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Abstract

This paper presents a consumer choice model in which both consumption and wealth are valued. The assumption on wealth can help explain observed costly consumer choices such as paying charges for late settlement of bills, and credit card debt costs. The paper addresses one such costly choice puzzle - the credit card debt, or co-holding, puzzle where cash and credit card debt are simultaneously held. An empirical analysis gives a new perspective on the extent of this puzzle and the model shows, theoretically, how including preferences for wealth can help explain the co-holding by individuals with very high levels of liquidity whose behaviour is thus hard to explain with existing theories for co-holding. The model also has implications for optimal demand levels in payment set-ups where payment is delayed, such as such as the rapidly growing Buy Now, Pay Later financing.

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1 Introduction

Consumers make certain costly choices such as incurring charges by delaying payment of bills, co-holding credit card debt and cash, and spending more when paying with a credit card. Such choices are rational if consumers face liquidity constraints.[1] But liquidity constraints appear inadequate to explain what is observed in the data and in experiments. See Prelec and Simester (2001), Ausubel (1991), Soman (2001), Silber (2008), for examples. I explain these empirical findings with a model in which rational consumers may choose such costly behaviours without being liquidity constrained. For an empirical example, I address the well documented credit card debt, or co-holding, puzzle where consumers simultaneously hold low yielding liquid assets and high cost credit card debt. Existing explanations cannot explain co-holding by highly liquid consumers, whereas the theory in this paper can.

The model assumes that consumers have preferences for wealth (used interchangeably with money) and thus dislike making payments. The pain of payment introduces a friction between consuming and paying that does not involve liquidity constraints and makes deferring payment attractive.[2] Given this, the model describes how the separation in time of consumption and payment affects utility and demand, including the case where separation is unsolicited, such as for convenience use of a credit card (labelled *exogenous temporal separation*). Under standard assumptions, the effect of separated transactions, exogenous or not, is neutral for utility and demand unless the separation is explicitly chosen by the consumer to address binding constraints. Yet the number of separated transactions faced by consumers is large.[3][4]

The three connected mechanisms - preferences for money, disutility of payment, and temporal separation - provide a framework in which to study the costly consumer choices

[1] Liquidity based explanations include savings and holding liquid assets for precautionary reasons and under uncertainty.

[2] Consider two examples. Silber (2008) notes that "A quarter of Americans pay at least one bill late each month", a much larger proportion than is implied by lack of liquidity. Heffetz, O'Donoghue, and Schneider (2016) study parking ticket payment rates using data for for 6.6 million parking tickets issued to 2 million individuals in New York City. They find that reminders are effective and conclude forgetting plays a role in late and costly payments. But there is substantial heterogeneity and unexplained behaviour.

[3] BNPL is expected to account for 4.2% of global payments by 2024 (Worldpay). In the UK alone, the volume of transactions quadrupled in 2020. BNPL firm, Klarna, handled estimated transactions $20-25$ bn in US in 2020 (Reuters). And unless these transactions are all separated because of liquidity constraints, a proportion must be exogenously separated. UK regulators highlight that the BNPL user journey may trigger biases discussed in behavioural literature; present bias, confirmation bias and availability bias suggesting there are concerns that BNPL may effect spending beyond consumption smoothing.

[4] The Woolard Review, Report to the Financial Conduct Authority Board, 2 February 2021.

mentioned above without relying on liquidity constraints.

The preferences for wealth at the center of the model are not standard in economic theory, where it is valued for the future consumption it facilitates. Early economists, however, had a different stance. David Hume, Adam Smith, John Maynard Keynes and Irving Fisher believed that people valued wealth as an end in itself. Recent literature reintroduces the idea that 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).[5] Pain of payment is also not part of standard economic theory but naturally follows from utility from wealth. Preferences for wealth are also included in some recent macroeconomic literature and has long been discussed in behavioural research (see Massenot (2021), Loewenstein and Prelec (1998), and Quispe-Torreblanca, Stewart, Gathergood, and Loewenstein (2019), for example).

The formal analysis proceeds in two steps. I first study a baseline model with preferences for money but without separation of payment and consumption, and second, I introduce separation of payment and consumption.

The baseline model is solved, first, for the one-period case and, second, for the inter-temporal case. The consumer maximises a net utility function with two arguments; consumption and money. Preferences across time and commodities are additively separable.

The structure of the one-period case is similar 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, she will increase money holdings today. This has two effects: it leads to higher optimal consumption today and this lowers money, and by extension, consumption, tomorrow. This friction limits the extent of borrowing from the future in a way that is analogous to the standard model except that savings can be optimal in both periods, without any other frictions such as a discount factor, uncertainty, costs of borrowing or returns on saving.

When separation of consumption and payment is introduced, a *consumption-payment*

[5] 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.

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 cases 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. The model addresses cases where the consumer may accept the offer, even if she does not need to, because, if she has preferences for money, delaying payment may increase her net utility.

The credit card debt, or co-holding, puzzle - simultaneously holding credit card debt and liquid assets - is an empirical example of where payment is delayed and where budget constraints *may* not bind. The assertion that constraints may not bind is based on evidence in the Panel Study of Income Dynamics (PSID) that a sub set of co-holders have very high levels of liquidity, ranging between 2 and 200 times credit card debt. The debt of this sub group is under-predicted by current explanations for the credit card debt puzzle. I show, theoretically, that holding high levels of liquid assets at the same time as credit card debt can be explained if the consumer has preferences for wealth.

To support the proposition that a sub group of co-holders with high liquidity exists, I outline the extent of the liquid co-holding by first ranking all co-holders according to a constructed measure of liquidity. The measure is the ratio of liquid assets and credit card debt at the household level. Based on this, co-holders are organised into two groups; a liquid group (*cash rich*) and a less liquid group (*cash poor*). I study the characteristics of these two groups of co-holders. Organising co-holders in this way gives a new perspective on the puzzle. In the literature co-holders are generally assumed to be a single group.

The two groups differ with respect to wealth, the cash-rich co-holder group is wealthier. It has higher house values, lower mortgages remaining, higher liquid assets, higher values of stocks and bonds. There is also a higher proportion owning stocks and bonds, 24% for the cash rich versus 12% for the cash poor, co-holders. From the perspective of wealth, cash-rich co-holders, in the PSID at least, are closer to the *savers*, defined as households with liquid assets but without credit card debt, than they are to their cash-poor counterpart.

I estimate a model explaining credit card debt, conditional on being a co-holder, as a function of liquid assets and controlling for many household level characteristics that the literature suggests are correlated with co-holding. Estimating the model over all co-holders shows a non linear relationship: credit card debt, conditional on co-holding, first increases in liquid assets, and then decreases. Estimating a piecewise linear model over the two co-holding groups, I find different credit card debt to liquid asset relationships. The coefficient on liquid assets is negative for the cash-rich group - credit card debt and liquid assets are substitutes. The coefficient on liquid assets is positive for the cash-poor group; credit card debt and liquid assets are complements. The fit of the model is not very good,but the signs on the coefficients are stable and robust to the different specifications.

Neither empirical studies nor structural models explain co-holding in households with high wealth, and/or relatively high liquid assets. When the level of liquidity and wealth is high enough, liquidity based explanations cannot generate co-holding. It may be that the cash rich households contribute to the observation that "no extant model ... can generate enough credit card debt", (Zinman, 2015) and noted also by Laibson, Repetto, and Tobacman (2000) and Druedahl and Jørgensen (2018), for example.

The remainder of this chapter is organised as follows. Section 2 reviews the literature. Section 3 introduces the model. Section 4 sets out the empirical work identifying liquid co-holders. Section 5 concludes.

2 Related Literature

The relevant literature falls into two broad categories; that related to preferences for money and that related to the credit card debt puzzle.

In order to explain macroeconomic puzzles, a growing number of papers that assume households get utility from wealth, per se, rather than from the future spending wealth allows. Although I solve a microeconomic, rather than macroeconomic, problem, the preferences for wealth I adopt are closely aligned to this work.

Carroll (1998) proposes revising the lifecycle model to include wealth in the utility function to explain the higher savings rate of the wealthiest households. This matches the data for the median household and those in the upper tail of the distribution.[6] Michau (2018) explains secular stagnation with a model including both utility for money and a utility from wealth. If the marginal utility for wealth is higher than the marginal utility for consumption, a high enough interest rate is needed to induce consumption. Similarly Ono (2015) identifies preferences for wealth as central to secular stagnation in Japan. Barnett, Fisher, and Serletis (1992) include money in utility as financial assets - different

[6]Of course, the high savings rates of the rich is itself not fully explained.

types of money. It states *"The benchmark asset....is assumed to provide no liquidity or monetary services. It is held solely to transfer wealth intertemporally."*.[7]. Kopczuk and Lupton (2007) include both consumption and wealth in the utility function to generate an egotistical, rather than altruistic, bequest on death. Households choose consumption or accumulation of wealth.

I also draw on the behavioural literature around consumption pleasure and payment pain, but extend it to include demand, as well as utility, effects. Most closely related, Loewenstein and Prelec (1998) considers the pain of payment as a natural self control mechanism when choosing to consume. It proposes that physiological costs and benefits in a *double-entry mental accounting* system to explain the reversals of preferences seen in experiments. The model finds that the type of good influences the optimal way to pay. Durable goods provide higher utility if they are paid for in installments, non durables deliver higher utility if they are pre-paid. The agent gets higher utility from a holiday if it is pre-paid, from a washing machine when it is post paid. Quispe-Torreblanca, Stewart, Gathergood, and Loewenstein (2019) use high frequency credit card data to test whether pain of payment is sensitive to type of purchase. It finds that debt related to non durable goods is more likely to be paid off, whiche supports the hypothesis of Loewenstein and Prelec (1998).

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.

The literature on the the credit card premium motivates the idea that temporal separation of purchase and payment affects utility and demand. Prelec and Simester (2001) study willingness to pay in an experiment that compares bid values in a second price auction. 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. It argues that neither liquidity constraints nor precautionary liquidity needs can account for the observed outcome.

Feinberg (1986) compares likelihood of purchase, amount spent, and decision speed, using credit card with alternative mechanisms such as cash and cheques. It finds more spending in the credit card case. Similarly, Soman (2001) finds that payment mechanisms influence spending. It recognises that while the credit card is often used as a convenient method

[7] Barnett, Fisher, and Serletis (1992), pp 2023 footnote 8

of payment, i.e. what is in the consumers wallet, spending paid for with a credit card is higher than when payment is contemporaneous. The paper tests the hypothesis that past payments influence current spending through the consumer's budget. However, recalling past payments is crucial. The chapter finds that the credit cards influence memory of past purchases and consumers underestimate them, leading to higher present spending.

The literature on the credit card debt puzzle has three broad categories of explanation for this costly consumer choice: precautionary motives; intra household or intra self mechanisms for self control; and other behavioural explanations such as personality types, financial literacy and mental accounting.

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'*. Telyukova (2013) suggests that much of the borrowing can be explained by precautionary liquidity 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. Cash, or equivalent forms of payment, dominate household expenditures and median levels of liquid assets for co-holding households are only 1.5 times monthly cash expenditures. A structural model motivates co-holding from cash consumption uncertainty and binding budget constraints.[8]

Druedahl and Jørgensen (2018) develop a broader precautionary savings theory, also with a structural model. The paper uses credit card debt and liquid asset data from from the SCF 1998 - 2013 to characterise co-holding and other borrowing behaviour and these variables provide targets for the model to match. Specifically, these are percentiles of credit card debt and liquid assets, expressed as a ratio of quarterly income in the survey year. Several groups are considered, co-holders, borrowers, a corner group, and savers. Households with positive liquid assets can increase their line of credit and accumulate new debt. This is optimal if the household needs to spend and accumulate precautionary savings and faces constraints, either in the current period or in the future.

Choi and Laschever (2018) investigate personality types as an explanation for co-holding. It 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.

[8] The precautionary liquidity idea implies co-holding should fall 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) find the puzzle group, by several definitions, to be stable over time (although, after nearly 20 years of stability, these data show a sudden drop of 7 percent in 2010). In the PSID, 2010-2014 used in this chapter, I also find the proportion of co-holding households to be stable over time.

Angrisani, Burke, Lusardi, and Mottola (2020) also study financial literacy but focus on how it evolves over time by using panel data. It finds that financial literacy is positively correlated with life satisfaction, ability to adsorb shocks and to plan for retirement. It finds little correlation, on the other hand, between financial literacy and debt management, in other words, *negative* financial behaviour such as carrying credit card debt. It is suggested that these negative behaviours may be more related to resource constraints or behavioural traits than a lack of understanding. A consumer can thus be finacially literate and also engage in negative financial behaviour. Gathergood and Weber (2014), more specifically , 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 based on 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.

Vihriala (2020) finds that co-holding *is* substantially less likely, and less persistent, in single, rather than two adult, households, in Finnish bank data. This, supports the accountant shopper explanation in the intra household, but not intra self, set up. Gathergood and Olafsson (2020) show that households with more bank accounts are also more likely to co-hold. Mental accounting (allocating different pots for different spending purposes) helps to explain co-holding. Work from these data sets illustrate the importance of the structure of financial institutions in explaining the puzzle. Both of these papers include in the *debt* calculations, negative balances held in bank accounts which have a fundamentally different structure to the credit card, and are not part of the typical unsecured borrowing portfolio of US (and UK) households. This makes the question a little different to that addressed in this chapter and the others discussed here, which mostly use US data.

3 The Model

3.1 One-period baseline model

The consumer 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 $v(m, x) = u(x)$, 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:

$$\max_x u(x) + \alpha t(m - px) \qquad x \geq 0; \qquad m - px \geq 0 \tag{1}$$

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 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

$$\mathcal{L} = u(x) + \alpha t(m - px) + \mu(m - px) \tag{2}$$

First order conditions are

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

$$\mathcal{L}_x = u_x(x) - \alpha t_x(m - px) - \mu p \geq 0, \quad x\mathcal{L}_x = 0 \tag{3}$$

The direction of the inequality of (3) reflects the upper bound of the budget constraint.

For the remainder of the chapter 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 $t_{xx}(y(x))$.[9] I will sometimes expand t, $t(y(x)) = t(m - xp)$. 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.[10] 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.

The solution to the problem is

$$x = \min\{m, x^\star\} \tag{4}$$

This is one way to address the unrealistic prediction that consumers consume all their wealth.

3.1.1 Numerical solution, one-period model

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

[9]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 throughout the chapter.

[10]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. This is not the area of interest for this chapter but 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.

$$u(x) = \frac{x^{1-\rho}}{1-\rho} \tag{5}$$

$$t(y(x)) = \frac{(m - px + \omega)^{1-\upsilon}}{1-\upsilon} \tag{6}$$

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

I assign the values

	Figure 1	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

Figures 1 and 2 show 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 figure 1, where $m = 40$, the consumer can reach this point. She optimally consumes 24 units of the good and holds 16 units of money. In figure 2, $m = 15$ 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.

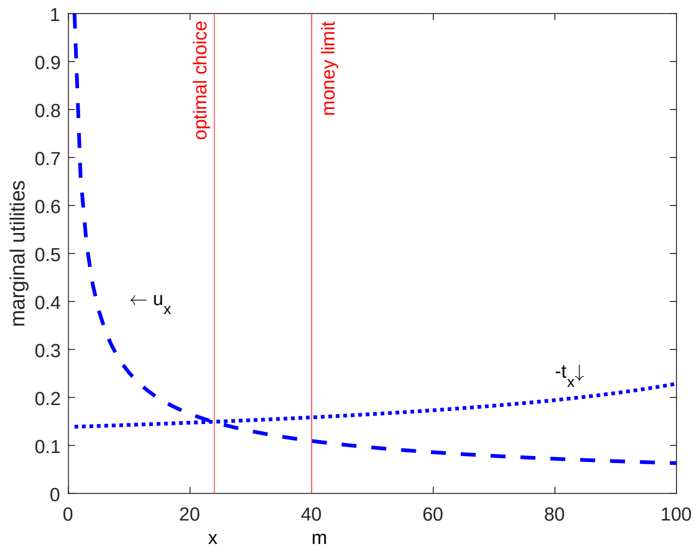

Figure 1: $\mathbf{m = 40}$, $x^\star = 24$. The consumer holds money and good $\{(m-x)^\star, x^\star\} = \{16, 24\}$

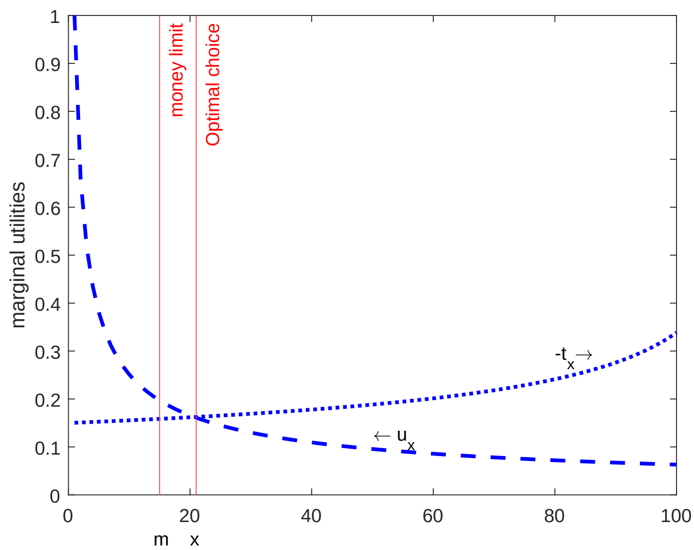

Figure 2: $\mathbf{m = 15}$, $x^\star = 21$. The consumer spends all her money on good: $\{(m-x), x\} = \{0, 15\}$

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. 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.

One result is that it may be optimal to borrow money from the future 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 would the consumer borrow when she does not need it for spending? When it is costless, she does this if she gets utility from holding money.

In the two-period model, the consumer chooses consumption in $t = 1$, x_1, consumption in period $t = 2$, x_2, and amount of borrowing from the $t = 2$ income, b.[11] If $b > 0$, the consumer borrows from the period $t = 2$ income; if $b < 0$, the consumer lends some of $t = 1$ income to $t = 2$.

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

$$y_2 = m_2 - p_2 x_2 - (1 + r)b + y_1 = m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \tag{7}$$

Then, consumer's problem can be written as[12]

$$\max_{x_1, x_2, b} u(x_1) + \alpha t(m_1 - p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \right) \tag{8}$$

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

$$\begin{aligned} \mathcal{L} = u(x_1) + \alpha t(m_1 - p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \right) \\ + \mu_1 (m_1 - p_1 x_1 + b) + \mu_2 (m_2 - p_2 x_2 - rb + m_1 - p_1 x_1) \end{aligned} \tag{9}$$

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

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

First order conditions are[13]

$$\begin{aligned}
\mathcal{L}_{x_1} &= u_{x_1}(x_1) - \alpha t_{x_1}(y_1(x_1)) - \beta\alpha t_{x_1}(y_2(x_1)) - \mu_1 p_1 - \mu_2 p_1 \geq 0 & x_1\mathcal{L}_{x_1} &= 0 \quad (10)\\
\mathcal{L}_{x_2} &= \beta\big(u_{x_2}(x_2) - \alpha t_{x_2}(y_2(x_2))\big) - \mu_2 p_2 \geq 0, & x_2\mathcal{L}_{x_2} &= 0 \quad (11)\\
\mathcal{L}_{b} &= \alpha t_b(y(x_1)) - \beta\alpha t_b(y(x_2))r + \mu_1 - \mu_2 r \leq 0, & b\mathcal{L}_{b} &= 0 \quad (12)\\
\mathcal{L}_{\mu_1} &= m_1 - p_1 x_1 + b \geq 0, & \mu_1\mathcal{L}_{\mu_1} &= 0 \quad (13)\\
\mathcal{L}_{\mu_2} &= m_2 - p_2 x_2 - rb + m_1 - p_1 x_1 \geq 0, & \mu_2\mathcal{L}_{\mu_2} &= 0 \quad (14)
\end{aligned}$$

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 borrow. She gets positive money utility from increasing y_1. But this also increases the consumer's 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, $y_2 = m_2 - p_2x_2 - (1+r)b + y_1$ 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

$$\max_{x_1,x_2,b} u(x_1) + \beta u(x_2) \tag{15}$$

subject to non-negativity constraints $x_1 \geq 0$, $x_2 \geq 0$, $m_1 - p_1x_1 + b \geq 0$ and $m_2 - p_2x_2 - rb + m_1 - p_1x_1 \geq 0$.

If there is a standard terminal condition, $y_2 = 0$, 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

[13] In equation 12 I inconsistently include r, but not p. I do this to highlight the effect of the interest rate on borrowing, appearing here for the first time.

not be the case, for example, that $m_1 - p_1x_1 + b > 0$ and $m_2 - p_2x_2 + m_1 - p_1x_1 > 0$ 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, $m_1 + m_2 = p_1x_1 + p_2x_2 + w$, 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 15, 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 8, 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 $t = 2$.

3.2.1 Numerical solution, two-period model

I solve the model numerically to find optimal consumption and borrowing over two periods.

In this example, I use the same functional form for $u(x)$ and $t(y(x))$ as set in equations 5 and 6.

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.[14] 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).

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

	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[15] and vary υ. I compare results to the standard case, denoted by the superscritpt st, x_1^{st}, x_2^{st}, equation 15.[16]

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 1: 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 15.

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 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 3). 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 15, when $\beta = 1$ consumption equals income in both periods

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

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

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 1, in the columns labelled y_1 and y_2.

Figure 4 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.

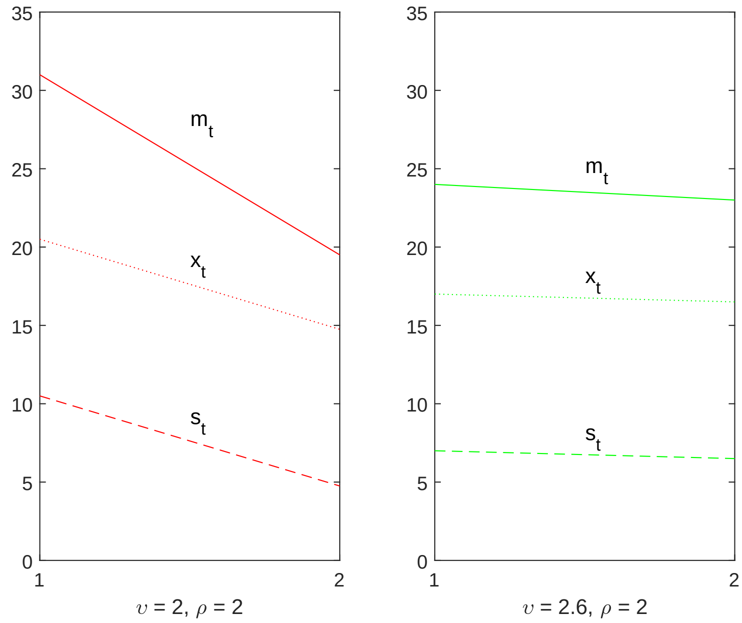

Figure 3: Results for the two-period case ($t = 1, 2$ on horizontal axis) where $\beta = 1$, for two values of υ, the elasticity of money, and constant $\rho = 2$, elasticity of consumption. $m_1 = m_2 = 20$. s_t is money *not* spent at the end of each period.

In this example, liquidity constraints do not bind; the consumer has enough income to achieve optimal consumption and money choices. If constraints did bind in both periods, the consumer spends m_1, m_2 in each period as in the standard case.

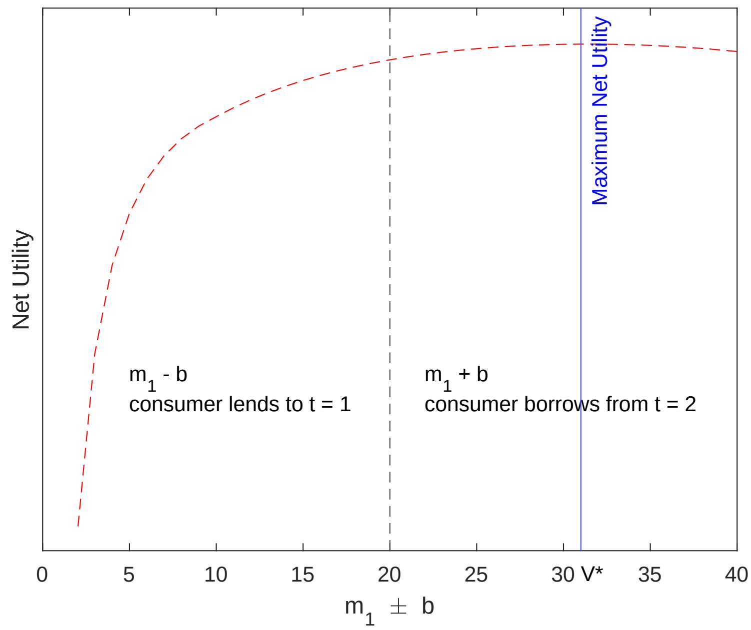

Figure 4: Shows how net utility over both period $t = 1$ and $t = 2$ changes as b changes. Parameter value for $t(y(x))$ is $\upsilon = 2$, and $\beta = 1$. Otherwise values are from table 1

3.3 One-period model with 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

$$v(x, y) = \max_x \; u(\gamma^{(j-s)}px) + \alpha t(m - \gamma^{(\tilde{j}-s)}px) \tag{16}$$

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

[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.

- $\tilde{j}$ 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

$$v(x, y) = \max_{x} \ u(x) + \alpha t(m - \gamma px) \qquad x \geq 0; \qquad m - px \geq 0 \tag{17}$$

This is identical to the one-period baseline case except that payment, px, is discounted by 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 2, 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 (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.

[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.

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 1 and $\mu = 0$ so the utility maximising x is $x^\star$, from 4, 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 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 2, 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.

3.3.1 Numerical solution, delayed payment

I provide numerical example where 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 5 and for $t(y(x))$, 6. I calculate results for two sub-period discount rates; $\gamma = 0.9$ and $\gamma = 0.8$.

	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

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	$\gamma = 0.8$	$x^\star = 32 > m = 30$
		constraint binds, $x = 30,\ (m-x) = 0$

Table 2: Results for numerical solution

Figure 5 plots these results. 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.

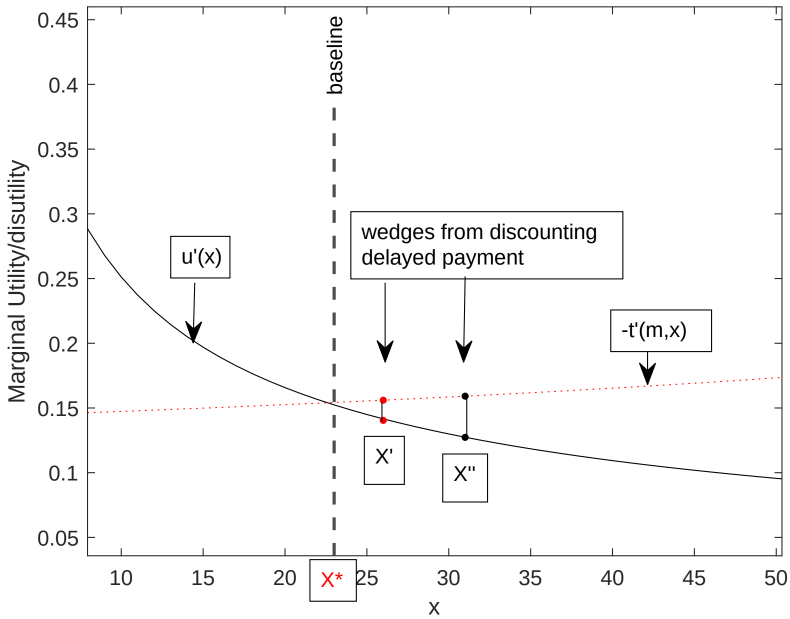

Figure 5: The x that optimises net utility is where the marginal utility of consumption (solid curve) is equal to the marginal disutility of payment (dotted line). If payment is delayed, the more impatient the consumer, the higher is the x that optimises net utility. The vertical lines between plots, at x' and x'' show the effect of delaying payment. $x^\star$ is the baseline demand choice. x' shows $\gamma = 0.9$, x'' shows $\gamma = 0.8$

Relating this result to consumer choices, the model predicts that when consumers face exogenous delayed payment, they will consume more *and* have higher ex ante utility. If they are *offered* delayed payment, for example at the point of check out as is the case for BNPL, if the consumer has already fixed her demand, she does 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.

[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.*

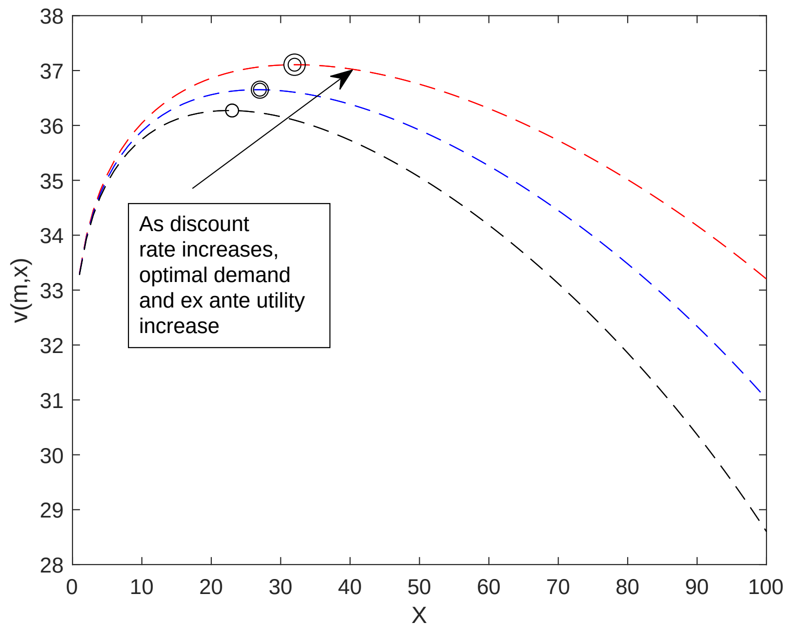

Figure 6: The arrow shows the effect of increasing sub period discounting (γ decreases) on net utility and utility maximising demand when payment is delayed. For a given x, net utility increases with sub period discounting. Optimal x also increases, shown by hollow circles.

3.4 Two-period model with separation

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 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 8 and 16 is

$$\max_{x_1,x_2,b} u(x_1) + \alpha t(m_1 - \gamma p_1 x_1 + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - p_1 x_1)\right) \quad (18)$$

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, 8, 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 $x^\star, x_2^\star, b$ from the two-period baseline case in sub section 3.2.

Next, in period $t = 1, s = 2$, (second sub-period of first time period) the consumer receives her credit card demand for $p_1 x_1^\star$. The consumer is committed to both $x_1^\star$ and b, 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 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 $t = 2$.

The consumer solves

$$\max_{x_2,c|x_1^\star,b} \alpha t(m_1 - \gamma p_1 c + b) + \beta \left(u(x_2) + \alpha t(m_2 - p_2 x_2 - rb + m_1 - c - (x_1^\star - c)(1 + r^c))\right) \quad (19)$$

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.

3.4.1 Numerical solution, credit card payment in $t = 1$

I use the results of the two-period baseline model in table 1 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. The points below summarise the discussion above

Assume the following values

	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 1	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

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 $r = 0.15$

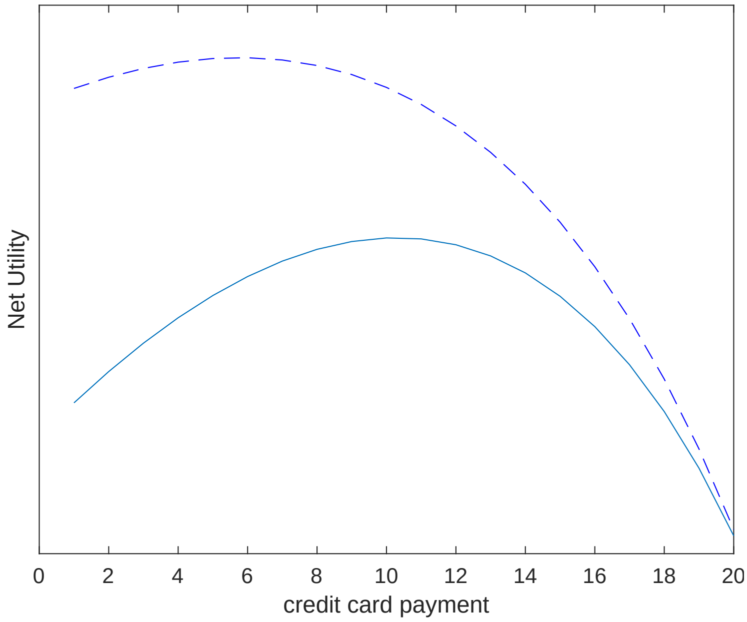

Figure 7: Net utility over two periods for different credit card repayment amounts. The credit card bill is $x_1^\star = 20.5$. Optimal repayment is where net utility is highest. The dashed line is net utility with a credit card interest rate, $r = 0.15$, optimal payment is 6. The solid line, $r = 0.20$, optimal payment is 10.

Table 3 sets out some results. In $t = 1, s = 2$, $x_1^\star$ and b are 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 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 $r^c = 0.15$.

Credit card interest rate	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 3: Optimal choices of (x_1, x_2, c) for the model with money when period 1 consumption is paid for with a credit card.

4 An empirical analysis of the credit card debt puzzle from the perspective of liquidity

This section revisits the well documented credit card debt, or co-holding, puzzle,[20] from the perspective of liquidity.

I establish the presence of liquid co-holders as a sub group of all co-holders in the Panel Study of Income Dynamics (PSID). By the definitions in this paper, liquid co-holders may account for around 40% of all co-holders. This liquid group has different characteristics to the illiquid group. It is wealthier on several measures and I find evidence that cash and credit card debt are substitutes for the liquid group, whereas for the illiquid group they are complements.

A large proportion of co-holding is explained by existing theories in the related literature. But when levels of liquidity are high relative to credit card debt, as is the case for the liquid co-holders, co-holding is typically under-predicted. One reason for this may be that existing theories require binding liquidity constraints to motivate the co-holding. As relative liquidity increases, this is increasingly difficult to achieve. A explanation in which utility maximising consumers choose to hold credit card debt and liquid assets, when liquidity constraints do not bind, may help to explain the borrowing of the liquid co-holders identified in this section of the paper.

4.1 Data and Descriptive Statistics

The data are from the US longitudinal biennial household survey, the Panel Study of Income Dynamics (PSID). Since 1968, it has recorded rich and detailed information on demographics, income, consumption, and assets of over 5000 households (about 18,000 individuals) and their descendants and has been .

The PSID introduces a specific question on credit card debt in the 2011 (labelled 2010) wave. The question identifies interest bearing debt. It excludes the balance to be paid in the next billing cycle, which does not attract interest and which is thus not of interest in the credit card debt puzzle. The full question is set out in appendix A.7. In total,

[20] Co-holders are defined as households holding positive liquid assets; the combined balance in checking and savings accounts and carrying interest attracting debt on their credit cards. There are many different definitions in the literature. The difference being around definitions of liquid assets and the levels of both liquid assets and credit card debt the household holds. The findings in this chapter are robust to other definitions used in the literature, Telyukova (2013) for example.

51% of households in the PSID report holding credit card debt in at least one of these periods.[21].

To get some idea of how persistent holding credit card debt is in the PSID, I calculate the number of waves (see table 19) 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 9). 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.[22]

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. In this chapter, 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, in this chapter 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 of this chapter are robust to stricter definitions.[23] 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

[21]This is consistent with other US surveys. For example, $60-62\%$, in the Survey for Consumer Finances, 51%, Census Bureau. This percentage is 51% of households with a credit card.

[22]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.

[23]I loose around one third of the puzzle group if I follow Telyukova (2013), but results hold. It would be a useful robustness exercise to test more definitions used in the literature.

much of the literature also.

Table 4 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.[24]

	Borrowers		Co-Holders		Savers	
	Mean	Median	Mean	Median	Mean	Median
Wealth	74,532	7,550	205,766	52,950	433,079	107,000
Income	52,696	40,000	77,556	65,063	78,686	50,500
Consumption (nd)	31,975	28,480	39,701	35,852	38,423	32,253
Credir Card Debt	7,621	4,900	7,357	4,000	0	0
Subjective House Value	94,063	37,500	158,157	125,000	176,405	120,000
Mortgage Remaining	53,996	0	88,541	54,000	62,940	0
Liquid Assets	-0	0	16,840	4,500	40,855	10,000
Stocks and Bonds	3,834	0	19,330	0	68,250	0
Observations	678		5488		6811	

Table 4: Income and Assets, USD Unscaled, Nominal Values

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 5 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.

[24]The same information is reported with scaled and deflated values in table A

	Borrowers	Co-Holders	Savers
	–	–	–
Age of Respondent	43.03	45.31	47.06
% Highest: Grade School	0.29	0.23	0.23
% Highest: Some College	0.34	0.32	0.25
% Highest: College or Higher	0.26	0.41	0.45
% White	0.78	0.91	0.91
% Retired	0.13	0.13	0.22
% Homeowner	0.55	0.69	0.65
% Married	1.93	1.65	1.72
Observations	678	5488	6811

Table 5: Age of respondent and demographic characteristics by group as a proportion of its total

Table 6 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.

	Borrowers	Co-Holders	Savers
	–	–	–
% Have Employee Savings	0.48	0.67	0.54
% Have Retirement Account	0.12	0.32	0.37
% Have Mortgage	0.45	0.59	0.43
% Owns Stocks and Bonds	0.05	0.16	0.24
Observations	678	5488	6811

Table 6: Financial asset information by group as a proportion of its total

The statistics presented in tables 4 and 5 show that the characteristics of households

Percentile (p)	$\phi_p|(ch=1)$
10	0.75
20	0.98
30	1.00
40	1.02
50	1.06
60	1.05
70	1.22
80	1.45
90	1.99

Table 7: Values of $\phi_p|(ch=1)$ for percentiles 10 - 90.

in the PSID sample are broadly similar to those of co-holders in other work, using US household data. In particular, 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).

4.2 Ranking Co-holders According to Liquidity

To study co-holding from the perspective of liquidity, a definition for what is meant by liquidity in the context of co-holding is needed. Before I introduce my approach for this I review how co-holder liquidity is typically described in the literature, and, importantly, how this description is related to judging model success.

The approach in much of the literature (see Telyukova (2013) or Druedahl and Jørgensen (2018), for example) is to compare percentile values of liquid assets for co-holders to the percentile values of credit card debt for co-holders. This gives a measure of the *extent* of the co-holding - that is, for a given percentile, if credit card debt was paid down with liquid assets, what would be the net position? This can be described as a ratio, I denote it as ϕ, conditional on being a co-holder.

$$\phi_p|(ch=1) = \left.\frac{percentile\ p\ of\ liquid\ assets}{percentile\ p\ of\ credit\ card\ debt}\right|\text{co-holder} \tag{20}$$

The p values of $\phi_p|(ch=1)$ provide target moments for structural models to match as well as discussion about the character of co-holding. Table 7 shows these conditional ratio values, $\phi_p|(ch=1)$ 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 (referring to $\phi_p|(ch=1)$ as ϕ_p from this point) 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 table 7.

The approach described above, and often adopted in the literature, obscures a more extreme level of co-holding that may be harder to explain with theories based on liquidity arguments. To see this, note 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.[25] Or

$$Ratio\ of\ percentiles\ p \equiv \phi_p = Percentiles\ p\ of\ ratio \tag{21}$$

A household, i, with debt that corresponds to the median value, may have liquid assets in *any* percentile. Taking the approach of equation 20 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.

To address this, I take a household level approach to calculate the ratio on the right hand side of equation 4.2. For each co-holding household, in each time period, a ratio, $\Upsilon_{i,t}|ch=1$ is calculated. The percentile values of the distribution of this ratio are

$$\Upsilon_p|(ch=1) = percentile\ p\ of\ ratio = \left[\left[\frac{liquid\ assets}{credit\ card\ debt}\right]_{i,t}\middle|\ ch=1\right]_p \tag{22}$$

I equivalently refer to $\Upsilon_p|(ch=1)$ as Υ_p. Table 8 compares the percentiles from equation 20 and 22. 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.

[25]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.

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 8: A comparison between ϕ and Υ over percentiles

The household level matching approach is a more 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 $0.0002 - 2000!$[26], that is, at its highest value, the household has liquid assets 2000 times greater than credit card debt.

Figure 8 plots ϕ and Υ by percentile.

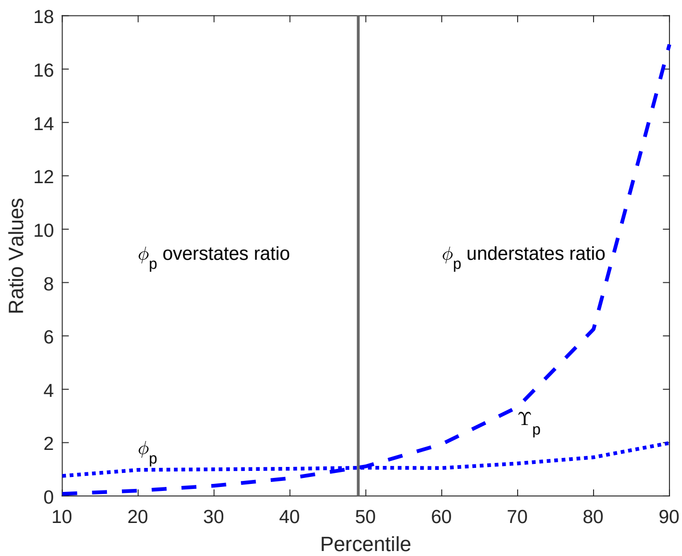

Figure 8: ϕ, dotted line. Υ by percentile.

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

Figure 8 plots the values from table 8. Structural models for co-holding aim, and do, match ϕ. But not Υ.

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. [27][28]

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 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.

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.

[27] 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.

[28] A further exercise is to study this ratio conditional on other variables important for co-holding, rather than in isolation.

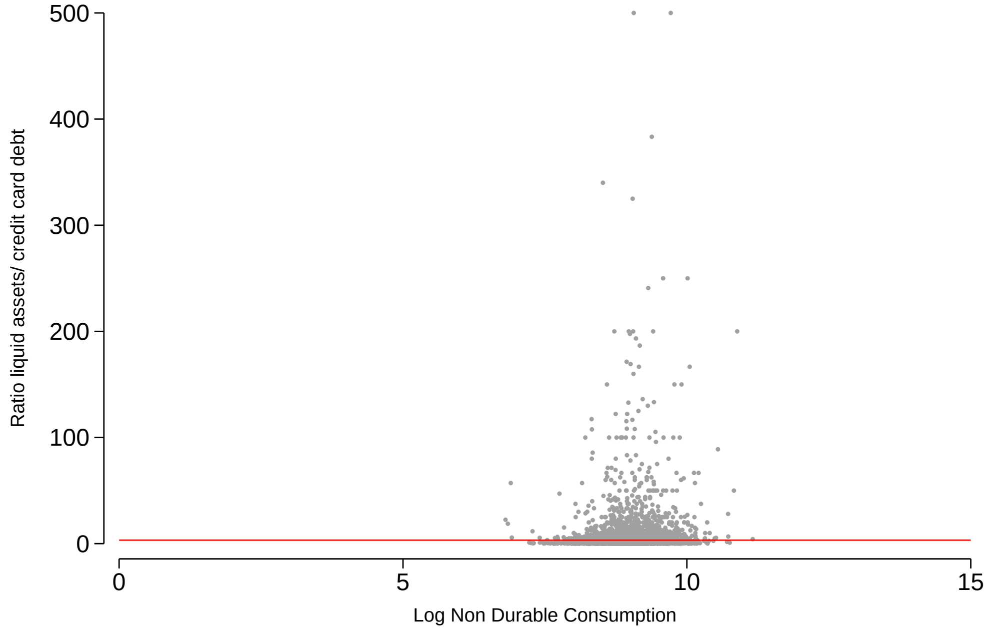

Figure 9: $\Upsilon_{i,t}$ plotted against log non durable consumption, x axis. The red line is $\Upsilon_{p=70} = 3.3$

I experiment with different thresholds for grouping co-holders and report here results of analysis based on a value $\Upsilon > 2$ as *cash rich* co-holders and $\Upsilon \leq 2$ as *cash poor* co-holders.[29]

I define dummies where CR is *cash rich* and CP is *cash poor*,

$$CR_{it} = \begin{cases} 1 & \text{if } \Upsilon_{i,t} > 2 \text{ and } CH = 1; \\ 0 & \text{otherwise} \end{cases}$$

$$CP_{it} = \begin{cases} 1 & \text{if } \Upsilon_{i,t} \leq 2 \text{ and } CH = 1; \\ 0 & \text{otherwise} \end{cases}$$

The cash poor group makes up 62% of the co-holding group, leaving 38% as cash rich co-holders. Table 9 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.

[29]The threshold value of $\Upsilon = 2$ corresponds to the turning point for the estimation of equation 23 over the whole co-holding group. A good exercise for later work, would be to back out household level certainty equivalence based on cash consumption shocks.

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

Table 9: 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, I revisit the demographic, financial, and asset information set out in tables 4, 5, and 6 this time dividing co-holders into cash rich and cash poor categories.

Table 10 expands table 4. 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.

	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 10: Table 4 restated with the two co-holding groups - Mean and Median values for Income and Assets, USD Unscaled, Nominal Values as before by cash rich and cash poor groups, as well as savers and borrowers.

Table 12 restates table 6, 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.

	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 11: Table 5 restated with cash rich and cash poor sub groups. Age of respondent and demographic characteristics by group as a proportion of its total.

	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

Table 12: Table 6, financial assets, restated with cash rich and cash poor sub groups. Financial asset information by group as a proportion of its total.

As an additional exercise, I calculate how liquid assets, credit card debt and consumption are correlated; if credit card debt and consumption rise together, but liquid assets do not, it suggests the cash-rich co-holders are just spending more and borrowing proportionally more - so the candidate for explaining cash-rich co-holding is consumption. I find raw correlation is low between liquid assets, credit card debt and consumption, but is higher for the cash poor co-holders. For full details see table 20.

4.3 OLS Model for Co-Holding for Cash Rich and Cash Poor Groups

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 results in table 20.

First I estimate a model all co-holders:

$$\mathbb{E}(ccd_{it}|CH = 1) = \alpha_i + \beta_1 la_{it} + \beta_2 la_{it}^2 + \lambda_t + \gamma' \mathbf{Z}_{it} + \kappa' \mathbf{W}_{it} + u_{it} \tag{23}$$

Estimation is by pooled OLS. The lower case notation denotes log values of the variables. The dependent variable is log credit card debt, conditional on being a co-holder. The right hand variables la_{it} and la_{it}^2 are log liquid assets and log liquid assets squared.[30] λ_t controls for time fixed effects.

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

$\mathbf{W}_{it}$, is vector of employment controls. It includes employment controls.[31] 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.[32]

I next estimate equation 23 piecewise over cash-rich and cash-poor co-holders. I want to identify the two groups of co-holders but doing this directly from the $\Upsilon_{i,t}$ values means the grouping is endogenous to the equation being estimated. To overcome this I select

[30] A version in which log non durable consumption is also estimated abut not reported here. Estimated results for liquid assets are not materially affected by including non durable consumption. A discussion of non durable consumption as a control is set out in the narrative around equation 24

[31] 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).

[32] 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.

a proxy of a measure of liquidity well established in the literature; I call a household *liquid* if it holds the equivalent of one months income, $Y/12$, in liquid assets.[33] I define a dummy variable

$$Liquid = \begin{cases} 1 & \text{if la } > \frac{Y}{12} \\ 0 & \text{if la } \leq \frac{Y}{12} \end{cases}$$

And the following equation is estimated

$$\mathbb{E}(ccd_{it}|CH = 1, liquid = j) = \alpha_i + \beta' \mathbf{X}^l_{it} + \lambda_t + \gamma' \mathbf{Z}_{it} + \kappa' \mathbf{W}_{it} + u_{it} \tag{24}$$

Where $j = \{0, 1\}$ depending on liquidity status.

There are three specifications of $\mathbf{X}^l_{i,t}$. The first includes log liquid assets.[34] Specification 2 adds non durable consumption. Specification 3 adds $\eta^2_{i,t}$, idiosyncratic cash consumption.

$$\mathbf{X}^l_{i,t} = \begin{cases} la_{it} & \text{if } l = 1 \\ la_{it} + ndc_{it} & \text{if } l = 2 \\ la_{it} + \eta_{i,t} & \text{if } l = 3 \end{cases}$$

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 idio-

[33] There is a reasonable correlation between liquid households and cash rich co-holders and a weak relationship between liquid households and cash poor co-holders.

	Liquid	Cash Rich	Cash Poor
Liquid	100	71	29
Cash Rich	71	100	0
Cash Poor	28	0	100

Table 13: Percent of all co-holders that are liquid, grouped: liquid, cash rich and cash poor. 71 percent of liquid co-holders are also cash rich co holders. Only 29 percent of cash poor co-holders are liquid. Being liquid is a reasonable, proxy for cash rich.

This makes being liquid *and* a co-holder a reasonable proxy for being a cash rich co-holder. Similarly, being illiquid is a reasonable proxy for being cash poor, by this definition.

[34] The polynomial included in equation 23 for log liquid assets is dropped in the piecewise model because the non linear relationship is captured by the conditioning on cash-rich and cash-poor co-holders.

syncratic cash consumption in specification 3 because the precautionary liquidity theory suggests that the scale of cash consumption uncertainty is explanatory for co-holding.

Results of OLS estimation

Estimation of equation 23 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.Full results are set out in the appendix A.2.

Piecewise estimation of equation 24 by cash-rich and cash-poor co-holders shows that the sign of the the coefficient for liquid assets is different for the two groups. For the cash rich co-holders, it 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 different specifications.

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

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).

For further discussion of the results see appendix A.8.

In summary, I estimate the relationship between liquid assets and credit card debt of households with a full set of controls. I test the inclusion of non durable consumption, as a proxy for permanent income, likely to be correlated with credit card debt generally, and also I include cash consumption risk, shown in the literature to be correlated with co-holding. I find that organising co-holders by the liquid asset and credit card debt ratio, $\Upsilon_{i,t}$ suggests different a liquid asset/ credit card debt relationship. The model shows a different sign for the credit card debt, liquid asset relationship for these two groups. For cash poor co-holders, the relationship is positive credit card debt is increased to protect liquid assets. For cash rich co-holders, the relationship is negative, which suggests they are *not* co-holding to preserve liquid assets, but they are still co-holding.

4.4 Linear Probability Model for Credit Card Debt

To identify the factors that may be predictive of co-holding I estimate a linear probability model. 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 model by pooled OLS and by fixed effects.

$$P(CH_{it} = 1) = \alpha + \beta' \mathbf{X}^l_{it} + \delta \mathbf{J}_{it} + \lambda_t + \gamma' \mathbf{Z}_{it} + \kappa' \mathbf{W}_{it} + u_{it} \tag{25}$$

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 $\mathbf{X}_{it}$, as in equation 24 and described in equation 4.3. $P(CH_{it} = 1)$ is the probability of being a co-holder.

I follow the same steps as described for equation 24. 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 $\mathbf{J}_{it}$.

To estimate the model 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.

The pooled model obviously ignores unobserved household level effects. To get some intuition 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.

Results of estimation of Linear Probability Model for Credit Card Debt

I estimate the model over the whole sample and also piecewise by the *liquid* dummy. Full results are set out in table A.3 for the pooled estimation and table A.4 for fixed effects.

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 certain liquidity constrained households it may be optimal to hold liquid assets at the cost of credit card debt. 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.

For non-liquid households the coefficient for non durable consumption is not significant in either estimation approach. One way of interpreting this is that there is not a level of consumption at which credit card debt is not needed; it is not a function of changing consumption for the non liquid household. For liquid households, the coefficient is positive in both estimation approaches, but only significant (at the 99% level) when the data are pooled. The probability of co-holding increases with consumption.

Results for the pooled and fixed effect estimations, for all specifications, give results that are directionally similar to each other. In other words, the estimation approach is not driving the results. This consistency provides some reassurance that household level effects are not distorting the picture in the pooled case. For further discussion of the results see appendix A.9.

5 Conclusion

Consumer choices such as delaying payment of bills, co-holding credit card debt and liquid assets when highly liquid, and the credit card premium, can be explained by standard models, providing consumers face liquidity constraints. Theoretical and empirical research, however, finds liquidity based explanations to be incomplete. This paper proposes a model in which rational consumers get utility from money as well as from consumption. A consequence of utility from money is that consumers dislike making payments and there can be gains from delaying payments, not related to liquidity. With these features the model is used to study settings where consumers are faced with, or are offered, a payment structure that is separated from consumption; either payment or consumption is delayed. This is different to where consumers explicitly seek a separated payment structure, for example, to smooth consumption.

The main prediction of the model is that if consumers have preferences for money (wealth), then optimally they choose to hold money *and* consumption goods, providing the budget constraint is sufficient. If the consumer is presented with a payment structure where payment is delayed, she will consumer more than when consumption and payment happen simultaneously. If the consumer is offered a choice to delay payment at the point of purchase, she improves her utility by accepting it, and may consume more. If the consumer is presented with a pre pay structure where consumption is delayed, she will consume less and have lower utility but ex post, she is better off with contemporaneous consumption and payment.

Including preferences for money in a model of consumer choice can contribute to the explanations for co-holding of credit card debt and liquid assets when levels of liquid assets are high relative to credit card debt. The paper considers this sub group of co-holders from the perspective of the model. It first establishes the existence of these co-holders using a household level ratio to rank the degree of co-holding. It highlights how liquid co-holders are different to illiquid co-holders and shows how including preferences for money can lead to consumers optimally choosing to hold credit card debt and liquid assets when liquidity constraints do not bind

The model can also make predictions about the spending of consumers using delayed payment offers such as BNPL. Regulatory bodies in the UK and Sweden are already expressing concerns about how BNPL impacts consumer spending, personal indebtedness, and financial stability at the household level. This paper is a first attempt at modelling consumer choices when payment and consumption are temporally separated and where liquidity constraints do not bind. Further work is needed to formalise the results. With respect to co-holders of liquid assets and credit card debt, a fully developed and calibrated model is needed to test the model's ability to explain the this puzzle.

References

Angrisani, M., J. Burke, A. Lusardi, and G. Mottola (2020): "The Stability and Predictive Power of Financial Literacy: Evidence from Longitudinal Data," Working Paper 28125, National Bureau of Economic Research.

Ausubel, L. M. (1991): "The Failure of Competition in the Credit Card Market," *American Economic Review*, 81(1), 50–81.

Barnett, W. A., D. Fisher, and A. Serletis (1992): "Consumer Theory and the Demand for Money," *Journal of Economic Literature*, 30(4), 2086–2119.

Bertaut, C. C., M. Haliassos, and M. Reiter (2009): "Credit Card Debt Puzzles and Debt Revolvers for Self Control*," *Review of Finance*, 13(4), 657–692.

Carroll, C. D. (1998): "Why Do the Rich Save So Much?," Working Paper 6549, National Bureau of Economic Research.

Choi, H.-s., and R. A. Laschever (2018): "The Credit Card Debt Puzzle and Non-cognitive Ability*," *Review of Finance*, 22, 2109–2137.

Druedahl, J., and C. N. Jørgensen (2018): "Precautionary borrowing and the credit card debt puzzle," *Quantitative Economics*, 9(2), 785–823.

Dynan, K. E., J. Skinner, and S. P. Zeldes (2000): "Do the Rich Save More?," (7906).

Feinberg, R. A. (1986): "Credit Cards as Spending Facilitating Stimuli: A Conditioning Interpretation," *Journal of Consumer Research*, 13(3), 348–356.

Fernández-Villaverde, J., and D. Krueger (2007): "Consumption over the Life Cycle: Facts from Consumer Expenditure Survey Data," *The Review of Economics and Statistics*, 89(3), 552–565.

Gathergood, J., and A. Olafsson (2020): "The Co-holding Puzzle: New Evidence from Transaction-Level Data," .

Gathergood, J., and J. Weber (2014): "Self-control, financial literacy the co-holding puzzle," *Journal of Economic Behavior Organization*, 107, 455 – 469, Empirical Behavioral Finance.

Gorbachev, O., and M. J. Luengo-Prado (2019): "The Credit Card Debt Puzzle: The Role of Preferences, Credit Access Risk, and Financial Literacy," *The Review of Economics and Statistics*, 101(2), 294–309.

Gross, D. B., and N. S. Souleles (2002): "Do Liquidity Constraints and Interest Rates Matter for Consumer Behavior? Evidence from Credit Card Data," *The Quarterly Journal of Economics*, 117(1), 149–185.

Haliassos, M., and M. Reiter (2005): "Credit card debt puzzles," Economics working papers, Department of Economics and Business, Universitat Pompeu Fabra.

Heffetz, O., T. O'Donoghue, and H. S. Schneider (2016): "Forgetting and Heterogeneity in Task Delay: Evidence from New York City Parking-Ticket Recipients," Working Paper 23012, National Bureau of Economic Research.

Kopczuk, W., and J. P. Lupton (2007): "To Leave or Not to Leave: The Distribution of Bequest Motives," *Review of Economic Studies*, 74(1), 207–235.

Laibson, D., A. Repetto, and J. Tobacman (2000): "A Debt Puzzle," (7879).

Lehnert, A., and D. M. Maki (2002): "Consumption, debt and portfolio choice: testing the effect of bankruptcy law," (2002-14).

Loewenstein, G., and D. Prelec (1998): "The Red and the Black: Mental Accounting of Savings and Debt," .

Mankiw, N. G. (2001): "The Inexorable and Mysterious Tradeoff between Inflation and Unemployment," *Economic Journal*, 111(471), C45–61.

Massenot, B. (2021): "Pain of Paying in Consumption-Saving Decisions," Discussion paper, SSRN.

Michau, J. B. (2018): "Secular stagnation: Theory and remedies," *Journal of Economic Theory*, 176, 552–618.

Michau, J.-B., Y. Ono, and M. Schlegl (2018): "Wealth Preference and Rational Bubbles," CESifo Working Paper Series 7148, CESifo.

Ono, Y. (2015): "Growth, Secular Stagnation and Wealth Preference," ISER Discussion Paper 0946, Institute of Social and Economic Research, Osaka University.

Prelec, D., and D. Simester (2001): "Always Leave Home Without It: A Further Investigation of the Credit-Card Effect on Willingness to Pay," *Marketing Letters*, 12, 5–12.

Quispe-Torreblanca, E. G., N. Stewart, J. Gathergood, and G. Loewenstein (2019): "The Red, the Black, and the Plastic: Paying Down Credit Card Debt for Hotels, Not Sofas," *Management Science*, 65(11), 5392–5410.

Silber, N. (2008): "Late Charges, Regular Billing, and Reasonable Consumers: A rRational for a Late Payment Act," *Lent Law Review*.

Soman, D. (2001): "Effects of Payment Mechanism on Spending Behavior: The Role of Rehearsal and Immediacy of Payments," *Journal of Consumer Research*, 27(4), 460–474.

Telyukova, I. A. (2013): "Household Need for Liquidity and the Credit Card Debt Puzzle," *The Review of Economic Studies*, 80(3), 1148–1177.

Vihriala, E. (2020): "Intra-household Frictions, Anchoring, and the Credit Card Debt Puzzle," *Proceedings of Paris December 2020 Finance Meeting EUROFIDAI - ESSEC.*

Zinman, J. (2015): "Household Debt: Facts, Puzzles, Theories, and Policies," *Annual Review of Economics*, 7(1), 251–276.

Appendix

A Data

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).

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.

Wealth and Assets

The PSID constructs an overall variable for wealth, weq_{it}. It is the sum of the value of a farm or business, stocks, annuities, savings, additional real estate, vehicles and any other assets and the value of the home, if any, less debt on this. Respondents are asked for the value of these assets net of any debt held against them.

House Value

House value is the home owners' *perceived* value of their home. The question has been included in the survey since it began in 1968. The proportion of home owners in the sample is close to the national average of around 60 percent. Perceived values of homes closely match average values in the National Prices Case Shiller Index showing that on average home owners perceptions are realistic. Average self reported, deflated house values and the Case Shiller index have a correlation of 0.96 overall.

Non Durable Consumption

Non durable consumption is the sum of imputed rent, house insurance, utilities, non durable vehicle costs, child care, education costs, health insurance, non durable transport costs such as parking, cabs and public transport, medical expenses, food at home, food away from home and the monetary value of food stamps.[35]

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 A shows the proportion of households with an IRA or an employment savings scheme.

[35]As is standard in the literature, these expenditures act as a proxy for consumption. In fact, it underestimates the true amount by not accounting for consumption of leisure, home production and durable goods but assume separable utility between these groups. Estimating the age profile over different categories; total consumption expenditures, non durable and durables all yield the hump shape. (Fernández-Villaverde and Krueger (2007)). On the issue of defining durables and non durables, Mankiw (2001) points out that they differ only in their rate of depreciation and that some non durables, for example, clothing, is *partly* durable. So if the weight of durability relates to the type of consumption then the mix matters. Also, simply removing perceived durables is not sufficient to exclude durability altogether.

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

Table 14: Proportions of households with IRA and Employee savings schemes.

Income

This chapter uses *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.

Household Characteristics, Scaled and Deflated

The Scaled and Deflated version of table 10.

	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 15: Summary statistics for each group, deflated using 1982 prices and scaled to adjust for household composition.

A.1 Single vs Married (2 adult) Households

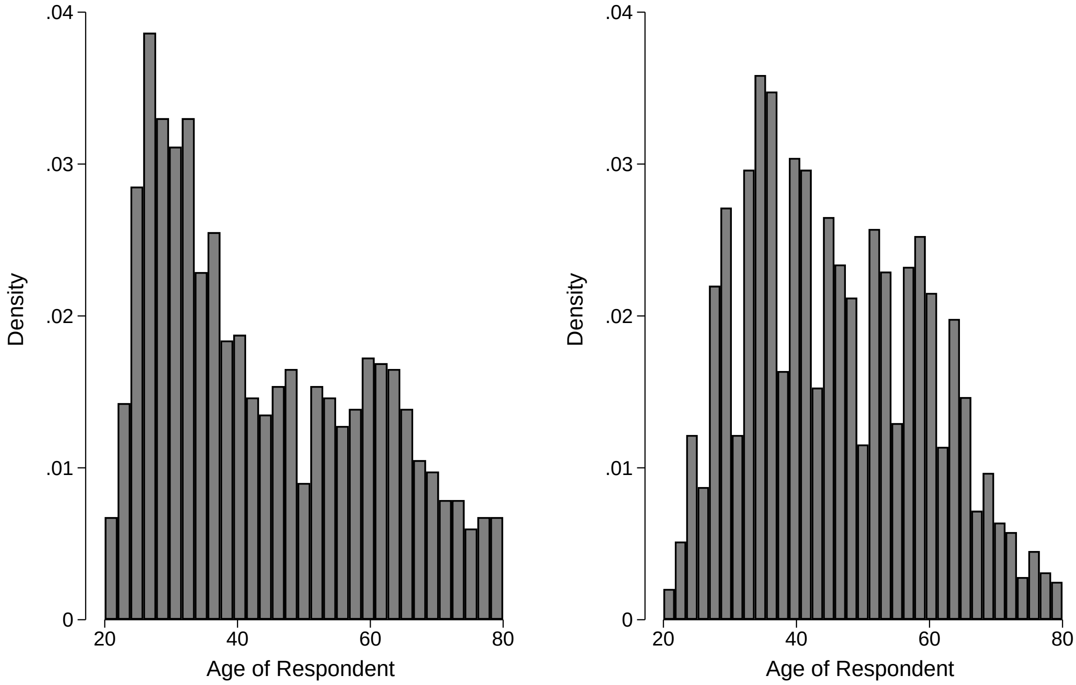

Figure 10: Left panel shows the age distribution for the single adult households, conditional on being a co-holder. The right panel shows the age of the head of married households where the household is a co-holder. There are clearly more people at either end of the age range who are single.

A.2 Regression results for equation 23.

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

A.3 Regression results for OLS estimation of equation 25. 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

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

A.4 Regression results for FE estimation of equation 25. 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

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

A.5 Regression results for whole sample, Pooled and FE estimation of equation 25. 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

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

A.6 Discussions of Explanations for Co-holding

I revisit some of the explanations for co-holding that are dominant in the literature from the perspective of the PSID data. Specifically the accountant - shopper theory; strategic bankruptcy; precautionary liquidity need.

The accountant-shopper theory for co-holding is desribed in section 2. It can be considered as an intra household problem, or an intra self problem (Bertaut, Haliassos, and Reiter (2009), Vihriala (2020)). If it is a household problem, then one prediction is that one adult households are less likely to co-hold. I test this in the PSID. I categorise households as married, single adult, and unmarried (but not necessarily single adult). I find 68% of co-holding households are married. Scaling this by the proportion of households in the data that report to be married, I find 13% co-hold. 25% of co-holders are single adult households, scaled to 10% of all single adult households co-holding. 32% of co-holders report being unmarried, 10% of all households these households co-hold. After scaling, there is not much difference across the groups.

I also compare the level of credit card debt, in raw values and scaled deflated values, across the same categories.

For married households, mean credit card debt, scaled and deflated, is $1652, the nominal unscaled value is $5239. For single households, mean debt is $1833, and the nominal unscaled value is $5239. Finally, for unmarried households, mean scaled and deflated credit card debt is $1933, the nominal unscaled value is $4910. Single household co-holders have the highest level of credit card debt and married households the lowest. This ordering of credit card values reflects the effect of scaling for household composition. If nominal, unscaled values are used, the order is reversed, but the scaled version is more comparative, and show the debt to be fairly similar in both proportion and amount across the household structures.

In the PSID, co-holding is not much more frequent in married households, and not much less frequent in single adult households. The level of scaled credit card debt is also fairly similar.

Households are more likely to co-hold when bankruptcy laws are more accessible (Lehnert and Maki, 2002). Are the co-holders in the PSID candidates for strategic bankruptcy? It is difficult to rule this out entirely. In the PSID, around 78 percent of all co-holders are home owners and only a small fraction have negative equity. But the current values for homestead exception, that protects home equity in bankruptcy, is more than $50,000 in around 40% of states rising to $600,000 in California and is unlimited in 7 states. It

	CH, Cash Poor	CH, Cash Rich
	-	-
Owns Some Stocks and Bonds	0.12	0.24
Home Owner	0.67	0.73
Observations	3422	2066

Table 16: The percentage of cash rich and cash poor co holders who own stocks and bonds.

is often doubled for married couples. The mean home equity value of co-holders (house value (subjective) - mortgage remaining) is $100,428, the median $62,000. Although the PSID data are from 1999 - 2014, homestead exemption changes seem to evolve slowly so 2021 values are still a reasonable guide. A large proportion of of home values are thus protected in bankruptcy. Only 16% of co-holders have stock and bonds, 5% of cash poor and 25% of cash rich. On the other hand, for cash rich co-holders, liquid assets are at least twice the level of credit card debt, suggesting that most cash rich co-holders have a lot to lose from bankruptcy and that holding relatively small levels of credit card debt, on average, is unlikely to be motivated by strategic bankruptcy.

I next consider the precautionary cash liquidity explanation for co-holding in the PSID. Telyukova (2013) (TEL) estimates the volatility of cash-only consumption. She uses this as a measure of the feasibility of the precautionary liquidity explanation for co-holding. She shows that the magnitude of the volatility is sufficient to explain much of the co-holding in the CEX (2001). I apply TEL's general procedure for estimating cash consumption volatility to the PSID data. I can extend the analysis to the cash-rich, cash-poor, categories of co-holders as well as the saver group and the borrower groups.

I follow TEL's detailed CEX categorisation for cash consumption in the PSID, but it is an imperfect comparison because the CEX data collects information on more expenditure categories than the PSID, 1999-2014. In particular, household operations and household maintenance are not collected in the PSID until 2005 and not included in my sample. The differences are listed in table 17.[36]

[36]Because I use 1999 - 2014 PSID data for some of the analysis, for consistency, I do not make use of the additional categories of consumption introduced in the 2005 wave. These would be useful and should be added in future work.

Table 17: Cash Goods Consumption

Items included in Cash Goods Measure of Consumption from CEX, Telyukova (2013)	In PSID Measure in this chapter
Food	Yes
Mortgage Payments	Yes
Alcohol	No
Tobacco	No
Rent	Yes
Property Taxes	Yes
Utilities	Yes
Household Maint	No
Cash Contributions	No
Household Operations	No
Health Insurance	Yes

Following TEL, a second specification of cash goods consumption omits food expenditures; food is not as volatile as the other cash goods categories so this is taken as a lower bound on the variance (Telyukova, 2013).[37]

Six waves of the PSID sample are used (1998 - 2014). Log values of cash consumption are regressed on a vector of controls containing age, age^2, earnings, time controls and household characteristics, $\mathbf{Z}_{it}$, details set out in section 4.1 and log total taxable income of the head and spouse, y_{it}. Estimation is by fixed effects.

$$c_{it}^{cash} = \gamma \mathbf{Z}_{it} + \delta y_{it} + u_{it} + e_i \tag{26}$$

The idiosyncratic part of household cash consumption is u_{it}. These residuals are modelled as a an AR1 process with a normally distributed residual, η_{it}.

$$u_{it} = \rho u_{i,t-1} + \eta_{i,t} \tag{27}$$

I calculate the variance of these residuals, η, by group. I first average this over the three main groups in line with TEL, η_g^2, $g = \{$borrowers, co-holders, savers$\}$. Telyukova (2013) interprets η_g^2 as cash consumption volatility, reflecting household response to unexplained

[37] For this exercise, because of the 16 year time period, as opposed to 6 years elsewhere, the PSID variables are deflated.

cash consumption risk. She assumes savers are better off than borrowers, and with this interpretation she finds that in the CEX data, savers have the highest variance reflecting their ability to respond to unexpected cash consumption shocks. Borrowers have the lowest variance, indicating the opposite.

In the PSID I find the variance ordering, by value, of the main groups, savers, co-holders, borrowers, to be consistent with TEL; η^2 savers $>$ η^2 co-holders $>$ η^2 borrowers (not reported). The magnitudes of the estimated values are however larger in the PSID than TEL's CEX values, for all three groups. This is perhaps not surprising - the composition of cash consumption is different in the PSID compared to the CEX, as already set out; the PSID values are estimated over a time period, the CEX values are from cross sectional data; items that cannot be paid for with a credit card may be different in the latter part of the PSID time series to the 2001 time period of the CEX; the PSID estimation controls for unobserved household level effects whereas the CEX does not.

I extend the categorisation to co-holding sub groups, cash-rich and cash-poor. I find it is more difficult to align the cash-rich and cash-poor values for η^2 with TEL's findings. The cash rich have the lowest value for both cash consumption measures. The cash poor co-holders and savers have the same value as each other. Under TEL's interpretation, cash poor co-holders are expected to have the lowest cash consumption volatility. It is possible that the savers and the cash poor co-holders have high variance, relative to the cash rich group, for different reasons. The cash poor group have less resources and perhaps cannot smooth consumption, so variance is high. The savers, on the other hand, insure, and then have the ability to diverge if needed, but this is a different interpretation to TEL.

Results are set out in table 18 for the two specifications - cash consumption and cash consumption excluding food.

The inconsistency of the results with TEL may mean that this measure is simply not informative in the PSID. Despite this uncertainty, I include $\eta^2_{i,t}$ as an explanatory variable for co-holding in a later model.

η^2_g	All Co-Holders	Cash Poor	Cash Rich	Savers
Cash Cons	0.11	0.12	0.07	0.13
Excluding Food	0.46	0.55	0.33	0.55

Table 18: Variance of ideosynchratic cash consumption by category. Reported are means by category calculated from each household in each time period, $\sigma^2_{i,t}$ and means of means, $\overline{\sigma}^2_i$.

A.7 PSID question about 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.

Issues around persistence of co-holding

Persistence of co-holding is a consideration in the credit card debt puzzle. The households of interest are the ones that habitually hold credit card debt and liquid assets. I first look at credit card debt persistence. A difficulty in identifying persistence in the PSID is its biennial structure, there are two years between waves. 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.

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. This should not be of much importance in the analysis because the chapter studies households *with* debt. A response of *no* to the credit card debt question can mean two things; the household has a credit card and no debt, or the household does not have a credit card and therefore no debt. Credit card, no debt, implies payment. No credit card, no debt can mean the household is refused a credit card or actively chooses not to have a credit card. Reasons for being refused are likely related to low income, too much debt or a poor debt history. This means the household is more likely to be in the liquidity constrained group and this is not the group of interest. On the other hand, a consumer who *chooses* not to have a credit card may do so because she knows she will accrue debt, so not having a card is a commitment device against debt. Unfortunately, we cannot identify these households.

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

Table 19: The table shows the debt frequency over the three waves of the PSID used in the analysis.

Consumption, credit card dbet and co-holding A possible explanation for cash-rich co-holding is that the lost utility from paying penalty interest is close to zero because the debt is so small relative to the household income. At what income/liquid asset/debt proportions would the loss from co-holding cease to be a puzzle? A large body of literature around loss aversion, endowment effects, and present bias shows that economic decisions involving small and large quantities do matter to people. To consider this more concretely a measure of the scale and importance of credit card debt to the household could be as a proportion of the household's income. To calculate this I choose non durable consumption as a proxy for income. [38] I construct another household level measure for each time period, $ccd_{i,t}/ndc_{it}$. This is the the proportion of monthly consumption that is held as credit card debt. A number less than 1 means credit card debt is less than monthly consumption. A number greater than 1 and credit card debt is greater than monthly consumption expenditures. The closer the ratio value is to zero, the smaller a proportion of the balance sheet the credit card debt represents.

I find credit card debt 2.5 times monthly expenditure for the all co-holders, $E(ccd_{i,t}/ndc_{i,t}) =$ 2.3. It is even higher for the cash poor co-holder, 3.5 (median 2.3). The proportion is 0.9 (median 0.6) for the cash rich households. These statistics show that credit card debt is not trivial for any of the groups. Even when the household has at least twice the level of cash to credit card debt (cash rich co-holders), this does not necessarily mean the credit card debt is too small to matter.

[38] This is preferred because while the PSID gathers several good measures of income, after tax income is not available and second, income is sensitive to transitory shocks. Consumption is a good proxy for permanent income (Dynan, Skinner, and Zeldes, 2000) and is well measured in the PSID after 1998.

Variable	Liquid Assets	Credit Card Debt	Consumption (nd)
Cash poor co-holders			
Liquid Assets	1.000		
Credit Card Debt	0.3367	1.000	
Consumption (nd)	0.3722	0.3253	1.000
Cash rich co-holders			
Liquid Assets	1.000		
Credit Card Debt	0.2709	1.000	
Consumption (nd)	0.2958	0.3066	1.000

Table 20: Correlation between liquid assets, credit card debt and consumption.

A.8 Additional discussion of results of estimation of equation 23 and equation 24

The coefficient for cash consumption risk is not significant for either group.[39] The different signs may be informative but given the lack of significance of the coefficients, I do not attempt to interpret this.

The coefficients for age and age squared are significant across all specifications for both groups, as would be expected. Race is significant only for the whole group estimation and one specification of the cash poor group. The coefficient value for race is also higher for the cash-poor co-holders, around 0.2 compared to 0.09 for the cash rich group.

None of the coefficients for employment status dummies are significant for the cash poor group. Marital status and households with only one adult are also not significant in any of the specifications, for either group.

For the cash rich households, the dummy for *unemployed* is significant and robust to the inclusion of the other variables. It has a coefficient value of 0.44 in specification 1. In specification 2, when consumption is included, it has the higher value of 0.5. This could be man tha for cash rich households, unemployment leads households to make use of their line of credit, as discussed by Druedahl and Jørgensen (2018), but liquid assets do not seem to be involved.

The coefficients for year dummies are positive significant for the cash rich group but not for the cash poor group. Possibly the cash poor group has less flexibility than the cash rich group. The cash-rich group can respond to business cycle effects and adjust spending and credit card debt. The cash poor group cannot.

[39]Note also that the number of observations drop when this variable is included. This is because in constructing this measure, we estimate equation 27, single wave households are dropped because there is no lag for income.

The estimate for home ownership is negative across all specifications and groups. But is only significant for the cash poor group. Credit card debt decreases if you are a home owner *and* cash poor.

Attaining a college degree, or above, is significant in each specification for the cash poor. The coefficients are positive; being in the cash poor group and having a high level of education leads to higher credit card debt. These households may experience liquidity constraints but possibly anticipate higher earnings in the future. Being self employed is significant and negative across all specifications and groups. Number of children has a negative coefficient value across both groups, but is only significant for the cash poor group.

In summary, for the cash poor group, the positive coefficient for the liquid asset variable supports precautionary theories; households accrue credit card debt to accumulate or preserve cash ((Telyukova, 2013) Zinman (2015)). This is also consistent with the shopper-saver theory, (Haliassos and Reiter, 2005); the saver is maximising utility with a higher rate of time preference than the shopper. The saver will this hold liquids assets and not sacrifice them to pay off a credit card bill that will just converge again to the shoppers utilisation level of their line of credit (**?**). In following this strategy, the saver accumulates assets.

For the cash rich households, the negative coefficient for liquid assets is more consistent with the standard theories such as the Permanent Income Hypothesis. The question remains, why do the households with high levels of liquid assets still hold credit card debt?

A.9 Additional discussion of results of estimation of equation 25

The coefficient for the variable η^2, is positive for the non-liquid households but not significant in either the pooled estimation or the fixed effects estimation. For the liquid households the coefficient for η^2 is negative in both estimation approaches, and significant at the 99% level in the pooled approach. The estimated variable for cash consumption risk, η^2, is highest in the cash-poor and saver group. And smallest in the cash-rich coholing group. It is difficult to interpret the results of the estimation, given savers and cash-poor co-holders face the highest risk, but one co-holds and the other does not.

Time effects are strongly significant for the liquid group and weakly so for the non liquid group. the signs are the same for both (negative). This is similar to results for equation

23. It again suggests the non-liquid households are less able to respond to business cycle effects.