Bulk Buying and Inequality

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Introduction

Economic theory posits that risk-averse households prefer smooth consumption paths. However, smooth consumption does *not* imply smooth expenditures. Indeed, households often consume items more smoothly than expenditures may suggest as demonstrated by purchases of durables or bulk purchases. For example, households often purchase smartphones, refrigerators, and toilet paper at a certain time and then proceed to consume those items smoothly until they break or their inventory is exhausted. Furthermore, in the presence of time and travel costs, households would prefer to make fewer trips to purchase these items.

This intuition is supported empirically because between 2004 and 2016, the number of shopping trips taken each month has fallen by about 25%, with little change in real expenditures. In fact, average real monthly expenditures were steady between 2004 and 2013 and since 2013 have declined by about 5%. Overall, this means that households have been able to realize both time and money savings when it comes to purchasing household non-durables. However, while all households experienced similar declines in real monthly expenditures, over the longer period of 2004-2016, real expenditures have been relatively unchanged for the poorest households and savings accruing to the richest households. Furthermore, for shopping trips, there remains a persistent gap in that richer households make about 10% fewer trips than poorer households. As a result, there are two imporant features to understand. First, there is a secular trend under which all households are making fewer, but larger shopping

trips. Furthermore, this secular trend is not uniform across income groups. I document that the secular trend is likely due to the expansion of "supercenter" shopping channels, which offer groceries alongside general merchandise. Second, there remains a persistent gap between rich and poor households where poor households make smaller, more frequent trips than their richer counterparts (i.e. rich household expenditures are "lumpier" than poor household expenditures). I first estimate how these different shopping patterns affect per-unit costs that households ultimately pay. Then, I estimate a model that rationalizes this pattern by incorporating travel costs, liquidity constraints, and time costs.

Research Questions

1. Why do low-income households not take advantage of quantity discounts at the same rate that high-income households do, especially for household necessities for which consumption is predictable?

2. How much does this spending pattern cost low-income households?

3. How important are liquidity constraints, time costs, and travel costs to generating this difference?

Data

I will use the Nielsen Consumer Panel Dataset from 2004-2016 available through the Kilts Center for Marketing at the University of Chicago Booth School of Business. This data is a longitudinal panel of between 40,000-60,000 households which record all purchases from any outlet intended for personal, in-home use. Products can be characterized as household non-durables such as groceries, cleaning supplies, health/personal care items, and basic general merchandise and are estimated to make up about 30% of consumer expenditures.

About 1.5 million unique items (defined by UPC code) are present in the data. The panel is constructed based on a stratified, proportionate sample designed to be projectable to the United States population and it is balanced on demographic characteristics including household size, income, education, children, race, and occupation.

Households are provided a scanner with which they scan all items that were purchased, input quantities and prices (if necessary), date of purchase, and store purchased from. Households are incentivized to stay active in the panel through monthly prize drawings, points for data transmission, and sweepstakes as well as ongoing communication from Nielsen to ensure cooperation and address any problems. Nielsen retains about 80% of its panel from year to year with the mean and median tenure of a household being 3 and 4 years respectively. To further ensure data quality, Nielsen institutes a minimum purchase threshold based on household size that must be met to be deemed "active".

Related Literature

This paper contributes to the growing literature on inequality, particularly consumption inequality. Research has found that since the 1980s, there has been a significant rise in income inequality (Autor, Katz, and Kearney 2008, Attanasio, Hurst, and Pistaferri (2014)). However, it is an active debate as to whether growing income inequality has translated into consumption inequality. Attanasio, Hurst, and Pistaferri (2014) document a commensurate rise in consumption spending using a variety of data sets and accounting for partial measurement error, which is also supported by Aguiar and Bils (2015). However, Coibion, Gorodnichenko, and Koustas (2017) demonstrate that secular declines in shopping frequencies mechanically generate an increase in expenditure inequality even though underlying consumption may not be changing.

Using granular shopping data, I avoid the measurement issues generate by declining shopping

frequencies and document that while shopping frequency has declined, there remains a persistent gap between rich and poor households. Furthermore, while there have been some gains spread across households, rich households are better able to save money through reduced time and travel costs as well as reduced out-of-pocket expenditures. Most strikingly, rich households have seen a 9% decline in real expenditures while poor households have seen no corresponding change in their expenditures.

Why Is This Important?

Consumption inequality is not well understood and quantifying the importance of various costs to different households will help shed light on the underlying factors that could be driving consumption inequality. For example, bulk buying is a commonly accepted way of saving money. Because the marginal dollar is more valuable to a low-income household than a high-income household, it is puzzling that high-income households take advantage of this money-saving technology at higher rates than low-income households. Quantifying these expenditure differences will highlight less visible areas of inequality. Furthermore, quantifying the relative contribution of transportation, travel, and liquidity constraints will help guide policy solutions to address this inequality.

Secular Trends

As mentioned above, there has been a secular decline in shopping trips across all groups and a more moderate decline in real expenditures between 2004 and 2016. Importantly, the decline in real expenditures has been concentrated among the richest households while poorer households have seen little change in their monthly expenditures on household necessities. As a result of these two trends, households are making fewer, but larger trips. Overall, households are making about 2 fewer shopping trips per month in 2016 than in 2004. To see if
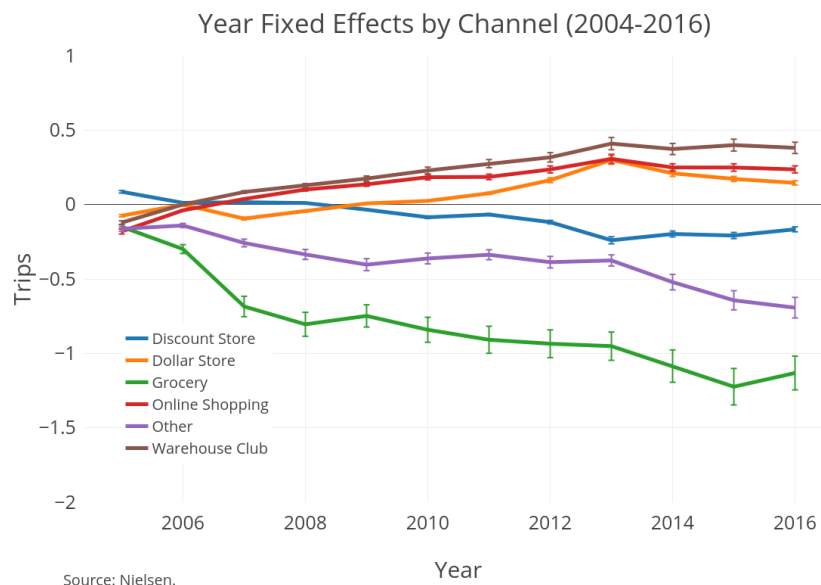
Figure 1

this decline is uniform across stores, I estimate how trips at different store types has changed over time. Figure 1 plots the year fixed effects after controlling for a variety of household characteristics including income, education, MSA, and other demographics and demonstrates that this decline has been concentrated among grocery stores, with the remainder being due to declines in "Other" stores and discount stores (e.g. Wal-Mart and Target).[1]

While the above is only suggestive evidence, put in context, these trends support the fact that households were likely shifting their purchasing to supercenters, which were expanding rapidly over this period. Starting in the late 1990s, Wal-Mart began converting many of its stores into Supercenters, which included a line of groceries. Since a lot of the grocery decline happens early in the data, with little change in trips to Discount stores, this would be expected if households were still shopping at Wal-Mart and forgoing a trip to their grocer since they could pick up groceries at Wal-Mart as well. Then, in the late 2000s, there is a secular increase in online shopping and warehouse clubs, which matches their growth over this period. The final, most interesting trend is between discount stores and dollar stores.

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[1] "Other" includes a wide range of outlets including drug stores, convenience stores, tobacco stores, and liquor stores. Generally, these were infrequently visited and the largest contributor was tobacco stores.

Starting in about 2009, they begin to mirror each other in that when dollar stores increase, discount stores decrease. This matches another lesser known trend where dollar stores have experienced explosive growth starting around 2010. Since 2010, Dollar General has been expanding at a rate of 2 stores per day and in 2017, that rate increased further to 3 stores per day. Given this context, and the mirror-image pattern, it may be that consumers are further substituting away from discount stores towards dollar stores.

Using the transaction-level data available in the Nielsen data, I will be able to more closely explore these trends. In order to test the substitution away from grocery stores towards discount stores, I can look at purchases of common grocery items such as milk, bread, and eggs and see if those purchases have shifted to discount stores. The substitution between dollar and discount stores could also be tested by looking at individual purchasing habits.

However, understanding these trends, as well as the persistent gaps between rich and poor households requires a deeper analysis of the costs of shopping, including time and travel costs.

Costs of Shopping

The costs of shopping include many characteristics beyond the price paid at the cash register. In particular, some of the most important non-pecuniary costs are the time it takes to shop (*time costs*), traveling to and from the store (*travel costs*), and transporting the items home (*transportation costs*). Understanding important these costs are relative to each other and how they may differ between households is important to understanding how aggregate shopping patterns have evolved over time as well as why notable differences in purchasing behavior persist between rich and poor households. In particular, we can conceptualize the growth of warehouse clubs and dollar stores along these lines. Warehouse clubs offer reduced time costs because bulk purchasing can reduce total shopping trips necessary, but this comes at the cost

of traveling to a further location and moving larger quantities of goods. Finally, dollar stores tend to reduce travel and transportation costs by offering smaller sizes at nearby locations. However, this may come at the cost of increased time spent shopping and potentially higher unit costs over the course of a year.

Example: Toilet Paper

For household necessities like toilet paper, consumption is relatively fixed and predictable. However, smooth consumption does not require smooth expenditures. Using expenditure data, I find that low-income households (making less than $25k) are more likely to smooth their expenditures by purchasing smaller sizes more frequently while high-income households (making more than $100k) exhibit "lumpier" expenditures by purchasing larger sizes less frequently.[2] Figure 2 illustrates that low-income households have lower, narrower per-trip expenditures compared to high-income households. Over a year, while high- and low-income households purchase about the same quantity of toilet paper, high-income households make about 20% fewer trips than average, which is offset by increased per-trip quantities.[3]

Unit Costs

In order to understand if these shopping patterns translate into different unit-costs, I run a regression of the unit costs paid per transaction on various household, product, and store characteristics. Table 1 displays the results. Unsurprisingly, rich households have higher unit costs than poorer households, but after controlling for brands, this difference becomes insignificant. It is surprising that this difference is insiginificant as opposed to being negative

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[2]The vast majority of households only purchase one package per trip. Households seldom purchase multiple packages of any given size. Households likely realize the value of bulk, so they will purchase one 8-pack instead of two 4-packs.

[3]I find that high-income households purchase about 4% more toilet paper, but this is small in relative terms and is likely due to the fact that some preferences may map into slightly larger or smaller amounts of my "standardized" rolls of toilet paper, which may differ from the actual rolls contained in the package.
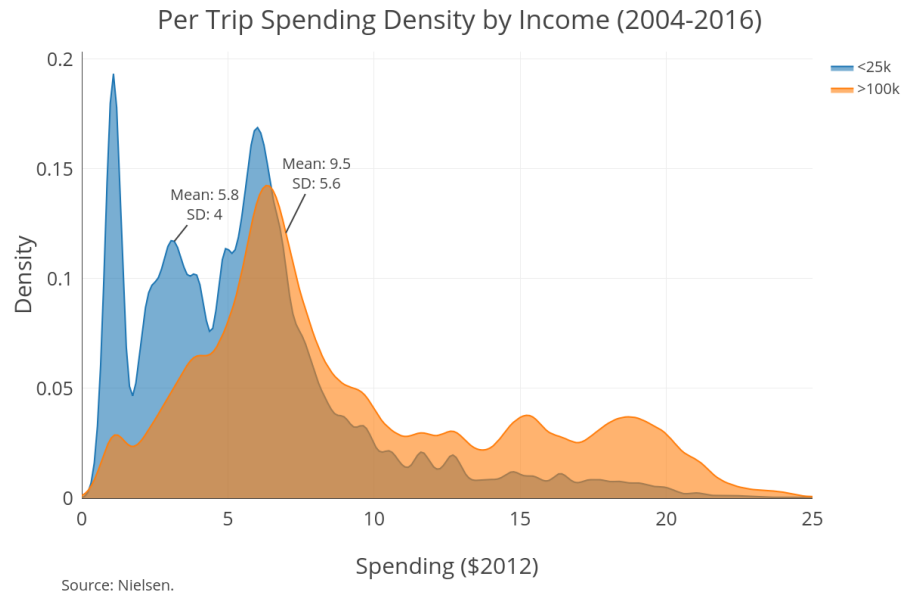
Per Trip Spending Density by Income (2004-2016)

Mean: 5.8
SD: 4

Mean: 9.5
SD: 5.6

Source: Nielsen.

Figure 2

because we know that a bulk discount exists on products like toilet paper and rich households are taking advantage of this discount.

How to Answer

To estimate transportation and storage costs, I can compare the purchasing of toilet paper with another storable, non-perishable household necessity that does not have substantial transportation and storage costs, such as toothpaste. This will provide some suggestion of how large this effect might be. However, pinning down each of these factors will take more work and I have not yet identified the best way of doing this.

Why Toilet Paper?

Toilet paper is a storable, non-perishable item for which consumption is relatively predictable. Furthermore, it is unlikely that larger purchase quantities imply increased consumption, especially compared to other consumables like soft drinks, chips, or candy. It is offered

Table 1

	Log Unit Cost			
	(1)	(2)	(3)	(4)
25-50k	0.049***	0.036***	0.006***	0.009***
	(0.005)	(0.004)	(0.002)	(0.002)
50-100k	0.117***	0.092***	0.012***	0.015***
	(0.006)	(0.005)	(0.003)	(0.003)
>100k	0.147***	0.121***	0.002	0.013***
	(0.008)	(0.007)	(0.003)	(0.003)
college	0.018***	0.015***	−0.004**	0.0001
	(0.004)	(0.004)	(0.002)	(0.002)
Brand FE	N	N	Y	Y
Store FE	N	Y	N	Y
Observations	3,617,787	3,617,787	3,617,787	3,617,787
Adjusted R^2	0.054	0.132	0.678	0.707

Note: *p<0.1; **p<0.05; ***p<0.01

in a variety of sizes, is available at a range of locations, and has limited dimensions of differentiation (mainly ply, sheet count, and softness).

Model

I develop a simple model to incorporate how liquidity constraints affect purchase decisions. I incorporate the following features into my model.

Model Features: Necessity Good

In order to capture important features of necessity goods like toilet paper, I assume that the good is storable, non-perishable, and non-substitutable (i.e. no feasible alternative product). Second, to capture the good's status as a necessity, I assume that utility from consuming it is binary, either 0 (or other normalization) if the minimum amount is not met, and some fixed amount if the threshold is met. In short, all that matters is having enough of the good to satisfy the consumption amount, but otherwise, utility does not increase in the necessity good. Furthermore, this consumption threshold is exogenously determined and not a function of price, inventory, or other model features. At most, it depends on some basic, fixed household characteristics (like household size, gender, etc.).

Since utility is not increasing in the necessity good beyond the threshold, households consume an outside good which increases their utility.

Model Features: Prices and Income

Product prices are functions of quantities, $p(q)$, such that $p' > 0$ and $p'' < 0$ so that prices are increasing, but there is a quantity discount that households can take advantage of. For

now, I assume that there is no uncertainty in prices, so households simply choose a quantity to purchase each period.

Households face a budget constraint with their per-period income being drawn from some distribution. The expected wage is a function of observables but the variance is fixed in levels across households. This means that income becomes relatively less volatile as a household becomes richer.[4]

Since minimum consumption must be met, if household's experience a bad draw, they need a way to meet their consumption threshold. Therefore, they can borrow money, but at a rate higher than the marginal utility of the outside good.

Model Features: States and Timing

Given their current inventory level, consumption threshold shock, income shock, and debt level, households choose how much of the necessity good to buy, how much to borrow, and the remainder is spent on the outside good.

Household Problem

We can write the household's problem as follows:

$$\max_{q,a} \sum_{t=0}^{\infty} \delta^t \mathbb{E}[u(c_t + v_t) - \alpha p(q)q | I(t)] \tag{1}$$

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[4]This wage draw could also be reinterpreted as households having a fixed monthly wage, but with expense shocks being drawn from a distribution that is the same across households, which once again implies that shocks are smaller shares of richer household's budgets.

$$c_t + v_t \geq \underline{c}$$

$$i_t \geq 0$$

$$q_t \geq 0$$

$$i_t = i_{t-1} + q_t - c_t$$

$$p(q_t) * q_t + \omega_t \leq y_t + a_t$$

$$b_t = b_{t-1} * (1 + r_t) + a_t$$

Follow-Up Question

Does improved access to bulk sizes increase bulk purchasing?

Why Is This Important?

Warehouse club stores like Costco and Sam's Club have increased their footprint over the past decade. Their bulk sizes provide hefty discounts on a per-unit basis for common household items. High-income households are substantially more likely to shop at a warehouse club compared to low-income households (in a given year, about 70% of high-income households visit a warehouse club compared to about 30% of low-income households). If access is an important factor preventing low-income households from purchasing in bulk, tracking spending before and after a club opening will provide an estimate of how sensitive household spending is when access to this new "technology" becomes available.

How to Answer

Using data on the location and opening dates of warehouse club stores, I can use a discrete choice model to estimate how distance (d) affects a household's likelihood of shopping at a warehouse club (Y) after controlling for household (i), market (m), and time (t) fixed effects.

$$Y_{imt} = \beta_0 + \beta_1 d_{imt} + \lambda_i + \lambda_m + \lambda_t + \epsilon_{imt}$$

Furthermore, since Nielsen records all spending on household nondurables, I would be able to estimate the elasticity of substitution between warehouse clubs and other shopping channels such as grocery stores, discount retailers (like Walmart and Target), and dollar stores.

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