The Credit Card Debt Puzzle: New Facts and Theory

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Abstract

Simultaneously holding liquid assets and credit card debt is known as the credit card debt, or co-holding, puzzle. Around 45% of households in the US Panel Study of Income Dynamics (2010-2014) fall into this category. I revisit the puzzle from the perspective of the degree of co-holding and show around 40% of co-holders hold between 2 and 200 times more liquid asset than credit card debt. This new fact has implications for co-holding explanations based on liquidity. I propose an alternative explanation in which consumers value wealth and thus dislike making payments. This explanation has applications to a range of consumer choices, such as Buy Now Pay Later and the credit card premium.

JEL Classifications: D11, D12, D14, G51

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1 Introduction

Simultaneously holding liquid assets and credit card debt is known as the credit card debt, or co-holding, puzzle. Around 45% of households in the Panel Study of Income Dynamics (PSID) (2010-2014) are co-holders.[1] The related literature focuses on various explanations that directly, or indirectly, rely on binding liquidity constraints. I document new facts that suggest liquidity need is not a complete explanation. I find around 40% of co-holders have liquid assets 2 to 200 times greater than their credit card debt (liquid group), meaning, they are very liquid. This observation is inconsistent with structural models that do not predict credit card debt for households with high liquidity.

Instead of studying co-holders as one group and comparing this group to non co-holding groups, as in the literature, I relax the one group assumption. I organise co-holders into two subgroups, according to their liquidity relative to their credit card debt. Studying the sub groups shows differences between them that suggest each may be co-holding for different reasons. I estimate a regression to pin down the relationship between credit card debt and liquid assets and find liquid assets are substitutes for credit card debt when the household is very liquid and complements otherwise. Descriptive statistics show the liquid group, are, on average, wealthier, have larger holdings of stocks and bonds, reach a higher educational level, and have somewhat lower mortgages and higher house values than the less liquid group.

Based on these new facts, I propose an alternative explanation for the credit card debt of the liquid co-holders that does not rely on liquidity need. The explanation assumes consumers have preferences for money (used interchangeably with wealth) and thus dislike making payments. The pain of payment introduces a friction between spending and paying that does not involve liquidity constraints and makes deferring payment attractive. Given this, the model describes how the possibility of separating consumption and payment in time affects utility and demand.

The assumption of preferences for wealth, which is at the centre of the model, is not new in economic theory. Early economists, such as David Hume, Adam Smith, John Maynard Keynes and Irving Fisher believed that people valued wealth as an end in itself. Recent literature also assumes wealth has a value in its own right, for example, secular stagnation Michau (2018), Ono (2015), rational bubbles (Michau, Ono, and Schlegl, 2018), and the savings of the rich, (Carroll, 1998).[2] Pain of payment has long been dis-

[1]This is consistent with other data sets in the US and Europe.

[2] A model with preferences for wealth is distinct from Money in Utility models, where its purpose is to justify holding cash over another asset with a higher expected return.

cussed in behavioural research (see Massenot (2021), Loewenstein and Prelec (1998), and Quispe-Torreblanca, Stewart, Gathergood, and Loewenstein (2019), for example. Pain of payment naturally follows from utility from wealth. If wealth is valued as a good, it follows that a reduction in wealth (payment) leads to a fall in utility. These ideas are in contrast to standard theory where the value of wealth is for future consumption.

The model predicts that if the consumer has sufficiently high levels of liquidity (or wealth), rather than spending up to her budget constraint, she reaches a utility maximising consumption level at which the constraint is non binding. She consumes optimally *and* retains liquidity. Consuming more, after the optimal point, necessarily makes her worse off because parting with the next dollar is more painful than consuming more is pleasurable. Further, when payment is exogenously deferred, as for convenience use of a credit card, the utility maximising choice relative to paying with cash or a debit card, is to is to spend more.[3] When consumption is put off to the future, in the case of booking a holiday, the consumer optimally spends less. But neither of these results hold ex post.

The total ex post net utility from time separated transactions is less than the utility from contemporaneous consumption and payment. That is ex-ante demand is not optimal ex post. The inconsistency means that in the period in which the consumer makes payment she is more likely to continue to defer. There are two reasons for this. First, making a payment on an amount that is deferred is *more* painful than payment contemporaneous with consumption. Second, because the ex ante optimal bundle choice is higher than the contemporaneous bundle choice would have been, the the pain of payment increases even more. Because of these two effects the consumer may accumulate unnecessary debt (in the sense that they have sufficient liquidity) by putting off paying the card card bill, settling the invoice, making the instalment payment etc. This is relevant for welfare and thus has implication for policy.

There is a growing category of consumer choices, in addition to the credit card debt puzzle, which are explained by binding liquidity constraints, but are observed where liquidity constraints appear not to bind. Examples are the credit card premium, the Buy Now Pay Later (BNPL) premium,[4] and paying late charges on bills (Prelec and Simester (2001), DiMaggio, Williams, and Katz (2022), and Ausubel (1991)). A common feature here is the separation of payment and consumption in time. A challenge in studying payment and consumption separated in time is that there is no mechanism in the standard lifecycle model that leads to deferring payment when budget constraints are

[3]This is consistent with the credit card premium puzzle, (Prelec and Simester, 2001).

[4]The BNPL premium refers to the emerging evidence that consumers spend more when paying with BNPL compared to other payment methods, even if they appear not to be liquidity constrained.

not binding.

The second contribution of the paper is thus to propose a general rational choice model for liquid co-holding and other liquidity puzzles. Consumers today increasingly face unsolicited offers to spread payments for a purchase, whether they have a liquidity need or not. Why so many accept the offer without an apparent binding constraint (DiMaggio, Williams, and Katz, 2022) is not well understood. Understanding the mechanisms for this, and other, choices may contribute to addressing the welfare trade-offs of consumer credit; welfare improving when it allows smoothing of consumption when constraints bind, versus welfare reducing when overspending leads to unnecessary consumer debt.

The paper is set out as follows: Subsection 1.1 review the literature. Section 2 explains the identification of two sub groups of co-holders and shows how they differ from each other with respect to credit card debt. Section 3 develops a consumer choice model with wealth preferences and shows its implications for optimal choice predictions in several consumer choice settings. Section 4 then concludes.

1.1 Related Literature

1.1.1 The credit card debt puzzle

Co-holding was first formally noted by Gross and Souleles (2002); *'over a third of borrowers simultaneously hold more than one months income in liquid assets'*. Since then a number of explanations have been proposed for this violation of the no arbitrage condition.

Telyukova (2013) suggests that much of the puzzle is explained by precautionary need for cash consumption; because not all goods can be paid for with credit cards, households hold cash for these items and for any unanticipated cash needs. One implication of this theory is that precautionary liquidity need falls as the proportion of goods that can be paid for with credit cards increases, as it has over the last 30 years. Using data from the SCF, 1998 - 2010, Gorbachev and Luengo-Prado (2019), however, find the proportion of co-holders to be stable over time.

Druedahl and Jørgensen (2018) develop a broader precautionary savings theory, and test it with a structural model. The paper uses credit card debt and liquid asset data from from the SCF 1998 - 2013 to estimate co-holding and other borrowing behaviour. It assumes households with positive liquid assets can increase their line of credit and accumulate new debt. Increasing the line of credit is driven by household needs to spend or accumulate precautionary savings in the face of dynamic constraints. It does not address co-holding if the household is already holding high levels of liquidity.

Angrisani, Burke, Lusardi, and Mottola (2020) find financial literacy is positively correlated with the ability to absorb shocks and to plan for retirement but finds little correlation with *negative* financial behaviour such as carrying credit card debt. These negative behaviours may be more related to resource constraints or behavioural traits than a lack of understanding. A consumer can thus be financially literate and also engage in negative financial behaviour.

Gathergood and Weber (2014) find co-holders score well on financial literacy tests but also have a high rate of reporting impulsive behaviour and this provides some support for the accountant-shopper theory. The accountant-shopper theory describes an intra-household or intra-self dynamic in which there is a patient *accountant* and a less patient *shopper*. Co-holding arises as the accountant controls consumption, chosen by the shopper. The shopper spends only on a credit card. The accountant controls the spending level of the shopper by not fully paying down the credit card bill. The effectiveness of this strategy is consistent with the finding of Gross and Souleles (2002) that paying the credit card bill leads the shopper to again accumulate debt up to some constant utilisation rate (proportion of line of credit taken as debt). The accountant's saving targets are motivated by income uncertainty and a bequest motive. The only available asset for this is the liquid asset. The theory explains high levels of co-holding, but it is not clear how the availability of an alternative asset, with higher returns than the liquid asset would affect the the level of co-holding explained.

Personality types are suggested as an explanation for co-holding. Choi and Laschever (2018) finds that personality traits are significant in predicting the likelihood of being a co-holder. The traits work through the two channels of precautionary liquidity motives and intra household/intra self dynamics.

1.1.2 Pain of payment

The alternative explanation for co-holding set out in section 3 abstracts from liquidity need by assuming consumers dislike making payment. Loewenstein and Prelec (1998) suggest a model which includes a pain of payment as well as pleasure of consumption. The model finds the type of good being purchased influences the optimal payment approach - instalments, pre pay, pay with debt, for example.

Quispe-Torreblanca, Stewart, Gathergood, and Loewenstein (2019) estimates a model over high frequency credit card data and tests whether pain of payment is sensitive to type of purchase. It finds that debt related to durable good purchases is more likely to be paid off than debt associated with non or semi durables. The result supports one of the predictions of the Loewenstein and Prelec (1998) model. The interpretation is that goods that deliver ongoing utility over time have lower associated disutility of payment thus payment is less likely to be deferred.

In a lifecycle model Massenot (2021) replaces opportunity costs (higher consumption today and forgone future consumption) with pain of payment costs. The main prediction is that liquid agents consume out of transitory shocks; consistent with empirical evidence but inconsistent with predictions of standard models. It points out the role of pain of payment in the case of the credit card premium but does not provide an explicit solution.

1.1.3 Other liquidity puzzles

Two related topics to liquid co-holding are BNPL and the credit card premium.

DiMaggio, Williams, and Katz (2022) finds consumers spend more after adopting Buy Now Pay Later (BNPL). The increase in spending is persistent and is observed where liquidity constraint appear to bind and, importantly, where they apparently do not.

The credit card premium refers to evidence that consumers spend more when paying for goods with a credit card than with cash. Prelec and Simester (2001) studies the credit card premium by measuring willingness to pay in an experimental setting. Participants bid in a second price auction for sporting event tickets and merchandise. Participants are randomly assigned payment methods of credit card or cash. The median participant is willing to pay a 64 percent premium by credit card versus cash. The paper concludes that neither liquidity constraints nor precautionary liquidity needs can account for the observed outcomes.

2 An Empirical Analysis of the Credit Card Debt Puzzle from the Perspective of Liquidity

I find around 40 percent of co-holders in the PSID, 2010 - 2014, are highly liquid. This makes their credit card debt inconsistent with liquidity based explanations for co-holding.

In this paper I first identify co-holders with high liquidity. I use a ratio of credit card debt and liquid assets at the household, time period, level. This is a new approach to characterising co-holding and is different to the approach typically used in the literature. Here credit card debt and liquid assets are matched at the variable, not household, level. In my configuration, when the ratio takes a value over 2, it means the household has more than twice the level of liquid assets relative to credit card debt. I use the ratio value to group co-holders, making the assumption that for a household with a ratio value greater than 2, liquidity need is not the explanation for their borrowing.

2.1 Data

I use data from the US longitudinal biennial household survey, the Panel Study of Income Dynamics (PSID) which follows around 5000 households (about 18,000 individuals) over time. In the 2010 a question on interest bearing credit card debt was added to the survey. The full question is in appendix A.

In total, 51% of households in the PSID report holding interest bearing credit card debt in at least one period, consistent with other US surveys. For example, $60-62\%$, in the Survey for Consumer Finances, 51%, Census Bureau.

Challenges in studying the credit card debt puzzle that are specific to the PSID structure such as the two year gap between surveys and the absence of information on households which have been refused a credit card, are discussed in appendix B.1.

2.2 Ranking of co-holders

I calculate a measure of the degree of co-holding, by household and time period. I divide the liquid assets of household i in time t by the credit card debt of household i in time t. Denote the ratio as $\Upsilon_{i,t}|ch = 1$, which I will refer to from here as $\Upsilon_{i,t}$, dropping the conditional notation for simplicity. I then calculate the centile values of Υ's distribution and denote these by Υ_p, $p \in [1, 10]$.

$$\Upsilon_p = \left[\left[\frac{liquid\ assets}{credit\ card\ debt} \right]_{i,t} \right]_{\mathbf{p}} = percentile\ of\ ratio \tag{1}$$

Plotting Υ_p against the percentiles shows the extent of co-holding across all co-holders.

An alternative approach, common in the literature, is to calculate the centiles of liquid assets and centiles of credit card debt and to compare the centile values to each other.

For example, the 30th centile value of liquid assets is 1000 and the 30th centile of credit card debt is 950. So the ratio is 1.05 This is equivalent to calculating the ratio as:

$$\phi_p = \left[\frac{liquid\ assets_{\mathbf{p}}}{credit\ card\ debt_{\mathbf{p}}}\right] = ratio\ \ of\ \ percentiles \tag{2}$$

where I again drop the conditional notation of being a co-holder for simplicity. Again p is denotes the centile $1, ..., 10$.

The p values of ϕ_p provide target moments for structural models to match as well as discussions about the characteristics of co-holders with respect to wealth, income, education and other characteristics possibly related to co-holding.

The first column of table 1 shows these ratio values, ϕ_p for percentiles 10 - 90 in the PSID sample.

The values range from 0.75 and 2. This is consistent with the literature (Telyukova (2013), Druedahl and Jørgensen (2018), for example) An interpretation of ϕ_p is that even co-holders in the 90th centile of liquid assets and the 90th centile of credit card debt, have less than twice as much liquidity as debt. For the 10th centile, even if the household did choose to use all its liquid assets to pay it credit card debt, it could not fully achieve this and it if it did, it would be left with no cash at all. These values of ϕ_p are robust to other definitions of co-holding. From this perspective, some of the theories presented in the literature are plausible; precautionary liquidity, precautionary savings, risk aversion. These theories are successful in matching the moments in column 1, table 1.

Table 1 compares the percentiles from equation 2 and 1. The comparison highlights that in terms of the extent of the credit card debt puzzle, ϕ_p overstates co-holding at the bottom of the ratio distribution and understates it at the top.

percentiles (p)	ϕ_p	Υ_p
10	0.75	0.08
20	0.98	0.20
30	1.00	0.38
40	1.02	0.67
50	1.06	1.11
60	1.05	1.94
70	1.22	3.33
80	1.45	6.25
90	1.99	16.92

Table 1: A comparison between ϕ and Υ over percentiles

The household level matching approach is a different way to quantify the extent of the co-holding puzzle. It shows that just under 50 percent of households have little cash coverage, reinforcing the precautionary liquidity explanation. But it also reveals households with high levels of cash coverage. Υ_p provides a scale by which the level of co-holding, can be ranked. The distribution of this ratio has a strong right skew and a range of $0.0002 - 2000!$[5], that is, at its highest value, the household has liquid assets 2000 times greater than credit card debt.

The first approach, Υ, reveals a more extreme level of co-holding that is harder to explain with liquidity need. Note also that ϕ_p assumes liquid assets and credit card debt are determined jointly, not independently. It assumes that the household with median credit card debt also has median liquid assets.[6] Or

$$Ratio\ of\ percentiles\ p \equiv \phi_p = Percentiles\ p\ of\ ratio \tag{3}$$

Household, i, with debt that corresponds to the median value, may have liquid assets in *any* percentile. Taking the approach of equation 2 makes it impossible to separate a household with \$500 of liquid assets and \$10,000 of credit card debt from a household with \$500 of liquid assets and \$500 of credit card debt, although from an empirical and theoretical perspective, they are different economic problems.

Figure 1 plots ϕ and Υ by percentile.

[5] I drop the 9 observations where the ratio is greater than 2000 but I keep the lower outliers.

[6] The literature typically focuses on the median values of liquid assets and credit card debt. Telyukova (2013) uses the Survey of Consumer Finances (SCF), 2001 to calibrate the model. Around half of co-holding households have roughly the same amount of credit card debt as liquid assets. Choi and Laschever (2018) finds the median household is holding only a little more liquid asset than credit card debt.

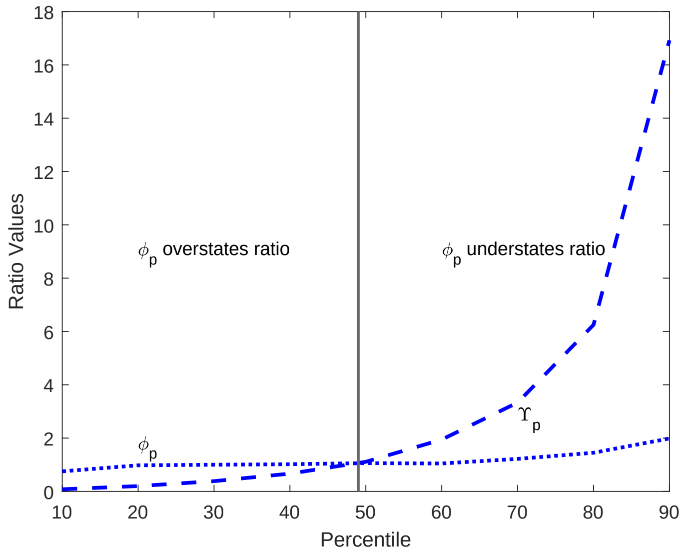


Figure 1: ϕ, dotted line. Υ dashed line by percentile.

Figure 1 plots the values from table 1. Structural models for co-holding aim, and do, match ϕ. But not Υ.

Table 2 gives mean values of liquid assets, credit card debt and total taxable household income by centile for the distribution of Υ. For example, the row labelled $\Upsilon_{10} < 1$ gives mean variable values for the households in the bottom centile of Υ values. In this centile, Υ takes values less than 1, as shown. This mean these households have more credit card debt than liquid assets. The exact Υ value for the centile boundaries are given in table 1.

Druedahl and Jørgensen (2018) compute a measure equivalent to ϕ with data from SCF and then target its moments with a model. It also computes a liquid net worth measure; household level liquid assets minus credit card debt, scaled by income. This is similar to Υ. The Druedahl and Jørgensen (2018) model matches the range of ϕ_p well but Υ_p is unmatched away from the median. This illustrates, again, how the typical characterisation of the distributions of both liquid assets and credit card debt of co-holding households, may lead to explanations which both overlook and do not explain a non trivial proportion of co-holders; those with liquid assets many times in excess of credit card debt. [7]

Note also that the accountant-shopper model (Bertaut, Haliassos, and Reiter, 2009) generates co-holding up to the point that the accountant is sufficiently wealthy. From here

[7] Looking at this another way, subtract the percentile values of liquid assets from the corresponding percentile value of credit card debt, creates a Υ_p distribution. The ϕ_p case gives net wealth values in the range $(-0.06, 0.31)$ and it is not ordered, at the lowest percentile the value is zero, at the median it is -0.06. In the Υ_p case, the range is $(-1.31, 1.55)$. The success of the structural model matches ϕ_p, but for Υ_p it does not; the simulated range is $(-.69, 0.49)$; The lowest and highest values are understated.

she will no longer impose a limit on the spending of the shopper. Once the accountant has sufficiently high liquid assets, the constraint on the shopper is relaxed, and eventually, reversed. This means that for wealthy households, credit card debt is not generated.

Telyukova (2013) accounts for between 44% and 56% of co-holding households in the Survey of Consumer Finances (SCF), 2001. She uses a version of ϕ for model targets. The proportion explained by the model reinforce both the precautionary liquidity theory and the proposition set out here, that liquidity based arguments are less plausible and for around 40% of co-holders based on high Υ values.

Centiles of Υ	Liquid Assets	Credit Card Debt	Income
$\Upsilon_{10} < 1$	540.3	14629.85	49078
$\Upsilon_{20} < 1$	1666.8	13147.35	62780
$\Upsilon_{30} < 1$	3222.5	11627.02	76453
$\Upsilon_{40} < 1$	4323.9	8553.71	74824
$\Upsilon_{50} \approx 1$	5748.2	6569.30	80122
$\Upsilon_{60} \approx 2$	8904.4	6220.59	81500
$\Upsilon_{70} > 2$	12064.8	4839.81	83034
$\Upsilon_{80} > 3$	16721.9	3756.45	92005
$\Upsilon_{90} > 6$	28253.4	2686.21	83697
$\Upsilon_{100} > 15$	87314.2	1460.32	92926

Table 2: Mean values for liquid assets, credit card debt and total taxable income by values of Υ_p, which is $\Big[[liquid\ assets \div credit\ card\ debt]_{i,t}\Big]_p$. Unscaled, nominal values in USD.

I define co-holders with a value if $\Upsilon_{it} \leq 2$ as cash poor group. Cash poor co-holders account for 62% of the total. I define the remaining 38% as cash rich. Table 3 shows the persistence of co-holding for all co-holders together and by cah-rich and cash-poor groups. Overall 42% co-hold in all three waves, with a higher proportion of cash poor co-holding in all three waves.

Periods borrowing	All Co-Holders %	Cash Poor %	Cash Rich %
1	27	23	31
2	32	30	34
3	42	46	36

Table 3: Persistence of borrowing by borrowing group.

Finally, I look at the persistence of the cash-rich group in more detail. Cash-rich households that co-hold in all three periods make up 38% of 2010 cash-rich co-holders, 46% of 2012 cash-rich co-holders and 58% of 2014 cash-rich co-holders. These co-holders have a mean Υ value of 34, a minimum value of 2 and a maximum Υ of 1150.

Based on the findings above, consider columns 2 and 3 in tables 5, 7, and 8 for demographic, financial, and asset information in appendix B.2. These columns divide co-holders into cash rich and cash poor categories. Separating co-holders into the two groups results in a polarization of wealth, income, consumption and credit card debt. The cash rich group are closer to the savers and the cash poor group, closer to the borrowers. Credit card debt is about 3 times higher for the cash poor group than the cash rich group. Median liquid assets are 6 times higher for the cash rich. These descriptive statistics show substantial differences in the constraints co-holders face. The proportion of each group holding financial assets. Employee savings are a little more commonly held in the cash rich group. Mortgages, less so. A more obvious difference is the proportion of IRA's; 40% cash rich, and 27%, cash poor. 24% of the cash rich own stocks and bonds, on a par with the saver group. Compare this to 12% for the cash poor.

2.3 Co-Holding by cash-rich and cash-poor groups

2.3.1 Amount of debt held by co-holders

This section sets out an estimation strategy to more precisely describe the relationship between credit card debt and liquid assets in cash-rich and cash-poor co-holding households; the purpose of estimating the models is thus not to make causal inferences. Rather, association between the variables can be more tightly estimated with controls than by the raw correlation.

First I estimate a regression explaining the amount of credit card debt in USD over all co-holders. The dependent variable is log credit card debt, conditional on being a co-holder.

$$ccd_{it}|(CH_{it} = 1) = \alpha_i + \beta_1 \mathbf{X}_{it} + \lambda_t + \gamma' \mathbf{Z}_{it} + \kappa' \mathbf{W}_{it} + u_{it} \tag{4}$$

Estimation is by pooled OLS. The lower case notation denotes log values of the variables. $\mathbf{X}_{it}$ is la_{it} and la_{it}^2; log liquid assets and log liquid assets squared. λ_t controls for time fixed effects.

$\mathbf{Z}_{it}$ is the baseline vector of household level controls. It includes controls for household composition, marital status, time fixed effects and educational attainment, life limiting conditions, race, home ownership, being married and age and age squared.

$\mathbf{W}_{it}$, is vector of employment controls.[8] There are dummies for unemployment, retirement, being a student, home-maker and a category for *other*. The excluded category is *employed*. A separate dummy is included for self employment. I experiment with a version with lags for employment status but do not report or include these because they were not informative - probably because the PSID gathers data biennially so a two years lag is too long to capture many job changes.[9]

The results of estimating equation 4 suggests a non linear relationship between credit card debt, conditional on being a co-holder, and liquid assets. Credit card debt is first increasing and then decreasing in liquid assets. To give an idea of the liquid asset value at which the relationship changes sign, plotting the fitted values for liquid assets and fitting it with a non parametric line shows a turning point around a log liquid asset value (deflated and scaled) of between 7 to 8, around the $75th$ to $95th$ percentile of liquid assets. In other words, when a co-holder has relatively high levels of liquid assets, the liquid asset/credit card debt relationship switches from positive, both liquid assets and credit card debt increasing, to negative, one increasing, the other decreasing. Full results are set out in the appendix D.1.

To address the non linearity I estimate equation 4 piecewise, running two regressions, one for the cash rich and one for the cash poor. Each has three specifications as follows; define $\mathbf{X}^{l}_{it}$ as (1) log liquid assets, (2) log liquid assets and log non durable consumption and (3) log liquid assets, log non durable consumption and $\eta^2_{i,t}$, idiosyncratic cash consumption consumption risk. Full results are in appendix D.1. Squared log liquid assets included in equation 4, are dropped in the piecewise regression because the non linear relationship is captured by the conditioning on cash-rich and cash-poor co-holders.

The two groups of co-holders defined by $\Upsilon_{i,t}$ are endogenous to the equation being estimated. To overcome this I select a proxy of a measure of liquidity well established in the literature; I define a dummy variable for liquid households where it is *liquid* if it holds at least the equivalent of one month's income, $Y/12$, in liquid assets. Of the households

[8] 2756 million credit card accounts were closed between 2008 and 2012 making losing a line of credit a real concern. The effect is amplified if a household faces unemployment. So as well as leading to higher credit card debt from liquidity constraints, unemployment may also be predictive of becoming a co-holder (Druedahl and Jørgensen, 2018).

[9] I also experiment with additional controls suggested in the literature; state level location dummies, dummies if the household head has moved from employment to unemployment, or has retired, since the last wave of the sample. I also try including dummies for having each of the following sort of other (than credit card) debt; student; family; legal; medical. None are significant.

with a ratio value over 2, 71 % have more than one months income in liquid assets. This makes being liquid *and* a co-holder a reasonable, but not perfect, proxy for being a cash rich co-holder. Similarly, being illiquid is a reasonable proxy for being cash poor, by this definition.

Non durable consumption is included as a proxy for permanent income. Permanent income is likely related to credit card debt but because income measurement inevitably includes other components such as, but not only, transient shocks, also likely to be correlated with credit card debt, I control for the permanent component by using log non durable consumption (Dynan, Skinner, and Zeldes, 2000). I include the estimated idiosyncratic cash consumption in specification 3 because the precautionary liquidity theory suggests that the scale of cash consumption uncertainty is explanatory for co-holding.

The piecewise estimations of equation 4 by cash-rich and cash-poor co-holders shows the sign of the the coefficient for liquid assets is both significant and different for the two groups. For the cash rich co-holders, the coefficient is negative, for the cash poor, it is positive. The sign is robust to different specifications of the equation although the significance is sensitive to the this.

$$\underbrace{\frac{\partial ccd|CR=1}{\partial la} < 0,}_{\text{Cash Rich}} \qquad \underbrace{\frac{\partial ccd|CP=1}{\partial la} > 0}_{\text{Cash Poor}}$$

An interpretation of the different signs is that for the cash poor co-holders, liquid assets and credit card debt are complements, the household chooses more credit card debt to have more liquid assets. This is directionally consistent with the predictions of theories for co-holding. The household preserves liquid assets at the cost of accumulating credit card debt. For cash rich co-holders, liquid assets and credit card debt are substitutes; the household's response to less liquid asset it to increase credit card debt.

Non durable consumption, as a proxy for permanent income, is positively correlated with credit card debt. This is the case for both groups. But it is not the whole story. In part, consumption is channelled through liquid assets. We can see this because introducing consumption makes the coefficient on liquid assets for the cash poor group smaller (0.0383 to 0.00237) and not significant. An explanation for this is that it is a lack of ability to smooth consumption, that drives credit card debt. For the cash rich group, introducing consumption works in the same direction and the coefficient becomes more negative, and more significant (-0.024 to -0.090).

2.3.2 Determinates of co-holding

I now consider the whole sample and estimate a linear probability model where the binary dependent variable, CH_{it}, is equal to 1 if the household is a co-holder and zero otherwise. This binary dependent variable approach is used in much of the empirical literature (see Gorbachev and Luengo-Prado (2019), Choi and Laschever (2018) for example).

I estimate the binary model in several ways. First, I estimate over the entire sample by pooled OLS and by fixed effects using the same structured approach described in subsection 2.3, that is, there are three specifications of $\mathbf{X_{it}}$. Challenges presented by using fixed effects is discussed in appendix D.1.1.

I first pool the data and over the whole sample. Next I take a piecewise approach by estimating over *liquid* households (*liquid*= 1) and *non-liquid* households, (*liquid*= 0). These dummies now identify liquidity rather than cash-rich and cash-poor co-holders, because all households are included, those that are, and are not, co-holders.

I find that for non-liquid households, the probability of being a co-holder increases with liquid assets. The estimated coefficient for liquid assets is positive and significant at the 99% level, in both the pooled and fixed effects approaches. This supports the theories that co-holding is motivated by some sort of constraint, based on precautionary motives, control issues, or smoothing issues.

For liquid households, the coefficient on liquid assets is negative and significant in both the pooled and fixed effects approach. The interpretation is that liquid assets reduce the probability of becoming a co-holder, conditional on having a *liquid* status. Credit card debt and liquid assets are substitutes for the liquid households. The results are robust to the inclusion of the additional variables of non durable consumption and cash consumption risk.

Results from pooled and fixed effect estimation of the linear probability model are directionally similar to each other and to estimation of equation 4. In other words, there is evidence that the estimation approach is not driving the results. In particular, this consistency provides some reassurance that household level effects are not distorting the picture in the pooled case.

2.3.3 Summary of empirical analysis

The results show that the sign of the estimated coefficient for liquid assets takes a different sign depending on the liquidity status of the group whose credit card debt is being conditioned on. For the illiquid co-holders, the coefficient is positive, credit card debt is increased to protect liquid assets. For the liquid co-holders, the relationship is negative, which suggests they are *not* co-holding to preserve liquid assets, but they are still co-holding. These results are stable when estimating the alternative, linear probability model by pooled ols and with fixed effects.

3 A Model for Liquid Co-Holders, and other Liquid Borrowers

I propose an explanation for liquid co-holding that does not rely on liquidity. The model solution rests on the assumption that utility maximising consumers value wealth (or equivalently, in this chapter, money) in addition to consumption.

The formal analysis of the model proceeds as follows: I first develop a static model where the consumer chooses optimal consumption given preferences for money and subject to a budget constraint. The case is comparable to the textbook two good model in consumer choice, or the intra-temporal model for consumption and leisure. For every extra unit consumed, an additional unit of money is parted with. The consumer may optimally hold the consumption good and money. If monetary resources are too low, the consumer cannot achieve the optimal point because she exhausts her budget before reaching it. In the two-period baseline case, consumers face a trade off between consumption and money today and consumption and money tomorrow. Net utility today is increasing in money so if borrowing from the future is costless, the consumer increases money holdings today. If liquidity constraints do not bind before optimal consumption is achieved, preferences for money has two effects over two periods: it leads to higher optimal consumption today and this lowers money, and by extension, consumption, tomorrow. It is this friction that limits the extent of borrowing from the future without requiring any other frictions such as a discount factor, uncertainty, costs of borrowing or returns on saving. This result is analogous to the standard model except that savings can be optimal in both periods, without additional assumptions.

When separation of consumption and payment is introduced, a *consumption-payment pair* is chosen at a time, t, but either consumption, or payment, happens at a different time. In both the one and two period case, the consumer may optimally choose higher demand levels when payment is delayed and less if consumption is delayed, compared to the contemporaneous case. Introducing two periods accommodates every day payment choices faced by consumers such as convenience users of credit cards. In this payment case, a consumption and payment choice happens at time t but payment, in fact, happens at some other date, $t+i$. The two period model with separation also provides insights for other payment cases, for example, where the consumer is not *seeking* delayed payment but is *offered* it at the point of sale, such as in unsolicited offers to Buy Now Pay Later (BNPL). If there are preferences for money, the consumer may accept the offer, even if she does not need to, because delaying payment may increase her net utility.[10]

3.1 One-period baseline model

To introduce preferences for money into the consumer choice setting, I begin with a static model. This shows how the additional assumption changes the utility maximising level of consumption.

Assume we have a consumer who gets utility $u(x)$ from consuming x units of the consumption good and utility $t(y)$ from holding amount y of money. The utility function satisfies the usual assumptions: $u_x(x) > 0$ and $u_{xx}(x) < 0$ and $t_y(y) > 0$ and $t_{yy}(y) < 0$. The assumptions on t mean that consumer gets disutility from parting with money and this disutility is increasing with spending. The consumer's preferences for money and consumption good are additively separable and so overall utility is $v(x, y) = u(x)+\alpha t(y)$, where α is the weight on the preferences for money. If $\alpha = 0$, net utility $v(y, x) = u(x)$, as in standard models for consumption. If $\alpha > 1$ the consumer places more weight on money than on consumption, if $\alpha \in (0, 1)$, less weight on money than on consumption. The parameter α reflects the consumer's type. For example, a consumer with a history of low income or with high levels of uncertainty may mind more about parting with the next dollar than other types. This is different to the consumer's budget constraint; wealth does not determine the type.

The consumer chooses x and y to maximise utility subject to feasibility constraints. Let p denote the price of the consumption bundle and $m > 0$ denote the consumer's income. Then, consumer's money holdings are $y = m-px$ and consumer's maximisation problem can be stated as follows:

$$\max_x u(x) + \alpha t(m - px); \quad x \geq 0; \quad m - px \geq 0 \tag{5}$$

The one-period, maximisation problem is solved with an inequality constraint; the budget constraint need not bind. The consumer may find it optimal to spend all her money, or

[10]BNPL is offered in a wide range of transactions including very small transactions. It is difficult to explain the use of BNPL for small transactions under standard assumptions.

she may find it optimal to hold some money and consume some of the good. This is in contrast to the standard problem in which the consumer consumes some combination of good(s) until the budget constraint is exhausted.

The Lagrangian is

$$\mathcal{L} = u(x) + \alpha t(m - px) + \mu(m - px) \tag{6}$$

First order conditions are

$$\mathcal{L}_\mu = m - x \geq 0, \qquad \mu\mathcal{L}_\mu = 0,$$

$$\mathcal{L}_x = u_x(x) - \alpha t_x(m - px) - \mu p \geq 0, \quad x\mathcal{L}_x = 0 \tag{7}$$

The direction of the inequality of (7) reflects the upper bound of the budget constraint.

Henceforth, I use a general notation for t and u as follows: the function t is written as $t(y(x))$, it has one argument, y, and this is a function of the consumer's level of spending, $y = m - px$. The first derivative of the function t with respect to y is written as $t_y(y(x))$ and the second $t_{yy}(y(x))$, and so on. Derivatives of t with respect to x are written $t_x(y(x))$ and $t_{xx}(y(x))$.[11] I will sometimes expand $y(x)$ by writing $t(y(x)) = t(m - xp)$. The derivative of u with respect to x is written $u_x(x)$.

The net utility function, $v(x, y)$, is strictly concave in x because $u_{xx}(x) < 0$ and $t_{xx}(y) < 0$.

Net utility, is maximised where $u_x(x) - \alpha t_x(y(x)) - \mu p = 0$. There are two main cases for the solution.[12] If $\mu = 0$, the budget constraint does not bind and first order conditions are $u_x(x) = \alpha t_x(y(x))$. The consumer chooses the x where $v_x(x, y) = 0$. Utility from consuming the next unit of the good is equal to the disutility of spending the next dollar. A non zero quantity of the good is consumed, $x^\star$, and some money, y, is held.

On the other hand, if $\mu > 0$, the upper bound of budget constraint is reached. Then $u_x(x) - \alpha t_x(y(x)) - \mu p = 0$ so obviously $u_x(x) > \alpha t_x(y(x))$. The marginal disutility of parting with another dollar is less than the marginal utility of consuming another unit, and the consumer could get higher net utility if she had higher income, m.

[11] Strictly I should write $\dfrac{dt(y(x))}{dx} = \dfrac{dt(y(x))}{dy}\dfrac{dy}{dx} = pt_x(y(x))$, but for ease and clarity I omit the p.

[12] I focus on solutions where $x > 0$. This means for small x, marginal utility of consumption is greater than the marginal disutility of payment - $u_x(x) > \alpha t_x(y(x))$ as $x \to 0$. There is a case where $v(x, y)$ is maximised where $x = 0$. The solution in this case is that even at very small levels of demand, say $x = \epsilon$, $u_x(\epsilon) < \alpha t_x(m - \epsilon)$) (if $m > \epsilon$, the constraint does not bind, $\mu = 0$) the marginal utility of consumption is less than the marginal disutility of payment. This requires either very low income m, high α or a high elasticity for money. For these values, the consumer prefers not to consume anything so optimally $x = 0$. Net utility is strictly decreasing and the consumer holds all her money. Pinning down threshold values for m, α and the elasticity of money utility, relative to consumption utility, for the $x = 0$ solution is a further exercise to be undertaken.

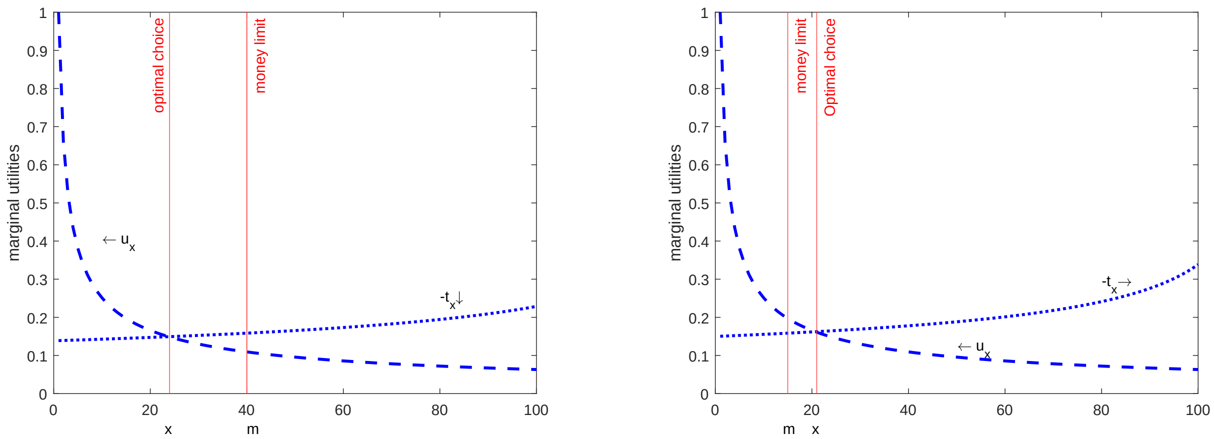


Figure 2: Left: $\mathbf{m} = \mathbf{40}$, $x^\star = 24$. The consumer holds money and good $\{(m-x)^\star, x^\star\} = \{16, 24\}$. Right: $\mathbf{m} = \mathbf{15}$, $x^\star = 21$. The consumer spends all her money on good: $\{(m-x), x\} = \{0, 15\}$

The solution to the problem is

$$x = \min\{m, x^\star\} \tag{8}$$

Appendix E.1 gives details of a numerical example for the two cases, one where the consumer's constraint does not bind and one where it does. The results are graphically shown in figure 2.

3.2 Two-period baseline model

This section sets out how including preferences for money affects dynamic choices. The model allows a setting where liquidity constraints can be slack, without uncertainty or a bequest motives and consumers can save and accumulate wealth. If liquidity constraints bind, or if the consumer attaches no weight to preferences for money, the model collapses to the standard case.

In the two-period model, the consumer chooses consumption in $t = 1$, x_1, consumption in period $t = 2$, x_2. Also chosen is the amount of borrowing, b.[13] If $b > 0$, the consumer borrows from the period $t = 2$ income; if $b < 0$, the consumer lends some of $t = 1$ income to $t = 2$.

One result is that it may be optimal to borrow in $t = 1$ from the future period and then not spend all the borrowing. Instead it is held in the present and carried forward to the next period. This is in stark contrast to the literature and seems counter intuitive. Why

[13] All notation remains the same as before, but acquires the period subscript.

would the consumer borrow when she does not need it for spending? One answer is; when it is costless to do so and the consumer gets utility from holding money.

Let r denote the interest rate and β denote the discount factor. The money holdings in $t=1$ are $y_1 = m_1 - p_1 x_1 + b$. These money holdings become part of consumer's disposable income in the second period if they are not spent on first period consumption and so in $t=2$, consumer's money holdings are

$$y_2 = m_2 - p_2 x_2 - (1+r)b + y_1 = m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \tag{9}$$

Then, consumer's problem can be written as[14]

$$\max_{x_1, x_2, b} u(x_1) + \alpha t(m_1 - p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \right) \tag{10}$$

subject to non-negativity constraints $x_1 \geq 0$, $x_2 \geq 0$, $m_1 - p_1 x_1 + b \geq 0$ and $m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \geq 0$.

The optimal choice solves a two step inter and intra temporal problem.

The Lagrangian is

$$\begin{aligned} \mathcal{L} = u(x_1) + \alpha t(m_1 - p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \right) \\ + \mu_1 (m_1 - p_1 x_1 + b) + \mu_2 (m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \end{aligned} \tag{11}$$

First order conditions are[15]

$$\begin{aligned}
\mathcal{L}_{x_1} &= u_{x_1}(x_1) - \alpha t_{x_1}(y_1(x_1)) - \beta \alpha t_{x_1}(y_2(x_1)) - \mu_1 p_1 - \mu_2 p_1 \geq 0 & x_1 \mathcal{L}_{x_1} &= 0 & (12)\\
\mathcal{L}_{x_2} &= \beta \big(u_{x_2}(x_2) - \alpha t_{x_2}(y_2(x_2)) \big) - \mu_2 p_2 \geq 0, & x_2 \mathcal{L}_{x_2} &= 0 & (13)\\
\mathcal{L}_b &= \alpha t_b(y(x_1)) - \beta \alpha t_b(y(x_2)) r + \mu_1 - \mu_2 r \leq 0, & b \mathcal{L}_b &= 0 & (14)\\
\mathcal{L}_{\mu_1} &= m_1 - p_1 x_1 + b \geq 0, & \mu_1 \mathcal{L}_{\mu_1} &= 0 & (15)\\
\mathcal{L}_{\mu_2} &= m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \geq 0, & \mu_2 \mathcal{L}_{\mu_2} &= 0 & (16)
\end{aligned}$$

Assume $r=0$ and $\beta=1$. If there are binding constraints in $t=1$, then the consumer borrows from $t=2$. But even if the the constraints do not bind the consumer may also

[14] I write $y(x) = m - px + b$ rather than the general form $y(x)$ to make clear how the borrowing, b, enters.

[15] In equation 13 I include r, but not p, to highlight the effect of the interest rate on borrowing, appearing here for the first time.

borrow. She gets positive money utility from increasing y_1. But this also increases the the choice of x_1. Her period 1 utility is maximised at $u_{x_1}(x_1) = \alpha t_{x_1}(y_1(x_1))$, assuming $\mu_1 = 0$. As b increases, the right hand term, marginal disutility of money, falls. For the equality to hold this implies a higher x_1. Borrowing from the future increases the optimal choice of x_1 *and* first period utility. As a consequence, $y_2 = m_2 - p_2 x_2 - (1+r)b + y_1$ falls and by the reverse of the above argument, so does the optimal choice of x_2. This friction stops the consumer borrowing everything from the future, in the absence of the usual frictions, despite getting utility from holding money. Of course a positive interest rate complements the effect. And a high discount factor works in the other direction.

I compare the above results to the case where the consumer has preferences only for consumption, $u(x)$, as in standard models. I again assume $r = 0$, $\beta = 1$. The consumer's problem is to maximise her lifetime utility

$$\max_{x_1, x_2, b} u(x_1) + \beta u(x_2) \tag{17}$$

subject to non-negativity constraints $x_1 \geq 0$, $x_2 \geq 0$, $m_1 - p_1 x_1 + b \geq 0$ and $m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \geq 0$.

If there is a standard terminal condition, $s_2 = 0$, all money must be spent in the second period and optimal consumption, $x_1^\star$, $x_2^\star$, is $x_1^\star = x_2^\star = \frac{y_1 + y_2}{2}$. If income is different in the two periods, $m_1 \neq m_2$, then $b \neq 0$; the consumer will smooth in order to maximize utility. If there is not a terminal condition, there can be savings and consumption in the final period. Solving the problem for all the different combinations $\mu_1 \geq 0, \mu_2 \geq 0$ gives that the consumer optimally smooths consumption when income is different in the two periods. All solutions however, require income to be allocated to spending. It can not be the case, for example, that $m_1 - p_1 x_1 + b > 0$ and $m_2 - p_2 x_2 + m_1 - p_1 x_1 > 0$ can be a utility is maximising solution, because utility is strictly increasing in x. There is no mechanism for holding money. But when $m_2 > m_1$, or the other way around, the consumer optimally holds some money for smoothing.

If there is a bequest motive, $m_1 + m_2 = p_1 x_1 + p_2 x_2 + w$, where w is saved money at the end of period 2. Then $x_1^\star = x_2^\star = \frac{m_1 + m_2 - w_2}{2}$.

Thus, in the intertemporal consumer problem, equation 17, borrowing happens if $m1 < m2$, lending happens when $m_1 > m_2$. Money held at the end of $t = 2$ is 0. In contrast, in equation 10, two period model with money, borrowing from $t = 2$ can be optimal even when $m1 = m2$ and money can optimally be held at the end of $t = 2$.

The consumers problem is to maximise net utility *in* each period and *across* both periods.

I discuss results in the case where the consumer's optimal consumption choice in both periods is reached before the budget constraint is exhausted because this is the group of interest. This means $\mu_1 = \mu_2 = 0$ and the net marginal utilities are equal; equations 12 equals 13.

$$u_{x_1}(x_1) - \alpha t_{x_1}(y_1(x_1)) - \beta\alpha t_{x_1}(y_2(x_1)) = u_{x_2}(x_2) - \alpha t_{x_2}(y_2(x_2)) \tag{18}$$

Or equivalently equation 18 can be expressed as

$$v_{x_1}(x_1, y_1) = v_{x_2}(x_1, x_2, y_2) \tag{19}$$

Where $v(x_1, y_1)$ is the net utility function for period 1 and $v_{x_1}(x_1, y_1)$ is the marginal net utility for good 1, and equivalently $v_{x_2}(x_1, x_2, y_2)$ for x_2.

As shown in the one-period case, to maximise intra period utility, the consumer chooses x_t such that the marginal utility of the next unit of good 1 is equal to the marginal disutility of spending the next unit of money. If borrowing from the future is frictionless then, utility in period 1 is maximised by borrowing all of m_2 and the optimising in period 1. To optimise in both periods, and across periods, the consumer will continue to borrow from m_2, increasing $v(x_1, y_1)$ until the next unit of borrowing leads to optimal x_1 such that $v(x_1, y_1) = v(x_2, y_2)$. After this point, further borrowing reduces $v(x_2, y_2)$. For the equality to hold, marginal net utility in both periods

$$t_{x_1}(y_1(x_1)) + \beta\alpha t_{x_1}(y_2(x_1)) = \alpha t_{x_2}(y_2(x_2))$$

For this equality to hold, it follows that $x_1^* = x_2^*$ because these correspond to a consistent point on the marginal utility axis. Because of this, $\alpha t_{x_1}(y_1(x_1))\beta\alpha t_{x_1}(y_2(x_1)) = \alpha t_{x_2}(y_2(x_2))$. Otherwise the optimum for each period could not correspond to the same level of demand. In this case, for this equality to hold, the consumer must borrow from period 2; so $b > 0$. As she borrows, y_1 increases and shifts $t(y_1)$ upward, or the marginal utility curve, $t_{x_1}(y_1, x_1)$ outward, increasing the intra period optimising choice of x_1. This will be utility improving for period 1 but has the opposite effect for period 2. As y_2 is decreasing in b. As x_1 increases, y_2 decreases and

If $b \leq 0$ then $y_2 > y_1$, even though $m_1 = m_2$ because if $\mu = 0$ it implies $m_1 - x_1 > 0$. This is carried forward to period 2, increasing y_2 and, because $t(y_t, x_t)$ is increasing in y_t, even though second period consumption

The $t(\cdot)$ function shifts as y_t changes.

The marginal utility function for consumption is identical in both periods. So some level of demand $\overline{x}$ corresponds to the same level of marginal utility in either period. Utility from money *shifts* according to y_t. If y_t increases, the utility maximising choice of consumption also shifts. is the , but the

In the special two period case, where the discount factor is equal to 1, $\beta = 1$ and the interest rate is 0, $r = 0$, and disposable income, m_t, in each period is the same; $m_1 = m_2$, and the constraint does not bind, $\mu = 0$.

The consumer will borrow from period 2; $b > 0$. If $b \leq 0$ then $y_2 > y_1$, even though $m_1 = m_2$ because if $\mu = 0$ it implies $m_1 - x_1 > 0$. This is carried forward to period 2, increasing y_2 and, because $t(y_t, x_t)$ is increasing in y_t, even though second period consumption

$x_1^* = x_2^*$ and $m_1 + b - x_1 = y_1 = y_2 = m_2 - x_2 + y_1$

I solve the model numerically to find optimal consumption and borrowing over two periods using the same functional form for $u(x)$ and $t(y(x))$ as set in equations 25 and 26. Income is the same in both periods, $m_1 = m_2$, and there is no uncertainty.

The solution method is in two steps. A grid is generated with each possible value of $m_1 \pm b$. Values are discrete and are in steps of 1 unit.[16] The upper bound for period 1 is that all of period 2 income is borrowed; $b = m_2$. The lower period 1 bound is that all period 1 income is lent to period 2, $-b = m_1$.

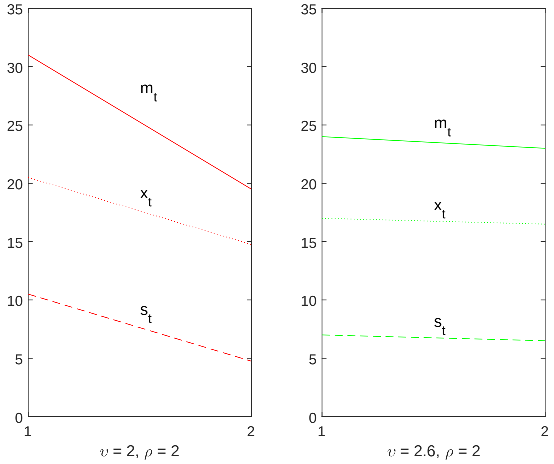
The second step is to solve the period 1 intratemporal problem; to find optimal x_1, given $m_1 \pm b$. This first period intratemporal choice determines the end of period 1 money, y_1. Then second period money is $y_2 = m_2 - b + y_1$. The period 2 intratemporal problem is solved for each combination. Net utility is calculated for each intertemporal allocation with values for period 1 and period 2 over the grid.

Choosing the highest combination gives optimal (x_1, x_2, b).

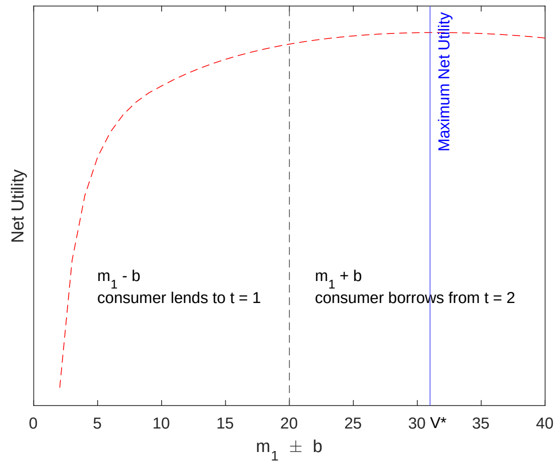
A numerical example with different discount factors shows how the consumer smooths over the two period lifecycle. Details of the example parameters and a table of results is set out in appendix E.2.

When the discount factor is 1, and $\rho = \upsilon = 2$, the consumer optimally borrows from the future. Positive b means optimal x_1 is higher than in the absence of the ability to borrow. The cost of this extra spending is that there is less to spend in $t = 2$. As the elasticity of money, υ, increases, the consumer becomes more sensitive to changes in money and

[16] A finer grid would give a more accurate result but this is for further work.



(a) Results for the two-period case ($t = 1, 2$ on horizontal axis) where $\beta = 1$, for two values of υ, the elasticity of money, and constant $\rho = 2$, elasticity of consumption. $m_1 = m_2 = 20$. s_t is money *not* spent at the end of each period.



(b) Shows how net utility over both period $t = 1$ and $t = 2$ changes as b changes. Parameter value for $t(y(x))$ is $\upsilon = 2$, and $\beta = 1$. Otherwise values are from table 10

Figure 3: Results for the two-period case

payment. This results in borrowing less from the future. Consumption and money are more evenly spread across the lifecycle when $\upsilon = 2.6$ than when $\upsilon = 2$ (figure 3a). When $\upsilon = 2.6$, income, spending and saving, is close to being evenly spread across the two periods, whereas when $\upsilon = 2$, period 1 has higher weight, and y_2 is lower.

A discount factor less than 1 acts as in standard models. For each value of υ, the consumer consumes more and holds more money, in period 1 than in period 2.

In the standard case, equation 17, when $\beta = 1$ consumption equals income in both periods and there are no savings. When $\beta = 0.9$ the consumer borrows from the future and spends m_1 ($c_1 = m_1 + b$) in period 1 and m_2 ($c_2 = m_2 - b$) in period 2. In order to induce savings, it is necessary to introduce some sort of uncertainty, or bequest motive, into the model. In the model with preferences for money, there is borrowing in the beginning of the period and there is money held at the end of the period as indicated in table 10, in the columns labelled y_1 and y_2.

Figure 3b shows how net utility over the two periods changes with the borrowing from $t = 2$. In the example set out, net utility is maximised when the consumer borrows 11 from the future.

3.3 One-period with sub periods and temporal separation

To introduce temporal separation I return to the one-period model. I extend this model to allow consumption or payment to be separated over short intervals. Denote these intervals as sub-periods, s. There are two sub-periods in each time period.[17] Let $s = 1$ denote the first sub-period and $s = 2$ denote the second sub-period.

The consumer discounts events that are in a future sub-period by $\gamma \in (0, 1]$.

As in the baseline case, the consumer chooses her consumption-payment pair, x, y, subject to feasibility constraints. Unlike the baseline case, consumption and payment can be temporally separated. Net utility is

$$v(x, y) = \max_{x} \; u(\gamma^{(j-s)}px) + \alpha t(m - \gamma^{(\tilde{j}-s)}px) \tag{20}$$

Where the superscripts $j, \tilde{j}$ denote the sub-period in which consumption or payment take place.

- j is the sub period consumption of good is experienced
- $\tilde{j}$ is the sub period payment of good is experienced

In the case where consumption is in sub-period 1 and payment is in sub-period 2, for example a meal paid for with a credit card, then

- Consumption; sub period 1, $j = 1$
- Payment; sub period 2, $\tilde{j} = 2$

And net utility is

$$\begin{aligned} v(x, y) &= u(\gamma^{1-1}x) + \alpha t(m - \gamma^{2-1}px) \\ &= u(x) + \alpha t(m - \gamma px) \end{aligned}$$

The consumer's maximisation problem is stated as

$$v(x, y) = \max_{x} \; u(x) + \alpha t(m - \gamma px) \quad x \geq 0; \quad m - px \geq 0 \tag{21}$$

This is identical to the one-period baseline case except that payment, px, is discounted by

[17] The model also allows for longer separation over time periods. But I focus on the one-period model to explain the effect of separation in the model. Expanding to a two, or more, time periods is for future work, but is discussed in a sketched solution in section 3.4 with respect to the credit card debt puzzle.

γ. The marginal derivative of $t(y(x))$ is $\gamma t_x(y(x))$[18] and since for a given x, $\gamma t_x(y(x)) < t_x(y(x))$, there is lower payment disutility, whereas consumption utility is unchanged.

Solving the maximisation problem, as for equation 6, first order conditions with respect to x are $u_x(x) = \alpha\gamma t_x(y(x)) + \mu$. For this equality to hold when payment is deferred, and thus discounted by γ, marginal utility of consumption must be lower than in the simultaneous baseline case and so optimal x must be higher. In the model, when the consumer faces exogenous payment delay she chooses higher consumption, providing the budget constraint does not bind, and net utility is also higher compared to the baseline case where consumption and payment are contemporaneous.

In the real world, consumers increasingly face *offers* to delay payments, which they (the consumer) have not requested, in addition to facing exogenous delayed payment. I briefly consider how, in the context of the model, the consumer responds to this unsolicited offer.

In the case where delaying payment is offered, the consumer has three choices. (1) she can refuse the delay. (2) she can accept the delay and keep x constant, (3), she can accept the delay and revise her choice of x.

In case (1), refusing the delay is optimal if $\alpha = 0$, that is she places no weight on utility for money. If $\gamma = 1$, she is indifferent to the delay.

In case (2), she accepts the delay, but holds her demand level constant because it offers higher utility. The consumer chooses this if $\alpha > 0$, $\gamma < 1$ but $\mu > 0$ *or* she has no option to adjust x. In the case where she has no option to adjust, she improves her net utility relative to accepting the delay, but does not maximise net utility: If consumption and payment are contemporaneous, as in equation 5 and $\mu = 0$ so the utility maximising x is $x^\star$, from 8, then $v(y(x^\star)) > v(y(x'))$ where $x' \neq x^\star$ is any other feasible demand level in the contemporaneous case. Because $t'(y) > 0$, so long as $0 < \gamma < 1$, net utility at $x^\star$ when payment is delayed is greater than when it is not: $u(x^\star) + t(m - \gamma p x^\star) > u(x^\star) + t(m - p x^\star) = 0$. In case (3), the consumer accepts the delay *and* adjusts x. Marginal disutility of payment is decreasing in γ, $t_\gamma(y(x)) < 0$ so first order conditions with discounting $u(x^\star) > t(m - \gamma p x^\star)$. Let $\tilde{x}$ restore the equality, it must be where $\tilde{x} > x^\star$ and $v_d(y(\tilde{x}) > v_d(y(x^\star))$ where the subscript d denotes the case where payment is deferred.

The higher net utility achieved by delaying payment does not hold ex post. Let the net utility maximising choice be $\tilde{x}$ when payment is delayed and the net utility maximising choice be $x^\star$ in the contemporaneous case. Define ex post net utility as the net utility

[18]Strictly, the derivative of t with respect to x in this case should be written $\gamma p t_x(y)$, but as before, I suppress the p.

from what was actually consumed and spent. In the deferred payment case, ex post net utility is $u(\tilde{x}) + \alpha t(y(\tilde{x}))$. This is maximised by $x^\star < \tilde{x}$ so must be decreasing at $\tilde{x}$ and $v(\tilde{x}, y) < v(x^\star, y)$.

If consumption is delayed, the model predictions are generally opposite compared to when payment is delayed. To illustrate, in sub-period 1 the consumer buys a ticket to an event. In sub-period 2 she attends the event.

- Consumption; sub period 2, $j = 2$
- Payment; sub period 1, $\tilde{j} = 1$

The value function is written

$$\begin{aligned} v_1(m_t, x) &= \max_x \; u(\gamma^{(j-s)} xp) + \alpha t(m - \gamma^{(\tilde{j}-s)} xp) \\ &= \max_x \; u(\gamma^{2-1} x) + \alpha t(m - \gamma^{1-1} xp) \\ &= \max_x \; u(\gamma x) + \alpha t(m - xp) \end{aligned}$$

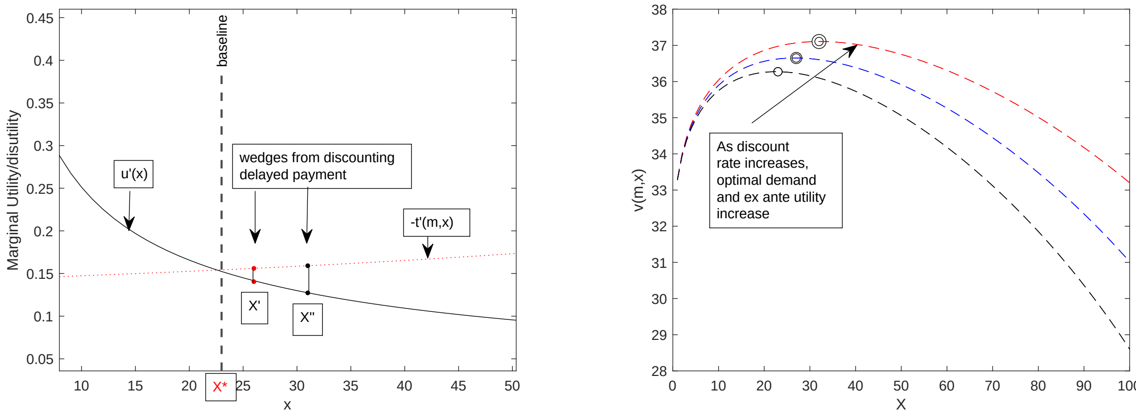
As before, solving the maximisation problem as for equation 6, first order conditions give

$$\gamma u_x(\gamma x) = \alpha t_x(m - xp) + \mu p$$

Because marginal utility of consumption is decreasing in x, $\gamma u_x(\gamma x) > u_x(x)$ so optimal x is smaller when discounted by γ. The more impatient the consumer, the less she will consume if she has to delay consumption.

Delaying consumption results in a fall in net utility and a choice of lower consumption optimally, analogously to the case where payment is delayed. Also similarly, if the consumer faces delayed consumption and has no choice to adjust her demand level, she will consume sub optimally at the higher simultaneous case level and have lower ex ante net utility.

I solve the model numerically. I compare outcomes for the one-period baseline case as set out in subsection 3.1 with the one-period case with delayed payment. The functional form for $u(x)$ is set out in equation 25 and for $t(y(x))$, 26. I calculate results for two sub-period discount rates; $\gamma = 0.9$ and $\gamma = 0.8$. Details of parameter values and numeric results are set out in appendix E.3 and a visual representation of these is in figure 4a. The vertical lines between plots, in figure 4a at x' and x'', show the effect of delaying payment.



(a) The x that optimises net utility is where the marginal utility of consumption (solid curve) is equal to the marginal disutility of payment (dotted line).

(b) The arrow shows the effect of increasing sub period discounting (γ decreases) on net utility and utility maximising demand when payment is delayed.

Figure 4: Effect of delayed payment

When payment is deferred, the consumer discounts payment by γ when choosing her level of demand. This leads to higher optimal choice compared to the baseline choice when consumption and payment are contemporaneous. The more impatient the consumer, the lower γ and the higher her optimal demand. In this example, when $\gamma = 0.8$ the consumer's optimal choice is 32 but this is not feasible; her budget constraint binds, $\mu > 0$. She thus maximises her net utility by spending all disposable income, 30, on the good. This is the best she can do given her preferences *and* her budget constraint.

Relating this result to consumer choices, the model predicts that when consumers face exogenous delayed payment, they consume more because it gives higher ex ante utility. If they are *offered* delayed payment, for example at the point of checkout as is the case for BNPL, if the consumer has already fixed her demand, she may not revise it to the utility maximising level, but she does accept the delay payment offer.[19] This increases her ex ante net utility. These effects may help explain the growing concern around delayed payment offers.

3.4 Two periods with temporal separation; the credit card case

In this section I present the two-period model with separation. A motivating example is the credit card, used for convenience, rather than for smoothing or borrowing. In this

[19] Anecdotally, some users of this service comment to me, *I may as well delay payment - I can have the item for free for a month.*

setting, the credit card structure implicitly generates exogenous temporal separation.

The set up is as follows: all spending in $t = 1$ is made on a credit card, and all spending in $t = 2$ is contemporaneous with consumption. Assume:

1. In $t = 1$, $s = 1$ (time period 1, sub-period 1), The consumer chooses x_1, x_2, b to maximise net utility.
2. In $t = 1$, $s = 2$, payment is due on the credit card, call this the *payment period.* Let the amount the consumer chooses to pay in the payment period be denoted as c. The consumer chooses c such that $c^\star$ is the repayment amount that maximises net utility, where $c \in [0, p_1 x_1^\star]$. For simplicity assume no minimum payment.
3. If the consumer chooses any value of $c < p_1 x^\star$, then she pays a penalty interest rate on $(p_1 x_1^\star - c^\star)$ of r^c in $t = 2$; that is, in $t = 2$ she pays, in total, $(p_1 x_1^\star - c^\star) \times (1 + r^c)$ as well as the period 2 consumption choice, x_2.

The consumer choice problem is solved in two stages.

To restate point 1, above, first the consumer chooses x_1, x_2, b to maximise net utility. Net utility, from equation 10 and 20 is

$$\max_{x_1, x_2, b} u(x_1) + \alpha t(m_1 - \gamma p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1)\right) \quad (22)$$

subject to non-negativity constraints $x_1 \geq 0$, $x_2 \geq 0$, $m_1 - p_1 x_1 + b \geq 0$ and $m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \geq 0$.

This is identical to the two period baseline model, 10, except for the γ in $t(y_1(x_1))$ in period 1. This captures the delay in period 1 payment due to the credit card. Assume $\gamma = 1$ for simplicity. In this case, the consumer's optimal choices are just $x_1^\star, x_2^\star, b$ from the two-period baseline case in sub section 3.2.

Next, in period $s = 2, t = 1$, (second sub-period of first time period) the consumer receives her credit card payment demand for $p_1 x_1^\star$. The consumer is already committed her ex ante choice of $x_1^\star$ and b (Denote this value of b as $\bar{b}$ to make this clear), from sub-period 1. The credit card offers the *option to defer payment.* The consumer chooses the repayment amount, $c \in [0, p_1 x_1^\star]$, and x_2, to maximise her net utility, given $x_1^\star$ and $\bar{b}$. The consumer either pays the credit card bill in full or she chooses to pay c plus a future penalty at rate r^c on $(p_1 x_1^\star - c)$ carried to $t = 2$.

In $s = 2, t = 1$ the consumer solves

$$\max_{x_2, c | x_1^\star, \bar{b}} \alpha t(m_1 - \gamma p_1 c + \bar{b}) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - r\bar{b} + m_1 - c - (x_1^\star - c)(1 + r^c)) \right) \tag{23}$$

Optimal c is increasing in the credit card interest rate, r^c. The lower the penalty, the less the consumer gains from paying for period 1 consumption, in period 1. Any non zero payment of c in $t = 1$ has implications for x_2 through $t(y_2)$. There is a trade off between money utility in $t = 1$ and $t = 2$. The consumer's choice, to pay the credit card bill or defer it and co-hold, depends on r^c, β, and preferences for money and consumption. In this model, the consumer may find it optimal to choose to carry a balance on the credit card, even if her budget constraint does not bind, and without uncertainty or any return on money held.

I use the results of the two-period baseline model in table 10 to calculate whether the consumer finds it optimal to pay back credit card balance in sub-period 2 or to defer some amount $p_1 x^\star - c \geq 0$ to the next period. If $\gamma = 1$ the baseline model is equivalent to the credit card case. Table 12 summarise the discussion above. Details of parameter values and numeric results are set out in appendix E.4 and a visual representation of these is in figure 5.

I calculate a grid for period 1 utility for each repayment amount in steps $0 : x_1$. Each repayment amount generates a different amount of money available for $t = 2$ spending; $y_2 = m_2 + m_1 - rb - c - (x_1^\star - c)(1 + r^c)$. Given this, optimal $t = 2$ demand is re-optimised. I calculate the two-period net utility over the grid. The consumer prefers to pay $x_1^\star$ in $t = 1, s = 2$ if net utility is highest where $c = x_1^\star$. In this case, she pays no penalty and consumes in period 2 as in the baseline case.

Results are reported for two interest rate values, $r = 0.2$ and $r = 0.15$

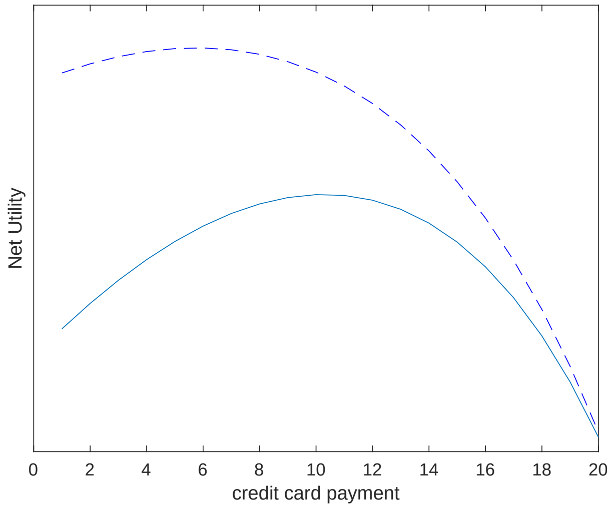


Figure 5: Net utility over two periods for different credit card repayment amounts. **dashed line**, $r^c = 0.15$, optimal payment, 6. **Solid line**, $r^c = 0.20$, optimal payment 10.

Table 13 sets out some results. In $t = 1, s = 2$, $x_1^\star$ and $\bar{b}$ are ex ante given. Both x_2 and y_2 (money held at the end of period 2), are highest in the baseline case. When $t = 1$ payment is delayed to $s = 2$, however, the consumer re-optimises in the second sub period of $t = 1$. From this perspective, and given the model parameters, she prefers to only partially pay the credit card bill. The lower the interest penalty, r^c, the lower the utility maximising c is. For $r = 0.15$ she repays $c = 6$. Her optimal $t = 2$, consumption demand, $x_2^\star = 14.75$ and is this lower than in the baseline case, as is the money she holds at the end of $t = 2$. When $r = 0.20$, she repays more, $c = 10$. Because of the higher r^c, $x_2^\star$ is lower than the baseline and lower than when a $r^c = 0.15$. This example is analogous to liquid co-holding, which I show is observed in the data. In the example, the consumer holds money, y_1 and y_2, at the end of each period. In other words, the budget constraint does not bind in either period. The discount rate is neutral, $\beta = 1$, and there are no returns on holding money, $r = 0$. Despite this, the consumer only partially repays the credit card bill in $t = 1$ because when it arrives for payment, the total utility loss from making full payment is greater than the total utility loss from partially deferring payment and paying a penalty in the next period.

4 Conclusion

This paper revisits the credit card debt puzzle. There are many ways to define and characterise the households that make up the puzzle. This paper uses a household level measure of liquid assets and credit card debt and ranks households according to how much liquid asset it holds, realative to the amount of credit card debt it carries. The approach reveals a more dispersed picture than is identified by some of the alternative methods in the literature, and may add a new perspective to understanding why the puzzle is not yet fully explained by exiosting theories. In particular, why co-holding is not predicted for households with high liquidity, despite its pressence in the data. Using the constructed ratio, I show that at the one end, co-holders have liquid assets that are a small fraction of credit card debt, meaning the household cannot pay off the debt with its cash. At the other end, co-holders have liquid assets many multiples of credit card debt. These households can pay off the debt and will have cash, often very high levels of cash, left over. Separating co-holders by this criteria and studying their characteristics shows that the co-holders with a liquid asset/credit card debt ratio greater than 2 (defined as cash rich) are also wealthier, by many measures, than the co-holders with a ratio value less than or equal to 2 (defined as cash poor). This is in contrast to the findings of other studies (Telyukova (2013), for example) which find co-holders sit between borrowers and savers in terms of wealth. Estimating a piecewise model by a liquidity measure, with a full set of household controls, reveals persistent differences between the two groups with respect to liquid assets and credit card debt, implying co-holding may have systematically different explanations, depending on wealth.

Liquidity need appears to an incomplete explanation for co-holding. To address this I suggest an alternative idea in which households value wealth, or money, as well as consumption. I show how the additional assumption leads to a pain of payment when consumption and payment are separated in time and this can result in optimally deferring repayment of debt, even if sufficient liquidity is available. The model may also be insightful about other cases where consumption and payment are separated in time. For example, consumers using delayed payment structures such as BNPL. Early work on this shows that spending with BNPL increases consumption, even when liquidity is high (DiMaggio, Williams, and Katz, 2022). Other examples include the credit card premium and late payment of small bills such as parking tickets, such that charges are incurred. This paper is a first attempt at modelling consumer choices when payment and consumption are temporally separated and where liquidity constraints appear not bind. Further work is needed to formalise the results.

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Appendix

A PSID question about credit card debt

The survey question asked in the PSID on credit card debt:

Aside from the debts that we have already talked about, (like any mortgage on your main home (or/like) vehicle loans,) do (you/you or anyone in your family living there) currently have any credit card or store card debt? Do not count new debt that will be paid off this month..

and

If you added up all credit card and store card debts for all of your family living there, about how much would they amount to right now?

For the sample as a whole, nominal credit card debt has a maximum value of $90,000 and a mean of $2,990. This includes the 49% of the observations where credit card debt is zero. For borrowers only, the nominal mean is $7,382.7.

B Data and Descriptive Statistics

The data are from the US longitudinal biennial household survey, the Panel Study of Income Dynamics (PSID).

In line with the literature, I compare co-holders to borrowers (credit card debt and no liquid assets) and savers (no credit card debt and liquid assets). This establishes that the sample in the PSID has similar characteristics to data used in the literature. I later extend the comparison to sub groups of co-holders; liquid and illiquid co-holders.

Table 5 gives mean and median values for financial variables over these different groups. Values are unscaled and nominal to give a more intuitive and comparative picture - deflation is with 1982 prices. The same information is reported with scaled and deflated values in table 6

For these financial measures, co-holders sit between borrowers and savers in the PSID. For credit card debt, borrowers and co-holders have similar values. Liquid assets are, by definition, zero for the borrowers. The co-holders have mean liquid assets of $\$16,840$, well below that of savers, $\$40,855$. Holdings of stocks and bonds has a similar pattern.

Table 7 gives demographic information for households in each group as a proportion. Savers are a little older than co-holders and borrowers. Savers also have a higher level of education than the other groups. A higher proportion are retired. Borrowers have a higher proportion of married households than the others but are less likely to be home-owners. The proportion of home-owners in the co-holding group is close to that of the saver group. Race is the same for co-holders and savers whereas borrowers have a lower proportion of white respondents.

Table 8 reports financial asset information by group as a proportion of its total. Co-holders have the highest proportion of households with employee savings schemes and mortgages, but the range across groups for both variables is tight; $48-67\%$ for employee schemes, $43-59\%$ for mortgages. There is a more obvious difference for Independent Retirement Schemes (IRA) - for co-holders and savers, 32 and 37% have IRA's, for borrowers only 12% have an IRA.

Overall, the differences between the groups are small and do not suggest some systematic difference between them that might explain co-holding.

The statistics presented in tables 5, 7, and 8, show that the characteristics of co-holding, saving and borrowing households in the PSID sample are broadly similar to those of co-holders in other work, using US household data. For example, the mean and median values of income and assets of borrowers are similar between borrowers, co holders, and savers in Telyukova (2013), Druedahl and Jørgensen (2018), and Choi and Laschever (2018).

B.1 Data challenges for credit card debt in the PSID

The PSID survey takes place every two years. Thus, a household which reports credit card borrowing for repeated waves may be habitually borrowing, or may be unlucky in the timing of the interview. Timing may also be an issue, borrowing is more likely at certain times of the year and at certain points in a month. Timing of the interview is not reported. Other literature in the credit card debt puzzle field face similar problems. Some surveys are cross sectional, for example, so only observe a household once, or for one year.

Another limitation of the PSID credit card debt question is that it asks whether the household has credit card debt, not whether it *has* a credit card. A response of *no* to the credit card debt question has two potential meanings. The household has a credit card and no debt, or the household does not have a credit card and therefore is not able to carry debt. The focus of this paper is on households with credit card debt and high levels of liquid assets. These households are compared with households with credit card debt and low levels of liquid assets and household with positive liquid assets and no credit card debt. This group could include households who would like to hold credit card debt but are not able to get a credit card.

To get some idea of how likely it is that liquid co-holders have been misallocated to the savers group I refer to the 2013 Federal Reserve Survey for household Well being. Around 16% of respondents in the survey report being denied credit at least once in the year. The figure includes those who received offers of credit lower than requested, as well as outright refusals. But excludes the 12% of respondents who did not submit an application but would like to have access to credit. Reasons are fear of refusal or fear of debt. The rate of denial is higher when income is less than $40,00. The average income of the liquid co-holders group in the PSID is around $87,000 with a median of $71,000. Thus the likelihood of households with high liquidity and unrealised credit card debt being mis-allocated to the saver group because they have been denied credit should be fairly small.

I identify the persistence in co-holding across waves. Even though there is a two year gap, if the household holds credit card debt in every wave.

Table 4: The table shows the debt frequency over the three waves of the PSID used in the analysis.

No. Yrs with credit card debt	No of Households in all Time Periods	Percent of Total Sample
0	6190	49
1	2590	20
2	1875	15
3	1920	15

B.2 Tables of Descriptive Statistics

Table 5: Income and Assets, USD Unscaled, Nominal Values. Column 2 is all co-holders, as one group. Column 3 and 4 separate co-holders according to Υ_{it}. Column 1 and 5 are comparison groups for co-holders; borrowers and savers.

	Borrowers Mean (Median)	All Co-Holders Mean (Median)	CP Mean (Median)	CR Mean (Median)	Savers Mean (Median)
Wealth	74,532	205,766	124,438	340,474	433,079
	(7,550)	(52,950)	(29,000)	(127,000)	(107,000)
Income	52,696	77,556	71,536	87,528	78,686
	(40,000)	(65,063)	(62,651)	(71,000)	(50,500)
Consumption (nd)	31,975	39,701	38,555	41,598	38,423
	(28,480)	(35,852)	(35,037)	(37,030)	(32,253)
Credit Card Debt	7,621	7,357	9,907	3,133	0
	(4,900)	(4,000)	(7,000)	(1,800)	(0)
Subjective House Value	94,063	158,157	143,383	182,629	176,405
	(37,500)	(125,000)	(115,000)	(150,000)	(120,000)
Mortgage Remaining	53,996	88,541	89,344	87,214	62,940
	(0)	(54,000)	(59,376)	(45,000)	(0)
Liquid Assets	0	16,840	4,206	37,766	40,855
	(0)	(4,500)	(2,500)	(15,000)	(10,000)
Stocks and Bonds	3,834	19,330	7,215	39,397	68,250
	(0)	(0)	(0)	(0)	(0)
Observations	678	5488	3422	2066	6811

Table 6: Information in Table 5, restated as deflated using 1982 prices and scaled to adjust for household composition. See section B.3 in this appendix for details on scaling and deflation.

	All CH		CP		CR		Savers	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Wealth	50,172	12,044	28,201	6,253	86,563	28,603	110,922	25,058
Income	17,619	14,773	15,874	13,959	20,510	16,102	18,219	12,411
NDC	8,310	7,380	7,890	7,117	9,006	7,826	8,450	7,175
CC Debt	1,711	955	2,287	1,529	755	405	0	0
Liquid Assets	4,249	1,019	958	539	9,699	3,593	10,693	2,304
House Value	36,115	27,733	31,747	24,417	43,350	33,369	43,513	26,532
Mort Remaining	18,975	11,464	18,868	12,193	19,150	10,167	13,988	0

Table 7: Age of respondent and demographic characteristics by group as a proportion of its total. Column 2 is all co-holders, as one group. Column 3 and 4 separate co-holders according to v_{it}. Column 1 and 5 are comparison groups for co-holders; borrowers and savers.

	Borrowers	Co-Holders	CP	CR	Savers
	-	-	-	-	-
Age of Respondent	43.03	45.31	44.26	47.05	47.06
% Highest: Grade School	0.29	0.23	0.24	0.21	0.23
% Highest: Some College	0.34	0.32	0.33	0.31	0.25
% Highest: College or Higher	0.26	0.41	0.38	0.45	0.45
% White	0.78	0.91	0.91	0.92	0.91
% Retired	0.13	0.13	0.11	0.15	0.22
% Homeowner	0.55	0.69	0.67	0.73	0.65
% Married	1.93	1.65	1.68	1.59	1.72
Observations	678	5488	3422	2066	6811

Table 8: Financial asset information by group as a proportion of its total. Column 2 is all co-holders, as one group. Column 3 and 4 separate co-holders according to υ_{it}. Column 1 and 5 are comparison groups for co-holders; borrowers and savers.

	Borrowers	All Co-Holders	CP	CR	Savers
	-	-	-	-	-
% Have Employee Savings	0.48	0.67	0.65	0.70	0.54
% Have Retirement Account	0.12	0.32	0.27	0.40	0.37
% Have Mortgage	0.45	0.59	0.60	0.58	0.43
% Owns Stocks and Bonds	0.05	0.16	0.12	0.24	0.24
Observations	678	5488	3422	2066	6811

B.3 Variable construction

The sample includes households with heads aged 20 - 80. I include households with single heads. Obvious outliers are dropped. The final sample has 12,597 observations, 5,641 households. I use data from three biennial waves, 2011 - 2015 (labelled 2010- 2014).

Scaling and deflation

To account for price changes, certain variables are deflated. Category specific price indexes are used where possible, and CPI where no index is available.

For some of the analysis it is important to account for household composition to interpret findings for an individual agent. Variables are scaled using the OECD approach $scale = 1 + 0.7(n - 1) + 0.5k$ where n is the number of adults in the household and k the number of children. Later, for estimations with log values, a further restriction is imposed for scaling with dummies for household composition by including dummies for the number of children and adults. Define scale as $S_{i,t} = \sum w_i N_i$, some weight w applied to household size and composition. Then the equation has the form $\ln ndc_{i,t} - ln(scale)_{i,t} = \sum \alpha_i N_i$. Or $\ln C_{i,t} = \gamma ln(\sum w_i N_i)_{i,t} + \sum \alpha_i N_i$. The hypothesis that $\gamma = 1$ is not rejected so imposing the scaling on the dependent variable is acceptable. This equation brings out the different way that the number in each category influences log consumption; linearly through the dummies and logarithmically through the scaling.

It is also necessary is to account for price changes. Values are deflated by category specific price indexes where possible, and by CPI where no index is available.

Savings Plans

Respondents in the PSID are asked if they, or anyone in their household, has money in an IRA. A dummy identifies these households;

$$IRA = \begin{cases} 1 & \text{if IRA} \\ 0 & \text{if no IRA} \end{cases}$$

Questions about employee savings plans are asked with respect to the head and spouse of household. I collect information on 401k savings plans with respect to the current job and previous jobs (head only for this question). For individuals employed in the civil service, or by and organisation without a 401k plan, individuals are asked about Keogh and Thrift plans.

$$\text{emp} = \begin{cases} 1 & \text{if household have at least one employee savings plan} \\ 0 & \text{if household have none of the employee savings plans} \end{cases}$$

where an employee savings plan includes any of the above definitions and where an individual is said to have and employee savings plan if either the head or spouse have such a plan from a current or previous job.

Table B.3 shows the proportion of households with an IRA or an employment savings scheme.

	Percent of Households
Employment Scheme	55
IRA	34
All Savers	65
Observations	12571

Table 9: Proportions of households with IRA and Employee savings schemes.

Income

I use *taxable income* for the head and spouse. This is a composite; the sum of the head's asset income (dividends, interest, rental income and asset income from farm business), the head and spouses asset and labour income.

C Definitions of co holding and persistence of co holding

To get some idea of how persistent holding credit card debt is in the PSID, I calculate the number of waves (see table 4) each household reports it and compare this to the findings in other surveys (Later, I look at co-holders in this way too, see table 3). I find the PSID estimates to be conservative in comparison to other surveys used in the literature. In the PSID over 30% of borrowing households, or 15% of all households, report carrying a balance in two or more waves.[20]

The definition of liquid assets takes several forms in the literature. The sum of balances of household checking, savings and money market accounts is widely used. For example, Telyukova (2013), Zinman (2015), Choi and Laschever (2018). Gathergood and Weber (2014) exclude balances from checking accounts but include money market balances. Liquid assets are defined as the sum of the balance of household's checking and savings account. Money market amounts are excluded because in the PSID, money market amounts are combined with savings (separate to savings account balances) and investments. The omission of money market accounts is not a major concern - it leads to a more conservative measure of liquid assets, and this understates the extent of the co holding problem.

The definition of co-holding also takes several forms in the literature. For example, Telyukova (2013) and Zinman (2015) set a lower bound for co-holding as having debt and liquid assets each greater than \$500. For Choi and Laschever (2018), credit card debt must be greater than zero. Gathergood and Weber (2014) use a more demanding criteria; the equivalent of one month's income is subtracted from liquid assets and remaining liquid assets must also be greater than credit card debt. Given the absence of a consensus. I do not take a stand on threasholds but instead define co-holders households with positive credit card debt and positive liquid assets. This may over state co-holding and certainly will include some households with close to trivial levels of credit card debt but the conclusions are robust to stricter definitions.[21] I also define *Savers* as households with zero credit card debt and positive liquid assets and *Borrowers* as households with positive credit card debt and zero liquid assets. These groups follow much of the literature also.

[20]The triennial Survey of Consumer Finance reports 36% of households carrying a balance on their credit card, month to month between 2010 - 2013. The Census Bureau's report on the Economic Well-Being of U.S. Households in 2016 finds 28% report mostly carrying a balance over the last year, 20% sometimes and 6% occasionally.

[21]I loose around one third of the puzzle group if I follow Telyukova (2013), but results hold.

D Consumption and Υ_{it}

To investigate the co-holding from the perspective of Υ further, I plot per household period, log non durable consumption against Υ to show how liquid assets, credit card debt and consumption (as a proxy for permanent income) relate to each other. Each dot is a household in a time period. For a given level of consumption, there is a wide range of Υ values. The horizontal line defines the $\Upsilon_{p=70} = 3.3$, the household has 3.3 times more liquid asset than credit card debt. The plot shows that these households are in the middle and higher middle consumption households and not the high spenders.

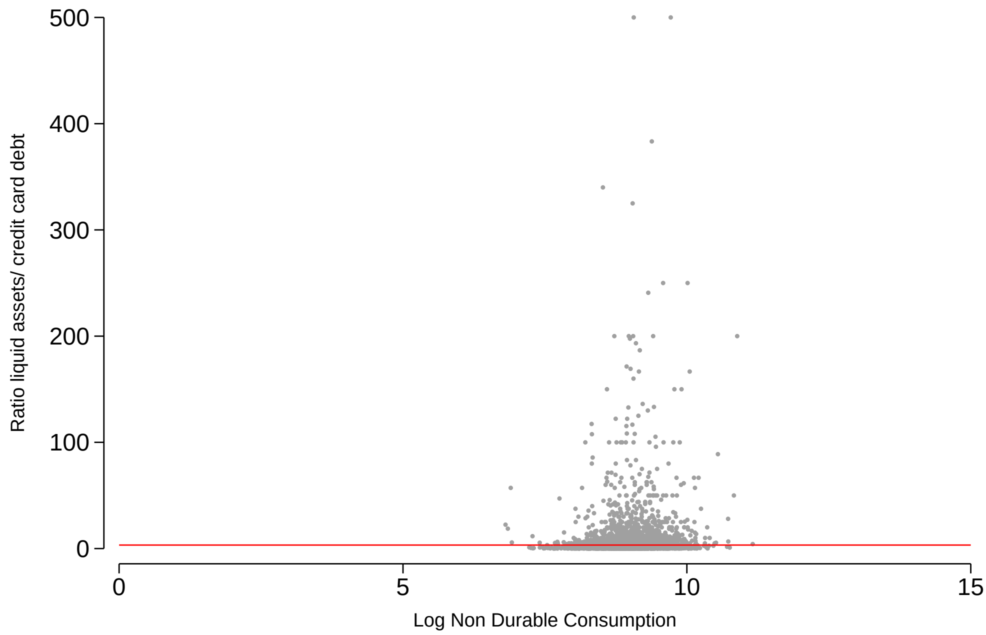

Figure 6: $\Upsilon_{i,t}$ plotted against log non durable consumption, x axis. The red line is $\Upsilon_{p=70} = 3.3$

D.1 Regression results for equation 4.

	Cash Poor			Cash Rich		
	(1)	(2)	(3)	(1)	(2)	(3)
Age	0.0654***	0.0604***	0.0622***	0.0712***	0.0606***	0.0684***
	(0.0146)	(0.0145)	(0.0167)	(0.0165)	(0.0165)	(0.0193)
Age^2	-0.0572***	-0.0534***	-0.0552**	-0.0685***	-0.0580***	-0.0665***
	(0.0162)	(0.0160)	(0.0181)	(0.0174)	(0.0173)	(0.0198)
Adults	-0.210***	-0.180***	-0.244***	-0.181**	-0.132*	-0.184**
	(0.0445)	(0.0446)	(0.0481)	(0.0618)	(0.0601)	(0.0662)
Children	-0.189***	-0.143***	-0.198***	-0.0633	-0.00608	-0.0554
	(0.0259)	(0.0269)	(0.0275)	(0.0350)	(0.0352)	(0.0374)
White	0.188	0.172	0.227*	0.0935	0.0656	0.0992
	(0.0973)	(0.0950)	(0.105)	(0.126)	(0.124)	(0.134)
unemployed	-0.0735	0.0391	-0.0496	0.443**	0.508***	0.503**
	(0.126)	(0.128)	(0.141)	(0.153)	(0.153)	(0.161)
Retired	-0.228	-0.160	-0.233	-0.111	-0.0605	-0.113
	(0.119)	(0.119)	(0.123)	(0.121)	(0.119)	(0.125)
Student	0.0361	0.101	-0.0716	-0.181	-0.128	-0.204
	(0.228)	(0.238)	(0.233)	(0.228)	(0.210)	(0.207)
Homemaker	-0.161	-0.200	-0.197	-0.262	-0.332	-0.290
	(0.204)	(0.194)	(0.236)	(0.252)	(0.244)	(0.279)
Other	-0.0845	0.130	-0.0523	0.462	0.321	0.194
	(0.526)	(0.517)	(0.495)	(0.516)	(0.589)	(0.530)
Not Hm Owner	-0.343***	-0.287***	-0.390***	-0.106	-0.0257	-0.0624
	(0.0628)	(0.0625)	(0.0692)	(0.0821)	(0.0808)	(0.0929)
Self Emplyd	0.173*	0.139	0.192*	0.246**	0.190*	0.257**
	(0.0760)	(0.0754)	(0.0806)	(0.0946)	(0.0913)	(0.0992)
Limiting Disblty	-0.0533	-0.0279	-0.0725	0.0181	0.0371	0.0286
	(0.0845)	(0.0843)	(0.0899)	(0.0886)	(0.0881)	(0.0963)
Marital Status	-0.0490	-0.0374	-0.0524	-0.0173	-0.00623	-0.00919
	(0.0291)	(0.0287)	(0.0319)	(0.0366)	(0.0357)	(0.0398)
2012	-0.0790	-0.0748	-0.0667	0.0725	0.0850	0.0841
	(0.0461)	(0.0458)	(0.0484)	(0.0557)	(0.0553)	(0.0589)
2014	-0.0461	-0.0365	-0.0368	0.267***	0.291***	0.275***
	(0.0478)	(0.0475)	(0.0505)	(0.0599)	(0.0590)	(0.0632)
Grade School	0.185	0.139	0.171	0.0959	0.0608	0.103
	(0.115)	(0.116)	(0.124)	(0.211)	(0.207)	(0.242)
Some College	0.223*	0.159	0.199	0.314	0.225	0.306
	(0.111)	(0.111)	(0.119)	(0.209)	(0.204)	(0.240)
College or Higher	0.566***	0.437***	0.558***	0.392	0.230	0.388
	(0.112)	(0.114)	(0.119)	(0.208)	(0.203)	(0.238)
Ln LA	0.0383*	0.00237	0.0324	-0.0240	-0.0896**	-0.0118
	(0.0191)	(0.0229)	(0.0201)	(0.0296)	(0.0301)	(0.0314)
Log NDC		0.384***			0.534***	
		(0.0843)			(0.0682)	
$\eta_{i,t}$			0.0291			-0.308
			(0.0156)			(0.172)
Constant	5.251***	2.145**	5.459***	5.085***	1.030	5.056***
	(0.368)	(0.742)	(0.417)	(0.473)	(0.686)	(0.551)
Observations	3352	3352	2949	2116	2116	1892

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D.1.1 Additional discussion and results for sub section 2.3.2, determinates of co-holding,

The linear probability model that is estimated is

$$P(CH_{it} = 1) = \alpha + \beta' \mathbf{X}^l_{it} + \delta \mathbf{J}_{it} + \lambda_t + \gamma' \mathbf{Z}_{it} + \kappa' \mathbf{W}_{it} + u_{it} \tag{24}$$

Where $u_{it} = \epsilon_{it} + e_i$ and in the fixed effects estimation we control for covariance between e_i and the other variables. I estimate over the three specifications of vector $\mathbf{X}_{it}$. $P(CH_{it} = 1)$ is the probability of being a co-holder. As before, I experiment with various controls. In this case, including employment controls and other debt categories improve model fit and are thus included in $\mathbf{Z}_{it}$. Specifically, dummies if the household head has moved from employment to unemployment, or separately, has retired, since the last wave of the sample. Also, a dummy that equals 1 if the household has student or family or legal or medical debt. This is vector $\mathbf{J}_{it}$.

The pooled model ignores unobserved household level effects. To get some idea for the strength of these effects, I estimate the model by fixed effects. The cost of this approach is that since there are only three time periods, there may not be much to estimate once time invariant means are subtracted, and also, it excludes households with credit card debt in every or no periods: the most persistent co-holders. For cash poor co-holders this is 46% of the observations. For cash rich, 42%. Results should be interpreted with this in mind. It is nonetheless useful to compare results of the pooled and fixed effects approach.

Regression results for whole sample, Pooled and FE estimation of equation 24. Dependent variable, $P(CH = 1)$

	Pooled	FE
Age	0.0103***	0.0484***
	(0.00213)	(0.0136)
Age^2	-0.00882***	-0.0185**
	(0.00228)	(0.00649)
Adults	0.00491	0.0173
	(0.00803)	(0.0113)
Children	0.00622	0.00982
	(0.00430)	(0.00855)
White	0.0367**	-0.240
	(0.0131)	(0.229)
Retired	-0.103***	-0.0423
	(0.0172)	(0.0235)
Student	-0.0840***	-0.0358
	(0.0250)	(0.0317)
Not Hm Owner	-0.0931***	-0.0255
	(0.0120)	(0.0177)
Self Emplyd	-0.0467***	-0.0211
	(0.0140)	(0.0182)
Limiting Disblty	0.0420**	0.0256
	(0.0129)	(0.0149)
2012	-0.0332***	-0.0951***
	(0.00676)	(0.0264)
2014	-0.0618***	-0.187***
	(0.00750)	(0.0527)
No Mort, Hm Owner	-0.208***	-0.0226
	(0.0146)	(0.0208)
Hv Stdnt Dbt	0.143***	0.0398**
	(0.0113)	(0.0153)
Hv Med Dbt	0.0711***	0.0147
	(0.0131)	(0.0145)
Hv Fam Ln	0.0849**	-0.0139
	(0.0291)	(0.0311)
Ln LA	0.0322***	0.0397***
	(0.00132)	(0.00197)
Constant	-0.0932	-1.384*
	(0.0512)	(0.594)
Observations	15111	15111

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for OLS estimation of equation 24. Dependent variable, $P(CH = 1)$

	Liquid = 0			Liquid = 1		
	Bsln	+ ndc	+ Var Csh	Bsln	+ ndc	+ Var Csh
Age	0.00366	0.00363	0.00106	0.0187***	0.0178***	0.0186***
	(0.00241)	(0.00241)	(0.00287)	(0.00336)	(0.00334)	(0.00379)
Age^2	-0.00257	-0.00257	-0.000253	-0.0154***	-0.0146***	-0.0152***
	(0.00266)	(0.00266)	(0.00308)	(0.00345)	(0.00343)	(0.00381)
Adults	-0.00300	-0.00238	-0.00510	0.00620	0.00945	0.00178
	(0.00854)	(0.00854)	(0.00953)	(0.0141)	(0.0140)	(0.0151)
Children	0.00826*	0.00913*	0.00679	-0.00837	-0.00258	-0.0106
	(0.00416)	(0.00421)	(0.00464)	(0.00852)	(0.00863)	(0.00910)
White	0.0373**	0.0371**	0.0334*	-0.0522	-0.0544	-0.0553
	(0.0117)	(0.0117)	(0.0131)	(0.0320)	(0.0318)	(0.0339)
Retired	-0.0409*	-0.0390*	-0.0474*	-0.114***	-0.110***	-0.124***
	(0.0197)	(0.0198)	(0.0214)	(0.0254)	(0.0254)	(0.0263)
Student	-0.0243	-0.0201	-0.0140	-0.0557	-0.0404	-0.0523
	(0.0228)	(0.0233)	(0.0280)	(0.0601)	(0.0578)	(0.0627)
Not Hm Owner	-0.0818***	-0.0799***	-0.0961***	-0.0500**	-0.0362	-0.0499*
	(0.0130)	(0.0133)	(0.0142)	(0.0194)	(0.0197)	(0.0210)
Self Emplyd	-0.0382*	-0.0384*	-0.0375*	-0.0196	-0.0250	-0.0265
	(0.0160)	(0.0160)	(0.0178)	(0.0204)	(0.0203)	(0.0213)
Limiting Disblty	0.0142	0.0151	0.0184	0.0577**	0.0601**	0.0553*
	(0.0142)	(0.0142)	(0.0157)	(0.0210)	(0.0210)	(0.0221)
2012	-0.00770	-0.00718	-0.00776	-0.0689***	-0.0672***	-0.0671***
	(0.00886)	(0.00888)	(0.00972)	(0.0118)	(0.0118)	(0.0123)
2014	-0.0233*	-0.0229*	-0.0225*	-0.118***	-0.116***	-0.114***
	(0.00955)	(0.00956)	(0.0105)	(0.0125)	(0.0125)	(0.0132)
Grade School	0.0288*	0.0275	0.0330*	0.102*	0.0982*	0.108*
	(0.0142)	(0.0143)	(0.0163)	(0.0398)	(0.0396)	(0.0430)
Some College	0.0584***	0.0564***	0.0590***	0.129**	0.121**	0.129**
	(0.0152)	(0.0154)	(0.0170)	(0.0395)	(0.0394)	(0.0426)
College or Higher	0.00525	0.00180	0.00240	0.0582	0.0411	0.0573
	(0.0175)	(0.0179)	(0.0194)	(0.0385)	(0.0387)	(0.0416)
No Mort, Hm Owner	-0.129***	-0.128***	-0.136***	-0.137***	-0.131***	-0.139***
	(0.0186)	(0.0187)	(0.0201)	(0.0188)	(0.0189)	(0.0196)
Hv Stdnt Dbt	0.0927***	0.0924***	0.0875***	0.125***	0.122***	0.126***
	(0.0121)	(0.0121)	(0.0135)	(0.0189)	(0.0189)	(0.0210)
Hv Med Dbt	0.0241	0.0241	0.0366*	0.111***	0.110**	0.138***
	(0.0131)	(0.0131)	(0.0145)	(0.0336)	(0.0335)	(0.0359)
hvfamln	0.0967***	0.0958***	0.107***	-0.0382	-0.0413	-0.110
	(0.0286)	(0.0286)	(0.0318)	(0.0547)	(0.0549)	(0.0632)
Ln LA	0.0781***	0.0778***	0.0795***	-0.0541***	-0.0612***	-0.0557***
	(0.00163)	(0.00161)	(0.00177)	(0.00568)	(0.00584)	(0.00609)
Log NDC		0.00679			0.0513***	
		(0.00607)			(0.0121)	
$\eta_{i,t}$			0.00339			-0.0215***
			(0.00250)			(0.00630)
Constant	-0.0492	-0.107	0.0252	0.360***	-0.0205	0.389***
	(0.0542)	(0.0775)	(0.0657)	(0.0988)	(0.134)	(0.112)
Observations	8923	8923	7492	6188	6188	5474

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for FE estimation of equation 24. Dependent variable, $P(CH = 1)$

	Liquid = 0			Liquid = 1		
	Bsln	+ ndc	+ Var Csh	Bsln	+ ndc	+ Var Csh
Age	0.0144	0.0146	0.0255	0.0630**	0.0624*	0.0668*
	(0.0178)	(0.0178)	(0.0199)	(0.0244)	(0.0244)	(0.0266)
Age^2	-0.0101	-0.0104	-0.00450	-0.0186	-0.0179	-0.0197
	(0.00946)	(0.00945)	(0.0107)	(0.0105)	(0.0106)	(0.0119)
Adults	0.0186	0.0181	0.0179	0.0115	0.0142	-0.0108
	(0.0141)	(0.0142)	(0.0156)	(0.0234)	(0.0242)	(0.0253)
Children	0.0106	0.0100	0.00687	-0.0210	-0.0186	-0.0180
	(0.0100)	(0.0101)	(0.0115)	(0.0192)	(0.0198)	(0.0218)
White	0.625***	0.624***	0	-0.416	-0.414	0
	(0.0621)	(0.0624)	(.)	(0.314)	(0.309)	(.)
Retired	-0.000530	-0.000978	0.0186	-0.0381	-0.0378	-0.0385
	(0.0334)	(0.0336)	(0.0365)	(0.0363)	(0.0363)	(0.0381)
Student	0.00667	0.00609	0.00758	-0.179*	-0.179*	-0.187*
	(0.0355)	(0.0358)	(0.0421)	(0.0776)	(0.0777)	(0.0868)
Not Hm Owner	-0.00979	-0.0103	0.00566	-0.0427	-0.0411	-0.0416
	(0.0232)	(0.0233)	(0.0255)	(0.0335)	(0.0339)	(0.0377)
Self Emplyd	-0.00248	-0.00253	-0.00908	-0.0277	-0.0269	-0.0137
	(0.0236)	(0.0236)	(0.0268)	(0.0315)	(0.0316)	(0.0321)
Limiting Disblty	0.0167	0.0167	0.0237	0.0280	0.0274	0.0374
	(0.0192)	(0.0192)	(0.0217)	(0.0269)	(0.0269)	(0.0282)
2012	-0.0181	-0.0184	-0.0523	-0.157***	-0.157***	-0.162**
	(0.0345)	(0.0345)	(0.0388)	(0.0464)	(0.0464)	(0.0509)
2014	-0.0370	-0.0373	-0.114	-0.295**	-0.295**	-0.300**
	(0.0687)	(0.0688)	(0.0776)	(0.0925)	(0.0924)	(0.101)
No Mort, Hm Owner	-0.0134	-0.0136	0.0119	0.0161	0.0163	0.0195
	(0.0296)	(0.0296)	(0.0315)	(0.0337)	(0.0337)	(0.0359)
Hv Stdnt Dbt	0.0435*	0.0435*	0.0298	-0.0317	-0.0332	-0.0367
	(0.0185)	(0.0185)	(0.0209)	(0.0306)	(0.0305)	(0.0347)
Hv Med Dbt	-0.00607	-0.00599	0.00535	0.00890	0.00852	-0.00269
	(0.0160)	(0.0160)	(0.0176)	(0.0429)	(0.0429)	(0.0458)
hvfamln	0.00906	0.00924	0.0224	-0.0466	-0.0475	-0.0161
	(0.0367)	(0.0368)	(0.0419)	(0.0684)	(0.0685)	(0.0734)
Ln LA	0.0681***	0.0682***	0.0697***	-0.0294***	-0.0295***	-0.0332***
	(0.00292)	(0.00292)	(0.00321)	(0.00866)	(0.00867)	(0.00928)
Log NDC		-0.00337			0.0111	
		(0.00926)			(0.0225)	
$\eta_{i,t}$			0.00213			-0.00493
			(0.00264)			(0.00758)
Constant	-0.849	-0.822	-0.931	-1.475	-1.570	-2.008
	(0.685)	(0.689)	(0.799)	(1.105)	(1.120)	(1.216)
Observations	8923	8923	7492	6188	6188	5474

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

E Details and results of numeric examples in section 3, A model for liquid co-holders and other liquid borrowers

E.1 One period baseline model

Let the functional form of net utility, $v(x, y) = u(x) + t(y(x))$ be

$$u(x) = \frac{x^{1-\rho}}{1-\rho} \tag{25}$$

$$t(y(x)) = \frac{(m - px + \omega)^{1-\upsilon}}{1-\upsilon} \tag{26}$$

Where ω is a subsistence level of income that cannot be spent.

I assign the values

	Left, Figure 2	Right, Figure 2
Weight on money utility, α	1	1
Elasticity of consumption, ρ	0.6	0.6
Elasticity of money, υ	0.4	0.4
Subsistence money, ω	10	10
Income, m	40	15
Price, p	1	1

Figure2 shows marginal utility from consumption and money as x increases. The dashed lines plot $u_x(x)$, marginal utility from consumption. The dotted lines show $t_x(y(x))$ the marginal disutility of payment. Disutility increases in x. Net utility is maximised where $u_x(x) = \alpha t_x(y(x))$. In the left hand figure, where $m = 40$, the consumer can reach this point. She optimally consumes 24 units of the good and holds 16 units of money. In the right hand figure, $m = 15$ but other parameters and values are unchanged. In this case disposable income is less than the optimal choice of the good and the consumer spends all her income on the good, $x = 15, m = 0$. She consumes where $u_x(x) = \alpha t_x(y(x)) + \mu$ but would be better off if she had more money. Optimally she would consume 21 units of the good.

E.2 Two period baseline model

	Value
Weight on money utility, α	1
Elasticity of consumption, ρ	2
Elasticity of money, υ	2, 2.3, 2.6
Discount factor, β	1, 0.9
Per period subsistence spending, ω_t	10
Per period income, m_t	20
Interest rate, r	0

I solve the model for two values of β. For each, I hold $\rho = 2$ constant[22] and vary υ. I compare results to the standard case, denoted by the superscriptt st, x_1^{st}, x_2^{st}, equation 17.[23]

Time Discount rate	Parameter υ on $t(\cdot)$	b	x_1	x_2	End of y_1	t Value y_2	Standard x_1^{st}	Case x_2^{st}
$\beta = 1$	2	11	20.5	14.75	10.5	4.75	20	20
	2.3	27	18.5	15.75	8.5	5.75	20	20
	2.6	14	17	16.5	7	6.50	20	20
$\beta = 0.9$	2	33	21.5	14.25	11.5	4.25	22	18
	2.3	8	19	15.5	9	5.50	22	18
	2.6	6	18	16	8	6.00	22	18

Table 10: Optimal choices of (x_1, x_2) for the model with money. The right hand column gives results for the standard case consumption, denoted x_1^{st}, x_2^{st}, equation 17.

E.3 Delayed payment

	Value
Weight on money utility, α	1
Elasticity of consumption, ρ	2
Elasticity of money, υ	2
Rate of sub-period discounting, γ	0.9, 0.8
Per period subsistence spending, ω	10
Per period income, m	30
Price, p	1

[22] $\rho = 2$ is a standard value in the literature

[23] Given the nature of the model, it turns out that $x_2 - y_2 = 10$.

Case	Sub Period Discount	Allocations
Baseline		$x^\star = 23,\ (m-x)^\star = 7$
Defer payment	$\gamma = 0.9$	$x^\star = 27,\ (m-x)^\star = 3$
Defer payment	$\gamma = 0.8$	$x^\star = 32 > m = 30$ so the constraint binds; $x = 30,\ (m-x) = 0$

Table 11: Results for numerical solution

E.4 Two-period model with temporal separation; credit card debt.

	Value
Interest rate on credit card debt, r^c	0.15, 0.2
Interest rate on borrowing from $t = 2$, r	0
Period 1 demand, $x_1^\star$, from table 10	20.5
Weight on consumption utility, α	1
Elasticity of consumption, ρ	2
Elasticity of money, υ	2
Rate of sub-period discounting, γ	1
Per period subsistence spending, ω	10
Per period income, m_t	20
Prices, p_t	1
Discount factor, β	1

Table 12: Summary of parameter values for numerical two period model with credit card debt

Credit card interest rate	$\bar{b}$	$x_1^\star$	$x_2 \vert c$	c	y_2
baseline case	11	20.5	14.75	20.5	4.75
$r = 0.15$	11	20.5	13.66	6	3.66
$r = 0.20$	11	20.5	13.7	10	3.7

Table 13: Optimal choices of (x_1, x_2, c) for the model with money when period 1 consumption is paid for with a credit card. The last column, y_2 is what remains after spending in period 2.