The Welfare Impact of Dollar Stores*

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Abstract

Dollar stores are small-box discount stores that offer a broad range of products at low prices with a limited selection within each product category. Major dollar store chains in the U.S. have experienced exponential growth in the past two decades, outgrowing Walmart and McDonald's in terms of store locations. In this paper, I discuss three potential channels through which dollar stores can affect consumer welfare: (1) dollar stores charge lower prices for the same products than their competitors and offer a higher share of private-brand products, which generate disproportionate sales; (2) dollar store entry leads to exits of grocery stores and changes the local market structure; and (3) low-income households are more exposed to dollar store entry than high-income households. I propose a nested-CES demand model to quantify the welfare impact of dollar store entry through these channels for households of different income groups. I find that between 2006 and 2019, on average, dollar store entry improved household welfare, albeit with large heterogeneity within and across household income groups. The variation in the welfare impact of dollar store entry across households is driven by differences in households' preferences (across income groups), their baseline retail conditions, and the number of dollar store entries. A decomposition of household welfare change due to dollar store entry reveals the different channels sustaining the welfare gains of low- vs. high-income households. Low-income households benefit from both the change in retail variety and product characteristics at dollar stores, whereas the welfare gain enjoyed by high-income households comes entirely from their value for product characteristics at dollar stores. Furthermore, this paper highlights the declining appeal of dollar stores as they continue to enter local markets and corroborates the need for existing placed-based dispersal policies for dollar stores.

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1 Introduction

The discount retail sector, while highly competitive, has become increasingly dominated by national chains (Foster et al. 2016; Smith and Ocampo 2022). The best-known example is the rise of Walmart since the 1980s. Its impact on neighborhoods and market structures is well studied in the literature (Ellickson 2016). With household demand ever changing, retailers in this sector continue to innovate and compete on prices, store locations, merchandise quality and assortments, and operational technologies. Since 2000, the most recent trend in the discount retail sector has been the rapid expansion of dollar stores.

Dollar stores are small-box discount stores that offer a broad range of products at low prices with a limited selection within each product category. Dollar stores resemble mom-and-pop stores in terms of store size and accessibility, yet they boast the efficiency and technology of national chains. In the U.S., the number of dollar stores operated by three major chains increased from 7,352 in 2000 to 31,164 in 2019. Figure 1 contrasts this quadrupling in the number of dollar stores between 2000 and 2019 with the moderate decline of other retail stores.

Until recently, as dollar store chains expanded across the nation, their presence in communities had largely been welcomed by locals. According to Good Jobs First, major dollar store chains have received a combined tax subsidy of $145 million in the forms of tax credits, grants, tax incremental financing, or enterprise zone programs. These subsidies were provided on the basis of the belief that dollar stores can contribute to local retail diversity and bring down the cost of living. However, the tide has recently turned, and dollar stores have seen growing pushback from local communities, with 27 cities imposing some form of restriction on dollar store entry.[1] Dollar store critics argue that dollar stores squeeze out or prevent the entry of full-service grocery stores and contribute to the formation of food deserts in local communities. Despite policymakers' evolving attitudes toward dollar stores, and with the exception of anecdotal evidence, little is known about the impact that dollar stores have on the local market structure and household welfare, which form the basis for the evaluation of dollar store–related policies. In this paper, I seek to fill this gap.

I begin by presenting three stylized facts about dollar stores. First, about 10% of products in dollar stores are private-brand products available only in dollar stores. These private-brand products generate disproportionate sales, highlighting their potential to positively contribute to household welfare. Second, compared to competing store formats, size-adjusted product prices at

1. The Institute for Local Self-Reliance provides a list of cities that restrict dollar store entry into their communities. The majority of these cities implement a dispersal policy that involves some separation requirement to limit dollar store density. For example, the city of Tulsa, Oklahoma, passed an ordinance in 2018 barring new dollar stores from locating within one mile of existing dollar stores.

dollar stores are, on average, 5.5% lower for name-brand products and 24.6% lower for private-brand products. Low product prices represent another channel through which dollar stores can benefit households. Third, there is a persistent gap in access to and spending at dollar stores across household incomes. Low-income households are disproportionately exposed to dollar stores and shop at dollar stores more intensively. In 2019, the average number of dollar stores located within one mile of low-income households was almost twice the average number of dollar stores to which high-income households have access, and the share of expenditures at dollar stores by low-income households was four times that of high-income households. The comparison suggests that dollar stores may have different welfare implications for households in different income groups.

I then use dollar store entry in an event study framework to examine the impact of dollar stores on the local market structure. In particular, I estimate how the numbers of grocery, mass merchandise, and drug stores in a local market change following dollar store entry. The potential endogeneity of dollar store entry that arises from confounding variables and simultaneity bias poses a threat to causal inference. To address this, I take two measures. First, I control for both long-term changes and levels of market demographic and economic conditions in order to mitigate confounding issues. Second, I extrapolate a linear trend using market information in years immediately preceding dollar store entry and estimate the effect of dollar stores on local market structure, while adjusting for the extrapolated linear trend.[2]

In the event study analysis, I find that the effect of dollar stores on their competitors varies over distance and by order of entry. The effect is most pronounced when dollar stores are located within one mile of market centroids, and it decays as dollar stores are located further away. Entry of dollar stores within one mile of a market centroid leads to changes in local market retail composition characterized by grocery and drug stores exits. The number of grocery stores decreases by 2.7% three years after the first dollar store entry, 8% after the second entry, and 14% after each additional entry beyond the first two. The exit rate of drug stores three years after dollar store entry is about 5% for both the first and second entry, and additional dollar store entries beyond the first two are associated with an increase of drug stores in the local market. Mass merchandise stores do not seem to respond to dollar store entry in any meaningful way. The changes in local market structure that result from dollar store entry and marked by the trade-off between dollar stores and grocery stores obscure the welfare implications of dollar stores.

To quantify the welfare impact of dollar stores, I propose and estimate a demand model of a representative household with nested constant-elasticity-of-substitution (CES) preferences over products, product categories, and retailers. The model has several desirable features. First, the

2. See Freyaldenhoven, Hansen, and Shapiro (2019) for a discussion of the extrapolation method.

CES preferences are consistent with an individual discrete choice model (Anderson, Depalma, and Thisse 1987). Under the nested model, households allocate spending over retailers that are distinguished by product prices and varieties and by households' preferences for store amenities. Second, the nested structure of the demand model allows flexible substitution patterns and thus can separately capture the welfare value of the new product variety of private-brand products and low product prices at dollar stores and changes in retail composition at the retailer level. Third, the demand model incorporates preference heterogeneity across products and across household incomes.

Combining the reduced-form and model parameter estimates, I measure the welfare impact of dollar store entry between 2006 and 2019 on households from different income groups. I find that the average household benefited from the dollar store expansion between 2006 and 2019, albeit with large heterogeneity across and within household income groups. Across household income groups, low-income households benefited most, with an average welfare gain worth 8% of their grocery expenditures, whereas the average welfare gain of middle- and high-income households was valued only at approximately 2.8% and 1.3%, respectively, of their grocery expenditures.

Within each income group, there was large variation in dollar stores' welfare impact across households. In particular, about 30% of households found dollar store entry undesirable from a welfare perspective. The variation across households within each income group can be attributed to the different baseline retail compositions faced by households.

Furthermore, I decompose household welfare change associated with dollar store entry into the welfare change that arises from product characteristics (i.e., the new product variety of private-brand products and low product prices) at dollar stores and the welfare change that arises from changes in local retail composition. The results reveal the different driving forces that underlie household welfare gains across household incomes that can be attributed to dollar store entry. The changes in local retail composition due to dollar store entry account for 70% of low-income household welfare gain yet bear no value for middle- and high-income households, whose welfare changes reflect their value of dollar store product characteristics.

Finally, I discuss dispersal policies that regulate dollar store entry based on the distribution of household welfare change that resulted from dollar store entry between 2006 and 2019. The first dollar store entry is mostly welfare-improving for households of all income groups, while additional dollar store entries beyond the first two lessen household welfare, especially for middle- and high-income households.

Related Literature

This paper is broadly related to two strands of the literature. The first studies the effect of big-box retailers on local retail competition and, in a few cases, on consumers. For example, a large body of literature examines the effect of entry by Walmart on the survival of incumbent supermarkets and discount stores (Ellickson and Grieco 2013; Jia 2008), incumbent revenues and prices (Arcidiacono et al. 2020; Basker 2005b; Basker and Noel 2009), incumbent product quality (Matsa 2011), and the local labor markets (Basker 2005a). Taking the analysis one step further, Hausman and Leibtag (2007) and Atkin, Faber, and Gonzalez-Navarro (2018) estimate the impact of Walmart entries on consumer welfare in the contexts of the U.S. and Mexico, respectively. My paper complements the existing literature by providing new evidence on the competitive effect of dollar stores on the local market structure. Dollar stores represent a store format that falls between national big-box chains and local mom-and-pop stores. Given their rapid rise in the 21st century, it is important to understand how dollar stores interact with their competitors and, subsequently, how they affect household welfare.

Recently, Caoui, Hollenbeck, and Osborne (2022), Chenarides, Cakir, and Richards (2021), and Chenarides et al. (2021) have advanced the growing literature on dollar stores. Their works focus on the location choices of dollar stores, model the location competition between dollar stores and stores of other formats, and explore the effect of dollar store entries on food access. For example, Caoui, Hollenbeck, and Osborne (2022) find that dollar store entries lead to a significant decrease in the number of independent grocery stores — a finding consistent with the empirical analysis presented in this paper. Contributing to the dollar store literature, my paper measures the impact of dollar store entry on household welfare and assesses the welfare importance of the product characteristics at dollar stores and changes in local retail composition caused by dollar store entry. I show that the value of dollar stores that arises from their product characteristics and contribution to retail variety is nontrivial and is perceived differently by households of different incomes. Failing to account for these factors can bias the narrative about dollar stores.

The second strand is place-based policies, or, more specifically, business tax incentives in the U.S. Previous work, which has focused mostly on the manufacturing industry, has examined the effect of new plants from the perspectives of productivity spillover (Kline and Moretti 2013; Greenstone, Hornbeck, and Moretti 2010) as well as increased employment and labor earnings (Moretti and Wilson 2014; T. J. Bartik 2019; T. Bartik 2019; Greenstone and Moretti 2003; Slattery and Zidar 2020). These results are not informative for place-based retail policies, which are typically designed to promote local retail diversity and improve consumer welfare. This paper presents a

framework that policymakers can employ to evaluate place-based dispersal policies that focus on regulating the density of certain retail activities and preserving local retail diversity. I apply the framework to study dollar store expansion between 2006 and 2019. My results —household welfare gains decrease as the number of dollar store entries increases—supports existing placed-based dispersal policies for dollar store. They also highlight the "placed-based" nature of such policies: the point of intervention is determined by the local context.

This paper proceeds as follows. Section 2 describes the data sets. Section 3 discusses the background of dollar stores and presents their product and location characteristics. Section 4 presents reduced-form analyses of the effect of dollar store entries on local market outcomes. Section 5 presents the demand model. Section 6 discusses the estimation strategy and presents the estimation results. Section 7 quantifies the welfare impact of dollar stores. Section 8 concludes.

2 Data

2.1 Nielsen Homescan Consumer Panel and Retail Scanner Data

The Homescan Consumer Panel covers an average of approximately $60,000$ households per year from 2006 to 2019. Households in the Consumer Panel record detailed information on their purchases from any outlet, intended for personal, in-home use. The recorded information includes items' barcodes, prices paid, quantities purchased, date purchased, and information on the retailers where the items are purchased.

This paper focuses on households' purchases of grocery products in dollar, grocery, mass merchandise, and drug stores across 44 cities (see Table C1 for the city list) in the U.S. A product is defined as a set of barcodes with the same brands and assigned by Nielsen into the same product module.[3] The median product consists of three barcodes. The data sample consists of 167,871 products produced by 84,619 brands and grouped into 68 grocery product categories (see Table C2 for a list of product categories and Table C3 for the distribution of products and brands across product categories). The sample represents $246 billion of household spending in 2019 for 75% of U.S. households.

The households in the Homescan Consumer Panel also report their demographic and geographic information. Household income is reported in 16 income bins. Using these income bins, I define low-income households as those with annual household income of less than $\$40,000$, middle-income households as those with annual income of $\$40,000 - -\$70,000$, and high-income

3. Product modules are detailed product categories defined by Nielsen. For example, within the "milk" product category are the milk module, flavored milk module, buttermilk module and cream module.

households as those with annual income of more than $\$70,000$. Household geographic information includes city and zip code of residence. Household purchase data are aggregated to the product–retailer–household income–city–quarter level for the purpose of demand estimation.

The Retail Scanner Data record barcode-level weekly pricing and volume sales data for more than 30,000 grocery, mass merchandise, drug and dollar stores across the U.S that represent 119 chains. Among them, approximately 30% are grocery stores, 10% are mass merchandise stores, 37% are drug stores, and 23% are dollar stores. I aggregate barcode-level weekly data to the product–store–quarter level for the product price comparison between dollar stores and other store formats and to the product–store–year level to compare product variety.

2.2 Retail Establishment Data

Data Axle Reference Solutions provides an annual census of business establishments in the U.S. for years since 2000. For each establishment, the data report basic business information, including parent company name, establishment location (latitude and longitude), and NAICS industry classification code. I use this data set to collect dollar store locations and measure the retail composition surrounding each census tract. Dollar store locations are identified based on whether an establishment's reported parent company name is one of the major dollar store chains in the U.S. For each dollar store location, the opening and closing year are the first and last year when the establishment appears in the data set. I then use the location and opening years of dollar stores to determine dollar store entry activities at varying distances from census tract centroids.

Furthermore, I use each establishment's reported geocode (longitude and latitude) to calculate its distance from census tract centroids and, combined with its NAICS information, to measure the number of grocery, mass merchandise, and drug stores located within one mile of the census tract centroids.

2.3 Neighborhood Demographic and Economic Data

Demographic and economic information for the census tracts comes from the American Community Survey (ACS) 5-year estimates. The ACS provides information on local communities across the U.S. over a broad range of topics. Table C4 provides a list of relevant ACS variables used in the analysis in this paper. For each variable, the ACS reports the average level over the years that define a data-reporting wave. This paper uses all 5-year waves from 2006 to 2019. Calculating the difference in each variable between two consecutive waves, I obtain each variable's five-year changes.

3 Background and Stylized Facts

3.1 Background

Dollar stores are small-box discount stores that offer broad categories of products at low prices, with a limited selection within each product category. As of the beginning of 2021, three major dollar store chains in the U.S. operated a total of 32,721 stores. Most of these stores were located in the southern, midwestern and eastern states (Figure 2). A typical dollar store features a no-frills, low-cost format with approximately 6,000–10,000 square feet of selling space and is operated by a store manager and a minimum of one assistant store manager and three sales associates. In comparison, the average square footage is more than 100,000 for a typical mass merchandise store (such as a Walmart Supercenter or a Costco warehouse club), 34,000 for a typical grocery store, and 10,000 for a typical drug store (e.g., CVS pharmacy).

Despite their small physical sizes, dollar stores offer a broad range of products, including consumable items (e.g., packaged food, paper and cleaning products, health and beauty items), seasonal items (e.g., holiday items, toys, batteries, and small electronics), household items (e.g., kitchen supplies, cookware, and small appliances) and apparel (e.g., casual everyday apparel, socks, and underwear). Among these products, consumable items account for approximately 77% of annual net sales.

Dollar stores offer products from a mixed selection of both name and private brands. Private brands are brands whose products are sold exclusively through only one retailer. Name brands are the opposite of private brands: their products are sold through more than one retailer. In general, all items in dollar stores are priced below $10, with some chains having a $1 fixed price point strategy.

The past two decades have witnessed tremendous growth of dollar store chains. Figure 1 plots the combined store growth of major dollar store chains in the U.S. each year from 2000 to 2019, with the number of dollar stores in 2000 normalized to 1. By 2019, the number of dollar stores across the U.S. was more than four times greater than in 2000. In contrast, grocery, mass merchandise, and drug stores, which dollar store chains regard as competitors, experienced a 5% decline from a total of 121,792 stores in 2000 to 115,484 stores in 2019. A decline of 13% occurred in other retail segments.

3.2 Product Variety and Prices

In this subsection, I document the variety and price characteristics of the products offered in dollar stores. Product variety and price constitute two important dimensions of consumer welfare. I use Nielsen Retail Scanner data to document the extent to which dollar store chains offer new product varieties and low product prices to consumers.

Table 1 reports the average share of products that are private brands in dollar stores and in stores of other formats. On average, a dollar store sells 1,986 grocery products from 63 product categories. The size of dollar stores' product set is similar to that of drug stores; it is approximately one-third of that in grocery stores; and it is more than one-half of the size of grocery product sets in mass merchandise stores. Among the products offered at dollar stores, approximately 10% are private brands, and these private-brand products generate 15% of store sales. The ability of private-brand products in dollar stores to generate disproportionate sales highlights the relevance of these products in dollar stores and their potential to positively affect household welfare through the channel of increasing product variety. The magnitude of positive welfare changes is determined by households' preference for product variety and private-brand products.

In addition, the availability of private-brand products varies across product categories, as shown in Panel C of Table 1. Private-brand products are not offered in fifteen (22%) product categories, while in two product categories approximately half of the products are private brands. Figure 3 shows the heterogeneity across product categories in the strength with which private-brand products generate sales, and it highlights the variable welfare relevance of private-brand products across product categories.

Table 2 compares the prices of name- and private-brand products in dollar stores and stores of other formats. The average log product price difference is estimated by regressing the log quarterly product prices in a store on an indicator variable for whether the product is sold in a dollar store and product–county–quarter fixed effects using the samples of name- and private-brand products separately. The product–county–quarter fixed effects ensure that the price comparison is made for the same product in the same period between dollar stores and other stores located in the same area (i.e., county).

A name-brand product in dollar stores costs, on average, 5.5% (-.057 log points) less than the same product in stores of other formats, while the average private-brand product in dollar stores is 24.6% (-.283 log points) cheaper than that in stores of other formats. Thus, the price comparison reveals another channel through which households can benefit from dollar stores: low product prices.

The average product price difference, however, masks the vast heterogeneity in product price differences across store formats and across product categories. Panel A of Table 2 shows that the price gap of name-brand products between dollar stores and drug stores is approximately 12% ($-.124$ log points), which is much larger than that between dollar stores and grocery stores ($-.018$ log points or -1.8%). In addition, the prices in dollar stores for the same name-brand products are 5.3% ($.052$ log points) higher than in mass merchandise stores. The results suggest that the incremental value that arises from low product prices at dollar stores depends on the composition of retail choices faced by households.

Table 2 also presents the heterogeneity in product price differences across product categories. It is worth noting that dollar stores charge higher product prices for both name-brand and private-brand products in numerous product categories. This heterogeneity introduces uncertainty in the welfare value that arises from product prices at dollar stores. In particular, any potential welfare gain from low product prices at dollar stores may not be as big as suggested by the average product price differences between dollar stores and stores of other formats.

3.3 Differential Access to Dollar Stores for Households of Different Income Levels

The welfare impact of dollar stores may be greater among low-income households than high-income households. Figure 4 plots the share of households in each income group that lived within one mile of a dollar store each year from 2000 to 2019. The gap in the share of households that have access to dollar stores within one mile of their residences is persistent over time across household incomes, with the largest share corresponding to low-income households. In 2019, the share of households that lived one mile or less from a dollar store was about 50% among low-income households and 33% of high-income households.

Figure 5, which examines households' access to dollar stores from an intensive-margin perspective, plots the average number of dollar stores located within one mile from households' census tracts of residence over time. The pattern of access to dollar stores is similar to that measured based on the extensive margin (Figure 4). The average number of dollar stores within one mile of low-income households was 0.96 in 2019, almost twice the average number of dollar stores to which high-income households had access the same year.

Given the greater access to dollar stores among low-income households, it is unsurprising that low-income households spent more at dollar stores than high-income households. Figure 6 shows that the average low-income households spent 5.5% of their grocery expenditures at dollar stores in 2019, up from 3.1% in 2006. In contrast, the average expenditure share at dollar stores for

high-income households grew from 0.8% in 2006 to 1.4% in 2019.

The observed gap in access to and spending at dollar stores across household incomes represents the status quo that arises from the interplay between the location choices of dollar store chains and household preferences, and it suggests that the expansion of dollar stores during the past two decades may have had very different welfare implications for households of different income levels.

4 The Effect of Dollar Store Entry on Local Market Structure

In the previous section, I discussed the product characteristics—the new product variety of private-brand products and low product prices—at dollar stores and their potential to positively contribute to household welfare. As these characteristics can attract households to shop at dollar stores, competition between dollar stores and their competitors (i.e., grocery, mass merchandise, and drug stores) arises naturally. How such competition evolves can have welfare implications for households. In this section, I measure the competitive impact of dollar stores on the local market structure by examining the responses of incumbent stores to dollar store entries.

I define a local market for each census tract using a 1-mile radius from the census tract centroid. This market definition of a one-mile radius, used by the USDA to measure households' access to supermarkets and grocery stores in urban areas, covers the primary stores for approximately 30% of households in the US as shown in Figure 7. For each market, I measure the number of grocery, mass merchandise, and drug stores and use an event study framework to examine the changes in store numbers of each store format following the entry of dollar stores.

Since the focal point of the policy debate on dollar stores largely focuses on the density of dollar stores in a market, I estimate the impact of ordinal dollar store entries within 0–1, 1–3, and 3–7 miles of census tract centroids in a flexible nonparametric way.

The key challenges to identifying the causal impact of dollar store entry on the local market structure are the potential coincidence of dollar store entry with confounding changes in local economic and demographic conditions and simultaneity bias whereby dollar stores enter locations where grocery or mass merchandise stores exit. To address the confounding issue, I control for both the five-year changes and levels of local demographic and economic conditions; they include age, race, and education composition, unemployment rate, median household income, and median home value. Table C4 provides a full list of the census tract characteristics that are controlled for.

To deal with simultaneity bias, I use information about local market changes prior to dollar store entry. Specifically, I extrapolate a linear trend of local changes in grocery, mass merchandise,

and drug stores based on their respective changes in the two years that immediately preceded dollar store entry. The impact of dollar store entry on the local market structure is then estimated as the deviation from the extrapolated linear trend while local demographic and economic conditions are controlled for.

Let ℓ index a census tract and t index a year. $Y_{\ell t}^{c}$ denotes the number of stores of format c in the market of census tract ℓ in year t, where c is grocery, mass merchandise, or drug stores. Let $b \in \{1, 2, 3+\}$ index the order (i.e., first, second, and additional) of a dollar store entry in a market and $d \in \{[0,1], (1,3], (3,7])\}$ index the distance band into which the dollar store entry falls. $E_{\ell,t}^{b,d}$ is then the number of dollar store entries of order b within d miles of census tract ℓ's centroid in year t.

Let $t_{\ell}^{b,d*}$ be the entry year of the dollar store of order b within d miles of census tract ℓ's centroid (i.e., $E_{\ell,t_{\ell}^{b,d*}}^{b,d} = 1$). A linear trend relative to the dollar store entry of each order in each distance can then be imposed in the estimation with $p_{\ell t}^{b,d}$, where

$$p_{\ell t}^{b,d} = \begin{cases} -2 & \text{if } (t+1) - t_{\ell}^{b,d*} < -1 \\ (t+1) - t_{\ell}^{b,d*} & \text{if } -1 \leq (t+1) - t_{\ell}^{b,d*} \leq 3 \\ 4 & \text{if } (t+1) - t_{\ell}^{b,d*} > 3 \end{cases}$$

$\Delta X_{\ell t}$ and $X_{\ell t}$ are the vectors of changes and levels of local conditions. The estimating equation for the impact of dollar store entry is

$$Y_{\ell t}^{c} = \beta_0 + \sum_{\substack{d \in \{[0,1], \\ (1,3],(3,7]\}}} \sum_{b=1}^{3+} \left(\beta_{-3,c}^{b,d} E_{\ell,t+3}^{b,d} + \sum_{k=0}^{3} \beta_{k,c}^{b,d} E_{\ell,t-k}^{b,d} + \beta_{p,c}^{b,d} p_{\ell t}^{b,d} \right) + \beta_{\Delta X} \Delta X_{\ell t} + \beta_{X,t} X_{\ell t} + \delta_t + \delta_{\ell} + \epsilon_{\ell t} \tag{1}$$

where δ_t is year fixed effects and δ_{ℓ} census tract fixed effects. The coefficients of interests are $\beta_{k,c}^{b,d}, \forall k = 0, \ldots, 3$, which capture the causal changes in local market structure k years after the bth dollar store entry within d miles of the census tract centroid.

Figure 8 presents the $\beta_{k,c}^{b,d}$ coefficients and 95% confidence intervals.[4] The left column shows the changes in the number of grocery stores in a local market following dollar store entry at different distances (0–1 mile(s), 1–3 miles, and 3–7 miles from top to bottom). Dollar store entry crowds out incumbent grocery stores, and this crowd-out effect is most pronounced for entry within one mile of census tract centroids; it decays with distance. The declining crowd-out effect of entry

4. Event study estimates without linear trend extrapolation are plotted in Figure D1.

over distance is consistent with households' pattern of trips to dollar stores. Figure D2 shows that the median distance that households travel to shop at dollar stores is less than one mile, and few households travel more than three miles to shop at dollar stores.

When we focus on dollar store entry within one mile of census tract centroids, the number of grocery stores in a local market three years after entry decreases by 0.13 after the first entry, 0.40 after the second entry, and 0.71 after the third entry. In other words, three dollar store entries within one mile of a census tract centroid leads to 1.25 exits of grocery stores in the local market three years later.

To clarify the magnitude of the crowd-out effect of dollar stores, Table 3 compares incumbent store exits caused by dollar store entry ($\beta_{k,c}^{b,d}$) and the average number of stores in a local market. The ratio of the two is reported as the incumbent exit rate in Table 3. An average census tract has five grocery stores in its market (within one mile of its centroid). Each of the first, second, and third dollar store entries within one mile leads to exit rates of 2.7%, 8%, and 14.1%, respectively, for grocery stores.

The middle column of Figure 8 plots the effect of dollar store entry on mass merchandise stores. Compared to the effects on grocery stores, the estimated effects on mass merchandise stores are noisier and of smaller magnitudes in both absolute and relative terms. I estimate that the number of mass merchandise stores in a local market increases by 0.04 and 0.07 three years after the first and second dollar store entries within one mile, but it will drop by 0.11 for each additional dollar store entry beyond the first two. Table 3 reports the corresponding incumbent exit ratios. These point estimates are not statistically significant.

Last, the right column of Figure 8 presents a nonmonotonic effect of dollar store entry on drug stores. The first and second dollar store entries within one mile of census tract centroids lead to 0.18 and 0.21 drug store exits, respectively, in local markets, whereas each additional dollar store entry beyond the first two increases the number of drug stores in a local market by 0.16. The reversal of the trend of drug store exits when there are more dollar stores may be due to the rise in unsatisfied demand left behind by exiting grocery stores. Recall that approximately one-quarter of incumbent grocery stores exit with three dollar store entries. The absence of grocery stores in a local market may create profitable opportunities for drug stores.

The results show that dollar store entry is not simply an addition to local retail variety; it also brings about changes to the local retail market. The most significant change is the exits of grocery stores. This raises the question of whether new dollar stores are valuable enough to compensate households for their loss of grocery stores.

5 Demand Model

In this section, I present a framework for measuring the impact of dollar store entry on household welfare. The framework takes into account both the value of dollar store product characteristics and the retail changes in local markets caused by dollar store entry.

I propose a demand model of a representative household with nested constant-elasticity-of-substitution (CES) preferences. The demand model consists of three nests. The outermost nest is retailers, indexed by $r \in R$. Within each retailer, there are food and nonfood departments, which are indexed by d. Inside each product department is the nest of product categories, indexed by $g \in G_{dr}$. Product categories consist of products, indexed by $j \in J_{gr}$. Under the nested CES demand model, a representative household decides its consumption quantity of products and allocates spending across products, product categories, and retailers given product prices and its taste for products and retailers.

Let h index household income group, $h \in \{Low,\ Middle,\ High\}$. The utility function of a representative household of income group h is defined as follows:

$$u_h = \left(\sum_{r \in R} (\beta_{rh} q_{rh})^{\frac{\eta_h - 1}{\eta_h}} \right)^{\frac{\eta_h}{\eta_h - 1}} \tag{2}$$

Here, $\eta_h > 1$ is the elasticity of substitution across retailers, and β_{rh} is households' preference for retailer r's amenities and is parameterized as $\exp(\beta_{c(r)h} + \epsilon_{rh})$, where $\beta_{c(r)h}$ is households' preference for the average amenities of retailer r's format $c(r)$ and ϵ_{rh} is households' idiosyncratic preference for retailer r.

q_{rh} is the household's consumption aggregate of products at retailer r and has a Cobb–Douglas structure over food and nonfood product departments and a CES structure over product categories.

$$q_{rh} = \prod_{\substack{d \in \{food,\\ nonfood\}}} \left(\left(\sum_{g \in G_{dr}} (q_{grh})^{\frac{\eta_{dh} - 1}{\eta_{dh}}} \right)^{\frac{\eta_{dh}}{\eta_{dh} - 1}} \right)^{\alpha_{dh}} \tag{3}$$

where α_{dh} is the household's satiation rate for product department d with the constraint of $\alpha_{\text{food},h} + \alpha_{\text{nonfood},h} = 1$ and $\eta_{dh} > 1$ is the elasticity of substitution across product categories in product department $d \in \{\text{food, nonfood}\}$.

q_{grh} is the household's consumption aggregate of products in product category g at retailer r

and again is modeled as a CES function over products within product category g:

$$q_{grh} = \Big(\sum_{j \in J_{gr}} (\beta_{jh} q_{jrh})^{\frac{\eta_{gh}-1}{\eta_{gh}}} \Big)^{\frac{\eta_{gh}}{\eta_{gh}-1}} \tag{4}$$

where $\eta_{gh} > 1$ is the elasticity of substitution across products in product category g. β_{jh} captures the household's preference for product j.

The nested CES demand model has several desirable features. First, as shown by Anderson, Depalma, and Thisse (1987), CES preferences are consistent with an individual discrete choice model over retailers in which retailers are distinguished by product prices and varieties and by households' preferences for store amenities.

Second, the nested structure allows flexible substitution patterns both horizontally and vertically across products. Horizontally, the product elasticity of substitution in a product category can vary across product categories,[5] while vertically, the product elasticity of substitution is allowed to differ from the product category elasticity of substitution. Intuitively, substitution across products is expected to be more elastic than that across product categories.[6]

The product elasticity of substitution in each product category determines households' value for the new product variety of private-brand products at dollar stores since households' elasticity of substitution can be alternatively interpreted as their value for variety. A household with a higher value for variety tends to find different product choices less substitutable. Allowing product elasticity of substitution to vary across product categories, the demand model has the ability to capture the differential value of new product variety across product categories.

Households' elasticity of substitution across product categories in the middle nest and across retailers in the outermost nest determine, respectively, households' value for low product prices at dollar stores and for changes in retail composition. Thus, the nested structure with vertically flexible substitution patterns can separately capture the welfare value of low product prices at dollar stores and changes in retail composition at the retailer level.

Third, the demand model incorporates preference heterogeneity across products and, at the same time, allows household preference for a product to vary by household income. The first heterogeneity ensures that product prices are adjusted for household preferences such that the low product prices offered at dollar stores are not overvalued if cheap products at dollar stores happen

5. For example, "Lay's" and "Kettle Brand" potato chips can have a different elasticity of substitution from that of "Tropicana" and "Simply Orange" orange juices.

6. This means in the context of the example above that products in the potato chip product category have a larger elasticity of substitution than the potato chip and orange juice product categories do.

to be of low quality or less preferred by households. The second heterogeneity makes it possible to capture the potentially different welfare impacts of dollar store entry on households from different income groups.

The representative household from income group h is assumed to be utility-maximizing subject to the budget constraint of $\sum_r \sum_j p_{jrh} q_{jrh} = Y_h$ and has the following expenditure function:

$$e_h = u_h P_h \tag{5}$$

where P_h is the overall exact price index that measures the minimum cost of consuming one composite unit of products across retailers for households of income group h and is given by the following expression:

$$P_h = \left(\sum_{r \in R} (\beta_{rh}^{-1} P_{rh})^{1-\eta_h} \right)^{\frac{1}{1-\eta_h}} \tag{6}$$

Analogously, P_{rh} and P_{grh} are the exact price indices of retailer r and of product category g in retailer r for households of income group h and are defined as follows:

$$\begin{aligned} P_{rh} &= \prod_{\substack{d \in \{food, \\ nonfood\}}} \left(\frac{1}{\alpha_{dh}} \Big(\sum_{g \in G_{dr}} (P_{grh})^{1-\eta_{dh}} \Big)^{\frac{1}{1-\eta_{dh}}} \right)^{\alpha_{dh}} \\ P_{grh} &= \left(\sum_{j \in J_{gr}} (\beta_{jh}^{-1} p_{jrh})^{1-\eta_{gh}} \right)^{\frac{1}{1-\eta_{gh}}} \end{aligned} \tag{7}$$

The expenditure function is used to quantify the welfare impact of dollar store entry in section 7.

6 Estimation and Results

The demand parameters that are required for the welfare quantification of dollar store entry can be grouped into three sets that correspond to the nest hierarchy (i.e., product category, product department, and retailer) of the demand model. The product category-level parameters include the product elasticity of substitution within each product category ($\{\eta_{gh}\}$) and household product preferences ($\{\beta_{jh}\}$); the product department-level parameters are the product category elasticity of substitution ($\eta_{food,h}$ and $\eta_{nonfood,h}$) and satiation rate ($\alpha_{food,h}$ and $\alpha_{nonfood,h}$) for each product department; and the retailer-level parameters are the retailer elasticity of substitution (η_h) and household preference for the average amenities of each retail format ($\{\beta_{ch}\}$).

I estimate the three sets of demand parameters recursively, starting with the set of demand parameters at the product category level. For the estimation, I use the Homescan Consumer Panel data. I aggregate household purchase data to the product–retailer–household income–city–quarter level and calculate total spending and average price paid. I exploit the variations in product expenditure shares and prices across retailers to pin down the product category-level parameters.

Let m index a city and t a quarter. A market is defined as a city–quarter. The demand model dictates that the representative household of income group h in market mt allocates expenditure across products within product category g in retailer r as follows:

$$share_{jrhmt} = \frac{(\beta_{jrhmt}^{-1} p_{jrhmt})^{1-\eta_{gh}}}{P_{g(j)rhmt}^{1-\eta_{gh}}} = \frac{(\beta_{jrhmt}^{-1} p_{jrhmt})^{1-\eta_{gh}}}{\sum_{j' \in J_{gr}} (\beta_{j'rhmt}^{-1} p_{j'rhmt})^{1-\eta_{gh}}} \tag{8}$$

$share_{jrhmt}$ is the expenditure share of product j within product category $g(j)$ in retailer r–market mt among households of income group h. The equation highlights the intuition that identifies the product elasticity parameter (η_{gh}) and product preference parameters ($\{\beta_{jh}\}$). Ceteris paribus, households' expenditure share of product j decreases with the product price and increases with household preference for the product. The extent to which the expenditure share of a product decreases with its price is determined by the product elasticity of substitution parameter. When households find products in the same product category to be more substitutable (i.e., have a larger value of η_{gh}), the expenditure share of a product will decrease by a larger amount for a given price increase. Thus, the product elasticity parameter (η_{gh}) can be identified using the within-product covariance of changes in expenditure shares and changes in prices across retailers within the same market.

Product elasticity of substitution The estimating equation is obtained by first-differencing log product expenditure shares in equation 8 over time:

$$\Delta^t \ln share_{jrhmt} = (1 - \eta_{gh}) \Delta^t \ln p_{jrhmt} + \gamma_{g(j)rhmt} + \gamma_{jhmt} + \Delta^t \epsilon_{jrhmt} \tag{9}$$

Δ^t is the first-difference operator over time such that $\Delta^t \ln share_{jrhmt} = \ln share_{jrhmt} - \ln share_{jrhmt-1}$. $\gamma_{g(j)rhmt}$ are product category–household income–retailer–market fixed effects that capture the change in the exact price index of product category $g(j)$ (i.e., $\Delta^t \ln P_{g(j)rhmt}$). γ_{jhmt} and $\Delta^t \epsilon_{jrhmt}$ are spun off from $\Delta^t \ln \beta_{jrhmt}$, which is the change in the preference for product j among households of income h that shop in retailer r in market mt. γ_{jhmt} is product–household income–market fixed effects that absorb any market-wide demand shocks, such as an advertising campaign by Coca-Cola for coke in New York City in some quarter. $\Delta^t \epsilon_{jrhmt}$ represents the idiosyncratic de-

mand shock.

The threat to the identification of η_{gh} is the potential correlation between $\Delta^t \ln p_{jrhmt}$ and $\Delta^t \epsilon_{jrhmt}$; i.e.,

$$E(\Delta^t \ln p_{jrhmt} \Delta^t \epsilon_{jrhmt}) \neq 0 \tag{10}$$

The change in the product price paid by households of income h may be correlated with the change in their preference for the product. To address this potential endogeneity issue, I employ a first-differenced version of the price instrument introduced by DellaVigna and Gentzkow (2019), which is calculated using the prices of the same product observed in the same retailer and quarter but in different cities. Specifically, the price instrument for $\Delta^t \ln p_{jrhmt}$ is

$$\Delta^t \ln p^{instr}_{jrhmt} = \ln(\frac{\sum_{m' \in M_r \setminus m} p_{jrm't} q_{jrm't}}{\sum_{m' \in M_r \setminus m} q_{jrm't}}) - \ln(\frac{\sum_{m' \in M_r \setminus m} p_{jrm't-1} q_{jrm't-1}}{\sum_{m' \in M_r \setminus m} q_{jrm't-1}}) \tag{11}$$

The price instrument has an intuition similar to the instrument in Hausman (1996), but it requires a weaker assumption in order to satisfy the exclusion restriction. For each product, the variation in the price instrument across retailers in the same market is assumed to be driven by the differential costs faced by different retailers or different retailer-level sales decisions unrelated to local demand shocks; i.e.,

$$E(\Delta^t \ln p^{instr}_{jrhmt} \Delta^t \epsilon_{jrhmt}) = 0 \tag{12}$$

This assumption is corroborated by the observation in DellaVigna and Gentzkow (2019) of rather uniform product pricing within retailers, despite heterogeneous demand conditions across locations where a retailer operates.

There are 68 product categories and 3 household income groups. The product elasticity of substitution is estimated for each combination of product categories and household incomes. The F statistics of the first stage range from 16 to 15,968.

Product preferences Revisiting the product expenditure share expression (equation 8), we observe that conditional on product prices (p_{jrhmt}) and the product elasticity of substitution ($\hat{\eta}_{g(j)h}$), the expenditure share of a product reveals information about household preference for the product. For products of equal price, households will spend more on those for which they have stronger preferences. I take advantage of this relationship and use the observed product expenditure shares and prices as well as the estimates of the product elasticity of substitution to uncover household product preferences.

Before estimating household product preferences ($\{\beta_{jh}\}$), I impose two restrictions to reduce

the number of product preference parameters to be estimated[7] and apply a normalization to address the fact that the product expenditure share function (equation 8) is homogeneous of degree zero in $\{\beta_{jh}\}$ such that it is not possible to independently identify all product preference parameters.

Restriction 1. Household preferences for the peripheral products in each product category are restricted to be the same, i.e., $\beta_{jh} = \beta_{j'h} = \beta_{\underline{j}(g)h}, \forall j, j^{'} \in J_g^p$. The set of peripheral products, J_g^p, consists of products whose average annual sales shares within a product category are in the bottom 80th percentile.

Restriction 2. Household preferences for the nonperipheral products of the same brand in the same product category are restricted to be the same, i.e., $\beta_{jh} = \beta_{j'h}, \forall j, j^{'} \in \{j \in J_g \setminus J_g^p \mid b(j) = b^{'}(j^{'})\}$.[8,9]

Normalization. Households' product preferences are normalized against their preferences for the peripheral products in each product category, i.e., $\beta_{jh} = \tilde{\beta}_{b(j)h}\beta_{\underline{j}(g)h}, \forall j \in J_g; \tilde{\beta}_{b(j)h} = 1, \forall j \in J_g^p$.

I first estimate the normalized product preferences ($\tilde{\beta}_{b(j)h}$) and defer the estimation of household preferences for the peripheral products ($\beta_{\underline{j}(g)h}$) until when I estimate the product department-level parameters. To derive the estimating equation for the normalized product preferences ($\{\tilde{\beta}_{b(j)h}\}$), I first-difference log product expenditure shares in equation 8 relative to the average log expenditure shares within each product category–retailer–household income–market and plug in the estimates of η_{gh}:

$$\ln \overline{share}_{jrhmt} = (1 - \hat{\eta}_{g(j)h}) \ln \overline{p}_{jrhmt} - (1 - \hat{\eta}_{g(j)h}) \Big[\ln \tilde{\beta}_{b(j)h} - \frac{\sum_{j' \in J_{g(j)rmt}} \ln \tilde{\beta}_{b(j')h}}{|J_{g(j)rhmt}|} \Big] + \overline{\epsilon}_{jrhmt}$$

$|J_{g(j)rhmt}|$ is the number of products in product category g purchased by households of income group h in retailer r–market mt.

The identifying moments that just identify the normalized product preferences ($\{\tilde{\beta}_{b(j)h}\}$) are

$$E(\overline{\epsilon}_{jrhmt}\ 1(b(j) = b)) = 0, \forall b \in B_g$$

$1(b(j) = b)$ is a dummy variable indicating whether product j is associated with brand b. B_g is the set of product brands associated with nonperipheral products in product category g.

7. The dimension of $\{\beta_{jh}\}$ equals the number of products. Recall that there are 167,871 products in total and approximately 2,469 products in an average product category. It is computationally intensive to estimate the product preference for every product.

8. For example, Organic Valley milk and Organic Valley cream are two products in the milk product category. Households' preferences for these two products is set to be the same.

9. This restriction does not impose any limit on preferences for products of the same brand but in different product categories (e.g., Organic Valley milk vs. Organic Valley butter).

Other demand parameters The remaining two sets of demand parameters can be estimated in a similar fashion. To estimate the product department–level parameters (i.e., the product category elasticity of substitution and satiation rate for each product department) and household preference for the peripheral products in each product category, I aggregate household purchase data to the product category–retailer–household income–city–quarter level and construct the product category-level exact price index using the estimates of the product category-level parameters and equation 7. The relationship between the expenditure share of a product category and its exact price index is analogous to that at the product level. A product category with lower product prices and a larger number of products will result in a lower exact price index and a higher expenditure share. Exploiting this relationship, I use the observed changes in the expenditure shares and exact price indices of each product category across retailers to identify the product category elasticity of substitution, and the residual expenditure shares across product categories that are not explained by prices recover household preference for the peripheral products in each product category.

The estimation of the retailer–level parameters (i.e., the retailer elasticity of substitution and household preference for the average amenities of each retail format) follow similar procedures. I aggregate household purchase data to the retailer–household income–city–quarter level and observe how retailer-level expenditure shares vary with retailer-level exact price indices. This variation identifies the retailer elasticity of substitution.

Details on the estimation of the product department– and retailer–level parameters, including construction of exact price indices and estimating equations for demand parameters, are in Appendix A.

Results Table 4 reports the estimates of substitution elasticities across products (η_{gh}), product categories (η_{dh}), and retailers (η_h) for each household income group. Panel A presents the distribution of the product elasticity of substitution (η_{gh}) across the 68 product categories. The median product elasticity of substitution, 2, is similar across household income levels. This indicates that in the median product category, when the relative prices of two products increase by 1%, their relative expenditure shares decrease by approximately 1% (i.e., $1-\eta_{gh}$). Given the distribution of the estimates, households' substitution toward other products in the same product category in response to some product price change is estimated to be milder than the price change (inelastic) for half of the product categories and more intense (elastic) for the other half of the product categories.

Figure 9 plots the distribution of household preference for private-brand products relative to name-brand products in the same product category across product categories. Since the mass of the density curve is concentrated below 1, households, regardless of their incomes, have a lower preference on average for private-brand products than for name-brand products in the same product

category. Nevertheless, households prefer private-brand products over name-brand products in more than 20 out of 65 product categories (25 for low-income households, 23 for middle-income households, and 26 for high-income households).

Both the product elasticity of substitution and product preferences affect household welfare gain that arises from the new product variety of private-brand products at dollar stores. Ceteris paribus, households derive more value from new product variety of private-brand products in a product category when products in the given product category are less substitutable (i.e., when households have a low elasticity of substitution across products and a high preference for variety) or households have a stronger preference for private-brand products relative to name-brand products in the given product category (such that households are willing to consume more private-brand products).

Figure 10 plots the correlation between the two driving forces that underlie the welfare gain from new product variety. For households in each income group, there are at least 10 out of 65 product categories for which the households have inelastic product substitution with respect to price changes (i.e., $\eta_{gh} \in (1, 2]$) and higher relative preferences for private-brand products. This suggests that some private-brand products offered at dollar stores can be quite valuable and welfare-improving for households in each income group. In addition, the low-income group's relative preferences for private-brand products and product elasticity of substitution tend to move in the same direction more than do those of the middle- and high-income groups. This suggests that retailers' strategy in private-brand product choices is to cater to low-income households' taste in product categories for which their demand is more elastic. Thus, low-income households may find less of a gradient in their welfare gain from new product variety across product categories as the product elasticity of substitution increases and are more likely to benefit more from private-brand products at dollar stores, despite the fact that their demand is slightly more elastic than that of higher-income households.

Panel B of Table 4 presents for each household income group the estimates for the product category elasticity of substitution (η_{dh}) within food and nonfood product departments. Across household incomes, when the relative exact price indices of two product categories increase by 1%, their relative expenditure shares decrease by $0.46 - 0.55\%$ within the food product department and $0.2 - 0.34\%$ within the nonfood product department. The estimates suggest that food product categories (e.g., cheese vs. milk) are slightly more substitutable than nonfood product categories (e.g., paper products vs. laundry supplies). In addition, if we compare the elasticity of substitution across product categories (η_{dh}) and that across products in a product category (η_{gh}), households find product categories generally less substitutable than products in a product category.

Both comparisons are consistent with our priors.

The elasticity of substitution across product categories determines the extent to which a given set of price changes (measured at the product category level) affects household welfare. Households that find product categories more substitutable derive more welfare gains from product price reductions because such households substitute more strongly toward and eventually consume more products that feature reduced prices. Thus, the results suggest that low-income households with larger elasticities of substitution across product categories benefit more from the low product prices at dollar stores.

Panel C of Table 4 reports the retailer-level parameter estimates for each household income group. Households are again quite price inelastic across retailers: the relative expenditure shares of two retailers decreases by $0.37 - 0.51\%$ in response to 1% increase in their relative exact price indices.

The rest of Panel C reports fixed effects of retailer formats, i.e., household preference for the average retailer amenities by retailer format, β_{ch}. All households prefer mass merchandise store amenities over amenities at retailers of other formats. Low- and middle-income households least prefer amenities at grocery stores, while high-income households least prefer amenities at dollar stores. When we account for household preference for average retailer amenities, the prices of dollar stores relative to those of mass merchandise stores increase by an order of 4 ($e^{-20.41-(-21.71)}$) for the low income, 7 ($e^{-23.77-(-25.77)}$) for the middle income, and 38 ($e^{-26.53-(-30.19)}$) for the high income. Thus, the relative preferences of households for amenities at dollar stores, which are broadly defined to include customer service, product display, interior decorations, etc., offset the potential welfare gain brought about by dollar store products, especially for high-income households.

7 Welfare Quantification and Policy Implications

Using the reduced-form estimates in sections 3 and 4 and the model parameter estimates in section 6, I now quantify the welfare impact of dollar store entry from 2006 to 2019 for households of different income groups.

7.1 Overall Welfare Impact

The welfare impact of dollar store entry is measured as the change in exogenous expenditures that make households indifferent to dollar store entry. It can be expressed as a function of the changes in the overall exact price index faced by households by plugging in the expenditure function of the

nested CES demand model (equation 7), i.e.,

$$CV_h = e_{h0} - e_{h1} = \Big(1 - \frac{P_{h1}}{P_{h0}}\Big)e_{h0}$$

where 0 indexes the baseline period prior to dollar store entry and 1 indexes the counterfactual period after dollar store entry. Later in this section I will discuss in more detail the construction of both periods.

To highlight the relationship between households' overall exact price index and dollar store entry, I rewrite households' overall exact price index, P_h, as a function of the number of retailers, n_{ch}, and the average retailer exact price index, P_{ch}, of retailers of each format, $c \in \{\text{grocery}, \text{ mass merchandise}, \text{ drug}, \text{ dollar}\}$, faced by households of income group h (omitting the subscript that indexes the period relative to dollar store entry).

$$P_h = \left(\sum_c n_{ch}\Big(\beta_{ch}^{-1}P_{ch}\Big)^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}}$$

The specific expression of households' overall exact price index, abstracted from individual retailers' characteristics, assumes that stores of the same format offer the same set of products at the same prices and have the average appeal of their format. Again, I defer the discussion of the construction of the average retailer exact price index for each retail format.

Household welfare change associated with dollar store entries can then be expressed as a function of the number of dollar store entries, n. See Appendix B for the derivation of the expression below.

$$1 - \frac{P_{h1}}{P_{h0}} = 1 - \left(\Delta^{incumbent}(n) + \Delta^{dollar}(n)\right)^{\frac{1}{1-\eta_h}} \tag{13}$$

Here, $\Delta^{incumbent}(n)$ captures the loss that arises from the changes in local market structure due to n dollar store entries:

$$\Delta^{incumbent}(n) = 1 + \sum_{c \neq dollar} s_{ch0}\frac{\Delta n_{ch}(n|n_{dollar,h0})}{n_{ch0}}$$

where s_{ch0} is the expenditure share of retailers of format c among households of income group h during the baseline period and $\Delta n_{ch}(n|n_{dollar,h0})$ is the change in the number of retailers of format c attributable to n dollar store entries.

$\Delta^{dollar}(n)$ characterizes the benefit from the entering dollar stores and depends on the exact

price index of the entering dollar stores, $P_{dollar,h}$, which summarizes the set of products and product prices offered at the entering dollar stores relative to the set of products and product prices at incumbent retailers.

$$\Delta^{dollar}(n) = n\Big(\frac{\beta_{dollar,h}^{-1} P_{dollar,h}}{P_{h0}}\Big)^{1-\eta_h}$$

These two forces, $\Delta^{incumbent}(n)$ and $\Delta^{dollar}(n)$, together determine the direction and magnitude of household welfare change as a result of n dollar store entries. The incumbent store exits due to dollar store entry move the loss component—$\Delta^{incumbent}(n)$—toward zero, causing welfare loss, while the low product prices and new product variety of private-brand products at dollar stores push up the benefit component, $\Delta^{dollar}(n)$, generating welfare gain.

Given that $\eta_h > 1$ (i.e., retailers are substitutes), households benefit from or at least are indifferent to n dollar store entries if the following condition is satisfied:

$$\Delta^{incumbent}(n) + \Delta^{dollar}(n) \geq 1 \tag{14}$$

Otherwise, n dollar store entries lessen the welfare of households.

When we rearrange the loss component to the right of equation 14, the condition for dollar store entries to be welfare-improving becomes very intuitive:

$$n\Big(\frac{\beta_{dollar,h}^{-1} P_{dollar,h}}{P_{h0}}\Big)^{1-\eta_h} \geq -\sum_{c \neq dollar} s_{ch0} \frac{\Delta n_{ch}(n|n_{dollar,h0})}{n_{ch0}} \tag{15}$$

On the left is the benefit brought about by n dollar store entries, and on the right is the absolute value of the loss incurred from n dollar store entries. Equation 15 thus provides an intuitive sufficient statistic for policymakers who prioritize consumer welfare to decide whether to ban dollar store entry in their communities.

Construction of the baseline condition The baseline consists of the retail composition in 2006 and the products in 2019. For each household, the initial retail choice set consists of grocery, mass merchandise, drug, and dollar stores within one mile of the population centroid of their census tract of residence in 2006. Each retailer in the choice set is assumed to offer the set of products purchased and charge the average prices paid by households from the same income group living in the same city across retailers of the same format in 2019. Table 5 reports the average size of households' 2006 retail choice set and 2019 representative store price indices of each retail format for households in each income group. The combination of 2006 retail stores and 2019 products ensures that the welfare quantification is abstracted from product set and price variation over time

and highlights the welfare change arising from the changing retail composition as a result of dollar store entries and the present (2019) product set and prices at dollar stores.

Construction of the counterfactual condition The counterfactual changes in local market structure due to dollar store entries are calculated by means of the estimates of incumbent stores' exit response to dollar store entry (reported in section 4) and the observed number and timing of dollar store entries within one mile of households' census tract centroids between 2006 and 2019. Specifically, for each household h,

$$\Delta n_{ch}(n|n_{dollar,h0}) = \max\Big\{-n_{ch0},\ \sum_{i} \beta^{b(i,n_{dollar,h0}),[0,1]}_{\min\{3,\ 2019-t(i)\},c}\Big\}$$

where i indexes each dollar store entry within one mile of household h's census tract centroid between 2006 and 2019. $b(i, n_{dollar,h0})$ is the order of dollar store entry i, and $t(i)$ is the entry year of dollar store entry i. $\beta^{b(i,n_{dollar,h0}),[0,1]}_{\min\{3,\ 2019-t(i)\},c}$ is the estimated number of exits by retailers of format c due to dollar store entry i. The counterfactual change in the number of retailers of format c that can be attributed to dollar store entry between 2006 and 2019 is then the sum of the estimated number of exits across all entries bounded by the number of retailers of format c in the baseline (because $n_{ch1} \geq 0$).

Welfare impact quantification Household welfare changes due to dollar store entries between 2006 and 2019 are calculated by plugging the baseline and counterfactual conditions into equation 13. I quantify household welfare changes associated with dollar store entries for households that had no more than three dollar stores in their baseline retailer choice sets and experienced between one and five dollar store entries and no dollar store exits between 2006 and 2019. The household sample includes 7.3 million low-income households, 4.4 million middle-income households, and 5.2 million high-income households.

Figure 11 plots the average welfare change (in percent) for households of each income group in the top row plus the distribution of welfare changes (in percent) across households in each income group in the bottom row. Figure 11a shows that dollar stores have, on average, improved household welfare, although the magnitude of welfare improvement falls dramatically with household income. The welfare gain is largest for the low income and is equivalent to about 8% of their grocery expenditures, whereas the average welfare gain for the high income is only worth about 1.3% of their grocery expenditures.

Figure 11b highlights the heterogeneity in the welfare impact of dollar stores across households within each income group. In particular, between 2006 and 2019, approximately 30% of households were worse off as a result of their exposure to dollar store entries. The average loss was

worth 8.2% of grocery expenditures for the low income, 11.8% for the middle income, and 10.9% for the high income. To understand the extent to which differential baseline retail compositions drive the heterogeneity in dollar stores' welfare impact across households, I calculate households' expected welfare changes based on their baseline retail compositions using a nonparametric kernel regression and plot households' expected welfare changes against the actual ones in Figure 12. The $\mathcal{R}^2$ of the nonparametric kernel regression for each income group shows that differences in the baseline retail compositions across households explain 62% of the variation in the welfare changes across low-income households, 40% across middle-income households, and 36% across high-income households.

7.2 Welfare Decomposition

As noted above, the sources of household welfare change associated with dollar store entries include low product prices and new product variety at dollar stores and changes in retail composition. To assess the relative importance of each source, I consider two hypothetical exact price indices, each of which highlights a strength of dollar stores. The first hypothetical price index, $\overline{P}_{dollar,h}$, is based on a product bundle that consists of only name-brand products available at dollar stores, with their prices set at average price levels observed at non–dollar stores. This price index, which strips dollar stores of their price and variety advantages, emphasizes the value of dollar stores as new retail choices. Using this price index, I measure the welfare change that arises from increased retail variety due to dollar store entry as the change in exogenous expenditures that make households indifferent to the entry of dollar stores characterized by $\overline{P}_{dollar,h}$ while muting incumbent stores' response to the entry, i.e.,

$$CV_h^{vr} = \left(1 - \left(1 + n(\frac{\beta_{dollar,h}^{-1}\overline{P}_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}}\right)e_{h0} \tag{16}$$

The second hypothetical exact price index, $\overline{\overline{P}}_{dollar,h}$, is constructed based on a product bundle of both name-brand and private-brand products available at dollar stores, with their prices again set at average price levels observed at non–dollar stores. Comparing this price index with the previous one informs us of households' value for new product variety of private-brand products at dollar stores. The corresponding welfare change, CV_h^{vp}, is defined as the change in exogenous expenditures that make households indifferent to the entry of dollar stores characterized by $\overline{\overline{P}}_{dollar,h}$

vs. those characterized by $\overline{P}_{dollar,h}$.

$$CV_h^{vp} = \left(\left(1 + n(\frac{\beta_{dollar,h}^{-1}\overline{P}_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} - \left(1 + n(\frac{\beta_{dollar,h}^{-1}\overline{\overline{P}}_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} \right) e_{h0} \quad (17)$$

Similarly, we can obtain an idea of how much households value low product prices at dollar stores by comparing the observed dollar store price index, $P_{dollar,h}$, and the second hypothetical price index, $\overline{\overline{P}}_{dollar,h}$. The two price indices are constructed based on the same set of products with the only difference being product prices. The welfare change attributable to low product prices at dollar stores, CV_h^{price}, can then be defined analogously to the change in exogenous expenditures that make households indifferent to the entry of dollar stores characterized by $P_{dollar,h}$ vs. those characterized by $\overline{\overline{P}}_{dollar,h}$.

$$CV_h^{price} = \left(\left(1 + n(\frac{\beta_{dollar,h}^{-1}\overline{\overline{P}}_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} - \left(1 + n(\frac{\beta_{dollar,h}^{-1}P_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} \right) e_{h0} \quad (18)$$

Thus far, the response of incumbent stores to dollar store entry has been muted. I now unmute the response and measure the welfare loss associated with incumbent store exits. The welfare loss is calculated as the changes in exogenous expenditures that make households indifferent to incumbent store exits (as a result of dollar store entry)

$$CV_h^{exit} = \left(\left(1+n(\frac{\beta_{dollar,h}^{-1}P_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} - \left(\Delta^{incumbent}(n)+n(\frac{\beta_{dollar,h}^{-1}P_{dollar,h}}{P_{h0}})^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}} \right) e_{h0} \quad (19)$$

Table 6 presents the average value of household welfare changes and each of its subcomponents described above—that is, CV_h^{vr}, CV_h^{vp}, CV_h^{price}, and CV_h^{exit}. The decomposition shows that the driving forces that underlie household welfare gains due to dollar store entry differ across household income levels.

For the low income, the changes in local retail composition (i.e., the addition of new dollar stores, not accounting for their product characteristics and loss of incumbent stores through exits) have a positive impact on their welfare and account for 70% of the welfare changes among low-income households brought about by dollar store entry between 2006 and 2019. In contrast, middle- and high-income households do not comparably value the increased variety of new dollar stores, such that their welfare gain from the increased retail variety only just offsets the loss that they suffer from incumbent store exits due to dollar store entry. Instead, the net welfare gain enjoyed by middle- and high-income households comes entirely from their value for the new product

variety of private-brand products and low product prices at dollar stores.

Furthermore, low-income households value product characteristics at dollar stores at approximately 2.5% of their grocery expenditures, twice the value among high-income households of 1.2% of their grocery expenditures.

7.3 Policy Implications

A question of interest to policymakers is when dollar store entry into local communities should be regulated. The framework presented in this paper provides an intuitive sufficient statistic (equation 15) that policymakers can apply to specific retail contexts in local communities to assist in their decision-making. In this subsection, I discuss some qualitative policy recommendations based on my findings of the impact of dollar stores on household welfare.

Figure 13 uses household welfare changes due to dollar store entry between 2006 and 2019 to highlight the share of households in each income group that benefit from the first, second, and additional dollar store entries. The first dollar store entry is generally well accepted by households of all income groups. All low-income households and 98% of middle-income households find the first dollar store entry welfare-improving. Nevertheless, the appeal of dollar stores disappears quickly as more dollar stores enter, with a dramatic drop in the share of households that benefit from dollar store entry. Less than 20% of low-income households, 4% of middle-income, and only 1% of high-income households would like to have more than two dollar stores in their local market. The results suggest that a ban on all dollar store entries is not justified but that it is necessary to cap the number of dollar stores in a local market. Whether a second dollar store should be allowed to enter a local market depends on the income composition of consumers in the local market.

8 Conclusion

This paper examines the impact of dollar stores on household welfare. Dollar stores have been growing exponentially across the US in the past two decades and have increasingly come under spotlight. Nevertheless, we know little about how dollar stores and their interaction with other stores affect household welfare.

This paper begins by highlighting the channels through which dollar stores can positively contribute to household welfare—i.e., through new product variety of private-brand products and low product prices. Dollar stores offer a higher share of private-brand products than their competitors, and these products are capable of generating disproportionate sales, highlighting their welfare relevance.

For the channel of low product prices, the size-adjusted product prices in dollar stores are, on average, lower than the prices of the same products in stores of other formats, with large heterogeneity across store formats and product categories. The heterogeneity in the size-adjusted price differences for the same products across store formats shows that the incremental value that dollar stores can deliver through low product prices depends on the local retail composition faced by households, while the heterogeneity across product categories stresses the complexity of measuring the welfare impact of the low product prices in dollar stores.

The event study analysis estimates the effect of dollar store entry on the local market structure. The results reveal the competitive relationships between dollar stores and other store formats. Dollar store entry leads to exits of grocery and drug stores, but it barely affects mass merchandise stores. The loss of grocery and drug stores constitutes the channel through which dollar stores have a negative impact on household welfare.

Using a demand model, I combine the stylized facts on dollar stores' product characteristics and the estimated effect of dollar store entry on the local market structure to measure the impact of dollar store entries between 2006 and 2019 on household welfare. The results show that during this period, the average household benefited from dollar store expansion. Low-income households benefited most, with an average welfare gain worth 8% of their grocery expenditures, whereas the average welfare gain was much lower for middle- and high-income households and valued at approximately 2.8% and 1.3%, respectively, of their grocery expenditures.

There is large heterogeneity in the welfare impact of dollar stores across households in the same income group. I show that a significant portion of the variation across households is accounted for by the different baseline retail compositions faced by households, especially for low-income households. The results indicate that the extent to which dollar stores affect household welfare depends on households' initial retail resources.

Furthermore, the sources of household welfare gain associated with dollar store entry between 2006 and 2019 differ across household income levels. Low-income households find both the changes in their local retail composition and product characteristics at dollar stores welfare-improving, while the main source of welfare gain for middle- and high-income households is product characteristics at dollar stores.

I conclude the paper with some qualitative discussion about dispersal policies that regulate dollar store entry. Based on the findings of the impact of dollar stores on household welfare, the policy implications are that a total ban on dollar store entry is not justified but that there is indeed a rationale for capping the number of dollar stores in a local market and that whether a second dollar store entry should be permitted is determined based on local context.

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Table 1: Variety Characteristics of Products in Dollar Stores

	Dollar	Grocery	Mass Merchandise	Drug
Panel A: Products				
Number of products	1,986	6,750	3,389	1,972
Number of product categories	63	68	42	62
Panel B: Private-brand products				
Product share	10.2	6.5	5.0	6.5
Sales share	15.1	22.4	22.1	10.02
Panel C: Private-brand products across product categories				
1	0.0	1.09	0.03	0.03
10	0.0	3.43	1.87	0.32
25	0.10	5.12	4.18	1.17
Median	8.36	6.93	8.84	5.09
75	18.48	10.06	15.18	12.78
90	33.33	15.74	27.37	28.06
99	50.58	28.71	44.85	59.63

Notes: This table presents the share of products that are private brands by store format in 2019. An observation is a store in 2019. Panel A reports the average number of products and product categories in stores for each store format. Panel B presents the average product and sales share of private-brand products in stores for each store format, pooling all product categories. Panel C reports the distribution of product shares of private-brand products across product categories. Private brands are brands whose products are sold exclusively in a retailer. Product definition is provided in section 2.

Table 2: Price Characteristics of Products in Dollar Stores

	Ln(Product Price) in Dollar Stores Relative to			
	All	Grocery	Mass Merchandise	Drug
	(1)	(2)	(3)	(4)
Panel A: Name-brand products				
Mean	-.057	-.018	.052	-.124
	(.00002)	(.00002)	(.00002)	(.00002)
Percentile across product categories				
1	-0.247	-0.265	-0.306	-0.273
10	-0.146	-0.143	-0.056	-0.236
25	-0.105	-0.102	-0.002	-0.197
Median	-0.052	-0.003	0.059	-0.107
75	0.107	0.113	0.186	-0.003
90	0.179	0.243	0.367	0.054
99	0.306	0.394	0.425	0.269
Panel B: Private-brand products				
Mean	-.283	-.193	-.293	-.706
	(.0001)	(.0001)	(.0001)	(.0001)
Percentile across product categories				
1	-1.102	-1.037	-1.232	-1.562
10	-0.548	-0.408	-0.705	-0.691
25	-0.296	-0.228	-0.365	-0.454
Median	-0.182	-0.123	-0.175	-0.281
75	-0.051	-0.010	-0.032	-0.063
90	0.185	0.282	0.262	0.089
99	0.491	0.755	0.605	0.424

Notes: This table compares the product prices in dollar stores with those in stores of other formats. Panel A presents the log product price differences of the same name-brand products between dollar stores and other store formats. The log product price differences are obtained from the regressions of log quarterly product prices in a store on an indicator variable for whether the product is sold in a dollar store and product–county–quarter fixed effects using the sample of name-brand products. Panel B presents the log product price differences of the same private-brand products between dollar stores and other store formats. The log product price differences are obtained from similar regressions but use the sample of private-brand products. In all regressions, an observation is a product–store–quarter. Across columns are the comparisons of product prices in dollar stores against those in stores of other formats. Across rows are the comparisons of product prices within product categories. The "Mean" row reports the average log price differences from the regressions that pool together all product categories, and the remaining rows report the distribution of the log price differences across product categories.

Table 3: Effects of Dollar Store Entry on Local Market Structure

	Grocery	Mass Merchandise	Drug
Avg. Store Counts (2019)	5.06	1.42	3.66
Incumbent exit rate due to entry within 0–1 miles			
1st entry ($b = 1$)	-0.027	0.026	-0.048
	(0.022)	(0.041)	(0.018)
2nd entry ($b = 2$)	-0.080	0.046	-0.057
	(0.026)	(0.042)	(0.019)
additional entry ($b = 3$)	-0.141	-0.077	0.043
	(0.037)	(0.047)	(0.026)
Incumbent exit rate due to entry within 1–3 miles			
1st entry ($b = 1$)	-0.003	0.0004	-0.017
	(0.015)	(0.029)	(0.014)
2nd entry ($b = 2$)	-0.046	-0.071	0.006
	(0.019)	(0.032)	(0.016)
additional entry ($b = 3$)	-0.040	0.035	0.058
	(0.019)	(0.030)	(0.014)
Incumbent exit rate due to entry within 3–7 miles			
1st entry ($b = 1$)	0.047	-0.011	0.024
	(0.015)	(0.027)	(0.014)
2nd entry ($b = 2$)	0.019	0.075	-0.006
	(0.015)	(0.028)	(0.013)
additional entry ($b = 3$)	0.026	-0.077	0.016
	(0.016)	(0.024)	(0.012)

Notes: This table reports the ratio of incumbent store exits caused by dollar store entry ($\beta_{3,c}^{b,d}$) to the average number of stores in a local market (the number reported in the first row for each retail format). $\beta_{3,c}^{b,d}$ is the number of exiting incumbent stores of retail format c three years after the bth dollar store entry within d miles from the center of a local market and is estimated using equation 1. Figure 8 plots the estimates of $\beta_{k,c}^{b,d}$ (including $\beta_{3,c}^{b,d}$). Standard errors are reported in parentheses and clustered by census tract.

Table 4: Demand Model Parameter Estimates by Household Income Level

	Low-inc	Mid-inc	High-inc
	(1)	(2)	(3)
Panel A: Product elasticity of substitution (η_{gh})			
Min	1.26	1.16	1.10
p1	1.28	1.19	1.21
p10	1.55	1.46	1.47
p25	1.77	1.75	1.72
p50	1.99	2.01	1.98
p75	2.34	2.35	2.26
p90	2.60	2.58	2.43
p99	5.99	3.25	3.39
Max	8.11	3.45	4.06
Panel B: Product category elasticity of substitution (η_{dh})			
food	1.55	1.46	1.53
nonfood	1.34	1.33	1.20
Panel C: Retailer-level parameters			
elasticity of substitution (η_h)	1.51	1.44	1.37
preference for store amenities (β_{ch})			
dollar store	-21.71	-25.77	-30.19
grocery	-22.13	-26.42	-28.47
mass merchandise	-20.41	-23.77	-26.53
drug	-21.40	-25.19	-28.85

Notes: This table reports the point estimates for parameters in the demand model for each household income group. Panel A reports the distribution of households' product elasticity of substitution across 68 product categories. Panel B reports households' elasticity of substitution across product categories in food and nonfood product departments, respectively. Panel C reports households' elasticity of substitution across retailers and their preference for average store amenities in each retail format.

Table 5: Summary Statistics of Baseline Retail Composition and Price Indices by Household Income Level

	Low-Inc	Mid-Inc	High-Inc
Dollar Store			
store count	0.48	0.40	0.28
preference-adjusted price	1,932	19,163	318,988
Grocery Store			
store count	11	9	10
preference-adjusted price	277	454	488
Mass Merchandise Store			
store count	2.5	2.3	2.5
preference-adjusted price	53	65	21
Drug Store			
store count	4.9	4.5	5.1
preference-adjusted price	6,867	78,739	368,660

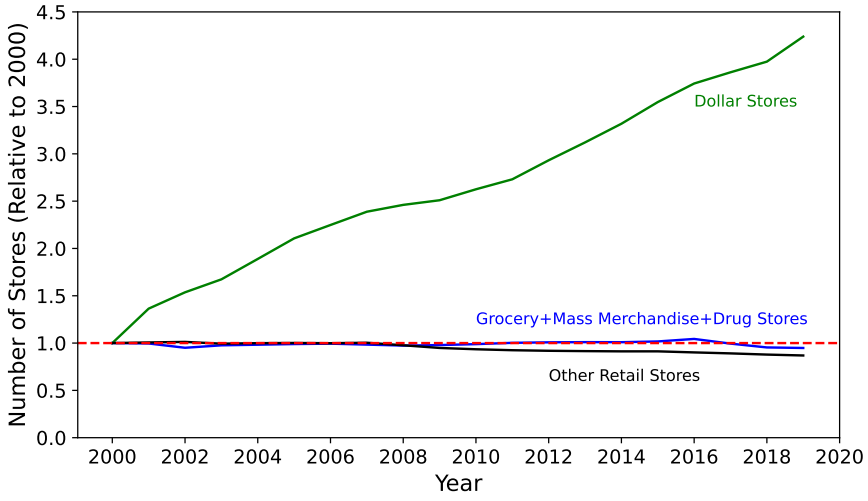
Notes: This table describes the average baseline condition (average size of households' 2006 retail choice set and 2019 representative store price indices of each retail format) faced by households in each income group for the sample of households included in the quantification of dollar stores' welfare impact.

Table 6: Welfare Decomposition by Household Income Level

	Low-Inc	Mid-Inc	High-Inc
welfare change ($\%CV$)	8.16%	2.80%	1.27%
new product variety ($\%CV^{vp}$)	1.63%	1.49%	0.91%
low product prices ($\%CV^{price}$)	0.82%	0.52%	0.28%
new retailer variety ($\%CV^{vr}$)	12.84%	9.06%	4.99%
lost retailer variety ($\%CV^{exit}$)	-7.12%	-8.27%	-4.92%

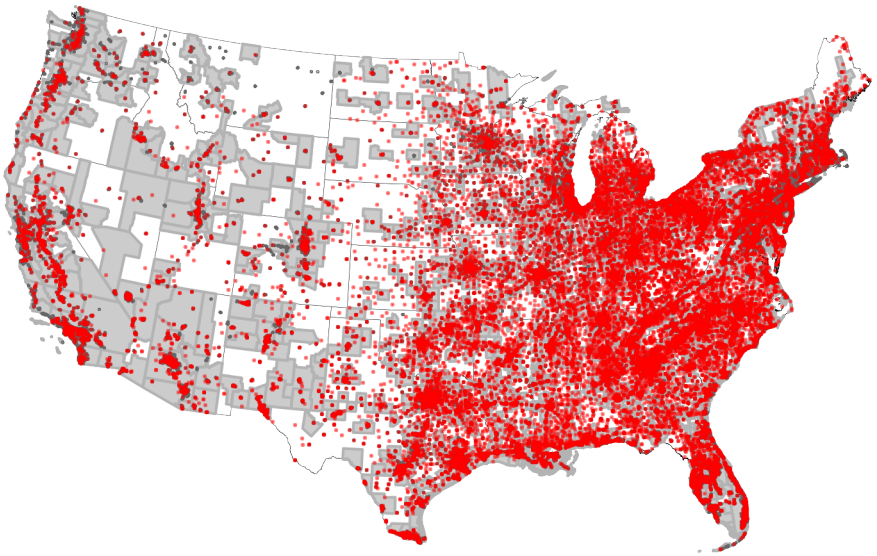
Notes: This table presents the decomposition of household welfare change due to dollar store entry between 2006 and 2019 into four subcomponents for each household income group. The top row reports the average welfare change for households in each income group. The middle two rows report the average household welfare change arising from the new product variety of private-brand products ($\%CV^{vp}$) and low product prices ($\%CV^{price}$) in dollar stores. The bottom two rows report the average household welfare change due to changes in retail composition caused by dollar store entry. New retailer variety ($\%CV^{vr}$) measures the household welfare change arising from the entering dollar stores while removing their private-brand products and setting their product prices at the average price levels observed at non–dollar stores. Lost retailer variety ($\%CV^{exit}$) measures the household welfare loss associated with incumbent store exits attributable to dollar store entry. The expression for each subcomponent is described in section 7.

Figure 1: Growth of Dollar Stores over the Past Two Decades



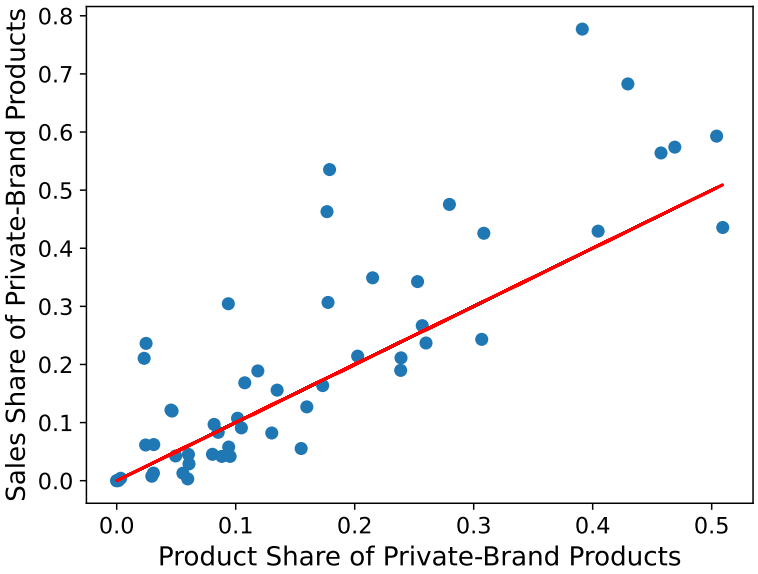
Notes: The x-axis represents years from 2000 to 2019. The y-axis reports the respective growth in store numbers of dollar store chains, dollar store competitors (grocery, mass merchandise, and drug stores), and other retail stores relative to their levels in 2000. The number of dollar stores is obtained from Data Axle Reference Solutions, and the store numbers for dollar store competitors and other retail segments are obtained from County Business Pattern data.

Figure 2: Geographic Distribution of Dollar Stores across the U.S. in 2019



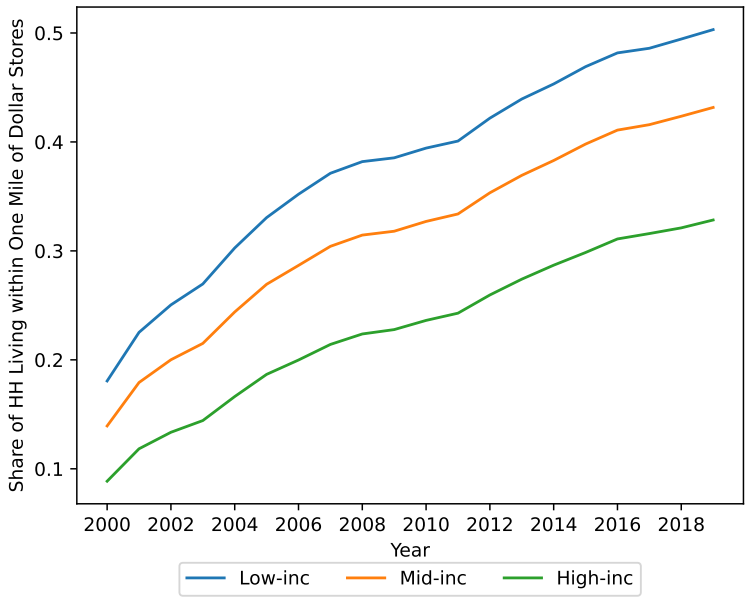
Notes: The figure plots the store locations of major dollar store chains in the U.S. in 2019. A red dot represents a store location. Data on store locations are from Data Axle Reference Solutions.

Figure 3: Sales Share vs. Product Share of Private-Brand Products across Product Categories



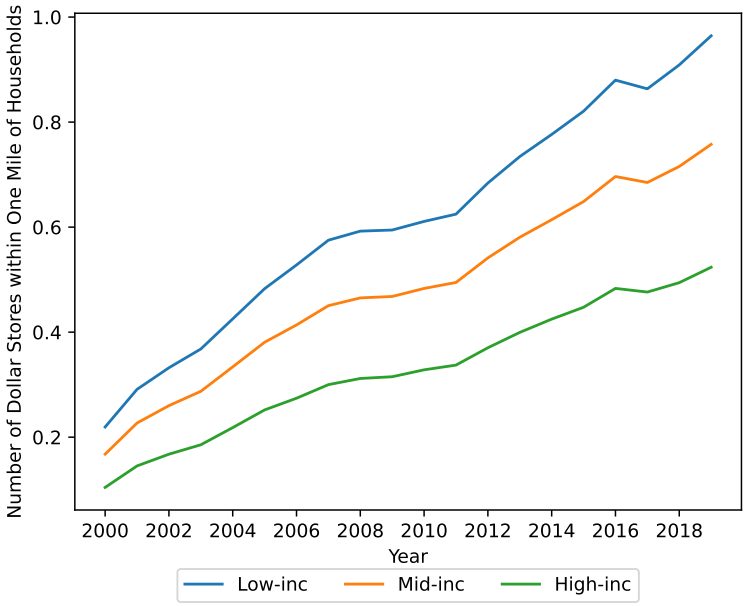
Notes: The figure plots the average sales share of private-brand products in dollar stores (y-axis) against the product share of private-brand products (x-axis) across product categories in 2019 along with the 45-degree line. Each dot is a product category. There are 53 product categories in which private-brand products were offered in dollar stores in 2019. The sales and product shares of private-brand products in each product category are calculated from Nielsen Retail Scanner Data.

Figure 4: Share of Households Living within One Mile of a Dollar Store by Household Income Level



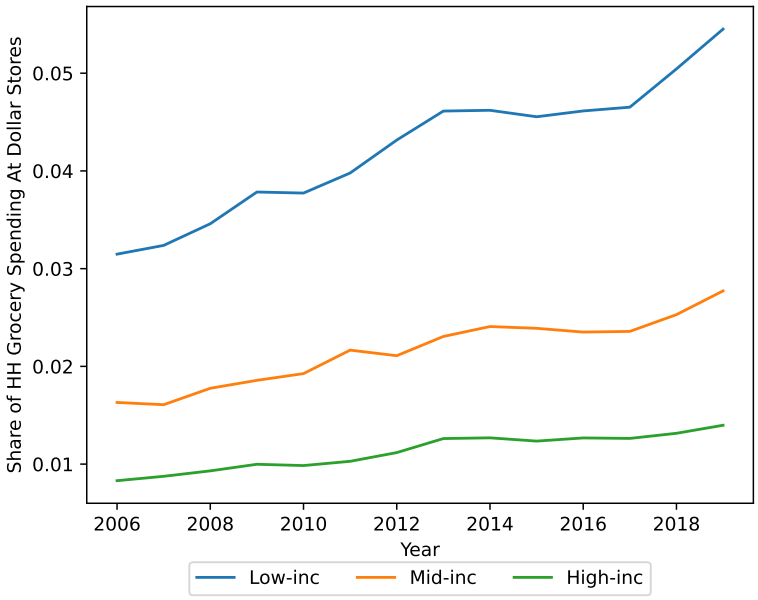
Notes: The figure plots the share of households living within one mile of dollar stores in each year from 2000 to 2019. Low-, middle-, and high-income households are represented by lines of different colors.

Figure 5: Number of Dollar Stores within One Mile of Households by Household Income Level



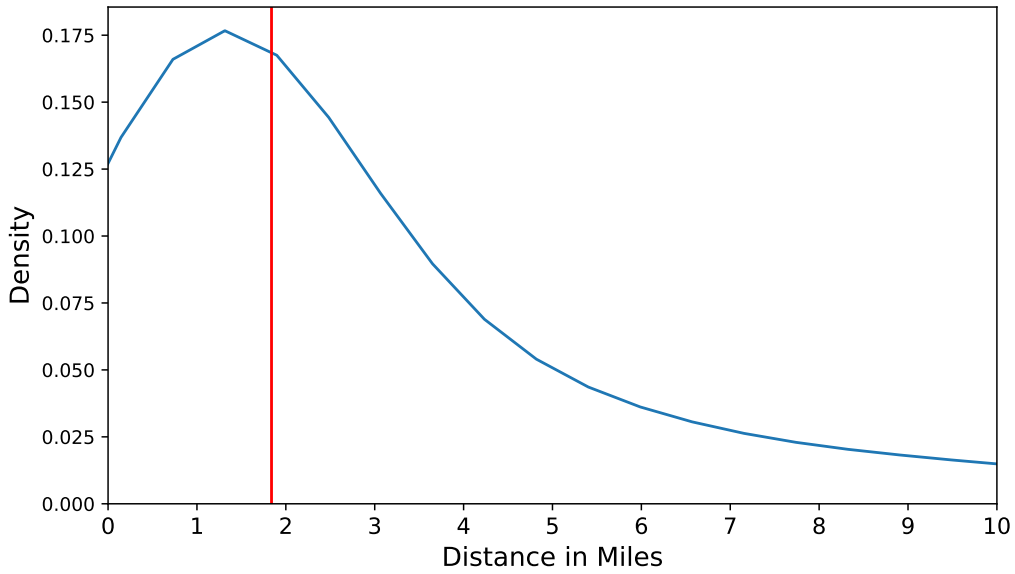
Notes: The figure plots the average number of dollar stores located within one mile from the population centroid of households' census tract of residence in each year from 2000 to 2019. Low-, middle-, and high-income households are represented by lines of different colors.

Figure 6: Share of Households' Grocery Expenditures at Dollar Stores by Household Income Level



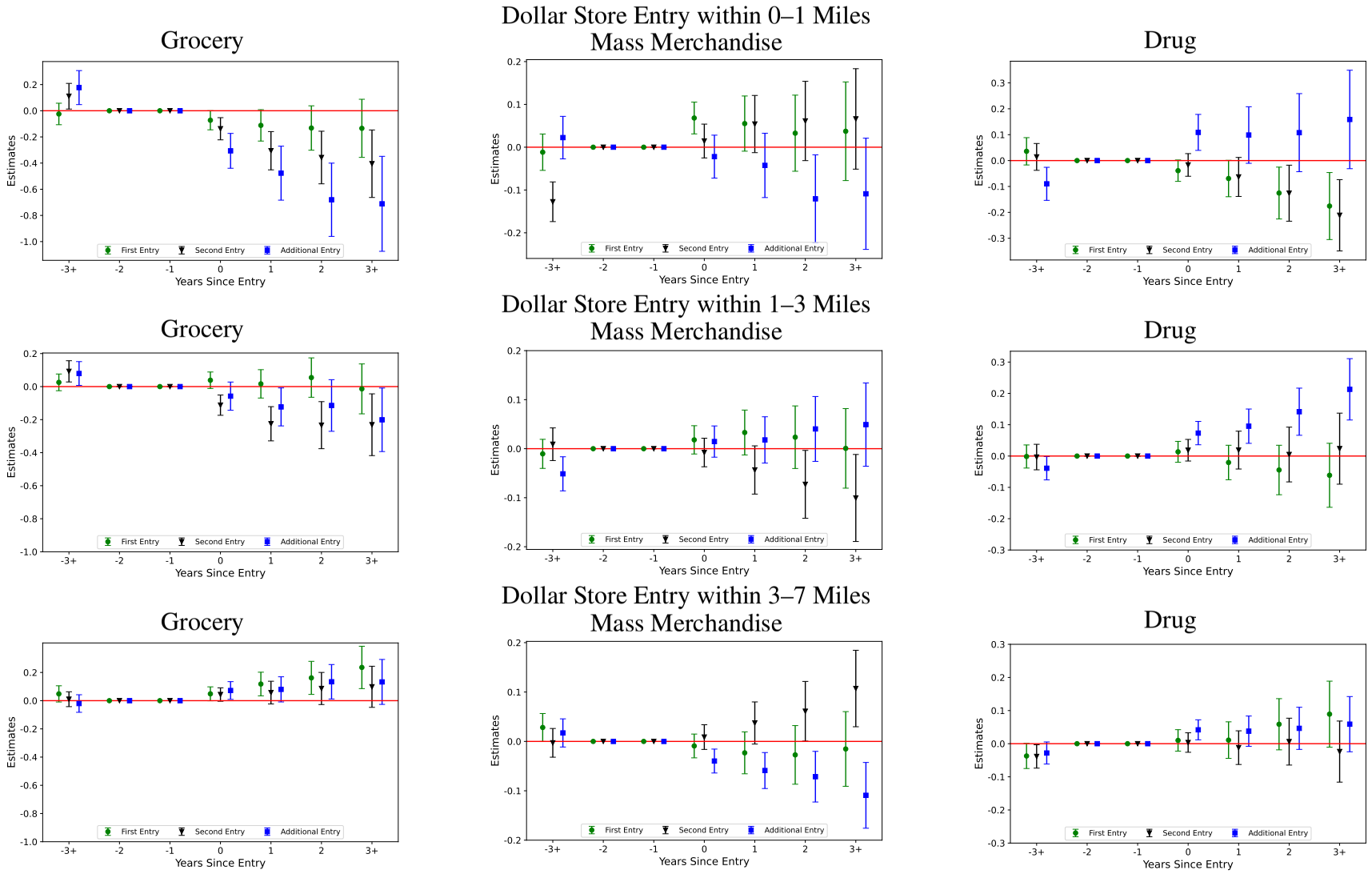
Notes: The figure plots the share of households' grocery expenditures at dollar stores in each year from 2000 to 2019. Low-, middle-, and high-income households are represented by lines of different colors.

Figure 7: Distribution of Distances between Households and Their Primary Stores for Food Purchases



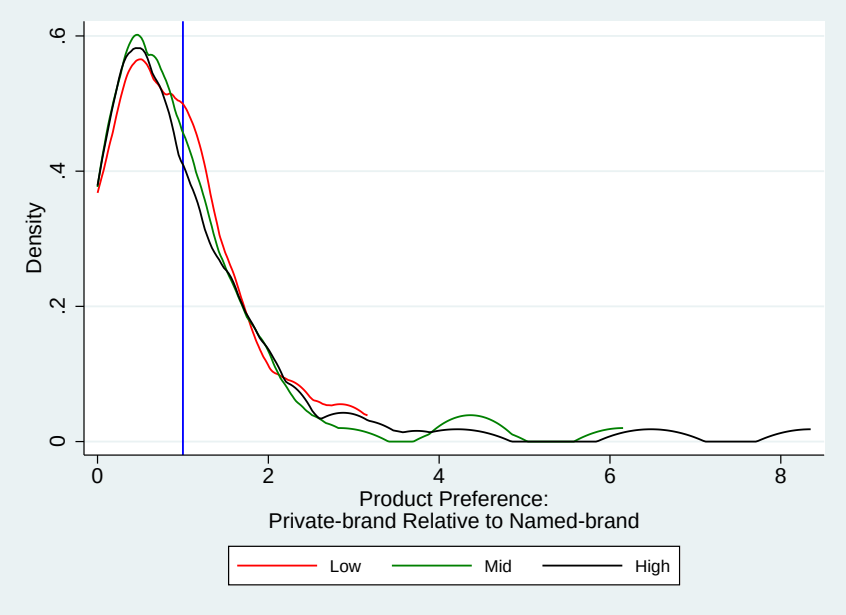
Notes: The figure plots the distribution of miles that households travel to their primary stores for food purchases based on data from the FoodAPS National Household Food Acquisition and Purchase Survey. The survey is representative of U.S. households and was conducted by the U.S. Department of Agriculture between April 2012 and January 2013. The vertical line represents the median distance that households travel to their primary stores for food purchases.

Figure 8: Event Study of Dollar Store Entry



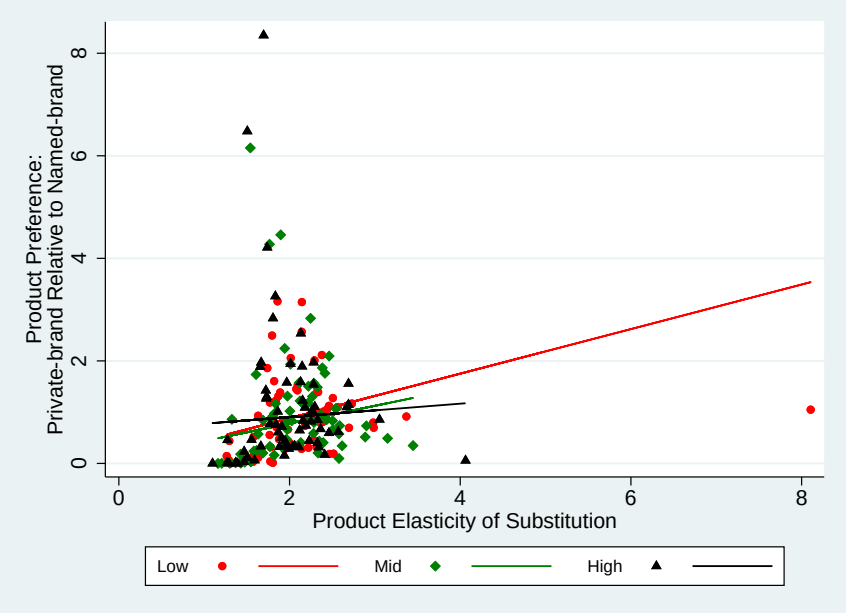
Notes: The figure plots the point estimates and 95% confidence intervals of $\beta_{k,c}^{b,d}$ from equation 1. $\beta_{k,c}^{b,d}$ is the causal changes in the number of stores of retail format c in a market k years after the bth dollar store entry within d miles of the center of the market. Equation 1 is estimated for each retail format. An observation in a regression is a census tract–year. Five-year changes and levels of the demographic and economic variables listed in Table C4, census tract fixed effects, and year fixed effects are included in the regression. For each retail format, local changes in the two years immediately preceding dollar store entry are used to extrapolate a linear trend. Standard errors are clustered by census tract. Each column is a retail format, and each row is a distance band for dollar store entry.

Figure 9: Distribution of Private-Brand Product Preferences by Household Income Level



Notes: The figure plots the distribution of households' preference for private-brand products relative to name-brand products in the same product category across product categories for each household income group. The vertical line sits at 1, indicating that households have the same preference for private- and name-brand products in a product category.

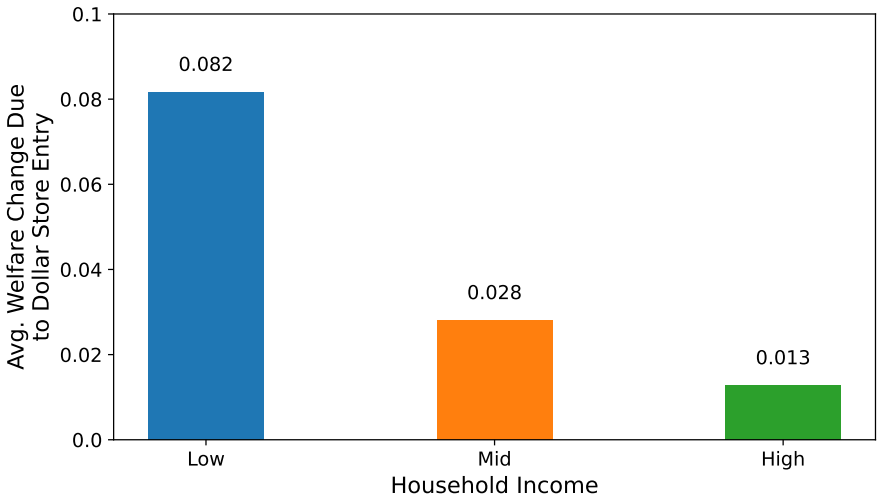
Figure 10: Private-Brand Product Preferences vs. Product Elasticity of Substitution by Household Income Level



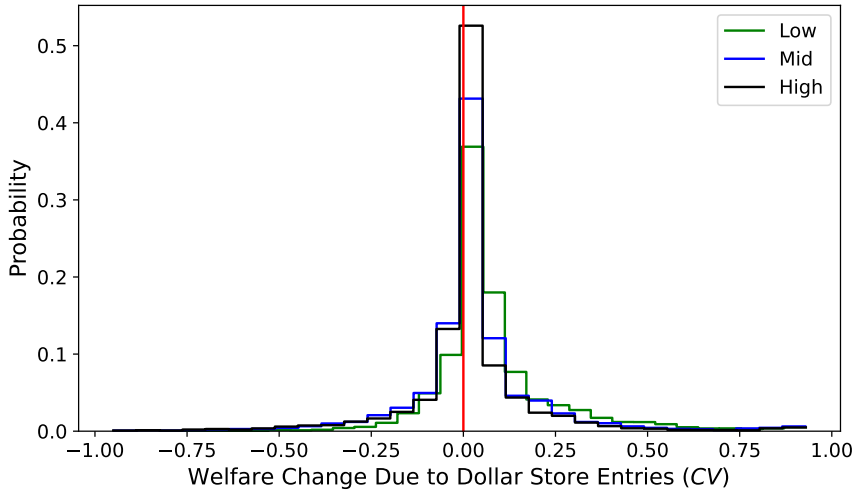
Notes: The figure plots households' preference for private-brand products relative to name-brand products in the same product category (y-axis) against their product elasticity of substitution (x-axis) across product categories for each household income group. Each marker represents a combination of product category and household income. The fitted line is obtained from OLS regression.

Figure 11: Welfare Changes Due to Dollar Store Entries between 2006 and 2019

(a) Average Welfare Change by Household Income Level



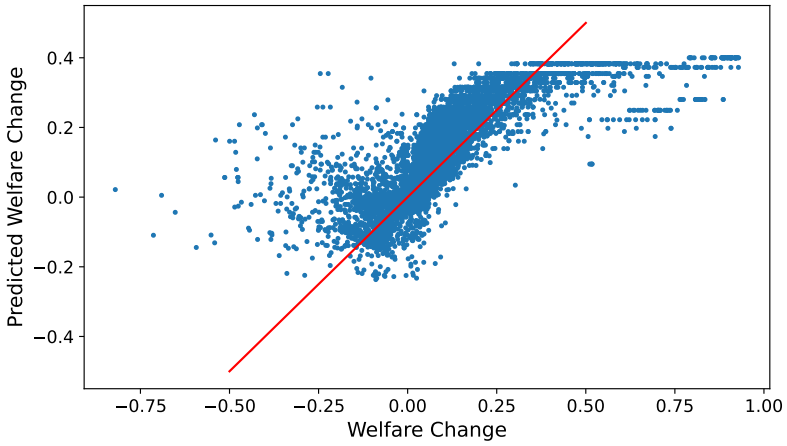
(b) Distribution of Welfare Changes across Households



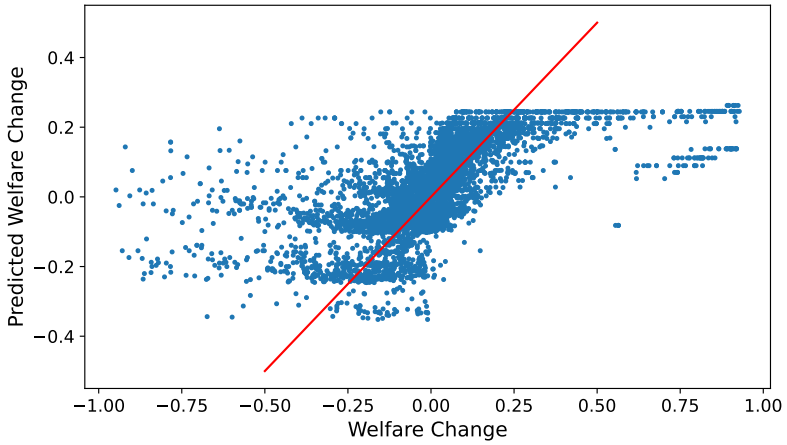
Notes: The figure plots the average welfare change (in percent) for households of each income group (top) and the distribution of welfare changes (in percent) across households in each income group (bottom). The calculation of household welfare change is described in section 7.

Figure 12: Household Welfare Changes Due to Dollar Store Entry: Observed vs. Predicted

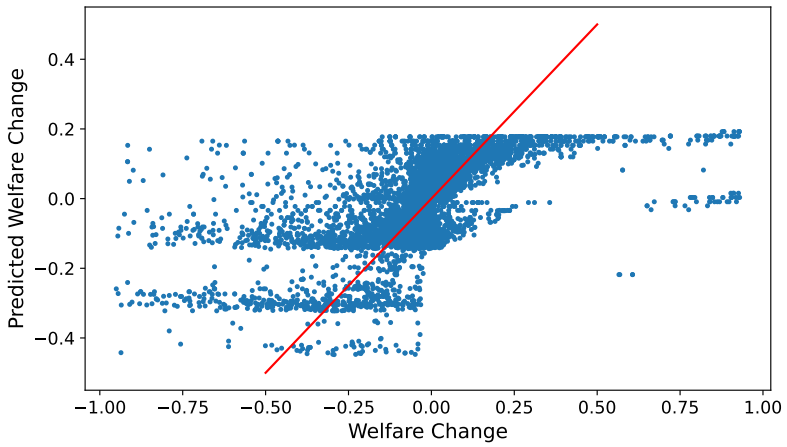
(a) Low-income



(b) Middle-income

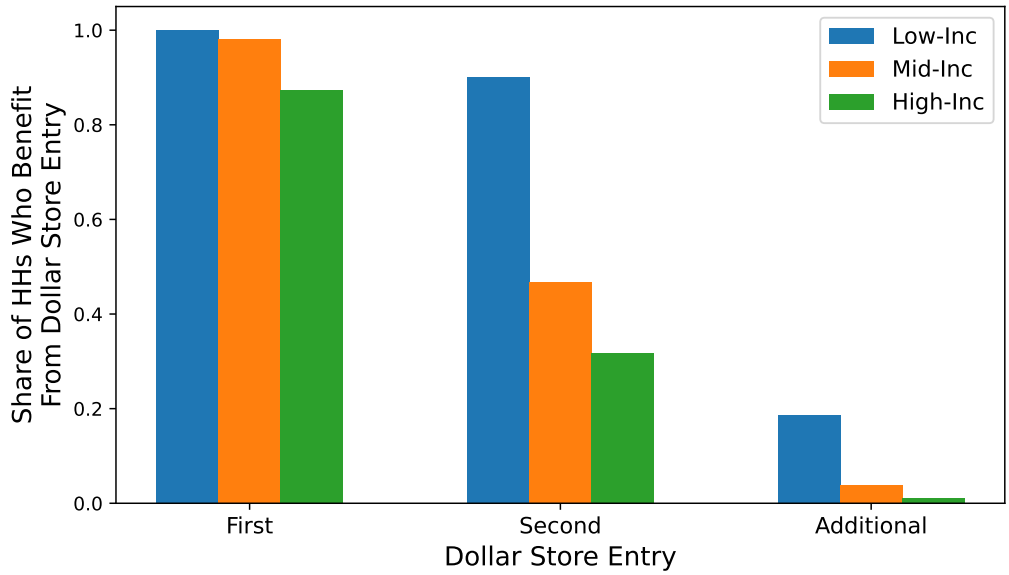


(c) High-income



Notes: The figure plots households' expected welfare changes conditional on their baseline retail compositions (y-axis) against the actual ones (x-axis) for each income group. Households' expected welfare changes are obtained from nonparametric kernel regressions on their baseline retail compositions.

Figure 13: Share of Households Benefiting from Dollar Store Entry by Entry Order



Notes: This figure reports the share of households in each income group that benefit from dollar store entry by entry order based on household welfare changes associated with dollar store entry between 2006 and 2019. The sample of households is as described in section 7.

Appendix

A Model Estimation: Additional Details

This section provides details on the estimation of the product department– and retailer–level parameters and, in particular, how I construct exact price indices for product categories and retailers using the estimates of the lower-level demand parameters.

A.1 Product Department-Level Parameters

Plugging the estimates of the product elasticity of substitution and product preferences into equation 7, I express the exact price index of product category g in retailer r–market mt faced by households of income group h as

$$P_{grhmt} = \beta_{\underline{b}(g)rhmt}^{-1} \left(\sum_{j \in J_{gr}} (\hat{\tilde{\beta}}_{b(j)h}^{-1} p_{jrhmt})^{1-\hat{\eta}_{gh}} \right)^{\frac{1}{1-\hat{\eta}_{gh}}} = \beta_{\underline{b}(g)rhmt}^{-1} \tilde{P}_{grhmt} \tag{20}$$

Under the demand model, the expenditure function of product category g within product department d is analogous to that of products and is given by

$$share_{grhmt} = \frac{\left(\beta_{\underline{b}(g)rhmt}^{-1} \tilde{P}_{grhmt} \right)^{1-\eta_{dh}}}{\sum_{g \in G_{dr}} \left(\beta_{\underline{b}(g)rhmt}^{-1} \tilde{P}_{grhmt} \right)^{1-\eta_{dh}}} \tag{21}$$

The intuition that identifies the product elasticity of substitution and product preferences in section 6 also applies here. The extent to which households' expenditure share of a product category varies with the product category's price index ($\tilde{P}_{grhmt}$) pins down the product category elasticity of substitution (η_{dh}). Across product categories, the variation in expenditure shares, everything else held constant, uncovers household preferences for the peripheral products in each product category ($\beta_{\underline{j}(g)h}$).

Product category elasticity of substitution The estimating equation for the product category elasticity of substitution (η_{dh}) is

$$\Delta^t \ln share_{grhmt} = (1 - \eta_{dh}) \Delta^t \ln \tilde{P}_{grhmt} + \gamma_{d(g)rhmt} + \gamma_{ghmt} + \Delta^t \epsilon_{grhmt} \tag{22}$$

$\gamma_{d(g)rhmt}$ is product department–household income–retailer–market fixed effects and absorbs the log difference term of the denominator in equation 21. γ_{ghmt} is product category–household

income–market fixed effects that capture any demand shocks specific to product category g within market mt. $\Delta^t \ln \tilde{P}_{grhmt}$ is instrumented for with the log difference of an exact price index that is constructed using the average product prices observed for the same retailer and quarter but in different cities.

$$\tilde{P}^{instr}_{grhmt} = \left(\sum_{j \in J_{gr}} (\hat{\tilde{\beta}}^{-1}_{b(j)h} p^{instr}_{jrhmt})^{1-\hat{\eta}_{gh}} \right)^{\frac{1}{1-\hat{\eta}_{gh}}}, \quad p^{instr}_{jrhmt} = \frac{\sum_{m' \in M_r \setminus m} p_{jrm't} q_{jrm't}}{\sum_{m' \in M_r \setminus m} q_{jrm't}} \tag{23}$$

Preferences for peripheral products Conditional on the estimate of the product category elasticity of substitution, the estimating equation for household preferences for the peripheral products in each product category is

$$\ln \overline{share}_{grhmt} = (1-\hat{\eta}_{d(g)h}) \ln \overline{\tilde{P}}_{grhmt} - (1-\hat{\eta}_{d(g)h}) \left[\ln \beta_{\underline{j}(g)h} - \frac{\sum_{g' \in G_{drmt}} \ln \beta_{\underline{j}(g')h}}{|G_{d(g)rhmt}|} \right] + \overline{\epsilon}_{grhmt} \tag{24}$$

Again, $\beta_{\underline{j}(g)h}$ is identified up to the normalization of one product category in each product department, denoted by $\underline{g}(d)$.

Satiation rate The estimation of the Cobb-Douglas parameters (α_{dh}) is straightforward using the property of Cobb-Douglas function that the Cobb-Douglas parameter for each product department (i.e. food or non-food) equals the expenditure share of the product department. $\{\alpha_{dh}\}$ is estimated by regressing, for each income group, households' expenditure share of a product department in a retailer-market on dummy variables indicating food or non-food product department and retailer-market fixed effects; i.e,

$$share_{drhmt} = \sum_{\substack{d' \in \{food, \\ non-food\}}} \alpha_{d'h} I(d = d') + \epsilon_{drhmt}, \quad \text{constraint: } \alpha_{food,h} + \alpha_{non-food,h} = 1 \tag{25}$$

A.2 Retailer-Level Parameters

Retailer elasticity of substitution Analogously to the estimation of product and product category elasticities of substitution, the retailer elasticity of substitution (η_h) can be estimated using the expenditure share function of retailers implied by the demand model:

$$share_{rhmt} = \frac{(\beta^{-1}_{rhmt} P_{rhmt})^{1-\eta_h}}{P^{1-\eta_h}_{hmt}} = \frac{(\beta^{-1}_{rhmt} P_{rhmt})^{1-\eta_h}}{\sum_{r' \in R_{mt}} (\beta^{-1}_{r'hmt} P_{r'hmt})^{1-\eta_h}} \tag{26}$$

P_{rhmt}, the exact price index of retailer r in market mt faced by households of income group h, can be calculated using equation 7 and the parameter estimates obtained in sections 6 and A.1,

$$\begin{aligned} P_{rhmt} &= \prod_{\substack{d\in\{food,\\ nonfood\}}} \left(\beta_{\underline{b}(\underline{g}(d))h}^{-1}\right)^{\hat{\alpha}_{dh}} \prod_{\substack{d\in\{food,\\ nonfood\}}} \left(\frac{1}{\hat{\alpha}_{dh}}\Big(\sum_{g\in G_{drmt}} (\hat{\beta}_{\underline{b}(g)h}^{-1}\tilde{P}_{grhmt})^{1-\hat{\eta}_{dh}}\Big)^{\frac{1}{1-\hat{\eta}_{dh}}}\right)^{\hat{\alpha}_{dh}} \\ &= \prod_{\substack{d\in\{food,\\ nonfood\}}} \left(\beta_{\underline{b}(\underline{g}(d))h}^{-1}\right)^{\hat{\alpha}_{dh}} \tilde{P}_{rhmt} \end{aligned} \tag{27}$$

Applying the first-differencing technique used before to the retailer expenditure share function (equation 26), we have the estimating equation for the retailer elasticity of substitution:

$$\Delta^t \ln share_{rhmt} = (1-\eta_h)\Delta^t \ln \tilde{P}_{rhmt} + \delta_{c(r)hmt} + \Delta^t \epsilon_{rhmt} \tag{28}$$

$\delta_{c(r)hmt}$ is retailer type–household income–market fixed effects. $\Delta^t \ln \tilde{P}_{rhmt}$ is instrumented for with $\Delta^t \ln \tilde{P}^{instr}_{rhmt}$, in which I construct $\tilde{P}^{instr}_{rhmt}$ by substituting $\tilde{P}^{instr}_{grhmt}$, defined in equation 23, for $\tilde{P}_{grhmt}$ in the formula above.

$$\tilde{P}^{instr}_{rhmt} = \prod_{\substack{d\in\{food,\\ nonfood\}}} \left(\frac{1}{\hat{\alpha}_{dh}}\Big(\sum_{g\in G_{drmt}} (\hat{\beta}_{\underline{b}(g)h}^{-1}\tilde{P}^{instr}_{grhmt})^{1-\hat{\eta}_{dh}}\Big)^{\frac{1}{1-\hat{\eta}_{dh}}}\right)^{\hat{\alpha}_{dh}}$$

$\tilde{P}^{instr}_{grhmt}$ is defined in equation 23.

Retailer preferences β_{rhmt} captures the preference of households of income group h for retailer r in market mt; it is parameterized as an exponential function of households' preference for the average amenities of retailer r's format (i.e., dollar, grocery, mass merchandise, and drug stores) and a disturbance term that represents households' idiosyncratic preference shock for retailer r:

$$\beta_{rhmt} = \exp(\beta_{c(r)h} + \epsilon_{rhmt}) \tag{29}$$

To estimate $\beta_{c(r)h}$, I take the log of the retailer expenditure share function (equation 26), rearrange the retailer exact price index, and obtain the estimating equation as

$$-\frac{\ln share_{rhmt}}{1-\hat{\eta}_h} + \ln \tilde{P}_{rhmt} = \beta_{c(r)h} + \delta_{hmt} + \epsilon_{rhmt} \tag{30}$$

δ_{hmt} is household income–market fixed effects that sweep out the overall exact price index ($\ln P_{hmt}$).

B Welfare Expressions

In this section, I show how the expression for measuring the welfare impact of dollar store entry (equation 13) is derived from the household overall exact price index.

As noted in section 7, household welfare change associated with dollar store entry is determined by the change of the overall exact price index that households face between the baseline and counterfactual period. The change in household overall exact price index can be expressed as

$$\frac{P_{h1}}{P_{h0}} = \frac{\left(\sum_c n_{ch1}\left(\beta_{ch}^{-1}P_{ch1}\right)^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}}}{\left(\sum_c n_{ch0}\left(\beta_{ch}^{-1}P_{ch0}\right)^{1-\eta_h}\right)^{\frac{1}{1-\eta_h}}} = \left(\sum_c \frac{n_{ch1}\left(\beta_{ch}^{-1}P_{ch1}\right)^{1-\eta_h}}{P_{h0}^{1-\eta_h}}\right)^{\frac{1}{1-\eta_h}}$$

$$= \left(\sum_c \frac{n_{ch0}\left(\beta_{ch}^{-1}P_{ch0}\right)^{1-\eta_h}}{P_{h0}^{1-\eta_h}} \cdot \frac{n_{ch1}\left(\beta_{ch}^{-1}P_{ch1}\right)^{1-\eta_h}}{n_{ch0}\left(\beta_{ch}^{-1}P_{ch0}\right)^{1-\eta_h}}\right)^{\frac{1}{1-\eta_h}}$$

The first term on the right-hand side of the equation, $\frac{n_{ch0}\left(\beta_{ch}^{-1}P_{ch0}\right)^{1-\eta_h}}{P_{h0}^{1-\eta_h}}$, is household expenditure share at stores of format c in the baseline period and is denoted by s_{ch0}. The second term captures the change in the number of incumbent stores of format c, $\frac{n_{ch1}}{n_{ch0}}$, and the change of product prices and variety at incumbent stores of format c, $\frac{P_{ch1}^{1-\eta_h}}{P_{ch0}^{1-\eta_h}}$, that result from dollar store entry.

Assuming that the product prices and variety at incumbent stores do not respond to dollar store entry (i.e., $P_{ch1} = P_{ch0}$), the change in household overall exact price index is rewritten as

$$\frac{P_{h1}}{P_{h0}} = \left(\sum_{c} s_{ch0} \cdot \frac{n_{ch1}}{n_{ch0}} \right)^{\frac{1}{1-\eta_h}}$$

$$= \left(\sum_{c \neq dollar} s_{ch0} \cdot \left(1 + \frac{\Delta n_{ch}(n|n_{dollar,h0})}{n_{ch0}} \right) + s_{dollar,h0} + n \left(\frac{\beta_{dollar,h}^{-1} P_{dollar,h}}{P_{h0}} \right)^{1-\eta_h} \right)^{\frac{1}{1-\eta_h}}$$

$$= \left(\underbrace{1 + \sum_{c \neq dollar} s_{ch0} \frac{\Delta n_{ch}(n|n_{dollar,h0})}{n_{ch0}}}_{\Delta^{incumbent}(n)} + \underbrace{n \left(\frac{\beta_{dollar,h}^{-1} P_{dollar,h}}{P_{h0}} \right)^{1-\eta_h}}_{\Delta^{dollar}(n)} \right)^{\frac{1}{1-\eta_h}}$$

where $\Delta n_{ch}(n|n_{dollar,h0})$ is the change in the number of retailers of format c attributable to n dollar store entries.

The equation above highlights the two forces, $\Delta^{incumbent}(n)$ and $\Delta^{dollar}(n)$, that determine the impact of n dollar store entries on household welfare: the welfare change that result from the changes in local market structure attributable to dollar store entries and the welfare change that arises from the increased retail variety and dollar store product characteristics.

C Additional Tables

Table C1: List of Cities

City Name	City Name
Atlanta	Milwaukee
Baltimore	Minneapolis
Birmingham	Nashville
Boston	New Orleans–Mobile
Buffalo–Rochester	New York
Charlotte	Oklahoma City–Tulsa
Chicago	Orlando
Cincinnati	Philadelphia
Cleveland	Phoenix
Columbus	Pittsburgh
Dallas	Portland OR
Denver	Raleigh–Durham
Detroit	Richmond–Norfolk
Grand Rapids	Sacramento
Hartford–New Haven	Salt Lake City–Boise
Houston	San Antonio
Indianapolis	San Diego
Kansas City	San Francisco
Los Angeles	Seattle
Louisville	St Louis
Memphis	Tampa
Miami	Washington, D.C.

Notes: This table presents the list of cities included in the analysis in this paper.

Table C2: List of Product Categories

Product Categories	Product Categories	Product Categories
Soup	Snacks	Cheese
Cookies	Table Syrups, Molasses	Butter and Margarine
Crackers	Sugar, Sweeteners	Snacks, Spreads, Dips – Dairy
Fruit – Dried	Tea	Cot Cheese, Sour Cream, Toppings
Shortening, Oil	Vegetables – Canned	Milk
Desserts, Gelatins, Syrup	Bread and Baked Goods	Pudding, Desserts – Dairy
Baking Mixes	Pet Food	Dough Products
Baking Supplies	Nuts	Yogurt
Prepared Food – Dry Mixes	Condiments, Gravies, and Sauces	Dressings/Salads/Prep Foods – Deli
Candy	Spices, Seasoning, Extracts	Packaged Meats – Deli
Coffee	Juice, Drinks – Canned, Bottled	Fresh Meat
Breakfast Food	Gum	Fresh Produce
Carbonated Beverages	Salad Dressings, Mayo, Toppings	Wrapping Materials and Bags
Pasta	Vegetables – Frozen	Laundry Supplies
Pickles, Olives, and Relish	Baked Goods – Frozen	Detergents
Cereal	Unprep Meat/Poultry/Seafood – Frozen	Fresheners and Deodorizers
Jams, Jellies, Spreads	Ice Cream, Novelties	Pet Care
Seafood – Canned	Pizza/Snacks/Hors Doeurves – Frozen	Household Supplies
Fruit – Canned	Prepared Foods – Frozen	Personal Soap and Bath Additives
Packaged Milk and Modifiers	Breakfast Foods – Frozen	Paper Products
Soft Drinks – Noncarbonated	Desserts/Fruits/Toppings – Frozen	Household Cleaners
Prepared Food – Ready-To-Serve	Juices, Drinks – Frozen	Charcoal, Logs, Accessories
Flour	Eggs	

Notes: This table presents the list of product categories included in the analysis in this paper.

Table C3: Distribution of Products and Brands across Product Categories

	Number of	
	Products	Brands
Mean	2,469	1,763
Percentile		
1	199	175
10	648	521
25	948	715
Median	1,862	1,418
75	3,124	2,320
90	4,750	3,693
99	8,795	5,969

Notes: This table presents the distribution of the number of products and product brands across product categories.

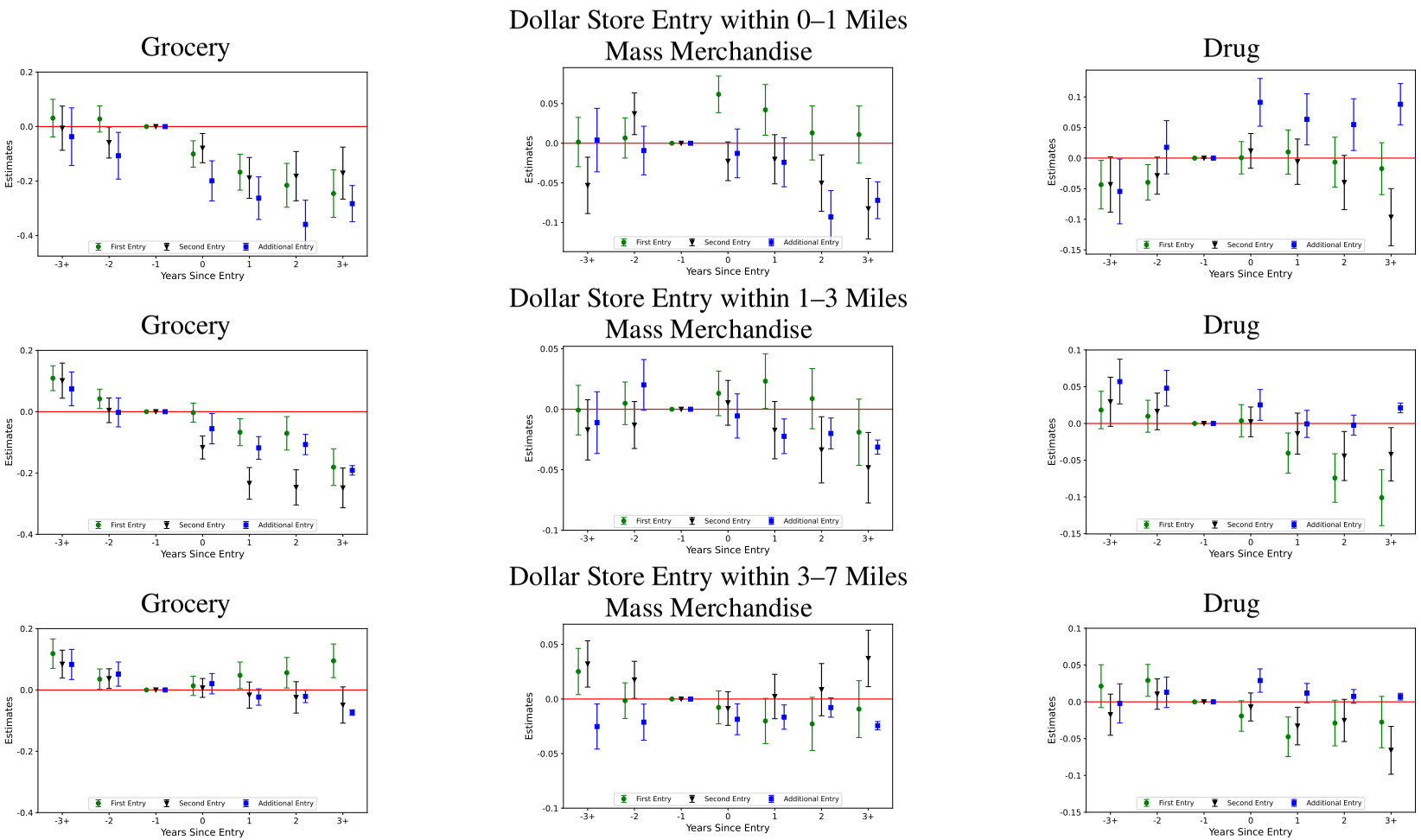
Table C4: List of Neighborhood Characteristics

Demographics	
Share of population age 35 or below	Share of population age 65 or over
Share of population – white	Share of population – black
Education	
Share of population with college degrees	High school dropout rate
Employment	
Unemployment rate	Share of population not in labor force
Income	
Log(median household income)	Share of households with income less than $\$40,000$
Share of population living in poverty	Income inequality (Gini index)
Housing	
Log(median house value)	Log(median gross rent)
Share of households without vehicles	
Others	
Log(retail stores, excl. grocery, mass merchandise, and drug stores)	

Notes: This table lists the demographic and economic variables obtained from the American Community Survey and whose changes and levels are controlled for in estimating the impact of dollar store entry on the local market structure.

D Additional Figures

Figure D1: Event Study of Dollar Store Entry without Linear Trend Extrapolation

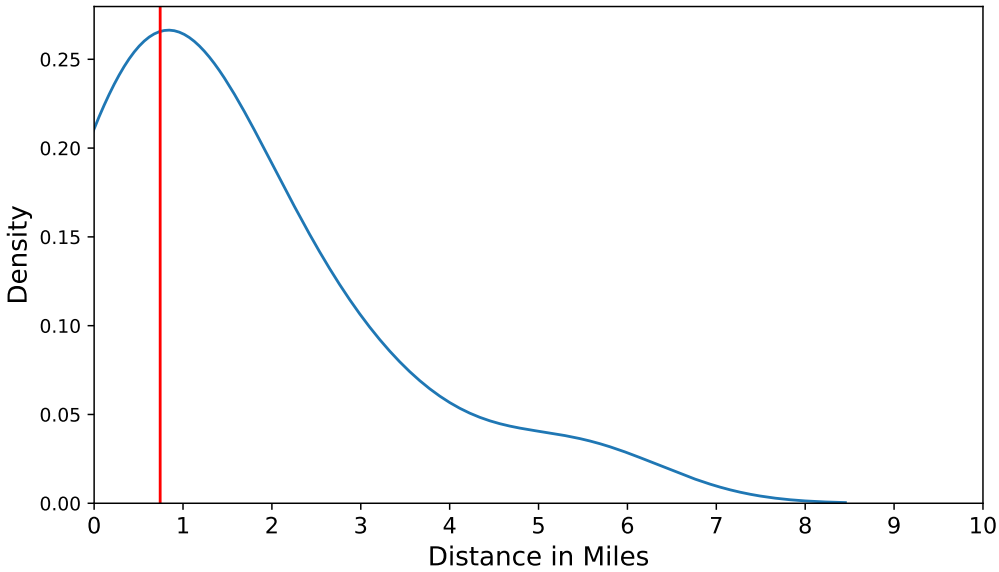


Notes: The figure plots the point estimates and 95% confidence intervals of $\beta_{k,c}^{b,d}$ in equation 1 without linear trend extrapolation, i.e.,

$$Y_{\ell t}^{c} = \beta_0 + \sum_{\substack{d \in \{[0,1],\\ (1,3],(3,7]\}}} \sum_{b=1}^{3+} \sum_{k=-3, k\neq -1}^{3} \beta_{k,c}^{b,d} E_{\ell,t-k}^{b,d} + \beta_{\Delta X} \Delta X_{\ell t} + \beta_{X,t} X_{\ell t} + \delta_t + \delta_\ell + \epsilon_{\ell t}$$

$\beta_{k,c}^{b,d}$ is the changes in the number of stores of retail format c in a market k years after the bth dollar store entry within d miles of the center of the market. An observation in a regression is a census tract–year. Five-year changes and levels of the demographic and economic variables listed in Table C4, census tract fixed effects, and year fixed effects are included in the regression. Standard errors are clustered by census tract. Each column is a retail format, and each row is a distance band for dollar store entry.

Figure D2: Distribution of Distances Households Travel to Visit Dollar Stores for Food Purchases



Notes: The figure plots the distribution of miles that households travel to visit dollar stores for food purchases based on data from the FoodAPS National Household Food Acquisition and Purchase Survey. The survey is representative of U.S. households and was conducted by the U.S. Department of Agriculture between April 2012 and January 2013. The vertical line represents the median distance that households travel to visit dollar stores.