile radius of each dealer, is generally found to reduce prices, the evidence suggests, as expected, that intra-brand competition also reduces prices for consumers. Our modeling approach allows these effects to vary by make and model and we do find some variation in these respects.

Holding inter-brand competition constant, the price of the popular Honda Accord changes by about $220 for every ten miles of distance between Honda dealerships (at the mean distance). In contrast, the price of the lower priced Honda Civic changes by about $70 for every ten miles of distance between Honda dealerships. Given that retail margins on auto sales are quite small (about 6% on average), the price reductions resulting from intra-brand competition are substantial relative savings for new-car consumers.

While we hope that these results are an important addition to the analysis of the retail auto industry, our findings may also have important policy implications. The number of new car dealers in the U.S. has been in a steady

---

[3] A discussion of the auto franchising laws is provided by F. Lafontaine and F.S. Morton, *Markets: State Franchise Laws, Dealer Terminations, and the Auto Crisis*, 24 JOURNAL OF ECONOMIC PERSPECTIVES 233-250 (2010). *See also* E.P. Kerrigan, *Econ 101: Dealership Supply and Demand*, DEALER-MAGAZINE (June 2009) (available at: http://autostarrealty.com/articles/erin_06-2009.pdf).

decline for decades, reflecting economic forces such as increasing inter-brand competition. Reductions in the number of dealerships, like those imposed by Chrysler and General Motors in their 2009 reorganization,[4] could soften intra-brand price competition in some markets. Also, the dealer franchise laws that have historically tended to support large-numbers intra-brand competition are presently being challenged in many states and at the federal level. Of course, the effects of intra-brand competition are only a part of these very complex forces impacting the structure of the automobile industry. Reductions in the number of brand-specific dealers are driven by many factors including declining market shares. Reforming state franchise laws has spurred a highly contentious debate and involves numerous tradeoffs for existing dealers, new entrants like Tesla Motors, local and state governments, and regional labor markets. We make no effort to address all these varied concerns, but instead focus on a piece of this very complex puzzle: intra-brand price competition.

Our PAPER is organized as follows. In Section II we offer some background on automotive retailing to provide context. After a review of the economic literature on competition in the industry in Section III, we turn to the empirical analysis in Section IV. Conclusions are provided in Section V.

II. Background

In the early days of the car business, getting around wasn't so easy, so manufacturers wanted large dealer networks that would be close to the customer and thus facilitate sales. In 1950, there were 47,000 new car dealers in the U.S., or about 308 dealers per million persons.[5] Given improvements in transportation, however, the number of retail automobile dealerships has declined steadily since that time. By 2013 the number of new car dealers had fallen to 17,540, or about 55 dealers-per-million persons. This reduction has impacted mostly domestic brands that have been shedding market share to international nameplates for

---

[4] J. Puzzanghera and K. Bensinger, *GM Proposes Painful Downsizing in Bid for Survival*, LOS ANGELES TIMES (April 28, 2009) (available at: http://articles.latimes.com/2009/apr/28/business/fi-gm28); C. Clifford, *Watchdog: Auto Dealers Shut Down Too Fast*, CNN MONEY (July 18, 2010) (available at: http://money.cnn.com/2010/07/18/smallbusiness/auto_dealership_report/); R. Reuteman, *What's the Road Ahead for Shutdown U.S. Auto Makers*, FOX BUSINESS: SMALL BUSINESS CENTER (October 27, 2009) (available at: http://smallbusiness.foxbusiness.com/entrepreneurs/2009/10/27/rip-rebirth-detroit).

[5] NADA Historical Dealer Count (available at: http://www.nada.org/Publications/NADADATA/historical_dealer_count.htm).

decades. The decline continues: over the past ten years, dealership counts have fallen by about 2% annually. While the data show a substantial and continued reduction in dealer counts, some analysts claim that there are still too many new car dealers, especially for domestic brands with legacy dealer networks like GM, Chrysler, and Ford.[6] Indeed, the established domestic brands have far more dealerships than the more recent, and mostly foreign, entrants. For example, in 2008 Ford had 3,430 dealers to Toyota's 1,235 dealers.[7] The average Ford dealer sold 470 cars per year while the typical Toyota dealer sold 1,585, a difference roughly proportionate to the dealer counts.[8]

While consumers certainly benefit from inter-brand competition, that competition is of a differentiated-products sort. Intra-brand competition, in contrast, is over homogeneous or near-homogenous goods (e.g., a white Ford Focus SE), so intra-brand rivalry focuses on price. Economic theory suggests and consumer experience demonstrates that more dealers in close proximity mean better deals for consumers. As one industry analyst observed,

> dealers compete with each other within the brand. One Ford dealer competes with the Ford guy a few miles away, rather than with Toyota or Volkswagen. This intra-brand competition always is on price. The customer runs from one dealer to another dickering for a lower price ….[9]

The National Automobile Dealers Association ("NADA") puts it this way:

> The ability of consumers to choose to comparison shop between different dealerships in selling the same brand keeps prices competitive and low. A Ford dealer's biggest competitor is the

---

[6] E.P. Kerrigan, *Econ 101: Dealership Supply and Demand - The New Market Equilibrium,* DEALER-MAGAZINE.COM (June 2009) ("We are still over-dealered. While the number of new car dealerships has declined, the reduction is certainly not in keeping with the steep decline in new car sales. In fact, since 2000, new car sales have declined five times more than the number of dealerships.") (available at: http://autostarrealty.com/articles/erin_06-2009.pdf).

[7] C. Isidore, *GM Whacks 1,100 Dealers*, CNNMONEY.COM (May 15, 2009) (available at: http://money.cnn.com/2009/05/15/news/companies/gm_dealers).

[8] *Id.*

[9] J. Flint, *Too Many Dealers, Again?*, WARD'S AUTOWORLD (September 2007) (available at: http://wardsauto.com/news-amp-analysis/too-many-dealers-again).

> Ford dealer down the street or in the next town. Because of broad access to vehicle pricing, consumers can bargain with multiple dealers to get a great deal.[10]

In these views, as dealer counts fall, intra-brand price competition should soften thereby raising new car prices for consumers.

The intensity of intra-brand price competition has become a significant policy issue of late as a result of Tesla Motors' efforts to own and operate its own dealerships, an approach which violates the laws of almost all states.[11] Tesla's plan has met strong resistance from existing car dealers and some state governments, not so much because of the threat of competition from Tesla (which sells only about 30,000 extremely high-end electric cars per year), but because of the threat of abandoning existing franchise laws protecting local car dealers from manufacturer-driven shut downs.[12] In response to such challenges, NADA lists, among other things, intra-brand competition as a benefit of such laws.[13] Implicit in NADA's defense of franchise laws is the seemingly reasonable assumption that a weakening of dealer protections in the franchise laws will result in a reduction of dealerships and, in turn, a lessening of intra-brand price competition.[14] While the reform of the franchise laws and prohibitions on

---

[10] *Why Franchise Dealer Laws? Why States Promote the Buying and Selling of Cars through Local Dealers*, National Automobile Dealers Association (2014) (available at: http://www.nada.org/NR/rdonlyres/39A36250-8BBA-41C0-9B15-E1BB1A2E9EA9/0/NADA_Why_Dealer_Franchise_Laws_20140616.pdf).

[11] *See, e.g.*, C. Trudell and C. Smithe, *U.S. Dealer Group Seeks Tesla Meeting on Retail Plans*, BLOOMBERG NEWS (October 24, 2012) (available at: http://www.bloomberg.com/news/2012-10-23/dealer-group-leaving-tesla-retail-challenge-to-states.html); A. Ohnsman and M. Niquette, *Tesla's Direct-Sales Push Raises Auto Dealers' Hackles*, BLOOMBERG NEWS (March 10, 2014) (available at: http://www.bloomberg.com/news/2014-03-10/tesla-s-direct-sales-push-raises-auto-dealers-hackles.html); S. Alcorn, *Car Dealers Sue Tesla, Citing State Franchise Laws*, NRP.ORG (November 9, 2012) (available at: http://www.npr.org/2012/11/09/164736569/car-dealers-sue-tesla-citing-state-franchise-laws).

[12] A. Ohnsman, *Tesla Rises After Model S Sales in 2013 Exceed Forecasts*, BLOOMBERG NEWS (January 15, 2015) (available at: http://www.bloomberg.com/news/2014-01-14/tesla-delivered-6-900-cars-in-fourth-quarter-executive-says.html).

[13] *Get the Facts: The Benefits of Franchised Auto Dealers*, National Automobile Dealers Association (available at: http://www.nada.org/GetTheFacts).

[14] According to Bill Wolters, President of the Texas Automobile Dealers Association (TADA), easily two-thirds of Texas car dealerships would be at risk if the law against manufacturer

(Footnote Continued. . . .)

vertical integration involve many factors beyond the effects of such changes on intra-brand competition, such competition is an important element of the debate.

Despite the evident relevance of intra-brand competition and the large amount of empirical work that has been done on the automobile industry, there is surprisingly little formal empirical analysis of the effects of intra-brand competition. In fact, we were unable to find any formal statistical analysis—published or otherwise—quantifying the price effect, if any, of intra-brand competition. The absence of such evidence is a significant hole in the academic literature on the automobile industry. As such, in what follows, we attempt to shed some light on this important and interesting issue.

III. Literature Review

In this PAPER, we attempt to assess and quantify the effect of intra-brand competition on the transaction prices for automobiles. Despite a wide search, we were unable to find any empirical evidence focused specifically on this issue. Earlier work has addressed the effects of competition (more broadly) on prices and services, often using aggregate data. None of the studies, however, attempted to quantify the effect of intra-brand competition using large samples of actual customer transaction prices. While not directly relevant to our work, the literature is nevertheless useful in some regards (e.g., model specification), so a brief review is warranted.

An early paper on the topic by Bresnahan (1987) tests for competition and collusion in the mid-1950s around an alleged price war in 1955, but the tests do not involve intra-brand competition within a single market.[15] Berry, Levinsohn, and Pakes (1995) develop an empirical model for analyzing demand and supply for differentiated goods and applies it to the automobile industry.[16] While a

---

ownership of dealerships is eliminated. B. Blanchard, *Tesla Motors, Car Dealers Clash Over Franchise Law*, THE TEXAS TRIBUNE (January 28, 2015) (available at: https://www.texastribune.org/2015/01/28/tesla-motors-automobile-dealers-debate-franchise-l).

[15] T. Bresnahan, *Competition and Collusion in the American Automobile Industry: The 1955 Price War*, 35 JOURNAL OF INDUSTRIAL ECONOMICS 457-482 (1987).

[16] S. Berry, J. Levinsohn, and A. Parkes, *Automobile Prices in Market Equilibrium*, 63 ECONOMETRICA 841-890 (1995). On the issue of differentiation, *see also* P. Golberg, *Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry*, 63 ECONOMETRICA 891-951 (1995); L. Thomas and K. Weigelt, *Production Location Choice and Firm*

(Footnote Continued. . . .)

sophisticated and interesting study, it does not consider intra-brand competition but focuses more on the attributes of cars (e.g., miles-per-gallon). Using data for years 1981 through 1990, Sudhir (2001) considers strategic pricing among major brands for compact and midsize market segments using a structural econometric model. This paper is focused on competitive interactions across segments (compact, midsize) and not intra-brand competition.[17] Alley (1997) uses a conjectural variations model to test for collusion in the Japanese automobile industry facilitated by partial-ownership arrangements over the period 1979 through 1994.[18]

Closest to our analysis is a paper by Olivares and Cachon (2009), though their analysis focuses on dealer inventories rather than prices and considers the inventories of GM dealers only.[19] Competition is measured by a count of all (major brand) dealerships in a market, though the authors test for a unique effect of the presence of other GM dealers in the same market. The study finds that competition generally, and intra-brand competition in particular, increases inventory levels. This result is of interest in light of the claim that a reduction in intra-brand competition will facilitate a rise in the quality of services offered by dealerships.[20] The study provides evidence counter to that claim, but quality has multiple dimensions beyond inventory. In any event, these findings motivate us by highlighting important potential differences in the effects of inter- and intra-brand rivalry in automobile retailing.

Studies that evaluate directly the determinates of automobile prices include (but are not limited to) Eckard (1985), Rogers (1986), Mathewson and Winter (1989), Walden (2005).[21] The focus of these studies is the price effects of franchise

---

Capabilities: Evidence from the U.S. Automobile Industry, 21 STRATEGIC MANAGEMENT JOURNAL 897-909 (2000).

[17] K. Sudhir, *Competitive Pricing Behavior in the Auto Market: A Structural Model*, 20 MARKETING SCIENCE 42-60 (2001).

[18] W. Alley, *Partial Ownership Arrangements and Collusion in the Automobile Industry*, 45 JOURNAL OF INDUSTRIAL ECONOMICS 191-205 (1997).

[19] M. Olivares and G. Cachon, *Competing Retailers and Inventory: An Empirical Investigation of U.S. Automobile Dealerships*, 55 MANAGEMENT SCIENCE 1586-1604 (2009).

[20] Olivares and G. Cachon, *id*.

[21] E. Eckard Jr., *The Effects of State Automobile Dealer Entry Regulation on New Car Prices*, 24 ECONOMIC INQUIRY 223–42 (1985); R. Rogers, *The Effects of State Entry Regulation on Retail Automobile Markets*, Bureau of Economics Staff Report to the Federal Trade Commission (1986); F. Methewson

(Footnote Continued. . . .)

laws and not competition directly, an empirical analysis made possible by variations in state laws regarding franchises in the past. Today, almost all states prohibit manufacturer-owned dealerships, so this question is no longer amenable to robust statistical testing. The results from these studies on franchise laws are varied, and the methods of some of the earlier studies subject to potential criticisms (Walden 2005). The latest study by Walden (2005) finds that the franchise laws did not raise prices. While these studies, like ours, are focused on price, our analysis is not directly concerned with the role of franchise laws on prices but on intra-brand competition. Nevertheless, the empirical methods of these earlier studies are useful in formulating an empirical model since they used individual transaction data. Generally, these earlier studies model the transaction price for an automobile as a function of market and car characteristics and we do the same.

Recent research has focused on the role of the Internet on auto sales. By most accounts, Internet use in the U.S. has done much to increase intra-brand competition in the automotive industry. A study by Sewell and Bodkin (2009) shows that the Internet does facilitate price shopping by consumers.[22] Unsurprisingly, with improved communications technologies, intra-brand competition has intensified.

IV. Empirical Model

Our interest is in the role of intra-brand competition on transactions prices for new cars sold in the United States. Detailed data on such transactions is not readily available, but we were able to obtain data on transactions in the state of Texas for three years (2011, 2012, and 2013) from IHS Automotive.[23] This data is collected when an automobile is registered within the state, so it includes nearly every automobile purchased and registered in the state. While some automobiles are purchased in other states but registered in Texas, we limit our attention to sales by Texas dealers to Texas customers (or customers registering their

---

and R. Winter, *The Economic Effects of Automobile Dealer Regulation*, 15/16 ANNALES D'ECONOMIE ET DE STATISTIQUE 409-426 (1989); M. Walden, *Do Geographic Entry Restrictions Increase Car Prices*, 35 REVIEW OF REGIONAL STUDIES 231-245 (2005).

[22] E. Sewell and C. Bodkin, *The Internet's Impact on Competition, Free riding and the Future of Sales Service in Retail Automobile Markets*, 35 EASTERN ECONOMIC JOURNAL 96-114 (2009).

[23] https://www.ihs.com/industry/automotive.html. We are grateful to the National Automobile Dealers Association for making the data available for our research.

purchases in the state). Our measures of competition, however, may include dealerships in neighboring states near a Texas border (New Mexico, Oklahoma, Arkansas, and Louisiana). Rival dealership counts and distances are based on the dealerships listed in the IHS sample; we assume it is inclusive of all dealerships (at least those of any competitive significance). The data does not indicate whether a car is new or used, so in an effort to limit our attention to new cars we exclude any car with more than 200 miles on the odometer when sold.

The IHS Automotive data includes a variety of information about each transaction including price, dealership name and address, make and model, model year, and model specifics such as engine cylinders, number of doors, and so forth. When available and relevant, our empirical analysis accounts for such differences. The IHS data are not constructed specifically for the type of empirical work we seek to perform so there are, unfortunately, some details about the car that are not provided, including color, the presence of options like a moonroof or special wheels. The transactions prices appear to include the effects of a trade-in value but offer no details about those values. As with options and premiums, we assume that the trade-in values are the source of a mis-measurement in prices, but that such measurement problems are idiosyncratic across dealerships. As such, the measurement error does not lead to inconsistent or inefficient estimates of the model's coefficients, with the exception perhaps of the constant term, though the error variance of the model will be higher.[24] As far as we can determine, these shortcomings in the data lead to undesirable but non-fatal "noise" in the price series, although we utilize several estimation techniques in an effort to reach conclusions on this point. This is explained in greater detail below.

The brand of each dealership listed in the sample is determined from the dealer's name. Any dealership with a particular brand in the name (e.g., Toyota, Honda, and so forth) is counted as a branded dealership.[25] Using the dealership addresses provided in the data, we geocode each location using the program *geocode3* in STATA 13. This program links the address to the geocode information using Google Maps. Distances between dealerships are computed using the program *geodist* in STATA 13. The distances are based on surface

---

[24] We have no reason to believe the measurement error has a mean of zero. J. Wooldridge, ECONOMETRIC ANALYSIS OF CROSS SECTION AND PANEL DATA (2002) at pp. 70-6.

[25] As an alternative, we included any dealer that sold 50 more new cars of a brand regardless of the dealer's name. The results were not materially different from those reported here.

curves, not driving distance. Using this data, we compute both the intra-brand and inter-brand competition variables. Intra-brand competition (*INTRACOMP*) for dealership *j* is measured as the distance (in miles) to the nearest same-brand dealership. We cannot use distance to each inter-brand competitor because of the large number of such rivals. Thus, inter-brand competition (*INTERCOMP*) for dealership *j* is a count of rival dealerships within a thirty mile radius of the address of dealership *j*, excluding same brand dealerships (Olivares and Cachon 2009). We view *INTERCOMP* as a measure of the general competitiveness of the retail automobile market in the vicinity of dealership *j*.

The difference in the definition of the competition variables is also statistically helpful (if not essential) in that the number of intra- and inter-brand dealerships within a given mileage radius are highly correlated.[26] Dealership counts across the brands appear to be driven by essentially the same factors, which is not surprising. Given the high correlation, it is nearly impossible to get an independent estimate of the price effect of the two when using a count variable for both types of competition.[27] Ideally, the two measures of competition would be similarly defined so that direct comparisons could be made and relative impacts compared. The nature of the data, however, prohibits us from doing so.

There are thousands of different automobile models included in the dataset. We choose to limit attention to the ten most popular automobiles purchased over the relevant time period. The ten most popular cars (excluding trucks) in the dataset (not in order) are the Toyota Camry and Corolla, the Nissan Altima and Rogue, the Honda Accord, CRV and Civic, the Hyundai Elantra, the Ford Focus, and the Mazda 3. In choosing these models, we limit our attention to the most popular sub-models in an effort to reduce variations in features for which we have no data.

---

[26] For Toyota dealers, the correlation coefficient between intra- and inter-brand rivals is 0.93. The correlation coefficient between *INTERCOMP* and *INTRACOMP* for Toyota dealers is -0.49, which while still high, is more manageable. The variance inflation factors for the count variables are in excess of 5.0, indicating very high collinearity.

[27] The Variance Inflation Factors were very large when using counts for both measures of competition, and, as expected, the estimated coefficients very unstable.

Table 1. Make, Model, and Prices

Make/Model	Obs.	Price (Mean)	Price (St Dev)	MSRP less Invoice*	Price-Cost Margin*
Toyota Camry	42,728	23,801	2,420	2,100	9%
Toyota Corolla	35,266	18,502	1,812	1,300	7%
Nissan Altima 2.5	33,258	23,875	3,204	1,500	6%
Nissan Rogue	24,372	23,605	2,926	1,100	5%
Hyundai Elantra Sedan	19,163	19,744	2,088	900	4%
Honda Civic LX	22,400	18,986	1,564	1,300	7%
Honda Accord EX	21,925	27,695	2,935	2,200	8%
Honda CRV EX	20,546	27,214	2,398	1,500	6%
Ford Focus SE	16,291	18,555	1,986	1,100	6%
Mazda 3i	14,737	18,855	2,370	1,100	6%

* Source (www.cars.com), Year 2012. Price-cost margins based on MSRP and dealer invoice and not actual transactions prices.

Table 1 lists the models included in the sample and some descriptive statistics. All ten cars are mid-sized and moderately priced. The standard deviation in prices is about 10% of the mean price. With one exception, we do not trim the data on prices.[28] While some prices appeared to be quite low, such cases are relatively rare and could be explained by the trade-in values. Also, two of our statistical methods address extreme values (i.e., Robust Regression and the Finite Mixture Model), so there is less motivation to trim for outliers in this data. With this in mind, we believe the results from these alternative estimation methods are more reliable.

The final two columns of Table 1 provide rough estimates of the dealer's typical price-cost margin on each model.[29] All the data is for the 2012 model year. The margin data is illustrative and based on the MSRP and Invoice data for models most closely matching those in our sample. This margin data is not based on actual sale prices and the invoice is not a perfect indicator of actual dealer costs. Dealers are also multi-product firms and so the sale of an automobile may lead to subsequent service revenues, though the buyer is not limited to any particular dealer for service. There also may be other dealer

[28] One observation for a Toyota Camry priced at over $200,000 was excluded on the grounds it was a coding error.

[29] All data is from www.cars.com for the Year 2012.

incentives from the manufacturer. Used cars often have higher margins than new cars. AutoNation, a large publicly-traded dealer conglomerate, reports an average *gross* margin on new car sales of about 6% (on an average sales price of $33,967), so the figures in Table 1 are plausibly representative.[30] We note, however, that industry data suggests that the profitability of new car sales is not robust and that the contribution to the dealers' profits is often negative.[31] Automobile dealers make most of their profits from the service department and from used car sales. This fact by itself highlights the competitive nature of automobile retailing.

Table 2. Descriptive Statistics, Competition Variables

Make	*INTRACOMP* (Miles) Mean, St Dev, Min, Max	*INTERCOMP* (Count) Mean, St Dev, Min, Max
Toyota	18.7 , 25.8 , 3.9 , 137.1	157.2 , 96.8 , 0 , 313
Nissan	23.40 , 28.6 , 4.5 , 137.6	159.3 , 102.3 , 0 , 314
Honda	19.2 , 28.9 , 3.5 , 212.1	180.0 , 90.3 , 5 , 306
Hyundai	21.2 , 21.8 , 2.0 , 116.5	144.7 , 92.2 , 13 , 301
Ford	12.2 , 8.2 , 2.4 , 74.7	134.5 , 103.4 , 0 , 310
Mazda	26.7 , 41.4 , 3.9 , 236.5	149.3 , 97.5 , 8 , 304

Table 2 summarizes the competition variables for each brand. For most brands, same-brand dealerships (measured using *INTRACOMP*) are similarly spaced geographically at about 16 to 20 miles, on average. Ford is the exception, with an average distance between dealerships of about 11 miles. The maximum distance between Ford dealerships is 75 miles, but for the other brands it is nearly double that amount. The rough average number of different brand rivals within a thirty-mile radius for dealers in the sample is about 150 rivals. There are instances of zero rivals in the radius and the maximum for each is about 300 dealers.[32]

Additional variables include dummy variables for the model year (*D2012* and *D2013*). For some models, there are dummy variables to account for a six

[30] AutoNation S.E.C. Form 10-K (2013), at p. 26. The average margin on a used car is about 9% (for an average sales price of $18,079).

[31] *Annual Financial Profile of America's Franchised New–Car Dealers,* National Automobile Dealers Association (2014) (available at: http://www.nada.org/NR/rdonlyres/DF6547D8-C037-4D2E-BD77-A730EBC830EB/0/NADA_Data_2014_05282014.pdf) at p. 7.

[32] Counting only new dealers had little impact on the econometric estimates in light of the high correlation of that count with the count of all dealers (which is very close to 1.0).

cylinder engine (*6CYL*), a sedan or hatchback body style (*SEDAN*, *HBACK*), and an all wheel drive transmission (*AWD*). Last year's models are often discounted, so we include a variable measuring the difference between the year purchased less the model year (*BUYLATE*). Larger values of this variable should be associated with lower prices. Most cars in the sample are purchased in the model year (82%), with about 15% purchased in the year prior and 3.4% in the year after the model year. Finally, using the zip code of each dealership, we added data on median income to measure the opportunity cost of driving and shopping for a car (*INCOME*) and the preferences for lower- or higher-priced automobiles.

A. *Statistical Model*

Given the large sample sizes we estimate the competition effects for each car independently. We note that all our sales occur in Texas, and are therefore subject to uniform regulations and legal requirements. This approach also permits us to easily measure differences in the competitive effects across brands and models, if any. Using the price for each car sale (*P*), the econometric model takes the general form

$$\begin{aligned} \ln P = {} & \beta_0 + \gamma \ln INTRACOMP + \beta_1 \ln INTERCOMP \\ & + \beta_2 D2012 + \beta_3 D2013 + \beta_4 \ln INCOME + \beta_5 BUYLATE + \varepsilon \end{aligned} \tag{1}$$

where ε is the econometric disturbance term and "ln" indicates the natural log transformation. In some cases, the regression will include additional variables to account for differences like engine size and so forth. The model is in log-log format so the coefficients are estimates of elasticities. Given the short-run nature of our study, we view industry structure as exogenous.

The coefficient of primary interest is γ, which measures the effect, if any, of intra-brand competition. Intra-brand competition is measured as miles to nearest same-brand dealer, so if intra-brand competition lowers prices then the coefficient γ will be positive (the greater the distance, the higher the price). We expect $\beta_1 < 0$ (markets will more inter-brand competition have lower prices) and $\beta_5 < 0$ (buying "last year's" model will lower price). Based on opportunity costs, we would expect β_4 to be positive (higher opportunity costs lead to less search), but since income may also influence preferences for particular cars we make no prediction about the sign of the variable. We also make no predictions about the signs of the coefficients on the year dummies. Additionally, six-cylinder engines and all wheel drive transmission should sell for higher prices. For some models,

hatchback models are dearer, so we have no general expectation for the sedan and hatchback dummy variables.

As a benchmark, we estimate the model using Ordinary Least Squares ("OLS"). Given evidence of heteroskedasticity, we compute robust standard errors for testing. Also, given heteroskedasticity and the fact that trade-ins and upgrades give some sales the appearance of outliers, we also estimate the model using Robust Regression ("RREG"). The RREG procedure first screens for gross outliers using Cook's distance and then performs Huber iterations followed by biweight iterations to produce the estimated coefficients.[33] As an alternative to robust regression, we estimate the equation as a Finite Mixture Model ("FMM").[34] Given the nature of the data, we believe there are transaction prices that are somewhat "normal" and others that are "extreme," perhaps reflecting special circumstances related to trade-in values, the addition of premium upgrades, and so forth. The FMM divides the sample into sub-populations without any sub-population identity information, relying solely on statistical computations. We permit two components expecting the procedure will separate the extreme prices in the distribution from the more "normal" prices. This expectation is largely confirmed, though the bulk of the data is typically placed into one component. In most cases, the "extreme" component is identified to be very small, and we limit our attention the "normal" subpopulation. In others, however, both subpopulations are sizeable shares of the whole. In these cases, we provide the results for both subpopulations.

B. *Results*

All statistical estimates are produced using STATA 13. While we begin with the Ordinary Least Squares estimates, we believe the nature of the data makes the results from Robust Regression more reliable. Detailed estimates of the models are provided in an Appendix. In the text, we present the results in a more useful form by using the estimated coefficients for intra-brand competition to compute the price differences based on mileage differences. For these tables,

---

[33] This approach is available as a default in STATA 13 and follows G. Li, *Robust regression,* in EXPLORING DATA TABLES, TRENDS, AND SHAPES (D.C. Hoaglin, C.F. Mosteller, and J.W. Tukey eds.) at pp. 281–340.

[34] Estimates are produced using the "fmm" package in STATA 13. *See also* G.J. McLachlan and D. Peel, FINITE MIXTURE MODELS (2000); P. Deb and P. K. Trivedi, *Demand for Medical Care by the Elderly: A Finite Mixture Approach*, 12 JOURNAL OF APPLIED ECONOMETRICS 313-326 (1997).

we set the minimum distance to 2.5 miles and compute the predicted average transaction price at this distance. The other values in the table measure the price difference from the price at 2.5 miles for other distances. For example, if the table shows $100 for 5 miles, then the price at a dealer with its closest same-brand rival at 5 miles would be $100 more than the price at a dealer with a same-brand rival at 2.5 miles. We choose 2.5 miles based on the minimum values reported in Table 2.

We note that for nine of the ten cars we consider the coefficient on intra-brand competition is positive and statistically-significant at standard levels (5% or better). The only exception is the Ford Focus, where the coefficient on intra-brand competition is not statistically different from zero. We had other problems with the Ford Focus data (e.g., non-convergence of the FMM), so we suspect there may be some unmeasured factor with a strong influence on the observed prices (e.g., fleet sales). The coefficient on intra-brand competition is also not statistically different from zero for the Honda Civic in the OLS model, but it is statistically significant in the RREG and FMM estimations, perhaps revealing the impact of outliers on the OLS results.

1. *Ordinary Least Squares*

The results from the OLS estimation of Equation (1) are summarized in the Appendix as Table A-1. Robust t-statistics are provided in parenthesis. The F-statistics of all regressions are statistically-significant at better than the 1% level. For the most part, all signs are as expected. Of most interest is the consistently positive and statistically significant sign on the *INTRACOMP* variable (coefficient γ from Equation 1), with the exception of the Ford Focus and the Honda Civic. The estimates indicate that intra-brand competition lowers prices. Also, the coefficient on *INTERCOMP* is negative in most cases and statistically different from zero for eight of ten cars. Positive signs are seen for the CR-V and the Mazda 3, with generally weak and variable statistical significance. Buyers consistently pay less when buying last year's model (*BUYLATE*), with negative and statistically-significant coefficients on the variable in nine of ten cases. A six cylinder engine and an all wheel drive transmission bring higher prices. Sedans sometimes sell for more, but not always. The coefficients on the model year dummy variables vary by model and year. No regular pattern emerges. Income also has both positive and negative signs, and is statistically different from zero in almost all cases. Areas with higher incomes tend to pay more for a Honda or a Toyota Camry, but less for Nissans and the other cars in the sample. More details on the marginal effects of these variables in provided in the discussion of the RREG results.

Table 3. Marginal Effects Intra-brand Competition (OLS)

(Values measure differences in dollars from price at 2.5 miles)

	Price at 2.5 miles	*Miles to Nearest Intra-brand Rival*								
		5	10	15	20	25	30	40	50	60
Camry	23,584	43	86	111	129	143	154	172	186	197
Corolla	18,227	89	178	231	269	297	321	359	387	411
Altima	22,823	341	684	891	1,038	1,150	1,243	1,392	1,506	1,600
CR-V	26,778	143	285	370	430	476	514	574	620	658
Elantra	19,386	100	200	259	301	333	360	402	434	461
Rogue	23,000	166	332	432	502	556	600	671	725	770
Accord EX	27,195	155	310	402	468	518	559	625	675	716
Civic LX*	18,915	3	6	8	9	10	11	12	13	14
Focus SE*	18,386	29	59	76	88	98	106	118	127	135
Mazda 3i	18,279	183	367	477	556	615	664	743	804	853

* Regression coefficient on intra-comp is not statistically-significant.

Table 3 summarizes the marginal effect on price from differences in the *INTRACOMP* variables. Prices are computed at ten different mileages and then subtracted from the computed price at 2.5 miles, which is approximate to the minimum distances in Table 2. So, a Hyundai dealer with a same-brand rival 2.5 miles away will charge a price $461 less for an Elantra than a dealer with a same-brand rival 60 miles away. This is a 2.4% discount off the sales price of the Elantra. Considering the low margins on an Elantra (about 4%, from Table 1), this discount is sizeable for the dealer as well as the customer. Of these ten models, the discounts are largest for the Altima ($1,600 at the 60-mile mark), which is one of the higher-priced cars in the group. For the Altima, the difference between MSRP and Invoice is about $1,500, so the effect of competition is substantial. Mileage-based discounts are the lowest for the Civic and Focus, but the difference between MSRP and Invoice is only about $1,200 for these models.

For both the Honda Civic and Ford Focus, the sign on the *INTRACOMP* variable is positive. Thus, price declines if an intra-brand competition is more proximate. Neither coefficient is statistically different from zero at standard levels. For the Civic, the predicted price differentials in Table 3 are quite small. We note, however, that the results from the Civic are much different in the RREG and FMM estimation approaches, suggesting outliers are influencing the OLS results. In none of the estimations is intra-brand competition statistically-significant for the Ford Focus. However, the Focus is an outlier in the statistics in many respects (perhaps due to fleet sales).

2. *Robust Regression*

Estimating the model using Robust Regression renders some changes relative to OLS; some of these changes are material, some are not. A summary of the estimates are provided in Tables A-2. The largest changes of interest are for the *INTRACOMP* variable for the Honda Civic, the Honda Accord, and the Ford Focus. For the Civic, the coefficient on *INTRACOMP* increased by a factor of about 26 (0.0002 from 0.006), and for the Accord the coefficient rises from 0.008 to 0.014. The coefficient on the Focus is nearly halved (0.0023 from 0.0014), but it remains poorly estimated and not statistically different from zero. Other than these three cases, the estimates are quite comparable across RREG and OLS.

Given the nature of the data, we believe the RREG results are more reliable so we provide additional details on the marginal effects of the non-competition related variables. The *BUYLATE* variable is in all regressions so we start there. For the Honda Civic (which has roughly the mean coefficient for *BUYLATE*), buying last year's model (*BUYLATE* = 1) saves the buyer about $850. The buyer would pay about $810 more to buy next year's model.

The coefficients on the dummy variables can be converted into price effects using the formula exp(β) – 1. A six cylinder in an Accord will cost you 12% more, or about $3,100. In 2012, the six cylinder Accord EX had an MSRP of about $3,000 more than the four cylinder, so the estimated differential seems accurate.[35] For the Toyota Camry, however, the six cylinder model is estimated to run about $6,300 more than the four cylinder model. This differential is most consistent with the MSRP spread between the lowest four-cylinder and highest six-cylinder models, so we suspect this price differential reflects the reality that the six cylinder models typically include features such as leather interiors, moonroofs, and other premium features that are unaccounted for in the data.[36]

---

35 http://www.cars.com/honda/accord/2012.

36 http://www.cars.com/toyota/camry/2012.

Table 4. Marginal Effects Intra-brand Competition (RREG)

(Values measure differences in dollars from price at 2.5 miles)

	Price at 2.5 miles	*Miles to Nearest Intra-brand Rival*								
		5	10	15	20	25	30	40	50	60
Camry	23,507	55	111	144	167	185	199	223	240	255
Corolla	18,176	98	197	255	297	328	354	396	428	454
Altima	22,756	347	697	908	1058	1173	1267	1420	1536	1632
CR-V	26,623	189	378	491	571	632	683	763	825	875
Elantra	19,276	100	199	258	300	332	359	401	433	459
Rogue	22,895	170	340	442	514	569	614	687	742	787
Accord EX	26,810	275	550	715	832	922	995	1113	1204	1278
Civic LX	18,613	82	164	213	248	275	296	331	358	379
Focus SE*	18,342	18	35	46	53	59	64	71	77	81
Mazda 3i	18,220	178	357	464	540	598	645	722	781	829

* Regression coefficient on intra-comp is not statistically-significant.

Table 4 provides the marginal price effects of intra-brand competition. The estimated price effects are very similar to those from the OLS estimates summarized in Table 3 for all but the Civic, Accord, and Focus. For the Civic, the 60-mile price increase is now $379 where under OLS it was only $14 (the latter being statistically insignificant). Likewise, for the Accord, the price differential at 60 miles rises from the OLS-based $716 to the RREG-based $1,278. In contrast, the OLS-based $135 price increase at 60 miles for the Ford Focus is now only $81. We generally view the RREG estimates are more reliable than the OLS estimates given the influence of trade-ins and other factors the model cannot account for given the data. The differences between OLS and RREG suggests these factors are perhaps material, but even with these few large differences the overall influence of intra-brand competition is unchanged—intra-brand competition lowers new car prices for consumers.

3. *Finite Mixture Model*

The Finite Mixture Model is the most complex of our three estimation methods. This approach divides the sample into two components. A review of the estimates indicates that the procedure typically divided the sample into an "extreme" price and "normal" price components, with the extreme group including both very low and very high prices. In many cases, one component contains almost all of the data. We reviewed the distribution of prices across the two components to confirm that the procedure effectively parsed the data into a "normal" and "extreme" sub-populations and the procedure was generally effective.

The econometric estimates for the "normal" component of the sample are similar to the estimates from both the OLS and RREG procedures. We expect the results to be more similar to the RREG approach, since both procedures address outliers. For many of the cars, the extreme component was very small and full of outliers, leading to poor estimates and nonsensical forecasts of prices. We ignore those results. For two models—the Nissan Rogue and the Hyundai Elantra—the observations were more evenly divided between the components, but still about two-thirds of the data was assigned to one component, so we report the results from the larger component. The FMM did not converge for the Ford Focus, so we exclude those results from further discussion. A summary of the estimates are provided in Table A-3, and the marginal effects are for the "normal" component are provided in Table 5.

Table 5. Marginal Effects Intra-brand Competition (FMM)

(Values measure differences in dollars from price at 2.5 miles)

		Miles to Nearest Intra-brand Rival								
	Price at 2.5 miles	5	10	15	20	25	30	40	50	60
Camry	23,585	48	95	123	143	159	171	191	206	219
Corolla	18,225	88	175	227	264	292	315	352	380	403
Altima	22,842	333	668	870	1,014	1,123	1,213	1,359	1,470	1,561
CR-V	26,376	247	494	641	757	827	892	998	1,079	1,145
Elantra	19,972	122	243	315	367	406	438	489	529	561
Rogue	24,097	136	272	353	410	454	490	548	592	628
Accord EX	26,690	305	611	794	925	1,025	1,106	1,238	1,339	1,421
Civic LX	18,319	142	284	369	429	475	513	573	620	657
Focus SE*	…	…	…	…	…	…	…	…	…	…
Mazda 3i	17,728	245	491	639	745	825	891	998	1079	1146

* Model would not converge.

There are some changes across the estimation approaches. The marginal price effect for Civic has risen again to $657 at the 60-mile mark, up from $378 under RREG, again suggesting the Civic data contains a good deal of noise. Convergence of the FMM was not obtained for the Ford Focus; the estimates for the Focus also changed substantially between the OLS and RREG estimates. We suspect that fleet car sales for the Focus may be influencing the results, but are unable to test this hypothesis with our data. The marginal effect for the Accord under FMM ($1,421) is close to the RREG value ($1,278), which was much higher than the OLS value. For both the Elantra and the Rogue, both of which have a larger second component, the marginal price effects are similar to those found for RREG.

C. *Summary*

On balance, we feel it is safe to conclude that intra-brand competition is effective in reducing the prices consumers pay for the most popular cars. Further, the extent of these effects often varies substantially with the distance the buyer must travel to visit same make rival dealer. When distances increase, consumers can pay hundreds of dollars more for the same car. This density effect is strong and robust across all makes and models in our sample.

While it is not possible to make a direct comparison of the relative effects of intra- versus inter-brand competitors, we can use the estimates to compute a rough equivalence across mileage and inter-brand competitors. To do so, we focus on the RREG results since we believe them to be the most meaningful. The question we seek an answer for is this: if the closest intra-brand competitor was one mile closer, how many inter-brand competitors could be lost without any change in price? Given the log-log form of the regression, the answer depends on the starting point for both variables, so we choose the means for each variable for our computations. These computations are based on non-linear marginal changes (i.e., linear in the logs) from the mean and thus are approximations.

Table 6. Tradeoff between Intra- and Inter-brand Competition

Car Model	Inter-brand Rivals: Intra-brand Mileage
Toyota Camry	4:1
Toyota Corolla	43:1
Nissan Altima	85:1
Hyundai Elantra	9:1
Nissan Rogue	19:1
Honda Accord EX	78:1
Honda Civic LX	8:1

The results of these computations for each car model are summarized in Table 6. In cases where the competitive effect of either intra-brand competition or inter-brand was not statistically significant (the Ford Focus and Mazda 3i), or inter-brand competition had the wrong sign (the Honda CR-V), the tradeoff calculation is excluded from the table. For the Camry, moving the nearest intra-brand competitor one-mile closer reduces prices by the equivalent of an increase in four inter-brand competitors. The tradeoff is much larger for the budget-conscious Toyota Corolla, where bringing a Toyota dealer one mile closer has the same effect as adding 43 inter-brand dealers to the market. As shown above, the marginal effect of intra-brand competition is very large for the Honda Accord.

Locating a dealer one mile closer to a Honda dealer reduces price by as much as adding 78 inter-brand rivals. Weighting the tradeoffs by sample sizes to approximate an "average" effect, the average tradeoff between intra- and inter-brand competition is about 35 inter-brand competitors (about 25% of the average inter-brand count) for every one-mile of distance.

V. Conclusion

Cars are expensive and most consumers know to shop dealers for the best prices. Yet, there is little to no empirical evidence on the price effects of intra-brand competition. Using large samples of transactions for ten of the most popular new cars purchased in the state of Texas for the years 2011, 2012, and 2013, we estimate the effects of intra-brand competition on prices. Intra-brand competition is measured as the distance (in miles) to the nearest same-brand dealer. Causal observation suggests and basic economic logic predicts that intra-brand competition should lower prices; for all automobiles we consider in our empirical analysis, we find that intra-brand competition does, in fact, lower new car prices for consumers. The price effects of intra-brand competition is relatively strong—at the sample means, moving an intra-brand dealer one mile closer reduces prices by the equivalent of an increase in 35 inter-brand rivals, or about 25% of the inter-brand competitors in the average market.

Given the paucity of empirical evidence on intra-brand competition, this PAPER is much needed addition to the economic analysis of the automobile industry. The results are also of economic and public policy relevance given the continuing decline in dealerships over time and the present calls to reform the state franchise laws which tend to increase the number of dealerships above what manufacturers may prefer. Our findings suggest that reductions in the number of dealerships are likely to lead to higher prices for new cars. We stress, however, that the dynamics of the automobile industry are complex and our findings shed light on but a sliver of the relevant factors impacting the industry.

Table A-1. OLS Results

Variable	Camry	Corolla	Altima	CR-V	Elantra
ln*INTRACOMP*	0.003**	0.007***	0.022***	0.008***	0.007***
	(2.82)	(7.87)	(16.02)	(5.12)	(8.59)
ln*INTERCOMP*	-0.011***	-0.001*	-0.002*	0.002	-0.007***
	(-13.92)	(-1.65)	(-1.77)	(1.24)	(-7.10)
D2012	0.068***	-0.032***	-0.016***	0.025***	-0.001
	(54.45)	(-23.74)	(-7.50)	(14.26)	(-0.32)
D2013	0.026***	-0.037***	0.045***	0.031***	-0.029***
	(18.88)	(-28.24)	(22.42)	(17.60)	(-13.23)
ln*MEDIAN*	0.005***	-0.008***	-0.039***	0.031***	0.003
	(3.65)	(-5.29)	(-16.72)	(17.69)	(1.24)
BUYLATE	-0.014***	-0.022***	-0.037***	-0.030***	-0.038***
	(-9.44)	(-14.65)	(-22.82)	(-14.46)	(-23.62)
6CYL	0.235***	…	…	…	…
	(5.93)				
SEDAN	…	…	…	…	…
HBACK	…	…	…	…	…
AWD	…	…	…	…	…
Constant	10.02***	9.923***	10.425***	9.819***	9.864***
	(640.8)	(585.8)	(373.5)	(445.5)	(351.5)
Obs.	42,728	36,065	33,203	20,546	19,163
R^2	0.10	0.03	0.09	0.05	0.06

Stat. Significance: *** (1%); ** (5%); * (10%)

Table A-1. OLS Results

Variable	Rogue	Civic	Accord	Focus	3i
ln*INTRACOMP*	0.010*** (7.63)	0.0002 (0.17)	0.008*** (4.64)	0.002 (1.43)	0.014*** (11.00)
ln*INTERCOMP*	-0.005*** (-4.06)	-0.009*** (-8.36)	-0.005*** (-3.71)	-0.003*** (-3.30)	0.003** (2.30)
D2012	0.028 (1.39)	0.029*** (14.53)	-0.023*** (-13.27)	0.126*** (47.43)	0.046*** (20.69)
D2013	-0.044*** (-22.63)	0.055*** (27.34)	0.051*** (32.29)	0.088*** (32.32)	0.019*** (7.57)
ln*MEDIAN*	0.032*** (12.82)	0.034*** (21.69)	0.018*** (10.74)	-0.023*** (-8.20)	-0.030*** (-7.80)
BUYLATE	-0.038*** (-15.84)	-0.044*** (-28.09)	-0.031*** (-18.86)	-0.037*** (-22.29)	0.003 (1.29)
6CYL	…	…	-0.008*** (-5.31)	…	…
SEDAN	…	0.003** (2.29)	0.112*** (95.74)	…	…
HBACK	…	…	…	0.044*** (27.31)	0.115*** (49.26)
AWD	0.075*** (22.17)	…	…	…	…
Constant	10.41*** (348.8)	9.481*** (492.9)	9.971*** (434.9)	9.960*** (336.3)	10.061*** (251.8)
Obs.	22,294	22,400	21,925	16,163	14,737
R^2	0.08	0.11	0.34	0.24	0.17

Stat. Significance: *** (1%); ** (5%); * (10%)

Table A-2. RREG Results

Variable	Camry	Corolla	Altima	CR-V	Elantra
ln*INTRACOMP*	0.003*** (3.65)	0.008*** (8.18)	0.022*** (16.22)	0.010*** (6.68)	0.007*** (7.87)
ln*INTERCOMP*	-0.011*** (-14.40)	-0.002*** (-2.71)	-0.002** (-1.99)	0.003** (2.17)	-0.006*** (-6.28)
D2012	0.069*** (57.40)	-0.033*** (-22.55)	-0.016*** (-7.23)	0.026*** (14.91)	0.000 (-0.12)
D2013	0.025*** (19.02)	-0.039*** (-28.42)	0.044*** (20.69)	0.032*** (18.24)	-0.030*** (-12.53)
ln*MEDIAN*	0.005*** (3.66)	-0.009*** (-6.03)	-0.037*** (-15.46)	0.030*** (16.98)	0.002 (0.83)
BUYLATE	-0.013*** (-9.42)	-0.023*** (-15.87)	-0.038*** (-22.78)	-0.029*** (-13.86)	-0.036*** (-22.05)
6CYL	0.65*** (8.34)	…	…	…	…
SEDAN	…	…	…	…	…
HBACK	…	…	…	…	…
AWD	…	…	…	…	…
Constant	10.02*** (667.2)	9.939*** (588.8)	10.405*** (365.4)	9.811*** (433.7)	9.868*** (341.8)
Obs.	42,728	36,065	33,203	20,546	19,163

Stat. Significance: *** (1%); ** (5%); * (10%)

Table A-2. RREG Results

Variable	Rogue	Civic	Accord	Focus	3i
ln*INTRACOMP*	0.011*** (8.18)	0.006*** (5.65)	0.018** (13.86)	0.001 (0.87)	0.014*** (11.09)
ln*INTERCOMP*	-0.004*** (-3.54)	-0.008*** (-7.96)	-0.002*** (-2.41)	-0.004*** (-4.95)	0.001 (1.01)
D2012	0.002 (1.17)	0.031*** (19.18)	0.022*** (14.88)	0.131*** (50.41)	0.044*** (18.25)
D2013	-0.047*** (-23.52)	0.057*** (34.72)	0.053*** (37.64)	0.089*** (34.80)	0.014*** (5.67)
ln*MEDIAN*	-0.027*** (-10.76)	0.032*** (23.57)	0.018*** (11.78)	-0.024*** (-10.70)	-0.025*** (-6.34)
BUYLATE	-0.039*** (-15.87)	-0.046*** (-39.95)	-0.030*** (-19.37)	-0.039*** (-24.21)	0.004 (1.36)
6CYL	…	…	-0.006*** (-5.03)	…	…
SEDAN	…	0.004*** (3.26)	…	…	…
HBACK	…	…	…	0.045*** (29.49)	0.114*** (46.45)
AWD	0.079*** (22.94)	…	…	…	…
Constant	10.36*** (342.2)	9.467*** (549.0)	9.938*** (554.3)	9.969*** (421.4)	10.014*** (248.5)
Obs.	24,294	22,400	23,832	16,163	14,737

Stat. Significance: *** (1%); ** (5%); * (10%)

Table A-3. FMM Results

Variable	Camry	Corolla	Altima	CR-V	Elantra (1)	Elantra (2)
ln*INTRACOMP*	0.003***	0.007***	0.021***	0.013***	0.002***	0.009***
	(3.31)	(7.45)	(15.83)	(7.91)	(2.59)	(6.43)
ln*INTERCOMP*	-0.010***	-0.002**	-0.003**	0.003**	-0.011***	-0.007***
	(-14.60)	(-2.08)	(-2.29)	(2.39)	(-5.03)	(-3.34)
D2012	0.069***	-0.032***	-0.016***	0.027***	-0.013**	0.000
	(58.69)	(-22.49)	(-7.64)	(15.14)	(-2.12)	(0.01)
D2013	0.026***	-0.038***	0.045***	0.034***	-0.031***	-0.035***
	(20.07)	(-27.81)	(22.55)	(18.34)	(-2.91)	(-4.73)
ln*MEDIAN*	0.005***	-0.002***	-0.039***	0.028***	-0.006**	0.009**
	(4.06)	(-5.60)	(-16.87)	(15.12)	(-1.99)	(2.17)
BUYLATE	-0.013***	-0.023***	-0.037***	-0.028***	-0.043***	-0.046***
	(-9.87)	(-16.16)	(-23.85)	(-13.08)	(-5.20)	(-8.90)
6CYL	0.237***	…	…	…	…	…
	(5.79)					
SEDAN	…	…	…	…	…	…
HBACK	…	…	…	…	…	…
AWD	…	…	…	…	…	…
Constant	10.02***	9.93***	10.43***	9.816***	9.945***	9.836***
	(688.3)	(600.2)	(375.3)	(416.8)	(333.0)	(232.0)
Obs.	42,728	35,065	33,203	20,546	19,163	19,163
Comp. Prop.	0.9985	0.9989	0.999	0.932	0.343	0.657
Var. Diff	34.08	17.38	19.74	10.85	-5.74	

Stat. Significance: *** (1%); ** (5%); * (10%)

Table A-3. FMM Results

Variable	Rogue (1)	Rogue (2)	Civic	Accord	Focus	3i
ln*INTRACOMP*	0.014*** (6.73)	0.008*** (3.99)	0.011*** (4.01)	0.019*** (14.18)	…	0.020*** (8.67)
ln*INTERCOMP*	-0.002 (-1.02)	-0.007*** (-3.93)	-0.008*** (-6.28)	-0.003*** (-2.72)	…	0.003* (1.77)
D2012	0.000 (-0.07)	0.005* (1.69)	0.033*** (11.20)	-0.023*** (-14.79)	…	0.029*** (3.18)
D2013	-0.060 (-17.99)	-0.032*** (-9.75)	0.062*** (13.63)	0.055*** (37.75)	…	-0.016* (-1.82)
ln*MEDIAN*	-0.011*** (-3.01)	-0.042*** (-11.20)	0.028*** (10.62)	0.017*** (11.35)	…	-0.024*** (-5.47)
BUYLATE	-0.060*** (-13.44)	-0.026*** (-7.02)	-0.049*** (-17.39)	-0.030*** (-19.42)	…	0.003 (0.85)
6CYL	…	…	…	0.112*** (102.2)	…	…
SEDAN	…	…	0.005*** (3.34)	-0.007*** (-5.17)	…	…
HBACK	…	…	…	…	…	0.130*** (20.06)
AWD	0.066*** (9.86)	0.075*** (15.89)	…	…	…	…
Constant	10.095*** (222.5)	10.576*** (229.3)	9.491*** (429.7)	9.837*** (544.7)	…	9.984*** (222.7)
Obs.	24,294	24,294	22,400	23,832	…	14,737
Comp. Prop.	0.341	0.659	0.817	0.940	…	0.783
Var. Diff	-6.31		2.23	23.2	…	3.83

Stat. Significance: *** (1%); ** (5%); * (10%)