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Riches to Rags Every Month? The Fall in Consumption Expenditures Between Paydays

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ABSTRACT

Riches to Rags Every Month? The Fall in Consumption Expenditures Between Paydays*

This paper finds declining consumption expenditure between paydays, for a typical household in the working population of the UK. The magnitude is inconsistent with exponential time preference, but compatible with quasi-hyperbolic discounting. However, the hyperbolic model predicts that credit constraints drive the decline, and we find only mixed evidence in this regard. We also observe a method-of-payment result that suggests a role for mental accounting: households choose declining cash spending but flat credit-card spending over the pay period. We propose an alternative explanation for the results, based on cognitive costs of budgeting and perceptual biases, rather than self-control problems.

JEL Classification: B49, D11, D12, J33

Keywords: consumption, hyperbolic-discounting, payday, mental accounting, reference-dependent preferences, credit cards

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“Remember: If you don't see it, you won't spend it! … If your company offers a 401(k) retirement plan, make sure you sign up for the maximum possible contribution. It will be taken out of your *paycheck* automatically… The whole point is to get the money out of your checking account before you see it and spend it.”

- T. Savage, *How small cuts become huge savings*,
MSN Money website (undated)

1. Introduction

This paper finds a pattern of declining consumption expenditure between paydays, for households in the general working population.[1] The magnitude of the decline is not trivial, amounting to roughly 12% of weekly household expenditure. Given that recipients generally know the amount and timing of paychecks well in advance, this sensitivity of consumption to receipt of the paycheck contradicts classic models of consumption smoothing.[2]

Assuming negative time-preference, and binding credit constraints, the standard model comes closer to capturing the qualitative features of the pattern we observe: impatience generates declining consumption over time, and binding credit constraints lead to a discrete jump in consumption after each payday. However, a calibration exercise produces the second main finding of the paper: the exponential daily discount rate assumed in the standard model cannot explain the *magnitude* of the decline we observe. The daily discount rate needed to explain the decline implies an implausibly high annual discount rate, or low annual discount factor, between 0.5 and 0.1. [3]

[1] We use the Family Expenditure Survey (Crown Copyright), a random national sample from the working population in the United Kingdom.
[2] The data reject several plausible explanations for non-smooth consumption: stockpiling, calendar-month effects, timing of non-discretionary payments, or intra-household strategic motives.
[3] I.e. the consumer values consumption today about 70 percent more than consumption in one year’s time, and 90 percent more than in two year’s time. Estimates become even

We show in another calibration exercise that the decline is consistent with quasi-hyperbolic time preference, in which an individual has two discount rates, one for the short-run and one for longer time horizons. This finding is important because it is one of the few pieces of evidence from outside the laboratory on the daily discounting of households in the general working population.[4] It is also important because the seemingly innocent assumption of a non-constant discount rate gives rise to a self-control problem, in the sense of dynamically inconsistent, "present-biased" preferences.

The hyperbolic model can explain the magnitude of the decline we observe, but is harder to reconcile with a fourth finding of the paper, a decline in expenditures even for households who own a credit card. As with any explanation based on time preference, the quasi-hyperbolic model requires binding credit constraints to explain a jump in expenditure after each payday. To the extent that households with credit cards have the ability to smooth short-term consumption, some other factor besides impatience is needed to explain the jump in spending after payday.

Another finding of the paper is an intriguing method-of-payment result. Households with credit cards choose declining cash expenditures, but "flat" credit card expenditures, over the course of the pay period. The decline in cash payments is comparable in magnitude to the decline for households without credit cards. Neither the standard model nor a model with hyperbolic discounting is sufficient to predict this

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more implausible for longer time horizons, precisely because the discount rate is constant.

[4] Shapiro (2004) finds a similar, although slightly, daily discount rate for food stamp recipients. DellaVigna and Paserman (2001) estimate the discount rates of health club members, DellaVigna and Malmendier (2002) do the same for job searchers, and Laibson, Repetto and Tobacman (2003) infer discount rates from lifecycle savings behavior.

pattern. We interpret this as evidence of a system of "mental accounting" at work, with different rules for spending out of the current bank account, as opposed to the flow of future income accessible with the credit card.[5] One potential explanation for the decline we observe is thus hyperbolic discounting, combined with a mental accounting rule that to some extent limits credit card spending and causes households to act as though they are credit constrained.

After presenting the results, the paper considers alternative explanations that have not been discussed in the literature. One explanation corresponds to a commonly held intuition, that consumers have a tendency to feel that spending is "less costly" towards the beginning of the pay period, when there has been a salient increase in the bank balance. As a consequence of this feeling of being "flush," they overspend. Because this type of perceptual bias has some basis in evidence from psychology, e.g. evidence on reference-dependent preferences, and could generate a decline in spending between paydays, we sketch a simple model that captures this intuition. This model also offers a different interpretation of the method-of-payment result, suggesting that flat credit card expenditures reflect the feeling that it is always payday when one spends with a credit card. However, we conclude that more research is needed to disentangle the relative importance of impatience, and perceptual biases, in explaining monthly budgeting behavior.

In addition to its theoretical interest, the decline in consumption spending over the pay period may be of interest to policy makers. Economists criticize in-kind transfer programs, designed to regulate the monthly spending of low-income individuals, from the

[5] See Thaler (1999) for an overview of the (mostly laboratory) evidence on mental accounting.

perspective of fully rational choice. Given that the decline in spending between paydays is difficult to explain without allowing for self-control problems or perceptual biases, these programs may be more-easily defended.[6] Evidence of sub-optimal budgeting during the pay period has larger implications as well, adding support to the view that small mistakes in budgeting can add-up over the lifetime, leading to sub-optimally low saving for retirement. In this case policies designed to encourage retirement saving may be appropriate.[7] Of course we must proceed with caution, because at this point it is hard to say exactly how large these welfare losses are. Furthermore, it is important that policies allow for the fact that some consumers may be less subject to self-control problems and biases than others.[8]

The paper is organized as follows. Section 2 discusses related literature, Section 3 describes the data and empirical design, and Section 4 presents the main results. Section 5 discusses the role of time preference and credit constraints, Section 6 presents our method-of-payment results, Section 7 discusses alternative explanations, and Section 8 concludes.

2. Related Literature

[6] In unreported regressions, we find a large payday effect for spending on alcohol, raising welfare concerns relating to health costs and productivity loss due to binge drinking.

[7] E.g. research on personal saving (Choi et al., 2001) has shown that employees save substantially more over time, if they participate in employer-sponsored defined contribution pension plans (such as 401(k)'s), which automatically debit part of their paychecks.

[8] See Camerer et al (2003) for a discussion of "asymmetric paternalism," a policy approach designed to help less-than-rational decision makers, without unduly harming rational decision makers.

Several recent papers find an impact of payday on consumption spending.[9] Stephens (2003) uses daily expenditure data from the CES, and finds that social security recipients spend significantly more right after the third of the month, when they receive their social security checks. Stephens concludes that this behavior violates the consumption-smoothing prediction of the Lifetime Permanent Income Hypothesis. Stephens remains largely silent regarding an explanation for what he finds, however, except to suggest that credit constraints could explain the phenomenon. Stephens (2004) is also conducting research on the decline in spending between paydays using the Family Expenditure Survey (FES). In this paper Stephens is again focused mainly on testing the LPIH, and proposes credit constraints as the main candidate explanation for the decline.

Shapiro (2004) uses daily caloric intake data on food stamp recipients in the US, and finds that recipients choose a pattern of declining consumption between monthly food stamp payments. Shapiro performs calibration exercises similar to the ones in this paper, showing that the magnitude of the decline cannot be explained with exponential time preference. Instead, Shapiro argues that hyperbolic discounting is the most likely explanation for the decline. Shapiro concludes that, while the decline may reflect sub-optimal budgeting, it is too small to imply significant welfare losses.

This paper differs from Stephens (2003, 2004) and Shapiro (2004) in a number of ways. Unlike Stephens, we leverage the decline in spending following payday as a useful tool for testing between alternative models of consumer choice, including non-standard models from behavioral economics. We calibrate the standard and hyperbolic models in a

[9] The initial version of this paper was completed before any of these related papers was publicly available. However, we have benefited from observing the literature evolve, and have endeavored to keep our research up-to-date and complementary.

similar way to Shapiro (2004), ruling-out credit constraints and exponential time preference as an explanation, but our results are more general than Shapiro (2004), as they apply to the working population rather than just food stamp recipients.[10] Another advantage compared to Shapiro is the fact that our data includes individuals who are not credit constrained, allowing us to test whether the decline only happens for individuals facing binding credit constraints, a prediction of the hyperbolic model. We are also able to explore how the decline varies with method of payment, and study the role of mental accounting, which Shapiro and Stephens do not do. Finally, we formalize an alternative intuition regarding the source of the decline in spending, based on perceptual biases rather than impatience.

3. Description of the Data and Empirical Design

3.1 The Family Expenditure Survey

The Family Expenditure Survey (FES) is administered every year in the United Kingdom, to a sample of between six and seven thousand households. The survey does not follow the same households across years. The survey includes an interview with at least one household member, asking about demographic and household information. Crucially for this paper, individuals report the amount and date of their last paycheck, and the frequency of pay.

Following the day of the interview, each participating household member starts a diary, and records everything they buy during the next fourteen days. Expenditures are

[10] A limitation of our results compared to Shapiro is that we use weekly data, and therefore must make an additional assumption to recover the daily discount rate. However, we find evidence that this assumption is in fact a reasonable one.

aggregated to diary "weeks" in the data, for reasons of confidentiality, resulting in two seven-day aggregates of expenditure for each individual. Importantly, the timing of the FES interview, and the diary recordings, is random during the sample year. Figure 1 illustrates the resulting data structure: diary weeks need not correspond to the calendar week, but rather start on different days of the week, at different distances from payday, and overlap to varying degrees.

The timing of the FES interview is important for a correct interpretation of the timing of payday. The interview occurs immediately before the diary period starts, so the question about the date of the most recent paycheck refers to a paycheck received before the diary period. Because the survey also includes the frequency of pay, e.g. calendar month, it is possible to impute the timing of the next payday. However, there is some measurement error involved in imputing the next payday, which is discussed in detail below.

3.2 Empirical Design

Estimating the weekly expenditure profile

The motivating question for the paper suggests a straightforward empirical design, in which expenditure is modeled as a function of distance from payday in days, over the course of a monthly pay period.[11] Because the FES diary data are aggregated over seven-day periods, we start by investigating how these week-long aggregates of

[11] The analysis focuses on a monthly pay period for reasons discussed below.

household expenditure change, as the start-date of the week gets farther away from the payday of the main earner.[12]

The basic regression we estimate is of the form:

$$C_{it} = \alpha + \sum_{t=1}^{3} \beta_t distance_t + \gamma \cdot T_t + \eta \cdot Z_i + \varepsilon \qquad (1)$$

The dependent variable, C_{it}, is the log of consumption expenditure by household i, during the diary week beginning at time t. The distance measure consists of four distance categories, represented by four dummy variables (the third category is omitted in the equation).[13] The first category includes diary weeks starting on payday and weeks starting 1 to 7 days after payday. The second category includes weeks starting 8 to 14 days after payday, and the third category includes weeks starting 15 to 22 days after payday. We exclude from our analysis weeks beginning 23 days after payday during 30-day pay periods (one day more or less for other lengths of pay period), but starting more than 4 days before the next payday. This is because measurement error makes it unclear whether these weeks include the next payday or not. Measurement error arises because employers might use one of two rules for the timing of a monthly payday: (1) pay on the same date of each month, or (2) always pay on the first or last day of the month.[14] The fourth and final distance category includes weeks that are certain to include the next

[12] We will often refer to dairy weeks as "weekly expenditures," meaning only that these aggregates are one week long, not that they correspond to calendar weeks.
[13] These categories correspond roughly to the four weeks of the pay period, and summarize the relationship observed in our graphical analysis. We verify that our basic results are also robust in a completely non-parametric specification, with 31 individual distance dummies.
[14]E.g. it is unclear whether someone paid on the 30th of April, the last day of the month, will next be paid on the 30th of May, or the 31st. Including these weeks would only obscure the relationship of interest, so we omit them. Stephens (2004), by contrast, uses all diary weeks.

(imputed) payday, i.e. weeks that begin 4 to 1 days before the next payday. We keep this category separate from weeks beginning on the next payday, in order to avoid confounding the payday effect with possible end-of-pay-period effects.[15]

The vector T_t includes dummies for day of calendar month, month, and year in which a diary week began, as well as a dummy for the day of week of payday, and a dummy for the second diary week, to control for survey fatigue. Z_i is a vector of socio-economic and demographic controls, including household income, interest income, credit card ownership, age and occupation of the main earner, household size, number of income earners, marital status, geographic region of residence, and size of city of residence.

Each household member records spending for only fourteen days, making it necessary to pool observations in order to study expenditures over a whole month. Thus, at each distance from payday, we use diary weeks from many different households. Pooling household observations would lead to a biased estimate if characteristics are not orthogonal to distance from payday, but the FES survey takes place randomly during the year and across households. Furthermore, we verify the randomness of the survey empirically, in the next section.

Estimating the daily discount rate

Another goal of the paper is to estimate the percent decline in daily spending over the pay period, for the purposes of calibrating the standard and quasi-hyperbolic models.

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[15] Stephens (2004) identifies the payday effect using all weeks that overlap with payday. This confounds two possible effects – a payday effect and an end-of-pay period effect – which may reflect very different types of behavior.

With our data on seven-day aggregates of expenditure, observed at different distances from payday, we can estimate the implied profile of daily expenditure over the pay period, if we are willing to make an additional assumption. We make the simple assumption that daily expenditure declines linearly over the pay period. We do not expect this assumption to be strictly true, but it turns out to be a reasonable approximation given the weekly expenditure profile we observe, and we cannot reject the assumption statistically.

Assuming a linear decline of daily expenditure, the level of daily spending on day t of the pay period can be written:

$$e_t = E - \theta \cdot t + u_t \qquad (2)$$

where t goes from zero until the day before the next payday, and θ describes the slope of the decline in daily spending. Given this expression for daily spending, and ignoring the error term for the moment, we can express the seven-day aggregate of expenditure beginning on day t, a_t, as:

$$a_t = \sum_{k=t}^{t+6} e_k = 7E - \theta t - \theta(t+1) - \theta(t+2) - .. - \theta(t+6) \qquad (3)$$

In the case of a 31-day pay period, this condition implies that the difference between any two overlapping, week-long aggregates of expenditure, which begin one day apart, can be written as:

$$a_{t+1} - a_t = -7 \cdot \theta \quad \textit{for } 0 \le t \le 24 \qquad (4)$$

$$a_{t+1} - a_t = 24 \cdot \theta \quad \textit{for } 24 < t \le 30 \qquad (5)$$

This says that dairy-week spending declines linearly over the first twenty-four days, with slope *-7θ*.[16] We can thus recover θ, by estimating the average change in weekly expenditure over this portion of the pay period and then dividing by -7. Note that conditions (2) and (3) imply an asymmetric, "V-shape" for the weekly expenditure profile, which we can later compare to the profile actually observed in the data.[17]

To estimate the change in weekly expenditure over the pay period, we estimate a restricted, linear spline regression, where the first segment covers the first twenty-four days of the pay period, and the second covers the final six days. We impose the specific relationship between the slopes of these segments given by conditions (2) and (3). The resulting equation is:

$$\begin{aligned} c_{it} &= until\_24 + after\_24 + \\ &+ \pi \cdot (until\_24 \cdot \text{dist.} - (\frac{24}{7}) \cdot after\_24 \cdot \text{dist.}) + \ldots \qquad (6) \end{aligned}$$

Where the dependent variable is the *level* of weekly expenditure beginning on day *t*, *until_24* and *after_24* are separate intercepts for the two segments of the spline, and the key coefficient, *π,* is equal to *-7θ* by assumption. We estimate a similar regression for 30-day pay periods, where the low point of the spline occurs at distance 23.[18] The regressions include all of the same controls as in our baseline specification.

[16] Following the same line of reasoning, 30-day pay periods have a declining segment with slope $\pi = -7*\theta$, up to distance 23, followed by a segment that increases with slope $23*\theta$ over the rest of the pay period.

[17] Figure 2 illustrates this relationship between daily and weekly spending with an example.

[18] This portion of the analysis excludes 28-day and 29-day pay periods, as there are many fewer observations in these sub-samples.

Using our estimate of θ, and the median level of spending on the first day of the pay period, e_0, we can then calculate the percentage change between each pair of adjacent days, and the average daily percent decline over the pay period.[19] With an estimate for the percent decline in daily expenditure in hand, we are in a position to calibrate the standard and quasi-hyperbolic models and study daily time discounting.

Sample restrictions

The most significant sample restriction is the exclusion of people who are paid weekly. For people paid weekly, it is impossible to compare spending right after payday to spending before the next payday, because every observation includes either the last or the next payday.[20] We focus on the relationship between household consumption spending and distance from payday of the main earner. If there is more than one paycheck received by the household, on different paydays, this would tend to obscure the relationship of interest, so we drop households where there is any secondary earner whose paycheck is greater than 25% of total household wage earnings, *and* for whom the paycheck arrives 3 or more days away from the main earner's payday, or is not a monthly paycheck.[21] We drop households missing information on key variables, households who

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[19] We solve for the median level of daily expenditure on payday using data on the median level of weekly spending, $a_{0,}$ on payday: $a_o = 7*E — \theta(1 + 2 + \ .. + 6) \ \Rightarrow \ E = (a_0 + 21*\theta)/7 = e_0$. By successively subtracting θ, we calculate the level of daily spending on all subsequent days of the pay period. We then express the changes in these levels in percentage terms, and calculate the average percentage decline in daily spending over the pay period.

[20] The sample includes roughly equal numbers of people paid monthly and people paid equally. About 90% of the sample are paid either weekly or monthly

[21] While the precise values chosen for these cut-offs are somewhat arbitrary, the results do not change appreciably with other cutoffs, e.g. eliminating households with secondary earners earning more than 33% ,or more than 10%, of total household income.

have zero wage income, and households with a head who is retired or unemployed. We also drop outlier households with more than US $5,000 of weekly consumption, or more than $600 of weekly expenditures on highly non-durable goods.[22] We use FES interviews conducted between 1988 and 2001. The FES extends back further than 1988, but issues of compatibility across years and the omission of key questions suggested the 1988 cutoff. Our final sample is composed of roughly 15,000 monthly-paid households. This translates into roughly 30,000 observations, because in most cases the sample includes two diary weeks for each household member.

Expenditures in the data are reported in pounds sterling. We adjust expenditures and pay amounts for inflation using the Retail Price Index for Britain, with 2000 as the base year.

3.3 Descriptive Statistics

Table 1 presents sample means of household characteristics, at different distances from payday. As expected given the survey design, these descriptive statistics appear to be orthogonal to distance, changing very little from one category to the next. Thus, although we include demographics in our regressions to check whether these variables affect the level of expenditure in a reasonable way, this is not strictly necessary for obtaining an unbiased estimate of the impact of distance.[23]

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[22] About 250, or less than 1%, are excluded because of outlier values for total or highly non-durable consumption.

[23] We performed an additional check by successively adding demographics to the simplest regression with only the distance dummies and a constant term. Adding demographics did not lead to any appreciable change in the coefficient on distance, consistent with orthogonality.

Figure 3 presents frequency distributions for key variables: distance from payday, pay date, and diary start date. The first graph shows that distance from payday is evenly distributed, i.e. the timing of FES interviews and timing of paydays is roughly orthogonal. The second graph shows that pay dates are unevenly distributed; there is a strong concentration of pay dates on the last few days of the calendar month. The final graph in Figure 3 shows that diary start dates are fairly evenly distributed throughout the calendar month, as expected given the randomness of the FES interview during the year, with the exception of a dip in the number of observations around the 22nd.[24]

4. Results

4.1 Graphical Analysis

Figure 4 presents a plot of mean log expenditure versus distance from payday with 95% confidence bands.[25] Each point on the graph is calculated by averaging all week-long aggregates of expenditure that begin at that particular distance from payday. The vertical line indicates the weeks that are dropped from the sample to minimize measurement error.

Figure 4 shows that average consumption expenditures are markedly higher right after payday. Expenditure declines over the pay period, reaching a low around three weeks after payday, then starts to climb rapidly about a week before the next payday. The

[24] The dip is partly due to the concentration of paydays at the end of the month, and partly due to our exclusion of weeks starting 22 days from payday and beginning more than 4 days before the next payday.
[25] The log of zero observations on expenditure is undefined, so we assign these observations a value of zero in the graph. Dropping the zeros does not appreciably change the appearance of the graphs, which is not surprising given the small number of zero observations: we have only 482 observations with zero expenditure out of more than 30,000, or about 1.6% of the sample.

increase in weekly expenditure in the latter part of the pay period is presumably due to the fact that these weeks overlap with the next payday. The shape of the weekly expenditure profile also suggests that the "v-shape" implied by a linear decline in daily expenditure is not an unreasonable approximation.

4.2 Regression Analysis

Table 2 presents our baseline results, regressions of log weekly expenditure on distance from payday and controls.[26] For these regressions, we focus on the four distance categories discussed in Section 2. Regressions in Table 2, and all subsequent regressions, include our extensive array of demographic and time controls, but only the coefficients on distance categories are reported in the table. Coefficients from all demographic controls are presented in an appendix, available upon request. All regressions report robust standard errors, which are adjusted for clustering, i.e. possible correlation of the error term across diary weeks for the same household.[27]

The first column of Table 2 shows that distance from payday has a significant impact on the category of all consumption spending. The dummy coefficient for 0 to 7 days after payday is significant at the 1% level, and says that consumption in diary weeks beginning in this interval is roughly 12% higher than for weeks starting 15 to 22 days after payday (the omitted distance category). This high level of spending extends well

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[26] As mentioned in the previous footnote, zero expenditures make up a negligible fraction of the sample of diary week observations. As a check, we have estimated tobits for all regressions and find very similar results. We choose OLS as our preferred estimation method, mainly because it is easier to adjust standard errors for heteroscedasticity and clustering. For sub-categories of expenditures with more zero observations, however, we do report the tobit estimates.

[27] Except for the column 4 Tobit regressions, where doing such an adjustment is not trivial.

into the pay period: in weeks beginning 8 to 14 days after payday, spending is still higher than in the omitted category by about 5%. The 4 to 1 category captures the increase in spending observed at the very end of the pay period in Figure 4. The fact that the point estimate is even higher for the fourth category than for the 0 to 7 category suggests that the increase in weekly expenditure late in the pay period could reflect a combination of an end-of-pay-period effect, and the effect of the next payday. However, it is difficult to say exactly how much of the increase is due to each of these effects.

To verify that our results are not driven by our parameterization of the distance measure, we regress log expenditure on a set of dummy variables for each distance from payday. This non-parametric specification corroborates our baseline results: the individual distance dummies are highly significant and positive for the all consumption category, starting on payday and continuing until a distance of 13 days. These results are reported in full in Table B1 of Appendix B.

Table 3 presents results from the restricted spline regression. The first and second columns report π, the slope of the first segment of the spline, for 31- and 30-day pay periods. The absolute decline in daily expenditure, θ, is obtained by dividing these point estimates by -7, yielding a decline of -0.23 for 31-day pay periods and -0.10 for 30-day pay periods. For a household with the median level of expenditure on payday, this translates into a percentage daily decline between -0.6% to -0.2% (which gives an average monthly decline of 12%). Using F-tests that compare the fit of these restricted regressions to completely non-parametric regressions with separate dummy variables for each distance, we cannot reject the assumption of a linear daily decline. The estimates we find using the assumption of linearity are quite similar to, although slightly smaller than, the 0.7% decline in food expenditures found by Shapiro (2004) using daily data.

The third column of Table 3 tests one possible explanation for why we find a smaller, and statistically insignificant π-coefficient for 30-day pay periods. In Figure 4, the data are reasonably close to a "v-shape," but in a graph for 30-day pay periods only (not shown), it is apparent that weekly expenditure begins to rise a bit earlier than predicted by a linear daily decline. Thus, the small point-estimate we find is likely to be attenuated, because it is based partly on a portion of the expenditure profile that is already increasing. The third column of Table 3 show that this is the case. Using an earlier threshold value of 21 leads to a steeper, and statistically significant, π -coefficient. One interpretation of the earlier rise in spending is that it reflects a systematic departure from our assumption of a linear decline, e.g. perhaps daily spending begins to rise just before the next payday. An alternative interpretation is that the early increase is due to the measurement error discussed above, in the timing of weeks during the pay period.

In summary, diary-week expenditure starts out significantly higher right after payday and then declines over most of the pay period, until it begins to rise rapidly again at the end. This pattern is robust to a non-parametric specification of the distance measure. The percentage daily decline implied by the data is similar to estimates from Shapiro(2004).

4.3 Robustness checks

Timing of non-discretionary payments

A possible explanation for declining expenditures between paydays is that the timing of non-discretionary payments, such as bills or pension contributions, happens to coincide with payday for most households. Returning to Table 2, however, the second column shows a significant decline in spending over the pay period, for spending that excludes bills and pension or savings contributions. This suggests that the payday effect is not driven by the timing of non-discretionary payments.

Intra-Household Strategic Motives

It is also possible that strategic interaction between household members could generate a downward sloping consumption path following payday. If household members compete for scare resources, then the optimal strategy could be for each household member to spend as much as possible, as fast as possible, right after payday in order to maximize their portion of the new inflow of resources. The third column of Table 2 tests this explanation by looking at the spending of single-person households (excluding bills). The decline in expenditures is particularly strong for this sub-sample, which goes against an explanation based on intra-household strategic interactions.[28]

Stockpiling

Non-smooth consumption between paydays could also reflect household efforts to minimize transactions costs of shopping, by stockpiling durable goods. If the timing of this stockpiling happens to coincide with payday, it could explain a surge in expenditure

[28] Shapiro (2004) calls this the "intra-household scramble for resources." He finds that adding one additional member to the household does not affect the rate at which food stamp spending declines over the month.

right after payday. Given that the decline we observe extends well into the pay period, this explanation does not seem likely. However, the fourth column of Table 2 performs another test, showing the expenditure profile for the category of instant, or highly non-durable consumption goods.[29] The evident decline in spending on highly non-durable goods provides additional evidence that stockpiling is not a sufficient explanation for the payday effect we observe.

Calendar-Month Effects

Given that there is a concentration of paydays on the final days of the calendar month, we consider the possibility that some unobserved event, which regularly occurs at the end of the calendar-month, could also drive the increase in expenditure we observe. This concern is addressed by the inclusion of dummies for day-of-calendar-month in all regressions. However, in unreported regressions we take the additional precaution of estimating the expenditure profile over the pay period for the sub-sample of households who are paid in the interior of the calendar month. We find that the decline is just as strong and statistically significant for these households, mitigating concerns about confounding calendar-month effects.

In summary, we find little evidence to support several plausible explanations for the between-payday decline based on the standard model: monthly cycles in non-discretionary payments, stockpiling, calendar-month effects, and strategic motives within the household.

[29] The category of instant consumption includes take-away food, alcohol and food consumed in bars and restaurants, cinema tickets, and admissions to discos.

5. Time Preference and Credit Constraints

One intuition for why households choose declining expenditures between paydays is that they are impatient, and face binding credit constraints.[30] This section evaluates this explanation with calibration exercises, assessing whether the standard model with exponential time preference, or a model with non-constant, hyperbolic time preference can better explain the magnitude of the decline we observe. We then test a prediction common to both models, that the decline should be present only for households who face binding credit constraints.

The Standard Model with Exponential Time Preference and Credit Constraints

It turns out that for a reasonable calibration of the standard model, time preference cannot explain a decline in expenditure over a short time horizon like a monthly pay period, even in the presence of binding credit constraints. Intuitively, this is because the rate of time preference, captured by the discount factor δ in the standard model, is constant, so that the δ needed to explain declining expenditure over a period of 30 days generates implausible predictions regarding longer-term impatience. We take this point from Rabin (2002), who illustrates the problem with a simple example: taking a *daily* rate of time preference of 1%, this implies a daily discount factor of 0.99 and an annual discount rate of 0.99365 = 0.03. This says that the consumer, who values consumption today 1% more than consumption tomorrow, must also value consumption today 97% more than consumption one year from now.

[30] Section A.1 of Appendix A provides a formal example, showing how, in the standard model, credit constraints lead to declining expenditures with a discontinuous jump after each payday.

To be more concrete, we perform a calibration exercise, calculating the exponential discount rate needed to rationalize our estimates of the decline in daily expenditure for the working population. The details of these calculations are shown in Section A.2 of Appendix A. We find that the daily discount rate needed to explain a decline in daily expenditure between -0.002 and -0.006 implies an annual discount factor in the range of 0.5 to 0.11. This says that the value a consumer places on consumption today must be between 65 and 89 percent greater than the value of consumption in one year's time. Such a degree of impatience over a year-long time horizon seems highly implausible, and illustrates the difficulty of explaining the decline in expenditures between month paydays with the constant rate of time preference in the standard model.[31]

A Model with Quasi-Hyperbolic Discounting and Credit Constraints

A model with hyperbolic discounting captures the intuition that consumers have a self-control problem arising from "present-biased preferences:" they plan to be frugal in the future, but cannot stick to their own plan, because their preferences put a special emphasis on present consumption. Non-constant discounting also makes it easier to explain a steep decline in spending over a short time period like a month, without implying implausible long-run impatience, because there is a separate discount rate for short- and long-run time horizons.

[31] Alternatively, we could assume a more plausible discount rate of .8, which is still lower than standard empirical estimates, and calculate the implied elasticity of intertemporal substitution. We show in the appendix that this discount rate yields an implausibly large elasticity of substitution between 6 and 12 percent.

The quasi-hyperbolic model, a convenient approximation to a model with a hyperbolic discount function,[32] adds one extra parameter, *β*, to the standard utility function:

$$U_t = E_t[u(c_t) + \beta \sum_{t=0}^{T} \delta^t u(c_{t+\tau})] \qquad (7)$$

Where *t* indexes days, δ is equal to the discount factor in the standard model, and $\beta < 1$. In this case, the consumer has a short-term discount factor, $\beta \cdot \delta$, between today and tomorrow, that is relatively small compared to the discount factor of δ between any two future periods. This gives rise to the type of self-control problem described above; although the individual plans to be relatively patient in period $t+1$, discounting consumption in $t+2$ by only δ, once period t arrives he discounts $t+2$ by $\beta \cdot \delta$ and overspends from the perspective of his previous-period self.

We calibrate the quasi-hyperbolic model to see whether it can explain the decline we observe for the working population. In Section A.3 of Appendix A, we describe the optimal consumption path in the hyperbolic model, and explain in detail how we perform the calibration. What we find is that the hyperbolic model can explain an average rate of decline of -0.45, which is the midpoint of the range we observe. This is true assuming $\delta = 1$, and plausible values for the other free parameters in the model: $\beta = .93$, which is within the range of estimates found in laboratory experiments (Fredrick, Loewenstein and O'Donoghue, 2002), and an intertemporal elasticity of .45, which says that a 10 percent decrease in prices leads to a plausible, 4.5 percent increase in consumption.

[32] The approximation was first proposed by Phelps and Pollak (1968) and has subsequently been used by Laibson (1994, 1997) and others.

Shapiro (2004) presents additional evidence on the role of time preference in household budgeting. He finds that consumers who appear impatient, in the sense that they would rather receive less than 50 dollars today than wait four weeks to receive a full 50 dollars, have a higher probability of having skipped a meal sometime during the previous month due to lack of money. Shapiro notes that reverse causality is potentially a problem, however, because a consumer who skipped a meal last month may still be desperate for money this month, not because of impatience, but because of the lingering ramifications of a negative shock to income last month.[33]

Testing the role of credit constraints

We test whether binding credit constraints are a prerequisite for the observed decline in spending between paydays. Our first test uses asset interest-income as a proxy for liquidity or access to credit, which is the approach typically used in the consumption literature. Although this approach is standard, it is not entirely satisfactory; asset income is a rather indirect measure of the ability to smooth short-term consumption, and may also have an impact on behavior for reasons unrelated to its correlation with access to credit.[34] Our second test uses a more-direct and potentially superior measure of a

[33] Shapiro tackles this issue by controlling for the amount of food stamps remaining from the current month's allotment, and finds a smaller but still significant effect. But this does not entirely solve the problem. The reverse causality problem arises because food-stamp income may be insufficient for all of the household's food needs, making food consumption sensitive to negative shocks (food stamp income is presumably not subject to negative shocks). Thus it is necessary to control for current, total income rather than just food stamp income, in order to rule out lingering effects of a negative shock.

[34] We discuss one possible explanation below, in Section 7.

household's ability to smooth consumption: access to a credit card.[35] This measure comes from a question in the FES survey that asks, for each household member, whether that individual has access to a credit card.

Table 5 reports our results on credit constraints. The first two columns show no evidence of declining expenditures for households in the top quartile of asset income. However, the second two columns show evidence of a decline in expenditures for households with access to a credit card. The decline is significant, and only slightly more gradual than for non-cardholders. To rule out the unlikely possibility that most households with a credit card are fully "maxed-out" on their cards, and are thus effectively credit constrained, we estimate similar regressions (not shown) for households who report some positive spending with their credit card during the diary week. We find very similar results using these households.

In summary, we find mixed evidence supporting the prediction that credit constraints, in combination with non-constant time preference, drive the decline in expenditures. To the extent that high asset income is a proxy for credit constraints, our results match the prediction of the hyperbolic model. However, using access to a credit card, we find evidence of a strong decline. This suggests that something besides present-biased preferences contributes to the decline in spending between paydays.

[35] Besides being farther-removed from the ability to smooth short-term consumption, high-asset income is probably a worse measure of the pure effects of borrowing constraints, due to selection: people in the top quartile of asset income are less likely to have self-control problems, or suffer from perceptual biases, which would attenuate the payday effect for reasons independent of credit constraints.

6. Method of Payment and Distance from Payday

The FES data distinguish between cash and credit card purchases, allowing us to investigate how households use these different methods of payment in relation to payday. For example, it might be that households only use their credit card as a last resort, to smooth consumption in pay periods when they have experienced a negative shock to income. In this case, we would expect to see that credit card expenditures increase over the pay period.

Table 6 looks at cash and credit card purchases separately, for households that have access to a credit card. We restrict the analysis to households who have used their credit card sometime during the diary week. The first two columns show that cash spending on all consumption goods exhibits a significant decline over the course of the pay period for these households. On the other hand, there is no statistically significant relationship between distance and expenditure. The second two columns show the same method-of-payment difference for spending excluding bills.[36] In unreported regressions, we find the same pattern for spending on instant consumption.

The method of payment difference we observe in monthly budgeting is suggestive of a system of mental accounting, in the sense of Thaler (1999). The idea of mental accounting is that individuals arbitrarily divide income into different mental categories, e.g. present income in the bank account, and future income accessible through credit cards, and have different rules for spending money from these "accounts." One

[36] Comparing cash and credit spending is complicated by the fact that that these methods of payment may be imperfect substitutes. If the timing of credit card purchases tends to be more non-discretionary, this could explain the lack of sensitivity to distance from payday. However, it is not obvious why the timing of credit card spending should be particularly non-discretionary, and furthermore, we find the same results when we exclude non-discretionary payments.

interpretation of the pattern we observe is that households are hyperbolic discounters, but have a rule against using their credit cards to make up for overspending at the beginning of the pay period with cash. Thus, although they are not credit constrained, they act as though they are, and end up with falling cash expenditures.[37] In the next section, we discuss another possible interpretation of the method of payment difference.

7. Discussion

One possible explanation for the decline in spending, which has not been discussed in the literature, is that households could have a custom of "celebrating" after each payday, with a binge in consumption. This practice could be related to culture, or class, which could explain the weaker decline observed for households with high asset-income. The celebration could also serve the function of a "self-reward," after another month of hard work. However, despite the intuitive appeal of this explanation, we find that the decline in spending extends well into the pay period, and thus seems too gradual to be consistent with a payday celebration or reward. This explanation also does not explain why there should be a celebration with cash spending but not with credit cards.

Another explanation corresponds to a common intuition regarding payday, which is that consumers have a tendency to feel that spending is "less costly" on payday, when there has been a salient increase in the bank balance. In this state, so the story goes,

[37] If there are two groups of cardholders, those who are maxed out on their credit cards, and thus have declining cash spending, and those who are not credit constrained and thus have essentially flat cash and credit spending, this could generate the type of pattern we observe. However, the results exclude households who make no use of their credit card, and furthermore, the decline in cash spending for cardholders is almost as steep as that of the sample as a whole, suggesting that it is not driven only by a small group of credit-constrained card holders.

consumers have trouble imagining that they will not always feel so "flush," and as a consequence they over-spend. Later, as the bank balance falls, consumers find that spending is increasingly painful.[38]

This explanation could explain the extended decline we observe in the data, and has some basis in evidence from psychology. Experiments show that people have *reference-dependent preferences (RDP)*, i.e. they feel sensations of gains or losses when their income changes around a reference level. RDP are also characterized by *diminishing sensitivity (DMS)*: changes in income have a bigger impact on utility as distance from the reference level decreases. Supposing that consumers have a minimum, reference balance in mind during the pay period, e.g. a balance of zero, RDP could explain why consumers progress from a feeling of being wealthy to feeling of being poor over the course of a typical pay period.[39] In particular, DMS implies that spending (a negative change in the bank balance) has a smaller impact on RD utility when the paycheck first arrives, because the bank balance is far above the reference level, but becomes increasingly painful as the bank balance falls towards zero.[40]

In Section A.4 of Appendix A, we outline a simple formal model that captures this intuition. We show that the consumer chooses declining expenditures, as long as the

[38] A similar intuition is present in the literature on budgeting behavior, e.g. Heath and Soll (1996) motivate their paper by arguing that self-imposed spending limits lead to artificial experiences of wealth and poverty, triggered by the amount of funds remaining in a given budget. Heath and Soll point to a passage from Sinclair Lewis' novel Babbit, which makes this point succinctly: "The effect of his scientific budget planning was that he felt at once triumphantly wealthy and perilously poor."
[39] RDP have also been used to explain savings and consumption behavior over the lifetime (Bowman, Minehart, and Rabin,1998) and portfolio choice (Thaler equity premium puzzle reference here).
[40]This is similar in spirit to the "pain of paying" model of Prelec and Loewenstein (1998), in which consumers experience an immediate hedonic cost when they spend income.

consumer makes the particular kind of mistake incorporated in the motivating intuition: the consumer expects the feeling that spending is painless on payday to last longer than it actually does.[41]

We also show that, although RDP can lead to declining expenditures between paydays, this can take the form of either over- or under-spending. To understand the intuition, consider a consumer who is fully forward looking, and calculates λ, the marginal utility of lifetime income in each period. If they also have RDP, this adds an additional, positive utility from having money in the bank, and thus makes them less willing to spend money at all points during the pay period. On the other hand, consider a consumer with RDP who does not calculate λ, in order to economize on cognitive costs.[42] In this case, one possibility is that the consumer uses RD utility as a cognitively inexpensive, but flawed, technology for limiting spending. As a result, the consumer might overspends on payday, because the RD marginal valuation of income is close to zero, but cut back on spending later in the pay period, as the bank balance falls and spending becomes increasingly uncomfortable.[43]

[41] This type of mistake is well-supported by evidence from psychology, e.g. people who go shopping when they are hungry overspend, because they fail to predict that they will feel satiated in the near future (Gilbert, Gill, and Wilson, 1998). Loewenstein, O'Donoghue, and Rabin (2003) formalize this mistake in their model of *projection bias*.

[42] The literature on bounded rationality emphasizes the (prohibitive) cognitive costs involved in calculating λ (Gabaix and Laibson, 2000), and surveys on budgeting behavior indicate that, in fact, many households do not have any sort of monthly budget or spending plan (Ameriks, Caplin, and Leahy, 2003a).

[43] Ameriks, Caplin, and Leahy (2003) have proposed a model of an "absent-minded" consumer, who avoids the cognitive costs of keeping track of spending by adopting a random purchasing strategy. The present argument is similar, in that a consumer seeks to avoid cognitive costs of budgeting, but differs in that the consumer has recourse to "budgeting by feel" rather than just random purchasing.

This model is admittedly speculative, but it has some intuitive appeal, and suggests an alternative interpretation of the evidence in this paper, and other papers on the payday effect. In this framework the gradual decline in spending is driven by a perceptual bias rather than impatience, and need not be limited to households facing binding credit constraints.[44] Given the assumption that the reference level does not increase with wealth, the model could explain why the decline becomes less pronounced for households with high asset-income: for these households, typical consumption expenditures may have a sufficiently small impact on the bank balance that the household never feels "poor" enough during the month to sharply curtail spending. The model also offers a different interpretation of the method-of-payment result: households may choose declining cash spending, because spending becomes increasingly painful as the bank balance falls, but choose flat credit card spending, because this type of spending does not have an impact on the current bank balance and always feels relatively painless.[45,46]

It is possible that both impatience and perceptual biases could play a role in explaining the decline in spending between paydays, and assessing the relative

[44] It is noteworthy that the process of collecting the FES data effectively forces households to keep track of how much they spend, so that our results may understate the magnitude of the typical decline in the absence of such an intervention.

[45] This interpretation was stated more eloquently by Russian playwright Anton Chekov: "When you live on cash you understand the limits of the world around which you navigate each day. Credit leads into a desert with invisible boundaries."

[46] An additional assumption is still needed, to explain why households do not choose increasing credit card spending over the pay period, as cash spending becomes more and more painful. Again, mental accounting is one possibility. Another possibility is that credit card spending is not a perfect substitute for cash spending, due to different transactions costs in different purchase situations. E.g. when one is running late to work, and standing at the head of a line of impatient customers, it is quicker and more pleasant to buy the morning coffee with cash than with a credit card. Imperfect substitutability between payment mediums, combined with the feeling that cash spending is painful but credit card spending is not, could generate the method of payment difference we observe.

importance of these factors seems a worthy subject for future research. For example, if overspending at the beginning of the pay period is driven by the salience of the increase in the bank balance, policies such as electronic direct deposit could help minimize the extent to which people "notice" the jump in the bank balance.

8. Conclusion

We find evidence of declining expenditures between paydays, for the typical household in the working population of the UK. This is hard to explain with the standard model, but is consistent with a quasi-hyperbolic model, which describes consumers who have trouble limiting their own spending because of "present-biased preferences." However, we find only mixed evidence supporting the prediction of the hyperbolic model, that binding credit constraints drive the decline. One possible explanation is suggested by the method-of-payment difference that we find: households could have a system of mental accounting, which limits the extent to which credit card spending is used to offset the fall in cash spending caused by impatience. We also discuss an alternative explanation, based on perceptual biases and cognitive costs of budgeting rather than impatience. More research is needed to disentangle the roles of impatience and perceptual biases, and to assess the magnitude of the welfare losses implied by sub-optimal budgeting.

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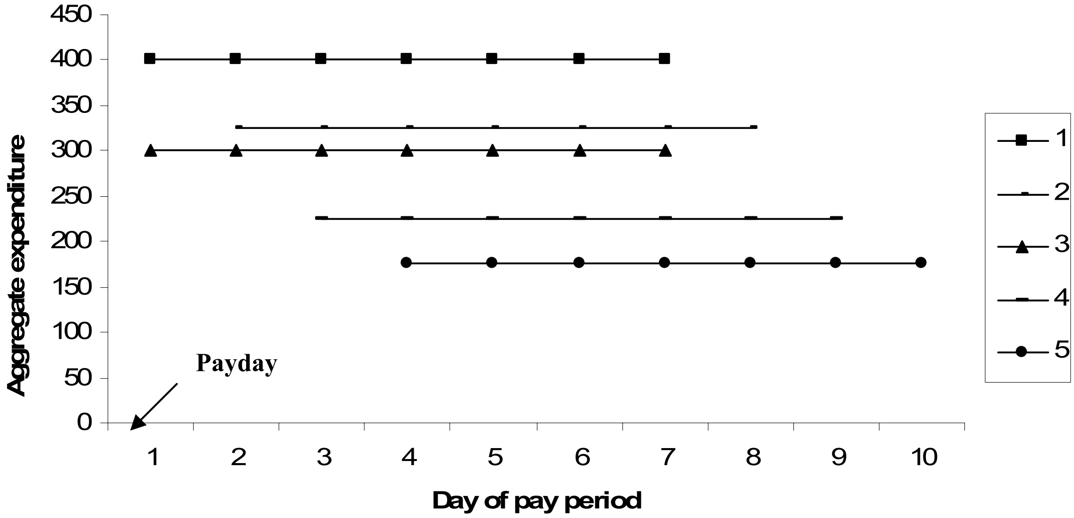
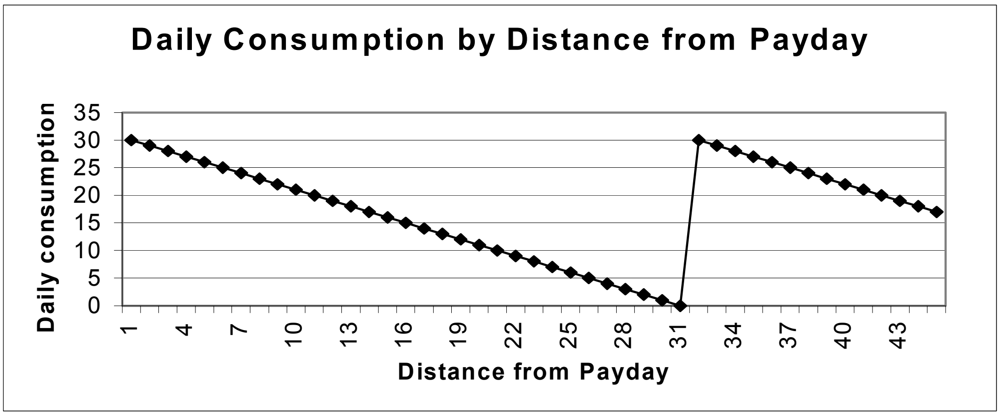
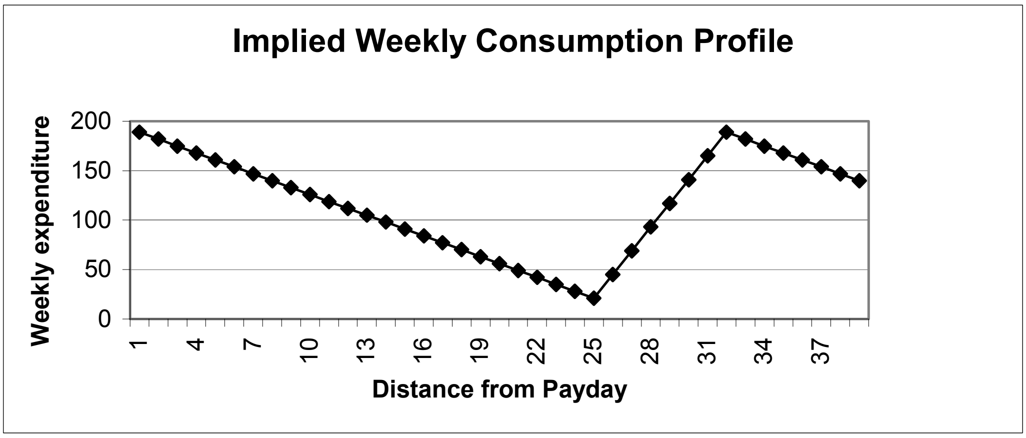
Figure 1: Data structure
Overlapping Diary Weeks, or Seven-day Aggregates of Expenditure, by day of the pay period



Notes: Diary expenditures are aggregated over seven-day, or week-long periods in the data, which need not correspond to the calendar week. Instead, the data contain many overlapping "diary weeks," beginning at all different distances from payday. E.g. average "weekly" expenditure beginning on day 1 of the pay period would be calculated by averaging observations (1) and (3).

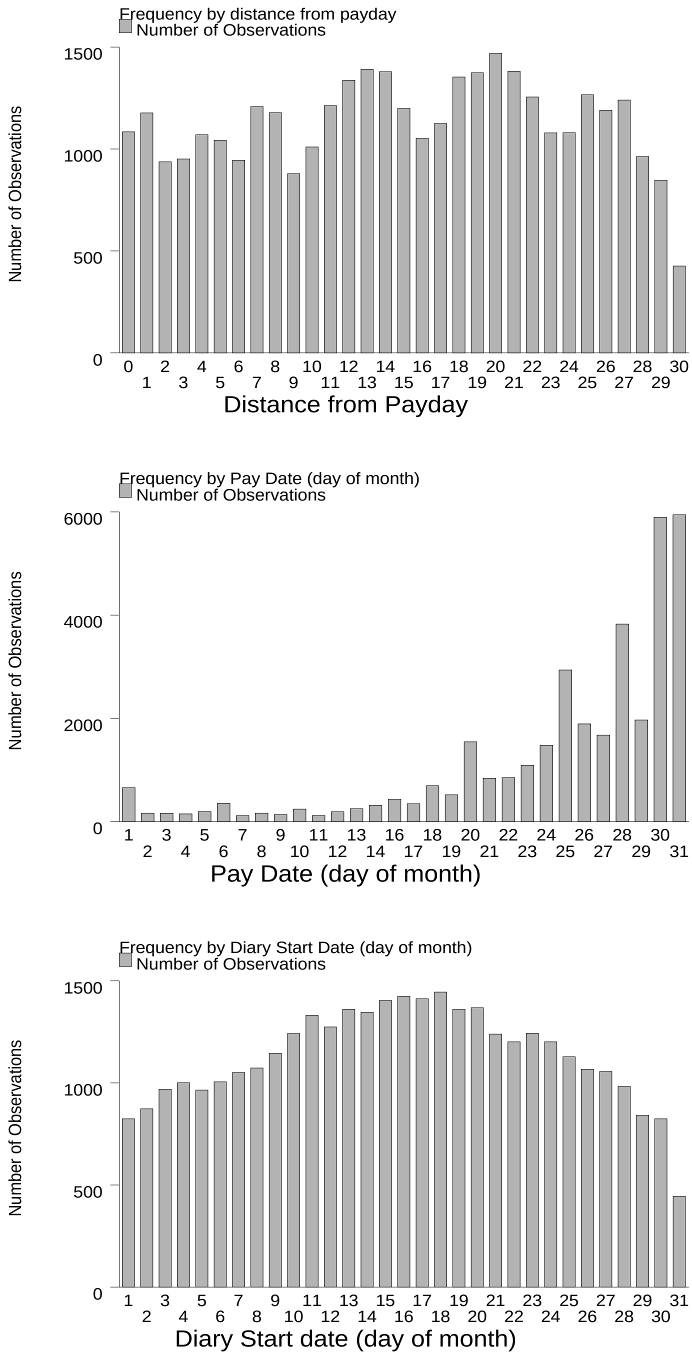
Figure 2: Linear Decline in Daily Consumption Expenditure and the Implied Dairy-Week Consumption Profile





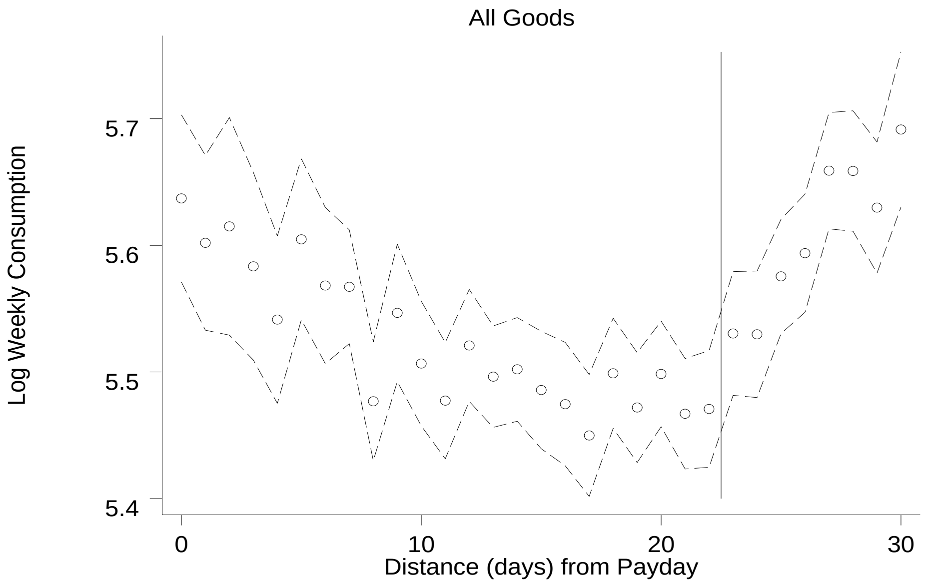
Notes: The first panel in this figure simulates a particular linear decline in daily consumption expenditure. The second panel shows the implied, "V-shaped" profile of weekly expenditure, where each point in the figure represents a week-long aggregate, beginning at that distance from payday. Weekly expenditure begins to rise six days before the next payday, because these weeks overlap with the jump in spending on the next payday.

Figure 3: Descriptive Statistics



Notes: These panels show sample frequencies for key variables: distance from payday, pay date, and start date of a week-long expenditure diary.

Figure 4: Weekly Consumption Expenditure by Distance from Payday
(With 95% confidence bands)



Notes: Each point in the figure represents an average of all diary weeks beginning at that distance. The vertical line indicates the exclusion of weeks beginning in the range of distances that are likely to be contaminated by measurement error, as discussed in Section 3.2 of the text.

Table 1: Household Demographics by Distance from Payday

Mean Household Characteristics	Distance of diary start date from payday			
	[-4 to -1 days before]	[0-7 days after]	[8-14 days after]	[15-22 days after]
Age (head)	37.83	37.90	38.46	38.34
	(0.20)	(0.17)	(0.16)	(0.15)
Income	1,727	1,710	1,694	1,694
	(15.81)	(14.05)	(12.38)	(11.15)
Credit Card	0.78	0.77	0.78	0.79
	(0.01)	(0.00)	(0.00)	(0.00)
Married	0.61	0.62	0.63	0.62
	(0.01)	(0.01)	(0.01)	(0.01)
No. of Earners	1.51	1.49	1.49	1.50
	(0.01)	(0.01)	(0.01)	(0.01)
Household Size	2.26	2.26	2.29	2.29
	(0.01)	(0.01)	(0.01)	(0.01)
Observations	5,465	7,359	8,384	9,219

Notes: Standard errors in parentheses.

Table 2: Log Weekly Consumption as a Function of Distance from Payday

	All goods (1)	No bills (2)	No bills Single-person h.h. (3)	Instant consumption (4)
0 to 7 days after	0.121	0.090	0.134	0.070
	(0.013)***	(0.013)***	(0.031)***	(0.025)***
8 to 14 days after	0.047	0.041	0.073	0.054
	(0.012)***	(0.011)***	(0.026)***	(0.023)**
4 to 1 days before next payday	0.149	0.108	0.133	0.095
	(0.014)***	(0.013)***	(0.032)***	(0.028)***
Controls: All time, region, demographic controls, survey-fatigue dummy				
Observations	30424	30424	7021	30424
Estimation method	OLS	OLS	OLS	Tobit
R-squared	0.29	0.32	0.12	n.a.

Notes: Bills refer to payments with non-discretionary timing during the pay period, e.g. utility bill payments and pension contributions.. Model (3) is estimated for single-person households only. Instant consumption includes take-away food, alcohol and food consumed in bars and restaurants, cinema and disco tickets. Robust standard errors are in parentheses, corrected for clustering on household. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Estimating the Decline in Daily Spending
Level of Weekly Consumption as a Function of Distance from Payday
Restricted Spline Regressions

	All goods		
	31-day pay periods	30-day pay periods	30-day pay periods, (earlier threshold)
	(1)	(2)	(3)
Slope of first segment.	-1.622 (0.434)***	-0.722 (.624)	-1.304 (0.624)***
Implied absolute decline	$\theta = 0.233$	$\theta = 0.103$	$\theta = 0.186$
Implied percent decline	**-0.6%**	**-0.2%**	**-0.4%**
F-Test of restriction	$F = 0.619$	$F = 0.526$	$F = 0.579$
Controls: All time, region, demographic controls, survey-fatigue dummy			
Observations	19218	10796	10796
Estimation method	OLS	OLS	OLS
R-squared	0.58	0.61	0.61

Notes: These regressions impose a particular, asymmetric "V-shape" on the relationship between distance and weekly expenditure, implied by the assumption of a linear decline in daily spending. Section 3.2 explains how the absolute and percent declines in daily spending are inferred from the slope coefficient of the first segment. The first segment extends from day 1 to day 24 in model (1), 1 to 23 in model (2), 1 to 21 in model (3). The slope of the second segment of the spline is not reported, as it is restricted to be a particular multiple of the slope of the first segment. The model includes separate intercept terms for the two segments, which are also not shown. Robust standard errors are in parentheses, adjusted for clustering on household. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Log Weekly Consumption on Distance from Payday, by Alternative Measures of Access to Credit

	Top Quartile of Asset Income		Households With Credit Card	
	All goods	No bills	All goods	No bills
	(1)	(2)	(1)	(2)
0 to 7 days after	0.015	0.016	0.111	0.079
	(0.032)	(0.031)	(0.015)***	(0.015)***
8 to 14 days after	-0.008	-0.015	0.045	0.040
	(0.029)	(0.026)	(0.013)***	(0.012)***
4 to 1 days before next payday	0.063 (0.036)*	0.021 (0.033)	0.128 (0.016)***	0.087 (0.015)***
Controls: All time, region, demographic controls, survey-fatigue dummy				
Observations	6068	6068	23706	23706
Estimation method	OLS	OLS	OLS	OLS
R-squared	0.24	0.26	0.26	0.29

Notes: This table reports separate regressions for households who are unlikely to be credit constrained: those with high asset income, and those with credit cards. Robust standard errors are in parentheses, adjusted for clustering on household. *significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Log Weekly Consumption on Distance from Payday, Cash Payment vs. Credit Payments of Cardholders.

(conditional on non-zero credit card spending)

	All goods		**No bills**	
	Cash	Credit card	Cash	Credit card
	(1)	(2)	(3)	(4)
0 to 7 days after	0.107	-0.004	0.075	-0.015
	(0.025)***	(0.048)	(0.022)***	(0.048)
8 to 14 days after	0.044	0.047	0.038	0.047
	(0.023)**	(0.040)	(0.02)*	(0.040)
4 to 1 days before	0.115	-0.018	0.062	-0.023
next payday	(0.027)***	(0.049)	(0.024)***	(0.049)
Controls: All time, region, demographic controls, survey-fatigue dummy				
Observations	22140	22140	22140	22140
Estimation method	Tobit	OLS	Tobit	OLS
R-squared	n.a.	0.13	n.a.	0.13

Notes: This table reports separate regressions for cash purchases and credit-card purchases, for households who have non-zero spending with a credit card during the diary week. Robust standard errors are in parentheses, adjusted for clustering on household. *significant at 10%; ** significant at 5%; *** significant at 1%

Appendix A

A.1 Time preference, credit constraints, and declining expenditures

In the standard model, a combination of impatience and credit constraints can generate a cycle of rising and falling expenditures with the peaks after each payday. Consider the benchmark model, in which a consumer maximizes a time-separable utility function with a constant discount factor $\delta < 1$ that reflects impatience. Assume that the consumer cannot borrow, and that there are two pay periods, with two periods each. The consumer thus maximizes utility subject to two budget constraints:

$$\text{Max} \quad U = \sum_{t=0}^{3} \delta^t u(c_{it}) \quad \text{st.} \quad Y_0 \geq c_0 + c_1 \quad \text{and} \quad Y_3 + A \geq c_3 + c_4$$

In this problem, initial wealth is equal to income that arrives at the beginning of the first pay period, Y_0. Wealth in the third period is equal to the sum of savings from previous periods, A, and new income, Y_3, arriving in at the beginning of the second pay period (for simplicity, assume that the price of consumption equals 1 and that the interest rate is equal to zero). The resulting Euler equation $u'(c_t) = \delta u'(c_{t+1})$ implies $c_0 > c_1 > c_2 > c_3$, but the borrowing constraint causes the consumer to violate the Euler equation, i.e. Y_0 is not sufficient to allow $c_0 + c_1 > c_2 + c_3$. The consumer spends all she can on c_0 and c_1 because these yield more utility on the margin (due to impatience) than c_2 or c_3, but then has income $Y_3 = Y_0$ left to spend on the remaining time periods ($A = 0$). Spending this income causes consumption to increase discontinuously at the beginning of the second pay period, back to the first-period level, $c_2 = c_0$ and then decline again to $c_3 = c_1$.

A.2 Calibration of the standard, exponential model

Assume that the consumer has the same time-separable utility function as in the last sub-section, but maximizes utility over a thirty-day pay-period.[47] The consumer is credit constrained, and thus maximizes utility subject to Y_0 during the pay period:

$$\text{Max} \quad U = \sum_{t=0}^{T} \delta^t u(c_{it}) \quad \text{st.} \quad Y_0 \geq \sum_{t=0}^{T} \frac{p_t c_t}{R_t}$$

Where period t is a day in a pay-period of length T, p_t is the price of consumption, and R_t is a gross interest rate. This maximization problem yields the standard Euler equation:

$$u'(c_{it}) = \frac{p_t}{p_{t+1}} \delta R u'(c_{it+1}) \qquad (8)$$

Assuming isoelastic utility, for which $u'(c_{it}) = c_{it}^{-\rho}$, one can take logs and express the Euler condition in terms of the percent daily change in consumption expenditure:

$$\ln(c_{it+1}) - \ln(c_{it}) = \frac{r - \gamma}{\rho} - \frac{\ln(p_{t+1}) - \ln(p_t)}{\rho} \qquad (9)$$

Where $\gamma = -ln(\delta)$ is the daily discount rate, ρ is the inverse of the intertemporal elasticity of demand for consumption, and $r = ln(R_t)$ is the daily interest rate. At this point we make the assumption that prices are constant over the pay period, eliminating the second term in the expression.

We calculate the value of ρ implied by the percent decline in daily expenditure we report in Table 3, substituting conservative values for the other free parameters. We assume a value of 0.8 for the annual discount rate, which is well below typical estimates

[47] For purposes of comparison we follow the notation of Shapiro (2004) in the calibration exercises.

and implies a daily discount rate of 0.0006.[48] We also assume an annual interest rate of .05, which implies a daily interest rate of 0.0001. Our estimates of the daily decline range from -0.002 to -0.006, generating a value of ρ that implies an intertemporal elasticity of substitution between 4 and 12. These estimates suggest an implausibly large willingness to substitute consumption between days: using the midpoint of the lower range for the elasticity, a 10 percent decrease in the price on day *t+1* would lead to an increase in consumption of about 80 percent, relative to day *t*.

As an alternative exercise, we calculate the daily discount rate implied by the daily decline we observe, using a more reasonable value of ρ = 1, which corresponds to the case of log utility, and again assuming a daily interest rate of 0.0001. We find that percent decline in daily spending is compatible with a daily discount rate between -0.0019 and -0.0061, but this generates an implausible annual discount factor between 0.5 and 0.11.

A.3 Calibration of the quasi-hyperbolic model

The quasi-hyperbolic model leads to the following generalized Euler equation, assuming isoelastic utility and assuming that the consumer is aware of their self-control problem (see Laibson, 1996 for a more complete derivation):

$$c_t^{-\rho} = [c'(W_{t+1})\beta\delta + (1 - c'(W_{t+1}))\delta]c_{t+1}^{-\rho} \qquad (10)$$

Assuming an inability to borrow, the initial condition for calculating the optimal consumption path over a pay period *T* days long is consumption on the final day of the

[48] This is substantially lower than recent estimates that put the annual discount rate in the neighborhood of 0.9 or higher (Laibson, Repetto, and Tobacman, 2003; Gournichas and Parker, 2002).

pay period, $c_T = W_T$. Now suppose that, in a given period $t+1$, consumption is equal to $c_{t+1} = \alpha_{t+1} W_{t+1}$, and substitute into the generalized Euler equation:

$$c_t^{-\rho} = [\alpha_{t+1}\beta\delta + (1-\alpha_{t+1})\delta](\alpha_{t+1}W_{t+1})^{-\rho} \qquad (11)$$

Using the fact that $W_{t+1} = W_t - c_t$, and rearranging terms, we arrive at:

$$c_t = \frac{\alpha_{t+1}}{\alpha_{t+1} + (\delta(1-(1-\beta)\alpha_{t+1}))^{\frac{1}{\rho}}} W_t \qquad (12)$$

Using this expression, and the initial condition $\alpha_T = 1$, it is possible to solve recursively for the optimal consumption path.

We calibrate the hyperbolic model by assuming $\delta = 1$ during the pay period, and then find values for β and ρ such that the consumption path yields a prediction in the observed range of -.006 to -.002 (the rate of decline is independent of the level of wealth W_t). We find that the model can predict the midpoint of the rage of estimates, -0.0045, for reasonable parameter values: $\beta = 0.93$ and an intertemporal elasticity of 0.45.

A.4 Model with Reference-Dependent Preferences and Projection Bias

A simple way to formalize the intuition discussed in Section 7 is to assume that the consumer maximizes a period t utility function:

$$u(c_t) + v(W_{t-1} - pc_t - r) \qquad (13)$$

Such that u() is a concave function of consumption, and $v()$ is a function describing the hedonic value placed on distance of the current bank balance, W_t - pc_t, from a reference level r. Because $v'()$ is assumed to be non-negative, spending p dollars causes a reduction in utility of $-pv'()$. The function $v()$ also incorporates diminishing sensitivity, with the assumptions $v''() < 0$ if $W_t - pc_t > r$, and $v''() > 0$ if $W_t - pc_t < r$. For convenience, we assume that the consumer never finds it optimal to go below *r* during the pay period.[49] The tendency for changes in the current bank balance to generate feelings of wealth or poverty is then a direct implication of diminishing sensitivity: $v''() < 0$ throughout the pay period, because the bank balance is never below *r*, and thus the hedonic cost of spending a dollar, $-v'()$, increases as the bank balance falls.

Assume that the consumer suffers from projection bias, i.e. mistakenly expects the future valuation of income to be same as the current valuation, and faces a standard lifetime budget constraint without credit constraints, in which *t* indexes days and *T* is the length of the lifetime:

$$\sum_{t=0}^{T} pc_t = W_{t-1} + \sum_{t=0}^{T} Y_t \; . \qquad (14)$$

In this case the consumer has the following spending rules for periods *t* and *t+1*, from the perspective of period *t*:

$$u'(c_t) - p \cdot v'(W_{t-1} - pc_t - 0) - p \cdot \lambda = 0 \qquad (15)$$

$$u'(c_{t+1}) - p \cdot v'(W_{t-1} - pc_{t+1} - 0) - p \cdot \lambda = 0 \qquad (16)$$

The consumer thus weighs the marginal utility of consumption against the standard marginal utility of income, λ, which is constant, and also against the reference-dependent marginal valuation of income $v'()$. Note that the consumer makes a mistake in period *t* (projection bias) by not taking into account the fact that current spending has an impact on reference-dependent utility in period *t+1* and all other future periods, by reducing the

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[49] Because we assume the individual does not go below *r*, *loss aversion*, the other key property of RDP, does not play a role. However, if we relax this assumption and include loss aversion the model makes the same qualitative predictions.

level of the bank balance. Once period t+1 arrives, the consumer finds that the true spending rule in *t+1* is actually:

$$u'(c_{t+1}) - p \cdot v'(W_t - pc_{t+1} - 0) - p \cdot \lambda = 0 \qquad (17)$$

Where $W_t = W_{t-1} - pc_t$. Given that $v''() < 0$, and $W_t < W_{t-1}$, it follows that the consumer chooses $c_t > c_{t+1}$, a declining consumption profile.[50]

If the consumer makes a fully forward-looking calculation of λ, as we have assumed so far, the consumer chooses declining expenditures, but always *under-spends* because the marginal valuation of income is always greater than in the standard model: $\lambda + v'()$, with $v'()>0$. An alternative assumption is that some consumers do not calculate λ, due to cognitive costs, in which theses consumers are likely to overspend on payday: the marginal valuation of income is simply $v'()$, which may be close to zero at the beginning of the pay period, implying that the consumer consumes to the point of satiation. As the pay period progresses, however, $v'()$ increases and acts as a crude limit on spending.

[50] With partial projection bias, expenditure is still declining, as long as the bias is not too mild. More precisely, $c_t > c_{t+1}$ if $v'(Y_{t-1} - p\,c_t) < ((2\alpha - 1)/\alpha)v'(Y_t - pc_t + 1)$, where $0 < \alpha < 1$, and projection bias becomes complete as $\alpha \to 1$.

Appendix B

Table B1: Log Weekly Consumption vs. Distance from Payday, Non-Parametric Distance Specification

Expenditure Diary Week Starts:	All goods (1)	No bills (2)	Instant consumption (3)	Instant consumption (4)
On payday	0.200 (0.027)***	0.150 (0.025)***	0.135 (0.047)***	0.142 (0.051)***
1 Day After	0.130 (0.028)***	0.082 (0.026)***	0.024 (0.047)	0.026 (0.050)
2 Days After	0.115 (0.030)***	0.082 (0.027)***	0.064 (0.052)	0.077 (0.054)
3 Days After	0.126 (0.030)***	0.107 (0.028)***	0.096 (0.052)*	0.106 (0.055)*
4 Days After	0.127 (0.029)***	0.108 (0.027)***	0.141 (0.050)***	0.150 (0.053)***
5 Days After	0.150 (0.029)***	0.118 (0.027)***	0.026 (0.051)	0.029 (0.053)
6 Days After	0.136 (0.030)***	0.115 (0.028)***	0.142 (0.053)***	0.154 (0.055)***
7 Days After	0.122 (0.027)***	0.107 (0.025)***	0.154 (0.048)***	0.163 (0.051)***
8 Days After	0.051 (0.028)*	0.047 (0.026)*	0.122 (0.049)**	0.131 (0.052)**
9 Days After	0.102 (0.031)***	0.098 (0.029)***	0.106 (0.054)*	0.108 (0.057)*
10 Days After	0.088 (0.029)***	0.060 (0.028)**	0.034 (0.051)	0.047 (0.055)
11 Days After	0.061 (0.028)**	0.061 (0.027)**	0.080 (0.048)*	0.084 (0.052)
12 Days After	0.096 (0.027)***	0.066 (0.025)***	0.047 (0.048)	0.052 (0.051)
13 Days After	0.058 (0.026)**	0.071 (0.024)***	0.142 (0.047)***	0.152 (0.050)***
14 Days After	0.033 (0.025)	0.046 (0.023)**	0.086 (0.043)**	0.089 (0.050)*
15 Days After	0.033 (0.026)	0.020 (0.024)	0.059 (0.046)	0.064 (0.051)
16 Days After	0.015 (0.028)	0.007 (0.026)	0.026 (0.051)	0.023 (0.053)
17 Days After	0.030 (0.028)	0.024 (0.026)	0.088 (0.050)*	0.097 (0.053)*
18 Days After	0.046	0.041	0.019	0.020

	(0.026)*	(0.025)*	(0.046)	(0.050)
19 Days After	0.035	0.048	0.065	0.072
	(0.026)	(0.025)*	(0.045)	(0.049)
20 Days After†	0.009	0.024	0.014	0.015
	(0.026)	(0.024)	(0.047)	(0.050)
-4 Days Before Payday	0.167 (0.027)***	0.127 (0.025)***	0.078 (0.047)*	0.079 (0.050)
-3 Days Before	0.176	0.128	0.090	0.098
	(0.025)***	(0.023)***	(0.043)**	(0.049)**
-2 Days Before	0.170	0.148	0.167	0.183
	(0.026)***	(0.025)***	(0.042)***	(0.051)***
-1 Day Before	0.151	0.102	0.157	0.171
	(0.029)***	(0.026)***	(0.051)***	(0.054)***
Controls: All time, region, demographic controls, survey-fatigue dummy				
Observations	30424	30424	30424	30424
Estimation method	OLS	OLS	OLS	Tobit[1]
R-squared	0.29	0.32	0.17	n.a.

Notes: The omitted distance category aggregates distances 21 and 22, due to low observations at these distances. Using 22 alone does not have an effect on the qualitative results in the table. Robust standard errors are in parentheses, adjusted for clustering on household. * significant at 10%; ** significant at 5%; *** significant at 1%.