

Online Appendix - Frugality is Hard to Afford

The online appendix is organized as follows:

1. Data Cleaning
2. Additional Robustness Checks in the Toilet Paper Category
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4. Survey Data: Cash Flows and Liquidity Constraints in U.S. Households

1 Data Cleaning

Toilet paper category

We make an effort to (conservatively) correct three data issues: (1) recording discrepancies for package size, (2) households that failed to report some of their purchases, and (3) outliers that suggest reporting mistakes.

Package size discrepancies For 111 UPCs accounting for 16,886 purchases, the “size1_amount” and/or “multi” variables appear to be miscoded, generating unreasonably large values for S_{htp} . For example, there is one UPC for which the value of both “size1_amount” and “multi” are 36, suggesting that there are 1,296 rolls in the UPC. We attempt to correct these recording discrepancies manually, identifying the “correct” value for sheets and rolls by comparing the UPC to other UPCs from the same manufacturer and with other similar features. In the example just cited, the “correct” package size was 36. We determined that for this UPC, only one of “size1_amount” and “multi” should have been 36, with the other equal to one. The price of the UPC is similar to that of other 36-roll UPCs from the same manufacturer. The results presented in the paper are for these “corrected” values of package size. As a robustness check, we also run all package-size related analyses excluding all households with a problematic observation. The results of both approaches are not materially different, and the results of the latter approach are available from the authors upon request.

Missing purchase occasions The homescan data indicate that some households may have failed to scan at least one purchase during their time in the panel. The interpurchase time between two purchases for a household is often so large as to be clearly inaccurate, likely due to the household forgetting to scan a purchase at some point in between. These missingness issues are likely to be at random with respect to our research interests. Therefore, in general, we expect them to add to the noise in the data. The consequences of this missingness can be severe, however, for two reasons. First, a missing interpurchase time observation isn't just missing – it causes the interpurchase time for the next purchase to be miscalculated. For example, if three purchases were made, each 60 days apart, but the middle purchase is missing, it would appear as though two purchases were made 120 days apart. Additionally, the missingness systematically biases consumption rates downward, as the amount of volume purchased is underestimated while the time in panel is not.

To fix this issue, we take a conservative approach that changes the data as little as possible, while catching obvious missingness issues. Our aim is to identify observations with unreasonably long interpurchase times. To do this, we first calculate the average duration until next purchase following purchase of each package size s , conditional on only one product (of size s) being purchased on a given trip. For example, following a purchase of a UPC containing twelve rolls of toilet paper, households wait 48 days before purchasing again, on average, and the standard deviation of duration until next purchase conditional on purchasing twelve rolls of toilet paper is 69 days. Denote the average duration for each size μ^s , and the standard deviation of these durations: σ^s . If the time between two purchases, made during trips t and $t + 1$, exceeds the mean interpurchase time for the package size purchased during trip t by more than two standard deviations, then we conclude that the household failed to report a purchase between t and $t + 1$. If, for a given trip t , more than one UPC was purchased, and/or if the quantity of the UPC(s) purchased was greater than one (e.g. three copies of a UPC), then the reference point used to identify whether a purchase is missing is a simple sum of the means and the standard deviations of the purchase times corresponding

to the purchased sizes. In sum, we conclude that there is a missing observation between t and $t + 1$ if:

$$(1) \quad IPT_{(t+1)} > \sum_{p=1}^P q_p (\mu^{s(p)} + 2\sigma^{s(p)})$$

where $p = \{1 \dots P\}$ indexes each UPC purchased on trip t and q_p is the quantity of each UPC bought.

Having identified observations with unreasonably long interpurchase times using this threshold, we then define “active periods” for a household. Active periods correspond the set of consecutive purchases over the course of which we do not believe any purchase is missing. If we conclude that there is a missing observation between t and $t + 1$, trip t marks the end of one “active period” and $t + 1$ marks the beginning of a new active period. To illustrate, consider a household that makes twelve purchases during two active periods ($a = 1, 2$), where active period $a = 1$ was from Jan 1, 2006 to Nov 3, 2006 and active period $a = 2$ was from March 5, 2010 to Dec 31, 2010. Rather than treating the five-year period spanning 2006 through 2010 as a household’s time-in-panel, we treat the periods in 2006 and 2010 as active periods. We calculate consumption rate based on these active periods. In particular, we calculate consumption rate per household as follows:

$$(2) \quad Consumption_h = \frac{\sum_{a=1}^A \sum_{p=1}^{P_a-1} V_{hpa}}{\sum_{a=1}^{a=A} T_a}$$

Here V_{hpa} is the volume of toilet paper for purchase p during active period a , P_a is the total number of purchases made during period a , and T_a is the time between the first and last purchase during active period a . We sum all volume purchased by a household except for that of the last purchase, then dividing that sum by the number of days a household was in the panel. The logic behind this approach is that a household’s consumption rate should reflect the relationship between volume purchased and the time over which the purchased volume was consumed — and since a household’s time-in-panel ends with the last purchase,

that last purchase should not be included, as it clearly would not be consumed during that time. Note that a household must have at least two consecutive non-missing purchases to calculate consumption rate. If consumption rate cannot be calculated due to the pattern of missingness, the household is not included in the sample, as detailed below.

Outliers There are additional reporting mistakes in the raw data that we cannot fix. For example, some households report purchasing products with erroneous volumes or prices that are much too high to be accurate. While we were able to catch some of these mistakes and fix them, as described previously, we were not able to determine the correct value for some of them. Furthermore, some households appear to be extreme outliers with respect to the volume of product purchased on a given shopping trip, potentially indicating that they are purchasing for business, rather than for household consumption. In addition, some households shop very infrequently. They either have too many episodes of missingness, such that we cannot reliably calculate their consumption rate, or their consumption rate is extremely low.

Therefore, households whose data present the following problems are not included in our sample:

- **Excessive Missingness:** The household has more than 3 missing observations, and/or the missing observations are spaced such that consumption rate cannot be calculated, and/or the maximum interpurchase time between any two consecutive purchases exceeds the 99th percentile of all households' maximum interpurchase time for the category.
- **Insufficient Activity in the Category:** The household's consumption rate is less than the 1st percentile of all households' consumption rates for the category, or the household was only active in the category for 90 days or fewer.
- **Abnormal Quantity, Volume, or Price:** The household made a purchase in which the

volume, quantity, or price exceeded the 99th percentile of the distribution of these variables in the category.

As a result of these criteria, 11% of observations and 22% of households are dropped. Note that our results are not sensitive to dropping these observations – all hypotheses are supported even if the analyses are run using data from all households. A breakdown of how many households and observations are reported in Table 1. The patterns indicate that the data cleaning steps mainly exclude households with very few purchases in the toilet paper category. Table 2 reports summary statistics of household consumption rate (rolls per day), total trip volume and interpurchase times for the raw and cleaned data. We can see that the final sample consists of households with less extreme consumption rates both at the right and left tail of the distribution.

Table 1: Dropped observations

Criteria	Obs dropped		HH dropped	
	Obs	% Obs	HH	% HH
Missing 3+ IPT:	203,054	5.7%	9,215	6.8%
Max IPT > 99th Pct:	38,788	1.1%	8,973	6.7%
Cannot calc. consumption:	29,421	0.8%	15,070	11.2%
Insufficient consumption:	11,399	0.3%	1,194	0.9%
Active 90 days or less:	22,706	0.6%	11,839	8.8%
Abnormal quantity:	50,351	1.4%	1,057	0.8%
Abnormal volume:	44,710	1.3%	1,167	0.9%
Abnormal price:	50,172	1.4%	1,345	1.0%
Total HH/Observations:	3,574,891	-	134,528	-
Total outliers dropped:	399,827	11.2%	29,705	22.1%

Note that the total number of households and observations dropped is not equal to the sum of each row, as some households fail more than one criteria.

Table 2: Consumption, Interpurchase Time, and Purchase Volume Summary Statistics

	Daily Consumption*		Interpurchase Time		Trip Volume*	
	Raw	Clean	Raw	Clean	Raw	Clean
1st pct	0.052	0.068	1	1	1.8	1.8
25th pct	0.170	0.178	14	14	5.8	5.8
50th pct	0.255	0.261	28	28	9.9	9.6
75th pct	0.378	0.382	56	53	17.3	15.7
99th pct	1.051	0.996	213	200	65.5	55.7
N**	119,458	104,823	3,293,777	2,974,335	3,506,283	3,115,936

*In standardized rolls. **Daily Consumption is presented at the HH level, while other variables are presented at the trip level

2 Additional Robustness Checks in the Toilet Paper Category

2.1 Different specifications of high-liquidity periods and consumption controls

In this section, we examine four additional definitions of the high-liquidity period, and one additional specification of consumption controls. In the main text of the paper, a purchase during high-liquidity periods was defined to have (a) occurred during the first week of the month, and (b) during one of the household’s first two days shopping in that month (to buy from any category). Here we examine both a different time window (the first ten days of the month) and different requirements for which shopping day the purchase occurred on (the first day the household went shopping in a month, the first two, or any within the time window). In total, we consider five liquidity shifters: (1) The first day the household went shopping in a month, conditional on it being during the first week of the month; (2) The first two days the household went shopping in a month, conditional on it being the first week of the month (the one used in the main text of the paper); (3) Any day during the first week of the month; (4) The first day the household went shopping in a month, conditional on it being during the first ten days of the month; and (5) The first two days the household went shopping in a month, conditional on it being during the first ten days of the month. Table

3 shows the percentage of observations, by income group, that fall into each of these high-liquidity periods. The specification used in the main text of the paper (specification 2) is in the middle of the pack: the percentage of observations that are fall into the high-liquidity period defined by specification 2 is lower than for specifications 3 and 5, but higher than for specifications 1 and 4.

Table 3: Percentage of Trips Made During High-Liquidity Periods, by Liquidity Shifter

Liquidity Shifter:	1	2	3	4	5
Inc Grp 1 (<\$20K)	12.9%	19.9%	26.2%	14.4%	23.8%
Inc Grp 2 (\$20–40K)	11.6%	18.0%	24.0%	12.9%	21.5%
Inc Grp 3 (\$40–60K)	11.5%	17.7%	23.5%	12.9%	21.3%
Inc Grp 4 (\$60–100K)	11.5%	17.7%	23.3%	13.0%	21.4%
Inc Grp 5 (> \$100K)	11.5%	17.7%	23.2%	13.0%	21.4%
Period	First 7 Days			First 10 Days	
Trip Number	1	1,2	ALL	1	1,2

We replicate our main analyses using all five of these liquidity shifters, and using three different specifications for consumption controls: (1) No controls, (2) third order polynomial of the consumption rate centered at the median consumption rate of the lowest income households (the set of controls used in the paper), and (3) indicators for consumption quintiles.

The results are presented in Tables 4 (bulk buying) and 5 (purchase acceleration). Each column of each table reports results for one of the liquidity shifter specifications. Each block of the table presents results using a different consumption control specification. The results are consistent with those presented in the main paper

Table 4: Bulk Buying: Alternate Specifications

Liquidity Shifter	1	2	3	4	5
Liquidity Period	First 7	First 7	First 7	First 10	First 10
Purchase Number(s)	1	1 or 2	ALL	1	1 or 2
No Consumption Controls					
Liquidity Shifter (ψ_1)	0.165*** (0.035)	0.175*** (0.030)	0.174*** (0.028)	0.181*** (0.034)	0.192*** (0.028)
× Inc Grp 2 (ψ_2)	-0.170*** (0.042)	-0.166*** (0.036)	-0.170*** (0.033)	-0.180*** (0.041)	-0.172*** (0.034)
× Inc Grp 3 (ψ_3)	-0.184*** (0.044)	-0.170*** (0.038)	-0.161*** (0.034)	-0.191*** (0.042)	-0.163*** (0.035)
× Inc Grp 4 (ψ_4)	-0.152** (0.044)	-0.153*** (0.038)	-0.159*** (0.035)	-0.155*** (0.043)	-0.144*** (0.036)
× Inc Grp 5 (ψ_5)	-0.184** (0.057)	-0.168*** (0.048)	-0.153*** (0.043)	-0.188** (0.054)	-0.174*** (0.045)
Consumption Rate Polynomial					
Liquidity Shifter (ψ_1)	0.161*** (0.035)	0.166*** (0.030)	0.164*** (0.028)	0.176*** (0.034)	0.182*** (0.028)
× Inc Grp 2 (ψ_2)	-0.170*** (0.042)	-0.169*** (0.036)	-0.174*** (0.033)	-0.180*** (0.041)	-0.175*** (0.034)
× Inc Grp 3 (ψ_3)	-0.184*** (0.044)	-0.175*** (0.038)	-0.165*** (0.035)	-0.191*** (0.042)	-0.168*** (0.036)
× Inc Grp 4 (ψ_4)	-0.151** (0.045)	-0.159*** (0.038)	-0.165*** (0.035)	-0.155*** (0.043)	-0.150*** (0.036)
× Inc Grp 5 (ψ_5)	-0.183** (0.057)	-0.172*** (0.048)	-0.158*** (0.044)	-0.187** (0.055)	-0.178*** (0.045)
Consumption Rate Quintiles					
Liquidity Shifter (ψ_1)	0.173*** (0.037)	0.166*** (0.032)	0.166*** (0.029)	0.186*** (0.036)	0.179*** (0.030)
× Inc Grp 2 (ψ_2)	-0.170*** (0.042)	-0.169*** (0.036)	-0.173*** (0.033)	-0.180*** (0.041)	-0.174*** (0.034)
× Inc Grp 3 (ψ_3)	-0.184*** (0.044)	-0.174*** (0.038)	-0.164*** (0.035)	-0.191*** (0.042)	-0.166*** (0.036)
× Inc Grp 4 (ψ_4)	-0.152** (0.045)	-0.157*** (0.038)	-0.163*** (0.035)	-0.155*** (0.043)	-0.148*** (0.036)
× Inc Grp 5 (ψ_5)	-0.184** (0.057)	-0.171*** (0.048)	-0.156*** (0.044)	-0.188** (0.055)	-0.177*** (0.045)
N	3,175,064				

SE are clustered at the household level and reported in parentheses. *** p<.001, ** p<.01, * p<.05

Table 5: Purchase Acceleration: Alternate Specifications

Liquidity Shifter	1	2	3	4	5
Liquidity Period	First 7	First 7	First 7	First 10	First 10
Purchase Number(s)	1	1 or 2	ALL	1	1 or 2
No Consumption Controls					
Sale \times Liquidity (ψ_1)	-1.111** (0.420)	-1.095** (0.342)	-0.989** (0.305)	-1.117** (0.404)	-1.034** (0.327)
\times Inc Grp 2 (ψ_2)	1.040* (0.504)	1.175** (0.411)	1.071** (0.363)	1.004* (0.485)	1.132** (0.389)
\times Inc Grp 3 (ψ_3)	1.086* (0.507)	0.914* (0.414)	0.589 (0.367)	1.225* (0.490)	1.066** (0.394)
\times Inc Grp 4 (ψ_4)	1.312** (0.501)	1.207** (0.409)	0.951** (0.363)	1.363** (0.483)	1.215** (0.390)
\times Inc Grp 5 (ψ_5)	1.852** (0.611)	1.846** (0.502)	1.225** (0.443)	1.635** (0.587)	1.856** (0.474)
Consumption Rate Polynomial					
Sale \times Liquidity (ψ_1)	-1.164** (0.432)	-1.131** (0.353)	-1.050** (0.316)	-1.152** (0.416)	-1.030** (0.337)
\times Inc Grp 2 (ψ_2)	1.002* (0.505)	1.148** (0.411)	1.042** (0.364)	0.976* (0.486)	1.122** (0.390)
\times Inc Grp 3 (ψ_3)	1.022* (0.509)	0.866* (0.415)	0.541 (0.368)	1.180* (0.492)	1.051** (0.396)
\times Inc Grp 4 (ψ_4)	1.225** (0.504)	1.145** (0.412)	0.888** (0.365)	1.300** (0.486)	1.196** (0.393)
\times Inc Grp 5 (ψ_5)	1.772** (0.613)	1.792*** (0.504)	1.166** (0.444)	1.579** (0.589)	1.845*** (0.476)
Consumption Rate Quintiles					
Sale \times Liquidity (ψ_1)	-1.600** (0.540)	-1.512** (0.444)	-1.302** (0.398)	-1.538** (0.519)	-1.247** (0.421)
\times Inc Grp 2 (ψ_2)	0.980 (0.505)	1.127** (0.411)	1.031** (0.364)	0.949 (0.486)	1.100** (0.390)
\times Inc Grp 3 (ψ_3)	0.989 (0.510)	0.835* (0.416)	0.523 (0.368)	1.140* (0.492)	1.018* (0.396)
\times Inc Grp 4 (ψ_4)	1.193* (0.504)	1.113** (0.412)	0.874* (0.365)	1.261** (0.486)	1.161** (0.393)
\times Inc Grp 5 (ψ_5)	1.735** (0.614)	1.754** (0.505)	1.147* (0.445)	1.533** (0.589)	1.804*** (0.476)
N	3,175,064				

SE are clustered at the household level and reported in parentheses. *** p<.001, ** p<.01, * p<.05

2.2 Week-by-week breakdown of effects

Figure 1 in the main text shows that daily expenditure and trip incidence is decreasing over the course of the month for the low-income households. To see if the impact of liquidity gradually declines over the course of the month, we extend our liquidity analyses by interacting indicators for the first, second, and third week of the month, rather than a binary indicator for the high-liquidity period.

The results from the bulk buying regression are reported in Column 1 of Table 2.2, and the results from the purchase acceleration regression are reported in Column 2. Compared to the end of the month (day 22 and onward), low-income households see a significant increase in their relative ability to buy in bulk in weeks 1, 2, and 3, but the effect is strongest in week 1. The story is much the same for purchase acceleration, except that we do not find statistically significant evidence that households are less constrained in week 3 than in week 4.

2.3 Changes in Cross-Sectional Results with Demographics and Location Controls

As Table 7 illustrates, income groups also vary in other demographics. For example, low-income households also tend to be the most likely to live in multi-family homes, which are associated with smaller living spaces.

Table 6: Difference versus last week of the month

Week 1 (versus Week 4)			
	Size		IPT
Liquidity Shifter	0.265*** (0.032)	Liquidity \times Sale	-1.661*** (0.365)
\times Inc Grp 2	-0.231*** (0.039)	\times Inc Grp 2	1.655*** (0.416)
\times Inc Grp 3	-0.240*** (0.040)	\times Inc Grp 3	1.291** (0.420)
\times Inc Grp 4	-0.231*** (0.040)	\times Inc Grp 4	1.585*** (0.417)
\times Inc Grp 5	-0.227*** (0.051)	\times Inc Grp 5	1.951*** (0.511)
Week 2 (versus Week 4)			
	Size		IPT
Liquidity Shifter	0.215*** (0.031)	Liquidity \times Sale	-0.870* (0.382)
\times Inc Grp 2	-0.122** (0.038)	\times Inc Grp 2	0.831 (0.434)
\times Inc Grp 3	-0.144*** (0.039)	\times Inc Grp 3	1.253** (0.434)
\times Inc Grp 4	-0.117** (0.040)	\times Inc Grp 4	0.912* (0.433)
\times Inc Grp 5	-0.112* (0.051)	\times Inc Grp 5	1.074* (0.530)
Week 3 (versus Week 4)			
	Size		IPT
Liquidity Shifter	0.105*** (0.031)	Liquidity \times Sale	-0.571 (0.384)
\times Inc Grp 2	-0.055 (0.037)	\times Inc Grp 2	0.560 (0.433)
\times Inc Grp 3	-0.091* (0.038)	\times Inc Grp 3	0.567 (0.435)
\times Inc Grp 4	-0.086* (0.039)	\times Inc Grp 4	0.760 (0.433)
\times Inc Grp 5	-0.103* (0.050)	\times Inc Grp 5	0.888 (0.527)

Standard errors are clustered at the household level and reported in parentheses. *** p<.001, ** p<.01, * p<.05

Table 7: Demographic Summary Statistics

	INC_1	INC_2	INC_3	INC_4	INC_5
Income Group:	10.5%	25.0%	22.9%	27.6%	14.0%
Household Size					
One person	57.1%	35.2%	21.8%	12.6%	6.9%
Two people	27.1%	40.7%	45.4%	46.2%	46.1%
Three people	8.4%	11.7%	14.2%	17.1%	19.1%
Four people	4.4%	7.4%	11.1%	15.2%	18.3%
Five or more people	3.0%	5.1%	7.4%	9.0%	9.6%
Average household size	1.71	2.09	2.41	2.67	2.82
Marital Status					
Married	25.2%	49.0%	65.6%	77.4%	85.3%
Widowed	20.8%	13.5%	6.1%	3.3%	1.8%
Divorced	31.5%	21.0%	14.3%	8.8%	5.4%
Single	22.5%	16.5%	14.0%	10.4%	7.4%
Race					
White/Caucasian	84.7%	85.6%	84.4%	83.2%	80.9%
Highest Education Attained in HH					
Less than high school	5.4%	2.0%	0.7%	0.3%	0.1%
High school grad	68.9%	64.1%	51.5%	36.2%	18.2%
College grad	20.8%	27.0%	35.0%	42.0%	42.0%
Post-college education	4.9%	6.9%	12.8%	21.5%	39.7%
Type of Residence					
Single-family home	58.3%	70.9%	79.4%	86.7%	90.7%

For some demographic categorical variables, we reduce the number of categories for use in our cross-sectional analyses. Specifically, (1) we condense the Type of Residence variable to a binary variable indicating whether a household resides in a single-family home or multi-family home (the source variable broke multi-family homes down into several, smaller sub-categories), (2) for the male and female head of a household's education (two separate variables), we divide households by whether they graduated from high school and graduated from college (rather than distinguishing, for example, between a high school graduate with no college and one with a little bit of college), (3) we condense the Race variable into a binary variable indicating whether the household head is caucasian or not, since the vast majority of household heads were caucasian, and (4) combine all households of size greater than or equal to five into a single category, since there were very few households with more

Table 8: Cross-Sectional Differences in Different Saving Strategies: Additional Controls

	Buy Store Brand			Buy Cheapest Brand			Package Size		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Income Grp 2	-0.05*** (0.006)	-0.04*** (0.006)	-0.04*** (0.005)	-0.02*** (0.003)	-0.02*** (0.003)	-0.02*** (0.002)	0.8*** (0.11)	0.6*** (0.11)	0.5*** (0.08)
Income Grp 3	-0.07*** (0.006)	-0.06*** (0.006)	-0.06*** (0.005)	-0.03*** (0.003)	-0.04*** (0.004)	-0.03*** (0.002)	1.6*** (0.11)	1.1*** (0.12)	0.9*** (0.09)
Income Grp 4	-0.09*** (0.006)	-0.08*** (0.006)	-0.08*** (0.005)	-0.03*** (0.003)	-0.05*** (0.004)	-0.03*** (0.003)	2.9*** (0.11)	2.2*** (0.12)	1.8*** (0.10)
Income Grp 5	-0.10*** (0.006)	-0.09*** (0.007)	-0.10*** (0.006)	-0.04*** (0.004)	-0.06*** (0.004)	-0.03*** (0.003)	4.7*** (0.14)	3.8*** (0.15)	2.9*** (0.13)
Controls									
Consumption	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Location	No	No	Yes	No	No	Yes	No	No	Yes
N	2,829,779			2,829,779			2,822,938		

Note: We report results from 4-digit zipcodes that include at least 10 reporting panelists.

Standard errors are clustered at the household level and reported in parentheses.

*** p<.001, ** p<.01, * p<.05

than five occupants.

Table 8 introduces additional (demographic and location) controls to the cross-sectional analyses presented in the main text. For each dependent variable, column 1 repeats the main cross-sectional specification that includes consumption rate controls. Column 2 adds levels of all demographics summarized in Table 7 as indicator variables. Column 3 further adds fixed effects for each 4-digit zipcode with at least 10 reporting households. For ease of comparison across three specifications, all results are based on the subsample that includes only observations from panelists living in 4-digit zipcodes with a minimum of 10 reporting households. We see that the degree of cross-sectional differences across income groups in buying store brands or the cheapest brand does not change with added controls. The extent to which households differ in their bulk-buying habits does respond to the addition of demographics and location controls, although large cross-sectional differences in this behavior remain even after we control for these factors.

3 Other Categories

Data Cleaning

In the three other leading non-food categories, we follow the same rules to identify households with excessive missingness, insufficient activity in the category and abnormal quantity, volume or price entries. However, we take a different approach to identifying unreported trips in the raw data. Recall that one feature of the toilet paper category that made it an ideal choice for studying intertemporal substitution was that the size of each UPC can easily be characterized by a few attributes readily available in the data. An additional benefit is that there are only a few primary sizes; 1-, 4-, 6-, 9-, 12-, 24-, 30-, and 36-roll UPCs. This made identifying missing interpurchase times as a function of previous size purchased fairly straight-forward. Other categories each present different challenges that make applying this approach challenging. Rather than take an idiosyncratic approach for each other category that would necessarily require more subjective input from the authors, we take a simpler, more consistent approach across these categories: we determine that a purchase is likely to be missing if the interpurchase time is in the 99th percentile of inter-purchase time distribution in the category. Based on this cutoff, as in the toilet paper category, we identify active periods for a household, and use only these active periods to calculate consumption rate. Additionally, because this procedure flags fewer missing observations, we set the threshold for excessive missingness to 2 observations per household, which produces the most similar percentage of households dropped by this requirement in the toilet paper category.

As a result, in the laundry detergent, paper towels, and cigarettes categories, we keep households that do not fall into one of the following criteria:

- Excessive Missingness: The household has 2 or more missing observations, and/or the missing observations are spaced such that consumption rate cannot be calculated (a household must have at least two consecutive non-missing purchases to calculate consumption rate), and/or the maximum interpurchase time between any two consecutive

purchases exceeds the 99th percentile of all households' maximum interpurchase time for the category.

- **Insufficient Activity in the Category:** The household's consumption rate is less than the 1st percentile of all households' consumption rates for the category, or the household was only active in the category for 90 days or fewer.
- **Abnormal Quantity, Volume, or Price:** The household made a purchase in which the volume, quantity, or price exceeded the 99th percentile of all purchases made in the category.

We apply one additional criteria to the cigarettes category. In this category, it is common to start and stop consumption, as some smokers make efforts to quit, and some are “social” smokers who may smoke only occasionally throughout the year. Because identification of intertemporal substitution is aided by focusing on categories where consumers engage in steady consumption, we try to focus on regular smokers. To this end, we take a simple approach: we drop the bottom 1% of households in terms of the total number of purchases they make in the category. Our conclusions are not sensitive to this additional restriction – the estimates are still statistically significant if we do not exclude those households – but it would be inconsistent to ignore this feature of the cigarettes category, given the criteria we outlined in the main text.

Summary statistics

4 Survey Data: Cash Flows and Liquidity Constraints in U.S. Households

This survey was conducted to understand the patterns of cash flows and liquidity constraints experienced by U.S. households from different income groups. The main goal of this data

Table 9: Summary Statistics for Paper Towel, Cigarette, and Detergent Categories

Paper Towels Category						
	Daily Consumption*		Interpurchase Time		Trip Volume*	
	Raw	Clean	Raw	Clean	Raw	Clean
1st pct	0.008	0.011	1	1	1.0	1.0
25th pct	0.041	0.041	14	14	2.0	2.0
50th pct	0.073	0.071	33	33	3.0	3.0
75th pct	0.126	0.121	75	73	8.0	8.0
99th pct	0.592	0.405	553	462	22.0	16.0
N**	115,350	103,570	2,234,240	2,082,549	2,363,026	2,186,692
Cigarettes Category						
	Daily Consumption*		Interpurchase Time		Trip Volume*	
	Raw	Clean	Raw	Clean	Raw	Clean
1st pct	0.3	0.5	0	0	20	20
25th pct	1.7	3.2	2	2	40	40
50th pct	5.2	7.8	6	5	60	60
75th pct	13.1	16.0	12	11	200	200
99th pct	58.1	53.2	215	103	800	800
N**	26,794	15,317	1,635,960	1,351,032	1,685,714	1,366,939
Detergent Category						
	Daily Consumption*		Interpurchase Time		Trip Volume*	
	Raw	Clean	Raw	Clean	Raw	Clean
1st pct	0.293	0.360	1	1	14	17
25th pct	1.028	1.019	21	21	63	64
50th pct	1.692	1.625	43	43	100	100
75th pct	2.804	2.583	89	88	150	150
99th pct	75.000	7.762	602	508	400	400
N**	121,245	107,266	2,084,833	1,939,081	2,544,465	2,046,998

*In rolls of paper towels, individual cigarettes, and ounces of detergent. **Daily Consumption is presented at the HH level, while other variables are presented at the trip level

collection effort was to provide external evidence regarding whether low-income households differentially experience liquidity constraints for everyday items, and if so, when they are most likely to experience these constraints. A total of 413 MTurk workers participated in the survey. We tried to over sample the households with less than 40K annual income. A total of 150 participants indicated a household income level less than 20K, 95 participants indicated a household income level between 20K and 40K, 64 participants indicated a household income level between 40K and 60K, 45 participants indicated a household income level between 60K and 80K, 29 participants indicated a household income level between 80K and 100K, and

30 participants indicated a household income level larger than 100K. We first replicate the survey below, and then report the responses.

Questions

What is your personal yearly income?

- Less than 10K
- 10K-20K
- 20K-30K
- 30K-40K
- 40K-50K
- 50k-60K
- 60K-80K
- 80K-100K
- 100K+

What is the yearly income of your household?

- Less than 10K
- 10K-20K
- 20K-30K
- 30K-40K
- 40K-50K
- 50k-60K
- 60K-80K
- 80K-100K
- 100K+

How many people live in your household?

- Just me
- 2
- 3
- 4
- 5 or more

How many children under the age of 18 live in your household?

- 0
- 1
- 2
- 3 or more

What are your sources of income? (Please check all that apply)

- Wages
- Food stamps
- Social Security payments
- Tips
- Other

The following questions were asked only if the participant indicated an item as a source of income.

You indicated "other" as a source of income. Please briefly describe this source of income.

When do you receive wages? Please check all that apply. For example if you receive most your wages in the beginning of the month, select first week of the month. If you get most your wages split between second and fourth weeks of the month, please select both those options. If you get wages on a weekly basis, please select all four weeks.

- First week of the month
- Second week of the month
- Third week of the month
- Last week of the month

When do you receive food stamps? Please check all that apply. For example if you receive food stamps in the beginning of the month, select first week of the month. If you get most the food stamps sometime on the second and third weeks of the month, please select both those options.

- First week of the month
- Second week of the month
- Third week of the month
- Last week of the month

When do you receive social security payments?

- First week of the month
- Second week of the month
- Third week of the month
- Last week of the month

When do you receive earnings from tips? Please check all that apply. For example if you receive most tips in the beginning of the month, select first week of the month. If you get most tips split between second and fourth weeks of the month, please select both those options. If you get tips on a weekly basis, please select all four weeks.

- First week of the month
- Second week of the month
- Third week of the month
- Last week of the month

When do you receive earnings from other sources? Please check all that apply. For example if you receive most of this source of income in the beginning of the month, select first week of the month. If you get most of this income between second and fourth weeks of the month, please select both those options. If you get this income on a weekly basis, please select all four weeks.

- First week of the month
- Second week of the month
- Third week of the month
- Last week of the month

The following questions were asked to participants.

How often, if at all, you find yourself unable to spend money on large ticket items (tools, appliances, etc.)?

- It happens at least once a week
- It happens about once a month
- It happens once in a while
- I can afford large ticket items almost all the time

How often, if at all, you find yourself unable to spend money on items that you would like to enjoy (clothing, dining out, cosmetics, etc.)?

- It happens at least once a week
- It happens about once a month
- It happens once in a while
- I can afford items I enjoy almost all the time

How often, if at all, you find yourself unable to spend money on basic necessities (groceries, cleaning products, toilet paper, etc.)?

- It happens at least once a week
- It happens about once a month
- It happens once in a while
- I can afford basic necessities almost all the time

During the span of the month, in general, when do you feel most cash constrained to purchase basic necessities?

- Beginning of the month is the worst
- Middle of the month is the worst

- End of the month is the worst
- How much constrained I feel stays the same throughout the month

We would like to make sure you are responding carefully. People differ in the degree to which they pay attention to survey questions. If you are paying attention, please select agree. Your answer will indicate attention.

- Strongly agree
- Agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Disagree
- Strongly disagree

Please indicate the state you live in:

How old are you?

- Younger than 18
- 18-24
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60-64
- 65 or older

Responses

Given the nature of the questions we would like to address, in our report below, we group participants into three groups: those with household incomes less than \$20K (income group

1), those with household incomes between \$20-40K (income group 2), and those that make more than \$40K (income group 3+).

Time of cash-flows

Interestingly, while monthly wage payments are not very common, income group 1 households are more likely to get wages on a monthly basis than income group 2 households.

Table 10: Percentage of households within an income group that indicate each wage payment schedule

	Weekly	Bi-weekly	Monthly
Income Group 1	44%	24%	22%
Income Group 2	33%	44%	13%
Income Groups 3+	25%	51%	24%

In addition, income group 1 households are the most likely to receive payments other than wages, such as social security payments and food stamps. In fact, for most households, these payments are the only sources of income.

Table 11: Percentage of households within an income group that receive each type of income

	Wages	Social Security + Food Stamps	Tips + Other
Income Group 1	55%	85%	35%
Income Group 2	88%	14%	31%
Income Groups 3+	95%	3%	15%

As expected, social security payments and food stamps are most likely to arrive at the beginning of the month.

Table 12: Arrival times of each type of payment

	Food Stamps	Soc. Security	Tips	Other
Monthly (Week 1 or 2)	88%	78%	0%	29%
Monthly (Week 3 or 4)	10%	20%	0%	13%
Bi-Weekly	2%	2%	18%	4%
Weekly	0%	0%	82%	54%

Feeling cash constrained

Income group 1 households are the most likely to report being cash constrained for basic necessities.

Table 13: Percentage of households within an income group that are cash constrained at least **once a month**

	Basic Necessities	Items I Enjoy Buying	Large ticket items
Income Group 1	42%	69%	62%
Income Group 2	31%	66%	59%
Income Groups 3+	9%	34%	26%

Table 14: Percentage of households within an income group that are cash constrained at least **once a week**

	Basic Necessities	Items I Enjoy Buying	Large ticket items
Income Group 1	22%	48%	38%
Income Group 2	14%	44%	38%
Income Groups 3+	7%	18%	9%

Also, note that the degree to which the income group 2 households feel cash constrained compared to how constrained the lowest income group feels, is most divergent for basic necessities, while being most similar for large ticket items.

Among households that report feeling cash constrained for basic necessities at least once a month, households that earn less than \$20,000 per year are more likely (than any other household) to feel most constrained during the end of the month compared to the beginning of the month.

Table 15: Percentage of households indicating the time of month when they feel most cash constrained

	Beginning	Middle	End	Same
Income Group 1	15%	20%	40%	25%
Income Group 2	16%	24%	30%	30%
Income Groups 3+	18%	14%	30%	38%