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The effect of retail competition on relationship-specific investments: evidence from new car advertising

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ABSTRACT

Longstanding state regulations restrict car manufacturers from terminating relationships with dealers, creating differences in retail competition across brands and markets. I use this variation to identify the causal effect of dealer competition on dealer and manufacturer local market advertising. I find that greater intra-brand dealer competition is associated with lower dealer advertising. US brand manufacturers decrease advertising with an additional same-brand dealer, but there is zero average effect for non-US brand manufacturers. The results are evidence that manufacturers can encourage retail relationship-specific investments by providing downstream market power. I discuss theories of oligopoly and vertical relationships that may explain the results and the relevance of the findings to the effects of state automobile franchise regulation and the recent financial troubles of US car manufacturers.

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1. Introduction

In many retail markets, local competition is a key determinant of the price a retailer charges and the selling effort it provides. Manufacturers want their downstream counterparts to charge low prices to avoid double marginalization, but they also want retailers to provide high levels of selling effort. These two goals may be at odds with each other. For example, retailers may have incentives to provide adequate effort only if they face little intra-brand competition and thus capture high rents from effort by charging high prices. If retailers do not provide enough selling effort, the manufacturer may have to invest in retail selling effort to help sell the product. However, there are competing theories about how retailers respond to different levels of intra-brand competition, and there is little empirical evidence on how upstream and downstream firms substitute relationship specific investments.

In this paper, I estimate the causal effect of new car dealer intra-brand competition on local market advertising spending by dealers *and* manufacturers. This is an interesting setting to consider because new car dealers and manufacturers are independently responsible for large amounts of local advertising in the United States, making advertising a very visible and economically meaningful relationship-specific investment. Additionally, intra-brand retail competition in the automobile industry has recently received public policy attention. During the U.S. financial crisis in 2009–2010, two U.S. manufacturers proposed closing thousands of dealers in order to limit competition between retail stores so that remaining dealers could better survive the recession. However, ubiquitous state franchise laws prohibit manufacturers from terminating dealer franchise contracts. The effects of dealer closures were the subject of Congressional hearings, policy analysis and public comment.

I use the number of same-brand dealers in a local market to represent the level of intra-brand competition in order to estimate the effect of competition on advertising. Estimates of the correlation between dealer competition and advertising may not be causal if both the number of dealers and advertising levels are chosen optimally by firms in response to demand and supply conditions. For example, manufacturers may decide to establish more dealers in markets where they face a favorable demand or cost environment, which may also imply a higher marginal benefit of advertising and therefore greater levels of optimal advertising. I deal with this endogeneity issue by using a novel instrument based on the enactment of automobile franchise regulations by US states ove From the 1950s through the 1990s, US states universally adopted new car dealer franchise regulations that restrict the ability of automobile manufacturers to terminate existing relationships with their franchised dealers. Improved technology of car distribution and increased competition from foreign brands made it ideal for manufacturers to utilize smaller retail networks than they originally set up in the early 20th century. Because manufacturers could not adjust their dealer networks after the adoption of termination regulations, markets with different historical population growth have drastically different numbers of dealers, especially for US brands. For example, US cities with recent population growth have far fewer US brand dealers than "older" cities with historically large (and low growth) populations. US manufacturers are essentially stuck with too many dealers in older cities. On the other hand, foreign brands entered after the adoption of these laws and have much more balanced dealer networks across markets.

Specifically, I use historical population growth as an instrument for the competitiveness of markets to estimate the effect of intra-brand dealer competition on advertising. The first stage results are strong and imply that differences in population growth across cities is associated with different dealer network sizes. In particular, recent growth cities have fewer US brand dealers, and in these markets US and foreign brand dealers look more similar.

Instrumenting for dealer market structure, I find that increased competition, in the form of the number of same-brand dealers, is associated with lower dealer advertising per dealer, on average. The point estimate suggests that in the average market, one additional dealer leads to a decrease in the average dealer's advertising expenditure by 11%. Additionally, I estimate that the presence of an additional dealer leads to little change in total local advertising by manufacturers for the same brand. However, for US brands, an additional dealer is associated with a decrease in total manufacturer advertising.

The effect of competition on retailers' advertising effort may be explained by different mechanisms. Two lines of thought from the theoretical literature predict that advertising decreases as competition increases. First, Dorfman and Steiner (1954) suggest that because firms that face greater competition make lower margins and sell fewer products, they have a lower marginal benefit of advertising and invest less in advertising. Second, Telser (1964) develops a framework where retailers will advertise less as markets become more competitive if advertising partially spills over to rivals. The more rivals, the greater the likelihood advertising positively affects rival demand instead of own demand.[2] An alternative relationship between competition and advertising is provided by Becker and Murphy (1993), who predict that advertising is under-supplied by firms with market power if advertising itself is a complementary good to the advertised product. The empirical results I present lend support to the Telser or Dorfman–Steiner mechanisms.

Although there is a well established theoretical literature on horizontal competition and advertising, much less is known about the vertical substitution of advertising or relationship-specific investments. This is an important consideration for total advertising supplied in a market because changes to dealer advertising might be offset, or exacerbated, by changes in manufacturer advertising. Early work by Telser (1960) identified the problem of *downstream moral hazard*, where retailers lack incentives to provide adequate

[2] The idea of advertising spillovers has a long history in the theory of relationship-specific investments in vertical relationships. For example Mathewson and Winter (1984) and Perry and Porter (1990) both analyze how manufacturers discipline advertising investment by retailers when advertising partially benefits rival retailers under the same manufacturer. Also, see Chandra and Weinberg (2018) for empirical evidence that markets with more concentration have higher advertising because of fewer spillovers. See Bagwell (2007) for an overview of theories of advertising.

effort from the upstream firm's perspective.[3] However, there is very little work, both theoretical and empirical, on how upstream and downstream firms jointly decide relationship specific investments. One exception is Lafontaine and Slade (2007), who present a model of two-sided moral hazard where the principal (manufacturer) and agent (dealer) both make a relationship-specific investment in effort. In the model, a single manufacturer charges a risk averse retailer a two-part revenue sharing tariff. The retailer's effort is increasing in the share of rents relative to the manufacturer, and manufacturer effort is decreasing in the retailer's share. Additionally, the greater the return on effort, the more effort is exerted by either party. However, the theory presented in Lafontaine and Slade (2007) is for a bilateral monopoly. Things get more complicated for the manufacturer when considering changes to the number of retail outlets in a local market. More retailers imply more sales and a greater marginal benefit from a dollar of advertising expenditure. However, if there are more retailers, there may be more total retail advertising (even though per-retailer advertising might fall), so the substitution of manufacturer advertising could work both ways.

I contribute to the empirical literature of vertical relationships by providing direct evidence of the role of non-price selling effort. An empirical challenge when studying non-price decisions in vertical relationships is the difficulty of quantifying these decisions. Consequently, there is limited empirical work in this area. For example, how does one quantify the aggressiveness or helpfulness of sales people or the attractiveness and comfort-level of a showroom? However, advertising provides an ideal measure of effort because it is both an important business decision and easily quantifiable. Three recent papers examine vertical externalities and non-price decisions. Conlon and Mortimer (2013) consider the restocking and display of candy in vending machines, but do not consider any effort by the upstream firm. Their focus is on the ability of the manufacturer to foreclose rivals. Xu et al. (2014) estimate the effectiveness of price advertising for consumer trucks by manufacturers and dealer associations, and Murry (2017) uses advertising and car transactions data from a single US state to estimate a structural model of advertising and vertical relationships in the automobile industry.[4]

My analysis also contributes to the literature on the effect of market structure on advertising.[5] Chandra and Weinberg (2018) find a similar result to my dealer result: increased concentration leads to greater advertising, where they measure concentration using HHI. They interpret their result as supporting the spillover theory of advertising

[3] See Tirole (1988) for a summary of moral hazard in vertical markets and Winter (1993) for an example of downstream moral hazard with downstream competition. Also, effort is typically thought of as something unobserved or not contactable in a principal-agent framework. In the car dealer-manufacturer relationship in the US, due to the regulatory environment, it is difficult to ex-ante contract on advertising, and there are limited mechanisms to ex-post enforce advertising levels by the manufacturer.

[4] Somewhat related, there is a more established empirical literature that examines the importance of downstream and upstream effort and the likelihood of vertical integration. Some of these studies use advertising to describe upstream effort, for example, Lafontaine and Shaw (2005).

[5] There are, of course, numerous studies about pricing and market structure. A particularly related paper is Brenkers and Verboven (2006), who consider how the liberalization of the European auto distribution system of exclusive territories affected prices and consumer welfare. However, they do not incorporate advertising or selling effort into their analysis.

from Telser (1964). As Chandra and Weinberg (2018) point out, there are a limited number of other studies that examine the effect of market structure on advertising, and in general, these studies use aggregate data and do not address the endogeneity of market structure. For example, Buxton et al. (1984) estimate a positive relationship between concentration and advertising using industry level adversing to sales ratios. However, they do not account for the endogeneity of market structure. See Bagwell (2007) for a comprehensive overview of empirical and theoretical advertising literature.

2. Industry background and data description

In the United States, new cars are sold through networks of independent franchised retailers, called dealers.[6] Manufacturers sell inventory at linear wholesale prices to dealers, who sell the inventory through showrooms at (typically) negotiated retail prices with consumers. New car manufacturers and dealers are huge advertisers at the national and local levels. Total auto advertising is more than any other sales category, including retail and pharmaceuticals. In 2013, car dealers and manufacturers combined to spend about $16 billion on advertising, or about $1,000 per unit sold.[7] About 65% of advertising spending is from manufacturers, and the rest is from dealers and dealer associations.

The large amount of advertising spending, along with the fact that advertising is not coordinated within the vertical channel, or among rivals, makes advertising an ideal subject to study selling effort in vertical relationships.[8] Along with national level advertising, manufacturers typically place advertisements directed at brand promotion in local markets. These advertisements are familiar mainstays on broadcast and cable television, and national and local print periodicals, among other media outlets. In addition, individual dealers advertise on their own, using their own creative material. These advertisements tend to focus on dealer characteristics like service, selection, and trust, and they are typically lower production quality. These ads are also familiar mainstays on television and radio, and in local newspapers, and represent a large portion of advertising revenues for local media.[9]

[6] For a more detailed overview of the industry, see Lafontaine and Morton (2010) and Murry and Schneider (2015).

[7] Aggregate ad statistics from adage.com.

[8] Manufacturers run co-op advertising programs for their dealers. This is a type of vertical restraint that aims to increase dealer ad spending by matching (or partially matching) dealer advertising spending up to some level. However, these programs are not heavily used by dealers; for example, an industry professional told me about 15% of co-op funds are used every year. Reasons for low take-up by dealers include the fact that advertising needs to be approved by the manufacturer and typically focuses on the brand, thus potentially spilling over to rivals. Other requirements of co-op advertising may be costly for dealers to meet.

[9] In addition to manufacturer and dealer advertising, manufacturers fund “dealer associations.” These typically take the form of a group of same-brand dealers who meet two to four times a year to decide on joint marketing strategy. However, the funds for these marketing campaigns are almost always provided by the manufacturer, and the particular advertising content is usually similar, or identical, to the content used by the manufacturer. I do not include dealer association advertising because in many cases these funds are based directly on dealer revenue at a rate determined nationally, so there is a mechanical relationship between sales and ads as opposed to an optimal advertising decision by the manufacturer or dealer.

Table 1
Variable definitions.

Market (DMA) Level	Description	Source
Population	2010 Decennial Census in millions	USC
TVHH	Number of households with a TV	KM
MedInc	2010 Decennial Census Median Household	
	Income, in thousands	USC
PopGrowthX	Population growth from Decennial Census in year X	USC
TotalDealers	Total number of new car dealer in a market	AD
Market-Brand Level		
IntraBrandDealers	Number of dealers in the market, by brand	AD
USbrand	=1 if brand is historically associated with the Big 3	
	auto manufacturers	AD
AdsDealer	Average advertising expenditures of	
	dealers for a particular brand	KM/AD
AdsManufacturer	Advertising expenditures of manufacturers	
	for a particular brand	KM/AD
	divided by *IntraBrandDealers*	

Note: USC = US Census; AD = AggData LLC; KM = Kantar Media.

The data I use include the locations of all automobile dealerships from all major manufacturers selling in the US at the end of 2013, the local media market advertising expenditures by dealers and manufacturers in 2013, and demographic information, including historical, aggregated to the media market geographic level. The cross-sectional unit of observation is a car brand (or make) in a Nielsen media market Designated Market Area (DMA). In total the data include 32 brands and 99 DMAs for a total of 3168 observations. See Table A1 in the Appendix for a list of brands included in the analysis.

2.1. Car dealers and markets

Data on the locations of automobile dealerships come from an on-line marketing firm, AggData LLC. I observe the street address for every dealership listed on the manufacturer's website at a given point in time. Using the zip code of the dealership, I assign each dealership to a Nielsen media market using information from Nielsen and GIS mapping software. There is a total of 27,221 dealers represented in the 99 DMAs, which is about 75% of all the dealers in the US reported from the data provider.[10]

Using a mapping from zip codes to counties to DMAs, I construct DMA level demographic information from the 2010 Decennial US Census publicly available files. The DMA information from Nielsen also includes the number of TV households per DMA. Additionally, I construct historical DMA level population going back to 1900 using publicly available historical county level decennial census information from the US Census.

[10] This number is somewhat larger as than the number of dealers reported in 2010 in Lafontaine and Morton (2010). My data come from a different source than theirs, and there was likely a small increase in the number of dealers from 2010 (the last year of their data) to 2013 (the year of my data). Also, I define a dealer as a single franchise. So a single location that sells both Dodge and Chrysler is considered as two dealers.

Table 2
Descriptive statistics: market (DMA) level variables.

variable	Mean	SD	Min	Median	Max	Obs.
Num. of dealers	276.455	193.936	72.000	218.000	1341.000	99
Num. of US brand dealers	141.242	82.271	31.000	122.000	505.000	99
Population	2.699	3.097	0.661	1.723	21.254	99
TVHH	0.960	1.040	0.143	0.636	7.392	99
PopGrowth1930	421.772	1353.925	−2.965	126.878	12773.154	99
PopGrowth1970	77.718	102.283	−14.270	50.199	637.415	99
PopGrowth1990	28.673	27.502	−8.381	22.683	172.001	99
MedInc	51.299	85.148	37.044	49.935	85.222	99

Note: Variable construction detailed in the text. *Population* and *TVHH* in millions; Growth in percent; *MedInc* in thousands.

In Table 2, I display descriptive statistics for those variables that vary at the DMA level, namely demographic information and counts of car dealerships. On average there are 276 car dealerships in a DMA, and 141 (51%) of them are US brand franchises. The average population of the DMAs is about 2.5 million, and the average DMA has nearly 1 million households. On average, there is a substantial amount of variation in population growth. For example, Youngstown, Ohio has saw a decrease in population of nearly 15% since 1970, and Las Vegas had an increase of over 600% since 1970. This will be important when I discuss how state franchise regulations have shaped the market structure of new car dealers across markets.

2.2. Advertising

Kantar Media, an advertising industry consulting firm, collects advertising expenditures for advertisements in the most populous DMAs. The advertising expenditures are broken down by single products, advertiser type (i.e., dealer or manufacturer), market, and media. Local market advertising is all advertising purchased from local media, for example from the local network television station or local newspaper (e.g. WNBC-TV New York, or the Baltimore Sun). This is in contrast to national advertising, which is purchased and "broadcast" nationwide, for example from the national television network (e.g. NBC Universal), or a national print publication (e.g. Time Magazine). I compute the total yearly local advertising expenditures for all dealerships of a particular brand by summing dealer expenditures across all products that mention the brand on all media. Some dealers own multiple franchises and advertise multiple brands, and some manufacturers produce multiple brands and place ads that mention multiple brands. For example this happens often for Ford and Lincoln, which are manufactured by the same parent company and are often sold from a dealer who has a franchise contract with both companies. In these cases, I divide the advertising expenditures equally among all brands.[11]

[11] Sovinsky Goeree (2008) faces a similar issue in the PC market, but uses a structural model to estimate the weights on how advertising are split between products in multi-product ads.

Table 3
Summary statistics: Market-brand variables.

Variable	Mean	SD	Min	Median	Max
US Brand	0.281	0.450	0.000	0.000	1.000
IntraBrandDealers					
US Brands	15.7	11.7	0	13	77
Non-US Brands	4.1	6.0	0	2	64
All Brands	7.3	9.5	0	4	77
AdsDealer					
US Brands	53.062	100.598	0.000	21.836	1103.390
Non-US Brands	97.850	167.579	0.000	41.833	2819.525
All Brands	85.253	153.074	0.000	33.043	2819.525
AdsManufacturer					
US Brands	874.037	1,987.959	0.000	275.809	27,908.148
Non-US Brands	440.670	1,708.014	0.000	7.303	44,098.988
All Brands	562.554	1,801.425	0.000	33.903	44,098.988

Summary statistics for those variables that vary at the market-brand level. Sample described in the text. Advertising in thousands of US dollars.

For the analysis, I define dealer advertising (*AdsDealer*) in a given market for a given brand as the sum of all dealer advertising in that market for that brand for the year 2013, divided by the number of dealers for that brand. In other words, *AdsDealer* is average dealer advertising for a brand in a market. I define manufacturer advertising (*AdsManufacturer*) as the total advertising expenditures of a manufacturer for a particular brand in a local market. I do not include national advertising because this spending is likely not driven by local market conditions.

I display the summary statistics for the advertising variables in Table 3. On average, average dealer advertising spending is $85,253 in 2013. On average manufactures spend $562,554 per market in local market advertising. However, there is substantial variation across brands and across markets. One natural way to dichotomize brands in this industry is by US versus non-US brand. Non-US brand dealer advertising is nearly twice as much as US brand dealer advertising spending on average. Non-US manufacturers also spend about twice as much as US manufacturers on average in local market advertising. The fact that that non-US brands typically have fewer dealers that sell more cars per dealers is preliminary evidence that less intra-brand competition is associated with higher advertising.

In the top panel of Table 3 I display summary statistics for the variable I use to measure competition, the number of intra-brand dealers in each market, *IntraBrandDealers*. On average, there are about 7 dealers per brand in a DMA. However, there is substantial variation across brands. For example, There are about 4 dealers per brand in a DMA for non-US brands on average, and about 16 dealers per brand for US brands. I interpret these differences across different types of brands as preliminary evidence that state franchise termination regulations created differences in intra-brand competition across different types of brands. I take this up in more detail in the next section.

3. Dealer competition and franchise regulation

My empirical strategy relies on instrumenting for the number of dealers in local car markets. The instruments are based on the historical regulatory environment in the automobile industry and differences in population growth across different geographic markets. In this Section 1 provide institutional background that motivates the empirical strategy and I provide analysis that amounts to a first stage to the primary analysis of dealer and manufacturer advertising in the next section.

Throughout the latter half of the 20th century, all US states adopted dealer franchise regulations that restrict manufacturers from unilaterally closing dealers. In general, manufacturers must give "good cause" to terminate a dealer relationship, and even then may be subject to settlement payments. In practice, unilateral termination is rare. In this section, I provide evidence that there are substantial differences in intra-brand dealer competition across brands and markets. I argue that dealer termination regulations contributed to these differences for three reasons: changes in demand in local markets over the past half century, changes in the technology of new car retailing over the past half century, and the recent emergence of competition from foreign brands who entered markets after the adoption of termination regulations.

In the early 20th century US manufacturers aggressively expanded their dealer networks. However, because of termination laws, they are unable to adjust these retail networks in the face of changing population and demand. The result is that cities that experienced the bulk of their population growth within the past few decades (like many cities in the south and southwest United States) tend to have fewer US branded dealers per capita than cities that experienced population growth earlier in the 20th century and have not grown very much in the past half century (or experienced population decrease, like cities in the "Rust Belt" region of the United States). However, foreign brands entered the US market recently and set up retail networks based on current population trends.

To provide suggestive visual evidence of the effect of termination laws, I map Toyota (Japanese headquartered) and Ford (US headquartered) dealers in two large American cities that have experienced markedly different population growth paths over the past century. Specifically, I compare Pittsburgh, an "old" city with small or declining population growth, to Phoenix, a "new" city that has recently experienced rapid population growth. The maps of these two cities with the locations of Ford and Toyota dealers is in Fig. A1 in the Appendix.[12] Although Phoenix is larger than Pittsburgh, it is striking that there are far fewer dealers in Phoenix than Pittsburgh, and the mix of Toyota and Ford dealers is much more balanced in Phoenix.

In addition to long-term changes in demand due to population growth, the technology of selling cars has changed since the adoption of dealer termination laws. In Congressional testimony, US manufacturers argued that the efficient scale of retail networks is smaller

[12] The map of Pittsburgh is meant to be comparable to a similar map in Lafontaine and Morton (2010).

Table 4
Tabulation of DMAs with different counts of dealers, by brand.

	Number of dealers			
Make	0–2	3–5	6–10	11+
US Brands				
Buick	0	7	25	67
Chevrolet	0	4	10	85
Chrysler	0	5	21	73
Ford	0	5	9	85
Non-US Brands				
BMW	69	21	5	4
Honda	5	43	27	24
Toyota	0	34	37	28
Volkswagen	32	38	20	9

Note: Table displays the density of dealer counts across brands. Each cell is the count of DMAs that have the number of dealers in the column bin for each major brand. For example, Ford has 3–5 dealers in 5 DMAs, and Toyota has 3–5 dealers in 34 DMAs.

than their current network size, (see SIGTARP, 2010). In fact, US manufacturers have been trying to decrease the size of retail networks for decades through organic means such as (a) allowing financially distressed dealers to close, and (b) permitting the consolidation of dealers by dealer conglomerates. In contrast, foreign manufacturers that entered the US market after the adoption of dealer termination laws set up much smaller dealer networks.

Lastly, the entry of foreign brands into the US market provided an impetus for US manufacturers to adjust their dealer networks in response to competition by having fewer dealers that were larger in the most desirable areas of the market. However, in “older” cities US manufacturers were unable to respond to competition by adjusting the size of their dealer network. As seen in Fig. A2 in the Appendix, competition from foreign brands started to rise in the 1980s and 1990s, after the adoption of dealer termination laws. In those markets with more recent population growth, the retail networks of US and foreign brands look more similar than in “older” markets. For example, see Fig. A1 in the Appendix.

I display how intra-brand dealer market structure varies across brands in Table 4. The table shows the density of DMAs that have varying numbers of dealers for different brands. Overall, DMAs are much more competitive for US brands than non-US brands. There are 4 DMAs in my sample with 3–5 Chevrolet dealers, and there are 85 DMAs with 11+ Chevrolet dealers. In contrast, there are 34 DMAs with 3–5 Toyota dealers and only 28 DMAs with 11+ Toyota dealers. The difference between US and non-US brands is an empirical regularity across all major brands. There is a greater disparity between the number of US and non-US dealers for luxury brands because US luxury brands often accompany non-luxury brands under a dual franchise. For example, there are only four DMAs with 11+ BMW dealers, but there are 67 DMAs with 11+ Buick dealers, a BMW competitor.

Table 5
Regression: # of dealers per market and population growth.

	Growth Base Year						
DepVar: *IntraBrandDealers*	1930	1940	1950	1960	1970	1980	1990
US Brand	12.099**	12.190**	12.413**	12.626**	12.940**	12.888**	12.778**
	(0.668)	(0.675)	(0.692)	(0.705)	(0.749)	(0.774)	(0.863)
*PopGrowth*YEAR	−0.000	−0.000	−0.000	−0.000	−0.001	−0.004	−0.007
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)	(0.003)	(0.007)
US Brand X *PopGrowth*	−0.001**	−0.002**	−0.004**	−0.008**	−0.017**	−0.027**	−0.040*
	(0.000)	(0.001)	(0.001)	(0.002)	(0.004)	(0.009)	(0.021)
Population	1.607**	1.608**	1.610**	1.609**	1.611**	1.615**	1.613**
	(0.104)	(0.104)	(0.104)	(0.106)	(0.108)	(0.109)	(0.110)
Inc/Cap	0.045*	0.045*	0.046*	0.048*	0.048*	0.054**	0.053**
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)
Constant	−1.681	−1.708	−1.768	−1.940	−1.991	−2.244*	−2.137*
	(1.209)	(1.204)	(1.197)	(1.198)	(1.207)	(1.212)	(1.217)
R^2	0.594	0.595	0.596	0.595	0.596	0.594	0.591
No. observations	3168	3168	3168	3168	3168	3168	3168

Note: Observation is a DMA-brand. Dependent variable is the number of dealers. Each column uses a different base year to calculate population growth. Robust standard errors shown in parentheses. * and ** represent statistical significance at the 5% and 1% levels, respectively. Population is in millions, and income is in thousands.

Next, I present more formal evidence that the number of intra-brand dealers correlates with population growth and that this correlation differs across brands. To do so, I run a regression where the left-hand side variable is the number of dealers for each brand in a given market, and the right-hand side variables include population growth rate, a dummy for US brand, an interaction of the two, and additional market controls. I present the results in Table 5. Each column represents a separate base year which I use to calculate the population growth rate, where I calculate all growth rates to the 2010 decennial census. For example, the column header "1960" uses growth rates calculated from the 1960 census to the 2010 census. As can be seen by the coefficient on the US brand dummy, between 12 and 13 for all base years, there are many more US brand dealers than non-US brand dealers. The estimate of the growth and brand interaction term for the 1970 base year is −0.017(0.004), which implies that the relationship between the number of dealers and population growth is more negative for US brands than non-US brands. For example, a 77% population growth since 1970 (the mean in the sample) is associated with about 1.5 fewer US brand dealers in a market than foreign brand dealers, conditional on other factors – this can be computed from the $PopGrowthYEAR$ and $USBrandXPopGrowth$ rows of the "1970" column in Table 5. This confirms the hypothesis that newer cities tend to have relatively fewer US brand dealers compared to foreign dealers than older cities. The negative relationship between population growth and the number of US brand dealerships is strongest for markets that have more recently experienced population growth; the coefficient on the interaction term $USBrandXPopGrowth$ is monotonically decreasing with the growth base years.

These results document how dealer franchise regulations affect the behavior of US car manufacturers. It is clear that manufacturers were less aggressive at opening dealers after the state regulations went into effect, which was also at the same time they started facing fiercer competition from imports and potential changes in the technology of retailing cars, all the while dealing with changing demand and populations. This is systematic evidence that confirms evidence provided by Lafontaine and Morton (2010), who display a map of Toyota and GM dealerships in Pittsburgh, an “old,” low growth city. Their map shows that there are many more GM dealerships than Toyota dealerships in Pittsburgh, with many of the GM dealerships in depressed parts of the city. They also document national trends in the dynamics of dealers by brand, and from that, one could reasonably infer that US manufacturers did not open as many dealers in new growth markets.

4. Empirical strategy and results

Next, I present the results of estimating the effect of downstream retail competition on the advertising expenditures of car dealers and manufacturers. The empirical strategy is to regress dealer and manufacturer advertising, separately, on the number of intra-brand dealers present in the market, market characteristics, and brand dummies. Intra-brand competition is a choice of the firms and is likely correlated with unobserved features of brands and markets that affect optimal advertising decisions. Therefore, I instrument for competition by exploiting the way in which state franchise regulations affect markets and brands differently. I described the institutional details that justify this strategy in the previous sections. Next, I describe the empirical strategy in more detail, and after that, I present and discuss the results.

4.1. Market structure endogeneity

I represent the level of intra-brand competition in a local market by the number of same brand dealers. In franchise industries, the number of retailers in a local area is a joint decision of the manufacturer/franchisor and willing entrepreneurs. For an entrepreneur to start a new car dealer franchise, the manufacturer must select the application of the entrepreneur and the two parties must sign a contract. The manufacturer has the final say on entry, but since new car manufacturers cannot sell directly to consumers, the manufacturers rely on willing entrepreneurs in local markets to effectively run their retail establishments.

It may be the case that unobserved market-brand characteristics correlate with the joint decision to open a franchised car dealer. For example, if the manufacturing facility of the car is geographically close, demand for the car might be high, and costs might be low in that particular market. If demand is particularly high or costs particularly low, the manufacturer might franchise additional dealers, but this may also be why advertising in that market is high. Therefore, OLS estimates of advertising on competition would not represent the causal effect of competition. I deal with the endogeneity problem by

Table 6
IV regression results.

	Log Average Dealer Advertising		Log Total Manufacturer Advertising	
	(1)	(2)	(3)	(4)
SameBrandDealers	−0.45**	−0.82**	0.69**	−0.10
	(0.11)	(0.20)	(0.19)	(0.41)
Population	1.14**	1.43**	1.56**	2.17**
	(0.12)	(0.15)	(0.24)	(0.39)
MedInc	0.36	0.33	2.34**	2.28**
	(0.23)	(0.25)	(0.32)	(0.33)
Constant	−10.07**	−13.66**	−36.90**	−44.56**
	(2.51)	(3.23)	(5.41)	(6.97)
Census Division Effect	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes
Observations	2804	2804	2907	2907

Note: Observation is a DMA-brand. Dependent variables listed in column headings. Standard errors are in parentheses clustered at the brand level. All specifications include brand fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively.

instrumenting for market structure. I do so by exploiting variation in the effect of state franchise regulations on market structure.

Specifically, I instrument for the number of intra-brand dealers, *SameBrandDealers* using market population growth and the population growth interacted with a US brand dummy. As explained above in Section 3, there are three reasons I argue that this instrument has explanatory power for *SameBrandDealers*. First, for technological reasons auto manufacturers needed more dealers to sell cars in the first half of the 20th century, before state franchise regulations were adopted, than are needed presently. Second, population growth throughout the country happened in a way that does not reflect the initial dealer network choices of US manufacturers. Third, non-US brands entered the market after state franchise laws were adopted, at a time when it was optimal for manufacturers to have fewer dealers in retail networks because of the first point. The story is that "older" cities (those with little recent population growth, or decline) tend to have many more US dealers because dealer franchise regulations restrict the ability of manufacturers to terminate dealer relationships. These differences in the number of dealers across cities will also differ by brand because foreign brands entered the US after states adopted franchise laws.

4.2. Results

I present results for the relationship between dealer advertising and intra-brand competition in Table 6. I report OLS estimates in column (1) and IV estimates in column (2). The specifications use the log of average dealer advertising as the dependent variable and logged control variables. I report results using a linear specification in Appendix C with quantitatively similar results. Differing population growth rates in different markets (my instrument) may be correlated with preferences for American cars. For example, perhaps residents of upper-Midwest cities (that tend to be low-growth) tend to have preferences for American cars. This would negatively bias the estimate of the effect of rivals on advertising (in the direction of my finding). To alleviate this concern, I include geographical dummies at the level of a Census division to control for common preferences for cars in different areas of the country. A Census division is a sub-region designation typically consisting of around six or seven states. The covariation in the data that identifies the effect of competition on advertising is then within Census division. For example, Cleveland, Ohio is a negative-growth market (−4% growth) but Columbus Ohio is a high growth market (51% growth). I use the log of *Population* and *MedInc* to control for market characteristics, such as consumer demand and the market for advertising, that are associated with advertising decisions of dealers. For example, controlling for population is important because larger markets can naturally support larger retail networks, so competition, as expressed in terms of the number of retail outlets, is relative to market size.

The results suggest that there is a negative economically and statistically significant average effect of the number of intra-brand dealers on dealer advertising. From Table 6, column 2, the point estimate implies that for the average market-brand, average dealer spending decreases by about 0.82% with an increase in the number of same-brand rivals by 1%. For example, the average number of intra-brand dealers in the sample is 7.3, so an increase in one dealer from the mean would imply, roughly, a 15% decrease in adverting per dealer. This is economically meaningful – the mean dealer has $85,253 in advertising spending, so this implies a decrease in advertising by about $13,000 per dealer, or roughly $90,000 in *total* dealer advertising spending for the average market. The coefficient on $log(Population)$ is positive and significant in all specifications. The coefficient on $log(MedInc)$ is negative and estimated imprecisely for the dealer specifications (columns 1 and 2). In all specifications I include brand effects and cluster the standard errors at the brand level.

I present results for manufacturer advertising in columns (3) and (4) of Table 6. I report OLS estimates in column (3) and IV estimates in column (4). The OLS results imply that there is a positive association between the number of intra-brand dealers and the amount of manufacturer advertising in a market. However, this effect disappears after accounting for the endogeneity of market structure. In column (4), the effect of the number of same brand dealers on manufacturer advertising is very close to zero, although less precisely estimated relative to the other specifications. The coefficients on population and income are positive and precisely estimated. In particular, it is interesting to compare the effect of income between dealer and manufacturer advertising. The fact that income is significant for only manufacturer advertising might suggest that dealer advertising decision is relatively local compared to manufacturer advertising (even though both types of advertising are DMA specific). For example, a dealer might only care about its immediate local demand when making advertising decisions, whereas the manufacturer considers the entire DMA.

4.2.0.1. Specification robustness. I conduct robustness checks to the main analysis and present the results in Appendix C. I report results using different base years for the population growth instruments *PopGrowth* and *USBrandXPopGrowth* for dealer advertising in Table A6 and for manufacturer advertising in Table A7. In general, the results are consistent with the main results. For dealer advertising, there is is a stronger effect the further back population growth is calculated. The results for manufacturer advertising are slightly less impervious to the base growth year. Results using recent growth rates suggest a positive effect of the number of dealers on manufacturer advertising. Older growth rates suggest the opposite. However, all results are relatively imprecise and not significant at the 10% level.

A little fewer than 10% of observations have zero advertising. To check if my results are sensitive to this censoring, I run Tobit and IV Tobit analysis that mimics the main analysis. The results are in Table A8, where for each specification in the main analysis I present the coefficient on *SameBrandDealers* for the associated Tobit specification.[13] The results are generally similar to the main results. I also estimate a specification that include DMA fixed effects. The results are presented in Table A4. I have reason to doubt these results because including DMA effects kills a lot of the covariation in the data needed to identify the parameters. In fact, the standard errors for Column (2) are larger than in the baseline specification, and the instrument does not seems to be doing any work in column (4).

4.2.0.2. Market Definition. First, the choice to model a market as a DMA is mostly driven by the data. A DMA is the level of observation of advertising expenditures. Especially for the case of manufacturers, it would seem unnatural to appropriate advertising expenditures at a finer geographic level. In some cases, DMAs can be quite large and may not accurately capture dealer markets. However, dealers themselves organize dealer associations around the DMA definition, so although too broad in some contexts, this definition is likely less ad-hoc than a any political boundaries, such as counties. Given that my market definition may be too broad in some contexts, my results may underestimate the effect of dealer competition on advertising. To understand how this market definition influence my results, I conduct the analysis for the smallest 50 DMAs in my sample. The logic is that a DMA may more accurately reflect the true market definition in smaller DMAs. The results are presented in Table 7 and are largely consistent with the baseline results.

4.2.0.3. Inter-brand competition. Additionally, I provide results where I include the number of inter-brand rivals. The baseline model is over-identified, so I instrument for the number of iter-brand rivals with the same instruments used in the baseline specification. The results are in Table 8. For dealer advertising, the negative effect of rivals now

[13] For the IV Tobit specification I estimate the model using STATAs implementation of the non-linear IV estimator proposed by Newey (1987).

Table 7
Robustness check: smallest 50% of markets.

	Log Average Dealer Advertising		Log Total Manufacturer Advertising	
	(1)	(2)	(3)	(4)
LogSameBrandDealers	−0.35**	−0.57**	0.75**	0.21
	(0.13)	(0.27)	(0.20)	(0.47)
log(*Population*)	1.12**	1.23**	1.70**	1.96**
	(0.26)	(0.24)	(0.23)	(0.33)
log(*MedInc*)	0.55	0.51	2.17**	2.10**
	(0.54)	(0.53)	(0.69)	(0.68)
Constant	−11.62**	−12.78**	−37.27**	−40.14**
	(5.60)	(5.55)	(8.31)	(8.56)
Census division effect	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes
Observations	1292	1292	1336	1336

Note: This sample includes the smallest 50 markets (in terms of population), or all markets with less than a population of 1.7 million. * indicates p-value<0.10. ** indicates p-value<0.05. Additional control variables *log*(*Population*), *log*(*medInc*) and a constant are included in all regressions, but not reported. IV Tobit specifications are estimated using STATA's implementation of Newey (1987).

Table 8
IV Regression results: inter-brand rivals.

	Log Average Dealer Advertising		Log Total Manufacturer Advertising	
	(1)	(2)	(3)	(4)
LogSameBrandDealers	0.83**	0.53	−0.23*	−0.01
	(0.20)	(0.49)	(0.11)	(0.29)
logOtherBrandRivals	−1.07**	−1.40**	−1.68**	−1.85**
	(0.20)	(0.47)	(0.13)	(0.40)
log(*Population*)	2.27**	2.75**	2.25**	2.21**
	(0.25)	(0.39)	(0.15)	(0.22)
log(*MedInc*)	2.02**	1.89**	−0.14	−0.17
	(0.32)	(0.36)	(0.21)	(0.23)
Constant	−37.96**	−41.59**	−11.67**	−9.91**
	(5.48)	(7.18)	(2.61)	(2.88)
Census division effect	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes
Observations	2804	2804	2907	2907

Note: Observation is a DMA-brand. Dependent variable is listed in column heading. Standard errors in parentheses clustered at the brand level. All specifications include DMA (market) fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively. Both dealer variables are instrumented for. Advertising expenditures in thousands USD.

appears for iter-brand rivals, whereas the effect of same-brand rivals is slightly positive but statistically indistinguishable from zero. Manufactures also have a negative effect of more rival dealers. This supports the story that the Dorfman–Steiner mechanism may also happen at the brand level: increased brand competition implied less advertising due to a lower marginal value of a dollar of advertising. The number of same brand rivals and inter-brand rivals has correlation coefficient of 0.52.

4.3. Instrument validity

Next, I discuss two concerns that may invalidate the instruments, both of which have to do with how consumer preferences may be correlated with market population growth. Newer cities may be populated with younger consumers and immigrants who are more likely to prefer foreign cars to domestic cars. However, if this were the case, US brands would likely advertise less in newer markets. These newer markets, in turn, are markets that tend to have fewer US brand dealers. This correlation between negative preferences for U.S. brands, the number of dealers, and advertising would bias the results in the opposite direction of my findings. Specifically, if population growth and preferences are correlated in this manner, we should expect less advertising by US brands in markets where we observe fewer dealers, which is the opposite of what I estimate. This concern would suggest my results underestimate the true effect of dealer competition on advertising.

Alternatively, new growth cities might be populated by older retiree transplants from northern states. These consumers likely have have preferences that favor US brands. This correlation between population growth and consumer preferences would bias my results in the direction of my findings. I do two things to address this concern. First, in all of the analysis I include Census Division dummies to capture preferences of different geographic areas of the US. Second, I conduct a robustness to my main results by dropping markets that are most likely to have northern retiree populations: markets in southeastern coastal states, Arizona, and Southern California. I drop 23 markets in total. Examples of dropped markets include Norfolk, VA, Charlotte, NC, Ft. Meyers, FL, and Tucson, AZ. I present the results from this selected sample in Table A5. In column (1) I present the results for dealer advertising that are analogous to column (2) in Table 6. In column (2) I present the results for manufacturer advertising that are analogous to the specification in column (4) of Table 6. The results in both columns for the effect of the *SameBrandDealers* on advertising are very similar to the results using the full sample.

4.4. Discussion: competition, advertising, and vertical relationships

In this Section 1 provide a discussion of conceptual frameworks that are relevant for interpreting the empirical results. I start with a discussion of the incentives of dealers advertising incentives, and then discuss the incentives of manufacturers.

4.4.1. Dealer advertising incentives

I show that local market dealer advertising decreases with intra-brand competition. This is consistent with two classic theories of competitive advertising. First, Telser (1964), suggests that in cases where advertising spills over to rivals, or in other words positively affects rivals' demand, firms should under-advertise. Intuitively, if a firm is not appropriating its entire marginal benefit of advertising (and especially if some of the benefit is being appropriated by rivals), then it will have a lower incentive to advertise. As the number of rivals increase, the larger the spillover externality, and the less advertising we should expect to see from individual firms. This story is not inconsistent with the institutional details of automobile advertising. Advertising by new car dealers will typically mention the common brand, so there is clearly a mechanism for advertising to spill over to intra-brand rivals. Other studies have found that distance is a large factor in dealer choice (see Albuquerque and Bronnenberg, 2012; Murry, 2017), so it could be reasonable to think that even if a consumer sees an advertisement from one dealer, she might instead visit a closer dealer who sells that same brand. As such, we could expect lower dealer advertising as competition increases, depending on the magnitude of the spillover. Chandra and Weinberg (2018) find evidence to support this theory of competitive advertising in the beer market.

Second, the classic theory of advertising of Dorfman and Steiner (1954) can explain the result that firms advertise less when they face more competitors. Dorfman and Steiner (1954) show that the marginal benefit of advertising depends on profit margins and the elasticity of sales to advertising: higher margins or a higher elasticity imply a higher marginal benefit from a dollar of advertising expenditures which, in turn, implies greater optimal advertising. However, the original Dorfman–Steiner theory is a theory of monopoly. Others have looked at optimal advertising in the Dorfman–Steiner paradigm in the context of oligopoly. Both Friedman (1983) and Fershtman (1984) examine dynamic advertising investment in the spirit of Dorfman–Steiner and find that advertising decreases with the number of competitors in steady state. Forbes (1986) shows in a Cournot problem with advertising, there is an inverse relationship between advertising expenditures and market concentration.[14]

In Appendix A, I present equilibrium advertising conditions for a Dorfman–Steiner oligopoly model along with simulations for a parameterized model. Here, I sketch out the main logic of why more competition should lead to less advertising. Consider that advertising expenditure (a) positively affects the sales (q) of a good, and the cost of advertising is simply the advertising expenditure (in this case advertising is an "endogenous fixed cost," abusing the terminology of Sutton). The Dorfman–Steiner advertising first order condition can be written as

$$(p - w)\frac{\partial q}{\partial a} = 1, \tag{1}$$

[14] The literature on optimal advertising is closely related to the literature on optimal quality provision. Gaynor (2007) surveys this literature in the context of the Dorfman–Steiner model. One key insight from the literature is that advertising should *increase* with the level of competition if prices are regulated. The intuition is that if markups cannot decrease as competition increases, then the business stealing motive for advertising dominates and firms will increase advertising to steal market share. I thank a referee for suggesting this connection.

where p is the price of a unit of the good, and w is the (constant) marginal cost of production (for example, the wholesale price of the good in the retail context). If something changes in the environment that leads to a lower margin for the firm $(p - c)$, for example the introduction of an additional competitor, then advertising must decrease for the advertising first-order condition to hold. Of course, optimal advertising and optimal prices are functions of each other, and so for some cross elasticity of price and advertising, the firm may be able to advertise its way to a higher margin. Also, optimal advertising is a function of rivals decisions. But if the cross price-advertising elasticity is not too large, the first order effect of an exogenous decrease in profit margins is a decrease in advertising, and the intuition comes from the fact that if a dollar of advertising generates less variable profit, then it is optimal to advertise less. In Appendix A, I make a more formal argument and provide simulations using a particular specification for demand to show the relationship between the number of competitors and advertising.

4.4.2. Manufacturer advertising incentives

On the manufacturer side, the empirical results provide novel evidence on the tradeoffs faced by a manufacturer when configuring its retail network and deciding on the optimal amount of relationship specific investment. There are multiple mechanisms that affect manufacturers' advertising incentives if an additional retail outlet is added to the market. First, the addition of a retail outlet would likely increase sales for the manufacturer on net, at the cost of some business stolen from existing outlets. Increased sales would create a larger marginal value of advertising. On the other hand, total dealer advertising can increase with the addition of an outlet. If dealer and manufacturer advertising expenditures are strategic substitutes in the vertical channel (as is the case in the model presented in Appendix A), then manufacturers may optimally decrease advertising in response to the additional retailer and associated increase in total dealer advertising. In the model presented in Appendix A, simulations suggest that manufacturer advertising is relatively flat in the number of associated retailers, and can either be slightly increasing or slightly decreasing.

Additionally, there could be different motives for manufacturer advertising based on the role of dealer advertising. For example, manufacturers may want to discourage dealer advertising if it is purely business stealing from same-brand dealers because dealers may need rents to encourage the provision of additional services. But manufacturers may want to encourage dealer advertising if it also steals business from rival brands. These issue fall broadly under the scope of the strategic complementarity or substitutability of manufacturer and dealer advertising. Although an analysis that employs sales and price information may be able to disentangle these mechanisms, the current study is limited on this front. Instead, my estimates should be interpreted as the net effect of the different mechanisms that determine the substitutability of dealer and manufacturer advertising.

Although the average effect of an increase in intra-brand rivals on manufacturer advertising is small and statistically indistinguishable from zero, I also consider the effect on the subset of US brand manufacturers (see Table A2 for a list of brands). The

Table 9
IV regression results – US brands subset.

	Log Average Dealer Advertising		Log Total Manufacturer Advertising	
	(1)	(2)	(3)	(4)
LogSameBrandDealers	-1.32^{**}	-1.68^{**}	0.11	-0.45^{**}
	(0.03)	(0.14)	(0.15)	(0.17)
log(Population)	1.44^{**}	1.70^{**}	1.39^{**}	1.79^{**}
	(0.11)	(0.09)	(0.09)	(0.17)
log(MedInc)	-0.70^{**}	-0.95^{**}	0.79^{**}	0.42^{**}
	(0.20)	(0.13)	(0.12)	(0.12)
Constant	1.78	1.85	-14.59^{**}	-14.47^{**}
	(1.36)	(1.35)	(1.66)	(1.40)
Census division effect	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes
Observations	594	594	594	594

Note: Observation is a DMA-brand. Dependent variable is average dealer advertising. Standard errors in parentheses clustered at the brand level. All specifications include brand fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively. Advertising expenditures in thousands USD.

results are presented in Table 9. For the subset of US brands, an increase of an additional intra-brand rival is associated with an decrease in manufacturer advertising. The effect is moderate. The point estimate implies that a one dealer increase from the average number of US brand dealers (roughly 15), leads to a 3% decrease in manufacturer advertising (or about $23,000 for the average manufacturer-market).

5. Conclusion

In this paper, I use cross market and brand variation in the effect of dealer franchise regulations as an instrument to estimate the effect of downstream competition on dealer and manufacturer advertising. I find that dealer advertising decreases with the number of intra-brand competitors. This result is consistent with two theories of advertising: (i) The theory that firms with lower margins have a lower marginal benefit of advertising (Dorfman and Steiner, 1954) and (ii) the idea that advertising might spill over to rivals, and this externality increases as the number of rivals increase (Telser, 1964). Additionally, I estimate that manufacturer advertising increases in the number of same brand dealers, which is evidence that dealer and manufacturer advertising are substitutes within the vertical channel. As dealers decrease advertising, manufacturers make up for this with their own advertising.

My findings have implications for the recent policy debate concerning the size of US brand dealer networks. Some have suggested (for example Lafontaine and Morton, 2010) that dealer franchise regulations contributed to the weakness of US manufacturers during the last decade, and especially during the 2009 financial crisis. One way this may happen is by forcing manufacturers to maintain larger-than-optimal selling networks. My results suggest by reducing selling networks, remaining dealers would advertise more and manufacturers less. However, my analysis cannot speak to how equilibrium prices would change in the vertical relationship, and hence the surplus of manufacturers and remaining dealers.

More broadly, my results have implications for how upstream firms should design selling networks. My results suggest there is a very clear reason why upstream firms would want to limit downstream competition, that is to encourage selling effort. However, my analysis cannot speak to how the double marginalization problem might be exacerbated as downstream market power increases. But in many industries upstream firms design wholesale contracts to help eliminate double marginalization. Whether these types are contracts affect selling effort as well is a question for each specific situation.

The results for dealer advertising is important because there is limited literature on how market structure affects advertising, and even less literature that accounts for the endogeneity of market structure. A notable exception is Chandra and Weinberg (2018), who also find that greater competition leads to less advertising. The results about manufacturer advertising are important because there is very little literature on the substitutability of downstream and upstream selling effort, both empirical or theoretical. However, the dual selling effort of upstream and downstream firms is a phenomenon that is common in many industries. Examples include advertising by computer chip producers and computer and software producers, clothing producers and retailers, and durable home goods producers and home improvement stores. Developing a theoretical framework to understand the substitutability of selling effort in vertical relationships that is consistent with empirical facts, and how this is related to classic theories of vertical externalities, is a potentially interesting direction for future research.

Appendix A. Dorfman–Steiner model of advertising competition

In this Appendix A provide a more formal discussion of oligopoly competitive advertising incentives. The purpose is to provide a framework to think about the Dorfman–Steiner conditions in oligopoly and the implications for the number of competitors on advertising decisions. Consider N symmetric, single product competitors.[15] Demand for a single firm, q, is a function of p, z, and the number of firms, N. Profit for a single competitor is:

$$\pi = (p - w)q(\mathbf{p}, \mathbf{z}, N) - z, \tag{2}$$

where $\mathbf{p}$ and $\mathbf{z}$ are vectors of all firms prices and advertising choices, and the firms face a constant marginal cost of production, w.

Firms simultaneously choose price and advertising to maximize profits. Products are differentiated, so price is not competed down to marginal cost. The equilibrium decision

[15] For example, the competitors could be differentiated, but in a symmetric way. See the next section for a parametric model where this is true.

of a firm is characterized by a system of two equations corresponding to first-order conditions for price and advertising[16]:

$$q + (p - c)q_p = 0 \tag{3}$$

$$(p - c)q_z - 1 = 0, \tag{4}$$

where, for example, q_p represents the own price derivative of demand. This is a multi-agent version of the classic Dorfman–Steiner monopoly advertising conditions. Note that if something exogenously decreases the price (markup), the firm has a lower marginal benefit of advertising, $(p - c)q_z$. To equate just the second FOC, it is optimal for the firm to cut back on advertising, assuming that $q_z > 0$ and $q_z z < 0$.

To understand how the number of competitors is related to optimal advertising decisions, it is useful to express the system of FOCs as a single condition, in a way similar to Dorfman–Steiner.

$$q + \frac{q_p}{q_z} = 0. \tag{5}$$

Next, I total differentiate the above equation in order to understand the optimal advertising incentives given the number of competing firms. This leads to the following expression:

$$\frac{dz}{dN} = \frac{q_N q_z + q_{pN} - \frac{q_{zN} q_p}{q_z}}{q_z^2 + q_{pz} - \frac{q_{zz} q_p}{q_z}} \tag{6}$$

I make the following assumptions about the shape of demand: $q_p < 0$, $q_z > 0$, $q_{zz} < 0$, $q_N < 0$, $q_{pN} < 0$. Many of these restrictions are standard, however, if $q_{pN} < 0$ then consumers are more sensitive to price changes when there are more competitors. Under these assumptions, the numerator of Eq. (6) is negative, but the denominator is undetermined and is a function of the relative shape of demand with respect to prices and advertising. Crucial to signing the expression in Eq. (6) is the sign and magnitude of q_{pz}. If $q_{pz} > 0$ then consumers are less sensitive to price changes for higher levels of advertising. If this cross derivative between advertising and prices is large enough, or at least not too negative , then having more competitors implies lower equilibrium advertising.[17]

A1. Example

Next, I provide the details of a parametric model of advertising competition that fits within the framework introduced in the previous section. I add a first-stage choice of wholesale price and advertising by a monopolist manufacturer. The model of demand is

[16] Throughout this discussion I assume that an equilibrium exists and can be characterized by the standard necessary conditions.

[17] Note that the expression in Eq. (6) is also still a function of the entire vector of prices and advertising for all firms, so I am abusing notation by not incorporating the equilibrium decisions of other firms and the entire mapping of best response functions.

Table A1
List of parameter values for simulations.

Parameter	Description	Value
$\bar{u}$	Mean inside product valuation	2
α	Price sensitivity	*various – see graph*
ϕ_d	Dealer Advertising preference	5.0
ϕ_m	Manufacturer advertising preference	5.0
M	Market Size	100
ψ	Cost of Ads	0.2

a discrete choice, differentiated products model popular in empirical work.[18] The model does not have a closed form solution, so I present numerical results.

Consumers decide to purchase at most one product out of $N+1$ choices, where one of the choices to not to purchase. The consumer receives indirect utility from a product, indexed by $n = 1, \ldots, N$, based on the price p, dealer advertising a, manufacturer advertising A, and an idiosyncratic match value ϵ,

$$u_n = \bar{u} + \alpha p_n + \phi^{dealer} log(a_n) + \phi^{man.} log(A) + \epsilon_n,$$

and receives the following indirect utility from the no-purchase option: $u_o = \epsilon_o$. The idiosyncratic match is distributed i.i.d. according to an Extreme Value distribution. The demand model incorporates vertical (advertising) and horizontal (ϵ) differentiation. In the car industry, it is natural to think of dealers of the same brand deriving market power from horizontal differentiation, including geographic location and idiosyncratic tastes for selling practices.

N single product retailers compete by simultaneously setting advertising and prices, taking the manufacturer wholesale price and advertising decisions as given. The manufacturer sets wholesale price and advertising anticipating the reactions of dealers. I rule out inter-brand competition for illustrative purposes and because my empirical analysis focuses on intra-brand competition. The model set-up and timing is very similar in spirit to Murry (2017). The profit maximization problem for a single retailer is the following:

$$\max_{p,a} \pi_n^{dealer} = (p_r - w) M s_n(\mathbf{p}, \mathbf{a}, A) - \psi \frac{a_n^2}{2}, \tag{7}$$

where w is the wholesale price choice of the manufacturer and I parameterize the advertising cost function with curvature and a scale parameter ψ. The equilibrium concept is full information Nash. In a first stage, manufacturers anticipate the retail stage-game, and optimally choose wholesale price w and manufacturer advertising A, facing the same parameterization of advertising costs:

$$\max_{w,A} \Pi^{man.} = (W - c) M \sum_n s_n(\mathbf{p}*, \mathbf{a}*, A) - \psi \frac{A^2}{2}, \tag{8}$$

[18] See Anderson et. al. (1992) and Berry (1994). This framework has been adopted in more recent structural empirical work on advertising – see Rysman (2004), Anderson et al. (2012) and Murry (2017).

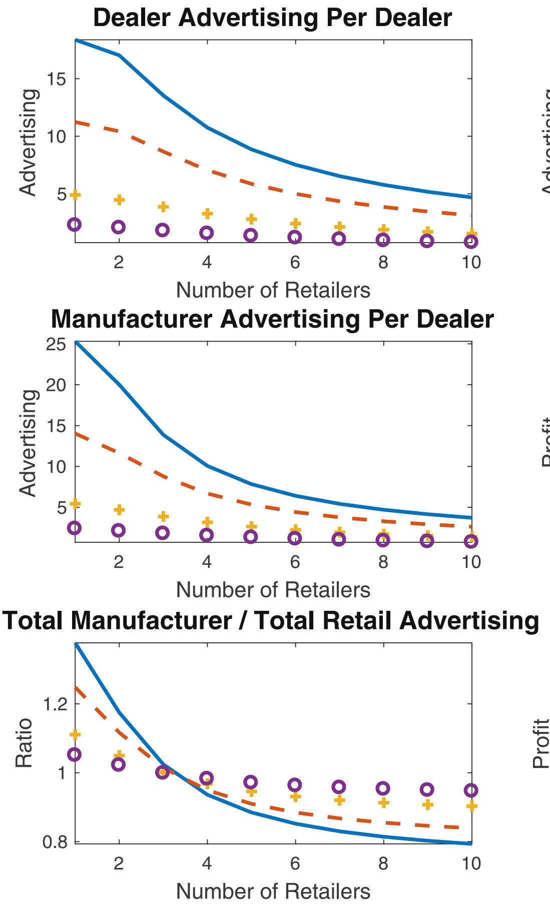


Fig. 1. Simulation results for various demand elasticities.

where c represents constant marginal production costs, and p^* and a^* represent the downstream equilibrium choices of price and advertising given the manufacturer's first-stage decisions.

I solve the model for various values of the parameter governing the price elasticity of demand (α). I also solve the model for various numbers of downstream competitors, N, to get a sense of the comparative statics with respect to N.[19] I display the results graphically in Fig. 1, where I graph various equilibrium market outcomes on the vertical axis and the number of competitors on the horizontal axis. For all values of the chosen parameters, advertising per dealer is decreasing in the number of intra-brand rivals, as is profit per dealer (not shown). Manufacturer advertising is non-monotonic in the number of dealers. One reason for this is that there is a substantial gain in total market share from going from one dealer to two dealers, which implies a substantial

[19] The code is available on the author's website: murryecon.weebly.com.

gain in the marginal value of advertising. But going from seven to eight dealers leads to more business stealing between dealers than market expansion, this combined with other equilibrium outcomes can lead to a decrease in the marginal value of advertising for manufacturers.

Appendix B. Data Supplement

Table A2
List of brands.

Acura	*GMC*	Mitsubishi
Audi	Honda	Nissan
Mercedes-Benz	Hyundai	Porsche
BMW	Infiniti	Land Rover
Buick	Isuzu	Scion
Cadillac	Jaguar	Smart
Chevrolet	*Jeep*	Subaru
Chrysler	Kia	Toyota
Dodge	Lexus	Volkswagen
Fiat	*Lincoln*	Volvo
Ford	Mazda	

Note: US brands in italic.

Appendix C. Robustness Results

Table A3
IV regression results: linear specification.

	Average dealer advertising		Total manufacturer advertising	
	(1)	(2)	(3)	(4)
logQ	−0.79	−9.29**	189.04**	−6.16
	(0.57)	(2.89)	(52.96)	(21.74)
logPop	8.89**	22.58**	314.64**	628.82**
	(1.78)	(5.50)	(73.91)	(111.79)
logInc	1.22**	1.59**	−1.94	6.51
	(0.29)	(0.29)	(3.78)	(5.29)
Constant	−19.43	−45.58**	−666.45**	−1266.91**
	(17.21)	(19.77)	(293.36)	(449.61)
Census division effect	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes
Observations	3168.00	3168.00	3168.00	3168.00

Note: Observation is a DMA-brand. Dependent listed in column headings. Standard errors in parentheses clustered at the brand level. All specifications include brand fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively. Advertising expenditures in thousands USD.

Table A4
IV regression results: robustness to DMA fixed effects.

	Log Average Dealer advertising		Log Total Manufacturer advertising	
	(1)	(2)	(3)	(4)
LogSameBrandDealers	0.16	−0.25	1.79**	1.71**
	(0.19)	(0.28)	(0.28)	(0.43)
Constant	7.69**	8.25**	7.67**	7.77**
	(0.61)	(0.72)	(0.68)	(0.92)
IV	No	Yes	No	Yes
Observations	2804	2804	2907	2907

Note: Observation is a DMA-brand. Dependent variable is listed in column heading. Standard errors in parentheses clustered at the brand level. All specifications include DMA (market) fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively. Advertising expenditures in thousands USD.

Table A5
IV regression results: robustness to retirement markets.

	Log Average Dealer advertising	Log Total Manufacturer advertising
	(1)	(2)
LogSameBrandDealers	−0.60**	0.38
	(0.24)	(0.26)
log(*Population*)	1.27**	1.75**
	(0.18)	(0.23)
log(*MedInc*)	0.35	2.64**
	(0.34)	(0.33)
Constant	−11.66**	−42.76**
	(3.76)	(5.06)
Observations	2137.00	2209.00
Census Division Effect	Yes	Yes
IV	Yes	Yes
Observations	2137	2209

Note: Observation is a DMA-brand. Dependent variable listed in column headings. Standard errors in parentheses clustered at the brand level. All specifications include brand fixed effects. * and ** represent statistical significance at the 10% and 5% levels, respectively. Advertising expenditures in thousands USD.

Table A6
Dealer advertising robustness to different base years for population growth.

	Population Growth Base Year						
	1930	1940	1950	1960	1970	1980	1990
LogSameBrandDealers	−1.357**	−1.284**	−1.126**	−0.959**	−0.822**	−0.600**	−0.474**
	(0.241)	(0.234)	(0.221)	(0.207)	(0.199)	(0.190)	(0.226)
log(*Population*)	1.845**	1.788**	1.667**	1.537**	1.431**	1.259**	1.162**
	(0.188)	(0.182)	(0.168)	(0.155)	(0.151)	(0.140)	(0.164)
log(*MedInc*)	0.289	0.295	0.308	0.322	0.333	0.352	0.362
	(0.289)	(0.283)	(0.271)	(0.257)	(0.246)	(0.231)	(0.220)
Constant	−18.817**	−18.109**	−16.589**	−14.979**	−13.656**	−11.512**	−10.302**
	(4.011)	(3.840)	(3.449)	(3.262)	(3.227)	(3.003)	(3.335)
Observations	2804	2804	2804	2804	2804	2804	2804

* indicates p-value < 0.10. ** indicates p-value < 0.05.

Table A7
Manufacturer advertising robustness to different base years for population growth.

	Population Growth Base Year						
	1930	1940	1950	1960	1970	1980	1990
LogSameBrandDealers	−0.429	−0.392	−0.340	−0.204	−0.096	0.138	0.235
	(0.295)	(0.310)	(0.377)	(0.407)	(0.412)	(0.409)	(0.434)
log(*Population*)	2.422**	2.394**	2.354**	2.249**	2.165**	1.985**	1.911**
	(0.300)	(0.313)	(0.366)	(0.387)	(0.391)	(0.383)	(0.401)
log(*MedInc*)	2.253**	2.255**	2.259**	2.269**	2.277**	2.295**	2.302**
	(0.346)	(0.344)	(0.341)	(0.334)	(0.329)	(0.322)	(0.319)
Constant	−47.797**	−47.436**	−46.931**	−45.615**	−44.559**	−42.289**	−41.356**
	(6.047)	(6.173)	(6.701)	(6.910)	(6.971)	(6.804)	(6.984)
Observations	2907	290	2907	2907	2907	2907	2907

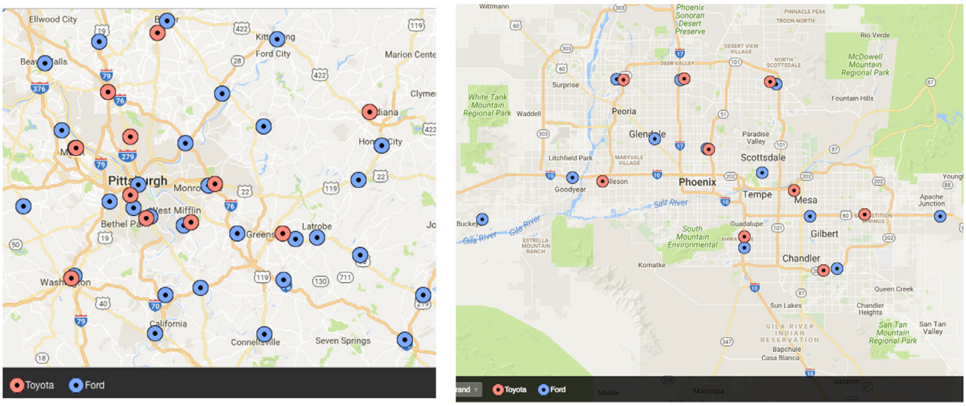
* indicates p-value < 0.10. ** indicates p-value < 0.05.

Table A8
Robustness check: Tobit specification.

	Log Average Dealer Advertising		Log Total Manufacturer Advertising	
	(1)	(2)	(3)	(4)
LogSameBrandDealers	−0.448**	−0.819**	0.694**	−0.096
	(0.079)	(0.267)	(0.073)	(0.255)
log(*Population*)	1.142**	1.429**	1.557**	2.165**
	(0.086)	(0.215)	(0.079)	(0.205)
log(*MedInc*)	0.362	0.332	2.335**	2.277**
	(0.302)	(0.302)	(0.277)	(0.283)
Constant	−10.025**	−13.602**	−36.901**	−44.559**
	(2.873)	(3.781)	(2.645)	(3.585)
Observations	2804	2804	2907	2907

* indicates p-value < 0.10. ** indicates p-value < 0.05. Additional control variables *log*(*Population*), *log*(*medInc*) and a constant are included in all regressions, but not reported. IV Tobit specifications are estimated using STATA's implementation of Newey (1987).

Appendix D. Additional Figures



(a) Pittsburgh, PA (b) Phoenix, AZ

Fig. A1. Toyota and Ford dealers in two major cities.

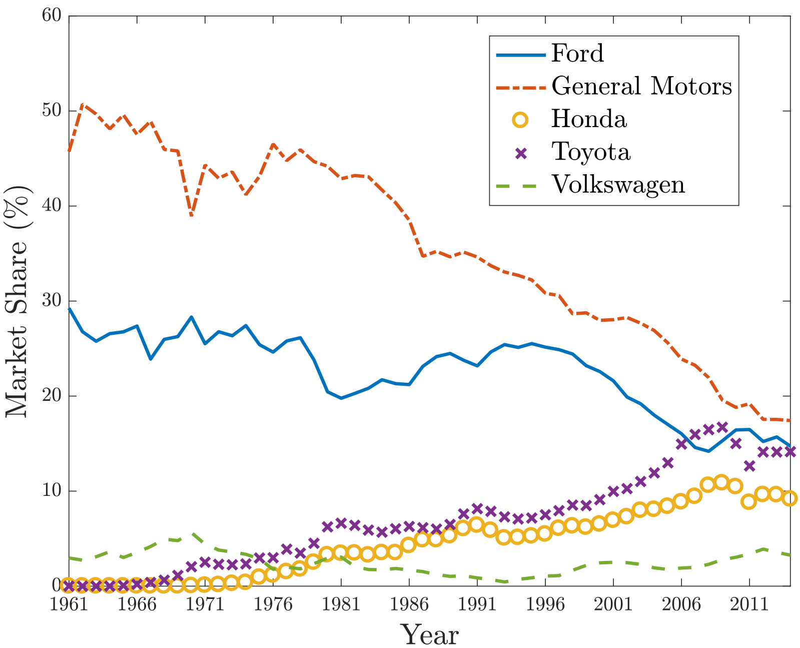


Fig. A2. Market shares of major brands, 1961–2013.

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