Why Do Prices Differ Across Stores?
Differential Competition Environments and their Price Impacts

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Abstract

Our study provides empirical insights into the extent to which differential market demographics and competition environments affect product prices. Using big data, we find that price variations are caused mainly by differential competitive environments. More specifically, we find that *Brand Competition Within Stores,* exerts the largest downward pressure on prices. A 10 percent increase in the number of brands reduces prices by about 10 percent. *Product Competition Within Stores* exerts the second-largest price effect, followed by S*tore Competition Within Local Markets.* Moreover, retailers operating multiple stores in a local market coordinate prices to attenuate competitive downward pressure on prices.

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1) Introduction

The evaluation of price and consumer welfare effects plays a crucial role in economic and business decision-making. The advent of big data has created opportunities to examine price variations for identical products across different stores and markets. Several studies (e.g., Nakamura (2008), Eden (2014), Kaplan and Menzio (2015), Dubois and Perrone (2015), and Hitsch et al. (2021)) have found significant price dispersion for the same product across different locations. DellaVigna and Gentzkow (2019) also observe that prices tend to vary between chains, with smaller differences within stores of the same chain.[1]

This study aims to empirically explore how various market determinants, such as demographics and competition, affect product prices. We particularly focus on competition within and across stores, including product and brand rivalry, and the interaction between retailers.

For managers and policymakers to make informed decisions—particularly on issues like market entry, product launches, mergers, and anti-competitive practices—they must understand how market characteristics influence consumer welfare and pricing (see Federal Trade Commission, 2010). Competition, in particular, plays a significant role by driving down prices, making goods more affordable for consumers. This is why competition and antitrust policies focus heavily on price pressures exerted by competition.

Competition is a fundamental economic concept driven by consumer choice. When consumers can purchase a competitor's product, it typically forces prices downward (Lancaster, 1966; Baumol, 1967; Boone, 2008). Competition can arise in various forms, including competition between firms, stores, brands, and products. Further research is needed to understand how these different layers of competition impact prices, a topic of particular relevance for managers and policymakers aiming to optimize pricing strategies in varying economic and competitive environments.

The retail sector offers a classical example of such competition. When competing with other stores in a local market, retailers must decide how many locations to operate and which

[1] The analysis of price discrimination and price variation has attracted much attention in the economics literature, especially with the availability of big data. Examples are Eden (2014), Dubois and Perrone (2015), and Eizenberg et al. (2021), with a focus on soft drinks (McMillan (2007)), movie tickets (Orbach and Einav (2007)), rental cars (Cho and Rust (2010)), online music (Shiller and Waldfogel (2011)), and the retail market (Stroebel and Vavra (2019). Chevalier and Kashyap (2019) consider intertemporal discounts as a mean of price discrimination. Similar to the cited literature, we also use big data. However, our study differs from their work as we observe price variations across regional markets and empirically evaluate the extent to which competition and demographic market environments affect prices.

products and brands to offer. Prices are influenced by the number of competing stores, as well as by the range of products and brands within each store. A key distinction arises between competition between brands sold across different retailers (inter-retailer competition) and competition among brands within the same retailer (intra-retailer competition). This distinction is especially important for antitrust analysis, particularly when evaluating the effects of vertical restraints.[2] Prices can also be influenced by market demographics, such as income levels, creating opportunities for price discrimination across stores and local markets. That is, retailers can adjust prices of identical products across stores and local markets to competition and demographic market conditions.[3]

Standard economic theories suggest that optimal prices are influenced by several factors, including: (1) marginal costs, (2) market demographics, and (3) competition, which includes the range of products offered within stores and the number of stores or retailers in a local market.[4] However, more empirical research is needed to better understand how market characteristics and competition shape price variations.

The literature presents diverse viewpoints on the role of price-setting authority. DellaVigna and Gentzkow (2019) argue that prices are generally set at the retailer level, while Ellickson and Misra (2008) document more localized pricing strategies that account for consumer demographics. Basker (2007) shows that Walmart's entry leads to competitive responses among large retailers, suggesting some degree of pricing discretion at the local level.

However, whether prices are set at the store or retailer level does not fully explain price variations. A store manager's pricing decisions, accounting for the number of products and brands offered, may result in greater price variation across stores. Conversely, pricing decisions may be uniform across locations, leading to smaller price differences. The same holds for centralized retail management. Price variations depend not only on the authority structure but also on how local and competitive market factors are considered.

Although the structure of retailer decision-making is relevant, this study focuses on examining the impact of market characteristics on price variations. In this context,

[2] For more details, see Rey (2003).

[3] Retailers usually engage in legal agreements with manufacturers, who determine guidelines regarding the minimum and maximum price for a product. Pricing guidelines are intended to protect retailers and manufacturers by providing fair opportunities to generate sales.

[4] See Ma and Siebert (2024) and Bonnet et al. (2022).

manufacturers—particularly brand producers—also influence prices through strategic interactions with retailers.

When examining within-store competition, we account for manufacturers—specifically, brand producers—in the price-setting process. While some retail prices emerge from anonymous market transactions, others are shaped by strategic interactions between retailers and manufacturers. These manufacturers not only produce but may also influence the positioning and pricing of their brands, which we observe in this study.[5]

We choose to focus on one product category: anti-inflammatory drug products (or pain killers). The pain killer market is an appropriate market for our purposes since pain killer products and their associated brands are established and well-known among consumers. Pain killer products are offered at various types of stores, including small and large retail stores, grocery stores, gas stations, etc. Hence, consumers can purchase pain killers at a variety of stores and retailers within and across markets. Furthermore, pain killers are purchased by consumers from all demographic backgrounds.

The pain killer market is characterized by a large variety of products and brands that (1) allows us to control for product differentiation,[6] (2) provides rich competition data within and across stores, and (3) minimizes the influence of private labels, which could obscure price variations. Therefore, we focus on the market for anti-inflammatory drugs (painkillers), a category with well-established products and brands. These products are available across various store types (e.g., large and small retail stores, grocery stores, gas stations) and are widely consumed across demographic groups. The variety of brands in this category makes it an ideal subject for studying price variations and competition dynamics. The market enables us to evaluate price effects depending on a large set of explanatory variables related to cost, market demographics, and competition.

We use a large dataset containing U.S. scanner transaction data from 2018, covering over 80% of retail stores across the country.[7] This dataset includes granular information on local market

[5] Existing literature suggests that grocery prices often reflect vertical relationships between retailers and manufacturers (e.g., Sudhir 2001) and, in European markets, may be further influenced by Resale Price Maintenance or multi-part tariffs (e.g., Bonnet and Dubois 2010; Haucap et al. 2022). These findings underscore the role of incorporating manufacturers and their branded products into competitive analyses.

[6] Exemplary product categories are breakfast cereals (Nevo 2001, Chidmi and Lopez, 2007) and Yoghurt (Draganska et al. 2009).

[7] The Kilts Center at the University of Chicago provided the NielsenIQ Retail Scanner (RMS).

characteristics, including the number of retailers and stores, the range of products and brands offered, and pricing and sales data for more than 1,200 painkiller products. With data from over 71 million purchase transactions and 46,000 stores across 879 regional markets, we can explore how market and competition characteristics affect pricing. One crucial advantage of the dataset is that it includes highly disaggregate information on local markets across the U.S., including the number of retailers and stores, as well as store-level number of products and brands, product prices, and sales volumes. The detailed product information provides an excellent setting for examining the price effects of market and competition characteristics across local stores and markets.

Summary statistics reveal substantial price variation, primarily driven by differences between stores and local markets rather than by price fluctuations over time. Our regression analysis identifies the market determinants that explain most of the price variation. Following DellaVigna and Gentzkow (2019), we address endogeneity concerns using an instrumental variable strategy.

Our regression results show that competition across brands within stores has the largest downward effect on prices. A 10% increase in the number of brands in a store leads to a price reduction of about 10%. The second-largest price reduction is driven by store competition within local markets. A 10% increase in the number of stores in a local market results in a 1% price decrease. Retailers with multiple stores in a local market can internalize competitive pressures, which diminishes price competition among their own stores.

Other market characteristics, such as market size and demographics (e.g., income, age, and unemployment rates), have smaller effects on prices. For instance, a 10% increase in income results in a 1% price increase. These findings have important implications for retail competition analysis, highlighting the significant role of inter-brand competition and manufacturers' influence on pricing. This insight is valuable for antitrust analyses, particularly in the context of grocery markets and vertical restraints.

Overall, our study provides empirical evidence that competition between brands and manufacturers, along with store competition, exerts the greatest downward pressure on prices. In contrast, competition among products within a retailer and other market characteristics have a smaller impact on prices.

The study is structured as follows: Section 2 provides insights into the market and summary statistics on price and market variation across local markets. Section 3 outlines the empirical model. Section 4 presents the estimation results and explores competitive effects on prices and margins. Section 5 concludes.

2) The Data

2.a) The Datasets

Our empirical analysis builds on several datasets. The Kilts Center at the University of Chicago provided the NielsenIQ Retail Measurement Services (RMS) retail scanner data and the NielsenIQ Homescan consumer panel data. The RMS dataset records product-level revenue and sales information for more than 47 thousand U.S. retail stores (including grocery stores, mass merchandisers, drug stores, convenience stores, and gas stations).

We focus on one product category, the anti-inflammatory drug market (pain killers), which allows us to concentrate fully on multiple competition environments. Pain killer products are defined using "universal product codes" (UPCs), which are identical across stores. Products are classified by brands, package sizes, dosages, and form of administration (tablets, capsules, caplets, etc.). For each product, we observe weekly sales and weekly revenues generated at every retail store. Each store's product assortment is defined by its completed weekly transactions. The retailers carry unique IDs that allow us to cross-link retailers across stores and local markets. Localities of retail stores are identified at the three-digit zip code level, which is the smallest geographic unit provided in the Kilts-NielsenIQ RMS data. Hence, in accordance with most of the studies cited earlier, we define the geographic market as the designated market area (DMA) at the three-digit zip code level.

The original scanner information stems from more than 85 million pain killer sales transactions that were conducted across U.S. retail stores in 2018. The scanner data represent almost 80 percent of all U.S. retail revenue in pain killers, such that extensive selection concerns are attenuated. We remove outliers by deleting the top and bottom 5 percent of observations of the product price distributions and the top 5 percent of the product sales distributions. We remove price promotions as defined by store-specific price changes that exceed more than 5 percent from one week to another. This procedure has been adapted frequently in marketing studies (see Hitsch et al. (2021)). After cleaning the data, our analysis encompasses information from more than 71 million sales transactions conducted in more than 46 thousand stores across 879 local markets. The dataset encompasses 84 brands, 143 retailers, and 46,933 stores, as well as prices and sales information of more than 1,200 different pain killer products.

To provide an example of the terminology being used in this study, we consider retailers (retailer A, retailer B, etc.) and their corresponding stores (e.g., a store by a specific retailer in a specific local market as defined by a three-digit zip code) that offer brands (Advil, Tylenol, etc.) and specific products (Tylenol 500 mg caplets, 100 pack).[8]

Drugs are sold at different dosages, which contain different amounts of the active ingredients. For example, Tylenol is sold in dosages of 325 mg, 500 mg, etc. They are also sold in different package sizes---containing 50 units, 100 units, etc. Our empirical analysis accounts for variations across dosage amounts and package sizes to avoid artificial price variations.[9]

We collect demographic information at the local market level from the Census Data Household Survey. This information includes county population, median age, and unemployment rate. We retrieve income data from the statistic of income office, which uses individual income tax returns (Forms 1040) filed with the Internal Revenue Service.

We retrieve information on wholesale prices from the IBM Micromedex Database.[10] This database provides information identified by the National Drug Code matched manually with the UPC.[11]

2.b) An Example for Price Variations across Stores and Markets

We begin the data descriptives by providing an illustrative example to motivate the existence of price variations across stores. (Later, we provide large-scale evidence from our big data that prices for the same products vary within and across local markets.) We focus on two cities or local markets in Indiana---West Lafayette and Lafayette. The two local markets lie adjacent to each other, separated only by the Wabash River (see Figure 1). These two cities differ

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[8] We refer to retailer A, retailer B, etc. to comply with the data provider's data policy to not disclose specific identities of retailers.

[9] We use two price measures to account for this. First, we use the price per pill product-specific weekly price per pill sold in a retail store (calculated using weekly product-specific revenues at the store level divided by sales and number of pills in a package). The different dosages and package sizes will then be accounted for in the empirical model. This helps us avoid distortions. Second, we consider product-specific weekly prices per mg (calculated using weekly product-specific revenues at the store level divided by sales and dosage/strength as measured in mg) to conduct further robustness checks.

[10] The IBM Micromedex data provides information on average wholesale prices. Note that the information is not available for all varieties which explains a slight loss of some observations. However, robustness check show that the loss of observations has hardly any impact on our estimation results.

[11] Homeopathic medicine is not listed in the Micromedex Database since there is no active ingredient that would require its listing. Manual matching was applied to products that exceed a sales threshold of around 1 percent.

in their demographics. For example, in West Lafayette 44.9 thousand people reside in West Lafayette (most are associated with Purdue University), the median age is 21.4, and the median household income is $30,317 (as of 2022). Lafayette has a population of 70.8 thousand people (many working in the manufacturing industry), the median age is 33, and the median household income is $50,674 (as of 2022).

We compare prices across the two cities while first concentrating on the two top-selling pain killer products (Tylenol 500mg, 100 caplets and Advil 200mg, 100 tablets). Figure 2 shows that prices of the Tylenol product differ drastically across retailers and cities. Moreover, focusing on one retailer (here, retailer C), prices differ across cities (see Figure 3). It is somewhat surprising that the price in the West Lafayette store is higher than that in the Lafayette store, even though West Lafayette is a smaller city, characterized by lower income and lower age. The demographics would suggest the opposite---that is, prices should be lower in West Lafayette. Turning to the number of stores and retailers as a measure for competition, West Lafayette has fewer stores and retailers than Lafayette, which suggests that competition is lower resulting in less downward pressure on prices. This fact serves as a first indication that competition in local markets plays a relevant role for which we need to account.

We adopt the same search for the other top-selling product (Advil) and realize the same price patterns across cities and stores (see Figures 4 and 5). Moreover, the product prices for Tylenol and Advil are very similar within the stores in West Lafayette and within the store in Lafayette, which signals that in-store competition across products/brands is intense.

2.c) Summary Statistics

To become more familiar with the pain killer market and the data, we provide summary statistics. Table 1 provides information on the 10 largest brands ordered by descending market share. Column 1 shows that private labels hold the largest market share, followed by Advil, Aleve, Tylenol, etc. The top 10 brands generate weekly revenues of around $700 million (see Column 2). To compare brand prices, we follow earlier studies and consider the average brand price per pill measured at the weekly level ($P_{Brand,Week}$) (see Column 3). There is a large variation in average prices across brands. The average price per pill varies from 5 cents for Bayer products to 76 cents for Goody's products.[12]

[12] We also use pill prices normalized by dosage (in mg) and can confirm that the large price variation across brands prevails.

We report summary statistics at the product level. Table 2 displays the top 10 pain killers ordered by descending market share. Column 1 shows that Tylenol 500mg caplets, 100 units is the top-selling pain killer product in the U.S. The product generates weekly revenues of $293 million on average (see Column 2). Column 3 shows that the average weekly product prices per pill ($P_{\text{Product,Week}}$) vary drastically across products, from 5 cents to 13 cents per pill. Figure 6 illustrates the evolution of the average price of the top 10 products by week in 2018. The figure displays little price variation over time for products beyond a small shift in magnitude at the end of the year.

We go beyond the top 10 top-selling pain killer products and consider the price variations of all products in our dataset. Moreover, we focus our analysis on examining price variations of identical products across local markets. We define a local market at the three-digit zip code level and consider product prices offered by stores within local markets in specific weeks.

Table 3 reports an average price per pill of 16 cents with a large standard deviation of 14 cents. The large standard deviation supports the argument that product prices vary drastically. It is important to recognize, however, that these price variations stem from a pooled panel data structure, so price variations are measured across products and within products (across time periods). To gain further insight into the primary source of price variations, we adopt two price dispersion measures commonly used in previous studies (see also Della Vigna and Gentzkow (2019), Goldberg and Verboven (2001), and Hitsch et al. (2021)).

The first measure focuses on identical products across local markets and evaluates the degree of *price variations across markets* while conditioning on time periods. We construct this measure by focusing on an identical product and dividing the standard deviation of prices across local markets by the mean of prices across markets. We conduct this individual product measure separately for every time period and then use the average across time periods. Finally, we average across all products. The *price variations across markets* measurement returns a value of 1.428. Hence, the standard deviation is much larger than the mean, providing evidence for large price dispersions of the same product.[13] Robustness checks confirm that the large price variation prevails if we condition on tablet dosages and package size.

[13] Other studies using the same measurement report price variations across products that lie in the neighborhood of one and identify these as large price variations (see Grennan (2013)).

The second measure captures *price variations within a market (across time)*. In accordance with the first measure, we condition on an individual product and divide the standard deviation of a product price across time by the corresponding mean across time. We repeat this for every product and market and use the average across products and markets. *Price variation within a market* takes a value of 0.139. This value is about 10 times smaller compared with *price variations across products*, which shows that the largest source of price variation is stemming from variation across products and local markets. This result is consistent with Figure 6, which shows large price differences across products but little variation across time periods.

The finding that prices vary drastically across products and local markets indicates that local market characteristics (such as competition, market size, and market demographics) are important features to account for, while seasonal and promotional effects that cause price variation within product lines are not as crucial. At this moment, however, it remains unclear which type of market characteristics influence prices the most. This is an empirical question, and it becomes the main focus in our empirical model section.

Table 3 shows summary statistics of the main variables used in our empirical analysis.[14] The average price per pill across weeks, products, and local markets is 16 cents with a corresponding standard deviation of 14 cents. For robustness purposes, we also use the pill prices per mg dosage. The average is around 0.8 cents with a standard deviation of 0.6 cents. The large standard deviation relative to the mean further strengthens the existence of large price dispersions.

The average wholesale price per pill is 13 cents with a standard deviation of 7 cents. It is noteworthy that the standard deviation of the wholesale price per pill is smaller than the standard deviation of product prices. Moreover, the standard deviation divided by the mean is much smaller for wholesale prices compared to the product prices. Hence, the price variation is larger for product prices in comparison with wholesale prices. This observation further supports the fact that differential market characteristics across local markets are important in explaining price differentials.

Turning to the average (normalized) price-cost margin---defined as *[[Price per Pill-Wholesale Price per Pill]/Price per Pill*]---Table 3 displays an average (normalized) price-cost margin of 27 percent. The magnitude of the margin is reasonable, and it conforms with published

[14] The variable definitions and the corresponding data sources are provided in the Appendix, Tables A.1 and A.2.

industry insights from the business press.[15] It should be noted that the variation measure, as defined by standard deviation divided by the mean, amounts to 0.7 which indicates a large amount of variation in price-cost margins. This variation is also large compared to the variation in wholesale prices (0.54). This is explained by the fact that prices are part of the price-cost margins and this pronounces the price-cost margin variations. This finding further supports the conjecture that market characteristics are important determinants of price variations.

We now turn our focus to various market characteristics that could impact product prices. We begin with the competition measures. We will incorporate several competition environments that reflect different viewpoints in terms of who has the authority to set product prices. We then empirically test the extent to which each competitive environment explains downward pressure on prices.

We consider four competition environments. The first two competition environments capture competition within a store, while the others account for competition across stores.

Product Competition Within a Store: This environment relates to the fact that products compete within a store. Several studies refer to store managers as being in charge of setting product prices. This implies that product prices are susceptible to product offerings within a store. This is a reasonable view since shoppers choose between alternative products offered within the store. Opportunities for customers to switch between products impose downward pressure on prices. Prices will decline as more products are introduced into the store. We establish the measure *Product Competition Within a Store* by using the number of pain killer products offered within a store.

It should be noted that a larger number of products in a store can also cause a countereffect and elevate product prices. The reason is that customer appreciate having larger product variety, as it becomes more likely that they will find their desired products in one store without having to switch stores. Consequently, consumers' willingness to pay for products may increase, which can result in price increases.

Table 3 shows that there is large variation in terms of the number of products offered within stores, which may imply different degrees of *Product Competition Within Stores.* On average, stores offer 50 pain killer products (with a standard deviation of 24). Figure 7 shows that the distribution of the number of products offered in stores is slightly left skewed. Figure 8 shows that

[15] https://pharmatimes.com/news/margins_squeezed_at_otc_drugmakers_995672/.

the average price per pill declines as the number of products offered in a store increases. At first sight, the number of products offered in a store appears to impose downward pressure on prices.

Brand Competition Within a Store: This competition environment builds on studies demonstrating that brand recognition is an important characteristic that influences consumer purchasing behavior. Furthermore, it is shown that manufacturers and retailers determine retail prices depending on store presence. It is reasonable to assume that brands compete less with products within their own product line (due to internalization of demand externalities) but compete more intensely with products from other brands. We establish the competition measure *Brand Competition Within a Store* using the number of brands offered within stores. This measure allows us to test whether competition among brands within stores is more intense than competition among products within stores. Table 3 shows that on average 12 brands compete within a local store (with a standard deviation of 3). Figure 9 shows that the number of brands in stores is close to normally distributed. Figure 10 shows a negative correlation between number of brands and product prices.

Store Competition Within a Market: This competition measure builds on spatial models that show that a larger number of stores introduced into the market reduces consumers' transportation costs and provides more opportunities for consumers. Therefore, more competing stores introduced into the market causes higher competition and more downward pressure on product prices. Table 3 shows that the number of stores differs drastically across markets, taking an average of 113 stores with a large standard deviation of 85 stores. Figure 11 shows that the distribution of the number of stores is right skewed. Figure 12 displays a slightly negative correlation between the number of stores in a local market and product prices.[16]

Store Competition Within Retailers: This competition measure accounts for the fact that a retailer can internalize competitive externalities among its own stores within a local market. Coordination of prices among a retailer's own stores diminishes price competition. Table 3 shows that a retailer introduces on average nine stores into the same local market (with a standard deviation of 6). Figure 13 indicates that the distribution of stores is right-skewed. Figure 14 shows that a higher number of stores owned by the same retailer increases price. It seems unusual that more stores by a retailer would in fact increase price (rather than attenuate price reductions). However, when evaluation the total effect of store competition within retailers, we need to account

[16] Note that we use the predicted prices after controlling for demographics and dosage, which limits the sample due to outliers.

for the fact that another store per se is introduced into the market another effect (as measured by the variable *Store Competition Within a Market*).

We are especially interested in empirically evaluating the isolated effects of each competition environment on prices. Since product prices are affected by more than just the competition environments, we also include product characteristics (wholesale costs, dosage, packaging size) and other market characteristics (market size and consumer demographics).

3) The Empirical Model

The aim of our empirical analysis is to examine the sources of price variation observed in the data. We have shown that *price variations of identical products across markets* largely exceed *price variations within a market (across time).* Therefore, we put special attention to how differential market characteristics---including the different types of competition---affect prices.

We follow standard theoretical models in specifying a pricing equation, which includes various product and market characteristics:

$$\ln\left(Price\ per\ Pill_{i,t}\right) = \alpha + \beta * X_i^P + \gamma * X_{i,t}^C + \delta * X_{i,t}^M + FE_t + \epsilon_{i,t} \ , \qquad (1)$$

where the dependent variable is the natural log of *Price per Pill.* The sub-indices *i,* and *t* represent a particular product *i* in a particular store located in a specific local market (specified by the three digit zip-code), at the corresponding week *t*, respectively. On the right-hand side of the equation, we include a constant, α, and a vector, X_i^P, which includes a set of product characteristics. We include *Package Size* since a larger package size saves on packaging costs and, therefore, generates scale economies, having a potential effect on price. We also include *Dosage* of a pill since higher concentrations require larger amounts of ingredients, which increases material cost and prices. Finally, we include the log of *Wholesale Price,* which captures procurement and remaining production costs. The β vector includes the associated coefficients.[17]

The vector $X_{i,t}^C$ includes the competition environment introduced earlier. We account for two within store competition measures (*Product Competition Within a Store* and *Brand*

[17] Note, the magnitude of the coefficient estimate for the *Wholesale Price* will indicate the extent to which wholesale prices will be passed on to sale prices, also referred to as the pass-through. The pass-through is expected to be between zero and one, indicating no and full pass-through, respectively. For further discussion on the pass-through of costs in the context of cartel overcharges, see Verboven and Van Dijk (2009).

Competition Within a Store) as well as two across store competition indices (*Store Competition Within a Market* and *Store Competition Within Retailers*).[18] The vector of coefficients (γ) summarizes the effects that each competition environment has on product prices.

The vector $X_{i,t}^{M}$ includes further market characteristics such as *Market Size, Age, Income,* and the U*nemployment Rate*. The associated price effects are summarized in the coefficient vector δ. Table A.1 in the appendix provides an overview of the dependent and independent variables.

4) The Estimation Results

Table 4 displays the estimation results of the price equation (1). The first five columns show various specifications that differ by subsequent additions of competition indices. We estimate these specifications by OLS.

The coefficient estimates on the product characteristics appear reasonable in terms of signs and magnitudes. Larger *Package Sizes* reduce prices while higher Dosages and higher *Wholesale Prices* increase product prices.

Most coefficients on the competition environments carry negative signs, as expected. It should be mentioned, however, that the coefficients on *Product Competition Within a Store* and *Store Competition Within Retailers* carry positive signs in the full specification, as shown in Column (5). The positive coefficient on *Store Competition Within Retailers* could be explained by the fact that retailers internalize competitive externalities, as mentioned earlier. It should be noted that the total effect of a retailer introducing another store is composed of the sum of two isolated effects---*Store Competition Within Retailers* and *Store Competition Within a Market*---since an additional store introduced by a retailer also creates additional competition.

The positive coefficient estimate on *Product Competition Within a Store* seems to indicate that the love of product variety and the associated higher consumer willingness to pay outweighs the product competition effect.

Finally, the coefficients on the market determinants *Market Size, Income,* and *Unemployment Rate* carry the expected signs, while the estimate for *Age* is switching signs across the five specifications.

[18] Our empirical analysis relates to the store level and, thus, controls for competition among stores, see also Della Vigna and Gentzkow (2019). We also added retailer-fixed effects, but this led to decreasing explanatory power of the overall model while the magnitudes of the estimation coefficients change only minimally. Results are available upon request.

It is important to recognize that the estimation results need to be interpreted carefully due to potential endogeneity concerns regarding the competition measures. More specifically, missing variables and unobserved shocks having an impact on prices could also determine entry incentives. For example, large manufacturing plants entering a local market may increase demand and prices, which create additional incentives for retailers and stores to introduce further products, brands, and stores.

We address the potential endogeneity issue of these competition measures using established instruments, as frequently used in industrial organization and marketing studies (see Hausman (1996) and Nevo (2000)). The instrumental variable technique suggests the use of instrumental variables of nearby local markets. In our application, this relates to using the competitive measures (number of products and brands within stores, number of stores within a market, and number of other retailer stores within a market) from adjacent markets, see Appendix Table A.2.

The rationale of adopting this instrumental variable strategy relies on correlation between retail prices across local markets due to common costs across markets. This rationale applies in our context since product, manufacturing, and ingredient costs are specific to the products but independent of local market. Marginal costs are drug specific since a drug is manufactured based on a specific molecular structure and its associated chemical ingredients. Furthermore, transportation and procurement costs support the fact that markets in close proximity are characterized by similar marginal costs.

A further underlying assumption of this instrumental variable approach is that demand shocks are uncorrelated across local markets. This is a plausible assumption in our case since shopping behavior is rather local and no demand spillovers exist across local markets. Furthermore, we observed drastic price variations across markets, which supports the notion that prices are determined by local market characteristics.

The instrumental variable estimation results are shown in Table 4, Column (6). A joint F-test of these instruments returns an F-statistic of at least 4.4e+05, which exceeds the value of 10 and provides strong support for using these instruments. The coefficient estimate on *Product Competition Within a Store* shows that having a larger number of products within stores intensifies competition and reduces prices. An additional pain killer product reduces the product price in the store. Column (7) shows the corresponding elasticity indicating that a 10 percent increase in the pain killer variety reduces the product price by 0.16 percent, which appears to be relatively small. However, if we doubled the number of products within a store, the price would be reduced by 1.6 percent. This appears reasonable given that the average normalized price-cost margin is 27 percent. In general, the downward pressure on price is probably smaller than expected. As noted earlier, however, the price competition effect seems to be attenuated by the product variety effect, which works in the opposite direction; it therefore diminishes the impact of *Product Competition Within a Store.* The small effect suggests that store managers have less incentive to reduce prices as the number of products in a store increases. It could possibly be interpreted that store managers would not readjust prices that much. Moreover, a brand manufacturer is hesitant to engage in severe price competition among its own products as well since this would cannibalize its own demand and take away from the brand's profits. Finally, we need to factor in that the price effect is limited to a change in only one out of four competition measures.

Turning to the second within store competition measure (*Brand Competition Within a Store*), the results show a coefficient estimate of -1.03. The corresponding elasticity shows that a 10 percent increase in brands within a store would reduce prices by 10.3 percent. Therefore, *Brand Competition Within a Store* imposes a higher downward pressure on prices compared with *Product Competition Within a Store,* highlighting the importance of intensive inter-brand competition. The intensive *Brand Competition Within a Store* effect on prices (especially in comparison with *Product Competition Within a Store*) is remarkable and explained by the fact that brand manufacturers compete intensively against other brands. However, they avoid competing against their own products, as the *Product Competition Within a Store* measure shows. Finally, the strong brand competition indicates that prices are determined by brand manufacturers or at a higher retailer level determining prices across stores.

Focusing on competition across stores measures, the coefficient on *Store Competition Within a Market* takes on a negative value. The associated elasticity shows that a 10 percent increase in local stores would reduce product prices by 0.8 percent. While the price effect is quite pronounced, it is slightly smaller compared with the brand competition effect.

The coefficient estimate on *Store Competition within Retailers* shows that a 10 percent increase in additional stores by a retailer increases prices by 2 percent. This net effect has to be adjusted by the fact that another store is being introduced, which imposes downward pressure on prices. The net effect results in a 1.2 increase in price if a retailer increases its store representation by 10 percent. At first glance, this result appears counterintuitive, as more stores are expected to increase competition and reduce prices. However, our result provides evidence that a retailer internalizes negative competition externalities that it imposes on each of its outlets. Therefore, it accounts for the fact that an additional store would cannibalize its demand and impose competitive downward pressure on price. To alleviate this downward pressure on price, it considers a joint profit-maximization objective, which accounts for competition and internalizes cross-price effects among its own retailers and results in elevated prices. In other words, retailers coordinate prices among their outlets.

Turning to the estimation results of the remaining market determinants (Table 4, Column (6)), we find retailers serving markets with larger and older populations and higher unemployment rates charge lower product prices. In contrast, stores located in wealthier neighborhoods charge higher prices. Among these remaining market determinants, *Income* exerts the highest price effect. A 10 percent increase in average income in the neighborhood would increase price by 1 percent. This effect is smaller than any of the four competition measures.

Overall, we find that the remaining market determinants impact prices, which supports price discriminatory strategies. Competition matters, as it has the strongest effect on prices compared to other market characteristics.

We adopt a robustness test regarding the measurement on prices. It is debatable whether prices per se is an appropriate procedure to evaluate differential competitive forces. While proponents suggest that price is all that matters from a consumer's perspective, opponents remark that products are characterized by different markups that characterize providers' market power and this is a more appropriate measure for competition (see also Boone (2008) and Griffith et al. (2010) for a discussion on price-cost margins). We adopt this alternative measure and replace the endogenous variable in our regression equation (1) with the normalized price-cost margins [[*price per pill*-*wholesale price per pill*]/*price per pill*] while using the same regressors and the same set of instruments as before. Table 5 shows the instrumental variable estimation results. The coefficients on the competition measures and the remaining market characteristics return the same signs as in our earlier estimations. Moreover, most coefficients using the markups are smaller in magnitude. This is reasonable since the normalized price-cost margin is smaller than price.

In a next step, we evaluate the elasticities of these variables to illustrate the relative impact of the different variables. As shown, *Brand Competition within a Store* exerts the largest impact of all competition variables. An increase by 1% reduces the price-cost margin by 2%. The second-largest impact is caused by *Store Competition within a Market*; an increase in *Store Competition within a Market* by 1% reduces the price-cost margin by 0.14%. An increase of *Product Competition within the Store* by 1% reduces the price-cost margin by only 0.08%. The coefficient of *Store Competition Within Retailers* has still a positive sign, showing that an increase of 1% of this measure increases the margin by 0.37%. Overall, the elasticities show that *Brand Competition within a Store* has a strong competitive impact on the prices of pain killer products.

Table 6 shows the impacts of the competition measures on the normalized margin (as shown in Column 1) and the overall impact of the competition measures evaluated at the mean of the observed sample (Column 2). *Brand Competition Within a Store* again exerts the largest competitive impact. Evaluating the impact at the sample mean of the sample shows that brand competition reduces price-cost margins by 57 percent. The second largest competitive impact is caused by *Store Competition Within a Market,* which reduces the normalized price-cost margin by 12 percent. Consistent with our earlier findings, *Product Competition Within a Store* has the smallest competitive effect; if products were doubled, the price-cost margin would change from 27 to 25 percent.

Finally, the effect of *Store Competition within Retailers* confirms our earlier results that retailers are able to coordinate prices among their stores. If retailers doubled their multi-store presence, the price-cost margin would increase from 27 percent to approximately 37 percent. The net effect, however, has to consider the introduction of a further store per se and it would result in a 1 percentage point decline in the price-cost margin.

Further Robustness Tests

We adopt further robustness tests. First, we used alternative definitions of our competition variables. More specifically, instead of using the number of products, brands, stores, and retailers per se, we weight these numbers by the revenues within a store and retailer. The estimation results are shown in Table A.3. The estimation results confirm our previous results in terms of signs, magnitudes, and significances.

Second, we tested whether our results are robust regarding the definition of local markets. In following other studies, we defined the local market at the more aggregate level and use the county level instead of the zip code level. The estimation results are quantitatively and qualitatively similar to our previously reported results.

Finally, we considered an alternative set of instruments. While the adopted instrumental variable approach above is widely used in the literature, its reliance on uncorrelated demand shocks could be considered questionable. To address this, we provide robustness test by incorporating county-specific demand shifters based on health outcomes, which instrument demand for painkillers and further validate the impact of within-store competition indices, see Appendix A.4. The estimation results are comparable in magnitude and efficiency levels to our previous results.

5) Conclusion

This article examines why and to what extent prices differ across stores and local markets. Building on big data, we empirically evaluate the extent to which different market determinants affect prices. We highlight the relevance of different competition environments in the marketplace having strong price-reducing effects.

We find that the highest price-reducing effects are caused by *Brand Competition Within Stores*, followed by *Product Competition Within Stores.* In contrast, S*tore Competition Within Local Markets* has a rather small effect on prices. Hence, a strong take-away is that competition among products and brands, and, thus, between manufacturers, within stores exerts more downward pressure on prices compared with competition across stores. We also find that retailers operating multiple stores in a local market adopt pricing strategies to internalize competitive externalities.

Our results provide important insights for competition policies targeting the evaluation of competition and investigating determinants of price, such as market entry and mergers. Our results are also insightful for business managers when determining optimal prices.

Figures

Figure 1: West Lafayette and Lafayette in Indiana

Figure 1 shows that the cities, West Lafayette and Lafayette (Indiana), are located next to each other. Source: Google Maps.

Note that information mentioned in Figures 2- 5 are taken from Google. They serve only for illustrative purposes and are not related to the NielsenIQ data.

Figure 2: Price Comparison for one Tylenol Product

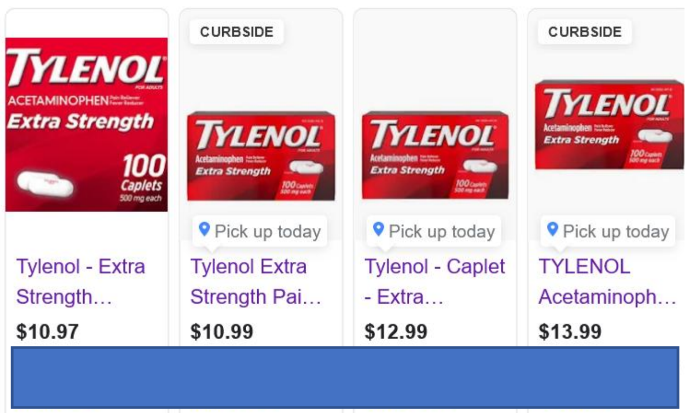

Figure 2 shows a price comparison for Tylenol 500mg, 100 caplets. Source: Google Shopping.

Figure 3: Price Comparison for one Tylenol Product across Markets

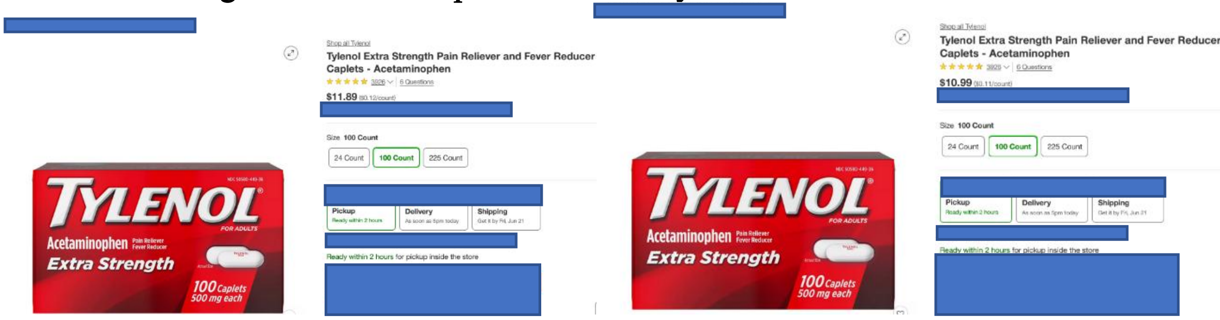

Figure 3 shows a price comparison (Tylenol 500mg, 100 caplets) across a Retailer's stores in both local markets. The left (right) display shows West Lafayette (Lafayette). Source: Google Shopping.

Figure 4: Price Comparison for one Advil Product

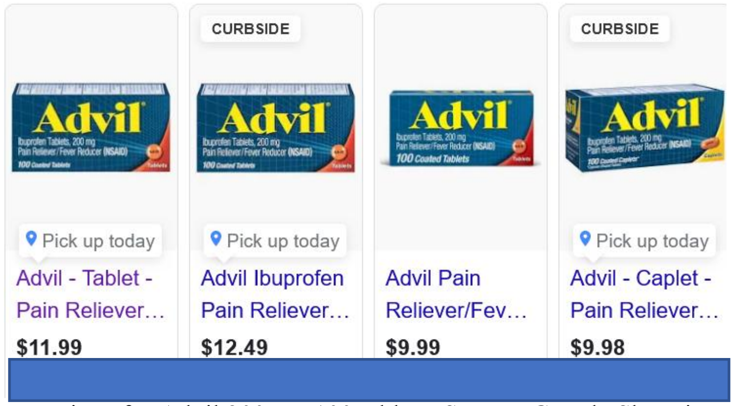

Figure 4 shows a price comparison for Advil 200mg, 100 tablets. Source: Google Shopping.

Figure 5: Price Comparison for one Advil Product across Markets

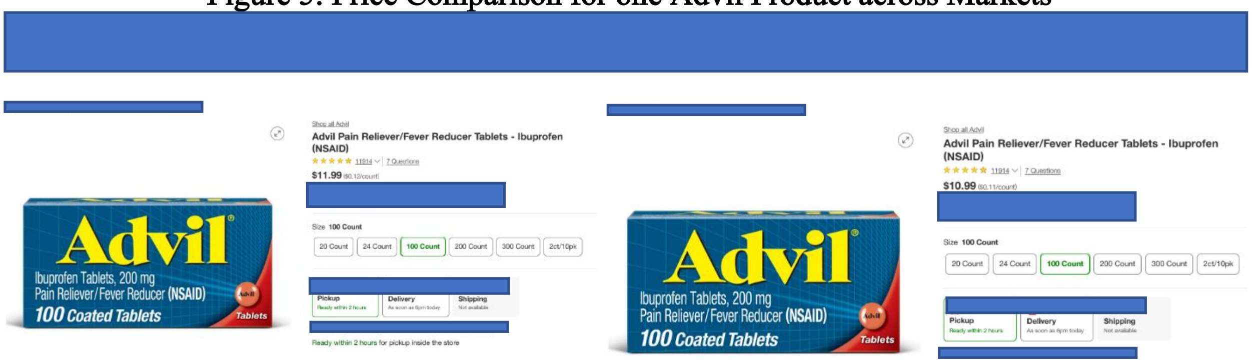

Figure 5 shows a price comparison (Advil 200mg, 100 tablets) across a Retailer's stores in both local markets. The left (right) display shows West Lafayette (Lafayette). Source: Google Shopping.

Figure 6: Average Price of Top Ten Products

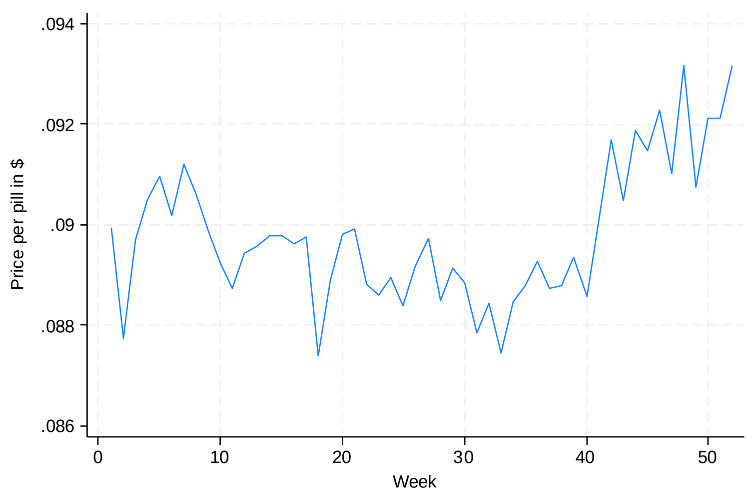

Figure 6 shows average (revenue weighted) product-specific prices per pill for the top ten pain killer products across weeks in 2018.

Figure 7: Number of Products in Stores across Markets

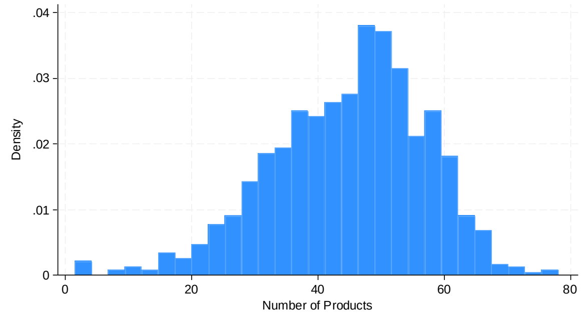

Figure 7 shows the number of pain killer products offered in retail stores across U.S. local markets.

Figure 8: Prices depending on Number of Products per Store

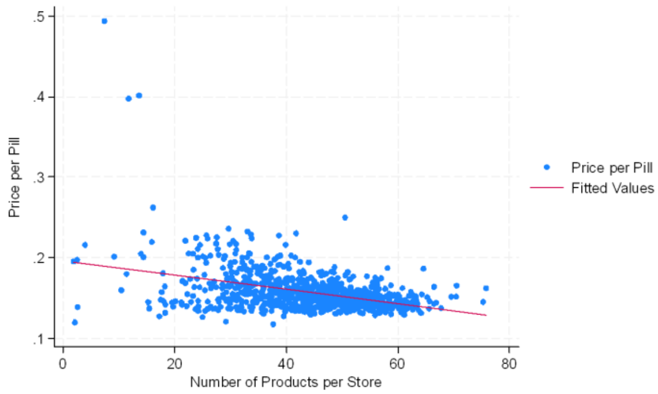

Figure 8 shows the prices of pain killer products depending on the number of products offered in a store.

Figure 9: Number of Brands in Stores across Markets

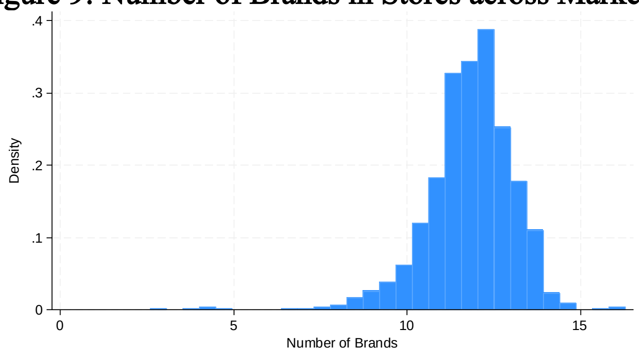

Figure 9 shows the number of pain killer brands offered in retail stores across U.S. local markets.

Figure 10: Prices depending on Number of Brands per Store

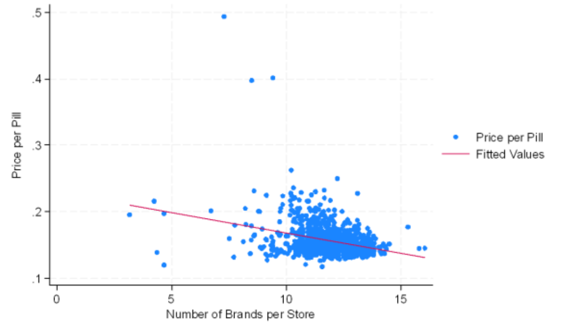

Figure 10 shows the prices of pain killer products depending on the number of brands offered in a store.

Figure 11: Number of Stores across Markets

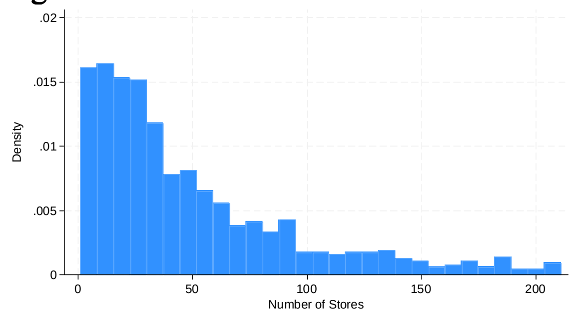

Figure 11 shows the number of stores across U.S. local markets.

Figure 12: Prices depending on Number of Stores

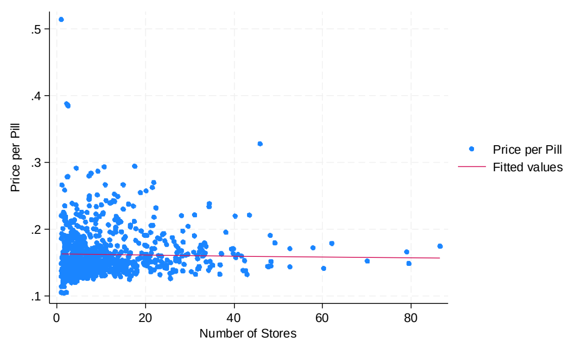

Figure 12 shows the prices of pain killer products depending on the number of stores in local markets. Fitted values use predict price conditioned on demographics and dosage.

Figure 13: Number of Stores per Retailer across Markets

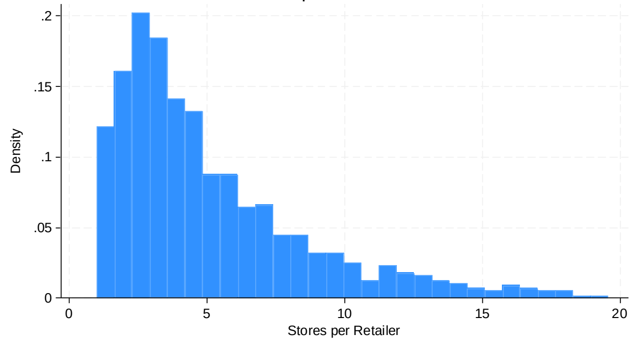

Figure 13 shows the number of retail stores per retailer across U.S. local markets.

Figure 14: Prices depending on Number of Stores per Retailer

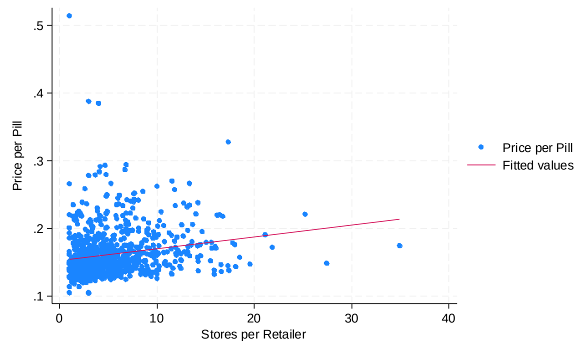

Figure 14 shows the correlation between the number of stores per retailer and product prices.

Figure 15: Price Impact of Competition Variables (Semi-Elasticity)

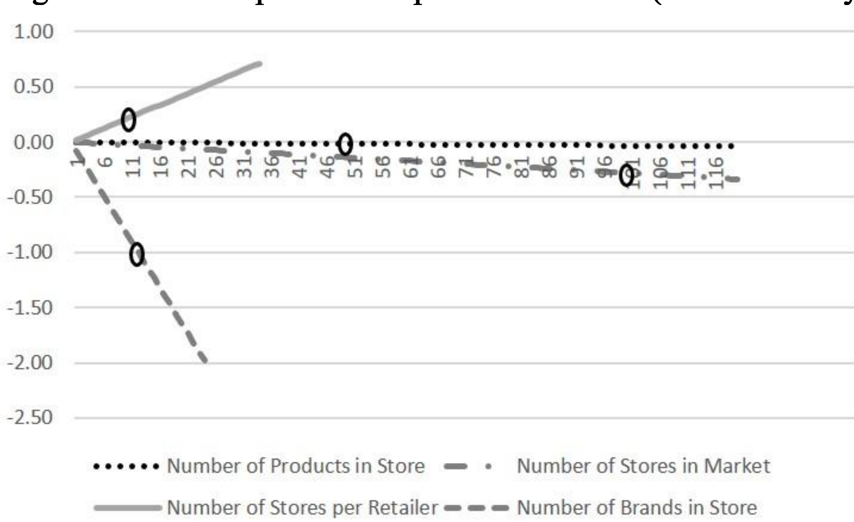

Figure 15 shows the impact of the competition indices on prices based on the estimation results shown in Table 4, Column 6. Mean values of specific competition variables are encircled.

Tables

Table 1: Top Ten Brands (Ordered by Descending Market Shares)

Brand Names	Market Shares (1)	Revenues (2)	Price per Pill (3)
PRIVATE LABELS	0.30	2,501.09	0.06
ADVIL	0.22	1,841.55	0.29
ALEVE	0.14	1,119.15	0.07
TYLENOL	0.12	984.79	0.12
BAYER	0.08	640.18	0.05
EXCEDRIN	0.06	510.95	0.26
MOTRIN	0.04	302.03	0.13
BC	0.01	72.46	0.15
GOODY'S	0.01	63.17	0.76
MIDOL	0.01	62.61	0.31
Mean	0.08	689.25	0.17

Table 1 shows brand-specific summary statistics ordered by market shares in descending order. Market Shares are computed using the total number of observations of 71,202,013. Brand-specific variables encompass all brand-specific products. The unit of observation is defined at the brand-weekly level. Revenues are measured in million dollars and prices are measured in dollars.

Table 2: Top Ten Products (Ordered by Descending Market Shares)

Product Names	Market Shares (1)	Revenues (2)	Price per Pill (3)
TYLENOL Acetaminophen Extra Strength Caplets, 100 pills	0.035	293.434	0.102
TYLENOL Acetaminophen Extra Strength Caplets, 225 pills	0.033	275.569	0.075
ADVIL Ibuprofen Tablets, 200 pills	0.027	221.943	0.078
ADVIL Ibuprofen Tablets, 100 pills	0.022	184.819	0.094
BAYER Aspirin Low Dose Enteric Coated Tablets, 300 pills	0.022	184.279	0.051
ADVIL Ibuprofen Tablets, 300 pills	0.021	170.661	0.069
ADVIL Ibuprofen Liquid Gel Capsules, 160 pills	0.019	157.003	0.104
PRIVATE LABEL Ibuprofen Tablets, 500 pills	0.019	156.802	0.029
ADVIL Ibuprofen Liquid Gel Capsules, 80 pills	0.018	146.399	0.131
ADVIL Ibuprofen Liquid Gel Capsules, 200 pills	0.014	116.006	0.104
Mean	0.02	206.194	0.087

Table 2 shows product-specific summary statistics ordered by market shares in descending order. Market Shares are computed using the total number of observations of 71,202,013. The unit of observation is defined at the product - weekly level. Revenues are measured in million dollars and prices are measured in dollars.

Table 3: Summary Statistics across Local Markets

Variables	Mean	StdDev	Min	Max
<u>Product Characteristics</u>				
Price per Pill	0.16	0.14	0.01	0.99
Price per mg	8.29E-04	5.90E-04	8.61E-05	6.51E-03
Wholesale Price	0.13	0.07	0.05	0.44
Normalized Price-Cost Margin (Ratio)	0.27	0.19	9.63e-09	0.88
Package Size	87.34	105.25	1.00	1,000.00
<u>Competition Indices</u>				
Competition Within Stores				
Product Competition Within a Store	49.83	23.54	1	143.00
Brand Competition Within a Store	12.34	3.17	1	29.00
Competition Across Stores				
Store Competition Within a Market	112.65	85.47	1	524.00
Store Competition Within Retailers	9.06	5.61	1	34.93
<u>Market Determinants</u>				
Market Size	1,099,876	1,752,498	731	1.01e+07
Age	38.29	3.92	24.9	67.5
Income	64,632.55	14,408.18	33,533.79	163,395
Unemployment Rate	3.92	1.04	1.4	18.9

Table 3 shows summary statistics of the main variables used in our empirical analysis. Total number of observations: 71,202,013. Prices and income are in US-Dollars. Market size is measured using the population. Package size is measured by the number of pills.

Table 4: Regression Results

Dependent Variable: Ln(Price per Pill)	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	IV (6)	Elasticity (Price per Pill) (7)
Constant	-0.507***	-0.461***	-0.447***	-0.233***	-0.277***	0.478***	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	
Product Characteristics							
Package Size	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.003***	-0.257***
	(1.37E-06)	(1.35E-06)	(1.37E-06)	(1.36E-06)	(1.37E-06)	(1.83E-06)	(1.40E-04)
Dosage	3.79E-04***	3.74E-04***	3.78E-04***	3.71E-04***	3.74E-04***	3.34E-04***	0.096***
	(4.31E-07)	(4.26E-07)	(4.24E-07)	(4.18E-07)	(4.18E-07)	(5.21E-07)	(1.50E-04)
Ln(Wholesale Price)	0.591***	0.590***	0.588***	0.593***	0.591***	0.589***	0.589***
	(1.50E-04)	(1.53E-04)	(1.53E-04)	(1.51E-04)	(1.50E-04)	(2.12E-04)	(0.00)
Competition Environments							
Competition Within Stores							
Product Competition Within a Store		-0.001***	-0.001***	0.001***	0.001***	-3.26E-04***	-0.016***
		(3.41E-06)	(3.41E-06)	(4.37E-06)	(4.36E-06)	(1.56E-05)	(7.90E-04)
Brand Competition Within a Store				-0.020***	-0.021***	-0.083***	-1.033***
				(3.26E-05)	(3.26E-05)	(1.30E-04)	(1.63E-03)
Competition Across Stores							
Store Competition Within a Market			-0.001***	-4.97E-04***	-0.001***	-0.003***	-0.088***
			(2.32E-06)	(2.27E-06)	(2.86E-06)	(5.54E-06)	(1.75E-04)
Store Competition Within Retailers					0.005***	0.021***	0.200***
					(1.46E-05)	(4.90E-05)	(4.66E-04)
Market Determinants							
Market Size	2.94E-09***	3.36E-09***	5.40E-09***	5.08E-09***	3.06E-09***	-2.83E-09***	-3.59E-03***
	(3.00E-11)	(3.00E-11)	(3.00E-11)	(3.00E-11)	(3.00E-11)	(6.00E-11)	(7.84E-05)
Age	2.47E-04***	3.30E-04***	-7.44E-05***	-0.001***	0.000***	-0.001***	-0.030***
	(1.77E-05)	(1.76E-05)	(1.77E-05)	(1.77E-05)	(1.77E-05)	(2.24E-05)	(8.59E-04)
Income	3.93E-07***	5.89E-07***	7.79E-07***	4.07E-07***	6.52E-07***	1.51E-06***	0.100***
	(4.44E-09)	(4.42E-09)	(4.53E-09)	(4.52E-09)	(4.58E-09)	(6.59E-09)	(4.35E-04)
Unemployment Rate	-0.003***	-0.005***	-0.004***	-0.005***	-0.005***	-0.018***	-0.070***
	(6.96E-05)	(7.00E-05)	(7.01E-05)	(6.94E-05)	(6.93E-05)	(8.77E-05)	(3.42E-04)
NOBS	20,181,369	20,181,369	20,181,369	20,181,369	20,181,369	20,172,072	20,172,072
R-squared	0.77	0.77	0.77	0.77	0.77	0.64	

Table 4 shows the regression results of equation (1). The unit of observation is a store within a market in a week. We instrumented for all competition indices. Our preferred specification is shown in column (6). All specifications include time fixed effects. The wholesale price elasticity is evaluated at the average wholesale price of the sample. Robust standard errors are shown in parenthesis (Specification 1-6). Elasticities in column (7) based on the estimates in column (6). Standard errors of column (7) are computed via the Delta-Method. ***, **, and * indicate 99%, 95%, and 90% significance levels, respectively.

Table 5: Margin Estimates

Dependent Variable: Normalized Margin	Coeff.	Elasticity
Constant	0.366***	
	(0.001)	
Product Characteristics		
Package Size	-0.002***	-0.443***
	(1.15E-06)	(0.000)
Dosage	2.36E-04***	0.251***
	(3.48E-07)	(0.000)
Ln(Wholesale Price)	-0.229***	-0.853***
	(1.47E-04)	(0.001)
Competition Indices		
Competition Within Stores		
Product Competition Within a Store	-4.23E-04***	-0.079***
	(9.39E-06)	(0.002)
Brand Competition Within a Store	-0.046***	-2.137***
	(7.56E-05)	(0.004)
Competition Across Stores		
Store Competition Within a Market	-0.001***	-0.143***
	(3.53E-06)	(0.000)
Store Competition Within Retailers	0.010***	0.372***
	(3.00E-05)	(0.001)
Market Determinants		
Market Size	-8.50E-10***	-0.004***
	(4.00E-11)	(0.000)
Age	-2.18E-04***	-0.031***
	(1.39E-05)	(0.002)
Income	7.21E-07***	0.178***
	(4.12E-09)	(0.001)
Unemployment Rate	-0.010***	-0.151***
	(5.41E-05)	(0.001)
NOBS	15,629,512	

Table 5 shows the estimation results for the normalized margin. The unit of observation level is a store within a market in a week. We instrumented for all competition indices. All specifications include time fixed effects. The wholesale price elasticity is evaluated at the average wholesale price of the sample. Robust standard errors are in parenthesis. *** indicate 99% ** 95% and * 90% significance levels.

Table 6: Impact on Normalized Price-Cost Margin

Dependent Variable: Normalized Margin	Coeff. (1)	Elasticities (2)
Competition Within Stores		
Product Competition Within a Store	-4.23E-04***	-0.021
	(9.39E-06)	
Brand Competition Within a Store	-0.046***	-0.571
	(7.56E-05)	
Competition Across Stores		
Store Competition Within a Market	-0.001***	-0.122
	(3.53E-06)	
Store Competition Within Retailers	0.010***	0.095
	(3.00E-05)	

Table 6 shows the marginal impacts of the competition measures on the normalized margin (as shown in column 1) and the overall impact of the competition measures when evaluated at the mean of the observed sample (column 2). Computations are based on the estimation results as shown in Table 5. Robust standard errors are in parenthesis. *** indicate 99% ** 95% and * 90% significance levels.

Appendix

Table A.1: Dependent and Independent Variables

Independent Variables	Definitions	Sources
Unit Price	Average price paid at a store at the local three-digit zip code market level in 2018 divided by the number of pills per package, weekly basis.	NielsenIQ Data
Wholesale Price	Average wholesale price paid by retailer, annual basis.	IBM Micromedex Data
Dose	Milligram of Active Ingredient per Pill, annual basis.	IBM Micromedex Data
Population	Average population at the local market level in 2018, annual basis.	Census
Age	Average age at the local market level in 2018, annual basis.	Census
Unemployment Rate	Average unemployment rate at the local market level in 2018, annual basis.	Census
Income	Average income at the local market level in 2018, annual basis.	Tax Survey
Product Competition Within a Store	Number of Products (UPCs) offered at a particular store, weekly basis	NielsenIQ Data
Brand Competition Within a Store	Number of brands offered at a particular store, weekly basis	NielsenIQ Data
Store Competition Within a Market	Number of retail stores in local markets, weekly basis	NielsenIQ Data
Store Competition Within Retailers	Number of distinct stores of a particular retailer in a local market, on weekly basis	NielsenIQ Data
Package Size	Number of pills per package, annual basis	NielsenIQ Data

Table A.1 provides definitions of independent variables.

Table A.2: Instrumental Variables

Hausman-type of instruments	Definitions	Sources
Average no of products at a retailer in surrounding local markets	Average no of products (UPCs) at a specific week, at a store of the retailer in the surrounding two-digit zip-market areas without considering the values within the corresponding three-digit zip code market area the observed observation is located in.	NielsenIQ Data
Average no of brands at a retailer in surrounding local markets	Average no of brands at a specific week, at a store of the retailer in the surrounding two-digit zip-market areas without considering the values within the corresponding three-digit zip code market area the observed observation is located in.	NielsenIQ Data
Average no of stores in surrounding local markets	Average no of retailer at a specific week, in the surrounding two-digit zip-market areas without considering the values within the corresponding three-digit zip code market area the observed observation is located in..	NielsenIQ Data
Average no of stores per retailer in surrounding local markets	Average no of stores of a corresponding retailer at a specific week, in the surrounding two-digit zip-market areas without considering the values within the corresponding three-digit zip code market area the observed observation is located in..	NielsenIQ Data

Table A.2 provides definitions of instrumental variables.

Table A.3: Robustness Check using Alternative Competition Measures

Dependent Variable: Ln(Price per Pill)	OLS (1)	IV (2)	Elasticity (Price per Pill) (3)
Constant	-0.609***	-0.620***	
	(0.001)	(0.001)	
Product Characteristics			
Package Size	-0.004***	-0.004***	-0.287***
	(1.32E-06)	(1.36E-06)	(1.04E-04)
Dosage	3.10E-04***	2.92E-04***	0.084***
	(4.09E-07)	(4.16E-07)	(1.20E-04)
Ln(Wholesale Price)	0.580***	0.577***	0.577***
	(1.52E-04)	(1.55E-04)	(1.55E-04)
Competition Environments			
Competition Within Stores			
Product Competition Within a Store	1.449***	1.958***	0.068***
(Share of Product in Store)	(0.003)	(0.004)	(1.25E-04)
Brand Competition Within a Store	0.188***	0.159***	0.019***
(Share of Brand in Store)	(0.002)	(0.002)	(2.39E-04)
Competition Across Stores			
Store Competition Within a Market	0.188***	0.694***	0.018***
(Share of Store in Market)	(0.002)	(0.006)	(1.45E-04)
Store Competition Within Retailers	-0.085***	-0.227***	-0.033***
(Share of Store in Retailer)	(3.66E-04)	(0.001)	(1.10E-04)
Market Determinants			
Market Size	3.02E-09***	2.89E-09***	0.004***
	(3.00E-11)	(4.00E-11)	(4.49E-05)
Age	5.16E-04***	4.47E-04***	0.017***
	(1.71E-05)	(1.76E-05)	(0.001)
Income	8.69E-07***	1.03E-06***	0.068***
	(4.46E-09)	(4.90E-09)	(3.24E-04)
Unemployment Rate	-0.006***	-0.007***	-0.025***
	(6.79E-05)	(7.02E-05)	(2.74E-04)
NOBS	20181369	19658524	
R-squared	0.78	0.78	

Table A.3 shows the regression results of equation (1) using alternative measures of competition as described in the text. The unit of observation is a store within a market in a week. Our preferred specification is shown in column (2), where we instrumented for all competition indices. All specifications include time fixed effects. Robust standard errors are shown in parenthesis. Elasticities are shown in column (3) and calculated based on the estimates displayed in column (2). The wholesale price elasticity is evaluated at the average wholesale price of the sample. Standard errors of column (3) are computed using the Delta-Method. ***, **, and * indicate 99%, 95%, and 90% significance levels, respectively.

Table A.4: Robustness on Instruments

Table A.4 replicates the main estimations from Table 4 (ln(price per pill)) and Table 5 (normalized margin), incorporating additional health instruments. We use data from the 2019 County Health Rankings & Roadmaps, a collaboration between the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute. The 2019 wave ensures instrument values are from 2018 or earlier, maintaining correct treatment.

The instruments include measures of health conditions and behaviors, such as days of poor health, smoking and excessive drinking rates, uninsured adults, and Medicaid flu vaccination rates (detailed in Table A.5). These variables capture structural differences in county-level demand, reinforcing the role of within-store competition—specifically, brand and product variety. Overall, the results support the main findings, underscoring the significance of brand competition, as estimates remain stable both qualitatively and quantitatively.

Dependent Variable: Ln(Price per Pill)	**Ln(Price per Pill) (1)**	**Normalized Margin (2)**
Constant	0.458***	0.356***
	(0.002)	(0.001)
Product Characteristics		
Package Size	-0.003***	-0.002***
	(1.80E-06)	)1.10E-06)
Dosage	3.3e-04***	2.4e-04***
	(5.10E-07)	-3.50E-07
Ln(Wholesale Price)	0.588***	-0.230***
	(2.1e-04)	(1.5e-04)
Competition Environments		
Competition Within Stores		
Product Competition Within a Store	-4.0e-04****	-3.8e-04***
	(1.50E-05)	(8.90E-06)
Brand Competition Within a Store	-0.080***	-0.046***
	(1.2e-04) 1	(7.1e-05)
Competition Across Stores		
Store Competition Within a Market	-0.003***	-0.001***
	(5.40E-06)	(3.50E-06)
Store Competition Within Retailers	0.020***	0.010***
	(4.10E-05)	(2.50E-05)
Market Determinants		
Market Size	-2.2e-09****	-1.1e-09***
	(5.50E-11)	(3.50E-11)
Age	-0.001***	-1.6e-04***
	(2.20E-05)	(1.40E-05)
Income	1.5e-06***	7.2e-07***
	(6.40E-09)	(4.10E-09)
Unemployment Rate	-0.018***	-0.010***
	(8.7e-05)	(5.4e-05)
NOBS	20,172,072	15,629,512
R-squared	0.6502	.

Table A.4 shows the regression results of equation (1) in column (1) and shows the estimation results for the normalized margin. In column (2). The unit of observation is a store within a market in a week. We instrumented for all competition indices. Additional to our instruments used in Table 4 & 5, we use county-specific health indices capturing demand for anti-inflammatory drug products. Robust standard errors are shown in parenthesis. ***, **, and * indicate 99%, 95%, and 90% significance levels, respectively.

Table A.5: Instrumental Variables for Estimates of Appenix A.4.

Definitions and names are as stated in the data documentation of the County Health Ranking & Roadmaps 2019.

Instruments	Definitions	Sources
Poor or fair health	Percentage of adults that report fair or poor health level, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.
Poor physical health days	Average number of reported physically unhealthy days per month, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.
Adult smoking	Percentage of adults that reported currently smoking, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.
Excessive drinking	Percentage of adults that report excessive drinking, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.
Uninsured	Percentage of people under age 65 without insurance, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.
Flu Vaccinations	Percentage of annual Medicare enrollees having an annual flu vaccination, measured on an annual basis per county	County Health Ranking & Roadmaps 2019, University of Wisconsin.

Table A.5., provides definitions of instrumental variables used in Appendix A.4.

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