Store Variety and Consumer Welfare in Canada-US retail

Nicholas Li*

University of Toronto

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Abstract

This paper explores the role of multi-product retail in generating differences in product variety across space. Using disaggregated (barcode) data from a large grocery-store chain for over 180 product categories and 300 stores in Canada and the United States, I find (1)there are large differences in variety within supermarket chains, even within cities, (2)many of these differences can be attributed to local neighborhood characteristics, especially store size and income, (3)some of these differences are also due to the economics of density that operate across much larger areas due to the distribution/warehouse network of the chain, (4)Canadian stores have substantially fewer than American stores even conditional on store size and local demographics. I show that these differences in product variety have important effects on consumer welfare.

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1. Introduction

Many New Economic Geography and trade models imply that larger markets have greater product variety, lowering the cost-of-living by raising consumer welfare and generating a pecuniary externality that gives rise to agglomeration. Recent empirical work builds on the trade and macroeconomics literature that uses CES preferences and the Feenstra (1994) index to measure welfare gains from new varieties over time (Broda and Weinstein (2006), Broda and Weinstein (2010)) by extending the analysis of varieties over space. In particular, Handbury and Weinstein (2012) use disaggregated barcode data for US households in 49 cities to examine whether cities with larger populations purchase have more varieties. They find that the elasticity of product variety with respect to city size is in the range of 20%-30%, translating into a welfare elasticty of 0.8%. Varieties can thus provide an important mechanism underling agglomeration in New Economic Geography models that operates through the demand-side. While the finding that larger cities have more varieties is in line with the predictions of some theoretical models, the precise mechanism generating this effect is unclear – is it because larger cities manufacture more varieties locally, is it because of entry by different competing retailers that offer different varieties, or does it depend on the economics of retail distribution networks?

This paper contributes to the literature by examining the supply-side of varieties operating through multi-product retailers. Retail – and multi-product retail in particular – is the final stage in the production of variety for consumers and the one that directly impacts consumer welfare. Despite its importance, there has been relatively little systematic analysis of variety supply by multi-product retailers and their in generating the differences in variety across cities identified in work using consumer data. This is largely because most retail scanner data sets only contain data on a few product categories. I use data from one of the largest supermarket chains in North America to fill this gap. With over 300 supermarkets across a dozen regions in the United States and Canada, and the complete set of UPC-barcode level products (over 13,000 per store and over 55,000 in total in over 180 product categories) the data provide one of the most complete pictures of the supply of varieties across space by a multi-product retailer. Using the cross-section of stores and products, I show how the number and composition of products offered depends on store, neighborhood, and regional characteristics *within* the same supermarket chain and estimate the effects on consumer welfare. Finally, the international dimension of the data also allows an analysis of the effect of international borders on variety and consumer welfare.

There are four main findings. First, there are substantial differences in the number of UPCs (and consequently consumer welfare) *within* a supermarket chain, implying that spatial differences in variety and the variety advantage of larger cities are not only (or necessarily) the result of differences in the number and type of retailers. These differences exist even within operating areas that are serviced by the same warehouse, indicating that number and size of local manufacturing activity is not enough to predict local variety. Second, "neighborhood" characteristics at the zipcode (US) or census subdivision (Canada) are important determinants of the number of varieties in a store – most of these characteristics (including population density, local competition and land prices) operate through store size, which is the primary determinant of store variety, but median income also predicts more varieties conditional on store size. Third, the strong positive relationship between the number of stores in an operating area of the chain serviced by the same warehouse/distribution center highlights the role of distribution networks and the potential for spillovers within the chain based on its organization. Stores in operating areas with a greater number of other stores have more UPCs even conditioning on store size and other local characteristics, and these spillovers occur over areas substantially larger than cities or MSAs (sometimes as large as states or provinces). Fourth, Canadian stores have a substantially lower number of UPCs than American stores even conditional on store size and the size of the local operating area/distribution network, suggesting that national-level distribution networks and other factors related to the "border effect" have a large impact on product variety.

Using the same Feenstra (1994) methodology that was applied across cities by Handbury and Weinstein (2012), I show that these store-level variety differences translate into large effects on consumer welfare. The elasticities of the cost-of-living with respect to income, store size, and the number of stores in the local network are as high as 1%, 5.3%, and 1% respecitvely. Canadian stores carry 23% less UPCs than similar American stores with the same size and consumer demographics, translating into 1.6% higher cost-of-living for Canadian shoppers. Overall the elasticity of welfare with respect to the number of UPCs is about 10% due to a combination of high elasticities of substitutions and the tendency for all stores to carry the most impactful varieties. Larger stores, those in higher income areas, and those in operating areas with more stores typically carry additional varieties that are more expensive, local (not sold outside an operating area), and are purchased infrequently, which lowers their welfare impact, but the welfare effects from variety I calculate are non-trivial.

In addition to the literature on welfare gains from variety and variety differences across cities discussed earlier, this paper also relates to a broader literature on product variety and the economics of retail. Holmes (2011) shows that Wal-Mart prefers to expand to locations closer to its existing stores to take advantage of the cost-savings from density despite the cannibalization of its own sales, and I find evidence that such density may also confer a benefit by enabling stores to carry more UPCs – thus the benefits of density may be realized on the demand-side (through consumer gains from variety) as well on the supply-side (by lowering the firms cost for providing a given number of UPCs to stores). Several papers have considered the productivity advantages conferred by large, multi-product stores and retail chains compared to traditional mom and pop stores or smaller stores within the same chain (Lagakos (2007), Haskel and Sadun (2011)) – while there are several potential mechanisms that would generate this productivity advantage, including simple cost reductions that are passed through to consumers in the form of lower prices, the evidence presented here confirms that product variety plays an important role on both the cost reduction and the demand-side. This has important implications for policies that restrict the entry of multi-product retail chains or large (so called "big box") stores analyzed by these authors. My results can be used to quantify the loss of consumer welfare from restrictions that limit the size of a store within the retail chain. The paper also provides direct evidence on one mechanism that may reduce the "cost of variety" from the consumer's perspective, as in Li (2012) – if denser, urban areas are more likely to have retailers that stock many varieties, this could dramatically lower consumer search and shopping costs and increase the number of varieties purchased by households. Finally, this paper builds on Gopinath et al. (2011), who use the same dataset to analyze the Canada-US "border effect" on retail price differences; I provide evidence of the border effect on product variety and its implications for welfare.

The paper is organized as follows. Section 2 presents the main facts on the relationship between variety, store size, and local area characteristics. Section 3 provides an analysis of the welfare effects of variety differences. Section 4 concludes.

2. Facts about store-level variety

The retail data come from one of the largest supermarket chains in North America, one that operates in over 1900 stores in the United States and 250 stores in Canada. The data set features weekly data at the UPC-level for items sold in each week between 2004 and mid 2007 for 250 stores in the United States and 75 in Canada. The American stores are organized into 9 operating areas/regions and 25-50 stores are sampled from each area, while the Canadian stores are organized into 3 operating areas/regions with 25 stores sampled from each. Each operating area has its own set of distribution centers/warehouses that service the stores within the area – all UPCs are shipped to the stores through these distribution centers except for a subset that arrive through direct-store delivery from the manufacture (most notably soft drinks). Figure 1 provides a map of the sample stores and their locations, color-coded by operating area.

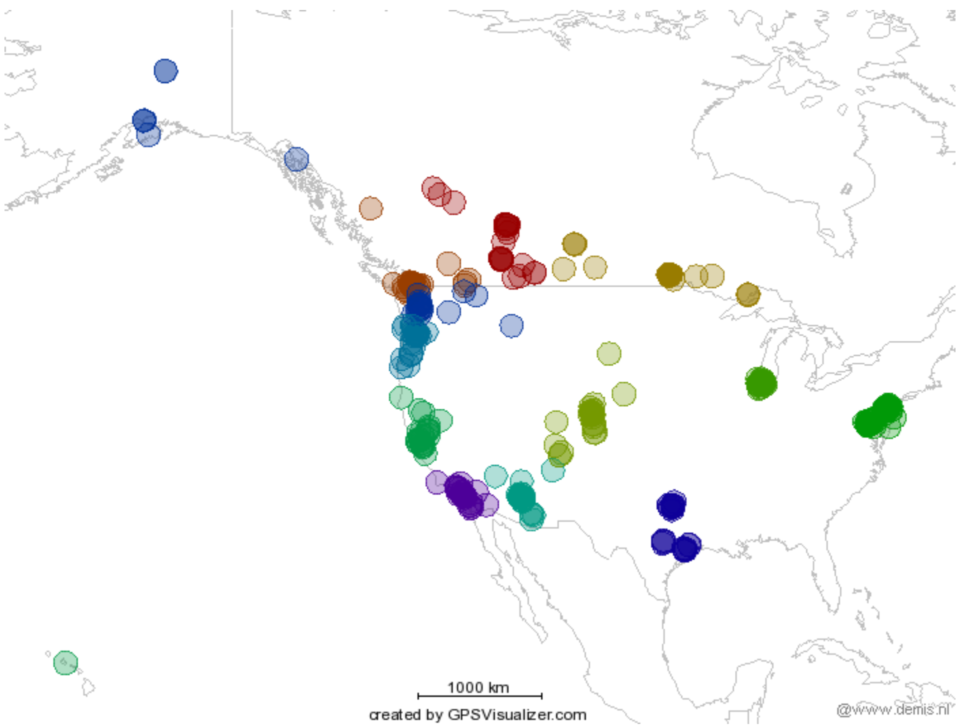

Figure 1: Sample store locations for Canada and the US, color-coded by operating area

Table 1 presents summary statistics for the retailer dataset. I drop four American stores and one Canadian stores from the sample that are outliers in terms of building size (below 10000 square feet) and number of UPCs. I also drop several product categories in the data that are often missing from many stores – automotive, alcohol (which is not sold in the Canadian stores or in states with state liquor monopolies) – and the books/magazines category. I aggregate up all weekly observation for the first quarter (13 weeks) of 2007. In addition to data on the size of the store, opening year and transaction data (on revenues, prices, number of UPCs sold) I match each store using its address to zipcode (US) or census subdivision (Canada) level census variables including median household income (in 2000 US dollars), population per square kilometer, number of competing supermarkets (from county business patterns), number of supermarkets per square kilometer, and the share of young (under 15) and old (over 65) people. For the United States I also match the stores to MSA level land prices from Davis and Palumbo (2007). See Gopinath et al. (2011) for the sources of the census variables and more information on the data set.

American stores are typically larger than Canadian stores, sell many more UPCs (despite similar revenue and a similar number of product categories), and are located in higher income and higher density areas. American operating areas have many more stores than Canadian operating areas. While no store sells the entire universe of UPCs in the sample, there are clear difference in the average number of UPCs is apparent at the store-level, at the operating area/regional level, and at the country level.

The best predictor of the variety of UPCs sold by a store is the size of the store. Figure 2 shows that there is a very tight quadratic fit between store size and number of UPCs for each country, though there is some variation in UPCs conditional on store size. The figure also reveals that the lower number of UPCs in Canada is not just a consequence of store size – while Canadian stores are smaller than US stores on average, American stores sell substantially more UPCs even conditional on the size of the stores.

Table 2 presents results from an OLS regression of store size on a several local-area characteristics. As some of the stores opened as early as 1942, the 2000-2001 census variables may be not particularly relevant as determinants of store size. Many of the stores were acquired rather than built by the parent corporation, another factor that may lead to a weak correlation between current census variables and store size if other supermarket chains base their store size decisions on a different formula. Finally, many communities have store size restrictions that may be binding. On the

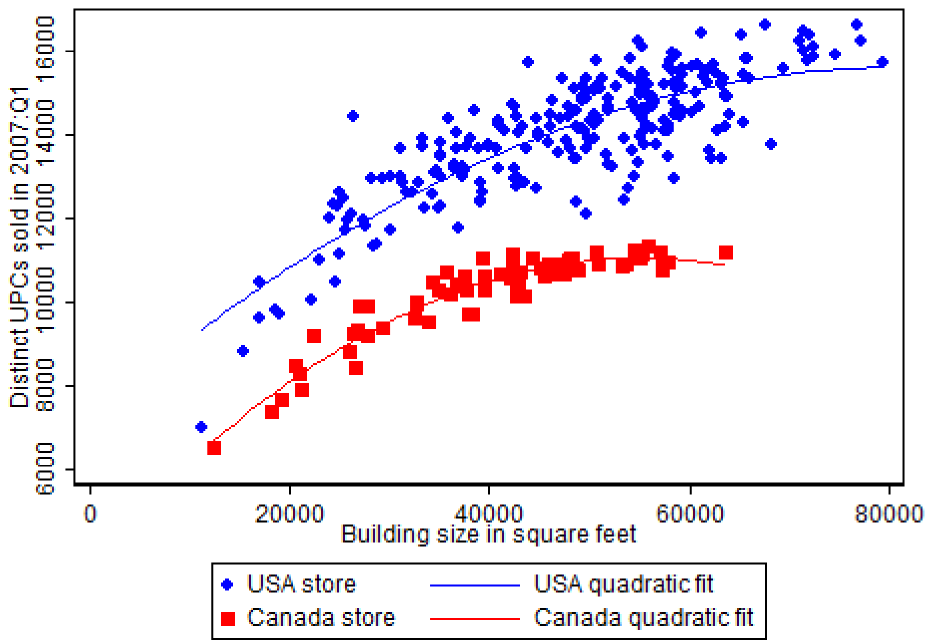

Figure 2: Store variety and store size for Canada and USA

other hand, the chain has the ability to renovate and expand existing stores and has done so in recent years. Despite these caveats, the results of table 2 suggest that local census variables can explain a large share – as large as 50% – of the variation in stores sizes in the sample. Income and population density individually predict a larger store size, but their interaction is negative suggesting that richer urban areas may feature smaller stores due to higher land prices. This is confirmed in the results for the US sample when controlling for MSA land prices - the coefficients on income and population density remain positive but lose significance and land prices are highly negative and significant. Locations with more competition from other retailers (high store density) tend to feature smaller stores, perhaps reflecting a lower number of shoppers conditional on population density, income and demographic factors. Canadian stores are smaller than US stores even conditioning on local characteristics. One of the strongest predictors of store size is the year the store opened – the average (conditional) store size in the sample has been growing by about 1.3% per year, an interesting fact that suggests some complementarity between the number of UPCs (which has been growing over time, see Broda and Weinstein (2010)) and store size as well as dynamics of the supermarket retail industry in general. Areas with more stores in the same chain tend to feature smaller stores as well, potentially reflecting the effects of cannibalization of the chain's own customers and consequently lower customer base and size requirements.

While store size is the best predictor of the number of UPCs and on its own predicts 52% of the variation in UPCs across stores (90% with the Canada dummy), there are still substantial differences in UPCs across stores conditional on store size. Table 3 presents store or category-store level regressions of the number of UPCs on various local area characteristics. The category-level regressions include category fixed effects. Columns (1) includes a Canada dummy which captures international differences in UPCs conditional on area and store characteristics. Column (2) and all subsequent columns include log building size as a control variable – this soaks up much of the variation in UPCs that would otherwise be attributed to local-area characteristics, and the local-area characteristics tend to have a relatively small impact on the residual variation in UPCs across stores.[1]

Column (3) includes the number of stores in each operating area which captures spillovers from the presence of other retail stores in the area on the number of UPCs stocked operating through the distribution channel – this also helps separate the impact of international distribution (the Canada dummy) from local distribution (through the operating areas), which is potentially important since there the Canadian operating areas have less stores on average than the US stores and there is substantial variation across US operating areas in terms of their total number of stores and UPCs. Column (4) uses operating area dummies, and I report the minimum and maximum coefficients for US operating areas to provide a sense of the variation across distribution networks *within* the United States – the omitted area is in Canada, so the positive coefficients reflect the extra UPCs in the United States. Column (5) includes a quintic in latitude and longitude to capture potential spatial variation in consumer tastes or other omitted variables – this is particularly relevant for thinking about the effects of distribution networks, which could be potentially correlated with consumer taste-areas.

The results indicate that income is the only local census variable that seems to have a strong predictive effect on the number of UPCs conditional on store size. Income is significant across all specifications and the elasticity of UPCs to median in-

[1]The relationship between store size and UPCs is roughly linear in logs. While a quadratic term would be significant it only increases the R^2 adjusted from 0.9 to 0.91 and makes interpretation more difficult so I leave it out of these results.

come is about 6% holding size constant – the total effect of income is even greater since income also predicts store size. Note that none of the effects identified are driven by category-level composition effects are the impact of income and other variables is typically similar or larger in the specification that uses category-store level UPC counts and controls for category fixed effects.

Two other variables that are always significant (but that are not necessarily related to local characteristics of the store zipcode/census subdistrict) are the Canada dummy and the number of other stores in the operating area. The Canadian dummy is reduced by controlling for store size, and then is further reduced by controlling for the number of stores in an operating area (which is much smaller in Canada) and then again by controlling for quartics in latitude and longitude, which potentially pick up omitted variables related to weather, demography, ethnicity, and local tastes that influence the stores decisions on variety. The number of stores in an operating area is highly significant and implies that some of the store-level differences in variety are determined at the operating area-level. Column (4) includes operating area dummies and I report the minimum and maximum dummies for the US (relative to a Canadian area), revealing that there are substantial differences in the number of UPCs from operating-area level factors such as the number of stores even within the United States.

The strong effect of country and operating-area level variables suggests an important role for national and subnational distribution channels in determining which products a store carries. Regardless of the size of the store or local area characteristics, the total set of UPCs carried is higher in operating areas and countries that feature more stores within the chain. This is consistent with a model in which the retailer or manufacturers must pay fixed costs to add a particular UPC to the distribution network, leading to more UPCs in the areas where the number of stores (or the number of operating areas) is larger and the fixed costs can be spread across a larger volume of sales. The large within country effect suggests that the economics of density are highly relevant in retail and not only for the purpose of reducing costs – they have a large impact on variety as well.

While the negative Canadian border effect on UPCs is always large and significant, the specification estimated in table 3 masks significant heterogeneity in the border effect across product categories. Figure 3 plots the distribution of Canadian border coefficients from category by category store-level regressions of the number of UPCs on a border dummy with and without the full set of controls in table 3. While the median category clearly features less UPCs in Canada than the US, there are some categories in which the average Canadian store has more UPCs than the United States.

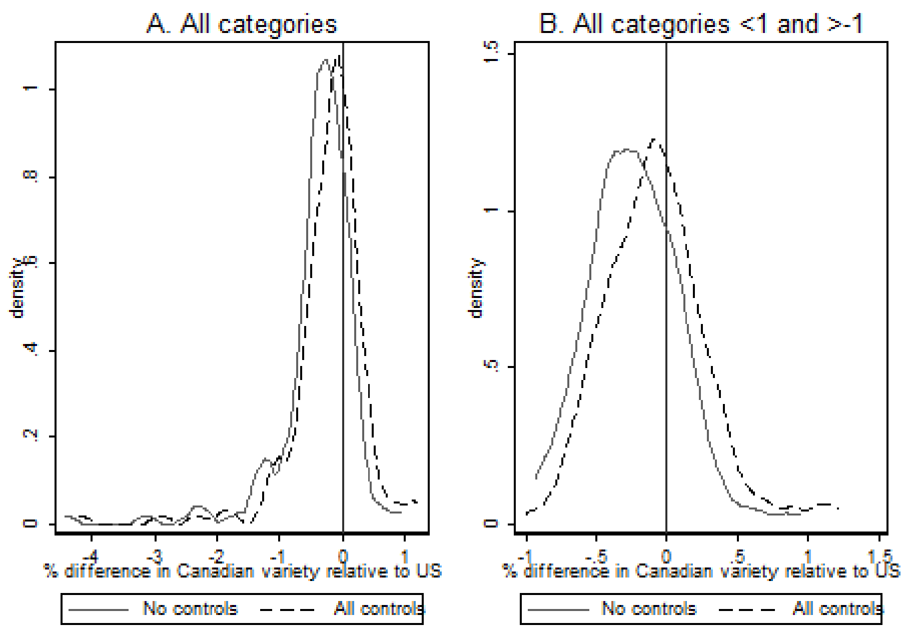

Figure 3: Canadian border effect on store variety across categories

Table 4 reports the categories and coefficient estimates of the top-10, median-10 and bottom-10 Canadian border coefficients.

Given that store size, local characteristics and operating area/country level factors affect the number of UPCs, a natural question to ask is which UPCs drive these effects – how does the composition of UPCs vary with these factors. To answer this question Table 5 presents results from regressions analogous to those from Table 3 applied to subsets of UPCs. Column (1) reproduces the estimates from column (3) of table 3 for comparison. Column (2) uses the log number of private label/store brand UPCs as the dependent variable. Column (3) uses the number of local UPCs, where local is defined as UPCs that are only sold within one operating area. Column (4) uses the number of international UPCs, where international is defined as UPCs that are sold in both Canada and the United States in the sample. Columns (5) and (6) define high and low-priced UPCs as those with unit prices in the top and bottom deciles within each category – as I do not control for pack size or the volume of the good, this is an imprecise measure that partly confounds higher quality/luxury goods with larger pack sizes. Columns (7) and (8) define the top and bottom decile of UPCs within each country based on mean revenue for stores that carry the UPC – using mean revenue (conditional on stocking the UPC) instead of total national revenue avoids confounding the extensive margin that we are interested in with a measure of the "importance" of the UPC in the consumer basket. Finally, column (9) looks at the number of brands instead of the number of UPCs, where I define brands using the first five-digits of the 10-digit UPC and only consider brands more than three UPCs in the sample.[2]

Several patterns emerge clearly in the data. Private label goods are negatively related to income but are less sensitive to "distribution" related country and operating area variables. Areas with intense competition and high incomes are much more likely to carry a large number of local UPCs, and while Canada seems to carry many less local UPCs the number of stores in an operating area does not have much of an effect. Canada does carry many more international UPCs, suggesting that direct importation of products without changing the UPCs (and instead of separate manufacturing in each country) plays a bigger role in Canada than the US. As we would expect high-priced (low-priced) goods tend to be carried more in richer (poorer) areas. High-priced goods also seem to be more affected by the number of stores in the operating area. Larger stores and richer areas tend to stock more of the least popular (lowest mean revenue) UPCs.

Combining the results from the previous columns, the data indicate that larger stores and richer areas tend to carry higher-priced but lower volume UPCs, many of which are local brands, whereas almost all of the stores carry private-label and low/medium priced national brands that achieve the highest sales volumes. The higher-priced but lower volume UPCs also seem to be more sensitive to the number of stores in the operating areas, suggesting that the distribution channel may be particularly important (and binding) for these goods. Finally, the results for UPCs as a whole seem to carry over to the level of brands and the coefficients imply that both the number of brands and the number of UPCs per brand rise in income, store size,

[2]This definition is imprecise as some brands may use multiple 5-digit codes and some 5-digit codes contain multiple brands. Another issue is that when brands are acquired by different companies the codes are unchanged, but this is less of a concern when analyzing brands as opposed to corporations/companies.

and the number of stores in the operating area (or country).

3. Welfare effect of store-level variety

Calculating the welfare effects of variety requires going beyond counts of UPCs to analyzing prices and quantities – prices are required to estimate the slope of the demand curves that reveal consumer surplus, and quantities are required to measure the quality or consumer preference for each good. As a first step towards a CES-based welfare calculation analogous to Feenstra (1994) and Handbury and Weinstein (2012) I plot the relationship between store size, the share of UPCs carried by the store (out of total national UPCs) and various weighted counts of UPCs where the weights reflect the "importance" of each UPC in revenue terms. One possible weight is the total national revenue share of the UPC, though this weighting allows the extensive (store) margin to affect the importance of the UPC. Another possible weight is to use the mean revenue for stores that carry the UPC, and the normalizing so that the weight of each UPC sums to one. This weighting still allows UPCs carried by stores in higher volume areas to have more importance than UPCs carried by stores in low volume areas. A third weighting scheme uses the mean (across stores) of the UPC share of store revenue, normalizing so that the weight of each UPC sums to one. This third scheme normalizes by store revenue so high and low volume stores get equal weight – it is only the revenue share relative to other UPCs in each store that plays a role.

Figure 4 plots these different measures against store size. When weighted by total national revenue, the national UPC-revenue share of each store is much higher than the national UPC count-share, reflecting the fact that all stores tend to carry the most important UPCs. The other revenue weights tell a similar if somewhat more muted story, but they also show a much flatter slope in store size. This implies that the marginal UPCs that get added as store size increases are "marginal" in revenue terms too, contributing less to consumer welfare than the infra-marginal UPCs that are carried by most stores. This is consistent with the earlier decomposition results, which find that richer areas with larger stores – the ones with more UPCs on average – tend to carry more local, high-priced and low volume UPCs and have a smaller (or even negative) advantage in terms of the highest-selling UPCs (including private labels which are typically much cheaper than national brands).

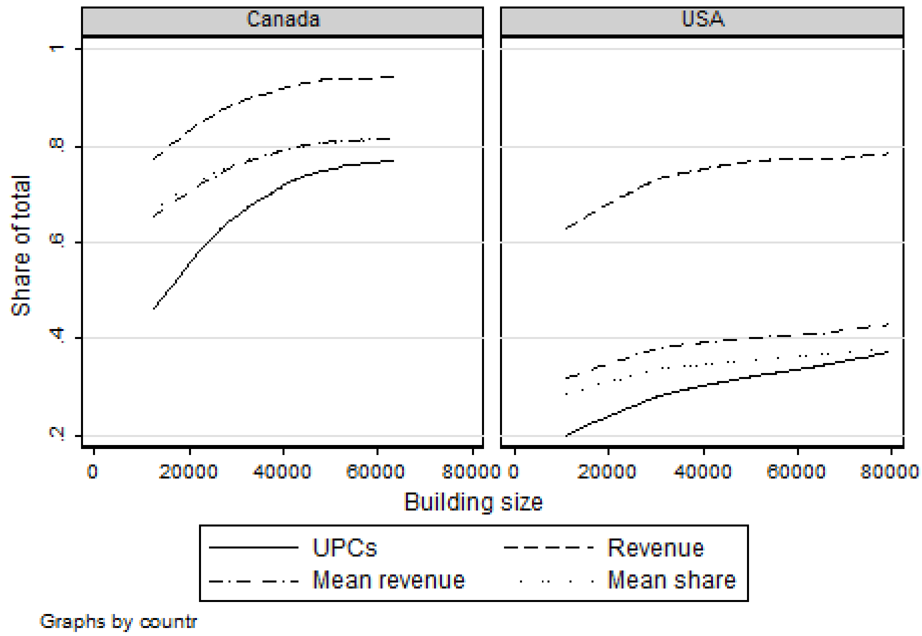

Figure 4: Store size and share of UPCs with different weights

3.1. Feenstra CES price index

The formula for the Feenstra (1994) CES price index with non-constant variety is as follows. Define a base store 0 and comparison store k, and index the categories by g. The set of UPCs in category g that are common to store k and 0 is defined as I_g, while I_{gk} and I_{g0} are sets of all UPCs in group g sold in stores k and 0 respectively. The exact CES price index for store k relative to store 0 as:

$$P_k = \prod_{g=1}^{G} \left(\frac{P_{kg}}{P_{0g}} \right)^{w_{kg}} \tag{1}$$

where

$$P_{kg} = \prod_{i \in I_g} \left(\frac{p_{kgi}}{p_{0gi}} \right)^{w_{kgi}} \left(\frac{\lambda_{kg}}{\lambda_{0g}} \right)^{\frac{1}{\sigma_g - 1}} \tag{2}$$

and

$$\lambda_{kg} = \frac{\sum_{i \in I_g} p_{kgi} q_{kgi}}{\sum_{i \in I_{gk}} p_{kgi} q_{kgi}} \tag{3}$$

$$w_{kg} = \frac{\frac{s_{kg} - s_{0g}}{\ln s_{kg} - \ln s_{0g}}}{\sum_{g \in G} \frac{s_{kg} - s_{0g}}{\ln s_{kg} - \ln s_{0g}}} \tag{4}$$

$$w_{kgi} = \frac{\frac{s_{kgi} - s_{0gi}}{\ln s_{kgi} - \ln s_{0gi}}}{\sum_{i \in I_g} \frac{s_{kgi} - s_{0gi}}{\ln s_{kgi} - \ln s_{0gi}}} \tag{5}$$

$$s_{kg} = \frac{p_{kg} q_{kg}}{\sum_{g \in G} p_{kg} q_{kg}} \tag{6}$$

$$s_{kgi} = \frac{p_{kgi} q_{kgi}}{\sum_{i \in I_g} p_{kgi} q_{kgi}} \tag{7}$$

Note that the necessary and sufficient condition for this formula to apply is that $d_{kgi} = d_{0gi}$ for $i \in I_g$ and $I_g \neq \emptyset$. In words, there must be some UPCs in common between the two stores within the category and consumer tastes for these UPCs must be identical (though tastes for non-common UPCs, e.g. local varieties, are allowed to differ).

While revenue shares are important in capturing the asymmetry in the valuation consumers put on different varieties, I also need the elasticity of substitution between goods, which captures how much consumers value additional varieties. While the store data could be used to calculate the elasticity following a procedure similar to Feenstra (1994) or using the Hausman-Nevo identification strategy (which assumes that the prices of neighboring regions can serve as instruments that capture exogenous supply-driven changes in local prices) I will simply use the elasticities calculated by Broda and Weinstein (2010) using AC Nielsen scanner data. This has the advantage of making the results directly comparable to those from Handbury and Weinstein (2012) and avoids the estimation problem confronting retail scanner data when consumers substitute to other stores in reaction to a price change.

I match the elasticities calculated by Broda and Weinstein (2010) to my data at the category-level, using the across brand-module elasticities where available and the within brand elasticities where these are missing.[3] I am able to match 150 out of 182 (82%) categories accounting for 48289 out of 57630 (84%) UPCs in the sample and 81% of total revenue. The mean (median) UPC-store observation in the sample has an elasticity of substitution of 13 (6.5), while the mean (median) UPC has an elasticity of 12.7 (6.5) and the mean (median) revenue-weighted UPC-store observation has an

[3]The across brand-module elasticities are generally smaller than the within brand-module elasticities. I am unable to use the nested structure in Broda and Weinstein (2010) or Handbury and Weinstein (2012) as the data do not contain brand-module identifiers.

elasticity of 11.2 (6).

Note that to calculate the index I need to define a base store. I use the store (based in Southern California) with the most UPCs. An alternative possibility is to use the aggregate over all stores – this gives aggregate expenditure shares for each UPC and defines a "national store" where all UPCs are available (i.e. in set I_{g0}). A disadvantage of doing this is that it weights the importance of UPCs not just by their expenditure shares conditional on their availability but also factors in the extensive margin – varieties available in more stores will get higher weight everything else equal. This is not an innocuous assumption – for example, UPCs available in both Canada and the United States, which are essential for valuing the non-common varieties in each country, will appear to be even more important compared to national UPCs because their aggregate revenue weight includes stores from both countries. Instead of using aggregate shares, I calculate the store-level share of each UPC and simply average this across all stores where the UPC is available to create a weight for each UPC – the importance of each UPC is then determined only by its importance relative to other UPCs sold in the same store. Unlike the case of aggregate revenue shares, this also gives equal weight to each store in the calculation.[4] The price for the aggregate store is just the mean price across all stores – note that this procedure will automatically reduce the effect of the Canadian border on prices if (as is the case in this period) Canadian prices are generally higher, because the comparison price for the common UPCs is somewhere between the average American and average Canadian prices.

The results of the welfare calculation are provided in table 6. I calculate separately the variety component of the Feenstra (1994) index and the price component. The variety component is just a category revenue-share weighted function of the category-level λ ratios that measure relative expenditures on common and non-common goods raised to the power $1/(\sigma - 1)$, while the price component is just a category revenue-share weighted function of the category-level price indexes constructed using the Sato-Vartia weights defined above. I present results for both the California store base (Cal) and the aggregate base (All), with and without controls for building size. Panel A reports the store-level results, while Panel B presents results using category-level variety and price indexes that control for category fixed effects.

When interpreting the coefficients, recall that a lower index implies a lower cost-

[4] A disadvantage of this procedure is that UPCs sold in stores with fewer varieties may have inflated shares.

of-living and hence a welfare gain. The gain in welfare can be interpreted in terms of percent changes in the cost-of-living or equivalently the share of expenditures that a household would give up to face the variety or prices of the base area. The results indicate that median income, store-size, and either the Canada dummy or the number of stores in the Area (and sometimes both) have significant impacts on welfare through the variety channel. Income is consistently an important predictor of welfare from store variety regardless of controls for the size of the store or when looking within categories – doubling the local income leads to a selection of varieties that raises welfare by 0.5 to 1%. This is equivalent to increasing the size of the store by roughly 20%-33%.

The effect of lower UPCs in Canadian stores is somewhat weak at the store-level and negative in one specification (implying higher welfare in Canada) but it is strongly negative when looking within categories. The Canadian border effect in the category-level specifications for California stores suggests that the lower number of UPCs for Canadian stores lowers welfare by 1.6%, equivalent to decreasing store-size by 0.4 log points or about 33%. The coefficient on the number of stores in an operating area is always negative and significant when controlling for building size, implying important welfare effects operating through the distribution channel – doubling the number of stores in the operating area leads to a selection of varieties that raises welfare by 0.3% to 1%, a magnitude roughly equivalent to the effect of doubling income in the local area of the store or increasing the size of the store by 10%-33%. The border and operating area effects are significantly larger for the category-level regressions suggesting that there may be important composition effects related to the particular categories in which there are common UPCs and their category share of total revenue weight.

The results for prices indicate that Canadian prices are generally higher (particularly using the California store base, for reasons discussed above) as we found in Gopinath et al. (2011). Interestingly prices also seem to be higher in operating areas with more stores. We also find that prices tend to be higher in areas with higher population density, though this effect is muted when the population density is due to young and old residents. Income, the local competition (proxied by retail density) and store size seem to have no predictive power on prices.

Comparing the effects of these variables on the number of UPCs (column (3) in Table 3) and the welfare effects that results from differences in UPCs (column (2) in Table 6) we see that roughly-speaking a 10% increase in UPCs translates into a 1% increase in welfare. For example, doubling income raises UPCs by about 7% but raises welfare by about 0.7%. Doubling the number of stores in the area raises the number of UPCs by 4.5% but raises welfare by about 0.7%. Doubling store-size raises the number of UPCs by 33% but only raises welfare by about 3.3%. The Canada dummy lowers the number of UPCs by about 25% but only lowers welfare by 1.6%. These results reflect a combination of the relatively high elasticity of substitution estimated by Broda and Weinstein (2010) and the lower importance of the marginal varieties that are stocked in stores with higher income, larger size, more stores in their operating area, and in the United States.

Comparing these results to Handbury and Weinstein (2012) is difficult since they do not report all of the coefficients for their welfare results and they use city-level population variables rather than local population densities. One difference from their results is that I find a much stronger effect for local income on the supply of varieties by the store, while they find zero or even negative effects of zip-code level income on the number of UPC varieties. One reason for this difference could be that the variety effects from higher income at the store level are offset by lower variety from other stores in the higher income areas though more work is needed to reconcile these findings.

Handbury and Weinstein (2012) also find large positive effects of city populations on both UPCs and welfare through variety, whereas I find very small effects of local population density. One way of reconciling these findings is if the number of stores in an operating-area is related to city populations – this is likely to be the case although the operating areas in my data are considerably larger than any city or MSA (many operating areas extend to entire states, and there are only two operating areas servicing all of California). Thus my results highlight that the variety effects of agglomeration may be strongly related to the structure of retail distribution networks, networks whose density does tend to depend on city and regional level population densities but perhaps depends on other factors (like competition) as well. My results also highlight that these spillovers may extend well beyond individual cities to entire states and provinces.

4. Conclusion

This paper provides insight into the important role of multi-product retail chains in generating variety differences across space. While some supermarket chains may act differently, the supermarket chain studied here is large enough that the patterns uncovered in this paper are likely to be active, to varying degrees, across the supermarket industry. My findings highlight the role for local characteristics - most notably store size, the factors like land prices, income, population density, and local competition that determine optimal store size, and policies and restrictions that limit store size – in the immediate neighborhood of stores. However, they also indicate that forces operating over larger areas – often larger than a city or MSA – such as entire states, provinces and countries play a large role in generating differences in variety through distribution networks and the warehouses that supply individual stores within operating areas. This emphasizes the role of the economics of retail density raised by Holmes (2011) with regard to Wal-Mart, and highlights one particular mechanism through which retail density can benefit a firm – the ability to stock more varieties in its stores and/or stock a given set of varieties at a lower price. The mechanism underlying the variety-city size relationship identified by Handbury and Weinstein (2012) may be quite complex, and future work should explore the respective roles of manufacturer location, across-chain retail competition, and the economics of density within retail chains in generating this relationship.

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Table 1: Summary statistics

Statistic	USA stores			Canadian stores		
	Mean	Min	Max	Mean	Min	Max
Store data						
Store size (sq.feet)	48831	11213	79399	41050	12466	63583
Net revenue (millions USD)	3.1	0.7	8	2.9	1	5.8
No. of UPCs	14046	6995	16623	10281	6546	11332
No. of categories	181	175	182	178	177	180
Year opened	1988.6	1942	2005	1985.9	1958	2006
Census data (zipcode or census subdivision)						
Median Income (2000 USD)	57299	24346	125105	41638	24067	64600
Population density (pop/sq.km)	1330	1.4	13307	1041	1.2	4759
No. competitors	5.8	0	38	86.8	0	410
Area (sq.km)	163	1.3	3500	441	2	5948
Supermarket density (no./sq.km)	0.37	0	6.85	0.43	0	3.58
Share senior	0.11	0.02	0.8	0.13	0.06	0.33
Share young	0.28	0.01	0.42	0.26	0.18	0.4
Other local area data						
MSA land price	308	32	1124	.	.	.
Stores in region	215	136	388	89	62	116
UPCs in region	21099	18297	24330	13107	12922	13445
	USA total sample count			Canada total sample count		
Stores	246			74		
Regions	9			3		
UPCs	44309			14497		
Categories	182			180		

Table 2: Determinants of store size

Variable	US only	US and Canada	US and Canada	US and Canada	US only
Store density	-0.05^{*}	-0.05^{**}	-0.04	-0.05^{*}	-0.05
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Pop. Density	0.91^{**}	0.86^{**}	0.8^{**}	0.85^{**}	0.49
	(0.42)	(0.4)	(0.4)	(0.39)	(0.58)
Median Income	0.46^{*}	0.42^{*}	0.43^{*}	0.46^{**}	0.22
	(0.23)	(0.22)	(0.22)	(0.22)	(0.36)
Pop. Den.x Income	-0.08^{**}	-0.08^{**}	-0.07^{**}	-0.08^{**}	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Young density	0.1	0.09	0.09	0.08	0.08
	(0.1)	(0.1)	(0.09)	(0.09)	(0.09)
Old density	-0.03	-0.05	-0.04	-0.03	-0.03
	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)
Year opened	0.01^{***}	0.01^{***}	0.01^{***}	0.01^{***}	0.01^{***}
	(0)	(0)	(0)	(0)	(0)
Canada		-0.12^{***}	-0.25^{***}		
		(0.04)	(0.05)		
Area stores			-0.15^{***}		
			(0.05)		
Area FE	NO	NO	NO	YES	NO
Land prices					-0.07^{**}
					(0.03)
Sample size	246	320	320	320	182
R^2	0.4	0.45	0.47	0.49	0.36

All variables in logs except year opened

Robust standard errors in parentheses

Table 3: Determinants of number of UPCs

Variable	(1)	(2)	(3)	(4)	(5)
			Panel A: Store UPCs (N=320)		
Store density	-.011	$.010^{**}$	.007	.007	.004
	(.011)	(.005)	(.005)	(.005)	(.005)
Pop. Density	.029	.003	.010	.026	.017
	(.039)	(.021)	(.020)	(.021)	(.019)
Median Income	$.076^{***}$	$.078^{***}$	$.068^{***}$	$.060^{***}$	$.056^{***}$
	(.020)	(.010)	(.010)	(.011)	(.011)
Young density	.025	-.014	-.017	-.028	-.019
	(.031)	(.018)	(.018)	(.019)	(.017)
Old density	$-.031^{**}$	.008	.007	.000	.004
	(.014)	(.006)	(.006)	(.006)	(.006)
Canada	$-.277^{***}$	$-.245^{***}$	$-.206^{***}$		$-.185^{***}$
	(.017)	(.007)	(.011)		(.016)
Area stores			$.045^{***}$		$.068^{***}$
			(.009)		(.013)
Max US area				$.308^{***}$	
				(.012)	
Min US area				$.215^{***}$	
				(.013)	
Building size		$.303^{***}$	$.311^{***}$	$.310^{***}$	$.312^{***}$
	(.013)	(.012)	(.012)	(.013)	
Area FE	NO	NO	NO	YES	NO
Lat./lon. controls	NO	NO	NO	NO	YES
Sample size	320	320	320	320	320
R^2	0.64	0.92	0.93	0.94	0.94
			Panel B: Category-store UPCs (N=57769)		
Store density	-.014	.007	.001	.003	.000
	(.011)	(.006)	(.006)	(.006)	(.005)
Pop. Density	.053	.028	$.040^{*}$	$.056^{**}$	$.042^{*}$
	(.037)	(.025)	(.023)	(.027)	(.023)
Median Income	$.093^{***}$	$.095^{***}$	$.080^{***}$	$.064^{***}$	$.060^{***}$
	(.020)	(.013)	(.011)	(.011)	(.011)
Young density	.007	-.032	$-.037^{*}$	$-.049^{**}$	$-.037^{*}$
	(.029)	(.021)	(.020)	(.023)	(.020)
Old density	$-.032^{**}$	.007	.005	-.005	.002
	(.014)	(.008)	(.007)	(.007)	(.007)
Canada	$-.324^{***}$	$-.292^{***}$	$-.226^{***}$		$-.185^{***}$
	(.018)	(.009)	(.012)		(.017)
Area stores			$.076^{***}$		$.092^{***}$
			(.011)		(.014)
Max US area				$.382^{***}$	
				(.012)	
Min US area				$.240^{***}$	
				(.014)	
Log building size		$.300^{***}$	$.314^{***}$	$.314^{***}$	$.313^{***}$
		(.014)	(.012)	(.012)	(.012)
Area FE	NO	NO	NO	YES	NO
Lat./lon. controls	NO	NO	NO	NO	YES
Sample size	57769	57769	57769	57769	57769
R^2	0.86	0.87	0.87	0.87	0.87

All variables in logs.

Robust standard errors in parentheses, clustered by store for category regressions.

Category-store regressions use category fixed effects.

Table 4: Selected border coefficients

Category	Canada border effect
Top 10 US	
VEGETARIAN / ORGANIC FROZEN PREPARED FOODS	-4.41
SHRIMP FAMILY	-3.14
GRAIN CAKES	-2.43
JEWISH SPECIALTY FOODS	-2.27
SNACKS AND APPETIZERS	-2.2
HISPANIC TORTILLA	-1.74
REFRIGERATED FOODS ALL OTHER	-1.5
DOG FOOD WET (EXCLUDING SUPER PREMIUM)	-1.33
SPORTS NUTRITION	-1.32
VARIETY PACKS	-1.32
Median 10	
DOG FOOD SNACKS (EXLUDING SUPER PREMIUM)	-0.3
CARBONATED SOFT DRINKS	-0.3
TOOTHBRUSHES	-0.29
POPCORN	-0.29
TOOTHPASTE	-0.29
BACON	-0.29
ONIONS/DRY GARLIC	-0.29
SALAD VEGETABLES	-0.28
AT HOME COOKIES	-0.28
LUNCH, COMMERCIAL FRESH BREAD	-0.28
Top 10 Canada	
GROCERY SNACKING CHEESE	0.23
FRESH CUT FLOWERS	0.24
ASIAN FOODS	0.24
RICE	0.3
ADULT JUICES AND DRINKS	0.31
SALMON FAMILY - FRESH (BULK)	0.39
RAMEN	0.51
ISB MAIN MEAL FRESH BREAD	0.54
FROZEN MEAT	0.75
POTATO CHIPS	0.94

Coefficients from regression of log store-level UPCs in category on Canada dummy and full set of store size, local variables and geographic controls.

Table 5: Composition of UPCs

Variable	All	Priv. lab.	Local	Inter.	High price	Low price	Top-10%	Bottom-10%	Brands
Panel A: Store UPCs (N=320)									
Store density	$.007$	$-.013^{*}$	$.199^{***}$	$-.011^{*}$	.008	-.003	-.002	$.066^{***}$	$.011^{**}$
	(.005)	(.007)	(.065)	(.007)	(.010)	(.004)	(.003)	(.020)	(.005)
Pop. Density	.010	$.039^{**}$	$-.380^{*}$	.030	.022	.023	.001	-.019	.022
	(.020)	(.020)	(.203)	(.026)	(.040)	(.015)	(.009)	(.075)	(.018)
Median Income	$.068^{***}$	$-.065^{***}$	$.919^{***}$	.011	$.073^{***}$	.005	$.031^{***}$	$.194^{***}$	$.067^{***}$
	(.010)	(.016)	(.121)	(.014)	(.018)	(.009)	(.006)	(.036)	(.009)
Country	$-.206^{***}$	$-.182^{***}$	-1.700^{***}	$.289^{***}$	-.002	$-.262^{***}$	$-.427^{***}$	$.679^{***}$	$-.464^{***}$
	(.011)	(.014)	(.155)	(.015)	(.019)	(.009)	(.007)	(.042)	(.010)
Area stores	$.045^{***}$	$.027^{*}$	-.120	$.078^{***}$	$.109^{***}$	-.002	$.034^{***}$	$.287^{***}$	.010
	(.009)	(.012)	(.118)	(.012)	(.015)	(.008)	(.006)	(.035)	(.009)
Log build	$.311^{***}$	$.139^{***}$	$.422^{***}$	$.302^{***}$	$.483^{***}$	$.245^{***}$	$.118^{***}$	$.750^{***}$	$.195^{***}$
	(.012)	(.022)	(.108)	(.020)	(.020)	(.012)	(.010)	(.035)	(.009)
R^2	0.93	0.69	0.62	0.76	0.81	0.94	0.7	0.84	0.96
Panel B: Category-store UPCs (N=57769)									
Store density	.001	-.010	$.091^{**}$	-.008	.007	.002	-.004	$.038^{***}$	$.016^{***}$
	(.006)	(.008)	(.043)	(.006)	(.009)	(.005)	(.003)	(.013)	(.006)
Pop. Density	$.040^{*}$	$.037^{*}$	-.153	.024	.014	.019	.005	.023	.005
	(.023)	(.022)	(.122)	(.020)	(.039)	(.015)	(.010)	(.047)	(.022)
Median Income	$.080^{***}$	$-.069^{***}$	$.574^{***}$	.009	$.055^{***}$	.000	$.027^{***}$	$.117^{***}$	$.087^{***}$
	(.011)	(.017)	(.074)	(.011)	(.017)	(.010)	(.006)	(.023)	(.010)
Country	$-.226^{***}$	$-.179^{***}$	$-.565^{***}$	$.334^{***}$	$.029^{*}$	$-.200^{***}$	$-.378^{***}$	$.383^{***}$	$-.281^{***}$
	(.012)	(.015)	(.080)	(.011)	(.016)	(.009)	(.007)	(.029)	(.010)
Area stores	$.076^{***}$	$.053^{***}$	-.062	$.051^{***}$	$.097^{***}$	.004	$.040^{***}$	$.180^{***}$	$.038^{***}$
	(.011)	(.012)	(.064)	(.010)	(.013)	(.008)	(.006)	(.022)	(.009)
Log build	$.314^{***}$	$.143^{***}$	$.378^{***}$	$.229^{***}$	$.393^{***}$	$.202^{***}$	$.115^{***}$	$.403^{***}$	$.200^{***}$
	(.012)	(.022)	(.069)	(.014)	(.014)	(.010)	(.009)	(.024)	(.009)
R^2	0.87	0.82	0.36	0.9	0.71	0.74	0.84	0.58	0.84
Share of UPCs	0.11	0.33	0.02	0.10	0.10	0.10	0.10		
Share of revenue	0.17	0.06	0.06	0.07	0.09	0.46	0.001		

All variables in logs

Robust standard errors in parentheses, clustered by store for category regressions.

All regressions also include old and young density (not reported).

Category-store regressions use category fixed effects.

Table 6: Store variety and welfare

Panel A: Store-level (N=320)								
	Variety index				Price index			
Base	Cal	Cal	All	All	Cal	Cal	All	All
Store density	.002	.000	.002	.000	.004	.003	.004	.004
	(.002)	(.001)	(.001)	(.001)	(.004)	(.004)	(.004)	(.004)
Pop. Density	.000	.002	-.003	-.001	$.016^{*}$	$.016^{*}$	$.017^{*}$	$.017^{*}$
	(.006)	(.003)	(.005)	(.003)	(.009)	(.009)	(.009)	(.009)
Median Income	$-.007^{***}$	$-.006^{***}$	$-.008^{***}$	$-.007^{***}$	-.003	-.003	.004	.005
	(.003)	(.002)	(.002)	(.001)	(.007)	(.007)	(.007)	(.007)
Young density	-.005	-.001	-.004	.000	$-.011^{*}$	$-.011^{*}$	$-.011^{*}$	$-.010^{*}$
	(.005)	(.002)	(.004)	(.002)	(.006)	(.006)	(.006)	(.006)
Old density	.002	-.002	$.005^{***}$	.000	$-.009^{*}$	$-.009^{*}$	$-.010^{*}$	$-.010^{*}$
	(.002)	(.001)	(.002)	(.001)	(.005)	(.005)	(.005)	(.005)
Canada	.002	-.006	-.004	$-.013^{***}$	$.121^{***}$	$.121^{***}$	$.054^{***}$	$.053^{***}$
	(.005)	(.004)	(.003)	(.002)	(.005)	(.004)	(.005)	(.005)
Area stores	-.002	$-.007^{***}$	.003	$-.003^{**}$	$.056^{***}$	$.055^{***}$	$.056^{***}$	$.055^{***}$
	(.003)	(.002)	(.002)	(.001)	(.006)	(.006)	(.006)	(.006)
Log build		$-.033^{***}$		$-.035^{***}$		-.001		-.003
		(.004)		(.002)		(.006)		(.006)
R^2	0.11	0.45	0.16	0.73	0.55	0.55	0.27	0.27
Panel B: Category/store-level (N=40779 or 47725)								
	Variety index				Price index			
Base	Cal	Cal	All	All	Cal	Cal	All	All
Store density	$.004^{**}$	.001	.003	.000	.002	.002	.004	.004
	(.002)	(.001)	(.002)	(.001)	(.004)	(.004)	(.004)	(.004)
Pop. Density	-.003	-.002	-.005	-.002	.016	.016	.014	.014
	(.007)	(.003)	(.008)	(.004)	(.009)	(.009)	(.009)	(.009)
Median Income	$-.007^{**}$	$-.005^{***}$	$-.010^{***}$	$-.009^{***}$	-.006	-.006	-.001	-.001
	(.003)	(.002)	(.004)	(.002)	(.007)	(.007)	(.007)	(.007)
Young density	-.005	.000	-.005	.002	-.009	-.009	-.009	-.009
	(.006)	(.002)	(.007)	(.003)	(.007)	(.006)	(.006)	(.006)
Old density	.003	-.001	$.006^{***}$	-.001	-.009	-.009	-.008	-.009
	(.002)	(.001)	(.002)	(.001)	(.005)	(.005)	(.005)	(.005)
Canada	$.027^{***}$	$.016^{***}$	$.016^{***}$	.003	$.095^{***}$	$.095^{***}$	$.046^{***}$	$.045^{***}$
	(.005)	(.004)	(.005)	(.003)	(.004)	(.004)	(.005)	(.004)
Area stores	-.002	$-.010^{***}$	-.001	$-.010^{***}$	$.047^{***}$	$.047^{***}$	$.047^{***}$	$.047^{***}$
	(.002)	(.002)	(.003)	(.002)	(.006)	(.006)	(.006)	(.006)
Log build		$-.041^{***}$		$-.053^{***}$		-.001		-.004
		(.004)		(.004)		(.006)		(.006)
R^2	0.17	0.19	0.86	0.86	0.25	0.25	0.07	0.07

Robust standard errors in parentheses, clustered by store for category regressions.
Category-store regressions use category fixed effects.
All X variables in logs, the Y variable is a cost-of-living index relative
to the base store (=1). The base story is either the California store (Cal)
with the most UPCs in the sample, or the average across all stores based on
mean prices and mean store expenditure shares.
The indexes measure either variety (effect of non-common goods) or prices (for common goods)
Note that a lower index implies higher welfare for given expenditure.