Untangling the credit card debt puzzle

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Abstract

This paper documents new facts and untangles mechanisms regarding the credit card debt puzzle that describes the co-holding of high-cost debt and low-yield assets. First, co-holding is less costly for the typical household than based on an extrapolation from a cross-section once I account for the persistence of co-holding with a monthly panel. Second, liquidity-based theories are insufficient to explain co-holding because co-holding occurs even with high liquidity and low credit limit risk, and few co-holding households take up an offer of low-cost liquidity. Third, my results suggest that limited intra-household financial pooling contributes to co-holding because co-holding is more prevalent within couples than at the individual level, and the intra-household distribution of assets and liabilities affects household demand for low-cost liquidity. Finally, my results suggest that anchoring to the minimum credit card payment contributes to co-holding.

Keywords: household finance, credit card debt puzzle, co-holding, intra-household financial pooling, anchoring

JEL codes: D13, D14, D91, E21

1   Introduction

Many households borrow and save at the same time by holding both high-cost debt and low-yield liquid assets. Across vintages of the Survey of Consumer Finances (SCF), around 30 percent of households in the US co-hold as noted first by Gross and Souleles (2002). The decision not to use liquid assets to repay high-cost debt to economize on interest costs has been labeled the *credit card debt puzzle* or the *co-holding puzzle*[1]. The seemingly suboptimal behavior ties to the broader household finance literature that seeks to understand why households make financial decisions that differ from standard model predictions.

Despite earlier explanations for the puzzle, we still do not understand many features of co-holding because of both data limitations and a lack of policy experiments. For instance, we do not know (i) how persistent co-holding is because of the lack of high-frequency panel data; (ii) whether households would stop co-holding if they had access to sufficient liquidity; (iii) how the intra-household distribution of assets and liabilities impacts co-holding; (iv) or whether anchoring of credit card payments to the contractual minimum contributes to co-holding. My paper contributes on these fronts with a new Finnish dataset with information on hundreds of thousands of households at a monthly frequency combined with evidence from a policy experiment.

First, I show that a cross-section, such as the SCF used in much of the literature, does not give an accurate picture of the persistence of co-holding. Households classified as co-holders in one month on average reduce co-holding over the subsequent year. Therefore, extrapolation from a cross-section tends to overestimate the costs of co-holding for the typical household. The mean discrepancy in extrapolated versus actual costs is not large, with actual costs on average almost 90 percent of extrapolated costs. Yet, the spread in the ratio of actual to extrapolated costs across households is significant (around 40 percent in the 10th percentile versus around 130 percent in the 90th percentile). Because of earlier data limitations, my paper provides the first evidence on the persistence of co-holding at a high frequency together with ongoing work by Gathergood and Olafsson (2020) who study co-holding on deposit accounts with an overdraft option.

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[1]Co-holding puzzle is a more accurate description when not restricting attention to only credit card debt but also other high-cost borrowing (Gathergood and Weber, 2014).

Second, I test whether the two liquidity-based theories are sufficient to explain co-holding. The *liquidity premium hypothesis* suggests that cash is more liquid than unused credit, and hence co-holding arises because a cash buffer is essential for certain expenses (Telyukova, 2013; Zinman, 2007). Yet, I find that co-holding often coincides with high liquidity well above a modest cash buffer, in line with earlier results (see, for instance, Gross and Souleles, 2002). By contrast, the *precautionary borrowing hypothesis* suggests that co-holding arises because households fear that banks would reduce their credit lines after a negative shock. The risk of, for instance, a job loss coinciding with a credit reduction creates an incentive to borrow and co-hold in advance (Druedahl and Jørgensen, 2018; Fulford, 2015; Gorbachev and Luengo-Prado, 2018). Yet, co-holding occurs also in my data despite the low negative credit limit risk in Finland. Finally, I test the liquidity premium and the precautionary borrowing hypotheses with a natural experiment that provided certain co-holding households access to new low-cost liquidity. According to liquidity-based theories, co-holding households should find an offer of low-cost liquidity beneficial. However, less than one in three co-holding households take up the extra liquidity, and I find no evidence that access to additional liquidity would have reduced co-holding.

Third, I provide evidence on the effect of intra-household dynamics on co-holding, which has been understudied previously because of data limitations. The standard approach of defining co-holding at the household level contains an implicit assumption of perfect intra-household pooling of assets and liabilities. However, the accountant-shopper models of Bertaut and Haliassos (2001) and Bertaut et al. (2009) used to explain co-holding can reflect a strategic game between two separate individuals. I provide supporting empirical evidence that within couples (i) co-holding is less prevalent at the individual than at the household level; (ii) the persistence of co-holding is lower at the individual than at the household level; (iii) the intra-household distribution of assets and liabilities impacts the take up of the low-cost liquidity offer. Therefore, part of the co-holding within couples is not puzzling if we relax the assumption of perfect intra-household pooling. My results on intra-household dynamics complement the findings of Choi and Laschever (2018) that income inequality and agreeableness within the couple impact co-holding. Finally, my results on differential co-holding between individuals and couples contrast with those from ongoing

work by Gathergood and Olafsson (2020).

Fourth, I providence evidence consistent with the hypothesis that anchoring (Tversky and Kahneman, 1974) to the minimum credit card payment contributes to co-holding. Various studies have shown that credit card debt payments are consistent with anchoring (Guttman-Kenney et al., 2018; Hershfield and Roese, 2015; Keys and Wang, 2019; Navarro-Martinez et al., 2011; Stewart, 2009). My paper corroborates, in particular, the findings of Keys and Wang (2019) regarding the pervasiveness of low credit card payments in a similar real-world setting. I further support the conclusion of Keys and Wang (2019) that liquidity constraints (instead of anchoring) are unlikely to explain low credit card payments, because I observe directly the (often high) liquidity associated with low payments. Consequently, my paper bridges the literature on anchoring in credit card payments and the literature on the credit card debt puzzle by showing that anchoring households are more likely to co-hold.

Finally, the earlier literature and my setup allow to comment on some other suggested mechanisms for co-holding. For instance, strategic bankruptcy motives (Lehnert and Maki, 2002) are unlikely to explain co-holding in Finland where households find it much harder to restructure/discharge their unsecured debts than in the US. Self-control problems at the individual level are unlikely to explain co-holding in isolation, because theoretically self-control problems make it difficult for individuals to maintain liquid deposits and hence co-hold. With a large share of electronic transactions, deposits are particularly liquid in Finland. The liquidity of deposits in my data does not imply, though, that self-control problems could not explain co-holding as an equilibrium within couples or in circumstances where deposits are less liquid. Indeed, Gathergood and Weber (2014) show that impulsiveness predicts co-holding with UK household data. Self-control problems could matter for co-holding also in conjunction with mental accounting, where different mental accounts for different types of expenditure could create *de facto* illiquidity of deposits despite *de jure* liquidity (Gathergood and Olafsson, 2020). Finally, financial illiteracy is unlikely to explain the puzzle, because earlier research has documented that co-holding households have relatively high financial literacy (Gathergood and Weber, 2014; Gorbachev and Luengo-Prado, 2018).

The paper is structured as follows. In Section 2, I define the credit card debt puzzle and introduce the data. In Section 3, I document the persistence and costs of co-holding. In

Section 4, I show that liquidity-based theories are insufficient to explain co-holding. In Section 5, I show that intra-household dynamics can contribute to co-holding within couples. In Section 6, I provide evidence consistent with anchoring to the minimum credit card payment contributing to co-holding. Section 7 concludes.

2 Definitions and data

In this section I first define the credit card debt puzzle. Second, I present the Finnish proprietary bank data. Finally, I document the sample selection procedure and provide descriptive statistics on the sample households.

2.1 Definition of the credit card debt puzzle

The simplest definition would classify any household with simultaneous positive holdings of liquid assets and interest-accruing credit card debt as a "puzzling" co-holder. Yet, low levels of co-holding carry negligible costs and can merely reflect differential timing of expenditure and income flows. Therefore, to classify a household as a co-holder, I follow the earlier literature and require simultaneous holding of (i) non-negligible interest-accruing credit card debt and (ii) liquid assets above a buffer.

Another issue is the definition of the asset and borrowing subsets underlying the puzzle. I opt to consider all balances in checking and savings accounts with no or limited withdrawal restrictions as liquid assets. In terms of the puzzle, credit card debt is not special in comparison to other unsecured credit lines that can be withdrawn and repaid repeatedly. Therefore, in defining the puzzle, I sum both credit card debt and other unsecured debt from credit lines that allow for repeated use.

Consequently, the baseline puzzle criteria at the household level are:

1. Have interest-accruing unsecured debt above 500 EUR
2. Have deposits greater than 1,500 EUR

The two criteria allow me to focus on non-negligible co-holding while allowing for a liquidity buffer as is standard in the literature. For comparison, I also provide statistics on

the share of households who co-hold any positive amount, and I also later study co-holding relative to income.

2.2   Data

The data comes from one of the largest banks in Finland. I have customer-level data on, for instance, assets, debts, income and card expenditure. Most of the data is available at a monthly frequency for 2014–2017. I can link individuals belonging to the same household to study co-holding both at the household and individual level. The data also has the advantage of electronic precision compared to ealier survey-based evidence on co-holding that can suffer from measurement error.

The main variables to analyze co-holding are:

Unsecured debt: I observe interest-accruing credit card debt and other unsecured debt at the bank, that is, I can distinguish interest-accruing debt from transaction balances subject to an interest-free period. In addition to credit cards, the bank offers a flexible unsecured credit line for repeated use. Interest rates on unsecured credit are, as a rule, product and not individual specific. Nominal interest rate margins on both credit cards and the unsecured credit line are similar (in the 5 to 10 percent range). The most common credit card has an interest rate margin of 7 percent. The total nominal interest rate on all the products is the interest rate margin + the 3 month Euribor reference rate, but the Euribor rate was close to zero during the sample period. In addition to the nominal interest rate, the total cost of unsecured credit includes monthly and yearly account fees and invoicing fees. None of the debt products preclude full or partial prepayment. In calculating co-holding, I sum all interest-accruing unsecured debt on credit cards and on the unsecured credit line that allows for repeat use. I do not include unsecured credit on an interest-free period in my measure of co-holding. Credit card debt accounts for roughly $\frac{3}{4}$ of the total interest-accruing unsecured debt.

Liquid assets: I include in liquid assets balances on all checking and savings accounts that do not have any or only limited withdrawal restrictions[2]. These deposits are available

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[2]Checking accounts have no restrictions. Some of the savings accounts have restrictions on the number of free withdrawals per year (typically four). However, these savings accounts also have yields close to zero

flexibly to repay unsecured debt. The nominal net interest rate on deposits averaged around 0.1 percent during the sample period (2014–2017).

Co-holding: I calculate co-holding as the minimum of interest-accruing unsecured credit and deposits.

2.3   Sample selection

Despite the advantages of high frequency, electronic precision, and the ability to study co-holding both at the household and individual level, a potential concern with my data is that it comes from a single bank. Data from a single bank may be unrepresentative of the full population, either because (i) the bank serves a particular subset of the population, or because (ii) the bank only captures a small subset of the financial activity of its customers. Regarding the first concern, the customer base of the bank is large and diverse because it is one of the largest banks in the country. For instance, in mortgages the market share of the bank is around $\frac{1}{3}$ of the national total. The bank also has branches in all parts of the country. Regarding the second concern, one mitigating factor is that the bank has a loyalty scheme that encourages households to concentrate their full financial portfolio (assets, debts, insurance) at the bank. Still, a significant chunk of customers may be only loosely tied to the bank. Therefore, I implement several additional conditions to ensure that my sample households use the bank for which I have data as their main bank:

1. Household needs to have at least one person over 25 years old
2. Household has at most two members over 20 years
3. Household needs to have a credit card issued by the bank
4. All over 25 year olds have a checking account at the bank
5. No household member has stated another main financial service provider
6. All over 25 year olds regularly use cards issued by the bank during 2014–2017
7. Household disposable income is over 500 EUR per month in 2015
8. I drop entrepreneur households not to mix personal and business accounts
9. Two oldest adults in household are unchanged during 2014–2017

percent over the sample period. Therefore, keeping money in savings accounts is arguably 'puzzling' if the household faces a non-negligible probability to use unsecured debt.

The first four conditions are my minimum criteria to study the credit card debt puzzle, because I am interested in households with a credit card and a checking account that at least have the possibility to co-hold. I use the age criterion and the restriction on the number of over 20 year olds to drop shared (student) households who live in the same address but have separate finances. The minimum criteria identify in total 642,410 households that are customers of the bank. I specify conditions 5–6 so that it is likely that the households that I identify use the bank for which I have data as their main bank[3]. These conditions reduce the number of households to 401,372. By adding conditions 5–6, I capture 69 percent of the total unsecured credit held by households defined by the minimum criteria only in January 2015. I specify the income condition to be able to study co-holding relative to income, and the condition on entrepreneurs is self-explanatory. Together conditions 1–8 reduce the total number of households to 347,978, and I capture 64 percent of total unsecured credit held by households defined by the minimum conditions only. The final criterion ensures that I can study the persistence of co-holding by focusing on households that stay together during the full sample period. In later analysis, I will describe how stable households differ from unstable households. After the household stability condition, the total number of households in my baseline sample is 291,718 and I capture 52 percent of total unsecured credit.

2.4   Sample descriptives

Figure 1 presents an overview of co-holding during the sample period. Average co-holding among all households is about 500 EUR. Among puzzle households, co-holding averages around 2,000 EUR. The share of households who co-hold any amount is roughly 40 percent during the sample period, and on average 17.2 percent of households satisfy the puzzle criteria. Table 1 presents further descriptive statistics on the key co-holding variables both for the full sample and the subset of observations that satisfy the puzzle criteria.

Table 2 provides more information on how co-holding households compare to other households. The table classifies households as borrowers, co-holders, savers, or in a 'neutral' category according to their January 2015 characteristics, similarly to Gathergood and Weber

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[3]The conditions on regular card purchases are that monthly card purchases average at least 100 EUR in each year, and that the individual makes card purchases in at least eight months in each year.

(2014) and Gorbachev and Luengo-Prado (2018). 'Borrower' households have less than 1,500 EUR of deposits and more than 500 EUR of unsecured debt. 'Co-holder' households have more than 1,500 EUR of deposits and more than 500 EUR of unsecured debt. 'Saver' households have more than 1,500 EUR of deposits and less than 500 EUR of unsecured debt. 'Neutral' households have less than 1,500 EUR of deposits and less than 500 EUR of unsecured debt.

Co-holding households are relatively large, with above average disposable income and expenditure levels. Co-holding households are also relatively likely to have a mortgage. Unsurprisingly, co-holding households are considerably better off than borrowers but have fewer assets than savers. Relative to savers, co-holding households tend to be also younger. My findings on the relative characteristics of co-holders are in line with, for instance, Gathergood and Weber (2014).

Although co-holders have distinctive features relative to other households, co-holding is not restricted to a particular subgroup. Table 3 documents that co-holding occurs in all age and income quintiles, even if co-holding is most common among middle-aged households with relatively high income[4]. The positive relationship with income is to a certain effect driven by the puzzle criteria where I only consider co-holding above a certain buffer of liquid assets. Therefore, households with modest deposits, correlated with low income, are too 'poor' to satisfy the co-holding threshold of at least 1,500 EUR in deposits. To account for this, in later analysis I will separately measure co-holding relative to income.

Finally, Table A.2 compares my baseline sample of *stable* households with unchanged two oldest adults over 2014–2017 to *unstable* households present in the data in January 2015 that either form after the beginning of the sample in January 2014 or dissolve before the end of the sample in December 2017, but otherwise fulfill the same sample criteria. Single households are stable if they remain single throughout the sample period. I find that unstable households tend to be younger, they tend to co-hold more, and a somewhat larger share of unstable households satisfy the puzzle criteria. Hence, my focus on stable households

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[4]My income measure (monthly disposable income) is derived from administrative tax percentile data. I can observe each individual's percentile rank in the 2015 income distribution. I derive monthly disposable income by combining tax percentile data with public data on the income distribution and tax rates. The income measure excludes income from assets.

somewhat underestimates overall co-holding.

3 Persistence and costs of co-holding

This section contributes to the literature on the credit card debt puzzle by studying for the first time the persistence of co-holding at the monthly level. Studying the persistence of co-holding informs researchers about how reliably a cross-section indentifies co-holding households. Persistence of co-holding also impacts the cost of co-holding.

3.1 How persistent is co-holding?

Existing evidence on the persistence of co-holding is scant. Gorbachev and Luengo-Prado (2018) present transition probabilities between waves 2004, 2008 and 2012 of the National Longitudinal Survey of Youth (NLSY). According to their 'strict' puzzle criteria around 40 percent of co-holding households continue to co-hold in two subsequent waves. In addition to Gorbachev and Luengo-Prado (2018), the SCF includes a survey question on whether households typically pay off their credit card balance. The high share of respondents that typically do not pay off their balance has been used as evidence that co-holding tends to be persistent. Yet, this conclusion does not necessarily follow from the survey answers, because even households who do not regularly pay off their balance may cease to co-hold if they reduce liquid assets. In ongoing work, Gathergood and Olafsson (2020) study persistence of co-holding on accounts with an overdraft option with daily data, and find that most co-holding spells last less than one month.

I first study whether a cross-section gives an accurate picture of households who tend to co-hold. Table 2 shows that information on co-holding in January 2015 neatly identifies households who tend to co-hold for a significant amount of time in 2015. A household who co-holds in January 2015 co-holds on average in about nine months during 2015. By contrast, households classified as 'savers', 'borrowers' or 'neutrals' satisfy the puzzle criteria on average in less than two months in 2015. Therefore, the cross-section provides a fairly accurate picture of which households tend to co-hold significant amounts.

Although the cross-section neatly distinguishes co-holding between the groups overall,

many households identified as co-holders in the cross-section do not co-hold consistently over the rest of the year. Figure 2 panel A depicts the survival share of households that satisfy the puzzle conditions in a given baseline month in the subsequent months. To measure an average survival share, panel B plots the results for all households satisfying puzzle conditions at some point during January 2014 to December 2016. The survival share here includes households who do not meet the puzzle criteria in one month but do so again later. The average survival share is 75 percent after 3 months, 70 percent after 6 months and 66 percent after 12 months.

A different way to measure persistence is to calculate the distribution of co-holding months over the next year conditional on satisfying the puzzle criteria in a given month (Figure 3). The mean number of co-holding months is 8.8 and the median 10. About 42 percent of households that co-hold in the baseline month have over 500 EUR of unsecured debt and 1,500 EUR of deposits in all months within the subsequent year. By contrast, about 27 percent of households that co-hold in the baseline month co-hold for six months or less within the next 12 months.

The persistence results so far have used a binary measure of co-holding with the somewhat arbitrary criteria of at least 500 EUR of unsecured debt and 1,500 EUR of deposits. Therefore, I study separately the persistence of co-holding at the intensive margin. First, Table 2 shows that for households defined as co-holders in January 2015 the mean amount of co-holding is 2,128 EUR in January 2015 versus 1,792 EUR (or 84 percent of the baseline amount) over the rest of 2015.

Figure 4 provides a fuller picture of the persistence of co-holding at the intensive margin. The figure plots the average persistence of co-holding using a continuous EUR measure of co-holding for all households that satisfy the puzzle criteria at any point during January 2014 to December 2016. In addition, the figure also depicts the differential persistence by initial level of co-holding (initial co-holding below or above the median). Overall, co-holding appears more persistent with the continuous measure than with the binary measure. One reason is that continuous measure of co-holding does not account for the liquidity buffer inherent in the binary classification. Unlike the continuous measure of co-holding, the binary measure considers that co-holding 'stops' once not only co-holding dips below a threshold (500 EUR),

but also if deposits dip below a threshold (1,500 EUR). Finally, Figure 4 shows that larger initial amounts of co-holding tend to decline faster over time than smaller initial balances.

My results on the persistence of co-holding with monthly data contrast with Gathergood and Olafsson (2020) who study overdraft use with daily data. Compared to their finding that most co-holding spells last for less than one month, co-holding in my data appears more persistent, because among households that satisfy the puzzle criteria in the baseline month 85 percent do so again in the following month. In addition to differences in credit card and overdraft use, differences in our results can partly reflect time aggregation. Because I observe the interest-accruing debt in the last day of the month, I cannot observe whether the 85 percent that continue to co-hold month-on-month pay off their interest-accruing debt at some point during the month only to accrue debt again before the end of the month[5].

3.2   Effect of persistence on costs of co-holding

This section calculates how persistence affects the estimated costs of co-holding. The costs of co-holding are the foregone savings in interest costs from not using liquid assets to pay down unsecured debt. The interest rate on unsecured debt differs somewhat by credit product, but overall unsecured interest rates are homogeneous across households in Finland. For instance, in January 2015 the 10th percentile of unsecured interest rates is 6.9, whereas for a household in the 90th percentile the interest rate is 7.1 percent. In addition to the nominal interest rate spread betwen unsecured debt and deposits, I include avoidable invoicing fees in the cost of co-holding. I assume that a household can avoid invoicing fees if the household has enough deposits to pay off all unsecured debt.

$$\text{costs} = \min(\text{deposits}, \text{unsecuredDebt}) * (r_{\text{unsecuredDebt}} - r_{\text{deposits}}) + \theta \tag{1}$$

, where θ refers to the avoidable invoicing fees.

I estimate the yearly cost associated with each puzzle observation from January 2014 to

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[5]Another source of differences between our results are the baseline criteria for co-holding (my paper: unsecured debt over 500 EUR and deposits over 1,500 EUR; versus co-holding of at minimum three consumption-day equivalent in Gathergood and Olafsson (2020)). In addition, Gathergood and Olafsson (2020) focus on individual rather than household co-holding; in later analysis I will show that individual persistence is lower also in my data, although still seems larger than in Gathergood and Olafsson (2020).

January 2017 in two ways: (i) by extrapolating the monthly cost of each puzzle observation to the yearly equivalent; (ii) by measuring the actual amount of co-holding within 12 months of each puzzle observation. The extrapolation method assumes no change in behavior within 12 months of the baseline month. The second method allows for households to either increase or decrease co-holding relative to the baseline month. The second method also accounts for the possibility that households switch funds between deposit accounts or unsecured credit accounts with different interest rates – conditional on the amount of co-holding – although this only has a small effect because heterogeneity in interest rates across products is low. Finally, I fix both deposit and unsecured credit interest rates at the product specific interest rate in December 2015 (sample midpoint), so that changes in interest rates over time do not create a discrepancy between extrapolated and actual costs. Fixing interest rates has little effect, though, because of the stability of interest rates from 2014 to 2017. For instance, the mean interest rate on unsecured credit products is 7.21 percent at the start of the sample, 7.07 percent at sample midpoint, and 7.3 percent at the end of the sample.

Overall, the costs of co-holding are relatively low (Table 4). The median yearly cost is 154 EUR based on the extrapolation method, and the median actual cost within 12 months of the puzzle observation is 135 EUR. At the 90th percentile these costs are 313 EUR (extrapolated) and 285 EUR (actual). Although avoidable yearly costs are fairly low, the total costs of unsecured debt can cumulate significantly over time (Gorbachev and Luengo-Prado, 2018).

Two caveats pertain to the level of costs. First, I do not observe assets or liabilities at other banks. Although the sample restrictions aim to identify households who have the bank for which I have data as their main bank, my results are still a lower bound for the total costs. Second, account fees can form a substantial fraction of the true costs of unsecured debt, especially for fairly small balances. However, I do not assume that co-holding households would close their unsecured credit accounts to avoid these costs. Therefore, I do not calculate the avoidable costs based on the total annual percentage rate (APR) of unsecured debt, and instead only consider avoidable invoicing fees and the nominal interest rate wedge.

Although my estimate for the level of avoidable costs is a lower bound, the relative difference between extrapolated or actual avoidable costs is likely to be less affected by

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unobserved information[6]. The extrapolation method overestimates the costs of co-holding for roughly 70 percent of puzzle observations[7], although the overestimation is relatively small because actual costs correspond on average to about 90 percent of extrapolated costs. Yet, the spread in the ratio of actual to extrapolated costs across puzzle observations is significant (42 percent in the 10th percentile versus 127 percent in the 90th percentile). Therefore, extrapolating costs of co-holding gives an inaccurate picture of the actual costs for many households, because some households increase and others decrease co-holding relative to the baseline month.

4 Liquidity-based hypotheses for coholding

Prior literature has emphasised how the differential liquidity of deposits versus unused credit can explain co-holding. In particular, if credit cards cannot pay for certain expenses, for instance rent, some degree of co-holding is necessary and reflects a *liquidity premium* (Telyukova, 2013; Zinman, 2007). A second liquidity-based candidate for co-holding is the *precautionary borrowing hypothesis* (Druedahl and Jørgensen, 2018; Fulford, 2015; Gorbachev and Luengo-Prado, 2018). This hypothesis explains co-holding as a response to negative credit limit risk. Precautionary borrowing can make sense, because in bad times banks can cut credit limits but banks cannot demand immediate repayment of existing debt.

This section argues that liquidity-based hypotheses are insufficient to explain co-holding. First, even households with high liquidity co-hold, which poses a challenge to the liquidity premium hypothesis. Secondly, negative credit limit risk in Finland is low, which limits the explanatory potential of the precautionary borrowing hypothesis in my context. Finally, both liquidity-based hypotheses would predict strong demand for lower-cost additional liquidity among co-holders. I use a natural experiment that provided a subset of co-holders access to new liquidity at a considerably lower interest rate than the unsecured debt rate. Yet, only

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[6]Relative costs are not sensitive to unobserved information if unobserved unsecured debt and liquid assets are proportional to the activity at the bank for which I have data.

[7]Conversely, the extrapolation method underestimates the costs of co-holding for about 30 percent of puzzle observations, because some households increase co-holding relative to the baseline month. In addition, the extrapolation method underestimates the costs for households who are not classified as co-holders in the baseline month but co-hold during the rest of the year. Yet, Table 2 showed that on average households not classified as co-holders do not co-hold much over the rest of the year.

about 30 percent of co-holders take up the option of new low-cost liquidity, and I find no evidence that access to low-cost liquidity decreases co-holding.

4.1 Liquidity distribution among co-holders

Table 5 presents the distribution of liquid assets associated with co-holding in January 2015. The median co-holding household has over 4,500 EUR of deposits at the end of the month. Because households with higher income need more liquidity, Table 5 also tabulates the distribution of the deposits-to-income ratio associated with co-holding. Almost 40 percent of co-holding households have deposits worth more than twice the monthly disposable income. Although the liquidity premium hypothesis may explain why households with few deposits co-hold, co-holding among households with considerably liquidity is a challenge for the liquidity premium hypothesis. My results are in line with earlier findings on the often high liquidity among co-holders (see, for instance, Gross and Souleles, 2002). In the portfolio choice model of Telyukova (2013), the liquidity premium channel explains well liquidity balances of the median co-holder. By constrast, model-predicted mean liquidity is lower than in the data, because the model struggles to match the upper tail of liquidity holdings among co-holders.

4.2 Negative credit limit risk in Finland

This section calculates two types of negative credit risk in my data to gauge whether the precautionary borrowing hypothesis could explain co-holding for households in my sample. The first type of negative credit risk is that the bank decreases the credit limit. Table 6 documents the risk of a credit limit decrease during 2014–2017. The results show that on average only 0.4 percent of credit accounts open in January of a given year observe a decrease in the credit limit during the year. What is more, some limit decreases were probably voluntary, although I cannot distinguish in my data whether the bank or the customer iniatiates the credit limit decrease. Even if all limit decreases are involuntary, though, the risk of a limit decrease is low compared to the 12 percent of credit accounts that experience a decrease in the US *per quarter* (Fulford, 2015)[8].

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[8]Fulford (2015) reports that "In any given quarter, two thirds of accounts had no change in credit limit. . . . 20 percent of accounts in any given quarter had an increase in limit, while 12 percent had a decrease.".

The second type of negative credit risk is that the bank closes the credit account. Table 6 documents the probability of account closure over 2014–2017 and distinguishes between closures initiated by the customer and the bank. The yearly risk of a bank closure of the credit line is only 0.3 percent; again only a fraction of the 5.4 percent reported by Fulford (2015) in the US[9]. Yet, co-holding occurs also in Finland in an environment with low negative credit risk.

4.3 Low-cost liquidity offer as test of liquidity-based hypotheses

This section provides further evidence that liquidity-based hypotheses are insufficient to explain co-holding, because few co-holders take up an option of additional low-cost liquidity.

The liquidity-based theories suggest that the benefits of liquid assets outweigh the interest costs of unsecured debt for co-holders. Because co-holders are willing to pay the unsecured interest rate to maintain liquidity, they should value additional liquidity at a lower interest, either to further increase liquidity or decrease the interest costs of their liquidity.

I use a natural experiment to test demand for additional low-cost liquidity. In February 2015, the bank made a surprise offer to all of its mortgage holders. mortgage holders received a free option to reduce the minimum mortgage principal payment to zero for up to 12 months without fees or conditions. For instance, a household paying 500 EUR/month in principal could obtain an additional 6 000 EUR of liquidity by taking up this offer. If the household took up the offer, the mortgage maturity would be extended by 12 months. Hence, the mortgage flexibility offer provided co-holders with a mortgage a long-term source of liquidity.

The terms of the mortgage payment flexibility offer should have been enticing to co-holders. Among co-holders eligible for the offer, the median nominal interest rate on unsecured debt was 7 percent, versus 1.3 percent on the mortgage. Mortgage and unsecured debt have similar interest rate risk because both unsecured debts and mortgages in Finland are almost always adjustable-rate loans[10]. Therefore, a lower interest rate risk does not compensate the higher

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[9]Fulford (2015) reports that "In the Consumer Finance Monthly (. . .) 5.4 percent (of consumers) report their bank closed an account (during the previous year).".

[10]Total interest rate on mortgages and unsecured debt is the interest rate margin + a Euribor reference rate. If anything, mortgage interest rate risk is probably somewhat lower because unsecured debt rates are typically tied to the more volatile 3-month Euribor rate, whereas mortgages are often tied to 6 or 12-month Euribor rates.

interest rate margin on unsecured debt. The bank, one of the largest in the country with an established reputation, also informed the mortgage holders that applying for the mortgage payment flexibility offer would not have any future repercussions, for instance, in terms of availability or cost of credit.

I calculate the per period potential savings from using the mortgage flexibility offer to reduce unsecured credit for households that co-hold in January 2015 (unsecured debt above 500 EUR and deposits above 1,500 EUR) as:

$$\text{savings} = \min(\text{flexLiquidity}, \text{unsecuredDebt}) * (r_{\text{unsecuredDebt}} - r_{\text{mortgage}}) + \theta \qquad (2)$$

, where flexLiquidity refers to the amount of liquidity that a household can gain from applying for mortgage flexibility and θ refers to the avoidable invoicing fees on unsecured credit if the additional liquidity is sufficient to pay off unsecured credit.

Table 7 provides two measures of potential savings for January 2015 co-holders with a mortgage (N = 35,096)[11]. The first measure is the yearly savings from lower interest rate costs and avoidable invoicing fees on unsecured credit if the household reduces unsecured credit with liquidity from mortgage flexibility. The second measure is the net present value of cumulative savings during the lifetime of the mortgage where I multiply the yearly savings by mortgage maturity and use a 3 percent annual discount rate. The cumulative savings measure assumes that the decrease in unsecured credit persists until the end of the mortgage. I base both measures of potential savings on the average amount of unsecured credit from February 2014 to January 2015, because as we saw earlier, information from a single month does not necessarily represent typical behavior.[12] The median yearly savings equal 155 EUR, and median cumulative savings equal 1,452 EUR. The potential yearly savings are fairly close to the yearly costs of co-holding (Table 4).

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[11]I calculate benefits for households that co-hold in January 2015 for whom I observe information on scheduled principal payments (and hence the amount of liquidity available from mortgage flexibility), with a mortgage maturity of at least 12 months, and a mortgage interest rate lower than the unsecured credit rate.

[12]I measure average unsecured credit before the offer because unsecured credit after the offer can be endogenous to the decision to apply for flexibility.

4.3.1 Demand for low-cost liquidity by co-holders

Table 8 presents the take-up rate of the mortgage flexibility offer by households that co-hold in January 2015. Overall, the take-up rate is 29 percent. Predictably, take up increases with potential yearly savings but is only 39 percent even in the top quartile. I do not find a connection between take up and the total months a household co-holds in 2015. Therefore, the low take up is not a result of most households stopping co-holding quickly and having no need for additional liquidity.

The low take up of the offer providing low-cost liquidity to co-holders seems at odds with the liquidity preference and precautionary borrowing hypotheses. Both theories argue that households value liquidity sufficiently to borrow at the unsecured debt interest rate. Therefore, co-holders should value additional low-cost liquidity, if only to repay high-cost debt whilst keeping equal or greater total liquidity[13].

A potential caveat to the low take up would be that households were inattentive to the offer. Yet, the mortgage flexibility offer was salient and the bank marketed it widely. The offer was the headline national news on the day of the launch, and media interest in the offer persisted during the five month application window. For instance, the main national newspaper, Helsingin Sanomat, had the mortgage flexibility offer as their lead article the day after the offer launch (Helsingin Sanomat, February 6th 2015 edition). The term for the mortgage flexibility offer ("lyhennysvapaa") returns 26 articles published during the application window in Helsingin Sanomat's digital archive[14]. The national broadcasting company Yle (equivalent to BBC) also covered the offer

To further address the worry that despite the major advertising campaign some households may still have been inattentive, I focus on the behavior of households that almost certainly knew about the mortgage flexibility offer. I identify eligible co-holding households in which at least one household member was an *employee* of the bank that provided the mortgage flexibility offer (N = 1,462). These households arguably knew about the offer by their emploer. Yet, only 45 percent of co-holding bank-employee households with a mortgage take up the

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[13]Low take up cannot be explained by the offer forcing "too much" liquidity on the households, because the overwhelming majority of mortgages are adjustable-rate and have no restrictions on extra principal payments.

[14]https://www.hs.fi/haku/. The search was made on the 20th of March 2019.

offer[15].

4.3.2 Dynamic effects of the low-cost liquidity offer

In addition to overall take up, the mortgage flexibility offer allows me to test if access to new liquidity affects co-holding. If liquidity needs drive co-holding, co-holding should decrease if households have sufficient liquidity. Therefore, I use an intention-to-treat framework to compare the evolution of co-holding by household eligibility for the mortgage flexibility offer.

The identification strategy is to compare co-holding households *with* a mortage at the bank (=treated) to co-holding households *without* a mortgage at the bank (=control). A caveat is that some competitor banks also made similar offers to their mortgage holders in 2015. Therefore, some households in my control group may have had a mortgage at one of the competitor banks and would have been also 'treated'. However, as detailed in the sample selection section, I focus on households that used the bank that I have data for as their main bank. Therefore, it is unlikely that a substantial portion of control households were eligible for a mortgage flexibility offer from another bank.

First, Figure 5 plots the overall co-holding rate by mortgage status before and after the mortgage flexibility offer. Because the mortgage flexibility offer was introduced in February 2015, the offer is exogenous relative to decisions made up to January 2015. Although co-holding is more common among mortgage households, the trends in both groups are similar. In particular, we do not observe a discontinuity in co-holding among households eligible for the mortgage flexibility offer after January 2015.

The unconditional comparison in Figure 5 does not account for characteristics that differ systematically between mortgage and non-mortgage households and influence co-holding. Therefore, I create a matched sample of households where I use propensity score matching to find for each household with a mortgage a non-mortgage match that is similar in terms of observable characteristics. The household characteristics that I use for matching are the number of adults and children, age of the oldest individual, deposits, unsecured debt and co-holding in the baseline month of January 2015, average card expenditure over 2014 and

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[15]Employee households are somewhat more likely to co-hold than regular customers. For instance, in January 2015 the employee household co-holding rate is 22 percent versus 17 percent among all customers.

the average monthly disposable income over 2015. The appendix contains further details on the matching procedure.

I study the relationship between eligibility for the mortgage flexibility offer and co-holding while accounting for differences in household characteristics using a a difference-in-difference regression:

$$
\begin{aligned}
\mathbb{1}_{\text{puzzle},h,m} =& \delta_h + \gamma_{\text{pre}} \mathbb{1}_{m<\text{Jan}2015} + \beta_{\text{pre}} \mathbb{1}_{m<\text{Jan}2015} * \mathbb{1}_{\text{mortgage}} + \\
& \gamma_{\text{post}} \mathbb{1}_{m>\text{Jan}2015} + \beta_{\text{post}} \mathbb{1}_{m>\text{Jan}2015} * \mathbb{1}_{\text{mortgage}} + \epsilon_{h,m}
\end{aligned}
\tag{3}
$$

, where h refers to the household, m to the month and δ_h refers to household fixed effects. The regression tests whether co-holding decreases disproportionately after the offer for households eligible for additional liquidity ($\beta_{\text{post}} < 0$). The regression also tests for equality of pre-trends ($\beta_{\text{pre}} = 0$) as a validity check of the difference-in-difference approach. The baseline month to which I compare the change in co-holding is January 2015. I estimate the regression with a panel that spans from January 2014 to December 2016.

Table 9 presents the estimation results of the effects of the mortgage flexibility offer on co-holding where I measure co-holding by a dummy variable. The first two columns present results for specifications where I use the full sample of households without matching. Columns 3–4 provide estimation results with the matched sample. No specification finds that households eligible for the mortgage flexibility offer reduced their co-holding propensity relative to non-eligible households after the offer. The results from the full sample specification with household fixed effects (column 2) create some concern about the validity of the constant pre-trends assumption because $\hat{\beta}_{\text{pre}}$ is significantly different from 0 although quantitatively small. Yet, the common pre-trends assumption holds in the matched sample specification with household fixed effects (column 4), and the results imply that households eligible for the mortgage flexibility offer do not decrease co-holding relative to non-eligible households after the offer.

Even if the mortgage flexibility offer did not affect the probability to co-hold at the extensive margin, the offer could reduce co-holding at the intensive margin. Therefore, I estimate a second difference-in-difference regression where I change the dependent variable

from a binary co-holding dummy to a continuous EUR variable. Results for this specification are presented in Table 10. Again, I find no evidence for mortgagors reducing co-holding after the offer.

In summary, (i) only a minority of eligible co-holding households take up the offer of additional low-cost liquidity, (ii) I find no evidence that co-holding decreases for eligible households after the mortgage flexibility offer. Consequently, the results of this section signal that liquidity-based hypotheses are unlikely to sufficiently explain the credit card debt puzzle. That said, my results do not imply that liquidity-based explanations could not contribute to co-holding. These mechanisms can matter particularly for households with limited liquidity and in countries with high negative credit limit risk (Druedahl and Jørgensen, 2018; Fulford, 2015; Gorbachev and Luengo-Prado, 2018).

5   Intra-household financial pooling and co-holding

The prevailing method of defining the puzzle at the household level implicitly assumes perfect pooling of household finances. This section studies whether the intra-household distribution of assets and liabilities matters. I find that co-holding is less prevalent and less persistent at the individual than at the household level within couples. The intra-household distribution of assets and liabilities also influences the take up of new low-cost liquidity. Therefore, part of co-holding can reflect imperfect intra-household financial pooling, consistent with the (multi-person) accountant-shopper model (Bertaut et al., 2009).

5.1   Co-holding among couples, linked individuals and singles

I start this section by documenting the prevalence of co-holding by couples, linked individuals within couples and singles. I measure co-holding both by the previous fixed puzzle criteria of at least 1,500 EUR of deposits and 500 EUR of unsecured credit as well as a relative metric of co-holding as a share of monthly disposable income. Figure 6 panel A provides the share of couples, linked individuals and singles that meet the fixed puzzle criteria. On average, 26 percent of couples satisfy the fixed criteria compared to 9 percent of linked individuals (and 10 percent of singles). By construction, the fixed criteria entail that the

puzzle share for couples is an upper bound for the puzzle share for linked individuals. Therefore, panel B uses a relative threshold to measure the share of couples, linked individuals and singles that co-hold at least 25 percent of monthly income (Table 11 documents results with alternative relative thresholds). The co-holding share among linked individuals is still 35 percent lower than among couples. Finally, Figure 7 calculates the ratio of total individual co-holding to household co-holding within couples. Household co-holding within a couple equals $\min(\sum_{i=1}^{2} \text{deposits}_i, \sum_{i=1}^{2} \text{unsecuredDebt}_i)$, and total co-holding by individuals within the couple equals $\sum_{i=1}^{2} \min(\text{deposits}_i, \text{unsecuredDebt}_i)$. Total individual co-holding accounts on average for 74 percent of household co-holding within couples. In summary, imperfect intra-household financial pooling can account for $\frac{1}{4}$ to $\frac{1}{3}$ of co-holding within couples.

Next, I study whether the persistence of co-holding differs between couples, linked individuals and singles. Figure 8 panel A depicts the persistence of co-holding with the fixed criteria of at least 500 EUR of unsecured credit and 1,500 EUR of deposits. Panel B depicts persistence by measuring co-holding as a share of initial co-holding for couples, linked individuals and singles that co-hold at least 25 percent of monthly income in the baseline month. Both measures show that co-holding is less persistent among individuals than among couples, which can reflect that intra-household differences in incentives sustain co-holding within couples.

The impact of intra-household distribution of assets and liabilities on co-holding has not been documented previously, because earlier studies have relied on data that aggregates assets and liabilities at the household level. In ongoing work, Gathergood and Olafsson (2020) similarly find that co-holding occurs more often among couples than individuals. Yet, contrary to my results, Gathergood and Olafsson (2020) find that co-holding among couples is less persistent than among individuals. Finally, Choi and Laschever (2018) also consider intra-household dynamics and find that the "Big Five" psychological characteristics of both members of the couple impact the probability of co-holding. In addition, they document that the income inequality and the level of agreeableness within the couple impact the likelihood of co-holding.

5.2 Intra-household pooling and take up of mortgage flexibility

In addition to the higher level and persistence of co-holding by couples than individuals, it would be interesting to observe direct evidence of uncooperative behavior within co-holding couples. I test for uncooperative behavior by studying whether the distribution of assets and liabilities impacts the household decision to take up the mortgage flexibility offer. I compare the take-up rate between households with similar amounts of total deposits and unsecured debt but varying distribution across household members. If the household pools its resources, only total assets and liabilities, but not their intra-household distribution, should influence take up of additional liquidity. Conversely, if the household does not pool its resources, the saver may prevent the take up of the mortgage flexibility offer to preclude the spender from overconsuming.

The aim is to test whether the personal financial situation of one of the partners affects disproportionately the take up of the mortgage flexibility offer. I operationalise the test as follows. For each individual mortgage holder within a couple, I derive information on both individual characteristics of the mortgage holder, individual characteristics of the partner, and common household characteristics (for instance, number of children). Then I estimate a linear probability model where the dependent variable takes the value 1 if the mortgage holder takes up the mortgage flexibility offer on at least one of her mortgages and 0 otherwise.

Before estimating the linear probability model, I need to define the primary and secondary partner in the household, which depend on the type of mortgage(s) the household has. With individual mortgages, it is straightforward to regress offer take up on individual financial variables of both the mortgage holder (primary partner) and her co-habitant (secondary partner). The definition of the primary and secondary partner is fuzzier with joint mortgages for which both are liable. I follow the bank classification, whereby the bank registers one of the individuals as the primary mortgage holder. In the case of joint mortgages, the primary mortgage holder is more likely to be male (69 percent of cases), has lower deposits (median 1086 EUR versus 1614 EUR for the partner) and more unsecured debt (median 967 EUR versus 707 EUR for the partner)[16].

The mortgage contract type affects the conditions on the take up of the flexibility offer.

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[16]These figures pertain to couples with positive deposits and unsecured debt in January 2015.

To take up the offer on a joint mortgage, both debtors need to agree to it. On the other hand, for decisions regarding individual mortgages the partners do not need to reach consensus. Therefore, my hypothesis is that the distribution of assets and liabilities would impact less the take up in households with a joint mortgage than in households with individual mortgages.

The main regression specification is:

$$
\begin{aligned}
1_{\text{liquidity},p,h} = & \beta_1 \text{unsecuredDebtShare}_{p,h} + \beta_2 \text{depositShare}_{p,h} + \\
& \sum_{b=1}^{10} \gamma_b 1_{\text{deposits}_h \in \text{depositBin}_b} + \sum_{b=1}^{10} \theta_b 1_{\text{unsecuredDebt}_h \in \text{unsecuredDebtBin}_b} + \\
& \Omega \mathbb{X}_h + \epsilon_{p,h}
\end{aligned} \tag{4}
$$

The subscript p refers to a given partner with a mortgage in household h. The key explanatory variables are *depositShare* and *unsecuredDebtShare*, which measure the share of total household deposits and unsecured debt held by the (primary) mortgage holder. Under financial pooling, the distribution of assets and liabilities does not affect the take up of the mortgage flexibility offer, and hence $\beta_1 = \beta_2 = 0$. On the other hand, if the (primary) mortgage holder has more weight in the household decision, then $\beta_1 > 0$ and $\beta_2 < 0$. That is, under imperfect financial pooling, the take-up rate is higher if the primary mortgage holder accounts for a larger share of total household unsecured debt or has a smaller share of total household deposits. All regressions control for total household deposits and unsecured debt by including dummies for deciles of total household deposits and unsecured debt, as well as for other household characteristics $\mathbb{X}_h$[17]. I restrict the analysis to couples with at most a 15 year age difference not to include single parents with adult children living at home.

I reject the hypothesis of perfect intra-household financial pooling when estimating equation 4 using my baseline sample (Table 12, column 1), which includes all couples with positive deposits and unsecured debt in January 2015. Yet, quantitively the effect on take up of mortgage flexibility is moderate. For instance, if the partner accounts for all unsecured debt in the household, the take-up rate is 3.4 percentage points lower (or 12 percent in

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[17]Number of adults and children, average age of adults, municipality, mortgage value, size of principal payment, mortgage interest rate, property value, disposable income level, card expenditure.

relative terms) than if the primary mortgage holder accounts for all unsecured debt. Results are similar if I concentrate on couples that satisfied the co-holding criteria in January 2015 (column 2).

Households with individual mortgages drive the overall rejection of intra-household financial pooling. Among households with only individual mortgages, the take-up rate is 8.3 percentage points lower (or 35 percent in relative terms) if the partner accounts for all unsecured debt than if the primary mortgage holder accounts for all unsecured debt (column 4). The effect of the deposit distribution is also large. On the other hand, coefficient estimates for households with only joint mortgages (column 3) are small or statistically insignificant[18].

The differential effects of the intra-household distribution of assets and liabilities on the take up of low-cost liquidity by mortgage contract type probably reflect multiple factors. First, the consensus requirement to take up the offer on joint mortgages can promote co-operation. Second, couples can self select into joint or individual mortgages depending on the desired level of financial pooling. Therefore, I am not able to say to what extent the null result for households with joint mortgages reflects the consensus requirement versus a mutual desire for financial pooling.

6   Anchoring and co-holding

Until now, I have focused on strategic motives for co-holding such as liquidity concerns or (lack of) intra-household financial pooling. This section provides evidence consistent with anchoring, a behavioral mechanism, influencing co-holding.

The anchoring hypothesis posits that a salient cue can anchor household choice even if the cue should not have an outsized influence on to the decision (Tversky and Kahneman, 1974). With regards to the credit card debt puzzle, the salient cue is the contractual minimum payment on credit card debt. If the contractual minimum payment anchors regular debt payments at or near the contractual minimum, co-holding will arise almost mechanically as long as households use credit cards.

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[18]A small minority of households have both joint and individual mortgages. I exclude these households from models 3 and 4. Therefore, the sum of observations in models 3 and 4 is smaller than in model 1.

Various studies have shown that the prevalence of low credit card payments is consistent with anchoring (Guttman-Kenney et al., 2018; Hershfield and Roese, 2015; Keys and Wang, 2019; Navarro-Martinez et al., 2011; Stewart, 2009)[19]. The paper closest to mine, Keys and Wang (2019), estimates that 29 percent of credit card accounts in the US regularly make only minimum or near-minimum payments. The authors use a clever identification mechanism based on changes in minimum payment rules to argue that the behavior of near-minimum payers reflects anchoring instead of liquidity constraints. If the contractual minimum payment rises, households that were originally making smaller payments than the new minimum because of liquidity constraints should bunch at the new higher minimum payment. Yet, the authors show that, consistent with anchoring, a significant fraction of households round up their regular payments both above the original (lower) contractual minimum and the new (higher) contractual minimum.

Keys and Wang (2019) argue that although anchoring is the likely explanation for low payments, it is difficult to distinguish anchoring and "near-rational" rounding: "Some consumers may both be liquidity constrained and have an intrinsic preference for round numbers, either for budgeting or aesthetic purposes. If liquidity-constrained consumers round up from the minimum, then their responsiveness to changes in the minimum would be observationally similar to what we interpret as anchoring, but would have different welfare implications." The authors find anchoring a more likely explanation, though, because near-minimum payments are common across the age and income distribution that they use to proxy liquidity.

I provide additional evidence to distinguish anchoring from liquidity constraints as the driver of low credit card payments. Crucially, I can observe liquidity directly, which allows me to show that low payments often coincide with high liquidity. Finally, I bridge the literature on anchoring in credit card payments and the literature on the credit card debt puzzle by showing that anchoring individuals are more likely to co-hold.

I study anchoring among the subgroup of individuals with electronic invoicing on their visa card in 2015 for whom I observe the total credit balance, the contractual minimum payment

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[19] Although my paper considers anchoring to the minimum credit card payment, households can also follow other heuristics. Gathergood et al. (2019) show that the repayment behavior of households with multiple credit cards is consistent with balance matching.

and the actual invoice payment. Individuals with a visa card are split roughly half-half between electronic debt invoicing and mail invoicing in January 2015. For individuals with mail invoicing, I do not observe all the required information to study anchoring. I omit from the analysis the 12 percent of electronic invoicing individuals with autopay, because anchoring concerns an active choice. I consider only visa invoices that have an invoice balance larger than the contractual minimum payment, because negligible invoice balances do not allow to distinguish between minimum and other payments. I also only consider individuals with at least three electronic visa invoices during 2015 to be able to infer their regular payment type. Finally, I omit a few percentage of individuals with more than one visa card or that make payments on cards owned by other individuals because I am not able to separately allocate invoices and payments pertaining to different visa cards. I am left with 133,998 individuals with 1,258,947 visa invoices during 2015.

First, I characterize each payment relative to the contractual minimum payment and total credit balance (Table 13). The contractual minimum payment equals $\max[\tau * \text{creditLimit}, x]$, where τ measures the percentage of the total credit limit, and x is a fixed EUR amount[20]. The total credit balance refers to the total credit used (sum of interest-free and interest-accruing balance). I classify a payment as *minimum payment* if the payment equals the contractual minimum. I classify a payment as *near-minimum payment* if the payment is larger but within 50 EUR of the minimum payment. I classify a payment as *maximum payment* if the payment equals the total credit balance[21]. Minimum and near-minimum payments account for slightly below 40 percent of all observations.

After classifying each payment observation, I classify individuals according to their regular payment type in 2015 following Keys and Wang (2019). If an individual makes the minimum, near-minimum, or maximum payment in over 50 percent of invoices, I classify the individual as a *minimum, near-minimum or maximum payer*. If none of the three main payment types accounts for over 50 percent of invoices, I classify the individual as *mixed payer*.

Table 14 documents the share of different payer types. A bit less than a third of individuals

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[20]The contractual minimum payment is a share of the credit limit, and not of the monthly balance, as for instance in the data of Keys and Wang (2019).

[21]I classify a payment as *maximum payment* if the payment equals the invoice balance and the invoice balance is at most the contractual minimum payment + 50 EUR to distinguish maximum payments from "overlapping" near-minimum payments.

are classified as minimum or near-minimum payers. Similarly, roughly one third of individuals regularly pay the full invoice balance. The share of minimum and near-minimum payers is similar to Keys and Wang (2019), although my distribution tilts more toward exact minimum payers. One potential reason is that in my setting the minimum payment is a percentage of the credit limit, and not account balance. Therefore, the minimum payment in my setting is already a round number, unlike in Keys and Wang (2019), and hence individuals in my data could feel less urge to round up the minimum payment.

Next, I study if liquidity constraints explain low payments by presenting the distribution of individual deposits associated with minimum or near-minimum payments in 2015 (Table 15). Because I only observe end-of-month deposits, I present two liquidity measures: 'pre-invoice deposits-to-income' uses deposits in the last day of the month preceding the invoice month; "post-invoice deposits-to-income" uses deposits in the last day of the invoice month. Panels A and B reveal that in over a third of low payment observations, individuals have deposits greater than one month's disposable income both before and after receiving the invoice. Therefore, liquidity constraints are unlikely to sufficiently explain the propensity of low payments.

Yet, even if liquidity constraints do not solely explain low payments, low payments do not necessarily reflect anchoring. Instead, low payments can reflect the differential attention or effort required to make low versus larger payments on electronic invoices. Each electronic invoice includes an 'invoice balance', which refers to the payment due in a particular billing cycle, and acts as a default payment. An individual can pay the invoice balance by simply accepting the invoice without having to open the statement with information on the total credit balance. By contrast, to pay a different amount, the individual needs to manually change the payment. Crucially, the invoice balance corresponds, by default, to the contractual minimum payment[22]. Therefore, low payments could reflect a default option effect because of limited attention or effort.

To overcome the confounders of limited attention and effort, I study *active* near-minimum payments where the invoice balance equals the contractual minimum payment, but the

---

[22]Individuals can choose a higher default payment amount than the contractual minimum. In principle, setting a near-minimum default payment amount can reflect anchoring, but in this case payment choices do not distinguish anchoring from limited attention or effort.

individual actively makes a larger payment manually. Table 15, panel C documents that the deposit distribution is similar in the case of active near-minimum payments as in the case of minimum payments and all near-minimum payments. The propensity to actively make low credit payments despite high liquidity provides evidence consistent with anchoring in a setting where limited attention or effort are not confounders.

Finally, individuals that regularly make minimum or near-minimum payments on their credit card invoice are disproportionately likely to co-hold (Table 16). These individuals co-hold more than 25 percent of monthly disposable income in almost half of the months during 2015. Around 10 percent of individuals with low regular payments co-hold more than one month's worth of disposable income. The association between low regular payments and co-holding is not mechanical because, first, if low payments were due to low liquidity, these individuals would co-hold little if at all. Second, individuals that pay a low amount on their monthly invoice could make additional manual payments. I do not observe in my data additional manual payments, but results on co-holding reveal that manual payments do not undo the positive correlation between low invoice payments and co-holding.

In summary, individuals often make low payments on their credit card debt despite high liquidity. The observation holds in active choices by individuals where limited attention or effort are not confounders. The behavior is consistent with anchoring where the minimum payment anchors actual payments, even though the individual would have sufficient liquidity to make higher payments. Finally, the propensity to make low credit card debt payments correlates positively with co-holding.

7   Conclusions

I have studied the credit card debt puzzle of why households co-hold high-cost debt and low-yield liquid assets and do not economize on interest costs. I have used a high-frequency Finnish dataset on hundreds of thousands of households to both document new facts and test existing and new hypotheses for co-holding.

The first main finding of the paper is that a cross-section used in most of the existing literature does not give an accurate picture of the persistence of co-holding. Because of missing

the imperfect persistence, extrapolating the costs of co-holding from a cross-section only seldom matches the actual costs for any given household. The long-run costs of co-holding for the typical household with significant co-holding at a point in time are on average somewhat smaller than based on an extrapolation because significant co-holding tends to decrease over time.

Second, liquidity-based theories are insufficient to explain co-holding, although my findings do not imply that liquidity concerns could not contribute to co-holding. But, liquidity-based theories struggle to explain why households with plenty of liquidity and low negative credit limit risk co-hold; or why most co-holding households do not take advantage of additional liquidity at considerably lower interest rates than the credit card rate.

Third, the assumption of perfect intra-household pooling of assets and liabilities significantly impacts the magnitude of the puzzle. However, it is debatable why pooling of finances should be the benchmark or why the lack of pooling would be *puzzling* (see, for instance, Chiappori and Mazzocco, 2017). My paper adds to the evidence that the intra-household distribution of assets and liabilities matters.

Finally, my results suggest that the tendency to anchor credit card payments to the contractual minimum contributes to co-holding. The results are consistent with the burgeoning literature on debt-repayment behavior that suggests that households often use heuristics or focus on particularly salient information instead of solving a complex optimization problem. Further research should study how to reduce the costs of anchoring without complicating the debt repayment choice for households with limited attention.

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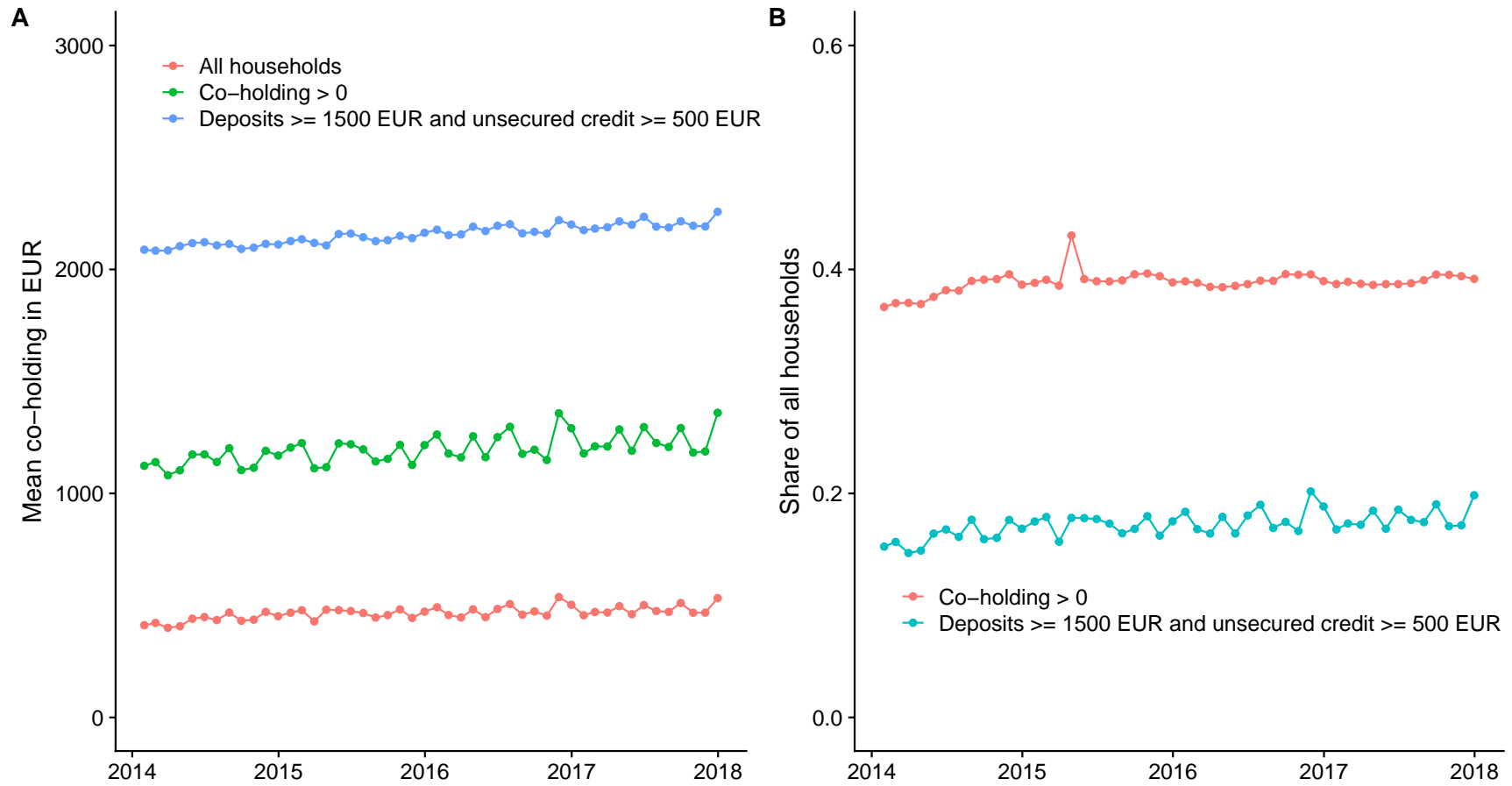
Note: Panel A presents average co–holding in EUR by different subgroups over the sample period. Panel B depicts the share of households that co–hold any amount and the share of households that satisfy the puzzle criteria (unsecured debt over 500 EUR and deposits over 1,500 EUR) over the sample period.

Figure 1: Co-holding by month 2014–2017
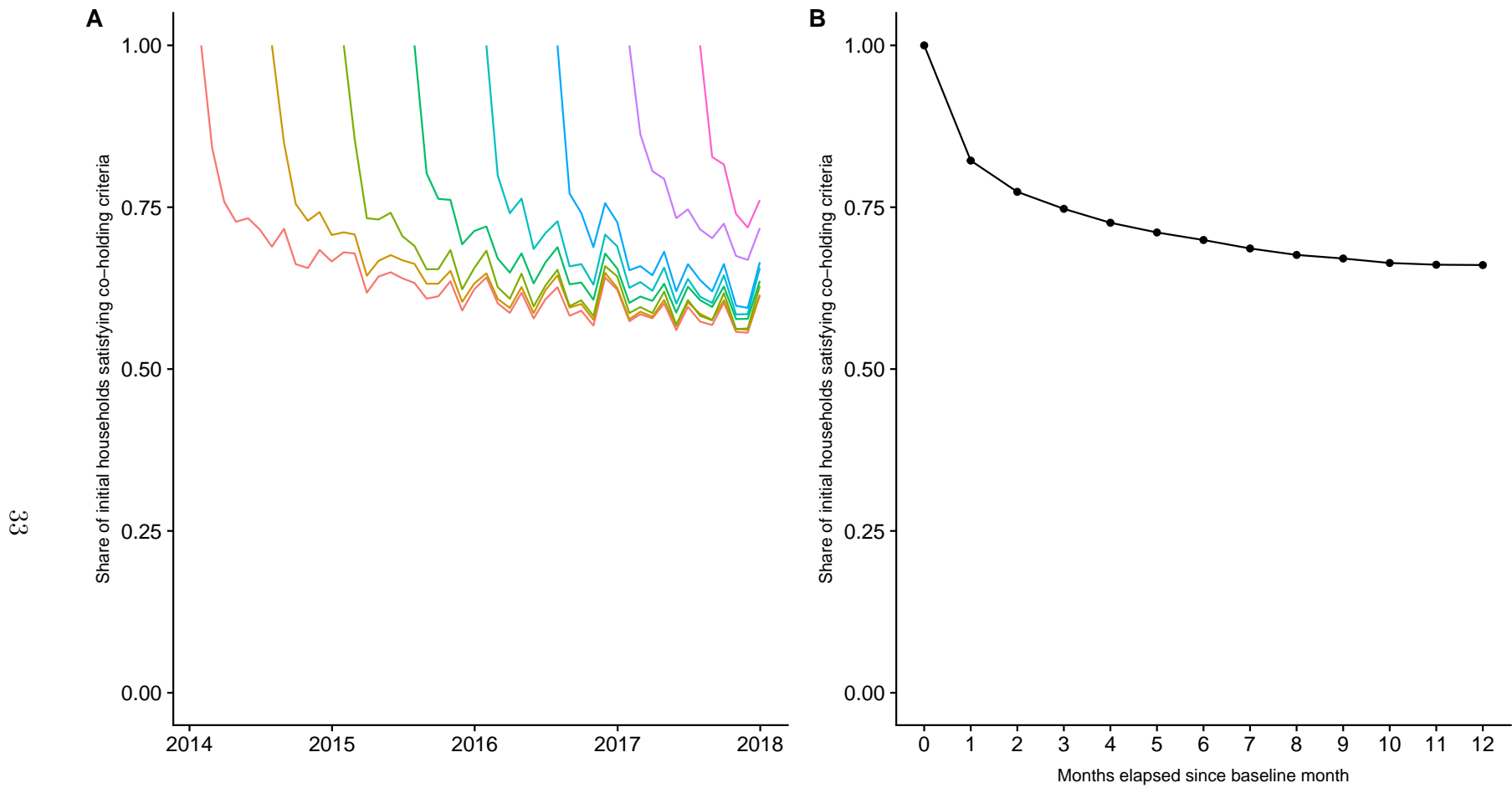
Note: Panel A presents the survival share of households that satisfy the co–holding criteria (unsecured debt over 500 EUR and deposits over 1,500 EUR) in the baseline months of January and July in 2014, 2015, 2016, and 2017. Panel B depicts the average survival share for households that satisfy the co–holding criteria at some point during January 2014 to December 2016.

Figure 2: Persistence of co-holding (binary co-holding measure)
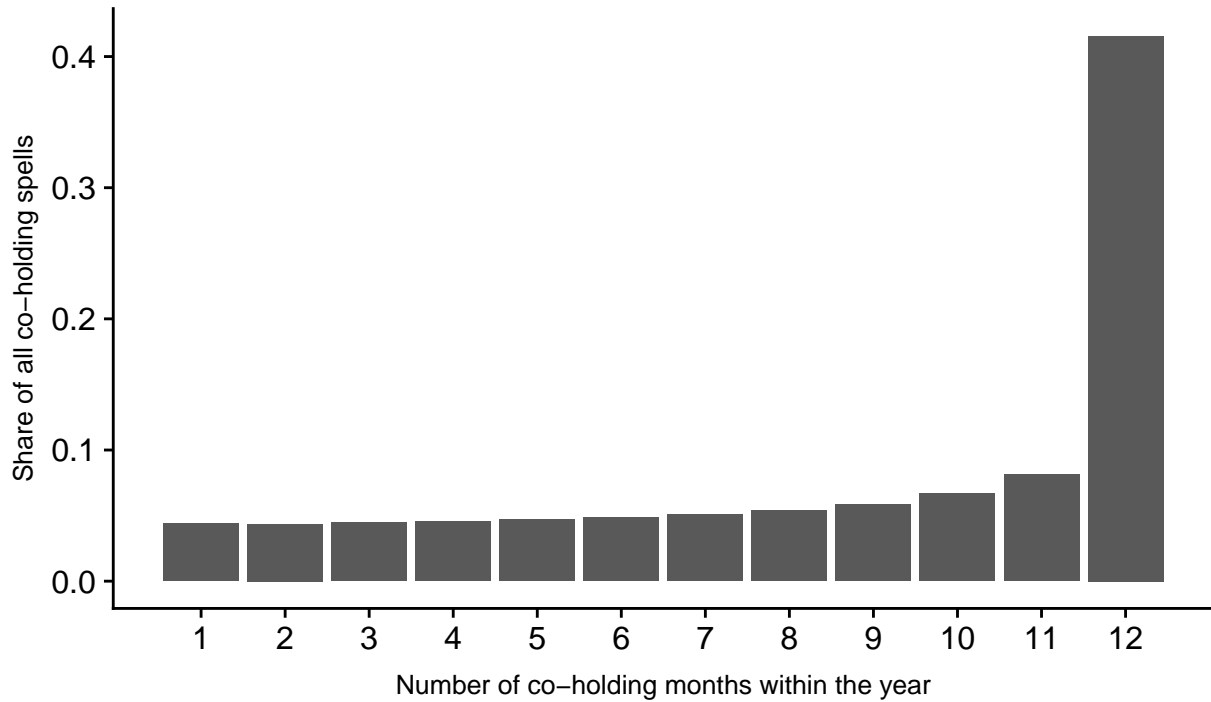
Note: The figure plots the distribution of co–holding months within the next 12 months among households who satisfy the co–holding criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) in the baseline month. Baseline months include all months from January 2014 to January 2017 because for baseline months after January 2017 the sample end point (December 2017) constrains the ability to study the persistence of co–holding.

Figure 3: Distribution of co-holding months within the year for co-holders
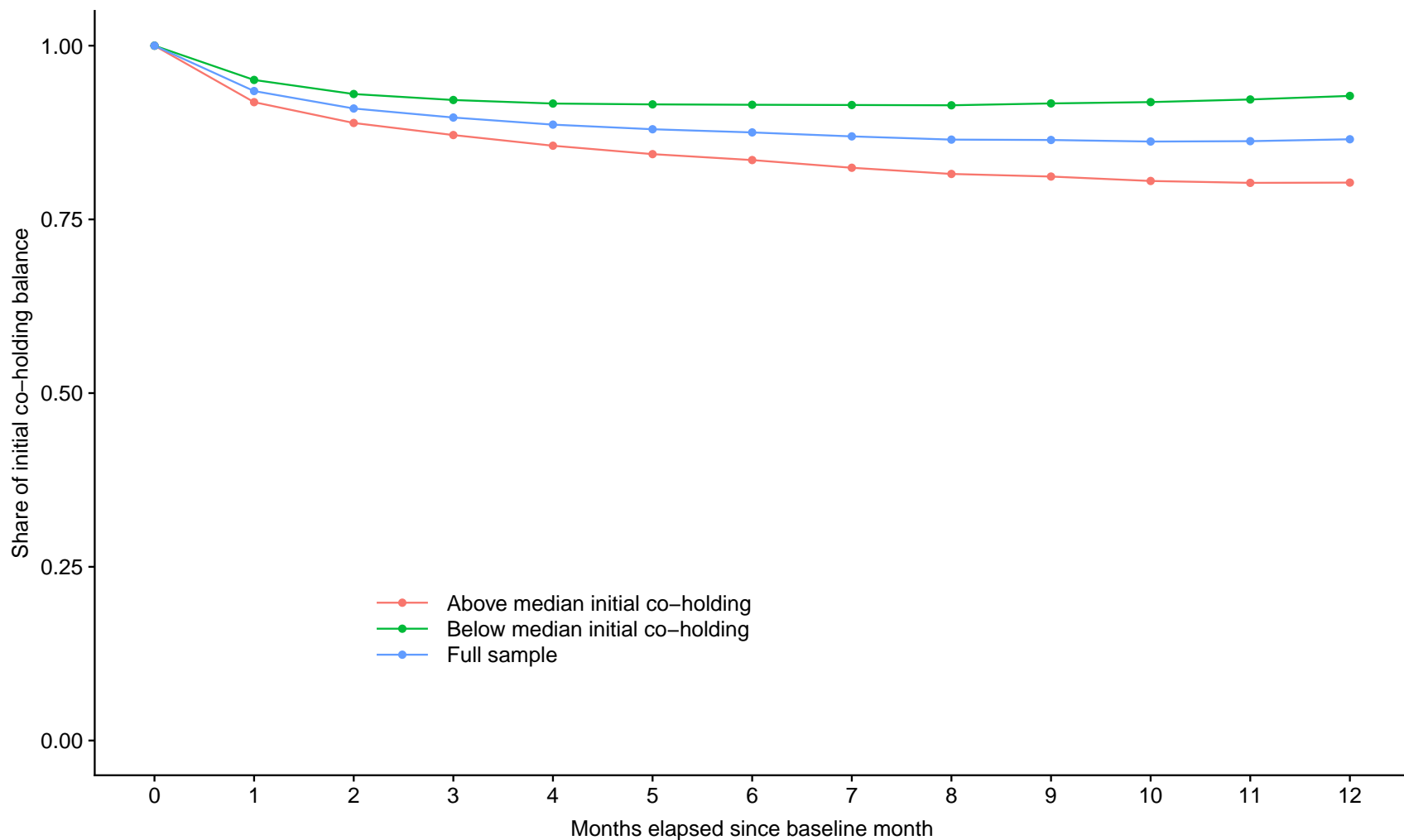
Note: The figure depicts the average persistence of co–holding for households who co–hold at some point during January 2014 to December 2016 where I measure co–holding as a continuous EUR variable. In addition to presenting the average persistence by all households who co–hold at some point in time, I present results separately depending on whether the initial level of co–holding is below or above median co–holding in the baseline month. I study persistence of co–holding among households that satisfy the puzzle criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) in the baseline month.

Figure 4: Co-holding is less persistent for larger initial co-holding balances (continuous measure of co-holding)

Note: The figure plots the share of households satisfying the co–holding criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) before and after the mortgage flexibility made by the bank in February 2015 (denoted by the dashed line) depending on whether households had a mortgage (=eligible).

Figure 5: Probability of co-holding by eligibility before and after the mortgage flexibility offer
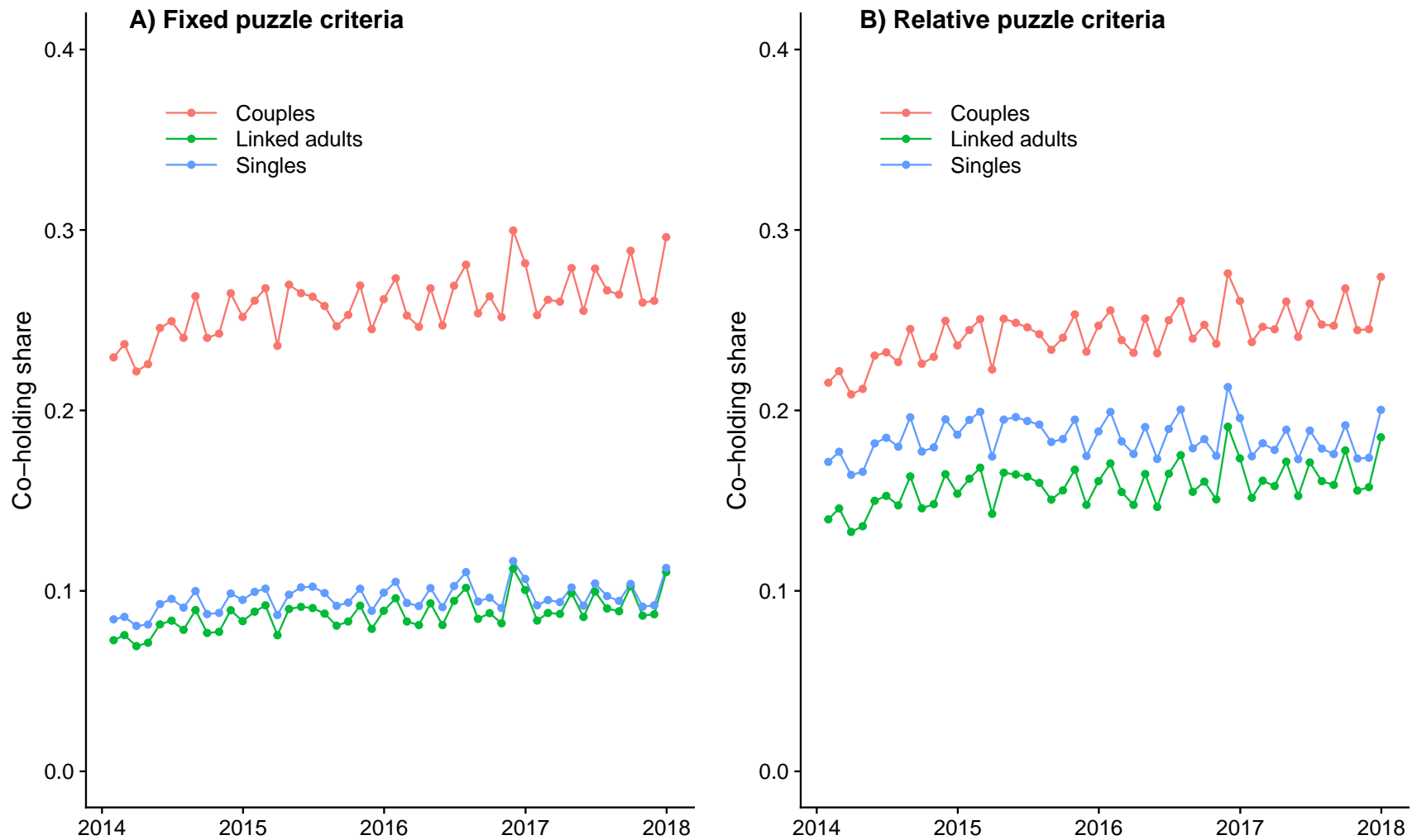
Note: Panel A depicts the share of couples, linked adults and singles that satisfy the fixed co-holding criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR). Panel B depicts the share of couples, linked adults and singles that co-hold more than 25 percent of monthly disposable income. Two linked adults form a couple.

Figure 6: Co-holding by couples, linked adults and singles
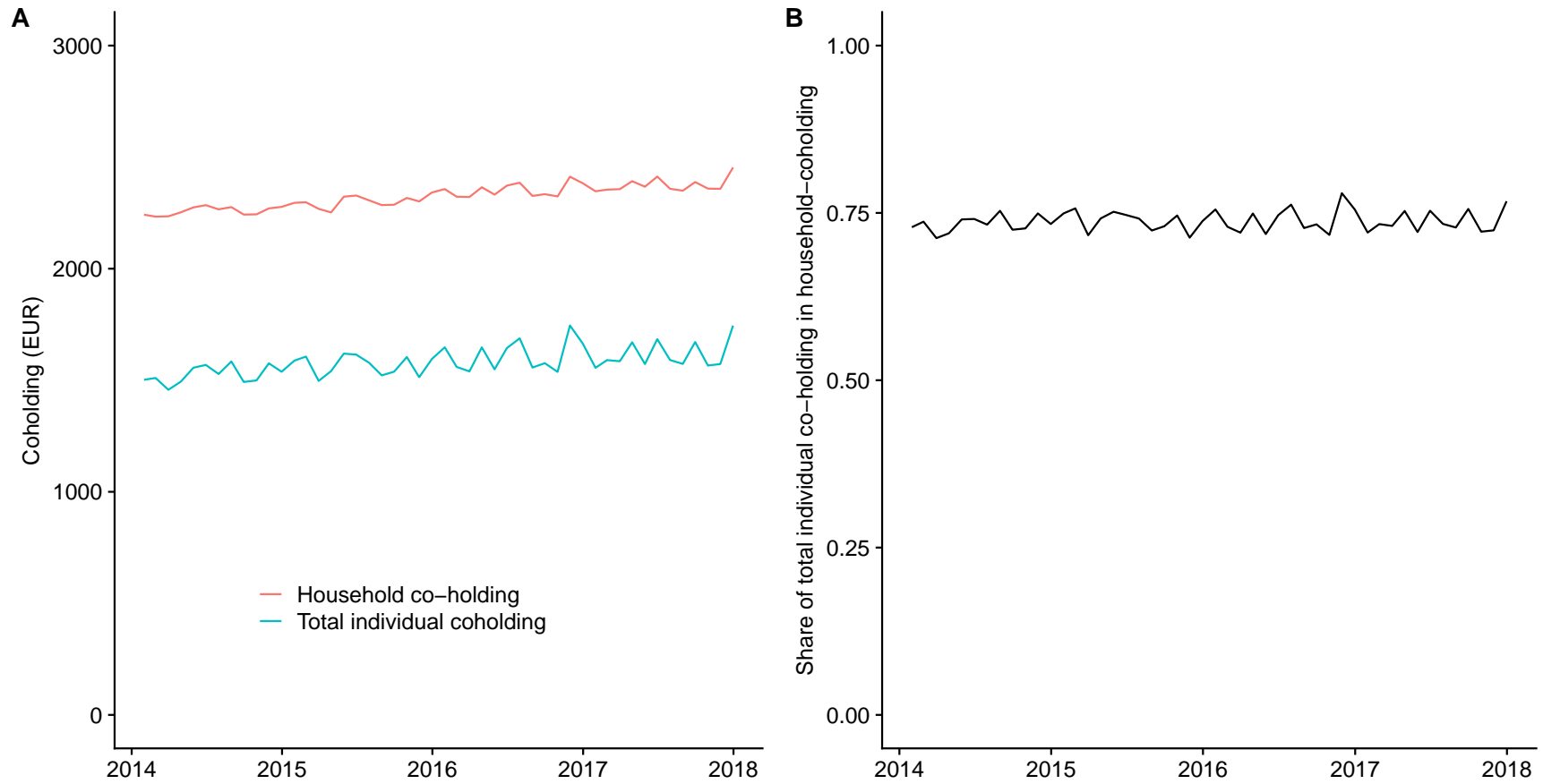
Note: Panel A presents average household co–holding and total individual co–holding within couples that satisfy the co–holding criteria (unsecured debt over 500 EUR and deposits over 1,500 EUR). Panel B depicts the share of household co–holding accounted for by total individual co–holding. Household co–holding is the minimum of total household deposits and unsecured credit. Total individual co–holding is the sum of of the minimum of individual deposits and unsecured credit across individuals.

Figure 7: Individual co-holding as share of household co-holding within couples
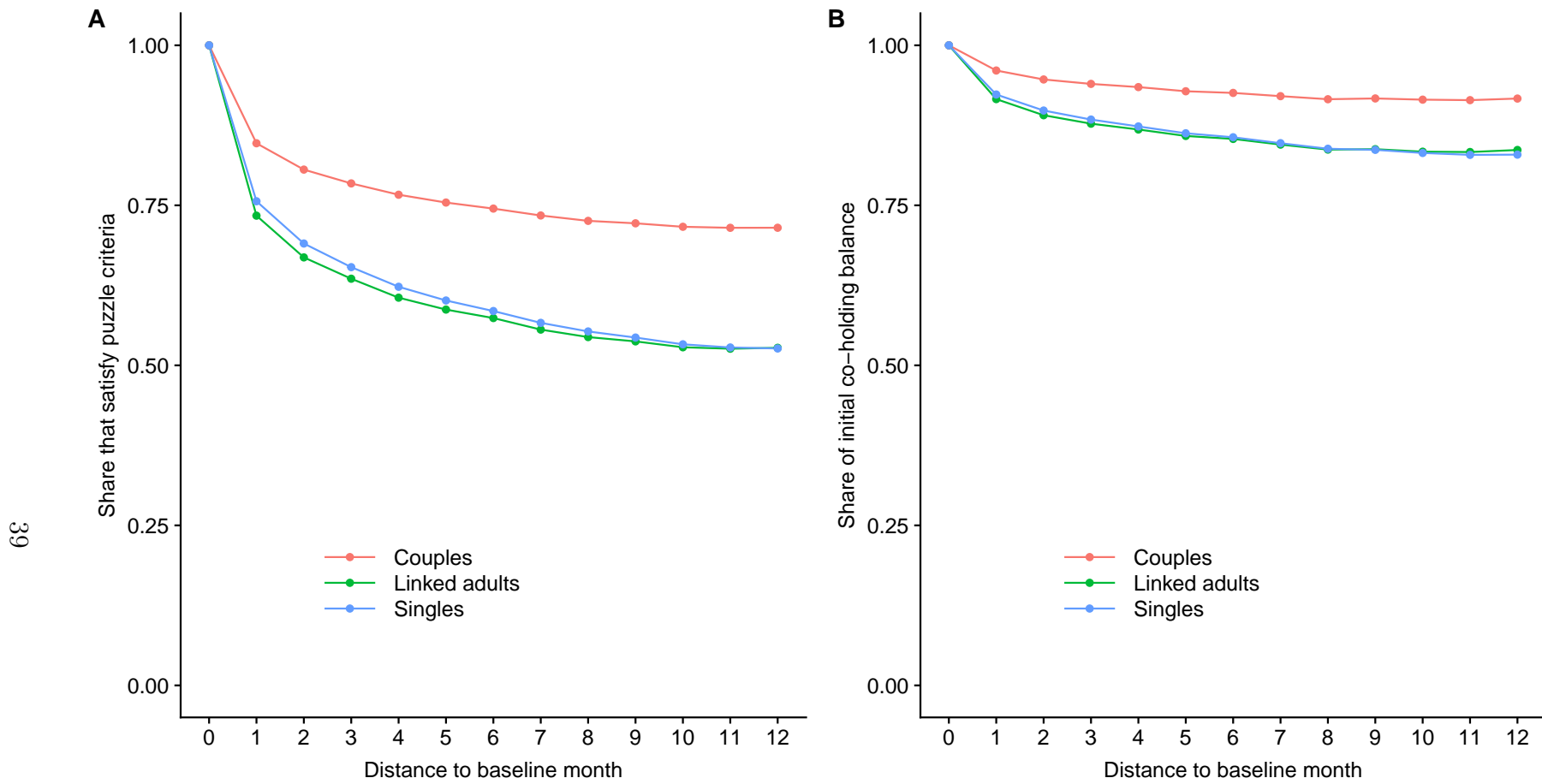
Note: Panel A depicts the share of couples, linked adults and singles that continue to satisfy the puzzle criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) conditional on satisfying the puzzle criteria in the baseline month (January 2014–December 2016). Panel B depicts the persistence of co–holding by a continous measure by calculating the share of co–holding relative to co–holding in the baseline month for couples, linked adults and singles that co–hold at least 25 percent of disposable income in the baseline month.

Figure 8: Persistence of co-holding by couples, linked adults and singles

Table 1: Distribution of key co-holding variables

	N	Mean	Q0.01	Q0.1	Q0.25	Q0.5	Q0.75	Q0.9	Q0.99
All observations									
Deposits	14,002,464	19,495	-782	373	1,680	6,558	20,967	49,242	172,561
Unsecured debt	14,002,464	997	0	0	0	0	1,124	3,482	9,223
Co-holding	14,002,464	465	0	0	0	0	460	1,592	4,941
Puzzle observations									
Deposits	2,412,093	11,028	1,532	1,848	2,520	4,555	10,509	23,862	95,441
Unsecured debt	2,412,093	2,795	519	711	1,071	1,936	3,696	6,052	11,174
Co-holding	2,412,093	2,158	519	711	1,071	1,769	2,697	4,063	7,958

[a] Co-holding equals the minimum of deposits and unsecured debt. If deposits are negative, co-holding is zero.

[b] Puzzle observations include household-month observations with over 500 EUR of unsecured debt and over 1,500 EUR of deposits.

Table 2: Household characteristics by household type

	Mean value				Median value			
	Borrower	Co-holder	Neutral	Saver	Borrower	Co-holder	Neutral	Saver
Group size	44,524	50,991	21,169	175,034	44,524	50,991	21,169	175,034
Demographics								
Adults	1.38	1.77	1.23	1.53	1.00	2.00	1.00	2.00
Children	0.47	0.73	0.32	0.40	0.00	0.00	0.00	0.00
Age of oldest adult	48.27	47.45	49.80	53.09	48.00	47.00	49.00	54.00
Co-holding								
Deposits	344	10,066	454	27,332	456	4,277	675	13,597
Interest-accruing unsecured debt	3,179	2,787	63	20	2,356	1,929	0	0
Unsecured credit limit	4,352	5,348	2,399	3,229	3,500	4,900	2,000	2,500
Co-holding (Jan 2015)	519	2,128	50	20	456	1,756	0	0
Co-holding (Feb–Dec 2015)	651	1,792	127	70	490	1,446	12	0
Co-holding months in 2015	1.62	8.73	0.33	0.45	0.00	10.00	0.00	0.00
Income/expenditure								
Disposable income	2,391	3,510	2,009	2,906	2,085	3,472	1,797	2,535
Card expenditure	1,149	1,872	1,026	1,459	974	1,790	851	1,241
Other debts and assets								
Mortgage indicator variable	0.57	0.71	0.46	0.43	1.00	1.00	0.00	0.00
Mortgage balance	49,640	78,927	34,391	39,618	18,636	57,929	0	0
Other financial assets	929	4,640	3,239	20,468	0	0	0	314
Other debt	8,053	9,679	5,182	4,107	811	1,039	0	0
Interest rates								
Unsecured debt interest rate	7.03	7.04	7.15	7.10	7.08	7.08	7.08	7.08
Deposit interest rate	0.08	0.10	0.08	0.13	0.07	0.07	0.07	0.07
Mortgage interest rate	1.43	1.34	1.42	1.31	1.34	1.25	1.34	1.23

[a] The table presents household characteristics by household type. 'Borrower' households have less than 1,500 EUR of deposits and more than 500 EUR of unsecured debt. 'Co-holder' households have more than 1,500 EUR of deposits and more than 500 EUR of unsecured debt. 'Saver' households have more than 1,500 EUR of deposits and less than 500 EUR of unsecured debt. 'Neutral' households have less than 1,500 EUR of deposits and less than 500 EUR of unsecured debt. Values refer in general to January 2015, but disposable income is a monthly average over 2015, and card expenditure is a monthly average over 2014. Interest rates are nominal rates (not APRs) and do not include non-interest credit fees.

Table 3: Co-holding share by income and age

	Disposable income quintile					
	All	Q1	Q2	Q3	Q4	Q5
Age quintile						
All	0.17	0.07	0.11	0.15	0.25	0.27
Q1	0.20	0.09	0.12	0.17	0.29	0.27
Q2	0.23	0.10	0.13	0.17	0.29	0.31
Q3	0.21	0.09	0.12	0.16	0.26	0.30
Q4	0.15	0.07	0.11	0.14	0.21	0.22
Q5	0.08	0.05	0.07	0.11	0.13	0.14

[a] The table tabulates the share of co-holders (unsecured debt above 500 EUR and disposable income above 1,500 EUR) in each age and income quantile over the full sample period.

Table 4: Cost of co-holding

	N	Mean	Q0.1	Q0.25	Q0.5	Q0.75	Q0.9
Extrapolated yearly costs	1,838,767	183	91	112	153	220	313
Actual yearly costs	1,838,767	157	57	89	135	199	284
Actual to extrapolated ratio	1,838,767	0.88	0.42	0.66	0.89	1.04	1.27

[a] The table presents two estimates of the yearly costs of co-holding for household-month obsevations satisfying the co-holding criteria (unsecured debt above 500 EUR and deposits over 1,500 EUR). Both estimates are based on the interest rate difference between liquid assets and unsecured debt and the amount of liquid assets available to reduce debt [equation 1]. The first estimate, 'Extrapolated yearly costs', assumes that yearly costs are proportional to co-holding in the baseline month (January 2014–January 2017). The second estimate, 'Actual yearly costs', uses data on actual co-holding within 12 months of each baseline month. The final row, 'Actual to extrapolated ratio', calculates the ratio of the two cost measures.

Table 5: Co-holding often associated with high liquidity

Liquidity measure	N	Q25	Q50	Q60	Q70	Q80	Q90	Q95
Deposits in EUR	2,412,093	2,519	4,554	6,094	8,607	13,153	23,861	39,116
Deposits-to-income ratio	2,412,093	0.83	1.47	1.94	2.71	4.17	7.74	12.86

[a] The table presents the distribution of liquid assets associated with co-holding observations (unsecured debt above 500 EUR and deposits above 1,500 EUR) over the full sample period. The two measures of liquidity are end of month deposits in EUR, and deposits scaled by average monthly disposable income over 2015.

Table 6: Credit limit risk in bank data

Year	Number of accounts	P(limit increase)	P(limit decrease)	P(Customer closure)	P(Bank closure)
2014	445,974	3.2	0.3	0.3	0.3
2015	454,139	3.0	0.3	2.2	0.3
2016	449,780	3.1	0.4	0.9	0.3
2017	451,319	3.2	0.6	1.0	0.3
Average		3.1	0.4	1.1	0.3

[a] The table presents the yearly risk of credit limit changes on unsecured products at the credit account level for the sample population over 2014–2017. The probability of a limit change or account closure in a given year equals the number of accounts that experience a limit change or closure during the year conditional on the account being open in January of the particular year. Values refer to percentage points.

Table 7: Potential savings from mortgage flexibility for January 2015 co-holders

	N	Mean	Q0.01	Q0.1	Q0.25	Q0.5	Q0.75	Q0.9	Q0.99
Population descriptives									
Unsecured credit	35,096	2,798	166	562	1,032	1,987	3,763	6,179	11,297
Liquidity from flexibility	35,096	8,013	1,221	3,240	4,881	7,201	10,105	13,510	23,578
Unsecured interest rate	35,096	6.51	2.35	5.21	6.46	7.04	7.04	7.04	7.94
Mortgage interest rate	35,096	1.34	0.25	0.72	0.99	1.25	1.63	2.09	2.79
Potential savings									
Yearly savings	35,096	184	15	57	95	154	244	353	586
Cumulative savings by mortgage maturity	35,096	1,840	88	361	762	1,452	2,513	3,820	6,746

[a] The table calculates the potential savings from using the mortgage flexibility offer to reduce unsecured credit for households that co-hold in January 2015 (unsecured debt above 500 EUR and deposits above 1,500 EUR). The savings accrue from the interest rate spread on mortgage and unsecured credit and from avoidable unsecured credit invoicing fees (equation 2). The net present value of cumulative savings by mortgage maturity equals yearly savings multiplied by mortgage maturity discounted by an annual discount rate of 3 percent. The amount of unsecured credit refers to the average value from February 2014 to January 2015. 'Liquidity from flexibility' equals the amount of principal payments that the household can defer by applying for mortgage flexibility. Although interest rates can change over time, I assume that the spread between the unsecured credit rate and the mortgage interest rate stays constant because both rates are tied to Euribor.

Table 8: Take up of mortgage flexibility offer by January 2015 co-holders

		Potential yearly savings quartile			
	All	Lowest quartile	Second quartile	Third quartile	Top quartile
Co-holding months in 2015					
All	0.29	0.22	0.24	0.30	0.39
1 to 3	0.29	0.23	0.25	0.33	0.46
4 to 6	0.30	0.23	0.28	0.32	0.41
7 to 9	0.31	0.23	0.27	0.32	0.42
10 to 12	0.28	0.20	0.23	0.28	0.37

[a] The table presents the take up rate of the mortgage flexibility offer by households that co-hold in January 2015 (unsecured debt above 500 EUR and deposits above 1,500 EUR). In addition to the overall take up rate, I tabulate the take up rate in bins by potential yearly savings from using liquidity from the mortgage flexibility to reduce unsecured credit (equation 2), and by the number of months that the household co-holds during 2015 (unsecured debt above 500 EUR and deposits above 1,500 EUR).

Table 9: Effect of mortgage flexibility offer on co-holding (binary dep. variable)

	Dependent variable:			
	Co-holding (0/1)			
	(1)	(2)	(3)	(4)
$\mathbb{1}_{m<\text{Jan2015}} * \mathbb{1}_{\text{mortgage}}$	0.13***	−0.01***	0.01*	0.002
	(0.001)	(0.001)	(0.003)	(0.002)
$\mathbb{1}_{m>\text{Jan2015}} * \mathbb{1}_{\text{mortgage}}$	0.14***	−0.001	0.01***	0.01**
	(0.001)	(0.001)	(0.003)	(0.003)
Sample	Full	Full	Matched	Matched
Household FEs	No	Yes	No	Yes
Co-holding share	0.17	0.17	0.23	0.23
Unique households with mortgage	147,276	147,276	147,174	147,174
Unique households without mortgage	144,442	144,442	60,473	60,473
Observations	10,501,848	10,501,848	7,475,292	7,475,292

Note: *p<0.1; **p<0.05; ***p<0.01

The table presents estimation results for different specifications of equation 3. The data is a panel from January 2014 to December 2016. The dependent variable takes the value 1 if the household co-holds in a given month (unsecured debt over 500 EUR and deposits over 1,500 EUR) and 0 otherwise. January 2015 is the baseline month because it preceed the bank's liquidity campaign for mortgage households that started in February 2015. Standard errors are clustered at the household level. The specification in column 1 does not include household fixed effects and hence the coefficients estimate the overall difference in co-holding probability by mortgage status before and after the offer. The specification in column 2 includes household fixed effects and hence the coefficients estimate the difference in the trend of co-holding by mortgage status before and after the offer. Columns 3–4 provide equivalent estimates using the matched sample where I find for each household eligible for the mortgage flexibility offer a similar-on-observables non-eligible household using propensity score matching.

Table 10: Effect of mortgage flexibility offer on co-holding (continuous dep. variable)

	Dependent variable:			
	Co − holding			
	(1)	(2)	(3)	(4)
$\mathbb{1}_{m<\text{Jan2015}} * \mathbb{1}_{\text{mortgage}}$	355.57***	−30.19***	3.61	9.39
	(3.20)	(1.92)	(10.57)	(6.07)
$\mathbb{1}_{m>\text{Jan2015}} * \mathbb{1}_{\text{mortgage}}$	394.28***	8.52***	11.28	17.06**
	(3.31)	(2.15)	(11.42)	(6.92)
Sample	Full	Full	Matched	Matched
Household FEs	No	Yes	No	Yes
Mean co-holding (EUR)	459.5	459.5	644.2	644.2
Unique households with mortgage	147,276	147,276	147,174	147,174
Unique households without mortgage	144,442	144,442	60,473	60,473
Observations	10,501,848	10,501,848	7,475,292	7,475,292

Note: *p<0.1; **p<0.05; ***p<0.01

The table presents estimation results for a variation of equation 3 where I change the dependent variable to the EUR amount of co-holding. The data is a panel from January 2014 to December 2016. January 2015 is the baseline month because it preceed the bank's liquidity campaign for mortgage households that started in February 2015. Standard errors are clustered at the household level. The specification in column 1 does not include household fixed effects and hence the coefficients estimate the overall difference in co-holding by mortgage status before and after the offer. The specification in column 2 includes household fixed effects and hence the coefficients estimate the difference in the trend of co-holding by mortgage status before and after the offer. Columns 3–4 provide equivalent estimates using the matched sample where I find for each household eligible for the mortgage flexibility offer a similar-on-observables non-eligible household using propensity score matching.

Table 11: Co-holding relative to income by couples, linked adults and singles

Co-holding to income threshold	Co-holding share			Ratio of co-holding shares	
	Linked adults	Couples	Singles	Linked adults to couples	Singles to couples
0.00	0.306	0.441	0.347	0.694	0.787
0.10	0.228	0.348	0.258	0.654	0.739
0.25	0.158	0.243	0.185	0.653	0.762
0.50	0.087	0.126	0.106	0.693	0.846
0.75	0.049	0.064	0.062	0.759	0.965
1.00	0.027	0.034	0.036	0.807	1.067

[a] The table tabulates the share of couples, linked adults and singles that co-hold more than a given share of monthly disposable income (thresholds specified in the first column). The last two columns calculate the co-holding share of linked adults and singles relative to couples.

Table 12: Take up of mortgage flexibility and the intra-household distribution of assets and liabilities

	Dependent variable:			
	Mortgage flexibility offer take up (0/1)			
	(1)	(2)	(3)	(4)
depositShare	−0.008	0.0005	0.009	−0.049***
	(0.006)	(0.008)	(0.007)	(0.012)
unsecuredDebtShare	0.034***	0.041***	0.012**	0.083***
	(0.005)	(0.006)	(0.006)	(0.009)
Sample	All co-holding couples	Puzzle	Joint mortgage	Individual mortgage
Household controls	Yes	Yes	Yes	Yes
Take-up rate	0.28	0.27	0.29	0.24
Unique individuals	50,991	31,414	37,432	11,621
Unique households	45,209	27,655	35,063	9,274
Observations	50,991	31,414	37,432	11,621

Note: *p<0.1; **p<0.05; ***p<0.01

The table presents estimation results of equation 4 with varying samples. Model (1) includes all couples with positive co-holding and a mortgage in January 2015. Model (2) includes the subset of households in Model (1) that satisfied the fixed co-holding criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) in January 2015. Model (3) includes the subset of households in Model (1) with only joint mortgage(s). Finally, Model (4) includes the subset of households in Model (1) with only individual mortgage(s). The dependent variable takes the value 1 if the primary mortgage holder takes up the mortgage flexibility offer. The unit of observation is an individual primary mortgage holder within a couple. All models control for the total amount of deposits and unsecured debt, the number of adults and children, average age of adults, municipality, mortgage value, size of principal payment, mortgage interest rate, property value, disposable income level, card expenditure.

Table 13: Descriptive statistics on electronic invoice payments in 2015

	Payment type			
	Minimum	Near minimum	Maximum	Other
Obs.	303,830	171,242	358,315	425,560
Obs. share	0.24	0.14	0.28	0.34
Mean				
Invoice balance	81	88	380	177
Payment	80	95	492	293
Contractual minimum payment	80	70	75	75
Total credit balance	1,927	1,646	492	1,471
Median				
Invoice balance	60	90	200	100
Payment	60	100	319	200
Contractual minimum payment	60	60	60	60
Total credit balance	1,705	1,388	319	1,062

[a] The table presents the distribution of electronic invoice payments for individuals with at least three visa invoices and no autopay during 2015. I classify each payment by payment type. For minimum payments the payment equals the contractual minimum. For near-minimum payments the payment is larger but within 50 EUR of the minimum. For maximum payments the payment equals the total credit balance. Other payments are the residual. 'Invoice balance' refers to the payment due in the particular billing cycle. 'Contractual minimum payment' refers to the minimum payment due given the credit limit. 'Total credit balance' refers to the total credit used (sum of interest-free and interest-accruing balance).

Table 14: Payer type distribution

Payer type	N	Share
Maximum	45,742	0.34
Minimum	27,040	0.20
Mixed	49,001	0.37
Near minimum	12,215	0.09

[a] The table tabulates the distribution of payer types based on the 2015 payment behavior of individuals with at least three electronic visa invoices. A minimum payer makes the contractual minimum payment in at least 50 percent of invoices. A near-minimum payer makes payments larger but within 50 EUR of the contractual minimum in at least 50 percent of invoices. A max payer pays the total credit balance in at least 50 percent of invoices. The residual cases are categorized as mixed payers.

Table 15: Low credit card debt payments coincide often with significant liquidity

	N	Q25	Q50	Q60	Q70	Q80	Q90	Q95
A) Minimum payments								
Pre-invoice deposits-to-income	303,830	0.16	0.54	0.79	1.15	1.86	4.19	8.18
Post-invoice deposits-to-income	303,830	0.15	0.54	0.79	1.14	1.86	4.19	8.17
B) Near-minimum payments								
Pre-invoice deposits-to-income	171,242	0.15	0.53	0.77	1.11	1.78	3.93	7.50
Post-invoice deposits-to-income	171,242	0.15	0.53	0.78	1.12	1.79	3.93	7.52
C) Near-minimum payments (active)								
Pre-invoice deposits-to-income	51,992	0.19	0.58	0.81	1.14	1.74	3.52	6.39
Post-invoice deposits-to-income	51,992	0.20	0.59	0.83	1.15	1.76	3.52	6.41

[a] The table presents the distribution of individual deposits to monthly disposable income ratios associated with minimum or near-minimum credit card debt payments in 2015 for individuals with at least three electronic visa invoices in 2015. Panel A presents the distribution of the deposit-to-income ratio associated with invoices when the payment equals the contractual minimum. Panel B presents the distribution of deposit-to-income ratio associated with invoices when the payment is larger but within 50 EUR of the contractual minimum. Panel C presents the distribution of the deposit-to-income ratio associated with invoices when the payment is larger but within 50 EUR of the contractual minimum and the invoice balance (default payment) equals the contractual minimum. "Post-invoice deposits-to-income" refer to deposits measured in the last day of the invoice month. "Pre-invoice deposits-to-income" refer to deposits measured in the last day of the month preceding the invoice month. The income measure is fixed at the average monthly disposable income over 2015.

Table 16: Individuals with low regular credit card invoice payments co-hold more

Payer type	Mean co-holding	Mean co-holding to income	P(Co-holding to income > 0.25)	P(Co-holding to income > 1)
Maximum	22	0.01	0.01	0.00
Minimum	745	0.41	0.49	0.10
Mixed	457	0.23	0.31	0.04
Near minimum	689	0.38	0.47	0.09

[a] The table presents descriptive statistics on co-holding during 2015 based on the credit card payer type of individuals with at least three electronic visa invoices during 2015. A minimum payer makes the contractual minimum payment in at least 50 percent of invoices. A near-minimum payer makes payments within 50 EUR of the contractual minimum in at least 50 percent of invoices. A max payer pays the total credit balance in at least 50 percent of invoices. The residual cases are categorized as mixed payers.

A   Appendix

A.1   Matching of households with and without mortgage

I create the matched sample of households with and without mortgage by nearest-neighbor propensity score matching with replacement. I use the following logit regression to calculate the propensity score based on information in January 2015:

$$
\begin{aligned}
\mathbb{1}_{\text{mortgage},h} = {} & \sum_{i}^{n} \alpha_i \mathbb{1}_{\text{adults}=i} + \sum_{i}^{n} \beta_i \mathbb{1}_{\text{children}=i} + \\
& \gamma \mathbb{1}_{\text{deposits}<0} + \delta \mathbb{1}_{\text{unsecuredDebt}=0} + \zeta \mathbb{1}_{\text{co-holding}>0} + \\
& \sum_{b=1}^{10} \eta_b \mathbb{1}_{\text{age}_h \in \text{ageBin}_b} + \sum_{b=1}^{10} \theta_b \mathbb{1}_{\text{unsecuredDebt}_h \in \text{unsecuredDebtBin}_b} \\
& \sum_{b=1}^{10} \iota_b \mathbb{1}_{\text{deposits}_h \in \text{depositBin}_b} + \sum_{b=1}^{10} \kappa_b \mathbb{1}_{\text{co-holding}_h \in \text{coholdingBin}_b} \\
& \sum_{b=1}^{10} \lambda_b \mathbb{1}_{\text{cardExpenditure}_h \in \text{cardExpenditureBin}_b} + \sum_{b=1}^{10} \mu_b \mathbb{1}_{\text{disposableIncome}_h \in \text{disposableIncomeBin}_b} + \\
& \epsilon_h.
\end{aligned}
\tag{5}
$$

The regression includes dummies for the number of adults and children, negative deposits, zero unsecured debt, and positive co-holding. In addition, the regression includes dummies for deciles of household age, unsecured debt, deposits, co-holding, card expenditure, and disposable income[23].

After estimating the propensity score, I find for each household with a mortgage a single match from the pool of households without a mortgage. I match exactly on the number of adults and children in the household, on the dummy for positive co-holding, and on the dummy for no unsecured debt. Within the remaining pool of potential matches, I use nearest-neighbor propensity score matching with replacement. Replacement means that a household without a mortgage can be matched to multiple households with a mortgage.

Figure A.1 and Table A.1 summarize the results of matching. Panel A of Figure A.1 shows that, before matching, the propensity score distributions of households with and without a mortgage differ substantially. The matching framework relies on overlap between the two distributions. Panel B confirms that there is overlap ex ante, because the distributions after matching are identical. Yet, matching should equate not only propensity score distributions but also other observable household characteristics. Table A.1 documents the mean of various household characteristics before and after matching in January 2015[24]. Average household

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[23]The measure for card expenditure is the average over 2014. Disposable income refers to the average over 2015.

[24]Compared to full data, the matched data drops about a 100 households with a mortgage, because of requiring an exact match on the number of adults and children in the household, on the dummy for positive co-holding, and on the dummy for no unsecured debt. Furthermore, because of matching with replacement, and given the large differences in propensity scores before matching, the unique number of households without

characteristics are in general similar after matching, except for other financial assets than deposits and debt other than unsecured debt and mortgage debt, which I did not match on. I can provide further characteristics of the covariate distribution after matching on request.

Finally, Figure A.2 plots the time-series of co-holding by eligibility for the mortgage flexibility offer with matched data (counterpart to Figure 5 with full data). Again, we do not see any indication that access to new cheap liquidity would have reduced co-holding.

## A.2 Comparison of stable and unstable households

Table A.2 compares my baseline sample of *stable* households with unchanged two oldest adults over 2014–2017 to *unstable* households present in the data in January 2015 that either form after the beginning of the sample in January 2014 or dissolve before the end of the sample in December 2017, but otherwise fulfill the same sample criteria. Single households are stable if they remain single throughout the sample period.

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a mortgage is considerably smaller than the number of households with a mortgage in the matched dataset.
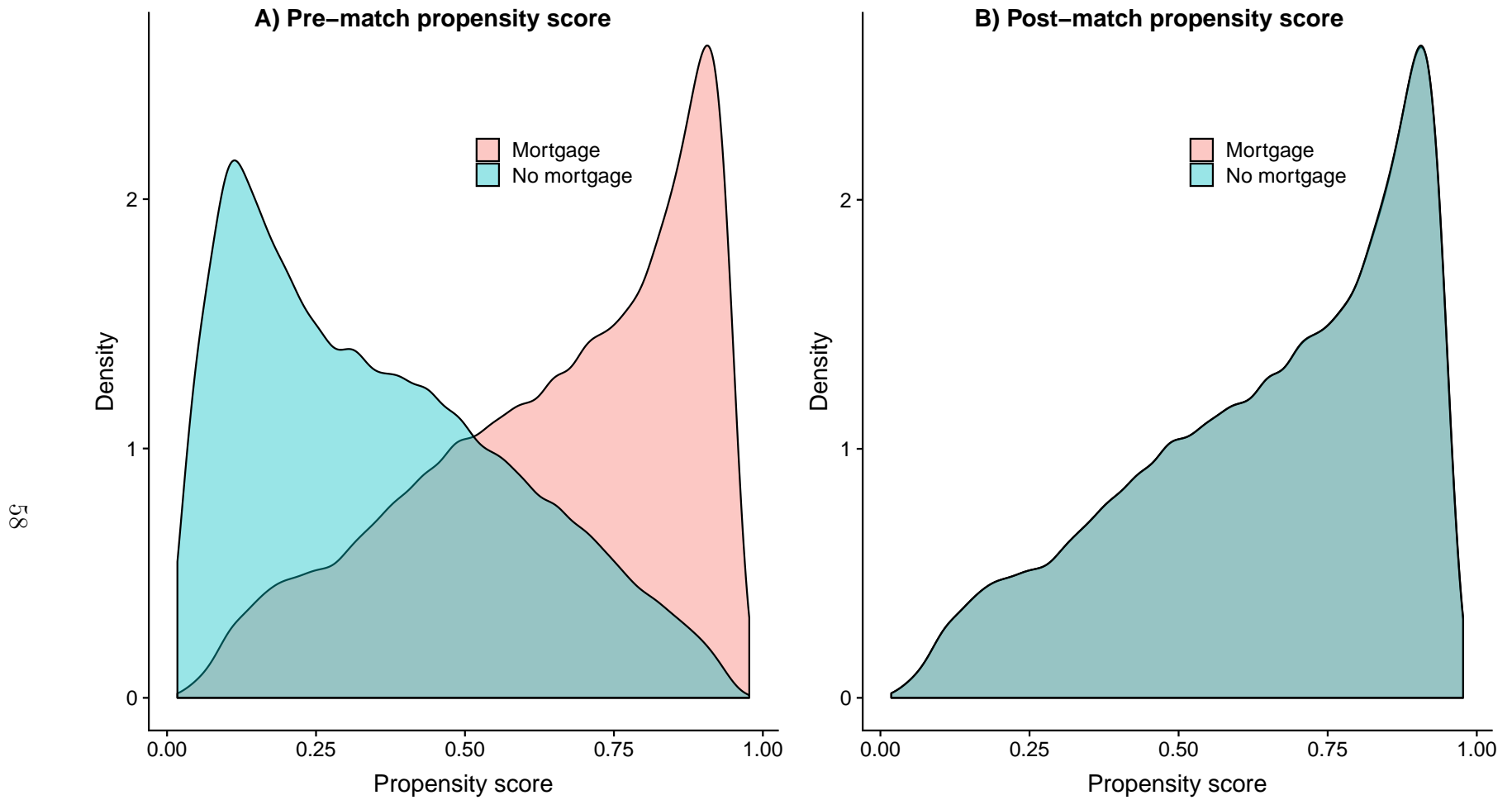
Note: Panel A presents the distribution of the propensity score before matching by mortgage status. Panel B presents the distribution of the propensity score after matching

Figure A.1: Distribution of propensity score before and after matching
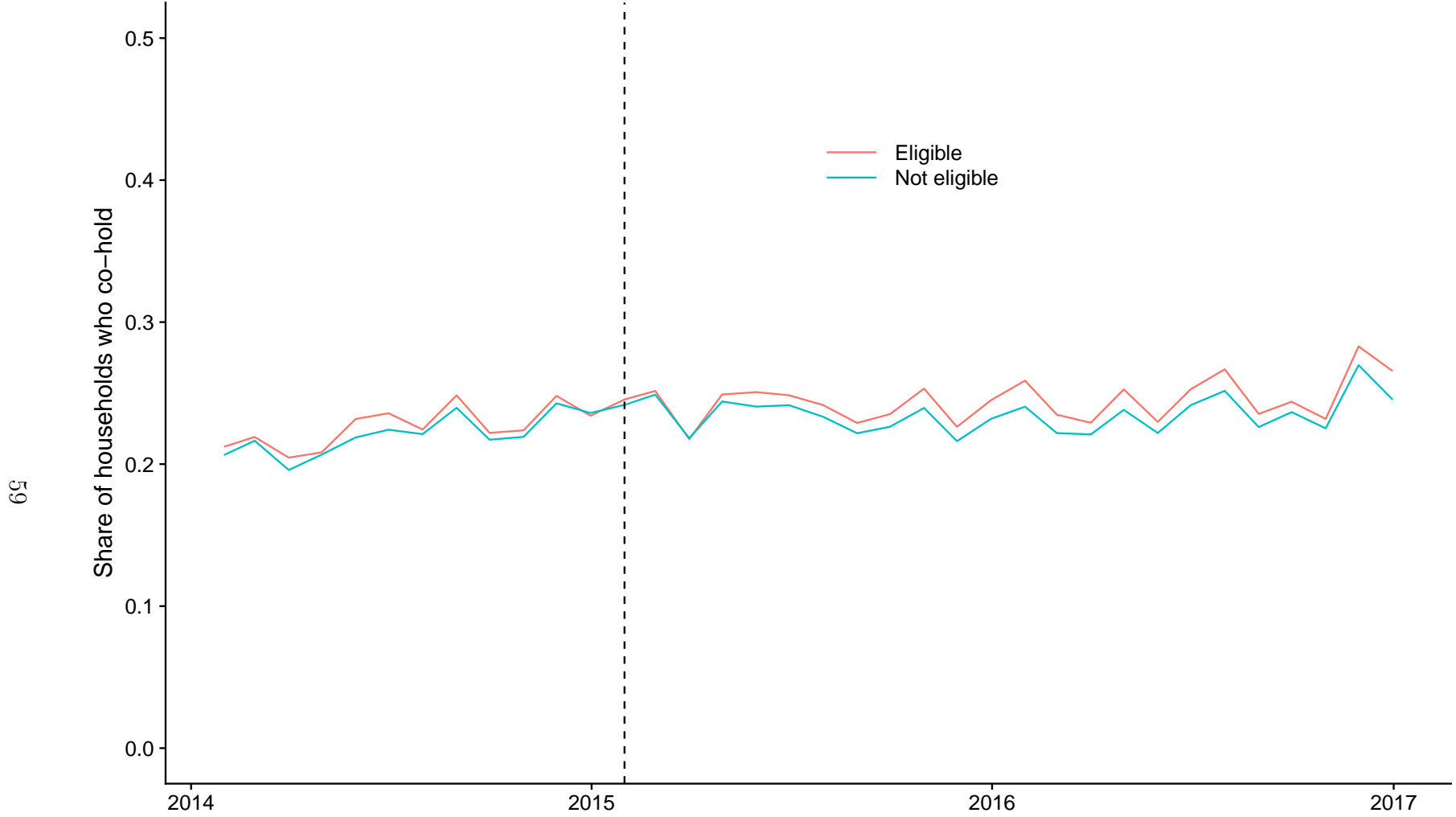
Note: The figure plots the share of households satisfying the co–holding criteria (unsecured debt above 500 EUR and deposits above 1,500 EUR) before and after the mortgage flexibility made by the bank in February 2015 (denoted by the dashed line) depending on whether households had a mortgage (=eligible) in the matched sample.

Figure A.2: Probability of co-holding by eligibility before and after the mortgage flexibility offer (matched sample)

Table A.1: Average household characteristics before and after matching

	Before matching		After matching	
	Mortgage	No mortgage	Mortgage	No mortgage
Unique households	147,276	144,442	147,174	60,473
Demographics				
Adults	1.67	1.39	1.67	1.67
Children	0.75	0.18	0.75	0.75
Age of oldest adult	46.19	56.17	46.19	46.95
Co-holding				
Deposits	11,773	24,842	11,777	11,915
Interest-accruing unsecured debt	1,345	626	1,345	1,362
Unsecured credit limit	4,276	3,133	4,277	4,151
Co-holding	658	272	658	664
Income/expenditure				
Disposable income	3,434	2,291	3,434	3,403
Card expenditure	1,756	1,142	1,755	1,773
Other debts and assets				
Other financial assets	7,054	20,009	7,058	10,867
Other debt	7,275	4,218	7,264	12,870
Interest rates				
Unsecured debt interest rate	7.08	7.08	7.08	7.06
Deposit interest rate	0.10	0.13	0.10	0.10

[a] The table presents household characteristics by mortgage status before and after matching. Values refer in general to January 2015, but disposable income is a monthly average over 2015, and card expenditure is a monthly average over 2014.

Table A.2: Comparison of stable and unstable households

	Mean value		Median value	
	Stable	Unstable	Stable	Unstable
Group size	291,718	56,260	291,718	56,260
Demographics				
Adults	1.53	1.74	2.00	2.00
Children	0.47	0.60	0.00	0.00
Age of oldest adult	51.13	43.86	51.00	41.00
Co-holding				
Deposits	18,244	16,629	6,337	5,683
Interest-accruing unsecured debt	989	1,128	0	0
Unsecured credit limit	3,710	3,969	3,000	3,000
Co-holding	467	595	0	0
Puzzle share	0.17	0.23	0.00	0.00
Income/expenditure				
Disposable income	2,868	3,332	2,514	3,206
Card expenditure	1,452	1,563	1,242	1,363
Other debts and assets				
Mortgage indicator variable	0.50	0.57	1.00	1.00
Mortgage balance	47,639	65,699	1,625	28,261
Other financial assets	13,469	13,963	0	0
Other debt	5,761	7,467	0	0
Interest rates				
Unsecured debt interest rate	7.08	7.09	7.08	7.08
Deposit interest rate	0.11	0.11	0.07	0.07
Mortgage interest rate	1.34	1.36	1.25	1.28

[a] The table compares characteristics of stable and unstable households. The two oldest adults of stable households are unchanged during the sample period 2014–2017. Unstable households are present in the data in January 2015 but have either formed after January 2014 or dissolve before December 2017. Values refer in general to January 2015, but disposable income is a monthly average over 2015. Interest rates are nominal rates (not APRs) and do not include non-interest credit fees.