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ABSTRACT

Prior research shows grocery stores reduce prices to compete with Walmart Supercenters. This study finds evidence that the competitive effects of two other big box retailers – Costco and Walmart-owned Sam's Club – are quite different. Using city-level panel grocery price data matched with a unique data set on Walmart and warehouse club locations, we find that Costco entry is associated with higher grocery prices at incumbent retailers, and that the effect is strongest in cities with small populations and high grocery store densities. This could be explained by a segmented-market model, or by incumbents competing with Costco along non-price dimensions such as product quality or quality of the shopping experience. We find no evidence that Sam's Club entry affects grocery stores' prices, consistent with Sam's Club's focus on small businesses instead of consumers.

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INTRODUCTION

How do incumbent grocers change their prices in response to entry by mass-market merchandisers? This paper presents evidence that incumbent grocers charge higher prices in response to competition from the discount wholesaler Costco. This is consistent with incumbents electing not to compete on price and instead focusing on appealing to less price-sensitive consumers, perhaps by offering higher quality products or a more pleasant shopping experience. The data suggest that Sam's Club, meanwhile, does not affect grocery store prices.

Ellickson (2007:45) points out three major changes in grocery retail during the twentieth century. The first was the rise of the chain store in the early 1900s. The second was the introduction and diffusion of the supermarket in the middle of the century. The third was the "adoption of technology-intensive distribution systems in the 1980s and 1990s" (Ellickson 2007:45). To this we might add a trend that accelerated in the 1990s: expansion by "big box" discounters and wholesalers like Walmart, Costco, and Target into the grocery business. In 2010, *Supermarket News* reported that Wal-Mart Stores, Inc. was North America's largest grocery retailer, Kroger was North America's second-largest, and Costco Wholesale Corp. was North America's third-largest.[1] This has increased variety in the grocery business: citing data from the Food Marketing Institute, Ellickson (2007:522) points out that "the number of products offered per store increased from about 14,000 in 1980 to over 30,000 by 2004."[2]

Wal-Mart Stores, Inc. again topped the Fortune 500 in 2010. Costco—categorized by *Fortune* as a "specialty retailer"—was ranked #25. Also in the top 50 were big box retailers Home Depot (#29), Lowe's (#42), and Best Buy (#45), and general merchandisers Target (#30)

[1] "SN's Top 75 Retailers for 2010." http://supermarketnews.com/profiles/top75/2010/index.html/, accessed December 30, 2010.
[2] Carden (2012) surveys the history of mass-market retail in the twentieth century.

and Sears Holdings (#48). 2010 revenues for Wal-Mart Stores, Inc. were higher than 2010 revenue for these other firms combined.[3]

Motivated by this trend toward nontraditional retail outlets, a growing body of research examines the effects of Walmart on a number of outcomes, including prices (Basker 2005b; Basker and Noel 2009; Volpe and Lavoie 2007; Hausman and Leibtag 2007, 2009), labor market outcomes (Basker 2005a; Hicks 2007; Neumark et al. 2008; Dube et al. 2007; Basker 2006), poverty (Goetz and Swaminathan 2006), small business activity (Sobel and Dean 2008), social capital (Goetz and Rupasingha 2006; Carden et al. 2009a), leisure activities (Carden and Courtemanche 2009), traditional values (Carden et al. 2009b), and obesity (Courtemanche and Carden 2011).[4] However, to our knowledge no previous research has used nationwide data to explore the effects of other big box chains. We provide a first step toward filling this void.

Basker (2005a), Volpe and Lavoie (2007), Hausman and Leibtag (2007, 2009), and Basker and Noel (2009) all present evidence that Walmart discount stores and Supercenters reduce market prices, either directly through their price advantages or indirectly through their influence on competitors. Most relevant to our study is Basker and Noel (2009), who use 2001-2004 American Chamber of Commerce Researchers Association Cost of Living Index (ACCRA COLI) data to show that entry by a Walmart Supercenter drives down prices among competing grocery stores. For these years they are able to determine the identity of the sampled stores, allowing them to exclude Walmart stores from the price computations and thereby isolate Walmart's effect on competitors. Pooling prices from 24 grocery items, they estimate that an additional Walmart Supercenter in a city reduce prices at incumbent retailers by 1-1.2%, with the largest changes occurring among smaller and lower-end grocers.

[3] "Fortune 500." http://money.cnn.com/magazines/fortune/fortune500/2010/, accessed December 30, 2010.
[4] Comprehensive reviews of the literature on Walmart can be found in Basker (2007), Hicks (2007), Carden et al. (2009a), and Carden and Courtemanche (2009).

The competitive response need not be to reduce prices, however, as segmented-market models with a mix of brand-loyal and price-sensitive consumers have shown that in some cases incumbents can raise prices in response to a low-cost entrant (Frank and Salkever 1992). Moreover, incumbents could also compete on non-price margins like distribution services, assortment, and convenience. For instance, Barber and Tietje (2004) studied entry by a Home Depot and found that one of the incumbent hardware stores raised prices on some of its goods in response.[5] They suggest that "Home Depot's superiority in pricing and assortment attracts a significant market, but smaller retailers can secure niche markets by delivering higher levels of ambiance and information" (Barber and Tietje 2004:98).

Motivated by this theoretical ambiguity, we estimate the effects of Costco and Sam's Club on grocery prices using a unique dataset of warehouse club entry dates and locations matched with city-level panel data on prices of a range of items from the ACCRA COLI.[6] The ACCRA COLI does not sample warehouse clubs, so our estimates capture the competitive effects of Costco and Sam's Club on prices charged by incumbent grocers in a market. Controlling for Walmart Supercenters, product-by-year fixed effects, city fixed effects, and lagged price, a new Costco increases competitors' grocery prices by a statistically significant 1.4% in the short run and 2.7% in the long run, while the impact of a new Sam's Club is small and insignificant. The results also provide further evidence that Walmart Supercenters reduce grocery prices.

We then conduct a falsification test and a wide range of robustness checks in order to increase confidence that the estimates reflect causal effects rather than spurious correlations. We also stratify by product and product type and find that Costco's effect is somewhat larger for the

[5] This paper is discussed by Betancourt (2004:36ff).
[6] ACCRA is now the Council for Community and Economic Research (www.c2er.org).

goods for which ACCRA's data collection process allows product quality to vary across stores. We interpret this as preliminary evidence that firms' responses to Costco entry include some competition along the quality dimension. Finally, we test for heterogeneity on the basis of market characteristics and show that Costco has the strongest effects in cities with low populations and a large number of grocery stores per capita.

THEORY AND BACKGROUND

Retail Price Responses to Competitive Pressure

An extensive literature explains patterns of entry, exit, and market structure.[7] We focus on incumbent grocers' price responses to entry. At first glance, it seems that market entry would drive down incumbents' prices. Frank and Salkever (1992), however, present a model in which pharmaceutical producers might raise prices in response to competitive entry under certain conditions and explain the tendency of brand name drugs to raise rather than lower prices when faced with generic competition after patent loss.[8] In their segmented-market model, firms sell to two kinds of buyers: loyal buyers (who are responsive only to the prices of the brand-name drug) and cross-price-sensitive buyers (who are responsive to the prices of both the brand-name and generic drugs). They show that brand-name producers might raise their prices in response to generic entry when 1) entry raises demand for brand-name drugs, 2) brand-name drugs have decreasing marginal costs, or 3) entry reduces the elasticity of the reduced-form demand curve for the brand-name drug (Frank and Salkever 1992:169). They focus on the third condition, as it is the most likely in the context of the market for pharmaceuticals. Intuitively, if low-cost generics are likely to steal the cross-price-sensitive consumers regardless of the brand name drug's response, then the brand name drug's pool of potential customers is effectively reduced to

[7] See e.g. Bresnahan and Reiss (1991), Ericson and Pakes (1995), and Sutton (1991 [2007], 1998 [2001]).
[8] Their model is discussed in detail on pages 168-170.

the less price-sensitive loyal buyers. In this case, raising prices to extract the most profit possible from the loyal customers makes sense.

Their model translates readily to the case of competitive entry by a discount mass-market merchandiser in the retail environment. The incumbent grocer takes the place of the brand name drug, while the entering big box store replaces the entering generic drug.[9] Loyal buyers are those who will not shop at the big box grocer regardless of its prices, as their preference for the products, convenience, or shopping experience of the conventional grocery store is too strong. Cross-price-sensitive buyers are those who could be induced to switch to the big box store if the price difference is sufficient. Big box entry could therefore leave incumbents with a market of relatively loyal, low-elasticity customers, leading to a price increasing response.

Differential Responses to Costco, Sam's Club, and Walmart Supercenter Entry

The above analysis considers only one generic mass-market merchandiser, whereas we are interested in estimating the separate effects of three different stores – Costco, Sam's Club, and Walmart Supercenter – that might each impact the incumbent grocer's reduced-form demand curve differently. Frank and Salkever (1992) offer additional insights that can help us predict these differential effects. As an extension of their model, they ask how the competitive effects differ depending on the share of consumers in the brand-loyal side of the market as opposed to the cross-price-sensitive side. They show that a conjecture made by Grabowski and Vernon (1992) – that increasing the size of the price-sensitive part of the market would make the price response more negative, and vice versa – holds under plausible assumptions. Intuitively, if there is a relatively large number of loyal customers, the strategy of writing off the cross-price-sensitive consumers and focusing on profit maximizing among the loyal customers is more

[9] One has to assume that the incumbent grocer has some degree of market power in order for the brand-name drug analogy to directly apply, but this seems like a reasonable assumption in an oligopolistic market such as groceries.

profitable. In contrast, if there are very few brand-loyal customers, continuing to sell to at least some cross-price-sensitive individuals becomes necessary to stay in business, so raising prices is not an option.

In our context, the cross-price-sensitive portion of the market is likely larger on the "Walmart versus grocery store" dimension than on the "warehouse club versus grocery store" dimension since warehouse clubs represent a bigger change to the type of product available and the general shopping experience. Compared to grocery stores and Walmart Supercenters, warehouse clubs sell goods in bulk quantities and offer much less variation within each product category, typically carrying a limited selection of name-brand or house-brand goods (e.g. Member's Mark at Sam's Club and Kirkland's at Costco) – perhaps only one brand of spaghetti sauce, for example (Fox et al. 2004:S36).[10] According to Beyman (2012), Sam's Club carries about 4,900 items, and Costco around 4,000; by comparison, the average grocery store carries approximately 50,000 and the average Walmart about 100,000. Moreover, the shopping experience at warehouse clubs is different – members pay a fee for access to goods stacked high and sold in bulk quantities in low-amenity environments. Warehouse clubs are very Spartan in their accommodations. They do not bag consumers' purchases, and a club employee checks all shoppers' carts and receipts upon exit.

Furthermore, differential competitive responses could exist even within the warehouse club category. Sam's Club and Costco differ in their business models: Sam's targets small business customers – as evidenced by their former slogan "We're in Business for Small Business" – while Costco offers low prices on higher-end goods aimed at upper-middle class

[10] Bates (1977 [2002]) offers an early discussion of the warehouse club format.

families.[11,12] According to their 2009 10k form, Wal-Mart's "focus for Sam's Club is to provide exceptional value on brand-name merchandise at 'members only' prices for both business and personal use" (p. 3). Costco, by contrast, "operate[s] membership warehouses based on the concept that offering our members low prices on a limited selection of nationally branded and selected private-label products in a wide range of merchandise categories will produce high sales volumes and rapid inventory turnover" (Costco 2009 10-K, p. 3). The different focuses are also evident in Walmart's 2009 annual report, which devotes a paragraph to Sam's Club's focus on supplying small businesses.[13] This discussion raises the possibility that Sam's Club is primarily a competitor for small business suppliers, whereas Costco is primarily a competitor for conventional grocers. In this case, grocery stores may change prices in response to Costco entry but not Sam's Club entry.

Costco and Sam's Club also differ in terms of the products sold, which could translate to further differences in competitive responses.[14] Table 1 compares Costco and Sam's Club sales by category for 2009. The categories are not strictly comparable as the two stores use slightly different terminology and slightly different definitions. For Costco, for example, "Food" is the sum of their category "Food" (21%), which is defined as "including dry and institutionally packaged foods," and their category "Fresh Food" (12%), which is defined as "including meat, bakery, deli, and produce." Sam's Club defines their category "Food" as "including dairy, meat,

[11] This is according to an author's conversation with an associate at Sam's Club. Vedder and Cox (2006: 119-120) note that Walmart tends to serve shoppers in low-income areas while Costco tends to serve shoppers in higher-income areas.

[12] BJ's Wholesale Club, which operates primarily on the east coast, is another important player in the warehouse club market. For reasons discussed in the data section, we do not include BJ's in our empirical analysis and therefore do not discuss it here either.

[13] http://walmartstores.com/sites/AnnualReport/2009/sams_club.html, accessed July 14, 2010.

[14] A quick Google search reveals several specific examples. For instance, while both offer pharmacy services, Costco offers more coupons (sometimes by direct mail). Sam's Club offers smaller packages and a "Click-N-Pull" service that allows people to shop online and pick up their purchases. For electronics, Sam's Club offers delivery and installation for a fee while Costco offers television installation and technical support (Conover, 2012).

bakery, deli, produce, dry, chilled, and frozen packaged foods."[15] The data should be interpreted with caution, but they suggest that Sam's Club gets a much greater percentage of its sales from "Sundries," which it defines as "including snack foods, tobacco, alcoholic and nonalcoholic beverages, paper goods, laundry and home care and other consumables" and which Costco defines as "including candy, snack foods, tobacco, alcoholic and nonalcoholic beverages and cleaning and institutional supplies." Hardlines and softlines—called "hardgoods" and "softgoods" for Sam's Club—provide a greater percentage of Costco's sales than Sam's Club's. Costco's hardline goods "includ[e] major appliances, electronics, health and beauty aids, hardware, office supplies, garden and patio, sporting goods, furniture, and automotive supplies" while Sam's Club's hardgoods "includ[e] home improvement, electronics, office supplies, outdoor living, grills, gardening, and furniture." Costco's softlines "includ[e] apparel, domestics, jewelry, housewares, media, home furnishings, cameras, and small appliances" while Sam's Club's "softgoods" includ[e] apparel, jewelry, housewares, mattresses, and small appliances."

Competition along Non-Price Dimensions

So far, we have focused exclusively on competitive responses to entry along the price dimension, holding constant all other aspects of the retail offer, such as product quality, convenience, and amenities. However, it is possible that incumbent grocers could respond to Costco, Sam's Club, or Walmart Supercenter entry along one or more of these non-price dimensions, in which case their prices could remain unchanged or rise. Changes in the elasticity

[15] The fact that Costco includes a separate category for "fresh food" suggests a different clientele. In an informal conversation between one of the authors and an employee at one of the stores, the associate said that Sam's Club serves small businesses while Costco's target customers are middle-class families. An employee of a store that competes with both Sam's Club and Costco pointed out that store design, convenience, and customer service are important elements of his firm's competitive strategy. Finally, an example is also suggestive. A friend of one of the authors once asked his six-year-old son where he wanted to go for breakfast after church. The child's reply: "Costco."

of demand for incumbents' goods may come from changes in the composition of the retail offer. Ellickson (2004, 2007) points out that large grocery chains compete on the basis of quality and variety, which require substantial fixed investments in retail services. Retailers serving less cross-price-sensitive consumers may be more likely to increase quality and variety in response to entry by Costco. Discussing Schumpeter (1950) and Kirzner (1973), Boudreaux (1994) analyzes price and quality adjustments in response to changing market conditions and notes that the Schumpeterian entrepreneurial function (upsetting market conditions) and the Kirznerian entrepreneurial function (adjusting production to the underlying pattern of preferences, technology, and resources) are complements, not substitutes.

In two papers on the structure of grocery retail, Ellickson (2004, 2007) argues that grocery stores compete by offering greater variety, which requires investments in distribution centers that increases quality by raising fixed costs, but not marginal costs (Ellickson 2004:524). Incumbents incur larger fixed costs to build better distribution networks; according to Ellickson (2004, 2007), this explains why larger markets have higher-quality products and greater selection rather than more firms.[16]

In sum, the effects of Costco, Sam's Club, and Walmart Supercenter entry on grocery store prices are theoretically ambiguous. Despite prior empirical evidence from Basker and Noel (2009) that grocers reduce prices to compete with Walmart Supercenters, the competitive effects of Costco and Sam's Club could plausibly be quite different. Motivated by this theoretical ambiguity, we next turn to empirical analysis.

[16] Ellickson (2006, 2007) notes that there is still a low-price, low-quality fringe in these markets.

DATA

Following Basker (2005b) and Basker and Noel (2009), we use price data from the Council for Community and Economic Research's (C2ER) ACCRA COLI. Through local chambers of commerce, the ACCRA COLI computes quarterly market prices for a wide range of grocery, energy, transportation, housing, health care, and other items by surveying retailers in between 274 and 334 small geographic areas. For simplicity, we refer to each area as a "city" throughout the rest of the paper, although some are actually multiple cities (i.e. Barre-Montpelier, VT) or entire counties. As a robustness check we later show that the results are not sensitive to dropping the multiple cities and counties from the sample.

We examine the effects of Costco, Sam's Club, and Walmart Supercenter on the prices of the 23 grocery items the ACCRA COLI reported consistently during our sample period. These products, which we describe in Table 2, span a variety of different categories: starches, fruits and vegetables, meats, beverages, additives, and non-food items. We also conduct a falsification exercise that tests for "effects" of these stores on the prices of 9 non-grocery items described in Table 3 that big box retailers do not typically sell.

Whether warehouse clubs and Supercenters are among the stores surveyed in the ACCRA COLI is critical to the interpretation of the results. As noted by Basker and Noel (2009:982), the sampling instructions specifically excluded membership clubs such as Costco and Sam's Club, so any estimated effect of these stores represents a response by competing grocers. The instructions also discouraged the inclusion of Walmart Supercenters, saying that discount retailers should not be sampled "unless upper-income professionals and executives really shop there" (ACCRA 2000:1.3). However, Basker and Noel (2009:982) report that 14% of grocery prices were nonetheless collected at Supercenters. Our estimated effect of Supercenters

therefore represents a weighted average of their price advantage and their effect on competitors. Both because interpretation of the results is less clear for Supercenters and because prior research has already estimated Supercenters' competitive effects, we emphasize the results for Costco and Sam's Club in this paper. Including Supercenters as a control variable is still critical, however, since Sam's Clubs and Walmarts are often located together.

We merge the ACCRA COLI price data with a newly-constructed database of big box retailer and distribution center locations. Costco, Sam's Club, and BJ's Wholesale Club data through May of 2003 were collected by Austan Goolsbee and Chad Syverson and generously shared by Chad Syverson. We updated these warehouse club data through the end of 2008 using the store locators on Costco.com and bjs.com, along with Sam's Club opening dates since 2003 provided by Walmart Stores, Inc. We assembled Costco, Sam's Club, and BJ's Wholesale Club distribution center locations and opening years by first searching Google Maps to find the locations, and then contacting the distribution centers and local chambers of commerce to determine entry years. Though our database therefore contains all three leading warehouse club chains, we do not use the BJ's Wholesale Club information in this paper since only one of the cities in our matched sample experienced BJ's Wholesale Club entry during the sample period. Walmart Supercenter, discount store, distribution center, and food distribution center entry dates and locations through January of 2006 were graciously provided online by Thomas Holmes and used in Holmes (2008).[17] We updated these Walmart data through the end of 2007 using the store locators on Walmart.com along with press releases containing store and distribution center opening dates.

We also include other city- and county-level characteristics as controls in some regressions. City population and land area from 2000 and median household income from 1999

[17] See http://www.econ.umn.edu/~holmes/data/WalMart/index.html.

come from the U.S. Census Bureau, accessed via Statistical Warehouse. The number of grocery stores and warehouse clubs or supercenters besides our stores of interest in each county (comparable city-level data are not available) are taken from the 1992, 1997, and 2002 Censuses of Retail Trade and imputed for the remaining years through linear interpolations and extrapolations.

We construct our sample by matching the annual store, distribution center, and control variables to fourth quarter ACCRA prices from 1994 to 2006. We use only one quarter per year as for some stores and distribution centers we know the year but not the month of entry. Given this limitation, the fourth quarter is the most natural choice in order to maximize the probability that new stores in a particular year open before the prices are recorded. As a robustness check we later show the results are similar if we instead match first quarter prices to store locations from the end of the previous year. We exclude years before 1994 because in 1993 Costco merged with Price Club while Walmart acquired PACE Wholesale Club; a large number of Costcos and Sam's Clubs therefore opened in 1993 and 1994 that were not actually new warehouse clubs. The ACCRA COLI cities varied somewhat over time; we include the 289 cities surveyed in over half of the 13 years. Our sample consists of 70,604 product-city-year-level observations for the main analysis and 27,657 for the falsification exercise.

Tables 2-4 present the descriptive statistics for the variables used in the empirical analysis. The sample mean grocery item price is $2.37, with average prices for the individual products ranging from $0.59 per pound of bananas to $7.99 per pound of T-bone steak. The average sample city has 0.2 Costcos, 0.7 Sam's Clubs, and 0.7 Walmart Supercenters and a population of about 200,000.

EMPIRICAL ANALYSIS

Our empirical analysis proceeds as follows. We begin by estimating the average effects of Costcos, Sam's Clubs, and Supercenters on the price of grocery items. Motivated by approaches used in the literature, we develop a baseline fixed effects model that we validate through a falsification test. We then evaluate the sensitivity of our baseline results through a wide range of robustness checks. Next, we examine the timing of the effect by including leads and lags, the former of which provides an additional test for endogeneity bias. Finally, we explore the possibility of heterogeneity on the bases of product and market characteristics.

Baseline Model and Falsification Test

Basker and Noel (2009) estimate the effect of Walmart Supercenter entry on competitors' grocery prices using ACCRA COLI data from the third quarters of 2001-2004. Their preferred specification regresses the natural log of price on the number of Walmart Supercenters in the city along with city and product-by-year fixed effects. They also estimate cross-sectional, long difference, and (in their appendix) instrumental variables models, but they favor the fixed effects specification based on its utilization of all available information and its passage of a falsification test. Our baseline model adopts Basker and Noel's (2009) fixed effects approach but adds Costco, Sam's Club, and the annual lag of the log of price. We include lagged price because Basker (2005b) documented the stickiness of price shocks in her earlier analysis of the effect of Walmart on ACCRA COLI prices; presumably Basker and Noel (2009) did not also include lagged price because of the short duration of their panel. Our regression equation is

$$p_{ict} = \beta_0 + \beta_1 costco_{ct} + \beta_2 sams_{ct} + \beta_3 swm_{ct} + \beta_4 p_{ic,t-1} + \sum_c \alpha_c city_c + \sum_{it} \theta_{it} product_i \tau_t + \varepsilon_{ict}. \quad (1)$$

where p_{ict} is the natural log of price (in 2006 dollars) of product *i* in city *c* in year *t*; $costco_{ct}$, $sams_{ct}$, and swm_{ct} indicate the number of Costcos, Sam's Clubs, and Walmart Supercenters in city *c* in year *t*; $p_{ic,t-1}$ is the lagged natural log of product price; and the summation terms reflect city fixed effects and product-by-year fixed effects. Standard errors are heteroskedasticity-robust and adjusted for clustering at the city level.[18]

The dynamic model (4) allows for the estimation of both short- and long-run effects. The short run effects of Costcos, Sam's Clubs, and Supercenters are given by β_1, β_2, and β_3. Computing long-run effects requires considering that a store that entered prior to the current year impacts contemporaneous price not only through contemporaneous number of stores but also through lagged price. If, for instance, a new Costco enters, the immediate effect on price is β_1, the additional effect the following year is $\beta_1\beta_4$, the additional effect the year after is $\beta_1{\beta_4}^2$, then $\beta_1{\beta_4}^3$, and so on. The total long-run effect of Costco is therefore given by the following geometric series:

$$\sum_{t=0}^{\infty} \beta_1{\beta_4}^t = \frac{\beta_1}{(1-\beta_4)} \qquad (2)$$

The long-run effects of Sam's Club and Walmart Supercenter can also be computed by replacing β_1 with β_2 and β_3.[19]

The key identifying assumption in regression equation (1) is that changes over time in unobservable city-level characteristics affecting prices are uncorrelated with changes in Costco,

[18] OLS coefficient estimators in models with lagged dependent variables can be inconsistent if the errors are serially correlated (Keele and Kelly 2006). We tested for serial correlation by compressing the data into a two-dimensional panel by computing average product prices in each city in each year, running an analogous regression to equation (4), and then performing the Arrelano-Bond test using the Stata module "abar" (Roodman 2004). The test found only weak evidence of first-order autocorrelation (significant at only the 5% level despite the large sample size). When the extent of the autocorrelation is small, the bias is negligible in large samples (Keele and Kelly 2006). We therefore estimate the model using OLS, and later conduct robustness checks to rule out the possibility that serial correlation is driving our conclusions.

[19] See Basker (2005b) for further discussion of the derivation of long-run effects in this context.

Sam's Club, and Supercenter presence. This assumption would be violated if, for instance, a positive demand shock both increases a city's grocery prices and makes it more attractive to big box retailers. Basker and Noel (2009) provide evidence to support the strict exogeneity assumption in fixed effects regressions with Supercenters from 2001-2004, but it is not clear that this generalizes to regressions with three stores and a longer time period.

We therefore conduct a falsification test where we re-estimate equation (1) using non-grocery prices instead of grocery prices as the dependent variable. The non-grocery prices used for this falsification exercise, listed in Table 3, are chosen to satisfy two conditions. First, they *are not* directly affected by Costcos, Sam's Clubs, or Supercenters. Under this assumption, any "effect" of these stores on the non-grocery prices could not be causal, so if one is found this would call into question the ability of the model to reveal causal effects on grocery prices as well. The second condition is that the non-grocery prices are presumably influenced by the same demand shocks as prices that *are* directly affected by Costcos, Sam's Clubs, and Supercenters. Under this assumption, null results for the non-grocery prices would suggest that omitted demand shocks are not biasing the estimated effects of these stores on grocery prices. To illustrate, consider one of our non-grocery prices: the price of a movie ticket. Since warehouse clubs and Walmarts do not contain movie theatres, entry of these stores should not directly impact movie theatre prices, so the first condition is plausible. Since an increase in the demand for movies should drive up both the prices of movie theatre tickets and DVDs, the latter of which are sold at warehouse clubs and Walmarts, the second condition is also reasonable.[20]

[20] These two conditions prevent several ACCRA COLI non-grocery prices from being viable candidates for the falsification analysis. The first condition rules out ACCRA's price of a tire rotation since many warehouse clubs have tire and auto centers, as well as the prices of hair salon services and McDonald's quarter pounders since Walmart Supercenters often have hair salons and McDonald's restaurants. The second condition rules out energy and housing prices, since they are likely driven by different demand shocks than items sold at warehouse clubs or Walmarts.

Another potential concern with the baseline specification is multicollinearity, as Walmart and Sam's Club often co-locate. If most Sam's Club and Supercenter openings are done together, there might be insufficient variation to precisely identify the impacts of both stores in the same model. Fortunately, this is not the case. 46 new Sam's Clubs opened in our sample cities during the sample period, and only in 11 cases did a Walmart Supercenter also open in the same city in the same year. In 9 cases, the new Sam's Club opened in a city that never had a Walmart Supercenter at any point during the sample. In the remaining 26 cases, the new Sam's Club entered a city that either already had or would later get a Walmart Supercenter. 336 Walmart Supercenters opened during our sample period, 80 of which were in cities that never had a Sam's Club during the sample period. The vast majority of the others (240) had a Sam's Club prior to the Supercenter opening; this commonly occurred when the new Supercenter was a converted discount store. To summarize, identification of the effects of Sam's Clubs and Supercenters comes from a mix of cases where one type of store exists without the other, and when the two enter at different times. Our regression results will suggest that there are sufficient numbers of both to obtain meaningful precision.

We report the results for the baseline regression and falsification test in Tables 5. A new Costco is associated with a statistically significant increase in grocery prices of 1.4% in the short run and 2.7% in the long run. The effect of Sam's Club, however, is small and insignificant. Walmart Supercenters reduce prices by a statistically significant 0.9% in the short run and 1.7% in the long run. Our Supercenter estimates are in line with those obtained by Basker and Noel (2009). We take this as evidence that, even though our ACCRA COLI data do not allow for the exclusion of Walmarts from the stores used to compute market prices, our estimates for Supercenters mostly reflect a competitive effect rather than Walmart's price advantage.

Importantly, the falsification test estimates small and insignificant effects of all three stores, providing preliminary evidence to support the baseline model. We next further test the validity of this specification by subjecting it to a number of robustness checks.

Robustness Checks

This section evaluates the sensitivity of the results from our preferred regression. Our robustness checks fall into five categories: additional control variables, alternate specifications for the store variables, other methods of sample construction, longer lags of price, and instrumental variables.

The first category re-estimates equation (1) including four different sets of control variables. First, we add interactions of each of the year fixed effects with city population. This addresses potential endogeneity bias from highly populated cities both experiencing differential price shocks and being more (or less) likely to attract big box retailers. Next, we add interactions of the year fixed effects with median city income to capture differential trends in price between high and low income areas. Third, we control for the county-level numbers of grocery stores and warehouse clubs or supercenters (besides our stores of interest) to help verify that our estimates reflect the effects of Costco, Sam's Club, and Walmart rather than overall retail structure.[21] This also addresses the possibility that the effects may be partly due to grocers going out of business when faced with competition from big box retailers. Finally, we consider a more general approach to modeling differential trends by including city-specific time trends, created by interacting each of the city fixed effects with linear year.

[21] In unreported regressions, we also added the number of Walmart discount stores to the model. Walmart discount stores do not contain a full grocery section but do sell a limited range of (typically processed) foods, so it is conceivable that they could affect market prices for some grocery items. We found it difficult to jointly identify the effects of discount stores and Walmart Supercenters, as the vast majority of changes in discount store presence in our sample reflected a conversion from a discount store to a Supercenter rather than a new discount store. We therefore do not report the results, though the estimates for Costco and Sam's Club remain similar.

In the second category of robustness checks, we utilize various alternative specifications for the Costco, Sam's Club, and Supercenter variables. These include the number of stores per 100,000 residents or 100 square miles in the city, binary variables reflecting the presence of at least one store in the city, and the number of stores in the county rather than the city. The first three reflect other measures used in the Walmart literature, while the fourth could potentially alter the results to the extent that big box retailers in outlying parts of a county draw customers away from grocery stores within the city limits.

The third category considers different sample construction rules. Recall that cities move in and out of the ACCRA COLI sample over time, and that we use an unbalanced panel of the cities included in over half of the sample years. We first restrict the sample to those cities present in every year. The next two robustness checks drop the multiple cities and counties from the sample and use the first quarter of the following year (1995-2007) rather than the fourth quarter of the current year (1994-2006). We then consider a more drastic change to the sample: instead of pooling the products, we compress the available information into one observation per city per year by computing both simple and weighted (by the shares given in the ACCRA COLI) average prices for the basket of grocery items.

The first three robustness checks of the fourth category replace the lagged grocery price variable with longer lags of 2, 3, and 4 years. This addresses the concerns that serial correlation in the error term or measurement error in the price data may bias the coefficient estimator for lagged price, and that some of the bias could spill over into the coefficient estimators for the store variables. The correlation between unobservables that affect contemporaneous and lagged price should weaken with longer lags, so confirming that the results are not sensitive to lag

length helps to alleviate this concern. We also run a regression that drops lagged price completely.

Our final category of robustness checks considers an entirely different identification strategy. Instead of attempting to control for the sources of endogeneity bias through city fixed effects, we attempt to purge the bias by using distance from the nearest Costco, Sam's Club, and Walmart food distribution centers (and their squares) as instruments for the three endogenous variables. Distance to the nearest distribution center affects operating costs and therefore provides a source of variation in a city's store presence that is potentially uncorrelated with demand-side characteristics influencing price levels. A concern with this approach, however, is that distribution center and store presence may be jointly determined – a corporation may decide to open a series of stores in a potentially profitable area along with a distribution center to service those stores. Another limitation is that there is not enough variation over time in cities' distances from distribution centers for the IV estimates to be meaningfully precise in models with city fixed effects; we therefore do not include fixed effects in the reported IV regressions. Because of these limitations, we prefer to use the IV analysis as a supplemental robustness check rather than as our main approach. We also estimate the IV model adding population, population density, and median income as controls in an attempt to compensate somewhat for the lack of city fixed effects.

To save space, we do not report the full set of results from the 20 robustness checks in this paper but instead show them in Table A1 of the appendix. The findings regarding signs and significance from the baseline regression – that Costcos significantly increase grocery prices, Supercenters significantly decrease them, and Sam's Clubs have no statistically detectable effect

– hold up well.[22] Moreover, the magnitudes of the estimates are generally stable across the different specifications (excluding the ones with alternate store variables, in which case the magnitudes are not comparable because of the differences in scale). For instance, the long-run effect of Costco on ln(price) is between 0.023 to 0.029 in all regressions with additional controls, alternate sample construction, or longer lags of price. It is a larger (though imprecisely estimated) 0.071 to 0.08 in the IV regressions.[23]

Timing

We next examine timing by adding leads and lags of the three stores. A finding that lagged Costco, Sam's Club, and Supercenter presence impact grocery prices conditional on current presence of these stores and lagged grocery prices would provide evidence that the timing of the effect is less smooth than the relationship given by equation (5). If the leads of Costco, Sam's Club, and Supercenters impact grocery prices and cause the estimated effects of contemporaneous stores to change, this would suggest the associations estimated in the preceding sections do not reflect causal effects – price levels are likely determining store entry instead of the other way around.

Table 6 presents results from regressions including one, two, or three year lags of each of the three stores, while Table 7 includes one, two, or three year leads. In unreported regressions we verified the conclusions reached are similar with longer lags or leads or with lags and leads included together. We find no evidence that the results from the preceding sections either mis-specify the timing of the effect or reflect reverse causality. The lags for Costco, Sam's Club, and

[22] There are only two cases in which signs or significance levels differ from those in the baseline regression. First, in the regression with binary store variables, the effect of Costco is still positive but not quite statistically significant. Second, in the regression with county-level store variables, the effect of Sam's Club is positive and significant – however, if we add county-specific linear time trends the effect again becomes small and insignificant.

[23] The IV estimators do not perform as well as the baseline fixed effects estimators in the falsification test, so we consider the fixed effects results more reliable.

Supercenters are statistically insignificant in all cases and including them has little effect on the coefficient estimates for contemporaneous stores. The leads of Costco presence are insignificant and make virtually no difference in the estimate for current Costco presence. The leads for Sam's Clubs are significant in two regressions, but in all cases the conclusion of a small and statistically insignificant association between contemporaneous Sam's Clubs and grocery prices persists. Future Supercenters are weakly significant in one of the three regressions and insignificant in the other two, while in all three the estimated effect of current Supercenters remains similar.

Heterogeneity by Product

All regressions to this point have assumed the impacts of Costcos, Sam's Clubs, and Supercenters are the same across different products and markets. We relax this assumption in the final two sections of the empirical analysis, by examining first whether the effects are different for different product types and then whether they depend on the size and retail landscape of the market.

We stratify by product type by splitting the sample into six categories of grocery items: starches, fruits/vegetables, meats, drinks, food additives, and non-food items, as classified in Table 2. We also consider a broader classification, dividing the sample into only two groups: products for which the ACCRA COLI specifies the brand to be sampled (cereal, peas, peaches, sausage, tuna, coffee, soft drink, shortening, parmesan cheese, margarine, tissue, and dishwasher detergent) and those for which it does not (bread, lettuce, bananas, potatoes, corn, steak, beef, chicken, eggs, milk, and sugar). This categorization could potentially help explain the finding that competitors compete with Costco by raising prices instead of lowering them: if grocery

stores respond to Costco entry by offering higher quality products, the price increase should be stronger among products for which the brand is not specified and therefore quality is not fixed.

Table 8 presents the results.[24] In all eight categories, Costco increases prices, Supercenters decrease prices, and Sam's Club has no statistically detectable effect. There are, however, some important differences in the magnitudes. Costco's effect is strongest for fruits/vegetables, meats, and drinks, while Supercenters' effects are strongest for starches and fruits/vegetables. Costco increases the prices of both items where the brand is specified and those where the brand is not specified. Costco's effect on items with unspecified brands is larger, consistent with some competition alone the quality dimension, but the difference is statistically insignificant (p-value of 0.32).[25]

Heterogeneity by Market Characteristics

We close our analysis by examining if the effects of new Costcos, Sam's Clubs, and Supercenters differ depending on the city's population or the number of grocery stores in the county per 100,000 residents.[26] Heterogeneity by population is possible since additional warehouse clubs or Supercenters might exert less competitive pressure in large cities where they represent a smaller shock to the market. Heterogeneity by grocery store density could work in either direction. On one hand, grocery stores in underserved areas may not need to make significant changes after warehouse clubs or Supercenters enter in order to continue earning comfortable margins. In this case, the competitive effect would strengthen with grocery store

[24] Table A2 in the appendix presents regression results for each of the products separately.
[25] The difference between Sam's Club's effects on brand-specified and non-brand-specified items is also insignificant (p-value of 0.79), while this difference is significant at the 10% level for Supercenters.
[26] We also considered tested for another possible source of heterogeneity -- the number of Costcos, Sam's Clubs, and Walmart Supercenters already in the market – by re-estimating our baseline regression (1) adding the squares of the three stores. Table A3 in the appendix uses these estimates to predict the effects of the first, second, third, and fourth stores to enter the average city. Costcos have a relatively constant effect across the distribution, while the price reductions from Supercenters become slightly weaker with each store.

density. Alternatively, in fiercely competitive markets grocers may already be doing everything they can to differentiate products and target particular types of consumers, in which case the competitive effect would weaken with grocery store density.

We test for heterogeneity on the basis of population by adding interactions of each store with city population to equation (1) and obtaining new estimates. Based on these estimates, we plot in Figure 1 the long-run marginal effects of Costcos, Sam's Clubs, and Supercenters on prices across the population distribution (up to approximately the 95th percentile of 1,000,000). (In Figures A1-A3 of the appendix, we present more detailed graphs that also include short-run effects and 95% confidence intervals.) Figure 1 shows that Costco increases competitors' prices most sharply in less populated areas. In the smallest cities Costco increases prices by about 2.8% in the long run. This effect gradually diminishes as population increases, eventually reaching about 0.5% in the largest cities. The impact of Sam's Club appears to become more positive as city population increases, but it is not statistically different from zero at any point in the distribution. Competitors in the smallest cities reduce prices by 2.5% in the long run in response to Supercenter entry. The reduction diminishes as city population rises, eventually reaching 0.4%.

We examine heterogeneity on the basis of grocery store density by adding grocery stores per 100,000 residents as well as its interaction with each of the three store variables to regression equation (1). We display the estimated long-run marginal effects (up to the 95th percentile of 130 grocery stores per 100,000 residents) in Figure 2. (Figures A4-A6 in the appendix also show the short-run effects and 95% confidence intervals.) Figure 2 shows that grocers increase prices more dramatically when Costco enters markets that are already saturated with grocery stores. The long-run effect is less than 1% if the grocery store density is very low, and rises to about

3.3% if the grocery store density is very high. The impact of Sam's Club also increases with grocery store density but is never significant. Supercenters' competitive effects strengthen in more saturated markets, as they lead to price reductions ranging from under 1% in cities with the lowest grocery store densities to 2.7% in those with the highest.

CONCLUSION

Research by Basker and Noel (2009) has shown that competing grocers lower prices when faced with competition from Walmart Supercenters. We provide evidence of very different responses to competition from warehouse clubs. Using a panel of cities from the ACCRA COLI and a dynamic fixed effects model, we find that Costco entry actually results in higher prices among incumbent grocers, while competition from Sam's Club has no statistically detectable effect. We conducted a variety of tests to increase our confidence that these relationships are causal, including a falsification test with non-grocery items; the addition of control variables, city-specific time trends, and leads of store presence; and the consideration of an instrumental variables strategy. We also examined heterogeneity on the bases of product type, order of store entry, and market population and grocery store density. Costco's effect is strongest for items for which the brand is not specified, and in sparsely populated cities with competitive grocery markets.

Our results are consistent with the segmented-market theoretical framework offered by Frank and Salkever (1992), work by Ellickson (2004, 2007) showing that firms compete on the basis of quality, and Barber and Tietje's (2004) argument that "big box" competitors might cause traditional retailers to raise prices. They also illustrate how firms' entrepreneurial and managerial decisions are multi-dimensional. Grocery stores may elect not to compete with deep-discount membership warehouses on the price dimension, instead focusing on the less price-

sensitive consumers or providing a higher quality shopping experience, higher-end products, or greater convenience.

More broadly, our work shows that not all big box chains are created equal. The big box retail literature has focused almost exclusively on Walmart, examining its effects on a wide range of outcomes including prices, labor market outcomes, small business activity, time use, obesity, and social and cultural indicators. Our finding that Costco and Sam's Club have very different effects on competitors' prices than Walmart Supercenters point to the need for future research to look beyond Walmart when examining how the proliferation of big box retailers in recent decades has impacted communities.

Our results also have implications for antitrust policy. When considering grocery store mergers, the Federal Trade Commission (FTC) often defines the market in which supermarkets compete to include only other supermarkets, ignoring cross-format substitution by consumers. As one (reasonably representative) example, when reviewing the 1999 Kroger-Fred Meyer merger the FTC justified this definition by claiming that,

> Supermarkets compete primarily with other supermarkets that provide one-stop shopping for food and grocery products. Supermarkets primarily base their food and grocery prices on the prices of food and grocery products sold at nearby supermarkets. Supermarkets do not regularly price-check food and grocery products sold at other types of stores and do not significantly change their food and grocery prices in response to prices at other types of stores. Most consumers shopping for food and grocery products at supermarkets are not likely to shop elsewhere in response to a small price increase by supermarkets (Clark, 1).

Our paper, together with Basker and Noel (2009), provides suggestive evidence of demand spillovers that contradicts these claims and could help to inform market definitions in future merger cases.

Finally, our results have implications for the measurement of price levels. Hausman and Leibtag (2009) note that the Consumer Price Index (CPI) does not account for prices at big box grocers. Therefore, if grocery stores raise prices when Costco enters a market, conventional price indices would suggest that the area's cost of living actually *increases*, as they would capture the small positive competitive response but not Costco's deep discounts. On a national level, then, standard measures would suggest that Costco causes inflation. This reinforces Hausman and Leibtag's (2009) argument that the CPI should be modified to account for the changing retail landscape.

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Table 1 – Costco and Sam's Club Sales By Category, 2009

	Costco	Sam's Club
Sundries	23%	37%
Hardlines	19%	16%
Softlines	10%	5%
Food	33%	30%
Services/Anciliary	15%	12%

Sources: Wal-Mart Stores 2009 10-K, p. 10; Costco 2009 Annual Report, p. 9.
Notes: Reports offer slightly different definitions of categories and use slightly different terminology. Costco food sales is the sum of "food" and "fresh food" percentages.

Table 2 – Grocery Item Prices (in 2006 dollars)

Category	Variable	Description	Mean (Std. Dev.)
All Items Pooled			2.371 (1.748)
Starches	Bread	Per oz, white bread	1.130 (0.230)
	Cereal	18 oz box of corn flakes; Kellogg's or Post	3.162 (0.540)
Fruits and Vegetables	Lettuce	Head of iceberg	1.283 (0.222)
	Bananas	Per lb	0.593 (0.111)
	Potatoes	10 lb sack	3.386 (0.910)
	Peas	15 oz can, sweet; Del Monte or Green Giant	0.858 (0.148)
	Peaches	29 oz halves or slices; Hunts, Del Monte, or Libby's	1.957 (0.220)
	Corn	16 oz whole kernel frozen	1.326 (0.238)
Meats	Steak	Per lb, t-bone	7.986 (1.284)
	Beef	Per lb, ground	2.060 (0.475)
	Chicken	Per lb, whole uncut	1.164 (0.204)
	Sausage	1 lb. package; Jimmy Dean or Owen	3.829 (0.697)
	Eggs	Dozen large, grade A or AA	1.196 (0.305)
	Tuna	6 oz chunk of light tuna; Starkist or Chicken of the Sea	0.859 (0.166)
Beverages	Coffee	11.5 oz can; Maxwell House, Hills Brothers, or Folgers	3.588 (0.840)
	Soft Drink	2 liter bottle; Coca Cola	1.437 (0.214)
	Milk	Half-gallon, whole	2.068 (0.259)
Additives	Sugar	4 lb cane or beat	1.940 (0.253)
	Shortening	3 lb can; Crisco	3.691 (0.426)
	Parmesan	8 oz canister of grated parmesan cheese; Kraft	4.346 (0.675)
	Margarine	1 lb sticks, Blue Bonnet or Parkay	0.913 (0.207)
Non-Foods	Tissue	Box of 175; Kleenex	1.607 (0.225)
	Detergent	75 oz dishwashing powder; Cascade	4.161 (0.808)

Table 3 – Non-Grocery Item Prices (in 2006 dollars)

Variable	Description	Mean (Std. Dev.)
All Items Pooled		15.693 (14.720)
Phone	Private residential line, basic monthly rate, fees and taxes	26.573 (4.742)
Haircut	Men's barber shop haircut, no styling	11.880 (2.029)
Dry Cleaning	Man's two-piece suit	9.402 (1.362)
Washer	Home service call, clothes washing machine; minimum labor charge, excluding parts	51.256 (8.957)
Newspaper	Daily and Sunday home delivery, large-city newspaper, monthly rate	16.191 (3.712)
Movie	First-run, indoor, evening, no discount	8.110 (0.870)
Bowling	Price per line (game), Saturday evening non-league rate	3.324 (0.667)
Pizza	11-12 inch thin crust cheese pizza; Pizza Hut or Pizza Inn	11.433 (1.010)
Chicken	Thigh and drumstick; Kentucky Fried Chicken or Church's	3.072 (0.348)

Table 4 – Store, Distribution Center, and Control Variables

Variable	Description	Mean (Std. Dev.)
Costcos	Number of Costcos in the city	0.183 (0.509)
	Costcos per 100,000 residents in the city	0.127 (0.557)
	Costcos per 100 square miles in the city	0.355 (1.598)
	Binary variable for any Costcos in the city	0.143 (0.350)
	Number of Costcos in the county	0.367 (1.344)
Sam's Clubs	Number of Sam's Clubs in the city	0.706 (0.965)
	Sam's Clubs in the per 100,000 residents in the city	0.608 (0.884)
	Sam's Clubs per 100 square miles in the city	1.254 (2.035)
	Binary variable for any Sam's Clubs in the city	0.529 (0.499)
	Number of Sam's Clubs in the county	0.932 (1.333)
Supercenters	Number of Walmart Supercenters in the city	0.730 (1.119)
	Supercenters per 100,000 residents in the city	1.041 (1.835)
	Supercenters per 100 square miles in the city	1.790 (3.194)
	Binary variable for any Supercenters in the city	0.447 (0.497)
	Number of Supercenters in the county	1.073 (1.845)
Discount Stores	Number of Walmart discount stores in the city	0.923 (1.200)
Costco DC	Miles to nearest Costco distribution center	499.817 (334.292)
Sam's DC	Miles to nearest Sam's Club distribution center	260.890 (184.949)
Supercenter DC	Miles to nearest Walmart food distribution center	297.910 (319.851)
Population	City population (units of 100,000)	2.253 (6.335)
Land	City land area (units of 100 square miles)	104.505 (192.651)
Income	City median household income (units of 10,000)	3.469 (0.672)
Grocery Stores	Number of grocery stores in the county	77.152 (173.277)
Warehouse clubs/supercenters	Number of warehouse clubs or supercenters in the county (after subtracting Costcos, Sam's Clubs, and Walmart Supercenters)	0.943 (1.970)

Table 5 – Baseline Results and Falsification Test

		Effect on Grocery Prices	Effect on Non-Grocery Prices
Costcos	Short-Run Effect	0.014 (0.004)***	0.002 (0.003)
	Long-Run Effect	0.027 (0.008)***	0.007 (0.007)
Sam's Clubs	Short-Run Effect	0.003 (0.004)	-0.0007 (0.003)
	Long-Run Effect	0.006 (0.007)	-0.002 (0.007)
Supercenters	Short-Run Effect	-0.009 (0.001)***	-0.0008 (0.001)
	Long-Run Effect	-0.017 (0.003)***	-0.002 (0.003)
Lagged Price		0.472 (0.009)***	0.649 (0.010)***
Observations		70604	27657

Notes: Standard errors, which are heteroskedasticity-robust and clustered by city, are in parentheses. *** indicates statistically significant at the 1% level; ** 5% level; * 10% level. The "short-run effects" are the coefficient estimates for the store variables; the "long-run effects" are the coefficient estimates for the store variables divided by one minus the coefficient estimate for lagged price. All regressions include product*year and city fixed effects.

Table 6 – Lags

		One Year Lag	Two Year Lag	Three Year Lag
Costcos	Coefficient Estimate	0.014 (0.007)**	0.013 (0.006)**	0.013 (0.006)**
	Coefficient Estimate for Lag	-0.0001 (0.006)	0.004 (0.005)	-0.003 (0.006)
Sam's Clubs	Coefficient Estimate	-0.003 (0.005)	-0.004 (0.005)	-0.003 (0.005)
	Coefficient Estimate for Lag	0.008 (0.006)	0.008 (0.005)	0.006 (0.005)
Supercenters	Coefficient Estimate	-0.011 (0.003)***	-0.010 (0.002)***	-0.009 (0.002)***
	Coefficient Estimate for Lag	0.002 (0.003)	-0.0003 (0.002)	-0.00004 (0.002)
Lagged Price		0.467 (0.009)***	0.460 (0.010)***	0.456 (0.010)***
Observations		65662	60487	55038

See notes for Table 5.

Table 7 – Leads

		One Year Lead	Two Year Lead	Three Year Lead
Costcos	Coefficient Estimate	0.012 (0.006)*	0.015 (0.005)***	0.017 (0.005)***
	Coefficient Estimate for Lead	0.004 (0.005)	-0.0006 (0.004)	0.0002 (0.004)
Sam's Clubs	Coefficient Estimate	-0.0006 (0.006)	0.0007 (0.004)	0.003 (0.005)
	Coefficient Estimate for Lead	0.005 (0.005)	0.008 (0.004)**	0.008 (0.004)**
Supercenters	Coefficient Estimate	-0.006 (0.002)***	-0.008 (0.002)***	-0.011 (0.002)***
	Coefficient Estimate for Lead	-0.003 (0.002)*	-0.002 (0.002)	-0.001 (0.001)
Lagged Price		0.472 (0.009)***	0.471 (0.009)***	0.481 (0.009)***
Observations		70674	65798	60646

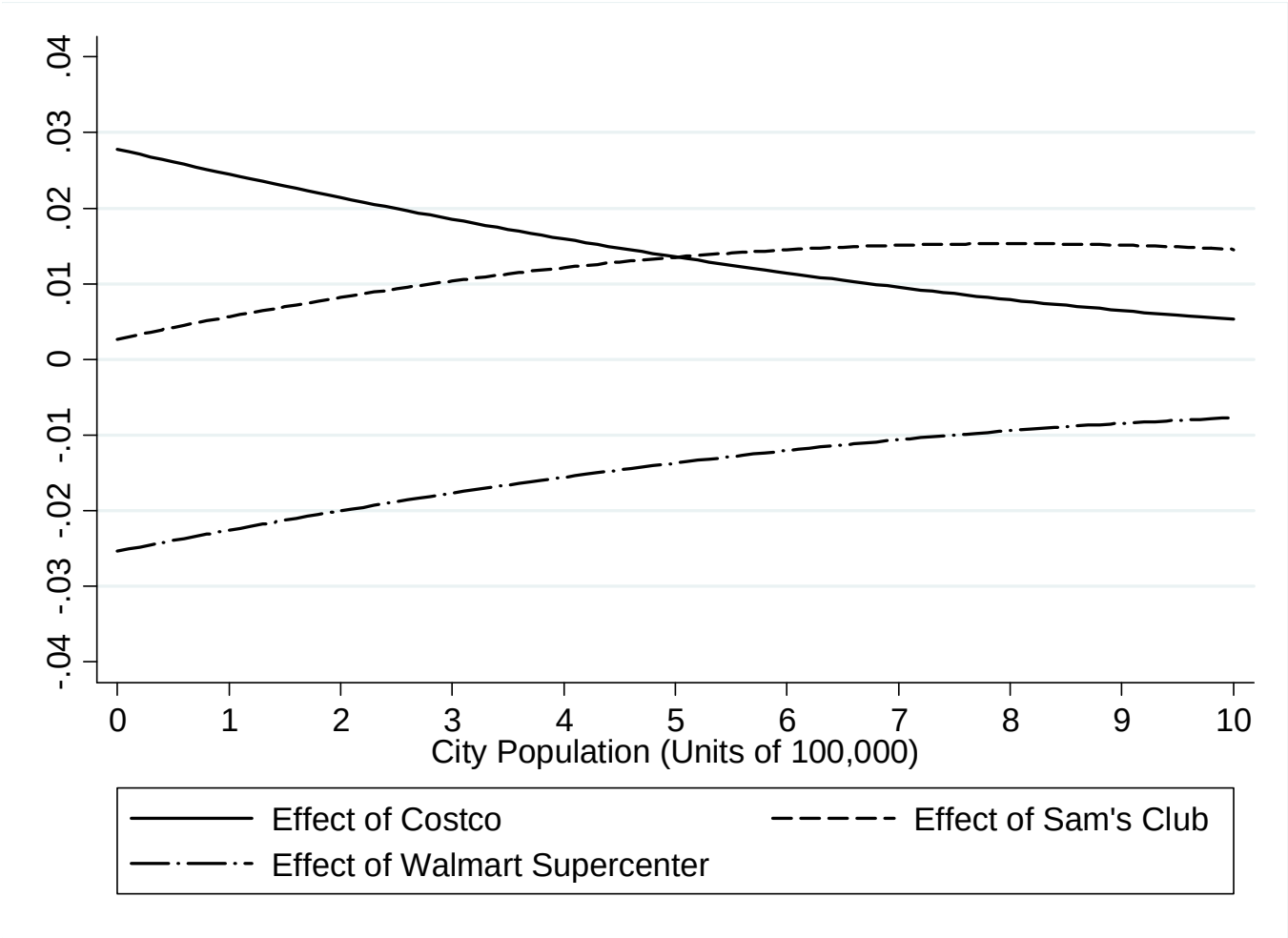
See notes for Table 5.

Table 8 – Product Categories

	Costcos		Sam's Clubs		Supercenters	
	Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
Starches (n=6146)	0.011	0.018	0.010	0.016	-0.017***	-0.027***
Fruits/Vegetables (n=18438)	0.021***	0.037***	0.007	0.012	-0.013***	-0.022***
Meats (n=18433)	0.016***	0.028***	0.004	0.007	-0.009***	-0.015***
Drinks (n=9219)	0.017***	0.034***	0.002	0.004	-0.006***	-0.011***
Additives (n=12292)	0.010*	0.017*	-0.0007	-0.001	-0.007***	-0.012***
Non-Food Items (n=6146)	0.008	0.010	0.004	0.006	-0.008***	-0.011***
Brand Specified (n=36871)	0.013***	0.023***	0.004	0.007	-0.008***	-0.015***
Brand Not Specified (n=33803)	0.017***	0.031***	0.003	0.006	-0.011***	-0.019***

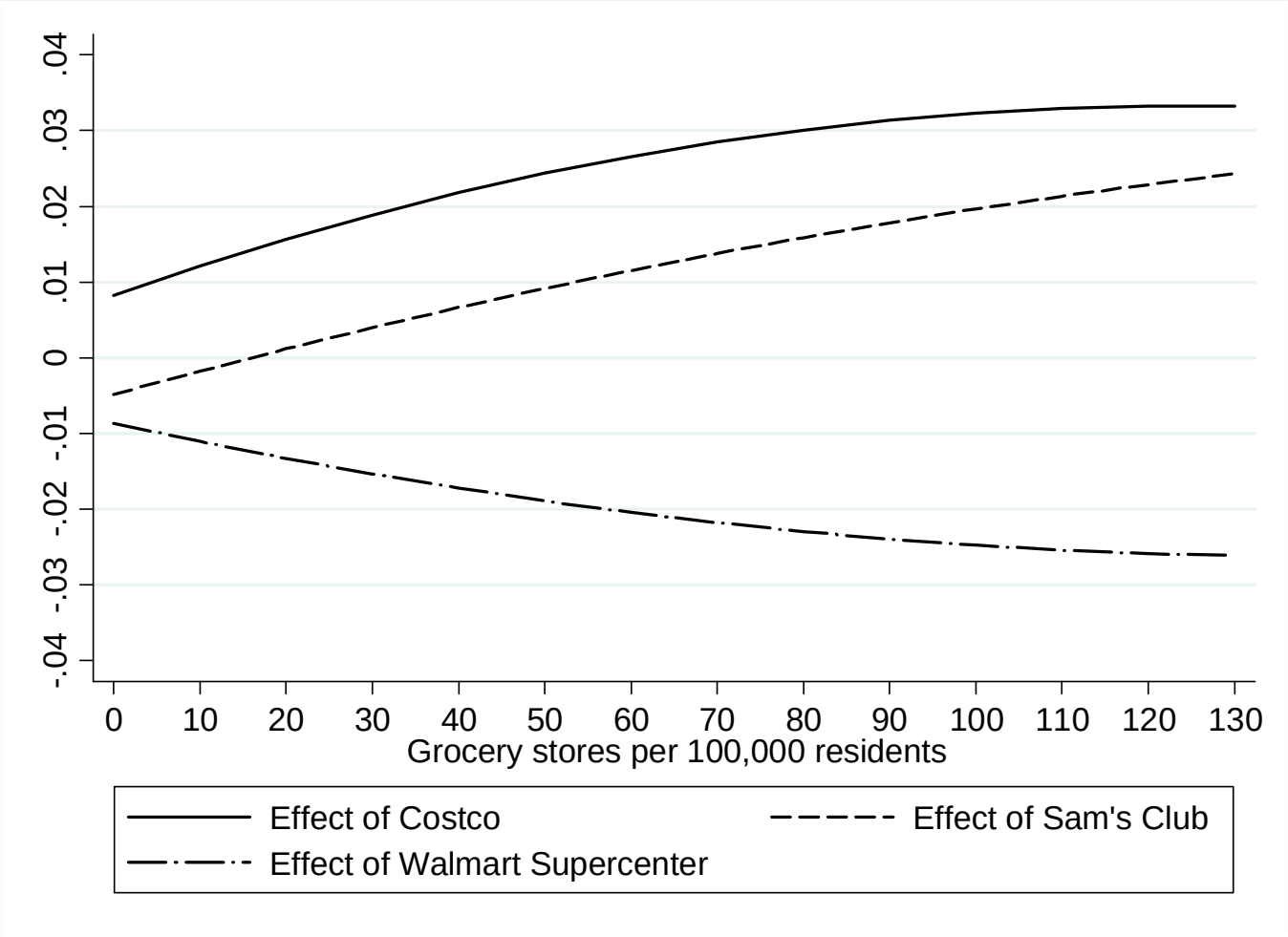
All regressions include product x year fixed effects, city fixed effects, and lagged price. Standard errors are suppressed to save space; they are available upon request. See other notes for Table 5.

Figure 1 – Long-Run Marginal Effects of Costcos, Sam's Clubs, and Walmart Supercenters on ln(Price) by Population



Coefficient estimates (standard errors): Lagged price 0.471 (0.009), Costcos 0.015 (0.007), Costcos*population -0.0018 (0.0015), Costcos*population^2 0.00006 (0.00004), Sam's 0.001 (0.006), Sam's*population 0.002 (0.002), Sam's*population^2 -0.0001 (0.0001), Supercenters -0.013 (0.002), Supercenters*population 0.0015 (0.0007), Supercenters*population^2 -0.00006 (0.00004).

Figure 2 – Long-Run Marginal Effects of Costcos, Sam's Clubs, and Walmart Supercenters on ln(Price) by Grocery Store Density



Coefficient estimates (standard errors): Lagged price 0.471 (0.009), Costcos 0.004 (0.008), Costcos*stores 0.0002 (0.0002), Costcos*stores^2 -8.27e-7 (6.70e-7), Sam's -0.003 (0.006), Sam's*stores 0.0002 (0.0001), Sam's*stores^2 -3.70e-7 (6.88e-7), Supercenters -0.005 (0.003), Supercenters*stores -0.0001 (0.00007), Supercenters*stores^2 -4.70e-7 (2.61e-7).

Appendix – Table A1 – Robustness Checks

		Costcos		Sam's Clubs		Supercenters	
		Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
Panel A: Add Controls	Population*year	0.012***	0.023***	0.003	0.006	-0.009***	-0.017***
	Income*year	0.012***	0.023***	0.003	0.007	-0.009***	-0.017***
	Additional stores	0.013***	0.025***	0.004	0.008	-0.009***	-0.017***
	Linear city trends	0.014*	0.025*	-0.006	-0.010	-0.010***	-0.018***
Panel B: Alternate Store Variables	Per 100,000 capita	0.008***	0.015***	-0.0002	-0.0004	-0.006***	-0.011***
	Per 100 square miles	0.008**	0.015**	0.004	0.007	-0.007***	-0.014***
	Binary	0.009	0.016	0.006	0.011	-0.021***	-0.041***
	County-level	0.009***	0.017***	0.008***	0.014***	-0.006***	-0.011***
	County-level; add county trends	0.009*	0.017*	-0.002	-0.003	-0.006***	-0.012***
Panel C: Alternate Samples	Balanced panel (n=26519)	0.011	0.022	-0.0001	-0.0002	-0.007***	-0.014***
	Single cities only (n=60628)	0.012**	0.022**	0.005	0.010	-0.009***	-0.016***
	1st quarter (n=69276)	0.011***	0.020***	0.007	0.013	0.011***	-0.017***
	Basket; simple average (n=3061)	0.013***	0.023***	0.005	0.008	-0.009***	-0.014***
	Basket; weighted average (n=3061)	0.013***	0.022***	0.004	0.006	-0.008***	-0.014***
Panel D: Longer Lags of Price	Price in t-2	0.018***	0.029***	0.004	0.007	-0.012***	-0.019***
	Price in t-3	0.017***	0.027***	0.006	0.009	-0.013***	-0.020***
	Price in t-4	0.017***	0.025***	0.007	0.010	-0.015***	-0.021***
	No lagged price	0.025***	0.025***	0.009	0.009	-0.014***	-0.014***
Panel E: IV	Baseline	0.038*** [7.63]	0.080***	0.013 [14.48]	0.028	-0.059*** [16.45]	-0.124***
	Add population, density, and income	0.034** [7.72]	0.071**	0.003 [11.46]	0.006	-0.043** [4.93]	-0.089**

Notes: Standard errors, which are heteroskedasticity-robust and clustered by city, are suppressed to save space; they are available upon request. *** indicates statistically significant at the 1% level; ** 5% level; * 10% level. The "short-run effects" are the coefficient estimates for the store variables; the "long-run effects" are the coefficient estimates for the store variables divided by one minus the coefficient estimate for lagged price. All regressions include product x year fixed effects, city fixed effects, and lagged price. In Panel E, the first stage F statistics are in brackets.

Table A2 – Individual Products

	Costcos		Sam's Clubs		Supercenters	
	Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
Bread	0.007	0.008	0.012	0.015	-0.023***	-0.028***
Cereal	0.021	0.028	0.017	0.023	-0.018***	-0.024***
Lettuce	0.060***	0.066***	0.007	0.008	-0.017***	-0.026***
Bananas	0.012	0.013	0.008	0.008	-0.017***	-0.018***
Potatoes	0.018	0.019	0.048***	0.050***	-0.020***	-0.020***
Peas	0.032**	0.038**	0.012	0.014**	-0.017***	0.020***
Peaches	0.013	0.018	0.011	0.016	-0.005*	-0.007*
Corn	0.040***	0.049***	-0.011	-0.013	-0.022***	-0.027***
Steak	0.018	0.020	0.001	0.001	-0.009**	-0.010**
Beef	0.025*	0.028*	0.035**	0.040***	-0.012**	-0.013**
Chicken	0.024	0.027	-0.006	-0.007	-0.013***	-0.015***
Sausage	0.017	0.018	0.008	0.009	-0.013***	-0.014***
Eggs	0.035**	0.038**	0.007	0.007	-0.018***	-0.019***
Tuna	0.027**	0.032**	0.003	0.004	-0.012***	-0.014***
Coffee	0.026**	0.031**	-0.006	-0.007	-0.009***	-0.011***
Soft Drink	0.027**	0.033**	0.012	0.015	-0.008**	-0.010**
Milk	0.016**	0.023**	0.009	0.013**	-0.007**	-0.009**
Sugar	0.017*	0.019*	-0.004	-0.004*	-0.006*	-0.006*
Shortening	0.011	0.020	-0.011**	-0.019**	-0.004*	-0.006*
Parmesan	0.019**	0.029**	0.008	0.011	-0.009***	-0.013***
Margarine	-0.003	-0.003	0.013	0.016	-0.016***	-0.019***
Tissue	0.001	0.002	0.011	0.013	-0.008***	-0.010***
Detergent	0.015*	0.019*	-0.00007	-0.00008	-0.009***	-0.011***

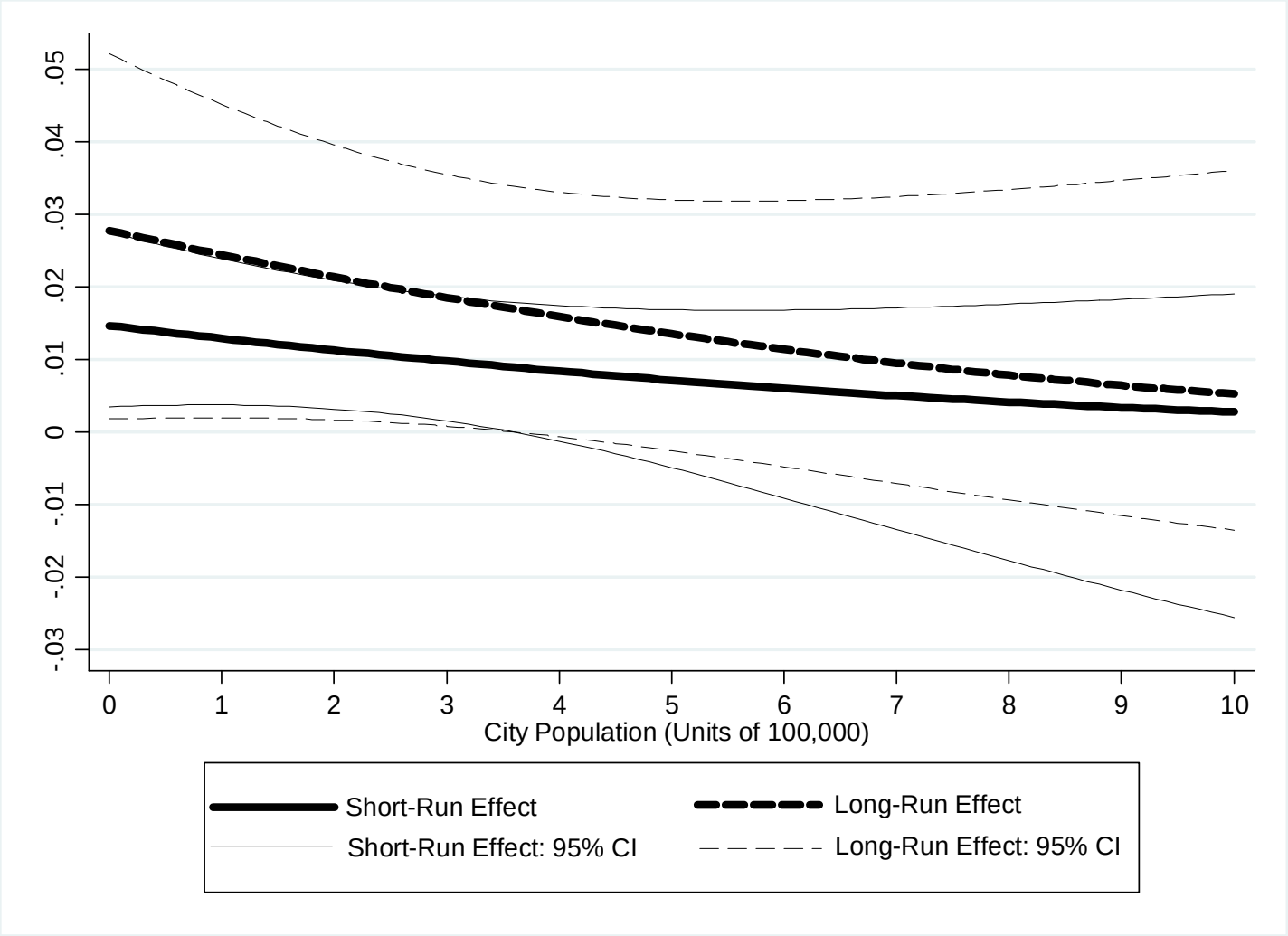
All regressions have a sample size of 3073, except for sausage for which five observations are missing. See other notes for Table A1.

Table A3 – Heterogeneity by Order of Store

	Costcos		Sam's Clubs		Supercenters	
	Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
1st Store	0.012**	0.023**	0.008*	0.015	-0.013***	-0.025***
2nd Store	0.013**	0.026**	0.004	0.008	-0.011***	-0.021***
3rd Store	0.015*	0.029*	0.0003	0.0006	-0.009***	-0.017***
4th Store	0.017	0.031	-0.003	0.006	-0.006***	-0.012***

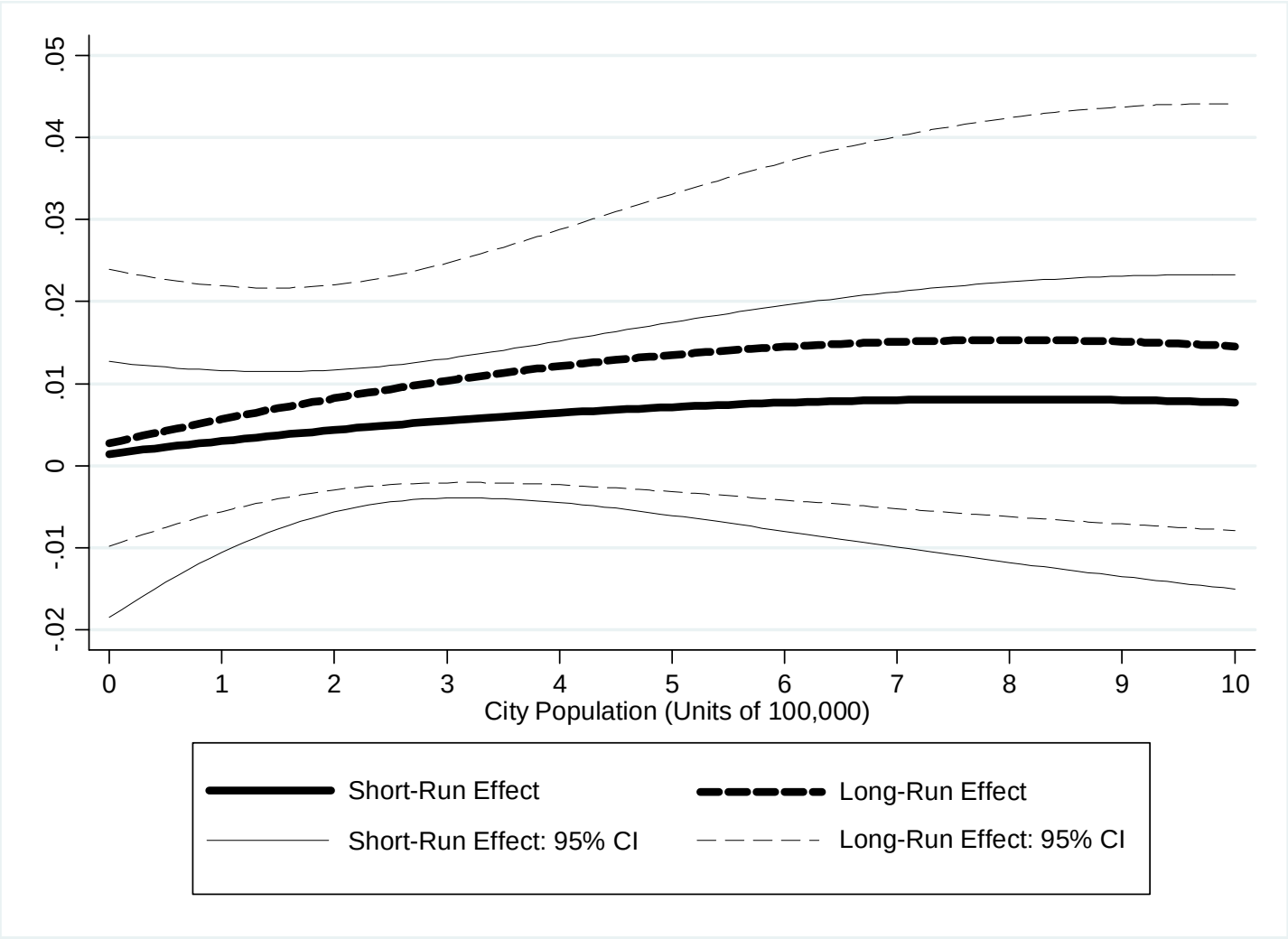
Estimates computed from regressions of ln(Price) on the number of stores and their squares, controlling for lagged price, product x year fixed effects, and city fixed effects. See other notes for Table A1. Coefficient estimates (standard errors) for the store variables: Costco 0.012 (0.007), Costco^2 0.0007 (0.002), Sam's 0.010 (0.004), Sam's^2 -0.002 (0.0005), Supercenters -0.015 (0.002), Supercenters^2 0.001 (0.0003).

Figure A1 – Marginal Effect of Costcos on ln(Price) by Population



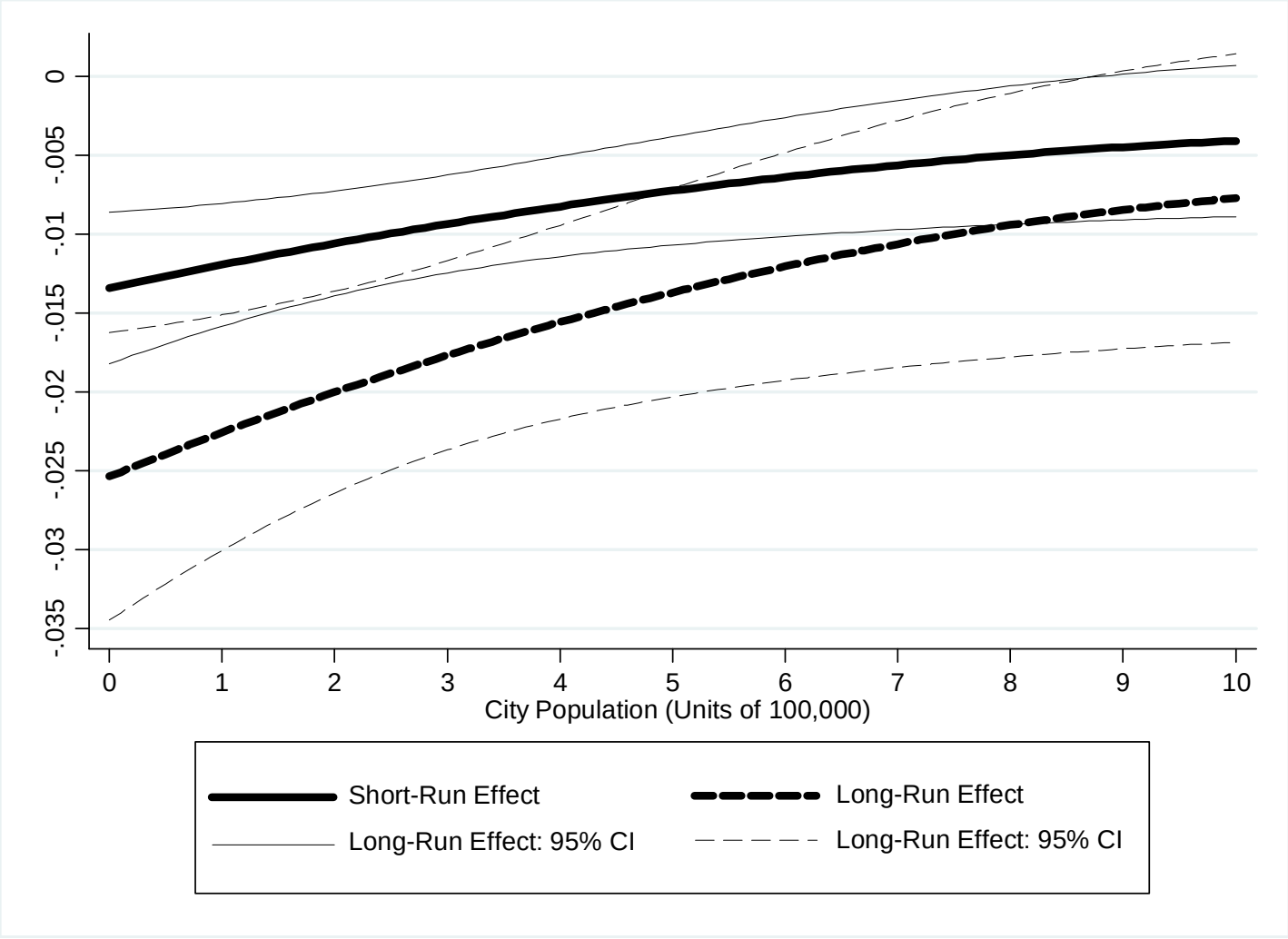
Coefficient estimates (standard errors): Costcos 0.015 (0.007), Costcos*population -0.0018 (0.0015), Costcos*population^2 0.00006 (0.00004).

Figure A2 – Marginal Effect of Sam's Clubs on ln(Price) by Population



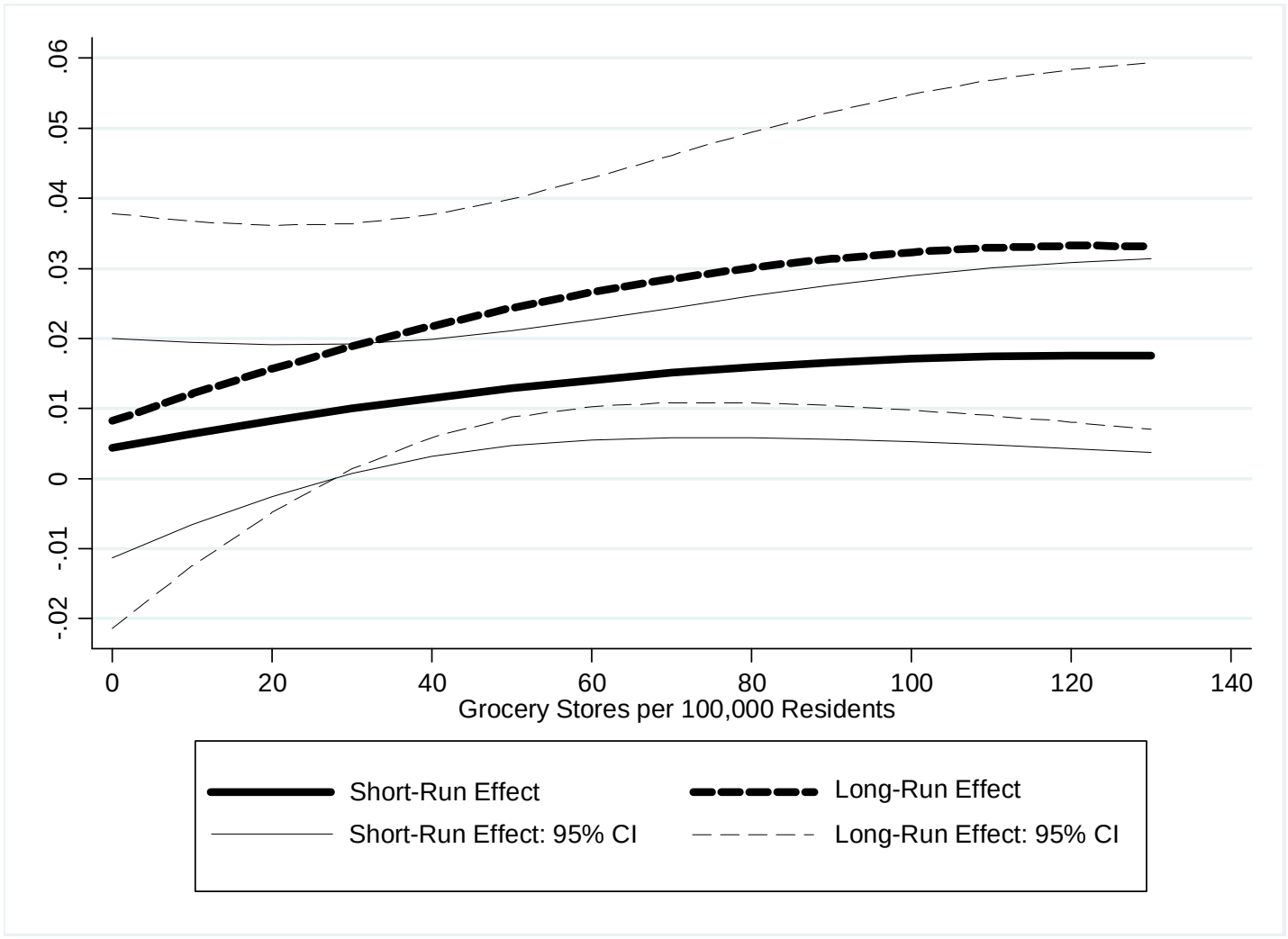
Coefficient estimates (standard errors): Sam's 0.001 (0.006), Sam's*population 0.002 (0.002), Sam's*population^2 -0.0001 (0.0001).

Figure A3 – Marginal Effect of Walmart Supercenters on ln(Price) by Population



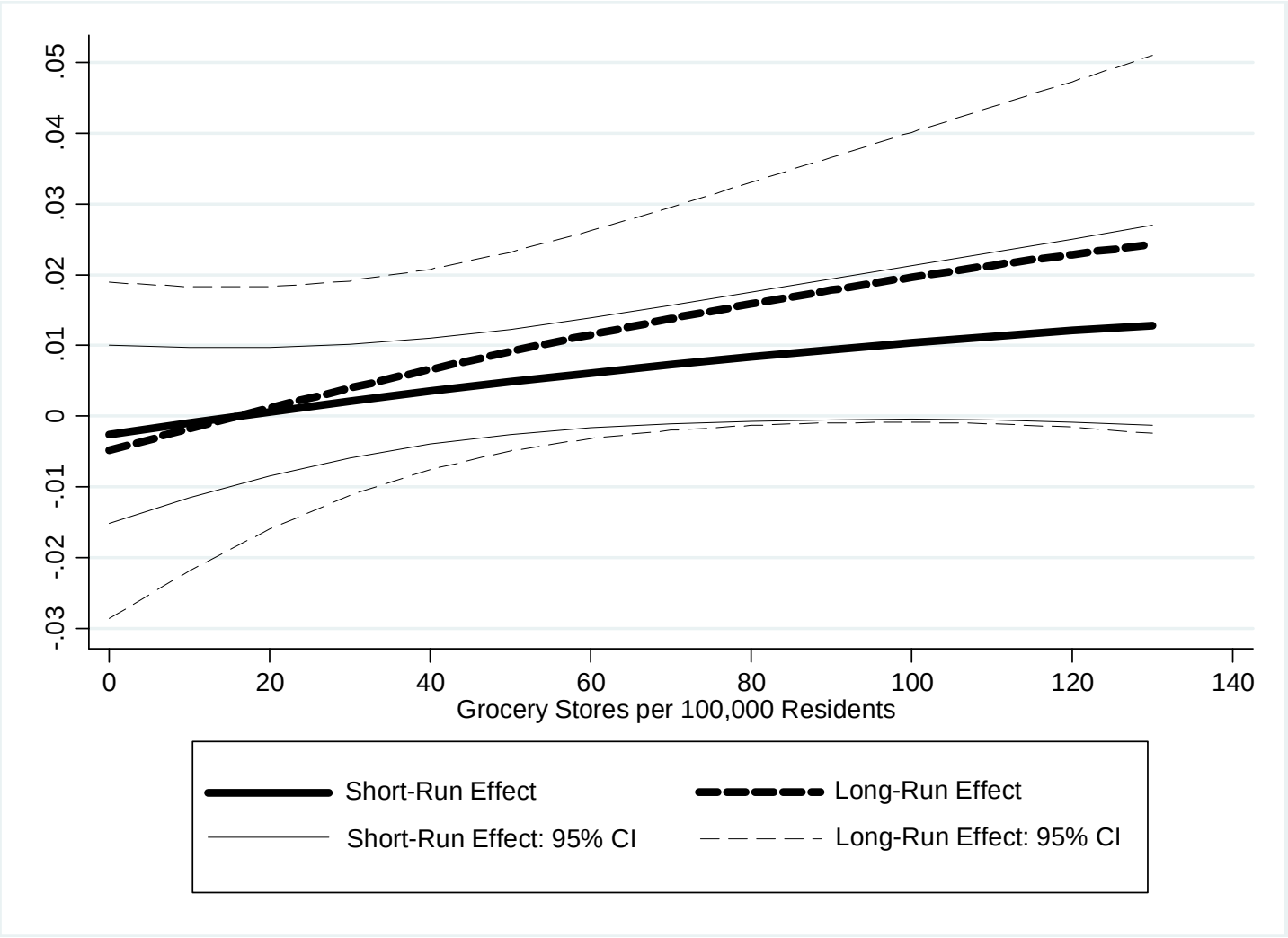
Coefficient estimates (standard errors): Supercenters -0.013 (0.002), Supercenters*population 0.0015 (0.0007), Supercenters*population^2 -0.00006 (0.00004).

Figure A4 – Marginal Effect of Costcos on ln(Price) by Grocery Store Density



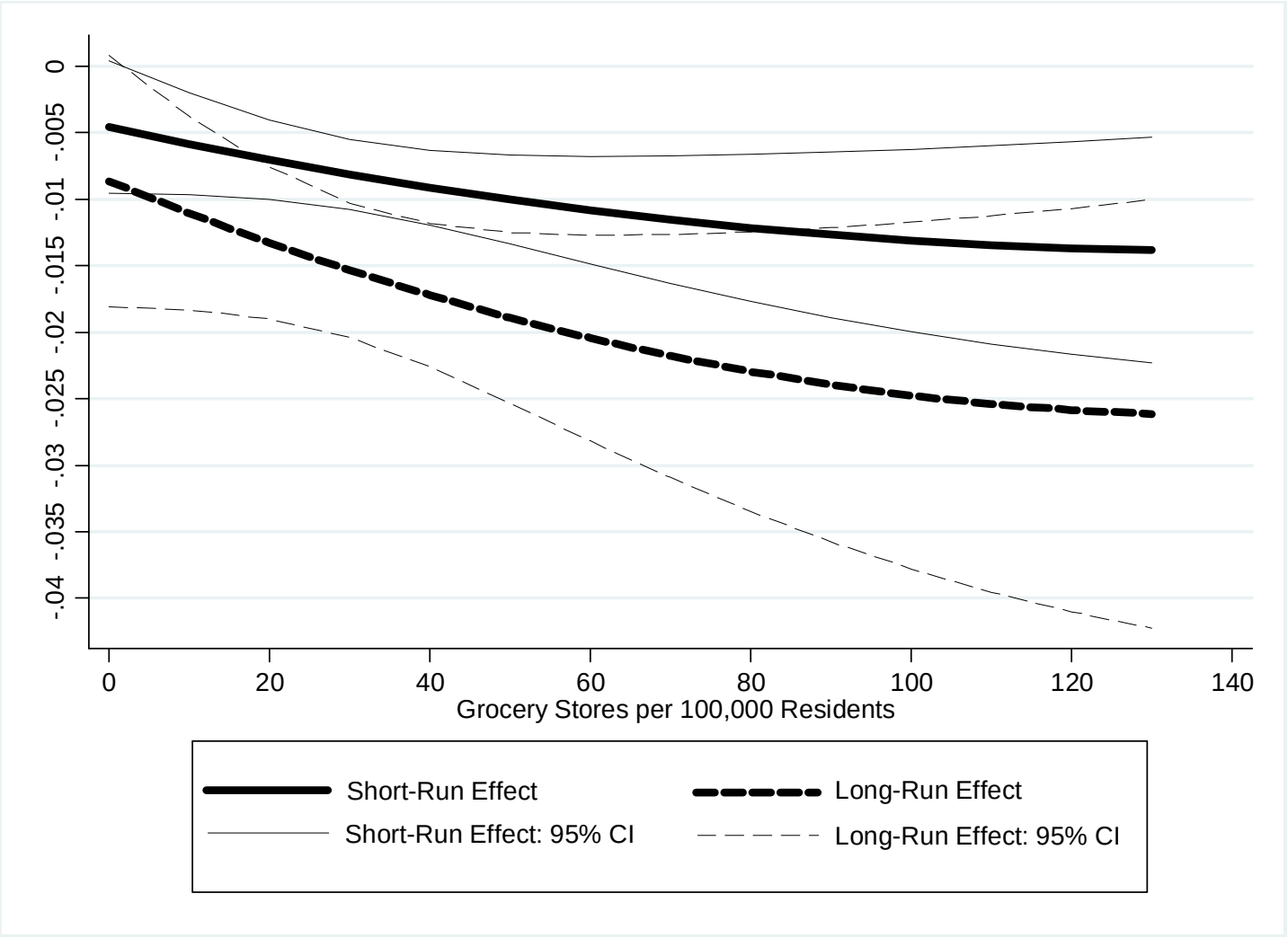
Coefficient estimates (standard errors): Costcos 0.004 (0.008), Costcos*stores 0.0002 (0.0002), Costcos*stores^2 -8.27e-7 (6.70e-7).

Figure A5 – Marginal Effect of Sam's Clubs on ln(Price) by Grocery Store Density



Coefficient estimates (standard errors): Sam's -0.003 (0.006), Sam's*stores 0.0002 (0.0001), Sam's*stores^2 -3.70e-7 (6.88e-7).

Figure A6 – Marginal Effect of Walmart Supercenters on ln(Price) by Grocery Store Density



Coefficient estimates (standard errors): Supercenters -0.005 (0.003), Supercenters*stores -0.0001 (0.00007), Supercenters*stores^2 -4.70e-7 (2.61e-7).