

The Effect of Competition on Pricing and Product Positioning: Evidence from Wholesale Club Entry*

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Abstract

This paper empirically examines incumbents' reactions to market entry along price and non-price dimensions in the example of wholesale warehouse entry into grocery retail markets. Leveraging a detailed retail panel spanning 2001-2011 and a novel dataset documenting opening and closing dates and locations of all Costco warehouse clubs, we classify incumbent retailers' strategic responses (e.g., pricing, assortment) by the storability of product categories, controlling for persistent local trends and systematic differences across markets. We find that retailers are substantially affected by increased competition from wholesale club entries and increase their adoption of the high-low pricing strategy in response. In addition, incumbent retailers' strategic responses differ significantly across storability levels: they are more likely to increase prices and reduce assortments for highly storable products and decrease prices and increase assortments for less storable products. We extend our analysis by exploiting the spatial variations in our data and analyzing divergent market effects across geographical areas. We find significant geospatial differences in these strategic responses.

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1 Introduction

Traditional studies in Industrial Organization in general and analyses of market entry in particular focus on prices effects. However, this is only part of the picture as producers do not only optimize over prices, but also over product characteristics. In this paper, we provide empirical evidence for product repositioning by incumbent firms in response to market entry. Our analysis focuses on the example of grocery stores' responses to entry by Costco, the world's largest warehouse club and the third largest retailer in the US.

This paper contributes to the growing literature on endogenous product choice by demonstrating that entry can lead to substantial repositioning by incumbent firms. More specifically, we find that Costco entry leads to adjustments along the dimensions of assortment, price, and pricing format (“Every-Day-Low-Price” vs. “Hi-Lo”) in incumbent retailers. Taken together, the moves by incumbents are consistent with a strategy of diversification from Costco.

Several features of the grocery retail industry make it particularly suited for studying the effect of entry. First, grocery stores typically compete in local markets.¹ This allows us to treat geographically distinct locations as independent markets. Second, detailed data on prices, sales, and assortments is widely available through IRI and Nielsen. Finally, to our knowledge no technological or regulatory barriers exist that would distort incumbents' price or non-price reactions to entry.

Additionally, warehouse clubs are a particularly interesting segment of the retail sector. They take the “big box” concept of Walmart and Target a step further by setting a unique business model: products in very large package sizes sold for very low profit margins; limited product variety within a given product category;² and members-only shopping, with

¹While large store chains exist, many of them still are active only regionally. Additionally, prices and assortment often differ between stores of the same chain, presumably to account for the conditions of each local market.

²Costco offers about 4,000 unique items in its stores compared to about 40,000 for the typical grocery

membership fees constituting the majority of store profits.³ They rely on a consumer base able to travel longer distances (as most warehouse clubs are located outside of city centers), with transportation conducive to bulk purchasing (i.e., bigger vehicles), and with sufficient income to cover membership fees. How the warehouse clubs position themselves in the retail sector has important consequences for the strategic behavior of incumbent retailers serving the residual demand. Furthermore, their strategies allow us to distinguish between products that are more or less strongly affected by the competition, thus sharpening our results.

While endogenous product choice has been discussed theoretically for almost 100 years, there is little empirical evidence of firms adjusting their products to altered market conditions. Harold Hotelling, in his seminal article discussing the linear city model (Hotelling (1929)), to our knowledge was the first to discuss, albeit somewhat informally, the optimal choice of product characteristics in a duopoly. More formal theoretical explorations of this topic have been since the 1970s, starting with Spence's influential exploration of quality choice in monopoly (Spence (1975)). This was soon followed up and added to by Spence (1976), Mussa & Rosen (1975), Maskin & Riley (1984). Efforts to conduct similar analyses in different settings continue today (see, e.g., Bauner et al. (forthcoming)).

A number of authors have incorporated endogenous product choice in empirical studies. Often, such papers assume that firms set product characteristics according to some structural model and analyze the welfare consequences of government or firm policies of interest. Articles in this flavor include McManus (2007), Fan (2013), Nosko (2010), Eizenberg (2014), Wollmann (2014), and Crawford et al. (2015). However, to date few papers have shown empirical evidence that firms do, in fact, adjust their product characteristics to react to changing market conditions. Hausman & Leibtag (2001) and Sweeting (2010) independently analyze the effect of consolidation in the radio industry. Both show significant repositioning

store, according to Golodryga & Ellis (2010).

³Stone (2013)

of station format as result of increased merger activity. Matsa (2011) provides evidence that incumbent retailers improve their quality when faced with market entry by Walmart. We add to this literature by providing evidence of repositioning after entry in the supermarket industry along several dimensions — pricing, assortment, and pricing format.

This paper is also related to research on the effect of big-box store entry. In contrast to WalMart’s venture into grocery retail, which has been the subject of substantial research (finding decreased prices overall in incumbent retailers (e.g., Basker & Noel (2009)), increased quality (Matsa (2011)), increased consumer-surplus (Hausman & Leibtag (2007)), and limited competition outside of local markets (Ellickson & Grieco (2012))), little is known about the impact of warehouse clubs on the strategic behavior of incumbent retailers and the reactions of consumers. Furthermore, unlike existing literature, which typically focuses on the overall effect on incumbent retailers using aggregate price indices or retail-level responses such employment, we examine in detail variations in strategic behavior—pricing and assortment—using product specific information across product categories and markets. We concentrate our analysis on Costco, which with a 50% market share is the largest warehouse club in the United States⁴ and the world’s third largest retailer⁵. To measure its effect on incumbent retailers, we take advantage of a detailed retail panel documenting sales volumes and prices for each Universal Product Code (UPC) sold in each week from 2001-2011 for 27 frequently purchased product categories and a novel dataset documenting opening and closing dates and locations of all Costco warehouses. We exploit variations across markets and over time to econometrically control for any persistent local trends and systematic differences across markets that might influence Costco’s strategic decision to enter a local market or the endogenous responses of its competitors.

Our findings suggest that incumbent retailers’ strategic reactions, in the face of increased

⁴Evans & Satchu (2010)

⁵Kantar Retail (2013)

warehouse presence, differ significantly across product categories. We classify product categories observed in the sample by how storable the product is (e.g., canned soup is highly storable; milk is not). Our classification of storability derives from two definitions: *perishability* and *stockpilability*, as defined in Bronnenberg et al. (2008). We further classify by size the incumbent retailers as either small or large. Under both definitions and across small and large stores, we find that incumbent retailers are more likely to increase the prices of more storable products while decreasing the prices of less storable products. Because warehouse clubs' typically offer products only in large packages, they are in many cases less attractive providers of perishable goods. Hence, the strategy of decreasing prices for less storable items is consistent with an attempt by traditional retailers to differentiate themselves from warehouse clubs. Our results differ from the only other paper on warehouse clubs of which we are aware, Courtemanche & Carden (2014), which finds that Costco's entry leads to price increases by non-warehouse supermarkets, while Sam's Club market entry does not affect local prices. Results from Courtemanche & Carden (2014) run somewhat counter to those of the numerous studies finding that Walmart market entry decreases the prices of products sold by incumbent retailers (Basker (2005), Volpe & Lavoie (2008), Basker & Noel (2009), Lopez & Liu (2011), Cleary & Lopez (2012), and Ellickson & Grieco (2012)). Our study adds significant nuance to Courtemanche & Carden (2014), which relies on quarterly city-level ACCRA COLI prices and does not break down by storability level. In contrast, our UPC-week-store level data gains us insight into incumbents' strategic pricing and assortment adjustments across product categories of different storability levels. This allows us to draw more detailed conclusions and gain a more complete understanding of Costco's effects on competing retailers.

While we find that price responses differ across product categories, we also find a uniform increase in variation in prices. That is to say, regardless of price increases or decreases, all product categories in incumbent retailers saw larger intertemporal price variations, sug-

gesting increased use of a Hi-Lo pricing strategy. This is consistent with the theoretical model developed in Gandon & Jaremski (2012), which suggests that entry of a low-cost retailer can lead to more frequent price reductions. Gandon & Jaremski (2012) also find empirical evidence using retail data from Chicago that suggests adoption of Hi-Lo strategy coinciding with Walmart’s expansion in that market. This and our results contrast with those of Ellickson & Misra (2008), which finds that frequent price reductions (Hi-Lo) or relatively constant pricing (“Every-Day-Low-Price” or “EDLP”) are positively correlated with the pricing format of neighboring stores post Wal-Mart entry.

We further examine how incumbent retailers’ assortment strategies react to entry of Costco’s limited assortment format. Again, incumbent retailers employ different responses across product categories, with differences varying by storability level. More specifically, we find that incumbent retailers generally decrease assortment in more storable categories but increase assortment in less storable ones. This is consistent with retailer efforts to differentiate themselves from Costco and establish a competitive advantage with their product offerings. In reaction to retailers’ changes to pricing and assortment, we find that changes in sales not surprisingly also differ across storability levels, with sales volume decreasing for more storable products and increasing for less storable products post Costco entry.

We extend our analysis and explore how the effects of Costco entry vary across geographically diverse markets with different traffic patterns, population size and income. Variation in our data—a total of 485,489,339 UPC-week observations across 33 markets—allows us to analyze the effect of Costco entry across storability levels at the national level and within each geographical market (Designated Market Area). We find that for certain storability levels strategic responses are uniform across all markets while for other storability levels strategic responses are dichotomous between large, coastal markets and smaller, central-U.S. markets. For instance, for least storable products, retailers in larger urban markets (such as New York City) respond to Costco entry by increasing prices, whereas retailers in smaller metropolitan

areas such as Des Moines respond by decreasing prices.

The remainder of the paper is structured as follows. We provide some background on the warehouse club industry in general and Costco in particular in section 2 and introduce the retail data, data on Costco entry and location, definition of storability by perishability and stockpilability, and our empirical strategy in section 3. Results by product category and geospatial variation are presented and discussed in section 4, and section 5 concludes.

2 Industry Background

The warehouse club sector dates back to 1954, when FedMart opened its doors.⁶ Although FedMart closed in 1983 (despite initial success),⁷ competitor Price Club followed closely on its heels and kept the warehouse club model alive. Price Club was originally intended as a one-stop solution for small business owners. It kept overhead costs low by choosing cheap locations, limiting sales personnel, and abstaining from advertising. The remaining overhead costs were covered by a membership fee paid by customers. As this concept generated poor results, Price Club soon opened its doors to individual consumers as well.⁸

Price Club's modified model proved so successful it was soon copied by several newcomers to the market in 1983.⁹ Most notable among them were Costco and Sam's Club, both of which expanded rapidly in the eighties and nineties. By 1994, the two accounted for more than 90% of sales in a market that had grown from an annual revenue of less than one billion dollars to more than 37 billion dollars in less than ten years.

Since then, the market has continued to expand, with Sam's Club and Costco retaining their dominant positions. In 2009 the warehouse club sector sold goods and services worth

⁶Unless otherwise specified all data cited in this section is from Coriolis Research (2004)

⁷Funding Universe

⁸Funding Universe

⁹According to Ralph Nader (as quoted by Stone (2013)) Sol Price, the founder of Price Club, exclaimed "I really wish I had worn a condom," when told he was the father of the warehouse discount retail concept. Price Club later merged with Costco in 1993.

114.7 billion dollars in gross revenue, with Costco holding a 50% market share and Sam's Club's 41%. The third-ranked BJ's operated only in 15 states and claimed only 9% of the market (Evans & Satchu (2010)).

Today, the warehouse club model remains unique in several ways. Warehouse clubs tend to earn very low markups on the products they sell (most items at Costco have an 8%-10% markup according to Santoso (2013)). They keep costs down in part by restricting product variety; typically, for any given product category, warehouses offer only one or occasionally two brands and membership fees continue to be an important contributor to profits. Stone (2013)

While Sam's Club continues to target small business owners, Costco embraces individual consumer as well (Courtemanche & Carden (2014)). Thus, Costco is much more likely to have a significant effect on incumbent retailers; indeed, Courtemanche & Carden (2014) find that Sam's Club openings have no significant effect on prices offered by other retailers. We therefore focus on Costco as an example of how warehouse clubs can affect local retail markets.

3 Determining the Impact of Costco

The goal of our empirical study is to analyze the impact of Costco on the pricing, assortment, and sales of incumbent grocery retailers in a detailed manner. To understand how affected retailers respond to Costco entry, several pieces of information are crucial: 1) detailed pricing, assortment, and availability of products in each store; 2) information on product characteristics that would allow us to differentiate product categories into levels of perishability and stockpiling; and 3) accurate information on the opening and closing dates on the full census of Costco stores.

3.1 Retail Data

Our retail panel, spanning 2001 to 2011, is drawn from the IRI Academic Dataset,¹⁰ which contains observations collected at the UPC-store-week level. That is, for each UPC in each retailer in the sample, we observe its price and the quantity sold each week¹¹. A UPC is observed in a given week as long as at least one unit was sold that week. Since nearly all in the sample are frequently purchased items, we can infer the assortment carried by each store over time.

We incorporate nearly all product categories from the IRI dataset in the analysis.¹² We include a total of 27 different categories in the sample, encompassing almost 140,000 unique UPCs with just under 500 million observations. Table 1 documents the available categories along with basic summary statistics on the number of observed stores offering the product category, the total number of UPCs observed in the category, and the number of observations. Not surprisingly, there is little variation in the number of stores offering each product category, as most categories are commonly carried and therefore present in all observed stores, while larger variation is seen in the numbers of UPCs and observations. All categories are observed over the entire duration of the sample. While we do not observe products carried in Costco, anecdotal evidence suggests all product categories included here are available in at least limited offerings in Costco.

Each UPC observed in the sample can be linked to a set of characteristics, including the brand, package size, and flavor. Furthermore, each product category and thus each UPC is linked to levels of perishability and stockpiliability identified in the IRI data, which is

¹⁰Please see Bronnenberg et al. (2010) for a detailed description of the entire dataset.

¹¹Prices are inferred based on information reported on the total revenue and total units sold. In addition, we also observe whether the UPC had features or displays associated in the week. We do not find these variables to significantly change the findings.

¹²We only exclude three categories - beer, cigarettes, and photo development. We exclude beer and cigarettes because we are concerned that state and local regulations make sales incomparable across metro areas. We also exclude photo development, because as a service rather than a good it is very different from the other categories in our analysis and it is also offered at only a select subset of both Costco warehouses and retailers in the IRI dataset.

Table 1: Overview of Data by Product Category

Category	Number of Stores	Number of UPCs	Number of Observations
Carbonated Beverages	1,285	13,691	42,368,680
Coffee	1,285	11,450	23,620,782
Cold Cereal	1,285	8,574	32,631,976
Deodorant	1,272	3,337	25,762,574
Diapers	1,279	3,581	10,358,623
Facial Tissue	1,285	1,152	4,015,143
Frankfurters	1,285	2,105	5,954,032
Frozen Dinners	1,285	8,034	50,733,536
Frozen Pizza	1,285	4,577	16,690,351
Household Cleaner	1,285	4,007	12,653,781
Laundry Detergent	1,285	3,897	15,327,957
Margarine/Spreads/Butt	1,285	860	7,436,401
Mayonnaise	1,285	1,362	5,710,736
Milk	1,285	7,626	12,997,831
Mustard & Ketchup	1,285	2,684	8,788,637
Paper Towels	1,285	2,191	4,648,199
Peanut Butter	1,285	1,091	6,015,128
Razors	1,266	377	1,560,718
Salty Snacks	1,285	21,624	44,297,240
Shampoo	1,272	8,314	25,420,076
Soup	1,285	6,840	43,350,600
Spaghetti Sauce	1,285	4,474	16,805,680
Sugar Substitutes	1,285	630	3,542,591
Toilet Tissue	1,285	1,617	6,012,929
Dental Accessories	1,272	3,243	13,458,362
Toothpaste	1,272	2,503	16,945,324
Yogurt	1,285	7,325	28,381,452
Total		137,166	485,489,339

Source: IRI Academic Dataset.

rated by Bronnenberg et al. (2008) on a scale from 1 to 3, where 1 indicates ‘not perishable/stockpilable’ and 3 indicates ‘highly perishable/stockpilable.’ Perishability and stockpilability measures are reported on a product category level, i.e., different items in the same category are assumed to be identical with respect to perishability and stockpilability. Table 2 provides an overview of product categories as classified by both perishability and stockpilability.

Table 2: Stockpilability and Perishability by Product Category

		Stockpilability		
		1 (low)	2 (medium)	3 (high)
Perishability	1 (low)	Diapers	Carbonated Beverages	Razor Blades
		Frozen Dinners		Coffee
		Frozen Pizza		Deodorant
		Paper Towels		Facial Tissue
		Toilet Tissue		Household Cleaners
				Laundry Detergent
				Mustard & Ketchup
				Razors
				Shampoo
				Soup
	Spaghetti Sauce			
	Sugar Substitutes			
	Dental Accessories			
	Toothpaste			
	2 (medium)	Cold Cereals	Mayonnaise	
		Margarine/ Spreads/Butter	Peanut Butter	
	3 (high)	Frankfurters		
		Milk		
		Salty Snacks		
		Yogurt		

Source: IRI Academic Dataset. Bronnenberg et al. (2008).

While perishability and stockpilability are strongly correlated (negatively) as expected; this correlation is by no means perfect. As defined by Bronnenberg et al. (2008), stockpilability refers to the ease with which a particular product can be stored. That is to say, the larger an item, the more costly it is to store and the lower its stockpilability index. Perishability, on the other hand, refers to the duration an item can be stored. Items such as shampoo, which are packaged in fairly small containers and have long shelf lives, are rated high on the stockpilability index and low on the perishability index. On the other hand, items such as paper towels, which come in large units and have long shelf lives, are rated low on the stockpilability index and low on the perishability index. We conduct our analyses using both definitions of storability.

The retail panel is collected weekly from stores in major metropolitan areas across the United States. Figure 1 displays the locations of stores in the IRI, with darker green indicating a larger concentrations of retailers. As shown, the dataset covers metropolitan areas in most states but not all. Naturally, we cannot measure the effect of Costco in markets for which retail data is missing; thus, we concentrate our analysis on the overlap of markets in the two datasets, which covers most of the continental U.S. Focusing on overlapping metropolitan areas across the two datasets, we observe a total of 172 openings and 4 closings of Costco warehouses in 50 markets between 2001 and 2011.

3.2 Census of Costco

We track opening and closing dates of Costco warehouses through two sources. First, we collection information from Costco’s official website, which lists the exact opening dates for most stores.¹³ For the remaining 8 of 448 stores for which information is not available on the Costco website, and also to control for warehouse closings, we consult Costco’s annual reports from 1998 to 2012. Each annual report includes a list of all Costco warehouse locations; thus,

¹³<http://www.costco.com/WarehouseLocatorView?langId=-1&storeId=10301&catalogId=10701>

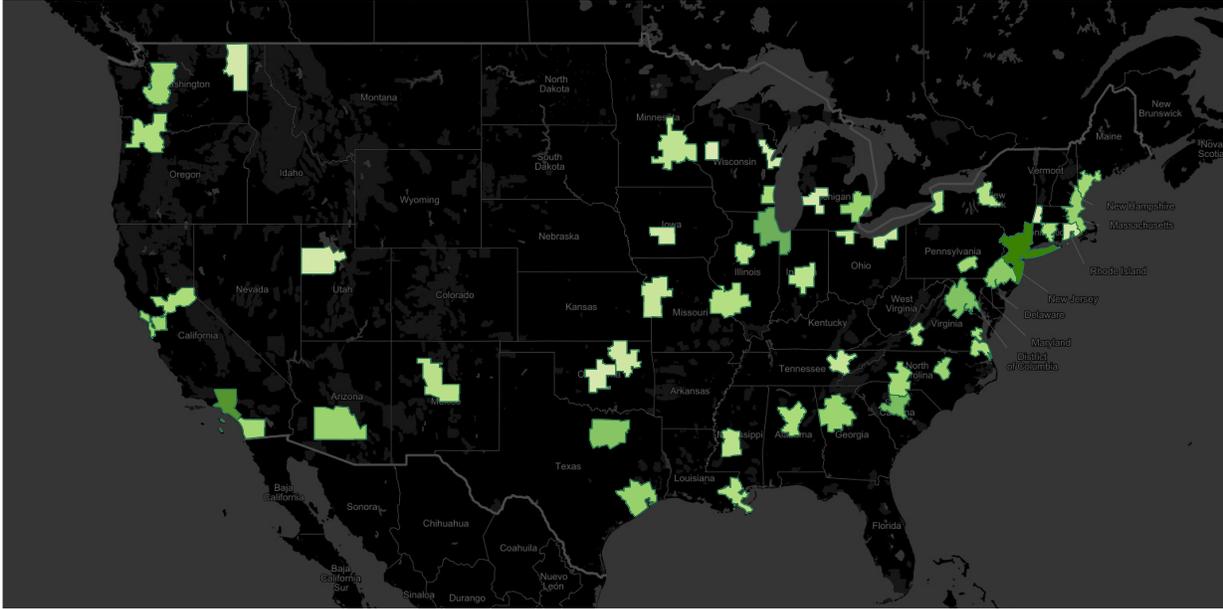


Figure 1: Locations of Stores in IRI by DMA

comparing two consecutive reports allows us to determine at least the years of openings and closings. Additionally, the annual reports in some cases provide more precise information on openings dates.¹⁴

Figure 2 shows the locations of Costco warehouses across the United States by opening dates, with darker red denoting stores that have opened more recently. While there is a clear concentration of stores on the west coast, where both Costco and Price Club (merged in 1993) were founded,¹⁵ today Costco operates in most major metropolitan areas in the United States.

¹⁴For instance, Costco’s 2006 Annual Report states that out of 36 to 40 warehouses expected to be opened in fiscal 2007, “[p]rior to the end of calendar 2006 [Costco] opened units in Kauai, Hawaii; Gypsum, Colorado; ... and Orland Park, Illinois.” Thus, for these warehouses we can narrow the window of opening from twelve to four months.

¹⁵Coriolis Research (2004)

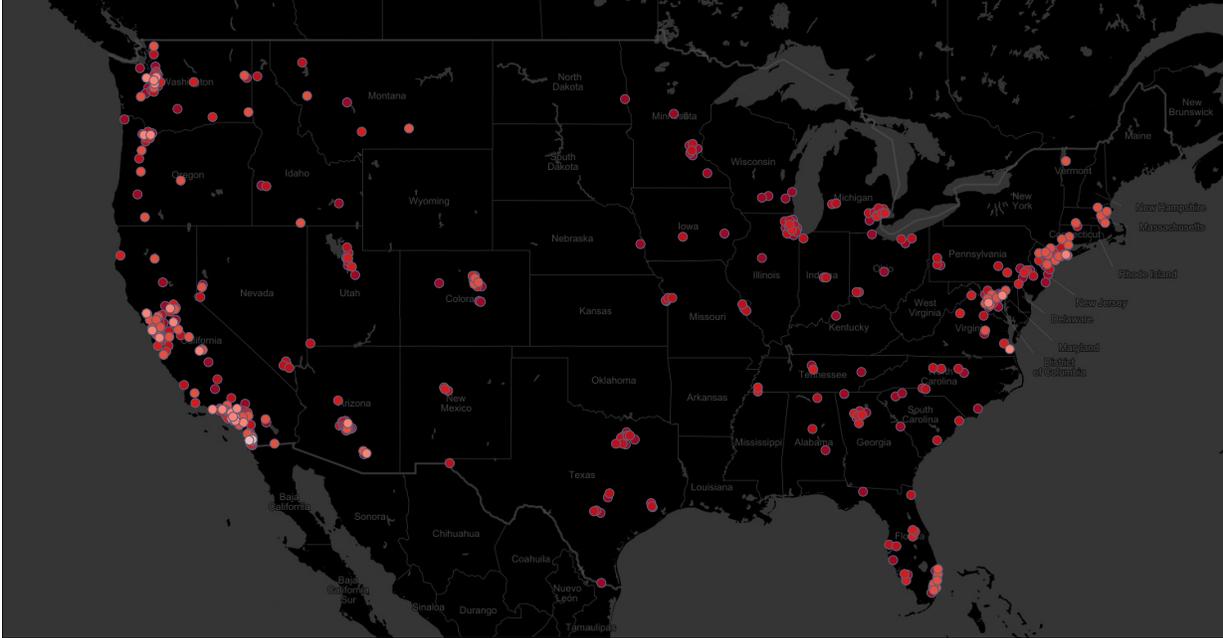


Figure 2: Costco Warehouse Locations by Opening Date

3.3 Empirical Strategy

Costco's concentration on bulk shopping undermines its attractiveness for purchasing perishable goods, particularly for members of small households. As a result, it seems likely that incumbent retailers would tailor their reactions to different product categories, in terms of both pricing and assortment. Standard models of competition predict that increased competition leads to reduced prices by all market participants. However, as discussed, currently existing empirical results on the effect of warehouse club presence as presented in Courtemanche & Carden (2014) show that Costco entry lead to price *increases* by incumbent retail stores. Due to data limitations in this prior research, however—namely, that the data used was aggregated across product categories—these earlier findings reveal only average effects across all products sold within a category. The authors of this prior work cannot differentiate between categories and investigate strategic repositioning within stores. With our more complete data set, we show that the effects of Costco entry on incumbent retailers differ

significantly across different product categories and depend strongly on the characteristics of the category and local market characteristics.

Relatedly, incumbent retailer response to warehouse openings depends on those retailers' existing pricing strategy: Hi-Lo pricing versus EDLP. The former serves to differentiate incumbent retailers from Costco, while the latter means retailers compete more directly with the warehouse entrant. We investigate whether incumbent retailers alter their pricing schemes between these two formats post-Costco opening.

Furthermore, previous literature investigating competition in the retail sector suggests that retailers compete through quality of products offered as well as price (Courtemanche & Carden (2014), Ellickson (2006), and Ellickson (2007)). One way to measure retailer quality is by assortment size. Investigating the effect of Costco presence on incumbents' assortments additionally provides insight into the extent to which traditional retailers try to differentiate themselves from Costco by expanding their product range.

To tease out this variety of strategic reactions employed by incumbent retailers in response to warehouse entry, our identification strategy relies on the fact that we observe varying numbers of Costco warehouses within various metropolitan areas over time: we regress respective variables of interest on the number of Costco warehouses in a given area and on the level of perishability/stockpilability of each product category, controlling for product, product size, store, and time. Thus, we can identify the effect of Costco warehouse openings or closings by comparing changes in each variable of interest in a given affected area with those in related unaffected areas. As such, our analysis takes a differences-in-differences approach as can be seen in equations 1 through 4, which will be discussed later in this section.

Store location is a strategic decision for Costco, and thus estimations based on store locations is subject to potential endogeneity bias. We use the panel feature of our data to overcome this problem. Since we observe each area of interest over time, we can use market-fixed effects to account for any unobserved variables. Most importantly, this allows us to

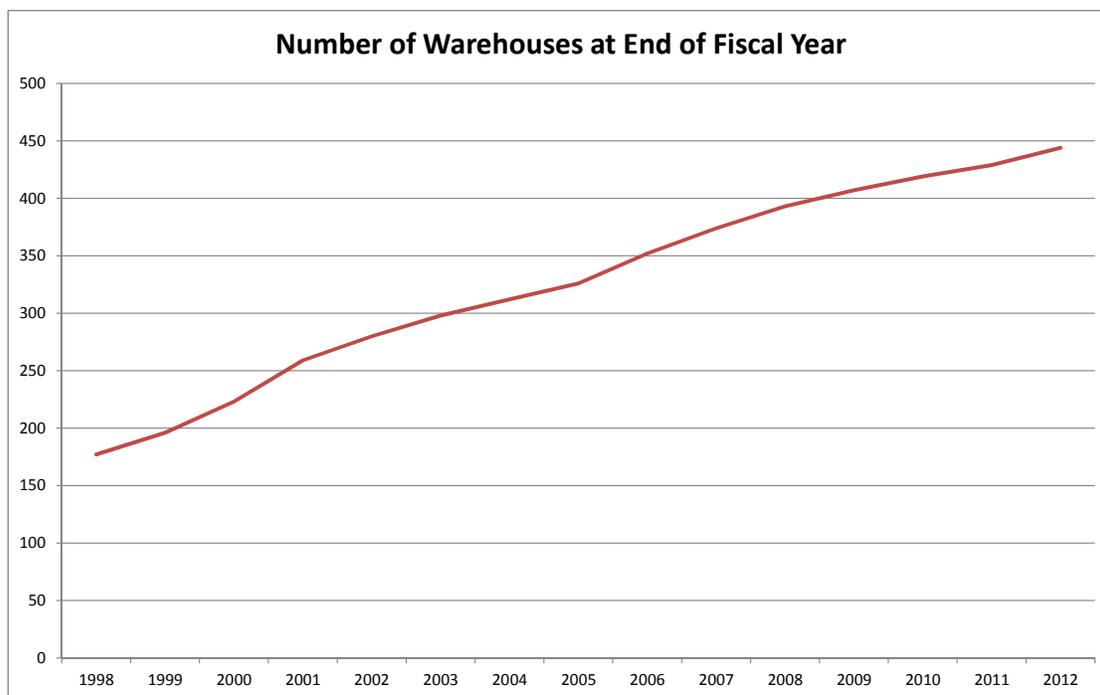


Figure 3: Number of Costco Warehouses Operating in the United States over Time.

control for the possibility that Costco may open warehouses in markets where, due to other factors, prices are high.

Time could pose additional endogeneity problems. As figure 3 shows, the number of warehouses operated by Costco grew significantly over the course of our sample, and prices tend to increase over time due to inflation. Together, this leads to a correlation of more warehouses with higher prices, even though the effect is not causal. One way of addressing this problem would be to use the Consumer Price Index (CPI) to convert prices to inflation-neutral figures. However, as actual inflation tends to differ across product categories, this would only partially solve the problem. Thus, we employ a different strategy: We introduce time-fixed effects in our regressions, allowing each month in our sample to have a different average price. This has the additional advantage of eliminating any problems of seasonality.

To investigate the effect of Costco warehouse entry on incumbent grocery retailers, we

examine changes in prices, sale strategies, and assortments across different product categories and incumbent retailer sizes. In addition, we also measure changes in sales volume post-warehouse entry. We examine each effect in two separate analyses: 1) aggregate effects seen across all observed incumbent retail stores across all markets and 2) effects seen in each market separately, which reveals geospatial variations in strategic responses.

The number of Costco warehouses in a given market typically increases incrementally; that is, warehouses are opened one at a time rather than all at once. To accommodate this pattern, and to allow for a decreasing marginal effect of warehouse entry, we measure Costco’s market presence by taking the natural logarithm of one plus the number of existing Costco warehouses in the market of interest. As discussed, we classify product categories by perishability and stockpilability, and incumbent retailers as large or small using an estimated All Commodity Value (ACV). Therefore, our regression of prices takes the following form:

$$\log(p_{rjt}) = \beta_{dbf}^{Price} \log(n_{lt} + 1) + \gamma_{rms}^{Price} + \delta_t^{Price} + \epsilon_{rjt} \quad (1)$$

$$\forall d \in \{\text{perishability, stockpilability}\}$$

where the natural logarithm of price p charged by retailer r for product j at time t , measured in month, is expressed as a function of the number of Costco warehouses in market l at time t (n_{lt}); a set of fixed effects, γ_{rms}^{Price} , capturing the interactions between retailer r where product j is sold, brand m of product j , and size s of product j ; a set of time fixed effects δ_t^{Price} ; and a random shock ϵ_{rjt} .¹⁶ Note that each product j is defined by its UPC code and is associated with a unique brand m and a unique size/volume s . Following the definition provided in Bronnenberg et al. (2010), product categories are divided into brackets following each definition of storability (perishability and stockpilability), as shown in table 2. Therefore,

¹⁶We also run a version where instead of log-price we use the linear price. Results are qualitatively identical to those from equation 1.

equation 1 is run separately, once for each definition d . The parameters of interest, β_{dbf}^{Price} , measure the percentage change in price for a percentage change in Costco warehouses for product j of classification d (perishability or stockpilability), level b (level of perishability or stockpilability), and store format f .¹⁷

We further investigate whether incumbent retailers change their pricing strategy as between High/Low and EDLP. To answer this question, we examine changes in the standard deviation of prices post-warehouse entry. Our intuition is that if the incumbent retailer switches from one pricing format to another, the dispersion of prices across time within the same product category would change in response to warehouse entry. Therefore, we regress the normalized standard deviation of prices on the same set of covariates as that specified in equation 1:

$$CV(p_{rjt}) = \beta_{dbf}^{PriceVar} \log(n_{lt} + 1) + \gamma_{rms}^{PriceVar} + \delta_t^{PriceVar} + \epsilon_{rjt} \quad (2)$$

$$\forall d \in \{\text{perishability, stockpilability}\}$$

where the $CV(p_{rjt})$ is the coefficient of variation and is equal to $st.dev.(p_{rjt})/avg(p_{rjt})$, where the standard deviation and average are calculated for each brand-size combination for retailer r in month t . The parameters of interest, $\beta_{dbf}^{PriceVar}$ then measure the increases and decreases in price variation resulting from one percent warehouses in the market. A positive parameter indicates an increase in price variation and therefore signals an increased adoption of High/Low strategy. A negative parameter, on the other hand, indicates a decrease in price variation and is consistent with increased use of EDLP strategies. However, it is possible that changes in assortments also drive changes in price variation. To control for this possibility,

¹⁷To deal with markets without Costco warehouses we use $\log(n_{rt} + 1)$ rather than $\log(n_{rt})$. Thus, a one-percent increase of number of warehouses is only roughly equivalent to a β_{dbf}^{Price} percent increase in price.

we run an additional set of regressions holding fixed assortment over time. Results from both set of regressions are discussed in the following section.

In the introduction, we postulated that increased Costco presence would significantly impact assortment strategies of incumbent retailers. That is, incumbent retailers facing increased competition from Costco would increase the variety of offered products in less storable product categories and decrease those in more storable product categories. We measure assortment by counting the number of unique existing products sold in each product category. The regression is as follows:

$$\begin{aligned} \text{count}(upc_{rjt}) &= \beta_{dbf}^{Assortment} \log(n_{lt} + 1) + \gamma_{rc}^{Assortment} + \delta_t^{Assortment} + \epsilon_{rt} & (3) \\ &\forall d \in \{\text{perishability, stockpilability}\} \end{aligned}$$

where upc_{rjt} denotes the UPC of product j carried by retailer r in month t and $\text{count}(upc_{rjt})$ is the number of unique UPCs in each category that retailer r carries in month t . $\beta_{dbf}^{Assortment}$ measures changes in the variety of products carried by a retailer post warehouse entry. Positive estimates show increases in product variety within a given product category and negative estimates show decreases.

Lastly we investigate how sales volumes are affected by additional presences of Costco in the market. We regress the number of units sold for each project on the same set of covariates as discussed above.

$$vol_{rjt} = \beta_{dbf}^{SalesVol} \log(n_{lt} + 1) + \gamma_{rms}^{SalesVol} + \delta_t^{SalesVol} + \epsilon_{rjt} \quad (4)$$

$$\forall d \in \{\text{perishability, stockpilability}\}$$

where sales volume vol_{rjt} is measured in the number of units sold for product j in retailer r during month t . A decrease in sales volume for product bracket b would be reflected in a negative value of parameter $\beta_{dbf}^{SalesVol}$.

We perform the above analyses first using data from all available markets and then for each market separately. The former allows us to investigate incumbent retailers' strategic responses across product categories of different storability when facing additional competition from warehouse clubs. The latter allows us to dive deeper and investigate geospatial variations in these effects. Specifically, in analyzing *geospatial* variation, we perform the regressions as specified in equations (1) to (4) separately for each of the 34 markets in our sample that experienced warehouse openings or closings. Our final step is to identify elements of the market environment that may affect strategic retailer responses by analyzing cross-market differences in the estimated coefficients.

4 Results

4.1 Aggregate Effects

We first explore how incumbent retailers across the nation respond to the competition of warehouse clubs. We allow strategic responses to vary across product categories characterized by levels of storability. We postulate that, given Costco's focus on large volume and limited variety, incumbent retailers may tailor their responses in individual product categories depending on storability, rather than reacting uniformly across all categories. That

is, strategic reactions for products that are more storable would be different to those for products less storable. Recall, storability is defined both in terms of perishability and stockpilability. Results using both definitions are presented in tables 3 and 5. To better isolate the effect of Costco entry, we use only stores that are present over the entire duration of the sample. To keep the discussion clear and concise, we concentrate on the set of perishability results. In general, similar conclusions can be drawn using the stockpilability results. Table 3 documents results under the perishability definition from regressions outlined in equations 1 to 4 respectively.

Our results suggest that incumbent retailers react to increased Costco market presence in two ways: through pricing and assortment. As the third column of table 3, $\log(\text{Price})$, shows, prices of more storable products increase while those of the less storable products drop. For instance, the price of an average UPC in a category of perishability 1 (most storable) sold in a small store increased on average by over 2.5 percent following the entry of an additional Costco store. In comparison, the price of an average UPC with perishability 3 (least storable) decreased on an average by almost 13 percent in small stores and more than 7.5 percent in large stores. This suggests that incumbent retailers vary their pricing reactions to warehouse openings for different product categories. Rather than implementing uniform price changes across products, they implement price decreases or price hikes based on the degree of storability of each product category. Furthermore, this pattern suggests that incumbent retailers compete more fiercely in categories less suitable to Costco's business model.

Regardless of price increases or decreases, we find incumbent retailers increase the variation in prices across all product categories when facing added competition from warehouse club entry. As seen in column 4 of table 3, corresponding to equation 2, coefficients across all categories are positive and significant. Note that while the coefficients in and of themselves may appear close to zero, their economic significance is substantial. As discussed in

Table 3: Regression Results by Perishability

Perish- ability	Large Store Dummy	Dependent Variable			
		log(Price)	Price Variation	Assortment	Sales Vol.
1	0	0.0257** (0.0114)	0.0019*** (0.0004)	5.4820 (3.8714)	-15.4102*** (2.2478)
1	1	0.0428 (0.0140)	0.0013*** (0.0004)	-2.8210 (5.8019)	-30.6268*** (7.3396)
2	0	0.0395*** (0.0105)	0.0017*** (0.0004)	-21.8533*** (7.7769)	-12.1930*** (2.4858)
2	1	0.0664*** (0.0198)	0.0010** (0.0004)	-36.0520*** (9.2390)	-23.5884*** (7.7336)
3	0	-0.1285*** (0.0125)	0.0018*** (0.0004)	63.5078*** (11.3946)	19.1862*** (3.0862)
3	1	-0.0754** (0.0319)	0.0010** (0.0004)	104.2300*** (22.0148)	53.8724*** (11.7361)
Fixed Effects:					
Store \times Brand \times Size		✓	✓	✓	✓
Month		✓	✓	✓	✓
Observations		194,741,030	187,358,763	194,741,031	194,741,031

Notes: Market-clustered standard errors in parentheses; *, ** and *** indicate significance at the 90%, 95% and 99% significance level, respectively.

the Empirical Strategy section above, the dependent variable is measured in coefficients of variation. Consider a simple example: Suppose the average price of a product in a given store is \$2 with a standard deviation of 10 cents, with variation arising from temporary price discounts. A magnitude of 0.0019 in price variation, as shown in table 3, implies a 3.8% increase in the standard deviation in price.¹⁸ That percentage increase in standard deviation is an increasing function of the average price. That is to say, another product with an average price of \$5 with the same 10-cent standard deviation would see a 9.5% increase in the standard deviation in price. This result is indicative of increased adoption of Hi-Lo pricing schemes by incumbent retailers post-Costco entry in order to attract consumers.

However, as alluded to earlier, this result could be driven by changes in assortments across product categories. Indeed, as will be discussed shortly, incumbent retailers react to Costco entry by strategically altering assortment sizes. To control for assortment changes, we re-estimate equation 2 holding constant assortment sizes. That is, we use only UPCs that are sold (within each store) consistently over the entire span of the data. Table 4 documents the results for both perishability and stockpilability. Concentrating again on the set of results under perishability, we see that not only do our previous results hold, the magnitude of the estimates increases across all levels. This provides further robustness for increased price variations post additional Costco entry.

In addition, as column 5 of table 3 shows, incumbents also respond by strategically changing the assortments within certain product categories, increasing variety in least storable product categories and reducing it in categories of more storable products. Product categories with perishability 2 on average saw a decrease of 21.85 UPCs per category for small stores, and 36.05 for large stores post warehouse entry. In comparison, in the least storable product categories we see an increase of 63.51 UPCs per category in small stores and 104.23 UPCs in large stores. We do not find statistically significant results in the least perish-

¹⁸ $[(0.1/2 + 0.0019) * 2 - 0.1]/0.1 * 100 = 3.8\%$

Table 4: Price Variation Results – Fixed Assortment

Level	Large Store Dummy	Perishability	Stockpilability
1	0	0.0029*** (0.0005)	0.0027*** (0.0005)
1	1	0.0024*** (0.0006)	0.0025*** (0.0004)
2	0	0.0019*** (0.0004)	0.0024*** (0.0005)
2	1	0.0011** (0.0005)	0.0020*** (0.0006)
3	0	0.0021*** (0.0005)	0.0027*** (0.0005)
3	1	0.0017*** (0.0004)	0.0021*** (0.0005)
Fixed Effects:			
	Store × Brand × Size	✓	✓
	Month	✓	✓
Observations		33,687,876	33,687,876

Notes: Market-clustered standard errors in parentheses; *, ** and *** indicate significance at the 90%, 95% and 99% significance level, respectively.

able category. These results suggest competition through differentiation, where incumbent retailer focus on shifting their business towards competing in the market for less storable goods.

Looking last at consumer behavior post Costco entry, the last column of table 3, corresponding to equation 4, shows by perishability rating and store size the change in total quantities sold after an additional Costco warehouse enters the market. Since the unit of observation is store-month-UPC, the coefficients indicate an average quantity change for a given product category post-Costco entry. We see that when competing with Costco, incumbent retailers sell fewer units of more storable products and more units of less storable products. For instance, for a product category with perishability rating 1 (most storable), the estimated coefficient on the log-number of Costco warehouses is -30.63. This indicates a loss of over 20 units per store-month-UPC when the first Costco warehouse in a metro area is opened.¹⁹ This result is consistent with the incumbents' pivot toward less storable items: As discussed above, incumbent grocers decrease prices and increase assortment for more perishable (and less stockpilable) products; hence, our observation of a larger quantity demanded can be explained by a move along the demand curve.

Regression results based on stockpilability, as seen in table 5, are largely consistent with those described above. For instance, a warehouse entry leads to significantly fewer units sold by incumbent retailers for products ranging from somewhat stockpilable (stockpilability = 2) to most stockpilable (stockpilability = 3), and for products ranging from least perishable (perishability = 1) to somewhat perishable (perishability = 2). This is unsurprising, as table 2 shows that highly stockpilable items mostly fall in the low perishability bracket and that highly perishable items usually display low stockpilability.

Perhaps the only exception to this rule is with regard to the set of regressions on assortments, which sees stronger conclusions under the stockpilability definition than previously.

¹⁹ $-30.63 \cdot (\ln(2) - \ln(1)) = -21.23$

Table 5: Regression Results by Stockpilability

Stockpil- ability	Large Store Dummy	Dependent Variable			
		log(Price)	Price Variation	Assortment	Sales Vol.
1	0	-0.0548*** (0.0094)	0.0020*** (0.0004)	92.0175*** (10.0995)	8.2168*** (2.7367)
1	1	-0.0151 (0.0186)	0.0013*** (0.0004)	113.5017*** (8.6554)	29.5240*** (10.2215)
2	0	0.0361*** (0.0102)	0.0018*** (0.0004)	55.2562*** (4.1509)	-11.9545*** (2.3301)
2	1	0.0492*** (0.0169)	0.0011*** (0.0004)	47.0815*** (5.7809)	-23.2810*** (7.6126)
3	0	0.0235* (0.0120)	0.0018*** (0.0004)	-61.1886*** (9.6147)	-19.8092*** (2.2502)
3	1	0.0413** (0.0154)	0.0012*** (0.0004)	-71.6775*** (7.3181)	-41.8699*** (8.3615)
Fixed Effects:					
Store × Brand × Size		✓	✓	✓	✓
Month		✓	✓	✓	✓
Observations		194,741,030	187,358,763	194,741,031	194,741,031

Notes: Market-clustered standard errors in parentheses; *, ** and *** indicate significance at the 90%, 95% and 99% significance level, respectively.

As table 5 shows, all estimated effects are statistically significant here. Furthermore, we see that less storable items offered by incumbent retailers (stockpilability < 3) all experience significant upticks in variety and that more storable items (stockpilability $= 3$) all experience significant drops.

We decompose these results by market to investigate geospatial variation in the effects resulting from additional competition by warehouse clubs.

4.2 Market-Level Heterogeneity

We examine geospatial variations in the effects of warehouse entry on incumbent retailers by analyzing how strategic responses differ across markets. A first step is to see whether the effects discussed above vary across markets (DMAs). We perform the analyses listed in equations 1 to 4 for each market separately. To ensure statistically significant results, we include only markets with a sufficient number of retailers (at least eight) and that have experienced at least one Costco entry/exit. Since some markets do not have large retailers present, this process leaves 36 markets with sufficient numbers of small retailers and 33 markets with sufficient numbers of large retailers.

Figure 4 shows the effect of Costco warehouses on the number of units sold per UPC by incumbent retailers. For conciseness, we concentrate our discussion in this section on large stores only and on results using stockpilability as a measure of storability. Results using perishability or small stores are qualitatively identical.

A couple of intriguing patterns emerge in figure 4. First, we see that our previous finding—that the effect of warehouse entry differs by storability—persists here but also along a different dimension. That is, demand responses in the most storable product categories are uni-directional, while those in less storable categories are dichotomous between large coastal regions and smaller central-U.S. regions. While incumbent retailers in all markets except Albuquerque lost sales of more storable products post-warehouse entry, the effects on less

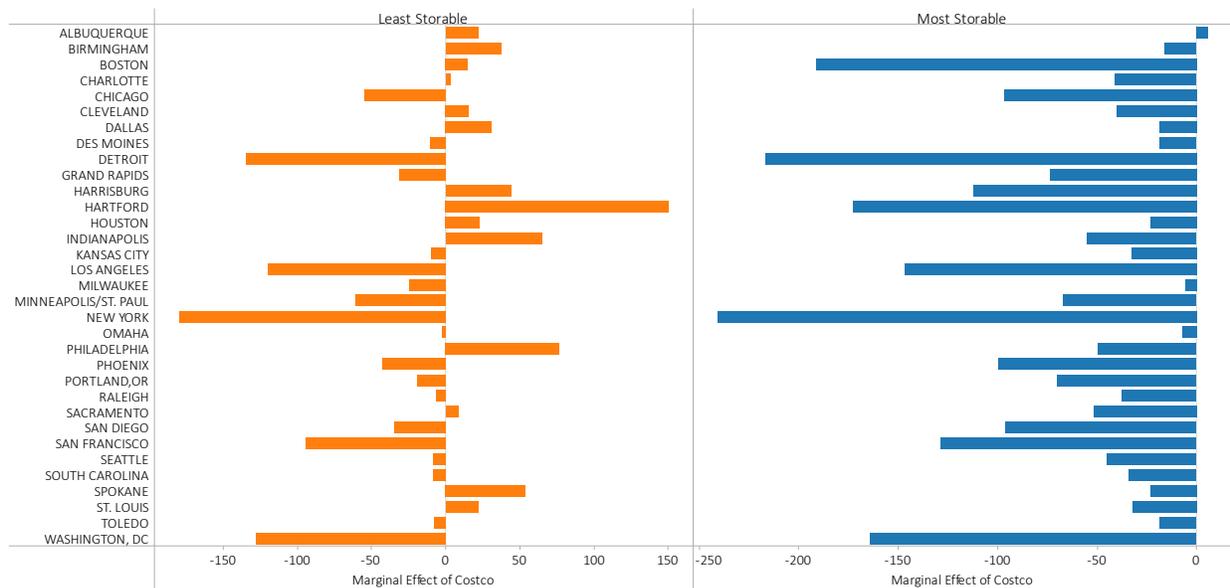


Figure 4: Geospatial Variation in Sales Volume

storable products are mixed, with some markets showing a reduction in sales volume and others showing an increase. To explore if there are clear patterns in which markets show a reduction and which show an increase, we plot the directions of sales volume for least storable product categories in figures 5, where sale volume decreases post-Costco entry are marked by red dots and sale volume increases by green dots.

Figure 5 suggests that larger, more populous, coastal markets are more likely to see decreased quantities purchased of the least storable categories. The most striking example of this is New York City, which experiences dramatic drops in sales volume. On the reverse side of the coin, we see that markets such as those in Mississippi and Alabama experience increased quantities in the same product categories.

The second pattern that we see in figure 4 is that the magnitude of these effects significantly differs geographically. Even in the most storable categories (where effects are unidirectional), different markets experience significant variations in demand responses. For instance, incumbent retailers in New York experience a loss in sales over four times that of

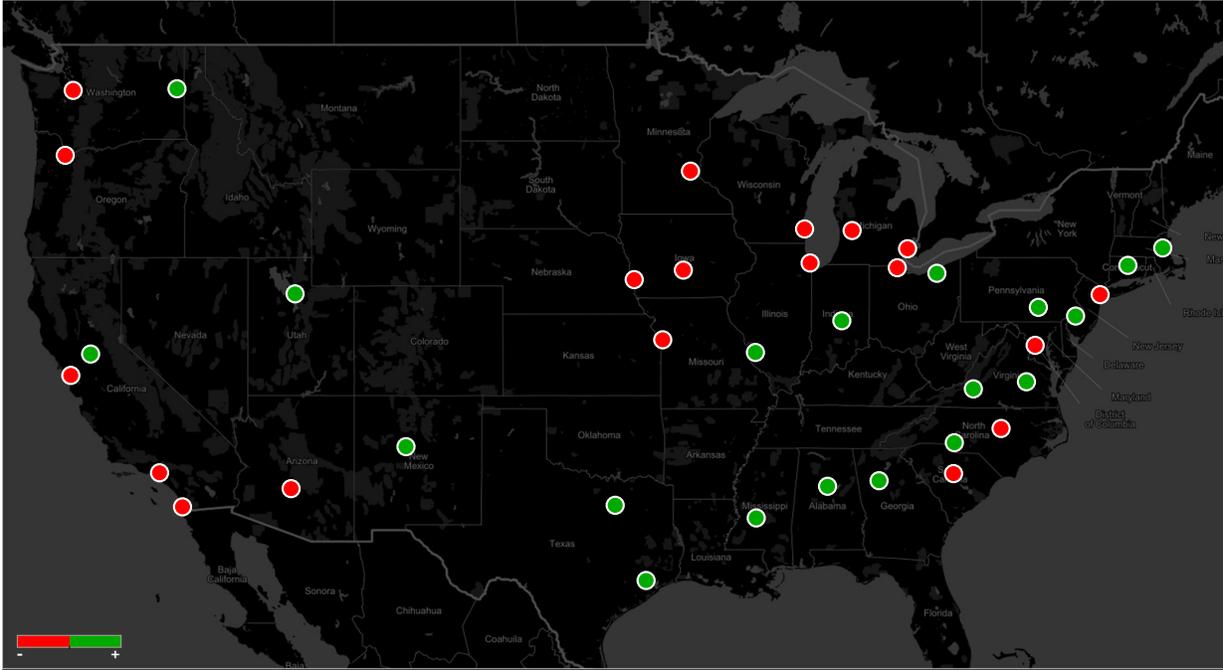


Figure 5: Sales Volume Response by Location – Least Storable Categories

counterparts in Minneapolis and St. Paul, MN. We now turn to examine market variation in the strategic pricing responses of incumbent retailers.

Recall we find that incumbent retailers selectively raise prices of more storable products when facing rising competition from increased Costco presence. In line with this previous finding, figure 6 shows that most markets see price increases in storable products, with the exception of a few select markets (i.e., Boston, Hartford, and San Francisco).²⁰

Furthermore, we see that price responses again differ significantly depending on how storable a category is. While price effects are nearly uni-directionally positive for more storable products, they are more mixed for products in less storable categories. We again plot the direction of these reactions to Costco entry on the US map. Figure 7 plots price

²⁰We capture the change in price here by using the natural log of price, which implies the marginal effects are easily interpreted as percentage changes in price. Regression results using price instead are qualitatively identical.

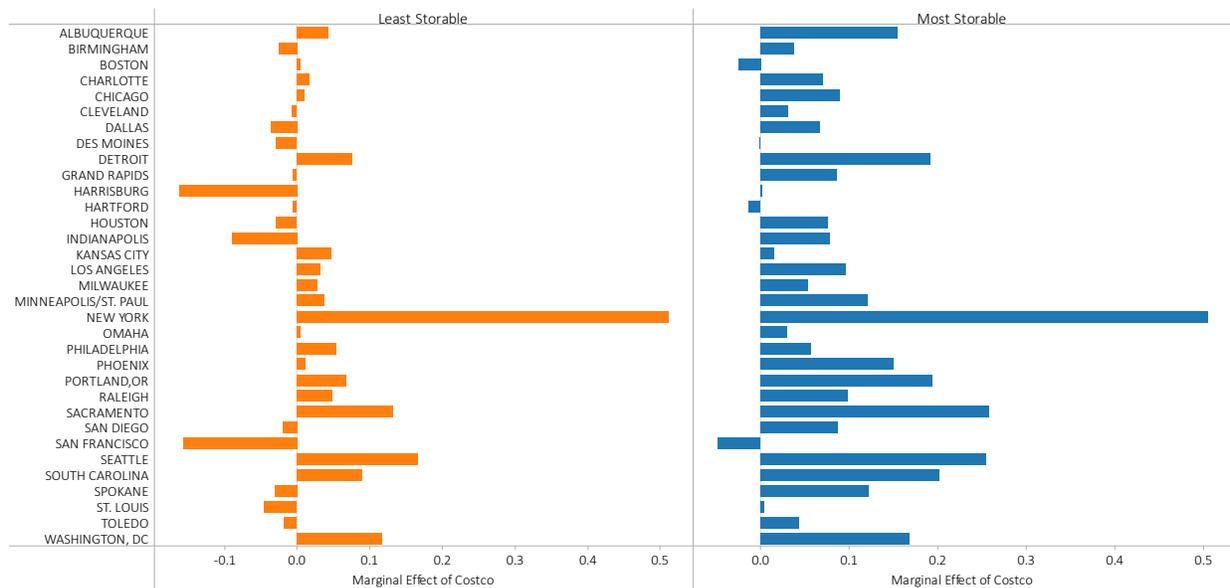


Figure 6: Geospatial Variation in Price Responses

increases by red dots and price decreases marked by green dots.

It is clear that incumbents in more Southern markets seem to respond to warehouse entry by decreasing the prices of less storable products, whereas incumbents in more metropolitan markets increase prices for similar products.

Patterns from sale volumes and prices together suggest that larger, more populous, markets are more likely to see increased prices and decreased quantities purchased of the least storable categories. The most striking example of this is New York City, which experiences dramatic price increases and simultaneous drops in sales volume. On the reverse side of the coin, we see that markets such as those in Mississippi and Alabama experience decreased prices and increased quantities in the same product categories. While it is not surprising that price and quantity move together, why these movements diverge across markets is more intriguing. One plausible story is that in some markets increased Costco presence causes sorting of consumers, such that more price-elastic consumers shop at warehouse clubs while

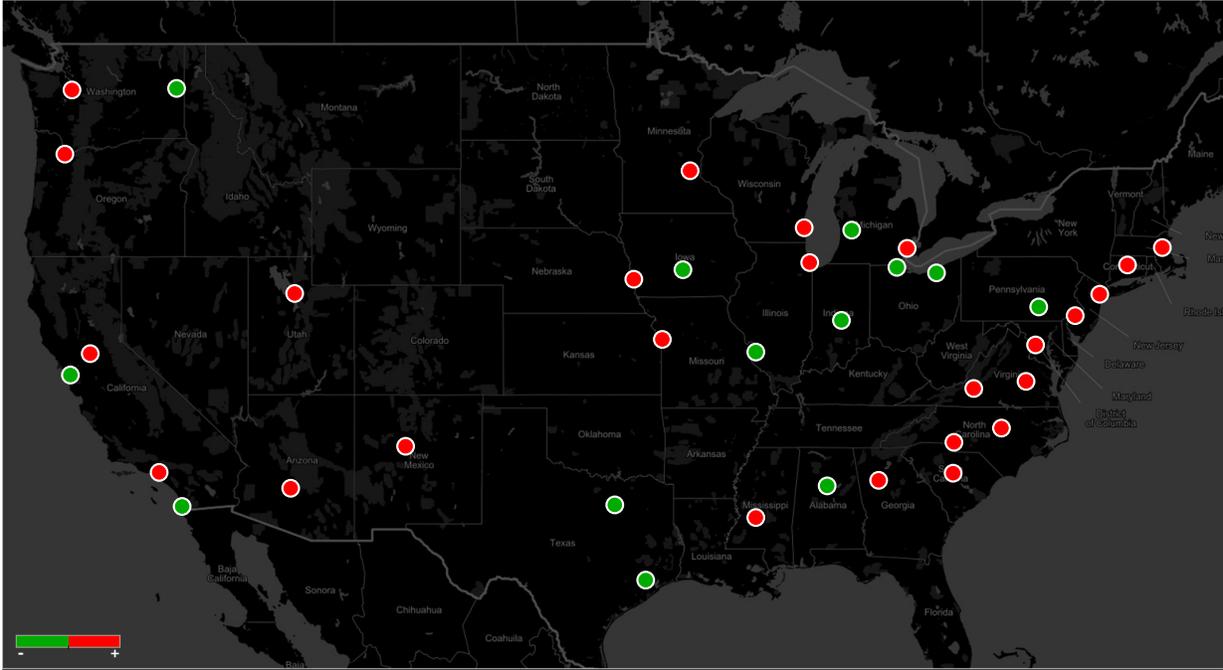


Figure 7: Price Response by Location – Least Storable Categories

the residual, less-elastic demand remains at retail grocers. And as a result, incumbent retailers increase prices to capture the residual demand, and we observe decreased sale volume as a result. In other markets, elasticities might be less diverse across consumers, such that the residual demand is not significantly less elastic than total demand. In this case, it is possible to observe decreased prices and increased quantities.

We find a similar divide along the storability dimension in strategic responses to product assortment. As figure 8 shows, the effect on incumbent retailers is uni-directional in less storable product categories. In all markets, retailers respond to Costco openings by increasing the variety of offerings for less storable products. Furthermore, we see that the magnitude of these effects differs across geographical regions. For instance, retailers in Detroit increased less storable product variety by nearly twice as much as retailers in Des Moines.

The effects in more storable categories is more dichotomous. Incumbent retailers in

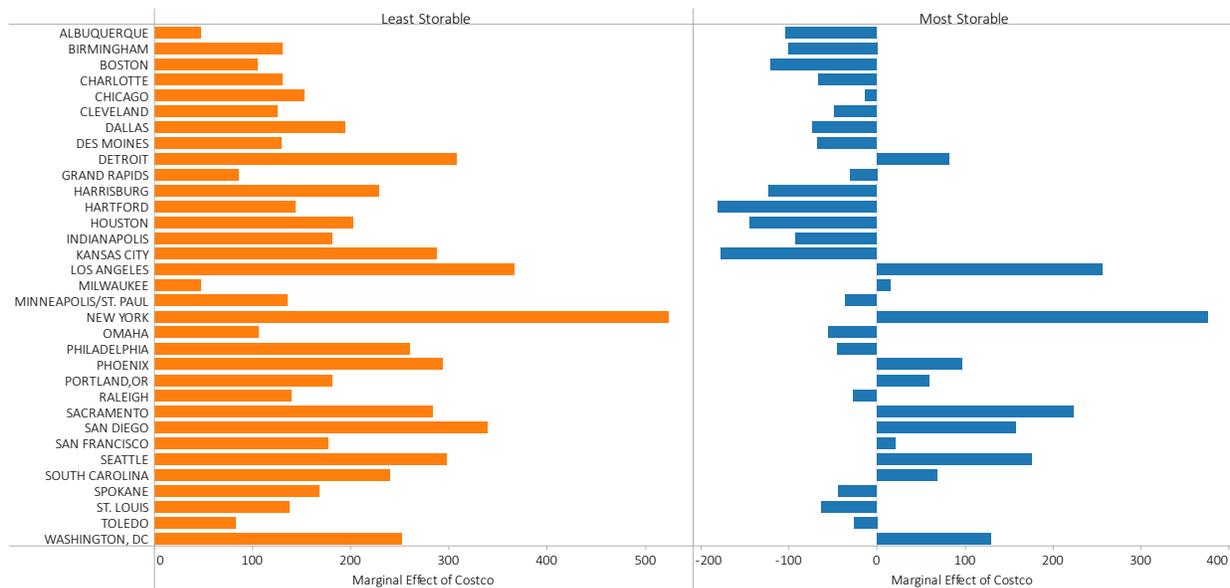


Figure 8: Geospatial Variation in Assortment Changes

some markets respond to Costco entry by increasing offerings of more storable products, whereas incumbent retailers in other markets respond by decreasing variety in these product categories. We use the same method as above in examining factors that may explain these divergent responses. We plot the direction of each response in figure 9, where green dots denote assortment increases and red dots assortment decreases.

Figure 9 shows that market size again seems to influence incumbent retailers' decisions to alter the variety of products offered in response to Costco presence. In general, we see that in larger coastal markets such as Los Angeles and New York, the variety of storable products offered is positively correlated with warehouse presence, while in more central areas the reverse is true.

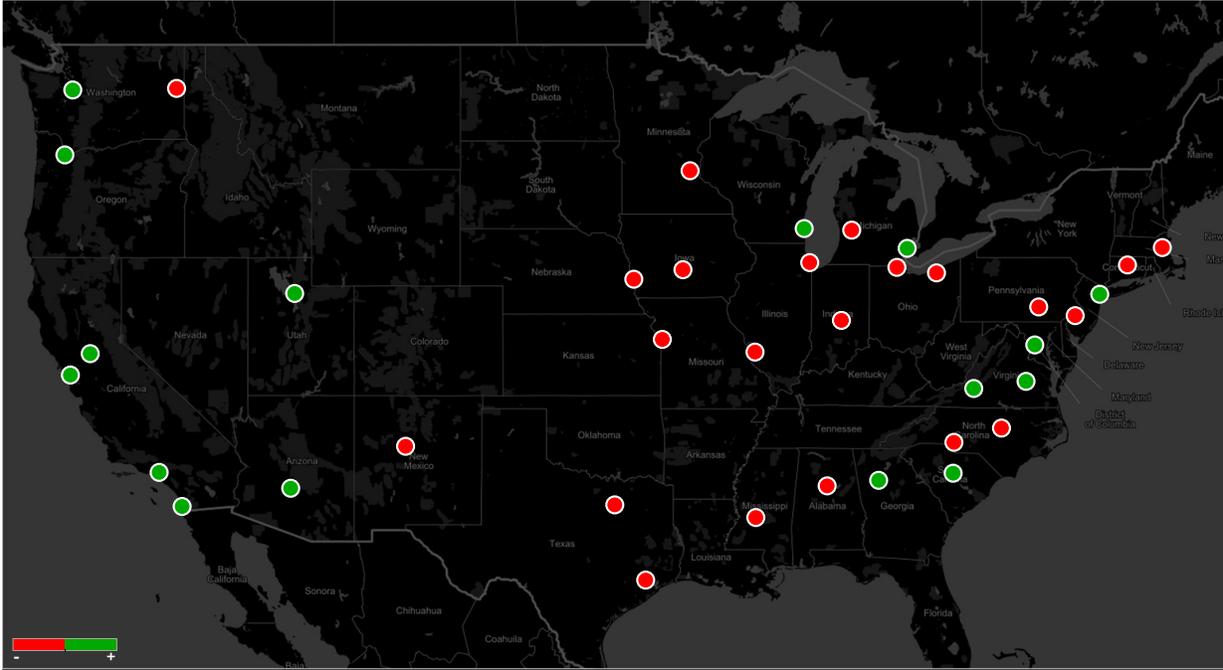


Figure 9: Assortment Changes by Location – Most Storable Categories

5 Conclusion

This paper provides evidence for repositioning by incumbent retailers in reaction to openings of warehouse clubs nearby. We study incumbent retailers’ responses along price and non-price dimensions and across product categories differentiated by storability.

Taking advantage of a large scale and detailed retail panel spanning 2001-2011 and a novel dataset documenting opening and closing dates as well as locations of all Costco warehouses, we find that while incumbent retailers move toward a High-Low pricing strategy in response to increased warehouse presence uniformly across all product categories, their pricing and assortment decisions differ depending on the storability of products offered. Incumbent retailers are more likely to increase prices and reduce assortments for more storable categories and decrease prices and increase assortments for less storable categories. This is consistent with a strategy of differentiation from Costco.

In that same vein, we further explore how these strategic responses vary across geographically diverse markets. We find significant geospatial differences, both in magnitude and direction, again with the strategic responses differing according to product storability. Strategic responses are in fact dichotomous as between large and small markets in some instances, with the differing direction of response explained by market size.

Overall, our results demonstrate the importance of taking both price and non-price dimensions of competition and location-specific aspects of markets into account when studying not only entry, but competition in general. Furthermore, we provide empirical evidence of endogenous product choice in support of assumptions made in past and ongoing theoretical and structural models.

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