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The Coholding Puzzle: New Evidence from Transaction-Level Data

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Why do individuals pay debt interest when they could use their savings to pay down the debt? We explore why individuals "cohold" debt and savings using detailed and highly disaggregated daily-level data on household finances. We find that coholding mostly occurs in short spells within the month and the level of coholding is typically modest. Periods of coholding are not associated with shocks at the individual level. We show that mental accounting has a role to play in explaining coholding, in particular how individuals allocate different categories of expenditure to accounts in credit and debit. (*JEL* D12, D14, D15, G51)

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Individuals commonly exhibit financial behaviors that appear inconsistent with models of rational, or even quasi-rational, behavior. These include, for example, failing to refinance a mortgage to a much cheaper interest rate even when a better deal is available, paying down debt on a lower interest rate credit card while forgoing the opportunity to pay down debt on a higher interest rate credit card, and choosing a dominated option from a menu of health insurance plans (see Andersen et al. 2020; Bhargava, Loewenstein, and Sydnor 2017; Gathergood et al. 2019). Understanding the prevalence and causes of suboptimal behavior is important for developing realistic models of consumer behavior and for contributing to debates surrounding the role of policy in improving consumer outcomes.

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In this paper, we study one of the starkest apparent violations of simple arbitrage on consumer balance sheets: holding low-yield, liquid savings while simultaneously holding high-cost unsecured credit on revolving credit lines. This tendency is known as the "coholding" puzzle (or "credit card debt" puzzle when referring specifically to credit cards as the revolving credit product).[1] In the U.S. Survey of Consumer Finances, approximately 25%–30% of households are found to cohold (Gross and Souleles 2002; Vihriälä 2022). Explanations for the existence of coholding offered in the previous literature include liquidity management, within-household coordination, cognitive ability, and self-control.[2]

We study coholding in a unique data set, sourced from an Icelandic financial aggregation platform, that provides granular records of balances and transactions across individual financial accounts at the daily level. In Iceland, as in many other countries, the main form of unsecured borrowing is via bank overdrafts, with an average Annualized Percentage Rate of approximately 12% during our sample period while, at the same time, deposit balances earn near-zero interest. Moreover, it is common for individuals to hold more than one deposit account. Individuals can therefore run a deposit account balance and an overdraft line simultaneously. In this context we observe coholding in the form of overdraft balances being held concurrently with deposit balances. With both accounts being fully liquid, individuals can make card transactions from either account, and can adjust balances at any point in time.

Our study makes two main contributions. First, by drawing on the high frequency of the daily-level data and transaction-record measures of consumption, we reveal new and striking patterns in the dynamics of coholding: levels of coholding are typically modest (relative to individual average consumption), and typically occur in short spells. Analyzing coholding at the individual × day level, in our data we find that (a) coholding occurs on 15% of individual × days in our baseline sample; (b) the level of coholding is typically

[1] A series of studies, beginning with Morrison (1998) and Gross and Souleles (2002), show in cross-section data that a significant fraction of individuals hold low-yield liquid savings and higher-cost revolving credit card debt simultaneously. Coholding liquid assets and revolving credit card debt is particularly puzzling because, unlike other credit products, there is no apparent friction in the terms and conditions of the products which would explain this behavior and coholders would be better off were they to use a fraction of their liquid assets to pay down their debts (Stango and Zinman (2009). This may not be the case with other credit products, such an installment loans, where it may not be possible to prepay the loan, or where consumers may be unable to reaccess the line of credit (and hence reduce their total liquidity by prepaying the loan).

[2] One line of explanation offered in the literature appeals to liquidity management including: the need to access cash (Telyukova and Wright 2008; Telyukova 2013); precautionary behavior in light of the risk of credit limit chase-down (Druedahl and Jørgensen 2018; Gorbachev and Luengo-Prado 2019); accumulation of additional credit in order to prove creditworthiness and reduce the future cost of credit (Bialowolski, Cwynar, and Weziak-Bialowolska 2022) or strategic asset allocation related to bankruptcy intentions (Lehnert and Maki 2007). Another explanation is low cognitive ability (Choi and Laschever 2018). Another explanation is that individuals holding-out credit balances as a means of self-control either for the individual, or due to lack of coordination among members of the household unit (Bertaut, Haliassos, and Reiter 2009; Gathergood and Weber 2014; Vihriälä 2022).

modest when scaled by consumption;[3] and (c) the duration of coholding spells is typically short, with a median duration of 10 days. As a consequence, in aggregate coholding does not generate large excess interest costs for most of the individuals in the sample.[4] This level of coholding we observe in the data might seem lower than the 25%-30% rates reported in recent waves of U.S. survey data (Vihriälä 2022). However, in those surveys individuals are found to cohold based on survey questions referring to credit card balances at the end of the month. If we take a month-level view of coholding in our data, we observe coholding in 23.5% of individual × months, with the short duration of coholding spells explaining the much lower daily-level rates of coholding in our data compared to monthly-level rates.

Second, we draw on features of the data to explore new explanations for coholding. This reveals new insights into how coholding occurs. We show that, in our sample, there is little evidence for coholding being attributable to lack of coordination of finances within the household: levels of coholding are only slightly higher within couples compared to within singles. Focusing our analysis at the individual level, we show that, in contrast to the characteristics of individuals typically associated with other financial "mistakes" coholders have similar individual characteristics to non-co-holders: on average they are of similar age, levels of income, and we find no gender differences. We also test whether coholding is associated with short-term shocks: given that most periods of coholding are short-lived, and coholders appear similar to non-co-holders, it is possible that coholding might arise for a subset of individuals at random due to unpredictable, short-term shocks. These shocks might either move individuals' finances out of a no coholding equilibrium (e.g., a shock to income) or reduce individuals' attention to their personal finances (e.g., a shock to health), resulting in coholding arising due to short-term inattention. However, we find no evidence that shocks to unemployment, income or health are associated with the onset of coholding.

Drawing on detailed transaction-level data, we show that coholding is related to the allocation of different categories of expenditure to accounts in surplus compared to those in overdraft. We show that individuals have a tendency to place some categories of expenditures on their accounts in overdraft: the proportion of transactions for lottery and gambling, alcohol and fuel spend incurred on an account in overdraft is much higher than for other categories (in particular, durable goods for which a larger share of transactions are made from

[3] Conditional on nonzero coholding, the majority of days on which accounts cohold involve coholding of less than 15 days' worth of consumption spending. Coholding of more than 1 months' worth of spending is uncommon, restricted to fewer than 1-in-5 individual × days with positive coholding in the sample.

[4] This finding is consistent with those from ongoing work in (Vihriälä 2022). That study uses Finnish data and calculates coholding using information on liquid assets and unsecured debt (defined as credit card debt plus revolving bank loans). Between 11% and 16% of individual × days exhibit coholding, depending on definition, similar to the 15% in our data. Calculations further show that coholding has low persistence at the individual level, again consistent with our findings.

accounts in surplus). Modelling the onset of a spell of coholding at the daily level, we find that the onset of coholding spell is associated with expenditure events in these categories. Our results suggest coholders are willing to pay excess interest costs in order to assign categories of consumption to credit accounts and debit accounts.

Our analysis does not prove a relationship, or establish causality, in the link between allocation of expenditures to accounts in surplus or overdrawn and coholding. It does, however, strongly suggest that coholding may be related to individuals engaging in a form of mental budgeting whereby some expenditure types are assigned to accounts in particular credit states. This view is consistent with recent evidence from Australian and Mexican data suggesting that coholders mentally separate their spending into debit and credit categories (Batista, Mao, and Sussman 2023; Medina and Pagel 2023).[5] This suggests the patterns we observe arising in allocation of transactions to assets/debts are unlikely to be specific to the Icelandic context, but occur in a variety of contexts where consumers can choose which account to choose to incur a transaction against, including overdrafts, credit cards, and potentially other products.[6]

Our data and context offer a number of features that provide advantages over previous studies. First, most previous studies rely on survey data to measure coholding. Yet survey-based measures of deposit account balances and credit card debt may suffer from measurement error (in particular, survey measures tend to underestimate revolving credit card debt, on which see Zinman 2009; Haughwout and van der Klaauw 2015; Madeira et al. 2022). Surveys also typically offer only low-frequency data (e.g., yearly), capturing monthly balances only at the interview date, and hence are not suitable for measuring within-year persistence. The short duration of spells of coholding in the data we analyze would not be detected in an annual survey. Furthermore, even with access to credit report data, there are challenges in identifying revolving balances from transacting balances, and linking in matched deposit or savings account data for the measurement of coholding.

Second, our focus on overdraft borrowing, in contrast with credit card borrowing, has a number of advantages. In our setting the cost of coholding is incurred with certainty from the point in time in which balances are held simultaneously (in contrast with credit card coholding, which is financially *beneficial* during the zero-interest float period). Overdrafts also do not offer additional benefits, such as frequent flyer miles, or cashback on spending,

[5] Batista, Mao, and Sussman (2023) conduct a large-scale field experiment which reveals that informing customers about their coholding behavior and its associated costs does not significantly alter coholders' debt repayment behavior. They find that a preference for using debit cards for everyday transactions is correlated with coholding. Medina and Pagel (2023) analyze an experiment involving 3.1 million bank customers who were encouraged to save through SMS messages. The intervention increased coholding in a way that suggests people cohold because they mentally separate savings and debt accounts.

[6] For example, Buy-Now-Pay Later.

which might confound the calculation of excess interest due to coholding.[7] While credit cards are commonly used for transaction purposes in Iceland, they are rarely used as a revolving credit instrument. In our data, 98% of credit card statements show zero revolving balance.[8]

Third, the detailed transaction data allows us to measure and model coholding at higher frequency. The data set provides to us a daily view of an individual's transaction-line expenditure and income as well as balance records. These data allow us to measure coholding at daily frequency. Using the spending data, we are also able to normalize coholding by individual average expenditure, thereby quantifying coholding in (approximate) consumption terms. Quantifying coholding in terms of days of spending provides an economically meaningful measure of the cost of coholding to the individual, which also allows us to measure coholding that is not undone by immediate spending needs.[9]

Our setting does not lend itself to testing some explanations for coholding, such as those based on liquidity management. For example, models of coholding based on high cash withdrawal interest rates on credit cards do not apply in our setting in which overdrafts are the dominant unsecured credit product.[10] It is also possible that mental accounting might interact with liquidity management, for example, if individuals hold target cash balances arising from mental accounts. These ideas could be explored in a rich structural model which might further our understanding of how motivations for coholding interact in individual decision making and their magnitudes.

Our findings also relate the broader recent literature on suboptimal financial behavior within the field of household finance. Using Danish data, Andersen et al. (2020) find that many Danish households fail to refinance a mortgage to a much cheaper interest rate, even in a setting in which the frictions to mortgage

[7] However, from the perspective of measurement of economic costs, coholding liquid assets and overdraft balances is particularly advantageous because there is no doubt about the amount of debt incurring interest, which is levied on overdraft balances every day and the flexibility with which payments can be made toward an overdraft line. Furthermore, while with credit cards coholding may occur due to forecast errors (e.g., a credit card balance might be held as a transacting balance in expectation, but held as a revolving balance *ex post* due to unanticipated shocks), the terms of overdraft balances are constant over time.

[8] We further show that patterns of credit card usage do not explain the coholding behaviors we observe in the sample. It is important to emphasize though that credit card use is very common in Iceland, and consumers take advantage of the zero-interest float period.

[9] For example, an individual who coholds $500 dollars while typically spending $500 per day incurs very little excess interest cost (given the very short duration of coholding) which is also small relative to their high level of consumption, whereas for an individual spending $50 per day the same level of coholding would accrue higher excess interest cost (given the longer duration of coholding) and represent a larger economic cost relative to their low level of consumption.

[10] For example, in the portfolio model of Telyukova and Wright (2008), coholding arises due to the need to pay for some items in cash. Agents avoid paying down credit card balances (which would save on revolving debt interest charges) as if they were to do so they would then incur cash withdrawal interest rates, which are often higher and offer no within-cycle grace period.

refinancing are minimal.[11] Gathergood et al. (2019) show that individuals in the United Kingdom who hold multiple credit cards misallocate, on average, 20% of their monthly repayment toward a lower-APR credit card.[12] Bhargava, Loewenstein, and Sydnor (2017) find that the majority of employees at a U.S. firm choose a health care plan dominated by a lower-cost option, on average resulting in excess spending equivalent to 24% of chosen plan premiums. Recent studies also suggest individuals exhibit suboptimal responses to taxes (Chetty, Looney, and Kroft 2009; Finkelstein 2009; Taubinsky and Rees-Jones 2018). For reviews of the household finance literature, see Campbell (2006), Guiso and Sodini (2013), Beshears et al. (2018), and Gomes, Haliassos, and Ramadorai (2021). See Gabaix (2019) for a review of the literature on behavioral inattention.

1. Data

The data we use are provided by Meniga, a financial aggregation software provider to European banks and financial institutions, serving approximately 20% of the Icelandic adult population. The platform allows customers to see all their accounts concurrently, including transaction flows. All banks in Iceland allow access to their banking data via the platform and anyone with a bank account in Iceland can register either in their internet bank or via meniga.is. Furthermore, online banking penetration in Iceland is very high.[13] Because there are technically no unbanked individuals in Iceland, this makes it very likely that the user population of this financial aggregation platform is representative of the underlying population than the user populations of similar aggregation platforms in other settings. This is confirmed when we compare our sample to a nationally representative sample. Statistics Iceland reports that in 2017 the average age among those above age 15 was 45.3 and that women constituted 50% of the population. The average age in our sample is 42.0 and the share of women is 48%. Furthermore, Carvalho, Olafsson, and Silverman (2019) show that additional characteristics of the Meniga user base are in line with those of the Icelandic population, as measured from nationally representative surveys.

Meniga's account-aggregation platform allows users to view financial records from multiple products (either within or across financial providers) on a single platform. To provide the single-platform view, Meniga scrapes transaction-line level data from financial providers on a daily basis. Users of the platform provide one-time consent for Meniga to scrape these data, allowing

[11] Other studies of suboptimal mortgage refinancing include Agarwal, Rosen, and Yao (2016), Keys, Pope, and Pope (2016), Agarwal, Ben-David, and Yao (2017) and Bajo and Barbi (2018).

[12] See also Ponce, Seira, and Zamarripa (2017).

[13] According to Eurostat, 94% of Icelanders used internet banking in 2018. *Source*: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_bde15cbc&lang=en.

the aggregator to scrape data "in the background" on an ongoing basis without requiring the consumer to reconsent.[14] These data are provided to us for our analyses. The data set we use in this paper covers the period September 1, 2014, to January 31, 2017.[15]

The main advantage of accessing data via the financial aggregator is that we are able to obtain detailed, objective financial records at very high frequency (daily). The transaction-line data are exceptionally detailed, containing each individual transaction undertaken by the account holder with information on the transaction category (merchant category code), transaction amount and the date on which the transaction took place. The data are also objective, not relying on individual recalls. The main disadvantage of the traditional alternative data source for analysis of coholding—survey data—is that surveys provide low-frequency data (often annual frequency) and are susceptible to self-reporting bias.[16] A drawback of using financial aggregator data is these data do not have individual characteristic-level information, such as education and health. However, we are able to construct measures relating to changes in individual circumstances, such as health status, using information from the transaction records. We will adopt this approach later when creating measures of shocks, including health shocks.

1.1 Sample selection

As of January 2017, the point of data extraction, approximately 20% of the Icelandic population use a Meniga account, equating to 53,000 users out of a total adult population in Iceland of 260,000 individuals. We restrict the sample for analysis in two ways to obtain a sample of individuals who appear to be well-integrated with the aggregation platform.

First, we restrict our sample to individuals who appear to be economically active, specifically individuals for whom we observe monthly income arrivals (e.g., labor market income or unemployment benefits, pension payments, invalidity benefits, and student loans). This restriction excludes cases where

[14] In some countries, data sharing regulations require consent of the consumer to be resought periodically for ongoing data sharing, for example, every 90 days under Open Banking regulations in the United Kingdom. In the United States, FINRA regulations require firms to notify consumers of the right to cancel their data sharing agreements.

[15] These data have been used previously in a series of studies to examine the spending responses of individuals to income arrivals (Olafsson and Pagel 2018a), the drivers of individuals' attention to their personal finances (Olafsson and Pagel 2017), how expenditures and financial decisions change around retirement (Olafsson and Pagel 2018b), and to evaluate the extent to which the demand for high-cost credit can be attributed to adverse financial conditions or imperfect decision-making ("mistakes") (Carvalho, Olafsson, and Silverman 2019).

[16] This is particularly severe for credit card debt, where the distinction between transacting and revolving balances is difficult to accurately measure in survey data. For example, Zinman (2009) shows that aggregate revolving credit card balances from the U.S. Survey of Consumer Finances capture only half the total credit card debt held in the United States. Using data from a South African lender, (Karlan and Zinman 2008) show that more than half of individuals do not report their high-cost borrowing. Furthermore, even when using credit report data, perfect separation between transacting and revolving balances is not possible, resulting in inaccurate measures of the amount of debt incurring interest charges.

individuals are holding dormant accounts, or conducting their main banking activity via an account not observed in the Meniga data.

Second, we restrict to individuals for whom we can observe key demographic information about the person (age, sex, and postal code). The final sample selection we apply is that the level of spending is above a minimum level, which we define as requiring at least five food transactions in at least 23 months of a 24-month period.

Applying these sample restrictions provides 11,551 accounts, which we refer to as the baseline sample. While only containing approximately one fifth of the total sample, the baseline sample is similar in average age to the full sample, at 41.7 (42), and in the proportion of women, at 49% (48%). In our baseline sample, 80% of individuals are economically active, very close to the economic activity rate in the population.[17] We focus on coholding at the daily level, hence the main unit of data we use in our analysis is an individual × day. In total, the data provides approximately 10.2 million individual × day observations. This forms the baseline sample for our analyses.

2. Results I: Measuring Coholding

2.1 Coholding calculation

Our main interest lies in measuring the extent of coholding behavior among account holders in the baseline sample. Our sample restrictions provide an analysis sample in which each individual × day observation shows a balance on the deposit account(s) and balance on the overdraft line(s), (either, or both, of which may be zero). Coholding in this setting arises as an individual holding a positive liquid deposit account balance (either a checking account balance or a savings account balance) while simultaneously holding an overdraft balance. Importantly, both balances can be easily adjusted on a daily basis using internet banking, or by visiting a bank.[18] Also, an individual can spend against an overdraft line using a debit card in the same way as spending against a positive deposit account balance, and can transfer money to pay down the overdraft line electronically at any point in time.

In our setting, the measurement of coholding using overdraft and deposit account data is straightforward because (a) both products allow individuals to move balances at any point, and (b) overdraft balances incur interest on a daily basis from the first day of the balance. This simplifies measurement of coholding compared with that on other products, such as credit cards, where calculation of coholding needs to take into account the interest-free

[17] Statistic Iceland reports the economic activity rate for individuals in 2017 was 78%.

[18] This setting differs from credit cards, where payments typically occur on set date ranges within the payments cycle.

float period, which varies by transaction type (e.g., purchase transactions vs. cash-in-advance transactions).[19]

Using an individual × day as the unit of observation, we measure coholding as the *minima* of deposit account balances and (the absolute value of) overdraft balances. This provides a value of coholding for each individual × day in the data period. For observations for which the individual either has zero deposit account balance, or alternatively zero overdraft balance, the value of coholding is set to zero. This calculation returns an individual × day measure of coholding in currency units, which can be interpreted as the amount of overdraft that the individual could pay down using readily-available liquid deposit account balances, while not reducing overall liquidity.[20]

To generate an economically meaningful measure of coholding for the individual, we normalize the value of coholding by individual average daily expenditure, calculated over the sample time period. We do this to control for wide variation in levels of expenditure in the sample. If a household has a high level of average daily expenditure, then a given amount of coholding might be economically unimportant to the household as it is very short-lived (because positive deposit account balances will be spent very soon) and incurs minimal excess interest costs as a proportion of daily expenditure. However, the same level of coholding among a household with a low level of daily expenditure would be much longer-lived (because positive deposit account balances will persist) and incur larger excess interest costs as a proportion of daily expenditure. Normalizing by average daily consumption therefore generates a more economically relevant measure of coholding.

2.2 Coholding at the daily level

We first illustrate the extent of coholding in the sample of individual × days in the baseline sample. Panel A of Figure 1 shows a scatter plot of the joint distribution of deposit account balances and overdraft balances, measured in units of consumption-days, together with histograms for both variables shown in panels B and C. The joint distribution plot in panel A of Figure 1 illustrates the extent of coholding in the sample of individual × days.[21] The *x*-axis measures cash holdings (normalized by individual average daily expenditure), and the *y*-axis measures overdraft holdings (also normalized). Hence, coholding increases to the top-right of the joint distribution plot.

Table 1, panel A, summarizes the joint distribution by binning the data into cells defined by consumption-days equivalent worth of overdraft holdings

[19] Furthermore, in the case of credit cards, coholding might arise because of forecast errors. An individual may hold a credit card balance intending upon clearing the balance by the end of the interest-free "float" period, but unexpectedly revolve the balance due to a financial shock.

[20] Paying down the overdraft balance neither reduces overall liquidity in terms of balances available, nor the ease of liquidity, as overdraft lines and positive account balances are equally liquid.

[21] For ease of visualization, the plot restricts to random sample of 3,000 individual × days from the total data used in analysis.

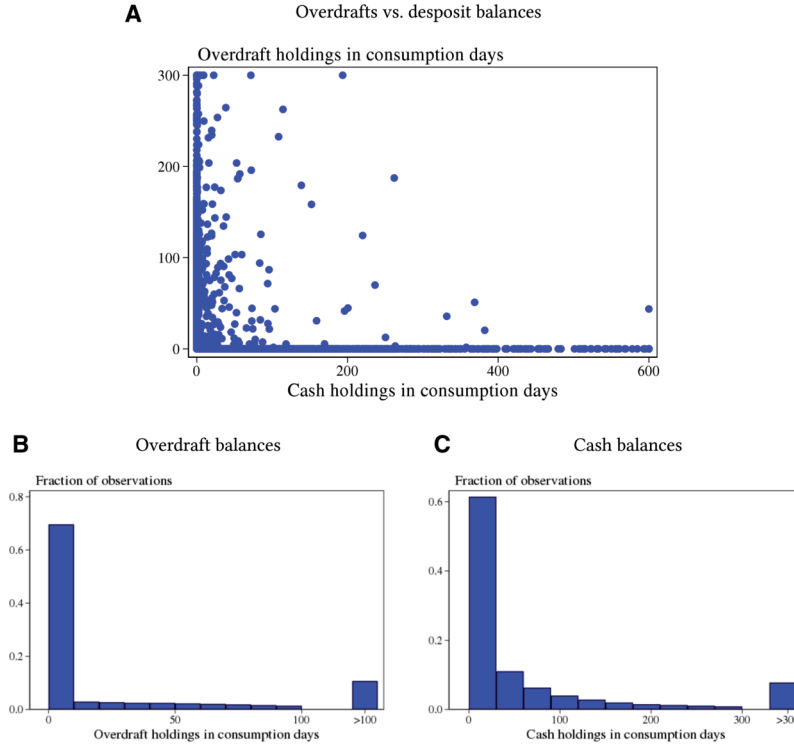

Figure 1
Coholding deposit account balances and overdraft balances
Note: that panel A shows a scatter plot of overdraft holdings and cash deposit account holdings, both measured in days of account-level average consumption expenditure. Panel B shows the distribution of overdraft holdings measured in days of account-level average consumption expenditure. Panel C shows the distribution of cash deposit account holdings measured in days of account-level average consumption expenditure. See Section 1 for details of sample restrictions.

and cash deposit account holdings. Panel A of Figure 1 illustrates that the majority of individual × days are located on either axis, indicating zero coholding, that is, where the individual carries only a positive balance or only an overdraft. In total, approximately 85% of observations are located on either axis: panel A of Table 1 shows that 65.7% of observations have an (absolute value) overdraft balance equal to zero and 18.5% have a deposit account balance equal to zero (2.9% of observations have both a zero overdraft balance and a zero deposit account balance). Hence, these observations show zero coholding. The marginal distributions (histograms) of deposit account and overdraft balances are shown in Figure A1, illustrating the large masses at zero in both distributions.

Approximately 15% of individual × days show positive levels of coholding, represented by points on the scatter plot within the interior of the plot. As seen in Figure 1, a small number of observations have high levels of coholding, with

Table 1
Coholding in the baseline sample

(A) *Coholding in consumption days*

	Cash holdings					
Overdraft holdings	0	> 0−10	> 10−20	> 20−30	> 30	Total
0	2.95	15.65	6.79	4.88	35.47	65.73
>0-10	1.65	1.27	0.19	0.10	0.63	3.83
>10-20	1.23	1.12	0.15	0.07	0.35	2.93
>20-30	1.16	1.04	0.14	0.07	0.28	2.70
>30	11.50	9.90	1.02	0.55	1.83	24.81
Total	18.50	28.98	8.29	5.67	38.56	100.00

(B) *Coholding in monetary units (000s ISK)*

	Cash holdings						
Overdraft holdings	0	> 0−20	> 20−40	> 40−60	> 60−80	> 80	Total
0	2.95	8.82	3.76	2.92	2.40	44.87	65.73
>0-20	0.60	0.38	0.05	0.03	0.03	0.35	1.43
>20-40	0.45	0.30	0.04	0.03	0.02	0.23	1.08
>40-60	0.41	0.31	0.05	0.02	0.03	0.20	1.01
>60-80	0.39	0.26	0.04	0.02	0.02	0.17	0.90
>80	13.70	9.57	1.22	0.79	0.57	4.00	29.84
Total	18.50	19.64	5.15	3.81	3.07	49.83	100.00

The table illustrates joint distribution of cash holdings (in deposit and/or savings accounts) and overdraft holdings in the baseline sample of individual × days. Panel A reports cash holdings and overdraft holdings normalized by average daily consumption spend of the consumer over the sample period. Panel B shows cash holdings and overdraft holdings in local currency. Each cell reports as percentage of observations. The cell (0,0) contains observations for which both cash and overdraft balance are zero.

coholding balances which run to many hundreds of days of consumption. Panel A of Table 1 summarizes these data, top-coding at 30 days of consumption. Coholding commonly arises because of large overdraft holdings (>30 days, the bottom row of the matrix) alongside modest deposit account holdings days. Of the interior cells, the highest populated is >30 consumption-days of overdraft holdings held alongside 1-10 consumption-days of cash holdings, which contains 9.9% of all individual × days. In total, only 1.8% of observations show more than 30 days of consumption in both deposit account and overdraft holdings. These calculations at the individual × day level therefore reveal that coholding is typically modest relative to consumption, implying that the period of coholding is typically short when consumers are engaged in average levels of consumption expenditure.

Panel B of Table 1 summarizes the same joint distribution in monetary amounts instead of consumption-days, with monetary amounts of cash holding binned in columns and monetary amounts of overdraft holding binned in rows. Of the interior cells, the highest-populated cell translates to holdings of at least 80,000 ISK (approximately $8,000) combined with 1–20,000 ISK of cash deposit account holdings, accounting for 9.6% of all individual × days. The table shows that 4% of individual × days have at least 80,000 ISK of overdraft and cash deposit account holdings coheld on the day.

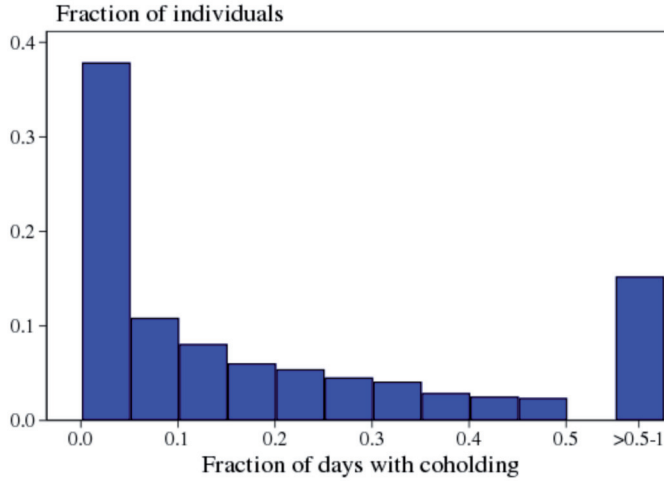

Figure 2
Share of days coholding
Note: that the figure shows the distribution of share of days that are coholding days, for the sample of accounts with at least one coholding day. Rightmost bin includes accounts for which the share is greater than 0.5.

2.3 Patterns in coholding at the individual level

2.3.1 Frequency and level of coholding. There is wide variation in the extent of coholding across individuals. In the baseline sample, 60% of individuals exhibit zero coholding throughout the entire sample period, that is, on no day of the sample period do these individuals ever simultaneously hold overdraft balances and deposit balances. Next, we will describe coholding among the remaining 40% of individuals that engage in coholding on at least one day.

Figure 2 shows a histogram of the fraction of days these individuals exhibit coholding. Each individual contributes one observation to the plot. The leftmost two bars show that more than half of coholders engage in coholding on fewer than 10% of the days we observe them in the sample. In the rightmost bar, approximately 15% of coholders engage in coholding on at least 50% of the days we observe them in the sample.

The extent to which an individual coholds also can be described by combining information on the *frequency of days* the individual coholds with the *level* of coholding (measured in consumption-days). Panel A of Table 2 summarizes the relationship between the level of coholding and fraction of days for the sample of individuals who ever cohold. Each row shows a level of coholding, ranging from coholding 3 days' worth of consumption to 30 days' worth of consumption. The summary statistics report the fraction of days individuals in the coholder sample cohold at that level. There is a negative relationship between the level of coholding and the frequency of coholding: coholders in the sample are observed to cohold at least 3 days of consumption

Table 2
Coholding summary statistics

(A) *Share of days with coholding*

	Mean	SD	p50	p75	p90	p95
Min(3,3)	0.216	0.255	0.109	0.325	0.636	0.808
Min(5,5)	0.196	0.242	0.090	0.283	0.588	0.765
Min(10,10)	0.165	0.220	0.064	0.226	0.492	0.699
Min(15,15)	0.146	0.207	0.051	0.195	0.441	0.637
Min(20,20)	0.134	0.197	0.043	0.176	0.419	0.596
Min(25,25)	0.124	0.190	0.037	0.155	0.394	0.566
Min(30,30)	0.117	0.182	0.036	0.143	0.369	0.514

(B) *Duration of coholding spells*

	Duration of coholding (#days)					
	Mean	SD	P50	P75	P90	P95
Individual x day level	22.5	52.5	9.0	23.0	43.0	85.0
Individual level	29.6	61.4	13.0	27.6	65.5	112.2

C. *Cost of coholding*

	Mean	SD	P50	P75	P90	P95
Individual × day:						
Annualized daily costs	4,702	16,673	0	1,403	12,793	26,917
Individual level:						
Average annual costs	4,702	9,813	1,198	4,548	12,518	20,823

In panel A each row of the table reports summary statistics for the level of coholding in the baseline sample, where the level is defined at the minimum of number of days' consumption held in overdraft balances and savings balance. For example, the first row reports that 21.6% of observations in the baseline sample with nonzero coholding show at least 3 days' consumption coheld in savings and overdraft balanced. Panel B reports summary data for duration of coholding spells, where a spell is defined as $Min(3,3)$, holding 3 days consumption in both cash and overdrafts. Panel C presents measures of the cost of coholding. Annualized daily costs refer to the cost of coholding on-the-day for each individual × day observation and then multiply by 365 to create a simple annualized measure. Average annual costs report average annual costs from observed periods of 365 days. See Section 2.2 for further details of the calculations. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

for 21.6% days of the sample period, while coholding at last 30 days of consumption for only 11.7% of the sample period.

2.3.2 Duration of coholding spells. In addition to examining the level and frequency of coholding, we also observe the length of a spell of coholding. For example, two individuals with the same level of coholding (measured in consumption-days), and same frequency of coholding (measured in fraction of days they cohold over the sample period) might do so with differing spell lengths. One individual exhibit many spells of coholding, while another individual might exhibit one long spell of coholding.

Panel B of Table 2 summarizes coholding spell lengths. To do so, we take each spell of coholding started by an individual, and measure the number of days in the spell. The mean spell length is 22.5 days, with a median spell length of 9 days, due to the long right-tail of the distribution containing very long spells. 11% of spells last longer than 40 days. Durations of 40 or more

days are rare. When we aggregate to the individual level, calculating a within-individual mean spell length and then summarizing across individuals, the mean individual spell length is 29.6 days, with a median of 13 days.

We also describe the relationship between the *frequency* of coholding (i.e., the number of spells of coholding an individual exhibits) and the duration of a spell of coholding over a number of days. Figure 3 illustrates the relationship between the frequency of coholding spells and spell duration using a binscatter plot. In panel A, the *y*-axis shows spell length, and the *x*-axis shows the number of spells of each respective length. The binscatter plots the mean of the *y*-axis variable by 15 equal density bins sorted along the *x*-axis, with a line of best fit plotted through the underlying data. Each individual contributes one observation to the plot, calculated as the mean spell length for the individual, and the total number of coholding spells observed in the sample period for the individual.[22] There is a strong negative relationship between the frequency of coholding and spell length.[23]

2.3.3 Coholding at the monthly level. Our focus on daily data differs from previous studies of coholding which have examined monthly data. Previous studies typically analyze coholding at the monthly level, measured either via survey questions that ask individuals about their financial balances (such as the U.S. Survey of Consumer Finances [SCF]) on their credit card statement for the previous month, together with their savings balances, or using credit card statement data showing accrued balances over the previous month (as in Gross and Souleles (2002)). Studies typically report approximately 25%–30% of individuals engage in coholding in a given month based on question responses (see Vihriälä 2022 for a recent calculation of levels of coholding in the SCF).

To examine coholding in our sample at the monthly level, we draw on the baseline sample and create an aggregate measure of coholding to the individual $\times$ month level, creating a dummy variable for whether the individual exhibited coholding on *at least one day* in the month. This measure is closer to the measurement of coholding in credit card data, in which the end-of-month balance is a sum of spending over the month, with transaction occurring at any time over the previous month. Levels of coholding at the monthly level will

[22] This relationship between the duration and frequency of coholding spells is confirmed in Internet Appendix Table A1, in which OLS regressions of spell length against frequency return a negative coefficient for the frequency variable in models with extensive controls for demographics, financial characteristics, and household expenditure budget shares.

[23] Of course, at the limit there must be a negative relationship between spell length and frequency. By construction an individual who coholds for a spell spanning all days they are observed within the data can only register a single spell of coholding. However, given spell lengths in the data are short, holding spell length fixed, it is feasible to observe a positive relationship between duration and number of spells at the individual level in Figure 3 for the majority of coholding individuals.

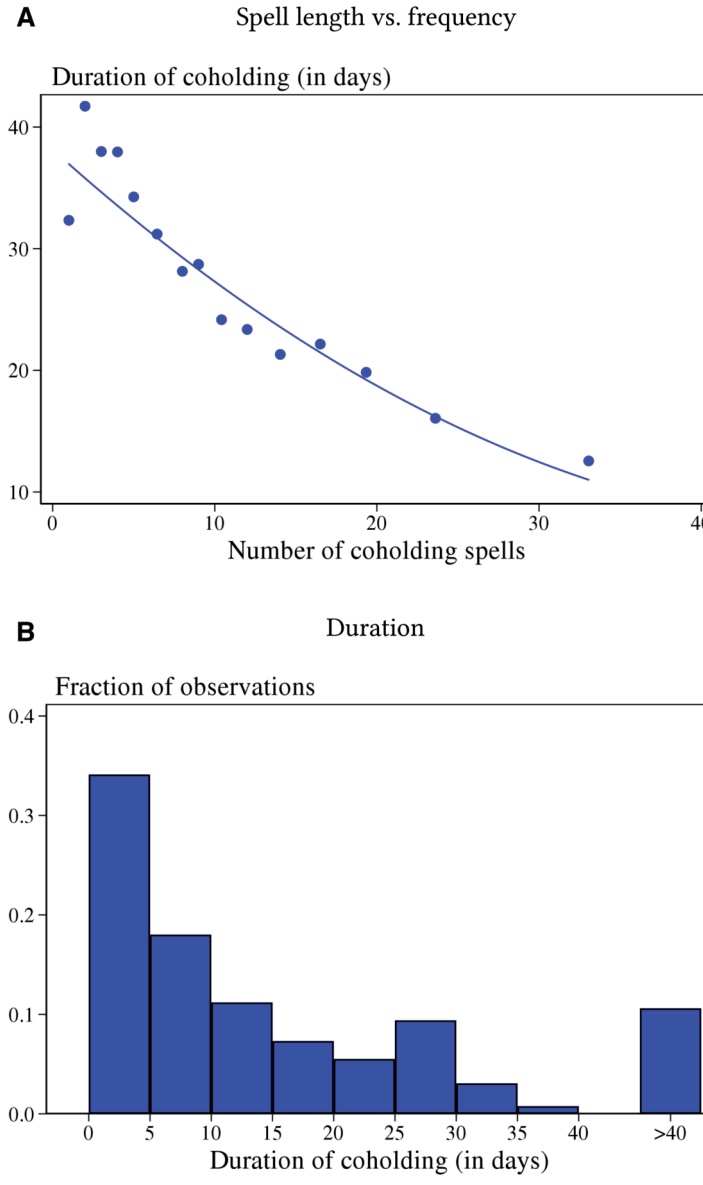

Figure 3
Coholding spell duration vs. coholding frequency
Note: that panel A shows a binned scatterplot of the number of spells of coholding per account and the average duration of each holding spell. The sample includes accounts with at least one coholding spell during the data period (using the definition of coholding a minimum of 3 consumption days of balances).

therefore exceed levels of coholding at the daily level. In this way, coholding is likely to be more persistent in credit card data compared with overdraft data.[24]

Using this measure, we find that 23.5% of individual × months exhibit nonzero coholding, compared with 15% of individual × days. This is consistent with the relatively short duration of coholding spells (as described above). Hence, aggregating our data to the monthly level returns calculations for rates of coholding not dissimilar to those in the existing literature.[25] There are of course caveats to this comparison, including the differences in usages of overdrafts compared with credit cards, survey compared with administrative data, and cross-country differences.

2.3.4 Cost of coholding. In this subsection we present estimates of the financial costs of coholding. Coholding creates excess interest payments, measured by the amount coheld multiplied by the difference between the interest rate on liquid savings and the interest rate on overdraft debt. For example, an individual who coholds $1,000 comprising a deposit account offering 1% interest in credit and an overdraft incurring 13% in interest would incur an associated cost of coholding of $140 per annum. In the sample period, the average interest rate of cash deposit balances was close to 0%, while the average interest rate of overdraft balances was 13%.

Given our panel is unbalanced, we adopt two approaches to aggregating the cost of coholding to an average annual cost for subjects in the data. For both of these calculations, we restrict to the sample of individuals with positive value of coholding on at least one day of the sample period. In the first approach, we calculate the annual cost of coholding for each individual as the average cost per day for each day for each day the individual has nonzero coholding, multiplied by 365. In the second approach, we report average annual costs at the individual level among individuals who are observed for at least 365 days of the sample period. Given that persistent coholding is concentrated among a relatively small subset of individuals or households, the average annual costs of coholding (calculated using the second method) show a much lower standard deviation compared with the annualized daily costs (calculated using the first method).

Table 2, panel C, reports results from this exercise. The mean annualized daily cost of coholding among coholders is approximately 4,700 ISK, or approximately $47. The median value is zero, reflecting the fact that the majority of individual × days in the sample of coholders exhibit zero

[24] For example, an individual with a savings balance of $100 might incur a $100 spend on the 20th of the month on a credit card. The individual will most likely hold the $100 credit card balance until month-end and payment becomes due (given that prepayment of credit card balances is very rare). In a survey referring to end-of-month balances, or administrative data reported at the monthly level, the level of coholding would be calculated as $100 for the month. At the daily level, the level of coholding would be $100 for 10 days.

[25] Previous studies using survey data have typically reported the percentage of individuals who cohold at a point in time, for example, in the month they are surveyed.

coholding. A subset of accounts incur very high costs associated with coholding, with 10% of observations incurring redundant interest charges in excess of 12,800 ISK (≈ $128) and 5% of observations incurring redundant interest charges in excess of 26,900 ISK (≈ $269). The second row shows that average annual costs, which by construction have the same mean as annualized daily costs, have lower variance. This is because all individuals in the sample coholding on at least one day (hence all average annual cost values are nonzero) and because only very few individuals cohold continually over the period. By this calculation, the interest costs of coholding are slightly lower at the top of the distribution, with 5% of individuals incurring average annual excess interest costs above 20,800 ISK ($208).

3. Results II: Explanations for coholding

In the remainder of the paper, we use our data to examine some of the explanations for coholding suggested in the previous literature, plus a new explanation based on mental accounting. Our data offer very rich daily transaction-level records of individual income and expenditures, together with daily measures of account balances. They also contain records of individuals who have linked accounts, allowing us to examine coholding at the individual and household levels. Using these data, we examine explanations for coholding based on (a) within-household coordination, (b) individual characteristics, (c) responses to shocks, and (d) mental accounting.

Our setting does not lend itself to examining other explanations for coholding, such as those based on liquidity management (as in Telyukova and Wright 2008, Druedahl and Jørgensen 2018, and Gorbachev and Luengo-Prado 2019). This is for two reasons. First, some explanation for coholding based on liquidity management are relevant only to credit cards. In the portfolio model of Telyukova and Wright (2008), coholding arises because agents require cash for certain transactions, and credit card cash advances are expensive. Hence, agents do not pay down revolving balances to save interest fees because, were they to do so, they would then incur expensive cash advance fees when accessing necessary cash. Overdraft accounts do not charge cash advance fees, and hence we cannot test this explanation in our setting. Second, our setting does not lend itself ot testing explanations based on credit line risk, as in the model of Druedahl and Jørgensen (2018). Here, individuals are reluctant to pay down their credit lines because of the risk that lenders "chase down" the credit lines as they are paid down, reducing the limit when the balance is repaid. Gorbachev and Luengo-Prado (2019) find evidence consistent with this explanation in U.S. survey data.[26] We do not see any evidence of banks "chasing down" credit lines

[26] In their study, relative to individuals with no credit card debt but positive liquid assets, coholders in the sample (referred to as "borrower-savers") have very different perceptions of future credit access risk and use credit cards for precautionary motives. Also, the study finds that, changing perceptions about credit access risk are essential for predicting transitions among the two groups.

and credit lines remain unchanged as bank customers pay down their overdrafts unless they engage in voluntary reductions, or enter default.[27]

3.1 Within-household coordination

One explanation provided in the existing literature is that coholding arises because of a lack of coordination within couples in the household unit. Previous studies have suggested that coholding could arise because of intrahousehold frictions that lead to noncooperative financial sharing behavior. In the model of Bertaut, Haliassos, and Reiter (2009), a household is characterized by a patient spouse, who holds back liquid savings so as not to unbind a liquidity constraint facing her impatient, debt-holding partner because that would only result in the impatient partner incurring new debts through impulsive spending. Bertaut, Haliassos, and Reiter (2009) also suggest that this same mechanism might operate within the individual, hence individuals cohold as a commitment device (albeit an expensive commitment device). Gathergood and Weber (2014) find evidence from U.K. survey data consistent with this hypothesis.

We examine whether lack of within-household coordination can explain coholding by calculating coholding at both the individual and the couple level. Our baseline sample comprises individuals, with the unit of observation being an individual $\times$ day. To analyze coholding at the couple level, we join individuals in the data who have associated their accounts together.[28] We create two groups. First, individuals who are linked to a spouse who also uses the meniga platform. We call this group "linked individuals." Second, the subset of the linked individual group where the spouse is also in the baseline sample. We call this group "couples." We calculate coholding at the household level (where the household is the individual plus their spouse) as the minima of total deposit account balances of the members of the household and (the absolute value of) total overdraft balances of the members of the household.

Household-level coholding is, by construction, weakly larger than individual-level coholding. For example, in the individual-level analysis, one individual may hold only deposits while a second individual in the same couple holds only overdraft, hence both exhibit zero coholding. In the household-level analysis, the couple as a household unit would exhibit coholding as the minima of one spouse's deposit balances and the other spouse's overdraft balances. If we were to randomly join individuals in the sample into hypothetical "household" units, we would therefore measure an increase in the prevalence of coholding among couples versus singles.

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[27] In the Icelandic setting, overdraft lines are attached to all checking accounts held by individuals age 18 and over and overdrafts constitute a major form of revenue for the banks. Customers choose their own overdraft limit, subject to the approval of their bank. The maximum overdraft facility a bank can offer is limited to 2,450,000 ISK. Extending, changing or discontinuing an overdraft limit does not incur bank fees.

[28] In Iceland, as in most Western nations, nonmortgage financial products are held in the names of single individuals only. Our construction of household units is therefore based on self-declared linkages of individuals with each other.

Figure 4 illustrates levels of coholding among the subsample of single individuals shown in panel A, among the subsample of individuals who are linked to a spouse in the sample shown in panel B, and among couples shown in panel C. The figures suggest very similar patterns in coholding among the three subsamples.[29]

Levels of coholding are only slightly higher among linked individuals and couples compared with singles. At the extensive margin, coholding among couples is a little more common: among the sample of couples × days, 13% of observations exhibit cash holdings of between zero and 10 days alongside overdraft holdings in excess of 40 days. The equivalent percentage among the samples of linked individuals × days and singles × days is 9%. At the intensive margin, coholding among couples is slightly higher compared with singles, but also less persistent: The highest level of coholding shown in the table, with more than 40 days of cash holdings and 40 days of overdraft holdings, accounts for 1.3% of singles × days, 1.1% among linked individuals, while it is 1.6% in the sample of couples × days.[30] However, the share of coholding days for couples is lower than for singles, and the duration of coholding spells is shorter for couples compared with singles.[31]

Given that coholding at the household level is weakly higher than singles, we interpret this mixed evidence for higher coholding among couples as weak support for explanations of coholding based on lack of coordination with households. It may be the case that coholding because of a lack of coordination within the household (as in Bertaut, Haliassos, and Reiter (2009)) is more likely to occur in more traditional societies with clearer distinctions in gender roles in financial management within the household.[32]

3.2 Individual characteristics

Studies suggest that heterogeneity in individual financial mistakes (the set of which might include coholding) is correlated with individual characteristics. For example, the literature on sluggish mortgage refinancing shows that household who are slower to refinance when mortgage interest rates fall are typically poorer, older and less educated (Campbell 2006; Keys, Pope, and Pope 2016; Andersen et al. 2020).[33] Jorring (2018) shows that the propensity of individuals incurring some financial mistakes (avoidable late fees, and avoidable overdraft fees), varies with demographic variables, such as age and

[29] Summary statistics for the three samples are show in Table A2. Summary tables for the level of coholding among single individuals compared with couples are shown in Table A3–Table A5.

[30] Table A6, A7 and A12 report summary statistics by level of coholding in currency.

[31] See Tables A9-A11 and A12.

[32] Given that within-household equity has increased over time in Western nations, the use of coholding as a strategy by the accountant in the accountant-shopper model may no longer be feasible in modern households.

[33] Fisher et al. (2022) also show that sluggish refinancing results in sizeable cross-subsidies from relatively poorer households and those located in less-wealthy areas toward richer households and those located in wealthier areas.

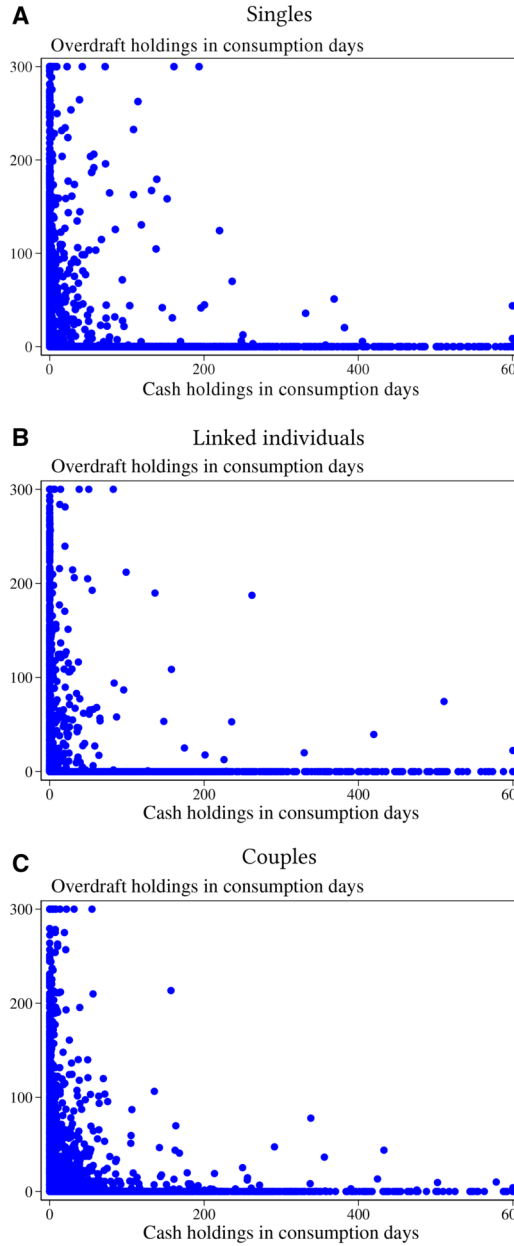

Figure 4
Coholding by singles vs. multiperson households
Note: that panel A shows a scatter plot of overdraft holdings and cash deposit account holdings, both measured in days of individual-level average consumption expenditure, for single individuals who are never linked to another person during the sample period. Panel B shows an equivalent scatter for individuals who are linked to a spouse in the sample. Panel C shows an equivalent scatter plot for households that are comprised of the individuals observed in panel B.

education, as well as financial characteristics, such as income, credit score, and assets. Studies also show that financial literacy varies systematically with age, income, and gender.[34]

To investigate the relationship between coholding and individual characteristics, we compare characteristics of the approximately 60% of individuals in our sample who never cohold with the 40% who cohold on at least one occasion in Table 3. Summary statistics in Panel A show that coholders are very similar to non-co-holders: they have comparable mean ages, share of women, and permanent income, while having a slightly higher share of individuals receiving at least one social security payment during the sample period.[35] Panel B presents OLS regression estimates, revealing that the probability of coholding is higher among older households, those with higher permanent income, and those claiming social security, while being lower among those who are in couple. In additional analysis, we examine the individual characteristics of coholders by their intensity of coholding. The highest coholders are on average slightly older, less likely to be women, have higher permanent incomes, and are less likely to be in a couple, consistent with the patterns seen in Table 3.[36] These results further suggest that coholders and non-co-holders are similar.

3.3 Time-varying responses to shocks

Coholding might arise due to shocks to individual circumstances that push households away from their equilibrium cash management position. Given that most periods of coholding are short-lived, and coholders appear similar to non-co-holders, it is possible that coholding might arise for a subset of individuals at random due to unpredictable, short-term shocks. These shocks might either move individuals finances out of a no coholding equilibrium (e.g., a shock to income), or might reduce individuals attention to their personal finances (e.g., because of a shock to health), resulting in coholding arising due to short-term inattention.[37]

Using the transaction data, we construct measures of economic shocks. We construct three measures: unemployment shock, health shock, and income shock. We construct these measures using information gleaned from the transaction strings in the expenditure data as follows: For each shock, we create a flag at the monthly level for the onset of a shock event. We identify the

[34] Lusardi and Mitchell (2011) show from a large multicountry study that women are less financially literate than men, the young and the old are less financially literate than the middle-aged, and more educated people are more financially knowledgeable.

[35] Summary statistics for the full sample are shown in Table A13 in the Internet Appendix.

[36] See Internet Appendix Tables A14-A17.

[37] For example, in periods of reduced attention or limited cognitive resource, individuals might mistakenly make transactions from an account they did not intend to use (e.g., a debit card transaction from an account with zero funds, which creates an overdraft balance), or individuals might not take the time to monitor their finances and eliminate arbitrage opportunities between their financial accounts. Reduced attention might therefore explain suboptimal outcomes as in Sims 2003, Sims 2006).

Table 3
Comparison of coholders and non-co-holders

(A) *Summary statistics*

	Non-co-holder	Co-holder	t-value	p-value
Age (in years)	41.31	42.33	−4.25	0.000
Woman (=1)	0.49	0.48	1.35	0.171
Permanent Income (ISK/1,000,000)	0.87	0.94	−0.12	0.903
Couple / Linked (=1)	0.41	0.40	3.30	0.001
Social security (=1)	0.29	0.33	−3.81	0.000

(B) *OLS regression*

	Co-holder = 1
Age (in years)	0.000687*
	(0.000373)
Female (=1)	−0.00554
	(0.00910)
Permanent Income (ISK/1,000,000)	0.118***
	(0.0164)
Spouse (=1)	−0.0472***
	(0.0132)
Social Security (=1)	0.0392***
	(0.00988)
Constant	0.259***
	(0.0167)
R-squared	0.009
#Observations	11,545

Panel A presents a comparison of means between individuals who cohold (on at least one day of the sample period) and those who never cohold. Panel B draws the same sample and presents a cross-sectional regression in which the outcome variable is a 1/0 dummy indicating whether the individual is a coholder. * $p < .1$; ** $p < .05$; *** $p < .01$.

start of a period of unemployment via a new unemployment-related social security claim occurring within the month. We classify a health shock as a month in which the individual more than trebles their health expenditure, and their health expenditure exceeds 15,000 ISK.[38] We classify an income shock as a reduction in income between months of at least 25%, which persists for at least 3 months.[39]

Table 4, panel A, summarizes the shock variables for individual × month observations, for all individuals in the sample who ever cohold (and hence among whom we can model the onset of coholding). Unemployment shocks are the most-rare form of shock, affecting less than 1% of observations, with approximately 3% of observations showing a health sock, and 10% showing an income shock.

[38] We use these two criteria to ensure (a) that health expenditure has increased substantially, where a trebling is interpreted as a substantial increase and (b) that the trebling is of a sizeable value. The minimum threshold of 15,000 ISK avoids classification of trebling of expenditure at very low levels of expenditure as a health shock, for example, an increase from 10 to 30 ISK. In the Internet Appendix we present results from a modified definition of health shock based on a quadrupling of health expenditure, see Table A18.

[39] We include this persistence clause in the definition of an income shock to avoid classifying cases where income payments are early/late in the payment period, delayed due to public holidays, such as Christmas, or variable at the end of the financial year due to bonuses or tax adjustments.

Table 4
Individual shocks and onset of coholding

(A) *Summary statistics*

Variable	Obs	Mean	Std. dev.
Unemployment shock	111,580	0.007	0.082
Health shock	111,580	0.029	0.166
Income shock	111,580	0.101	0.301

(B) *OLS regression*

	Probability of co-hold period starting		
	(1)	(2)	(3)
Unemployment shock	−0.0035	0.0005	−0.0792
	(0.0033)	(0.0053)	(0.2074)
Health shock	−0.0011	−0.0010	0.0701
	(0.0022)	(0.0023)	(0.1162)
Income shock	−0.0039***	−0.0042***	0.0507
	(0.0012)	(0.0012)	(0.0626)
Unemployment shock_t-1		−0.0050	
		(0.0044)	
Health shock_t-1		0.0023	
		(0.0023)	
Income shock_t-1		0.0006	
		(0.0012)	
Unemployment shock_t-2		−0.0046	
		(0.0034)	
Health shock_t-2		0.0008	
		(0.0023)	
Income shock_t-2		0.0002	
		(0.0012)	
Unemployment # spread			0.0065
			(0.0174)
Health # spread			−0.0059
			(0.0096)
Income # spread			−0.0045
			(0.0052)
Spread			0.0135***
			(0.0017)
Constant	0.0146***	0.0150***	−0.1490***
	(0.0004)	(0.0005)	(0.0209)
R-squared	.0001	.0002	.0007
#Observations	111,580	103,610	111,580

Panel A presents summary statistics for unemployment, health and income shocks in the sample of coholders. The unit of observation is an individual × month, with the shock variables in each cases coded to one if the individual experiences the shock in the month, and zero otherwise. See Section 3.3 for definitions of the shock variables. Panel B presents a cross-sectional regression in which the outcome variable is a 1/0 dummy indicating whether the individual begins a period of coholding within the month.

Panel B reports estimates from an OLS regression in which the dependent variable is a 1/0 dummy for whether a period of coholding begins in the month. In column 1, the independent variables are the three shock variables, which enter the model together with a constant term. In this model, the coefficients on the shock variables are each negative, in the case of the income shock variable also statistically significant. These coefficients imply shocks are associated with a reduced likelihood of the onset of a spell of coholding. Column 2 adds two lags of each shock variable, to account for potential time lags between

the individual experiencing the shock and the onset of coholding, with no statistically significant coefficients among the lag terms.

If the effect of shocks is to reduce attention, then we might expect this would vary by the economic cost of attention. To test for this, we include interaction terms with the spread between the overdraft interest rate and the savings interest rate in column 3. The coefficient for the spread variable is positive, which is unexpected given a higher spread indicates a higher financial cost to coholding. The interaction terms between the shock variables and the spread variable are in each case not statistically significant, providing no evidence that shocks affect the probability of coholding to a greater or lesser extent when the spread is higher.

3.4 Mental accounting

In this final subsection, we explore whether coholding arises in a manner consistent with mental budgeting, whereby individuals assign balances on their financial products (here cash balances and overdrafts) to separate mental accounts. This explanation has not been considered in detail in the previous literature. In models of mental accounting (also referred to as mental budgeting) individuals organize their finances into budgets tagged by hypothesized purposes and needs, in contrast with economic accounting in which individuals organize their finances to minimize costs (Thaler 1985, 1999; Prelec and Loewenstein 1998; Shefrin and Thaler 2004; Quispe-Torreblanca et al. 2019).

In our setting, mental budgeting might lead to coholding through individuals choosing to assign categories of expenditures to different accounts, with some accounts in surplus and others in overdraft, concurrently. In particular, spending from an account in overdraft while holding another account in surplus (because of a category of current expenditure being mentally assigned to the account in overdraft, despite the higher financial cost of running the overdraft balance), could generate increased coholding through mental budgeting.

To explore this idea, we first test whether individuals tend to assign particular categories of expenditure to overdraft accounts. Using data on all individuals in the baseline sample, we calculate for each individual the share of transactions by category that are placed on an overdraft account (in contrast to an account in surplus). We then take the average of this share variable across individuals and normalize by the mean.

Summary statistics are shown in Table 5. A value greater than one indicates the category has a greater-than-average share of transactions placed on overdraft accounts, while a value less than one indicates the category has a less-than-average share of transactions placed on overdraft accounts (and hence a greater than average share placed on accounts in surplus). The table shows that gambling, temptation goods, gasoline and alcohol are the categories of expenditure with the highest excess transactions on overdraft accounts, while holidays, home renovation and books & stationary are the

Table 5
Excess Transactions on Overdraft Accounts

	Whole	Age		Income	
	Sample	High	Low	High	Low
Gambling	1.18	1.13	1.24	1.14	1.24
Temptation	1.11	1.07	1.13	1.09	1.13
Gasoline	1.10	1.09	1.11	1.09	1.10
Alcohol	1.09	1.07	1.11	1.09	1.10
Pharmaceuticals	1.08	1.06	1.08	1.09	1.07
Transportation	1.07	1.08	1.05	1.06	1.07
Swim & leisure	1.06	1.09	1.03	1.07	1.04
Groceries	1.04	1.04	1.04	1.05	1.03
Special occasions	1.03	1.02	1.02	1.01	1.05
Online media	1.02	1.01	1.02	1.02	1.02
Online gaming	1.02	1.11	0.98	1.06	0.97
Toys	1.01	1.01	1.03	0.99	1.03
Ready made food	1.01	1.05	0.98	1.03	0.98
Clothes and accessories	1.01	1.01	0.99	1.02	0.99
Sports and activities	1.01	1.00	1.02	0.99	1.02
Home furnishings	1.00	0.99	1.00	1.01	1.00
Recreation	0.98	1.00	0.97	0.99	0.98
Hobbies	0.97	0.97	0.94	0.99	0.96
Cinema	0.97	1.06	0.91	1.02	0.92
Books & stationary	0.96	0.97	0.93	0.97	0.95
Home renovation	0.96	0.89	1.06	0.94	0.97
Holidays	0.94	0.93	0.93	0.93	0.95

The table presents summary data for the normalised share of transactions by category that are placed on an overdraft (in contrast to being placed on an account in surplus).

categories of expenditure with the lowest excess transactions on overdraft accounts. Those categories with the highest excess transactions reflect types of nondurable expenditures typically associated with impulsivity / impatience, such as gambling. Those categories with the lowest excess transactions, by contrast, reflect types of (in some cases) durable expenditures associated with planning / patience, such as home renovation and books & stationary.[40]

We further explore whether the summary data in Table 5 reflect patterns in allocation of transactions to accounts in overdraft and surplus related to coholding. We do so by exploiting the high frequency of the data to model the relationship between expenditures and the onset of a period of coholding at the daily level. Specifically, we take all individual $\times$ days in the baseline sample and identify the starting day of each spell of coholding. We then first estimate an OLS regression model, pooling individual $\times$ day observations, in which the outcome variable is a dummy variable for whether the individual commenced a period of coholding on the day, and the regressors of interest are a set of dummy variables indicating in which categories of expenditure the individual made (at least one) transaction on the day. The model includes a set of covariates including individual characteristics (including age, gender, whether

[40] Holidays are a nondurable good, but transactions for holiday purchases typically occur in advance of the holiday commencing, and hence reflect a planning decision.

the individual is part of a couple), and financial characteristics (including log total income, whether in receipt of social security).

Results are shown in Table 6. Results in column 1 show the likelihood of cohold spell starting is positively related to the age of the individual, and also positively related to income and whether they received social security, consistent with the earlier results shown in Table 3 contrasting the characteristics of coholders versus non-co-holders. Column 1 includes a dummy variable indicating whether the individual received their regularly monthly salary into one of their accounts on the day. The coefficient for this dummy is negative, implying that salary payments are associated with a decreased likelihood of a period of coholding commencing.[41]

Our main independent variables of interest are the dummy variables indicating in which categories of expenditure the individual made a transaction on the day on which the spell of coholding commenced. Before including these, we first add to the model a series of control variables for the composition of spending and account activity undertaken by the individual. These variables might arise endogenously with the decision to cohold, and are important controls that could relate to the propensity of individuals to make transactions in certain categories. Column 2 includes the share of discretionary expenditures on durable goods and nondurable goods. The coefficient for nondurable goods is larger than on durable goods, indicating that the onset of a spell of coholding is associated with a higher share of expenditures on nondurable goods. Control variables for the number of current accounts and savings accounts both show positive coefficients. In columns 3 and 4, we add controls for the level of expenditure undertaken in cash, and the level of expenditure undertaken on a credit card, which both show positive coefficients.

The model in column 5 incorporates the full set of control variables, plus dummies for expenditure categories, reporting coefficients for the top-three categories and bottom-three categories by excess transactions on overdraft accounts as shown in Table 5. The coefficients on the gambling, temptation, and gasoline categories are all positive and statistically significant, while the coefficients on home renovation, books & stationary, and holidays show no statistical significance. In the sample used in the regression, the mean of the dependent variable is 1.1%, reflecting the approximate one in a hundred chance that coholding commences on a given day observation in the baseline sample. The coefficient of 0.0014 on the gambling dummy implies that an individual making at least one gambling transaction on the day is associated with approximately a 15% increase in the probability of a spell of coholding commencing on the day.

[41] The negative relationship between a salary receipt event and the probability of a spell of coholding commencing implies salary payments are less likely to be made to an account in surplus (while the individual concurrently holds an account in overdraft), compared with an account in overdraft (while the individual concurrently holds an account in surplus).

Table 6
OLS regression: Probability of cohold period starting

	Co-hold Spell Starting = 1				
	(1)	(2)	(3)	(4)	(5)
Age	0.0001***	0.0000***	0.0001***	0.0001***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Woman	−0.0001	−0.0001	−0.0001	−0.0001	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Linked	−0.0004***	−0.0005**	−0.0003	−0.0004***	−0.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Benefits person	0.0006***	0.0006***	0.0005***	0.0006***	0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Log total income	0.0008***	0.0006***	0.0005***	0.0005***	0.0008***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Payday[a]	−0.0043***				−0.0049***
	(0.0006)				(0.0007)
Durables[b]		0.0001**			0.0000
		(0.0000)			(0.0000)
Non-durables[b]		0.0006***			0.0001*
		(0.0001)			(0.0001)
Nr. current accounts		0.0002**			0.0001
		(0.0001)			(0.0001)
Nr. savings accounts		0.0010***			0.0010***
		(0.0000)			(0.0000)
Log cash spendings			0.0003***		0.0003***
			(0.0000)		(0.0000)
Log credit card spendings				0.0001***	0.0000***
				(0.0000)	(0.0000)
Gambling[c]					0.0014***
					(0.0005)
Temptation[c]					0.0006**
					(0.0003)
Gasoline[c]					0.0005***
					(0.0002)
Home Renovation[c]					0.0001
					(0.0012)
Books & Stationary[c]					0.0002
					(0.0005)
Holidays[c]					−0.0001
					(0.0003)
Constant	0.0113***	0.0112***	0.0099***	0.0111***	0.0102***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
R-squared	0.002	0.003	0.002	0.002	0.003
#Observations	3,521,856	3,094,876	3,521,856	3,521,856	3,094,876

[a] Dummy that equals 1 if salary payment is made into the account on the day. [b] Expenditure on durable and nondurable goods in the preceding month expressed as a share of individual-specific average expenditures. [c] Dummies that equal 1 if there is at least one expenditure on an item in that category on the day. Standard errors are clustered at the individual level. Individual location dummies are included in all models but coefficients not reported. Total income, cash and credit card balance are inverse-hyperbolic-sine transformed. Additional controls are day of week and day of month, but coefficients are not reported. * $p < .1$; ** $p < .05$; *** $p < .01$.

Table 7 presents estimates from an individual fixed effects version of the model presented in Table 6.[42] This model accounts for individual-specific, time-invariant heterogeneity, which might cause the correlation between the covariates of interest and the outcome variables, such as unobserved factors that cause individuals to be both more likely to start a spell of coholding and more

42 This model omits the control variables which do not vary over time from the model presented in Table 6.

Table 7
Individual fixed effects regression: Probability of cohold period starting

	Co-hold period starting = 1				
	(1)	(2)	(3)	(4)	(5)
Log total income	0.0008***	0.0006***	0.0005***	0.0005***	0.0008***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Payday[a]	−0.0044***				−0.0049***
	(0.0010)				(0.0012)
Durables[b]		0.0001***			0.0000
		(0.0000)			(0.0000)
Non-durables[b]		0.0006***			0.0001
		(0.0001)			(0.0001)
Nr. current accounts		0.0020***			0.0016***
		(0.0006)			(0.0006)
Nr. savngs accounts		0.0024***			0.0020***
		(0.0003)			(0.0003)
Log cash spendings			0.0003***		0.0003***
			(0.0000)		(0.0000)
Log credit card spendings				0.0001***	0.0000**
				(0.0000)	(0.0000)
Gambling[c]					0.0013**
					(0.0005)
Temptation[c]					0.0007**
					(0.0003)
Gasoline[c]					0.0003
					(0.0002)
Home Renovation[c]					0.0002
					(0.0013)
Books & Stationary[c]					0.0002
					(0.0005)
Holidays[c]					−0.0000
					(0.0003)
Constant	0.0129**	0.0110	0.0114*	0.0127**	0.0102
	(0.0056)	(0.0072)	(0.0059)	(0.0056)	(0.0068)
R-squared	0.003	0.003	0.003	0.003	0.003
#Observations	3,522,740	3,095,136	3,522,740	3,522,740	3,095,136
#Individuals	3,985	3,985	3,985	3,985	3,985

[a]Dummy that equals 1 if salary payment is made into the account on the day. [b]Expenditure on durable and nondurable goods in the preceding month expressed as a share of individual-specific average expenditures. [c]Dummies that equal 1 if there is at least one expenditure on an item in that category on the day. Standard errors are clustered at the individual level. Individual location dummies are included in all models but coefficients not reported. Total income, cash and credit card balance are inverse-hyperbolic-sine transformed. Additional controls are day of week and day of month, but coefficients are not reported. * $p < .1$; ** $p < .05$; *** $p < .01$.

likely to make transactions in some categories compared with others. Estimates in Table 7 show a very similar pattern in the coefficients, and the implied effect sizes, to those shown in Table 6. The likelihood of a spell of coholding starting is approximately 13% higher on days on which an individual makes a new gambling transaction.[43]

Our results suggest that, in particular, forms of expenditure associated with impulsivity and impatience might give rise coholding, as individuals incur these on their overdraft accounts, while holding surpluses in other accounts (and hence create coholding in their financial portfolios). Previous studies

[43] The individual fixed effects model estimates the effect of a new gambling transaction (i.e., a transaction made today, but not yesterday) on the likelihood of beginning a spell of coholding.

have found that coholding might be related to impulsiveness (as in Bertaut, Haliassos, and Reiter 2009 and Gathergood and Weber 2014). However, a key distinction between those studies and our study is the role of liquidity. In Bertaut, Haliassos, and Reiter (2009), an impulsive individual holds out their savings in a nonliquid savings account, and accrues a balance on a credit card in order to limit their liquidity available for impulsive spending (which is limited by the inability to transact from the savings account directly, and by the credit limit on the credit card).[44] Gathergood and Weber (2014) finds evidence consistent with this in survey data.[45] By contrast, in our setting both the surplus and overdraft accounts are fully liquid, so coholding does not offer any benefits in reducing available liquidity.

4. Conclusion

In this paper, we explore one of the starkest violations of simple arbitrage on household balance sheets: holding low-yield, liquid savings while simultaneously holding high-cost unsecured credit on revolving credit lines. Previous studies, mostly using annual survey data with reported month-end balances, have shown this is a common behavior among individuals. We shed new light on this behavior using detailed, high-frequency, objective data from a financial aggregation platform. We find rates of coholding consistent with those measured in survey data, but with very different underlying patterns at the submonth level. We find levels of coholding (relative to consumption) are typically modest and occur in short spells. As a result, the excess interest costs arising from coholding are modest in our sample.

Our analysis of competing explanations for coholding points to a prominent role for mental accounting, in particular our results suggest coholders are willing to pay excess interest costs in order to assign categories of consumption to credit accounts and debit accounts in a financial suboptimal way. While mental accounting has for some time been suggested as an approach consumers might take to financial decision making, ours is the first study to link mental accounting to coholding in transaction data. We suggest analysis of transaction patterns at high frequency might fruitfully shed light on other puzzles in household finance.

Code Availability: The replication code and data are available in the Harvard Dataverse at https://doi.org/10.7910/DVN/DKO35X.

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[44] Were the individual to use the savings balance to pay down the credit card debt, they would increase their available-to-spend limit on their credit card, and hence increase the potential to succumb to impulsive spending desires.

[45] Gathergood and Weber (2014) show that coholders report both higher rates of impulsivity compared with the population, as well as higher rates of financial literacy, possibly showing that coholding is a deliberate behavior by individuals who are financially aware of the cost, yet also aware of their own impulsivity and hence deliberately constrain their spending via coholding.

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