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House Prices, Home Equity, and Personal Debt Composition*

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Keywords: Household Decision, Personal Debt Management, Credit Constraint, Cash-out Refinancing, Entrepreneurship.

JEL: D14, G21, L26, R31.

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Using a monthly panel dataset of individuals' debt composition including mortgage and non-mortgage consumer credit, we show that house price changes can explain a significant fraction of personal debt composition dynamics. We exploit the variation in local house price growth as shocks to homeowners' housing wealth to study the consequential adjustment of personal debt composition. To account for local demand shocks and disentangle the housing collateral channel from the wealth effect, we use renters and non-equity-withdrawal homeowners in the same region as control groups. We present direct evidence that homeowners reoptimize their debt structure by using withdrawn home equity to pay down comparatively expensive short-term non-mortgage debt during a housing boom, unsecured consumer loans in particular. We also find that homeowners withdraw home equity to finance their entrepreneurial activities. Our study sheds new light on the dynamics of personal debt composition in response to changes in house prices.

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1 Introduction

Housing is often the most important private wealth for a typical household and the most valuable asset available to use as collateral for consumer borrowing.[1] According to life cycle models, households should adjust their consumption plans, labor inputs and investment/leverage decisions when new information about private wealth arrives. In particular, house price movements create opportunities for homeowners to reoptimize their debt structure and change the consumption and saving behavior accordingly. When house price increases substantially, homeowners could extract home equity through cash-out refinancing and home equity loans. They can use the proceeds for debt repayment (e.g., Brown et al., 2015), home improvement (e.g., Davey, 2001; Almaas et al., 2015), business investments (e.g., Corradin and Popov, 2015; Jensen et al., 2015; Kerr et al., 2015; Schmalz et al., 2017), college education (e.g., Lovenheim, 2011; Lovenheim and Reynolds, 2013), and consumption (e.g., Mian and Sufi, 2011). However, excessive borrowing against home equity during a housing boom may lead to debt overhang and depress consumption if house prices drop or interest rates increase, especially if households accumulate excess consumer debt in the anticipation of future debt substitution using home equity. Therefore, it is important to understand the impact of house prices on a household's balance sheet, especially the composition of personal debt.

Previous studies indicate that households use home equity withdrawal to manage their personal debt composition, but most studies, such as Mian and Sufi (2011) and Brown et al. (2015), emphasize the U.S. experience, which differs from the European setting in part due to fundamental legal and institutional differences. For example, unlike in the U.S., where a large proportion of unsecured debt is discharged in bankruptcy, in Sweden, borrowers have the full obligation to pay according to the installment schedule for at least five years in the individual debt restructuring process, under the supervision of the Swedish Enforcement Authority.[2] Therefore, excessive borrowing may create a more severe debt overhang for households in periods of high interest rates and decreasing house prices, leading to a higher propensity of aggregate consumption decline and slower economic recovery (Finocchiaro et al., 2011; Huo and Ríos-Rull, 2013, Gete and Zecchetto, 2016).

[1] Campbell and Cocco (2003) show that middle-class families in the United States have more than half of their assets in housing. Betermier et al. (2017) document that housing wealth is around 65% of total wealth for an average Swedish household in their sample.

[2] See the following link for detailed information on the personal bankruptcy and debt restructuring process in Sweden: https://www.kronofogden.se/Kanintebetalaprivatperson.html.

In this paper, we focus on the debt composition and flow dynamics between long-term mortgage and short-term unsecured debt. The personal debt composition affects the interest costs that a borrower bears, which is an important contributor to the debt service ratio (DSR). The DSR, defined as interest payments and debt repayments divided by income, is a more accurate measure of personal debt burden than other leverage measures, such as the debt-to-income (DTI) ratio. Drehmann and Juselius (2012) show that high DSRs prevent borrowers from smoothing consumption or undertaking profitable investments, and the effect cannot be deduced from the borrower's DTI ratio. Ganong and Noel (2017) find that default is driven by short-term cash flow shocks rather than by long-term debt obligations. Therefore, it is crucial to investigate both the stocks of personal debt and the flows between long-term and short-term debt in response to the changes in house prices, in order to fully understand how house price changes affect personal debt burden. In addition, DSR, especially in the household sector, produces a very reliable early warning signal ahead of systemic banking crisis (Drehmann and Juselius, 2012). The changes of household debt composition in the housing boom period would have implication for financial system stability in the medium to long run.

We use a rich individual-level dataset from Sweden to study how house prices affect the debt profile dynamics of individuals. The panel data at monthly frequency give us the opportunity to link home equity withdrawals to subsequent changes in debt composition directly. To be specific, we investigate how growth in house prices affects the difference between homeowners and renters in the composition of mortgage and non-mortgage debt. This identification strategy helps to mitigate omitted variable problems widely encountered in the literature. If we treat the substitutions between mortgage and other consumer debt as the effect of home price movements on the liability side of homeowners' balance sheets, the use of home equity for entrepreneurial investment can be viewed as the effect of house prices on the asset side of the balance sheet. With a comprehensive framework, we explore the effect of house price growth on both the liability and asset sides of homeowners' balance sheets.

Taking advantage of monthly debt balance data, we can track changes of each individual's debt by category over time. We focus on the movement in different types of personal debt, and explore the monthly dynamics of personal debt portfolios in response to house price appreciations. Monthly debt balance data might be the most relevant high-frequency data one can find from an accounting

record point of view. Due to transaction costs, it is unlikely that individuals renew mortgage loans or other types of personal debt several times within a month. The high quality high frequency personal-level information allows us to explore both cross-sectional and time series differences in household behaviors. We argue that our results bring new insights in studying household debt decisions during the housing boom because of the rich heterogenous individual dimension, a major distinction compared to past studies. The average effect of house price growth on personal debt structure might mask heterogeneous behaviors among different types of homeowners.[1] Thus it is important to categorize households in groups with different housing consumption behavior. It appears in the data that some homeowners use home equity to pay down other more expensive consumer debt to optimize their personal debt portfolios, and other homeowners may increase their mortgages for purchasing new properties, or amortize continuously no matter how house price moves. Using monthly debt balance data, we are able to trace the evolution of personal debt across different debt categories and investigate the effect of house prices on personal debt among different homeowner types.

We first examine whether equity withdrawers use home equity to pay down more expensive non-mortgage debt by exploring the effect of house prices on cumulative consumer debt changes during the entire sample period July 2010–July 2014. We find a substitution effect between mortgage and non-mortgage debt, in particular unsecured consumer debt, during this housing boom era. We find that equity withdrawers cash out home equity and use the proceeds to pay back non-mortgage debt, especially unsecured consumer debt. On average, unsecured consumer debt is paid down by 9,624 SEK,[2] which is equivalent to 53.5% of the average unsecured consumer balances outstanding. We find no significant evidence that other consumer debt is paid off using home equity. In contrast to the findings in the United States that homeowners refinanced their mortgages for consumption purpose without paying down outstanding non-mortgage debt during the housing boom period 2002–2006 (Mian and Sufi, 2011; Brown et al., 2015), Swedish homeowners reoptimize their debt structure by substituting more expensive unsecured consumer debt using withdrawn home equity.

[1] Many studies show that it's important to consider household heterogeneity for understanding aggregate consumption and saving patterns in the data, for instance Jappelli et al., 1998, Chetty et al., 2014, Kaplan et al., 2015 and more. Browning and Lusardi, 1996 and Ahn et al., 2017 provide a good review in household heterogeneity in various dimensions.

[2] 9,624 SEK is approximately 1,458 USD, with an average exchange rate 6.6 SEK per USD during the period of July 2010–July 2014. Source: Bloomberg.

This may be explained by the fact that Swedish households, unlike U.S. households, are fully liable for personal debt and have difficulty obtaining discharges during the personal bankruptcy process. Therefore, they borrow less excessively and behave more conservatively when managing personal debt than U.S. households during a housing boom.

We then investigate whether homeowners use withdrawn home equity to finance entrepreneurial activities. Several recent papers have emphasized the collateral channel that enables credit constrained households to borrow against home equity for entrepreneurial financing (e.g., Corradin and Popov, 2015; Jensen et al., 2015; Schmalz et al., 2017). Using the monthly dataset, we are able to track whether homeowners withdraw home equity in the month prior to becoming entrepreneurs. We find that a 20,000 SEK home equity withdrawal could increase the probability of transition into entrepreneurship by 0.05%, which is a substantial increment compared with the baseline probability of entry into self-employment at 0.066%.

One challenge in the empirical literature investigating relationship between house price movements and households' decisions is the endogeneity problem caused by omitted variables. We exploit variations between renters and mortgagors, and additional heterogeneity among different types of homeowners, to investigate the effect of house price shocks on personal debt decisions. Renters are considered to be the control group to absorb common factors such as local economic conditions. Another challenge is to separate house demand effects from supply effects on the house price dynamics. As robustness checks, we use two instrument variables (IVs) for house price growth[1] to verify our findings. Inspired by Palmer (2015), we use house price volatility from 1981–2005 as an IV for the house price growth during the period July 2010–July 2014. Because Sweden is known for its restrictive regulatory environment regarding housing supply, we then adopt a construction regulation measure, the fraction of municipal appeals that have been overruled by the county, as an IV for house price growth. Our results are robust to the use of IVs. To ensure that our results are not driven by outliers within equity withdrawers, we use alternative definitions of equity withdrawers and still get consistent results.

[1]In the literature, the housing supply elasticity introduced by Saiz (2010) based on the geographic constraints across metropolitan statistical areas (MSAs) is widely used as the IV for the housing supply measure. However, in Sweden, there are not so many MSAs as in the United States, and geographic constraints might not play such an important role as in the United States. Instead, restrictive regulations are considered the main factors that affect the housing supply in Sweden (e.g., Lind, 2003; Hüfner et al., 2007). Therefore, we use a regulation measure on housing supply together with the historical house price volatility (Palmer, 2015) as IVs for robustness checks.

Comparing the findings in our paper to results in the studies using U.S. datasets, we show that homeowners adjust their personal debt composition more substantially in response to house price increases in Sweden, where borrowers have full liability for their debt. Expecting that the cost of not being able to repay debt is particularly high in Sweden, homeowners use home equity to reoptimize their personal debt structure rather than exhaust their debt capacity for consumption during a housing boom period. This can reduce the debt service burden and mitigate the negative consequences of undesirable income shocks. On the other hand, if households design their debt structure with the expectation of future substitution between costly consumer credit and less-costly home equity borrowing (e.g., household might accumulate excess consumer debt in the anticipation of future debt substitution using home equity extraction), an unexpected break in the home value appreciation trend will leave households with high debt service costs each month. Due to the full obligation of debt repayment and the strict rules on personal debt discharges in Sweden, it may generate a more severe debt overhang problem for households, which might trigger a deeper recession than the mortgage crisis experienced in the United States.

Our paper belongs to the group of recent literature studying the effect of house price growth on mortgage refinancing and household debt portfolio management, particularly Mian and Sufi (2011) and Brown et al. (2015). Both Mian and Sufi (2011) and Brown et al. (2015) use similar panel data on consumer debt based on credit reports from the U.S. credit reporting agency Equifax. Mian and Sufi (2011) find no evidence that home equity-based borrowing is used to pay down expensive credit card balance or invest in properties during the housing boom period in the Unites States. Brown et al. (2015) find substitution between credit card and home equity debt in response to home equity changes during the preboom period. However, this effect is not significant during the housing boom period 2002–2006. Bhutta and Keys (2016) show evidence on the usage of home equity for paying down unsecured consumer debt using a US sample from years 1999-2010, but they mainly focus on the relationship between equity extraction and interest rates other than housing prices. Our paper provides evidence from an European perspective and shows that homeowners borrow less excessively and reoptimize debt structure during a housing boom under a legal system where borrowers have full liabilities for personal debt. [1] This paper is also related to the growing literature

[1] Cloyne et al. (2017) argue that the effect of house prices on borrowing originates mainly from collateral effects. They don't study the composition of household debt related to house prices.

on the role of the housing collateral channel in entrepreneurship (e.g., Corradin and Popov, 2015; Jensen et al., 2015; Kerr et al., 2015; Schmalz et al., 2017). Our results complement this strand of research by using the monthly individual debt balance panel to directly identify the home equity channel that homeowners indeed extract home equity in response to the house price growth and use the proceeds for entrepreneurial investment.

The remainder of the paper is set up as follows. In Section 2 we describe our data and present summary statistics. Section 3 presents identification strategy and empirical results. In Section 3.4 we discuss alternative explanations for our results. Section 5 concludes.

2 Data and summary statistics

2.1 Data

We combine data from two different sources in the empirical analysis. The individual-level credit and loan information is sourced from Upplysningscentralen (UC), the Swedish credit bureau. The house price at the parish[1] level is from Valueguard, a data vendor specialized in constructing house price indices in Sweden.

The UC dataset contains detailed information about mortgage and other non-mortgage household debt outstanding at monthly frequency from July 2010 to July 2014. The non-mortgage debt includes credit card debt, unsecured consumer credit[2], installments, payment cards and secured loans. In this paper, we focus on credit card debt and unsecured consumer loans, because these two types are the most commonly used non-mortgage debt formats in Sweden. There are roughly 23% individuals with credit card debt and 10% individuals with unsecured consumer loans in our sample. Other non-mortgage debt, including installments, payment cards and secured loans cover only 1.67% of the population.

Since UC has access to data from the Swedish Tax authority for each individual, our dataset also contains information on credit score,[3] age, disposable income, and self-employment status during

[1] Parish was the basic geographical unit under the management of the Church of Sweden in history. For statistic purpose, Sweden is still using parish as the geographical unit today.

[2] Unsecured consumer loans, or referred as "blanco" loans, are usually used to pay the down payment for home purchase, or to purchase durable consumption goods.

[3] The credit score provided by UC is the estimated probability of default for an adult individual in the next 12 months, which is different from the FICO score used in the United States.

the same period. The entire database covers around 4.8 million individuals, which counts for 62% adult population in Sweden.[1] The empirical analyses in this paper are based on a random sample of about 150,000 individuals from the UC dataset. The distributions of key variables between the random sample and the whole sample are quite comparable. We define that an individual is a homeowner if she has mortgages during the whole sample period, and is a renter if she only has non-mortgage debt during the entire sample period. There is a small group of individuals who were renters but became mortgage holders during the sample period. We exclude this first-time mortgage borrower group because of our identification design. We also exclude those individuals who were homeowners in July 2010 but became renters during the sample period. There are 100,896 individuals remaining in the sample, of which 81,667 (81%) are homeowners. [2]

House price growth at the parish level is calculated using the house price index from Valueguard. Valueguard provides a monthly house price index for both apartments and single-family houses at the parish level for the same sample period. There are 1373 parishes in total in Sweden. For each parish, we calculate house price index growth as the weighted average of the apartment price index and the single-family house price growth. The weights are determined by the number of households in the parish owning single-family houses or apartments. We then merge house price growth with the UC dataset using the parish code of an individual's address.

2.1.1 Home equity withdrawal

Home equity can be viewed as the difference between the market value of the home and the mortgage outstanding. When an individual buys a house, the initial home equity is the down payment. Over time, home equity might increase if the individual pays back the mortgage or if the house prices go up. [3] As the majority of mortgage borrowers in Sweden take interest-only loans, the increases in home equity mainly come from the increase in house prices. An individual can choose to refinance the loan and raise the amount of mortgage against increased home equity. In our sample, we have

[1] The population of adults is 7.76 million in Sweden in 2014.

[2] The UC data allow us to identify homeowners with mortgages outstanding; thus we might miss the homeowners who purchased their houses with cash or who had mortgages but have already paid back fully before the sample period. However, these two cases are rare in Sweden. We could plausibly assume that the mortgage takers covered by the UC data can well represent homeowners in Sweden.

[3] Chetty et al. (2017) show that it's important to distinguish the home equity and mortgage debt for studying the effects of housing on portfolios. However, we cannot directly identify the two separate components due to data limitation.

monthly mortgage outstanding for each individual, we could identify home equity withdrawals for individual i in month t through the following formula:

$$EquityWithdrawal_{i,t} = MortgageOutstanding_{i,t} - MortgageOutstanding_{i,t-1} \quad (1)$$

if the outstanding mortgage change is positive.

Based on this definition, we have found 63,905 home equity refinancing cases during the sample period. Because we focus on the effect of home equity on activities that are not property investment, we need to exclude the cases in which individuals cash out home equity for the purpose of purchasing a new home. We can observe whether individuals changed the house type, purchased a second house, or moved to another address during the same month they withdrew home equity.[1] After excluding all those cases in which the home equity withdrawals are used for purchasing a new home, we have 52,748 cases remaining. Because a mortgage contract renewal is costly for households, we use 20,000 SEK as the threshold for home equity withdrawal identification to avoid measurement errors. It is equivalent to the average monthly disposable income of an individual in our sample (the average annual disposable income is 232,700 SEK as shown in Table 1). In the end, we obtain 46,499 home equity withdrawal events in the final sample.

2.2 Summary statistics

Panel A of Table 1 gives the summary statistics for the full sample of personal debt. Individuals in our sample are, on average, 51 years old, with an annual disposable income 232,700 SEK. The average mortgage size is 662,700 SEK for homeowners, while the distribution is right-skewed. The average debt balance outstanding is 3,100 SEK for credit card debt and 18,300 SEK for unsecured consumer loans. However, renters have, on average, higher credit card debt and unsecured consumer loans. It is worth pointing out that homeowners and renters are similar in terms of age distribution, income and other observable dimensions, though homeowners have slightly higher average disposable income than renters. Because the Swedish rental market is highly regulated and

[1] We cannot rule out the case that an individual borrows against home equity to purchase a new home of the same property type (apartment or small houses) in the same address. However, this case is rare; hence, it should not affect our identification of home equity withdrawal.

based on a queueing system,[1] it can alleviate the concern that a household's choice of being a renter or homeowner is based on their wealth. Also, in Sweden, the rental market is geographically evenly distributed, and there is no big difference between homeowners and renters regarding accessibility to the rental market. Therefore, renters can be viewed as a good control group for homeowners for their similarities in individual characteristics regardless of their homeownership choices. This motivates our identification strategy in using renters as the control group who cannot benefit directly from rising house prices, for homeowners as treatment group who has access to the home equity-based financing channel.

Figure 3 shows the dynamics of aggregate consumer debt of homeowners in our sample during the period of July 2010–July 2014. Figure 3(a) presents the total aggregate mortgage and non-mortgage debt of homeowners, as well as the house price index. The solid line represents the house price index of the entire Swedish housing market. The Swedish housing market has been booming for many years since 2000. The Financial Crisis 2007–2009 only marginally affected the Swedish housing market. The period in our sample witnessed fast-growing house prices in Sweden. The house price index rises by 20% during the four-year period, especially after January 2012, when the house price grows dramatically after a slight drop during the second half of 2011. Correspondingly, the aggregate mortgages have increased from 54,500 million SEK in July 2010 to 63,200 million SEK in July 2014. The aggregate non-mortgage debt increased from 55,000 million SEK to 58,500 million SEK during the first one and half years in the sample period and stayed stable during the rest of the sample period. Figure 3(b) presents the breakdown of non-mortgage consumer debt of homeowners: credit card debt and unsecured consumer loans. It shows that the dynamics of both types of consumer debt are similar, in consistence with the time series pattern of the aggregate non-mortgage debt.

We categorize consumers in our sample into separate groups, based on the homeownership and mortgage payment conditions (see Figure 1). The first such categorization gives us the benchmark group of renters versus homeowners. Both are exposed to local economic development and unobserved common economic shocks, which serves as the base of our key identification strategy. The second categorization using mortgage debt changes separates households with different housing

[1] As pointed out in Finocchiaro et al. (2011), a buy-to-let market has never fully developed in Sweden. Households who cannot rent are forced to buy a house.

consumption preferences. We consider four homeowner groups: home equity withdrawers (EWs), amortizers (AMs) or home equity savers, house traders (HTs), and others. Based on the household mobility record, we identify individuals as active HTs who were buying and selling their apartments to climb the property ladder. The decision to move is considered to be a result of idiosyncratic shocks. Among the households who did not move in our sample period, we further group them based on their mortgage variation during the sample period. EWs are mortgagors who have withdrawn home equity at least once in the sample. We define an equity withdrawal event as a one-time increase of mortgage worth more than 20,000kr, which roughly amounts to 6% among all positive increases of mortgage not due to home purchases. In principle, the withdrawn home equity may be used for consumption (including home improvement), investment, and/or paying off other debt. AMs, or home equity savers, are homeowners who actively reduced their mortgages, at least three times with more than 150kr decrease. We choose the cut-off at 150kr to define amortization as it is approximately 5% lowest decrease among observed debt reductions. Around 12.1% homeowners traded their homes actively. The fraction of people who amortize during the sample period is 1.4%, which is consistent with the common practice that most Swedish mortgage borrowers do not amortize mortgages. The majority of mortgage borrowers have either interest-only loans or an amortization schedule of greater than 45 years. The rest of mortgagors are the ones who have not traded their home, and did not change the size of their mortgages significantly. EWs account for 40.0% of individuals in the sample. Above 75% of EWs have only withdrawn home equity once during the whole sample period. If we look at Figure 2(a), the fraction of EWs is 0.7%-1.6% each month (or 8.4%-19.2% per year), which is close to the result of Bhutta and Keys (2016) using U.S. household data. The median value of home equity withdrawal size varies from 100,000 SEK to 125,000 SEK with a dispersed distribution over the period between July 2010 and July 2014.

Panel B of Table 1 shows summary statistics on mortgage and non-mortgage debt for the subcategories of homeowners: EWs, AMs, HTs, and others. It appears that age distribution is similar across different groups. HTs have the highest disposable income and probability of default. They also have much higher credit card debt and unsecured consumer loans compared with both EWs and AMs. It might indicate that HTs might need to borrow extra money on top of home equity to finance home purchases, when house prices increase dramatically during the sample period. EWs have the highest average mortgage debt outstanding (804,500 SEK) compared with HTs and AMs;

while their non-mortgage debt outstanding are lower than HTs but higher than AMs. Compared with the other two types of homeowners who borrow against home equity, AMs have much lower mortgages and non-mortgage outstanding, which is consistent with their saving behavior.

Additionally we plot the median values of different sorts of debt that homeowners pose over time across different homeowner groups (see Figure 4). From Figure 4(a), we see that both EWs and HTs experienced a substantial increase of mortgages during the four-year sample period; while HTs increased their mortgages at a much higher speed than EWs. To the contrary, AMs steadily decreased their mortgage debt outstanding during the same period. In terms of total non-mortgage debt, which is presented by Figure 4(b), the median value of debt outstanding demonstrates similar decreasing patterns across different homeowner types during the sample period. When broken down by non-mortgage debt type, we see that all homeowner types have almost parallel trends for credit card debt outstanding over time during the sample period. However, the three groups demonstrate different patterns regarding the dynamics of unsecured consumer loans. EWs and HTs started with similar levels of unsecured consumer loan balances at the beginning of the sample period. However, HTs experienced a steady increase in unsecured consumer loans while the median value of unsecured consumer loans for EWs decreased after staying stable for the first half of the sample period. AMs have much lower but slightly more volatile median value of unsecured consumer debt level compared with the other two homeowner groups.

3 Results

3.1 House price growth and personal debt composition

3.1.1 Identification strategy

We start the analysis by investigating the relationship between the regional house price increase and the debt growth over the whole sample period. Equation (2) shows the regression specification. It is comparable to the study in Brown et al. (2015).

$$\Delta Debt^{j}{}_{ict_1-t_2} = \beta HPGrowth_{ct_1-t_2} + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2} \tag{2}$$

$\Delta Debt^j{}_{ict_1-t_2}$ is the difference of the debt balance (total debt, mortgage, total non-mortgage debt, credit card debt, and unsecured consumer loans) of individual i in parish c between July 2010 ($t1$) and July 2014 ($t2$). j denotes the debt type. $HPGrowth_{ct_1-t_2}$ is the house price index growth during the same period, which is defined as $\frac{HP_{ct2}-HP_{ct1}}{HP_{ct1}}$. $X_{ict_1-t_2}$, presents a vector of observable individual characteristics, including credit score, age, and disposable income. Individual i's credit score and age take the corresponding values in July 2010. Disposable income is the difference of individual i's disposable income between July 2010 and July 2014. Finally, $\mu_{ict_1-t_2}$ is an idiosyncratic error.

The growing debt level and the house price increase could be correlated for different reasons. A simple explanation could be that both growths may be attributed to regional economic development. The relationship is not necessarily coming from the house ownership channel. To account for the spurious relationship due to omitted variables, such as local economic growth and other common regional factors, we use renters as the control group. The identification assumption is that the unobserved local economic conditions, which drive both house price growth and individuals' debt profiles, affect renters and homeowners in a similar fashion. The regression specification is:

$$\begin{aligned}\Delta Debt^j{}_{ict_1-t_2} = \beta_1 HPGrowth_{ct_1-t_2} * Homeowner_i + \beta_2 HPGrowth_{ct_1-t_2} \\ +\beta_3 Homeowner_i + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2} \end{aligned} \tag{3}$$

The above discussed regressions focus on the sample begin-end debt level variations for households residing in areas with heterogeneous house price development. The cross-sectional house price dynamics heterogeneity is the main source of variations in the econometric model. Next we will explore the time series dimension differences, which will help us to understand the shift in household debt portfolio over time. The regression specification is:

$$\begin{aligned}Debt^j_{ict+1} = \beta_1 HPGrowth_{c,t-36,t} * Homeowner_i + \beta_2 Homeowner_i \\ +\gamma X_{ict} + \theta_{ct} + \mu_{ict} \end{aligned} \tag{4}$$

where $Debt^j{}_{ict+1}$ is the logarithm of debt balance for type j of individual i who is located in parish c in month $t+1$. $HPGrowth_{c,t-36,t}$ measures cumulative three years' house price growth until month

t.[1] Here the house price growth is calculated using the weighted average of single-family house and apartment price growth in the same parish. Weight is decided by the number of households owning single-family houses and apartments in the parish. $Homeowner_i$ is a dummy variable that equals one if individual i owns a home during the whole sample period and zero otherwise. X_{ict} stands for personal characteristics of individual i in parish c in month t, including credit score, disposable income and age. θ_{ct} represents parish-month fixed effects. μ_{ict} is an idiosyncratic error. To control local common factors, we employ the Difference-in-Difference (DiD) approach by interacting the house price growth variable with the homeowner dummy. The $HPGrowth_{c,t-36,t}$ term is absorbed by the parish-month fixed effects. Standard errors are clustered at parish level.

3.1.2 Empirical findings

Effect on cumulative personal debt changes. Panel A of Table 2 reports the estimates of relationships between house price growth and personal debt during the entire four-year sample period. Column (1) shows the effect on the change of total debt. The coefficient on *HPgrowth* is 92.67 with significance at 1% level, which indicates that a one percentage point increase in house prices in a homeowner's parish is associated with an increase of 926.7 SEK in total debt, which is equivalent to a 4% increase in house value.[2] The positive relationship between house prices and total debt is largely driven by the positive relationship between house prices and mortgage. This is demonstrated by the coefficient on *HPgrowth* in Column (2) of Panel A of Table 2. A one percentage point increase in house prices in a homeowner's parish is associated with an increase of 937.9 SEK in mortgage. However, the relationship between house price growth and total non-mortgage debt is negative (see Column (3) in Panel A of Table 2), though not statistically significant. From Column (4) and Column (5) we can see that the responses of credit card debt and unsecured consumer debt to house prices demonstrate different patterns. In Column (4), the coefficient on *HPgrowth* is 1.27, indicating that a one percentage point increase in house prices in a homeowner's parish is associated with an increase of 12.7 SEK in credit card debt.[3] In contrast to the positive relationship between

[1] The house price index data from Valueguard covers years before and during our sample period July 2010–July2014. As a result, we can use the full sample of household panel data in the regression.

[2] According to Statistics Sweden, the average purchase price of residential property in one- and two-dwelling buildings in Sweden was 2.15 million SEK between 2010 and 2014. Thus, a one percentage point increase in house prices is equivalent to a 21,500 SEK increase in house value.

[3] The effects look small at first glance. However, it is worth pointing out that the Swedish house prices have increased more than 20% on average during our sample period (see Figure 3(a)).

credit card debt and house prices, unsecured consumer loans are negatively associated with house prices, though not significantly. Hence, our first inference regarding house prices and personal debt is that we observe a large increase in total consumer debt in response to house price growth, which is mainly indicated by a large increase in mortgage as well as an increase in credit card debt. Moreover, the coefficient on credit score is negatively significant at the 1% or 5% level across all regression specifications in Panel A of Table 2, indicating that more creditworthy individuals have larger debt capacity, and thus larger personal debt increases. Similarly, the coefficient on age is negatively significant at the 1% level in each column of Panel A of Table 2, suggesting that younger people increase their debt more than older people.

Panel B of Table 2 summarizes the results from regression specifications where renters were used as the control group, as shown in equation (3). The coefficient on *Homeowner* is positively significant across all columns in Panel B of Table 2, indicating that homeowners in general experienced a larger increase in consumer debt compared with renters during the four-year sample period. From Column (1) we can see that a one percentage point increase in house prices in a homeowner's parish leads to a 959.1 SEK increase in total debt, which is slightly higher than the magnitude observed with the regression specification that does not use renters as the benchmark group. Similar to Panel A of Table 2, the effect of house price growth on total non-mortgage change is still negative but not significant. However, regression results dividing non-mortgage debt into credit card and unsecured consumer loan changes suggest a different story. In Column (4) the interaction term between house price growth and homeowner is 0.09, neither economically nor statistically significant, implying that the positive significant relationship between the house price growth and the credit card debt change observed in Panel A of Table 2 is mainly driven by local common factors that affect both homeowners and renters. On the other hand, the interaction term between house price growth and homeowner in Column (5) equals to -7.23 and is significant at the 5% level. Combined with the estimate of the coefficient on house price growth, we can infer that a one percentage point increase in house prices leads to a 25.4 SEK decrease in unsecured consumer loans. The magnitude is similar to the estimate found in Panel A of Table 2. Estimates on the coefficients on individual characteristics are quite stable and consistent with the results without using renters as the benchmark group.

The results obtained so far show opposite directions of mortgage and non-mortgage debt changes

in response to the house price growth, implying a substitution mechanism between mortgage debt and non-mortgage debt, particularly unsecured consumer loans. Since mortgage is collateralized debt, which is typically associated with lower interest rates than uncollateralized non-mortgage debt such as unsecured consumer loans, homeowners could borrow against home equity when house prices rises in order to replace more expensive unsecured debt with mortgage debt. This reflects the reoptimization behavior of Swedish homeowners during the housing boom period. Brown et al. (2015) also discover the existence of substitution between non-housing and home equity line of credit (HELOC) debt in response to house price changes in the U.S. market, but only for the preboom and postboom periods.[1] While during the U.S. housing boom of 2002–2006, homeowners withdrew home equity for consumption without paying down expensive unsecured personal debt (also suggested by Mian and Sufi, 2011).

Time series dynamics of personal debt composition. Both Panel A and Panel B of Table 2 represent results of regressions that try to capture how the sample begin-end debt level variations respond to the cross-sectional house price growth heterogeneity in the sample period. Those results mainly reflect the cumulative effect of house prices on consumer debt, not about the debt dynamics over time. Table 3 reports estimates obtained with the recursive regression in equation (4), which explores the time series dimension differences of personal debt changes in response to house price growth. The β_1 (the coefficient on the interaction term between house price growth and homeowner dummy) point estimates for total debt and mortgage are positively significant at the 1% level, while those for total non-mortgage debt and unsecured consumer loans are negatively significant at the 1% level, which is consistent with the results in Panel B of Table 2. Meanwhile, the β_1 estimate for credit card debt is also negative but only significant at the 10% level. These findings confirm the substitution effect between mortgage and non-mortgage debt in response to house price changes. Since we have controlled for parish-month fixed effects, local common factors that drive both house price changes and consumer debt should have been wiped out.

It is also worth pointing out that the estimates of coefficients on personal characteristics also present meaningful results. The β_2 point estimates are positive for both total debt and mortgage but negative for total non-mortgage debt, credit card and unsecured debt; all of them are significant

[1] Brown et al. (2015) find near dollar-for-dollar substitution between credit card debt and home equity in response to home equity changes for all preboom homeowners, and older and prime post-boom homeowners.

at the 1% level. This is consistent with the summary statistics in Table 1, that homeowners have higher total debt but lower non-mortgage debt compared with renters. The estimates of coefficients on credit scores are significantly negative for mortgage and significantly positive for non-mortgage debt, suggesting that a more creditworthy borrower tends to have a higher level of mortgage debt and lower level of non-mortgage debt. This is not surprising because a more creditworthy borrower is more likely to access a cheaper mortgage and relies less on expensive non-mortgage debt. Moreover, the estimates of coefficients on disposable income are positively significant for all debt types, reflecting the fact that income is an important factor for deciding an individual's debt capacity. Similarly, the estimates of coefficients on age are negative and statistically significant at the 1% level across all columns in Table 3, which indicates that younger people have lower debt capacity.

Heterogeneity by homeowner type. As shown in Figure 1, homeowners might increase their mortgages for changing residential properties, which is usually driven by reasons (such as family size expansion or job relocation) exogenous to local house price changes. For those who have not moved, the changes of mortgages in response to house price growth might reflect different purposes and financial conditions of homeowners. Therefore, it is important to investigate heterogeneous effects of house price changes on personal debt structure by homeowner type.

Table 4 reports the effect of house price growth on personal debt change during the period of July 2010–July 2014 using homeowner type subsamples. It shows that there is large heterogeneity among different homeowner types in the responses of personal debt to house prices. The most important finding is that substitution between mortgage and non-mortgage debt, unsecured loans in particular, only exists among EWs. HTs and AMs do not demonstrate such credit-savvy behavior using favorably priced mortgage debt to replace high-cost unsecured loans in a strengthening housing market.

Panel A presents the estimates of the coefficient on house price growth in regression equation (2). We find that both EWs and HTs experience substantial debt accumulation, most of which is mortgage. The growth in mortgage associated with a one percentage point increase in house prices is 3,207 SEK for HTs, which is roughly twice the magnitude (1,578 SEK) for EWs. These findings are not surprising and are consistent with the trend of median mortgage by homeowner type presented in Figure 4(a). What is interesting is that the three types of homeowners demonstrate

heterogeneous behavior regarding their non-mortgage debt in response to house prices. While borrowing against home equity, EWs decrease their total non-mortgage debt, especially unsecured loans. This indicates that EWs are sophisticated borrowers who replace expensive unsecured debt with cheap mortgages when the housing market is booming. However, credit card balance for EWs increases in responses to house prices during the sample period. HTs, who trade real estate to climb the property ladder, increase non-mortgage debt especially credit card debt. AMs, who can be viewed as risk-averse home equity savers, have neither increased or decreased their non-mortgage debt. It is important to point out that renters, who are used as the benchmark group, increase both credit card and unsecured debt, and therefore total non-mortgage debt during the sample period. This is not surprising because renters cannot benefit from home equity-based borrowing in the booming housing market; thus they may rely solely on non-mortgage debt to boost their consumption. Meanwhile, the growth in renters' total and within the subcategory of non-mortgage debt also implies that unobservable local common factors might have driven house price and personal debt growth. This may explain why we observe an increase in credit card debt in response to house price growth for EWs, although they have substantially decreased unsecured loans.

Panel B in Table 4 presents the estimates of the coefficient on the interaction term between house price growth and homeowner for the regression specification using renters as the benchmark group. After controlling for unobservable local common factors, the heterogeneity of personal debt changes in response to house price growth among different homeowner groups still remains. Moreover, the substitution between mortgage and non-mortgage debt, unsecured loans in particular, for EWs is more significant. Meanwhile, the change in credit card debt in response to house price growth becomes insignificantly negative. In addition, the positive relationship between total non-mortgage, in particular credit card debt, and house prices for HTs is no longer significant when adding renters as the benchmark group.

We also repeat the recursive regression in equation (4) using subsamples of different homeowner types. Table 5 reports estimates of the coefficient on the interaction term between house price growth and homeowner dummy. The results are consistent with the findings in Table 3. The β_1 point estimates for total debt and mortgage are positively significant at the 1% level across all homeowner types. However, those estimates for total non-mortgage debt and unsecured loans are

only negatively significant for EWs and HTs but not AMs. This is consistent with the findings in Table 4, namely that EWs demonstrate the credit-savvy behavior of substitution out of comparatively expensive into comparatively inexpensive debt, while the substitution effect is not significant for AMs. Interestingly, HTs also seem to show such credit-savvy behavior when we use time series analysis on the dynamics of personal debt composition, which has not been observed using cross-sectional analysis on cumulative debt changes. Since the magnitude of the substitution effect is smaller for HTs compared with EWs, we can still conclude that the substitution effect between mortgage and non-mortgage debt is mainly driven by EWs.

It is worth pointing out that both Mian and Sufi (2011) and Brown et al. (2015) focus on credit card debt. However, in Sweden, credit card debts do not play such an important role as in the United States. Unsecured consumer loans are comparatively more important non-mortgage debt than credit card debts.

3.2 Home equity withdrawal and non-mortgage debt paying down

Previous literature has shown that households can have inefficient behavior regarding personal debt management, for example keeping excess liquid wealth and large mortgage balances at the same time (Vissing-Jørgensen, 2007). Because we cannot observe the wealth of Swedish households during the sample period,[1] it might be possible that individuals increase mortgages for consumption at the same time pay down their non-mortgage debt using other assets. So evidence on the stock changes of mortgage and non-mortgage does not necessarily suggest that homeowners borrow against home equity to pay down the more expensive non-mortgage debt and reoptimize their debt structure. Focusing on the flow between mortgage and non-mortgage debt and controlling for the disposable income, which takes into account the effect of wealth through the realized capital gain, we could identify the debt reoptimization behavior of homeowners.

In this section, we show direct evidence that homeowners withdraw home equity to pay down non-mortgage debt. Taking the advantage of the monthly data on individual level debt balances, we can track the corresponding changes of debt balances across months for EWs and examine whether there is subsequent decrease in non-mortgage debt following an increase in mortgage. The logic behind it is that if homeowners withdraw home equity with the motive to pay down

[1] Statistics Sweden stopped collecting personal wealth data in 2008 due to the removal of inheritance taxes.

comparatively expensive non-mortgage debt such as unsecured loans, we should observe subsequent substantial decrease in non-mortgage debt balances in month $t+1$ taken that we observe a home equity withdrawal event in month t. We continue to employ the identification strategy of the DiD approach using renters as the benchmark group to control for unobservable local common factors. The regression specification is shown in equation (5):

$$\Delta Debt^{j}_{it+1} = \beta_1 EquityWithdrawal_{it} + \beta_2 Homeowner_i + \gamma X_{it} + \theta_{ct} + \mu_{it} \tag{5}$$

$\Delta Debt^{j}_{it+1}$ is change of non-mortgage debt type j of individual i located in parish c in month $t+1$, $EquityWithdrawal_{it}$ is the equity withdrawal measure. We use two equity withdrawal measures here: (1) *EW dummy*, a dummy variable that equals one if individual i withdraws home equity in month t and 0 otherwise; (2) *EW size*, the amount of home equity in terms of thousand SEK that individual i withdraws in month t. As described in Section 2.1.1, we identify an equity withdrawal event as an individual withdrawal of at least 20 thousand SEK home equity in month t. X_{it} represents a vector of personal characteristics including age, disposable income, and credit score. We control for parish-month fixed effects and cluster standard errors at the parish level.

Since $EquityWithdrawal_{it}$ is a positive number (1 for dummy measure and a positive number for size measure) or zero for homeowners and only zero for renters, the interaction term $EquityWithdrawal_{it} * Homeowner_i$ is equivalent to $EquityWithdrawal_{it}$ and therefore does not show up in equation (5). In this analysis, we only include EWs and renters in the sample because EWs is the primary homeowner group that shows the sophisticated credit-savvy behavior of substituting comparatively expensive short-term debt into comparatively inexpensive mortgage debt.

Table 6 reports the results. The odd columns present the average effect whether homeowners use the money borrowed against home equity to pay down comparatively more expensive non-mortgage debt. The even columns present the marginal effect on the size of substitution between home equity-based borrowing and non-mortgage debt paying down. It can be seen that homeowners withdraw home equity to pay back non-mortgage debt, in particular unsecured loans, confirming the findings in Section 3.1.2. On average, if a homeowner withdraws home equity in month t, she

will pay back credit card debt by 73.3 SEK and unsecured loans by 9,624 SEK, which sum up to a total non-mortgage debt paydown by 9,698 SEK. Since EWs have average credit card debt outstanding of 3,100 SEK and unsecured loans outstanding of 18,000 SEK across the 48-month period (see Panel B of Table 1), it is not difficult to calculate that around 2.4% of credit card debt and 53.5% of unsecured debt balances are paid back in the following month after home equity withdrawal events. The paying down of credit card debt balance is not economically significant, and the estimate of the coefficient on the size measure of equity withdrawal in Column (2) is not statistically significant. This implies that the usage of home equity for paying down credit card debt is negligible.

The estimate of the coefficient on the size measure of equity withdrawal in Column (4) equals to -0.0298 and is significant at the 1% level, which indicates that on average only 2.98% of the total withdrawn home equity money is used to pay down the comparatively expensive unsecured consumer loans.[1] This implies that replacing comparatively expensive non-mortgage debt by favorably priced mortgage in a booming housing market is just one type of use of the money borrowed against home equity. EWs might withdraw home equity for other purposes such as consumption or home improvement, or investing in their own businesses. In Section 3.3, we investigate whether homeowners borrow against home equity for entrepreneurial investment. In Section 4, we connect our study to the previous literature and discuss other home equity-based borrowing channels.

3.3 Home equity withdrawal and entrepreneurial investment

So far we have investigated the effect of the home equity-based borrowing channels on the liability side of a homeowner's balance sheet by providing evidence on substitution between mortgage and non-mortgage debt. In this section, we examine the effect of house prices on the asset side of a homeowner's balance sheet, in particular we are interested in the entrepreneurial investment using home equity.

Recently, a growing literature has emphasized the important role of home equity on entrepreneurial financing (e.g., Corradin and Popov, 2015; Jensen et al., 2015; Schmalz et al., 2017). In this section, we focus on EWs, and examine whether they use the withdrawn home equity to start their own

[1] However, the estimate 2.98% is a lower bound estimate of the proportion of the extracted home equity used for paying down non-mortgage debt.

businesses. Our monthly dataset enables us to trace the monthly changes of an individual's labor supply status (self-employed or not) and mortgage balance, and therefore directly identify whether the equity withdrawal activities subsequently lead to becoming self-employed.

We use the same identification strategy as described in Section 3.2 with the following regression specification:

$$Entry_{it+1} = \beta_1 EquityWithdrawal_{it} + \beta_2 Homeowner_i + \gamma X_{it} + \theta_{tc} + \mu_{it} \tag{6}$$

where $Entry_{it+1}$ is a dummy variable which equals one if individual i becomes an entrepreneur in month $t+1$, $EquityWithdrawal_{it}$ is the equity withdrawal measure. We use two equity withdrawal measures here: (1) *EW dummy*, a dummy variable which equals one if individual i withdraws equity in month t and 0 otherwise; (2) $ln(EW\ size)$, the logarithm of the amount of home equity individual i withdraws in month t. X_{it} includes age, the logarithm of disposable income, and UC credit score. Since the interaction term $EquityWithdrawal_{it} * Homeowner_i$ is equivalent to $EquityWithdrawal_{it}$, and it does not show up in equation (6). We only include EWs and renters here to investigate whether EWs cash out their home equity to start their own businesses. θ_t represents time fixed effects, and η_m represents regional fixed effects. We use two versions of time and regional fixed effects: (1) municipality-year fixed effects; (2) parish-month fixed effects. Since parish is a comparatively small geographic category unit in Sweden,[1] it is unlikely that transitions to entrepreneurship events are seen monthly in a parish. Also, for some parishes, it is possible that there are no such events happening during the four-year sample period. Therefore, we start to control for the time fixed effects at the year level and regional fixed effects at the municipal level, and then move step by step to more restrictive time and regional fixed effects specifications.

Table 7 reports the results of estimates of the coefficients from the linear probability models shown in equation (6). The coefficients on equity withdrawal measures are very stable across columns and statistically significant at the 10% level for most cases including all specifications with fixed effects at the year and municipality level. The smallest estimate of the coefficients on $ln(EW\ size)$ across columns is 0.00006, which implies that a 20,000 SEK home equity withdrawal could increase the probability of transition into entrepreneurship by 0.05%. The baseline probability of

[1] There are 21 counties, 290 municipalities and 1373 parishes in Sweden.

entry into self-employment is 0.066%, thus the 0.05% increment of the probability of transition into entrepreneurship is quite substantial. Since a minimum starting capital of 50,000 SEK is required to register a limited liability company in Sweden,[1] we restrict the equity withdrawal events to those with at least 50,000 SEK and then repeat the regression analysis. The results are quite similar to those seen in Table 7.

We do find evidence that homeowners borrow against home equity for entrepreneurial investment, which could complete our findings in Section 3.2 that only a small proportion of the withdrawn home equity money is used to pay down comparatively expensive non-mortgage debt.

3.4 Robustness checks

For robustness check, we first use house-price volatility or housing supply regulation as the instrument variable to solve the issue that the house-price growth is endogenous to household demand. Then, we use different definitions/thresholds of equity withdrawal to check the validity of our findings. All results are in the online appendix file available upon request.

3.4.1 Instruments for house price growth

Palmer (2015) finds that historical housing market volatility over the 1980s is a strong predictor of the house price cycle experienced over the 2000s in an MSA in the United States. House-price volatility is thus used as the instrument variable in Brown et al. (2015) and is treated as a predictor of house price growth over the 2000s. We follow the same approach and use historical house price volatility 1981–2005 for each municipality as an instrument for the house price growth for the corresponding regions during the period of July 2010–July 2014.[2] The results using the Palmer instrument are consistent with the ones using house-price growth directly, though the estimates of coefficients using the Palmer instrument are generally larger.

Sweden is known for its restrictive regulatory environment with housing supply. The municipal planning process is complicated and involves various interest groups, thus construction must go through a lengthy planning process with a high probability of appeals. Even though a construction company obtains building permit from the municipality, local residences might appeal against the

[1] http://www.bolagsverket.se/en/bus/business/limited/2.1144

[2] Because Valueguard only provides the house price index data from 2005, the historical house prices 1981–2005 we use is the annual average house price per transaction in SEK at the municipal level from Statistics Sweden.

new construction to the county. The county that the municipality belongs to will decide whether to overrule the appeal or not. We use the fraction of municipal appeals that has been overruled by the county as the instrument to measure how building-friendly or in favor of promoting regional development the local politicians may be. A higher fraction of municipal appeals overruled by the county means a more building-friendly environment and therefore less constraint on housing supply. The measurement is created based on the planning and building survey by Sweden's National Board of Housing, Building and Planning in 2013.[1] We find that the results are consistent with the ones using house-price growth directly.

3.4.2 Alternative definitions of equity withdrawers

We define home EWs as mortgagors who have withdrawn home equity at least once in the sample but without purchasing new properties. Around 75% of home EWs withdrew only once in the sample period, and 95% of EWs withdrew less than five times in the sample period. To rule out the possibility that our results are driven by the EWs who withdrew more frequently in the sample period, we redefine EWs as mortgagors who have withdrawn home equity only once in the sample but without purchasing new properties and repeat the analyses in Tables 4-7. The results are generally consistent.

Another concern regarding the current definition of EWs is that it might include individuals who increase mortgages to change their old home to a new one within the same property type (apartment or single-family house) at the same location. Those individuals should be categorized as HTs, though those cases are rare. Thus we repeat the analyses by restricting EWs to those who withdrew between 20–100 thousand SEK during the sample period. We choose 100 thousand SEK as the threshold because it could be used to pay down non-mortgage debt substantially and is enough to register for a limited liability company but at the same time is not enough to purchase a new property. The main results are robust to different definitions.

[1] Sweden's National Board of Housing, Building and Planning only has the open data of the planning and building survey from 2013–2015 on their website. We decided to create the instrument variable using the survey in 2013 because it is the earliest year which is fully covered in our sample period.
http://www.boverket.se/sv/om-boverket/publicerat-av-boverket/oppna-data/plan--och-byggenkaten/

4 Discussion

One caveat which might weaken our results is that homeowners, especially EWs may be wealthier than renters. Though we have no data on individuals' financial assets holdings, we indirectly control for the effect from financial wealth through disposable income in all our regression analyses. The disposable income[1] has already taken into account the net capital gain on financial investments. Though the net realized capital gain might not proportionally reflect the total financial wealth of an individual, in this study we focus on the flows rather than stocks of personal debt. Thus only the net realized capital gain of financial wealth can affect our results.

Another concern is the wealth effect that the local house price appreciation might affect consumer behavior or preference of entrepreneurial investment. In our study, we assume that the psychological effect of the increase in housing wealth on local households are homogeneous. Renters cannot benefit directly from house price increases; however, it is likely that they will increase spending due to peer pressure and behavior reasons. Those who live in a neighborhood with a higher proportion of rich people tend to borrow more through their credit card debt, which is known as the "keeping up with the Joneses" effect on consumption. [2] By using renters as the control group, we consider the effect of house prices on the consumption for homeowners, which allows us to focus on the housing collateral channel. Thus the wealth effect is partly absorbed through using renters as the control group. In addition, our results are driven by EWs, the wealth effect due to the appreciated house value should have the same effect on both EWs and other homeowner types. The subgroup study suggests that the wealth effect is not the main driver of our empirical findings.

Our results show that homeowners indeed withdraw home equity in response to the house price appreciation and use the proceeds to pay down comparatively more expensive non-mortgage debts or invest in entrepreneurial activities. However, it is also possible that homeowners borrow against home equity for consumption or home improvement.[3] In the United States, according to surveys on mortgage refinancing activities during 1998–1999 and 2001–2002, 51% of cash-out refinancing is

[1] Disposable income=labor income-tax payment+net realized capital gain (after tax)

[2] Bos et al. (2017) use the credit registration data on Swedish households to investigate the peer effects on consumption.

[3] Many papers have studied the effect of house prices on consumption growth through the collateral channel in times of credit constraints (e.g., Hurst and Stafford, 2004; Iacoviello, 2004; Lehnert, 2004; Lustig and Van Nieuwerburgh, 2005; Ortalo-Magne and Rady, 2006; Campbell and Cocco, 2007; Cooper, 2009; Gan, 2010; Mian et al., 2013; Justiniano et al., 2015; Agarwal and Qian, 2017; Saxena and Wang, 2016).

used for home improvement and consumption (33% for home improvement and 28% for consumer expenditures) while 47% of the extracted home equity money is used for repayment of other debt and real estate or business investment (Brady et al., 2000; Canner et al., 2002). Similarly, the consumer survey in the U.K. during 1998–2000 shows that home equity withdrawal is an important financing channel for consumption, in particular home improvements (Davey, 2001). In addition, Almaas et al. (2015) investigate home equity-based refinancing in Norway based on household-level data from 2012 Survey on Living Conditions for Norwegian Residents. The survey reports that the percentage of new issued mortgages of home equity credit lines for home improvement and consumption (measured by purchasing of a car, boat or cabin) are respectively 33% and 32%. In this study, we cannot verify whether homeowners use withdrawn home equity to renovate their houses or consume due to data limitations. However, this does not inflate our findings that paying down more expensive non-mortgage debt and investing in entrepreneurial activities are two important purposes for home equity-based borrowing. Moreover, a recent study by Sodini et al. (2016) that uses a quasi-experiment surrounding privatization decisions of municipally owned apartment buildings in Sweden suggests that consumption responses to house wealth shocks require liquidation of illiquid housing wealth. They find little effect on consumption from the housing collateral channel.

5 Conclusion

Using the credit registration data on Swedish individual debt composition between July 2010 and July 2014, we investigate how homeowners adjust their borrowing behaviors and manage their personal debt in response to rapid growth in house prices. We find that homeowners demonstrate sophisticated behavior in saving debt payment costs by using extracted home equity to pay down comparatively more expensive non-mortgage debts. We also find that homeowners borrow against home equity to invest in properties or businesses. This indicates that home equity is an important financing channel for homeowners with financial constraints to optimize their debt portfolio and make investments. However, the home equity borrowing channel needs a booming house market and could be fragile if house prices start to fall. If an unexpected house price downturn occurs, homeowners cannot substitute non-mortgage debt with cheaper mortgages and would face high interest payments from unsecured personal debt. Therefore, they might need to cut their consump-

tion expenses to cover higher interest costs. Meanwhile, homeowners, especially those with high income risk, might need to increase their precautionary savings and reduce consumption even further.[1] Though the microlevel evidence on the home equity financing channel in this paper is based on the house booming era, it could help us to consider the possible consequences when the booming housing market trend ends. With unexpected negative shocks to house prices, over-optimistic households, who are usually severely financially constrained, will be exposed to high interest rate costs and may default on the payments.

Our results show that homeowners indeed extract home equity and use the proceeds to start their businesses, confirming the findings in recent studies that strengthen the role of housing collateral channel on entrepreneurship (e.g., Corradin and Popov, 2015; Jensen et al., 2015; Schmalz et al., 2017). Though the rising house prices ease financing constraints and enable homeowners to access more credit, the efficiency of business investments financed by home equity needs further investigation. For example, Schmalz et al. (2017) find that entrepreneurs with access to more valuable collateral start larger firms that remain significantly larger even six years after creation. However, Jensen et al. (2015) find that newly started businesses financed through home equity-based borrowing are more likely to fail and have lower performance than those who have not used home equity financing. They argue that those entrepreneurs who have no credit allocation from banks due to less-promising businesses, can bypass bank screening and select into entrepreneurship with the benefits of home equity. Thus, more comprehensive analyses of the efficiency of credit allocation to businesses based on home equity-based borrowing are needed.

Housing is the most important asset for most individuals and the purchase coincides with a large jump in the household leverage. It is a crucial decision how to optimally manage the mortgage and other types of debt over life cycle phases. Therefore, it could be interesting to look at the intergenerational dynamics of debt profile and explore how house prices affect personal debt management decisions of heterogeneous households over their life cycles. We leave this for future research.

[1] Agarwal and Qian (2017) find a significant negative consumption response to a housing policy experiment in Singapore resulting in a decrease in access to home equity. The consumption response appears to be stronger among individuals with limited access to credit market or with high precautionary saving motive.

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Table 1. Summary statistics

	Panel A: homeowners vs. renters					
	N	Mean	Std. Dev.	p25	Median	p75
	Full sample					
Credit card debt	4,867,513	3.1	9.6	0	0	0.8
Unsecured loans	4,867,513	18.3	72.1	0	0	0.9
Mortgage	4,867,513	535.4	870.7	71.9	348.3	769.0
Age	4,844,322	51	14	40	50	62
Credit score	4,844,322	1.8	8.5	0.1	0.1	0.3
Disposable income	4,844,322	232.7	299.1	152.2	211.3	276.7
	Homeowner					
Credit card debt	3,932,005	2.8	9.2	0	0	0
Unsecured loans	3,932,005	15.4	72.7	0	0	0
Mortgage	3,932,005	662.7	924.2	229.2	480.4	892.5
Age	3,917,775	51	14	40	50	61
Credit score	3,917,775	1.0	6.2	0.1	0.1	0.2
Disposable income	3,917,775	237.4	228.7	157.2	216.4	283.7
	Renter					
Credit card debt	935,508	4.5	11.1	0	0	4.1
Unsecured loans	935,508	30.3	68.2	0	0	35.0
Mortgage	935,508	0	0	0	0	0
Age	926,547	53	16	41	54	66
Credit score	926,547	4.9	14.4	0.1	0.3	1.3
Disposable income	926,547	212.6	496.0	134.8	191.5	246.3

	Panel B: by homeowner type							
	EWs		HTs		AMs		Others	
	mean	sd	mean	sd	mean	sd	mean	sd
Credit card debt	3.1	9.6	4.1	11.0	2.7	13.0	2.2	8.0
Unsecured loans	18.0	89.8	28.5	106.4	8.5	32.4	10.0	37.1
Mortgage	804.5	1025.3	671.9	826.5	597.9	662.8	541.0	843.0
Age	49	13	49	14	51	13	53	14
Credit score	0.6	3.6	1.9	8.7	0.8	5.2	1.2	7.0
Disposable income	244.1	242.7	273.8	336.8	224.0	172.7	222.7	175.8
Obs	1,563,832		472,879		55,384		1,825,680	

Notes: This table shows descriptive statistics on personal debt balances and individual characteristics. Panel A presents the summary statistics for the full sample and subsamples for homeowners and renters, respectively. Panel B presents the summary statistics for the subcategories of homeowners: equity withdrawers (EWs), active house traders (HTs), amortizers (AMs), and others. Personal debt includes mortgage and short-term consumer debt (credit card debt and unsecured loans). Individual characteristics include credit score, age, disposable income, and an indicator whether the individual is self-employed or not. Disposable income, credit card debt, unsecured loans, and mortgage debt are in thousand SEK.

Table 2. House price growth and cumulative personal debt changes

	ΔTotal debt	ΔMortgage	ΔTotal non-mortgage debt	ΔCredit card debt	ΔUnsecured loans
	(1)	(2)	(3)	(4)	(5)
			Panel A		
HPgrowth	92.67***	93.79***	-1.12	1.27***	-2.69
	(17.56)	(17.44)	(2.19)	(0.27)	(1.94)
Additional controls	YES	YES	YES	YES	YES
Observations	79,441	79,441	79,441	79,441	79,441
Adjusted R^2	0.011	0.011	0.001	0.002	0.001
			Panel B		
HPgrowth*Homeowner	107.40***		-5.71	0.09	-7.23**
	(18.88)		(3.98)	(0.58)	(3.46)
HPgrowth	-11.49**	93.79***	4.78	1.18**	4.69
	(4.92)	(17.44)	(3.32)	(0.53)	(2.99)
Homeowner	41.34***		4.89***	0.37***	4.43***
	(4.10)		(1.10)	(0.13)	(0.98)
Additional controls	YES	YES	YES	YES	YES
Observations	98,135	79,441	98,135	98,135	98,135
Adjusted R^2	0.011	0.011	0.001	0.003	0.001

Notes: This table reports the effect of house price growth on cumulative personal debt changes during the period July 2010–July 2014. Panel A reports the results of regression

$$\Delta Debt^{j}{}_{ict_1-t_2} = \beta HPGrowth_{ct_1-t_2} + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2}$$

Panel B reports the results of regression

$$\Delta Debt^{j}{}_{ict_1-t_2} = \beta_1 HPGrowth_{ct_1-t_2} * Homeowner_i + \beta_2 HPGrowth_{ct_1-t_2} + \beta_3 Homeowner_i + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2}$$

The dependent variables are the differences of debt balances (total debt, mortgage, total non-mortgage debt, credit card debt, and unsecured consumer loans) between July 2010 and July 2014. The units of dependent variables are thousand SEK. *HPgrowth* is the parish-level house price growth between July 2010 and July 2014. *Homeowner* is a dummy variable that equals one if individual i is a homeowner and zero if individual i is a renter. This variable is time invariant during the sample period. Additional controls include the difference of the individual's disposable income between July 2010 and July 2014, and the individual's credit score and age in July 2010. Standard errors are in parentheses. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3. House price growth and time series dynamics of personal debt composition

	Total debt	Mortgage	Total non-mortgage debt	Credit card debt	Unsecured loans
	(1)	(2)	(3)	(4)	(5)
HPgrowth*Homeowner	736.30***	766.00***	-29.68***	-1.20*	-25.20***
	(104.50)	(104.30)	(4.66)	(0.69)	(4.20)
Homeowner	533.00***	546.10***	-13.15***	-1.38***	-11.97***
	(13.14)	(13.07)	(0.83)	(0.10)	(0.75)
Additional controls	YES	YES	YES	YES	YES
Parish-Month FE	YES	YES	YES	YES	YES
Observations	4,645,653	4,645,653	4,645,653	4,645,653	4,645,653
Adjusted R^2	0.182	0.188	0.028	0.017	0.028

Notes: This table reports the results of regression equation

$$Debt^{j}_{ict+1} = \beta_1 HPGrowth_{c,t-36,t} * Homeowner_i + \beta_2 Homeowner_i + \gamma X_{ict} + \theta_{ct} + \mu_{ict}$$

Both homeowners and renters are included in the analysis. The dependent variables are the debt balances (total debt, mortgage, total non-mortgage debt, credit card debt, and unsecured consumer loans) in month $t+1$. *HPgrowth* measures the cumulative three years' house price growth until month t at the parish level. *Homeowner* is a dummy variable that equals one if individual i is a homeowner and zero if individual i is a renter. This variable is time invariant during the sample period. Additional controls include the disposable income of individual i in month t, and the individual's credit score and age in July 2010. All regression specifications have parish-month fixed effects. Standard errors, which are in parentheses, are clustered at the parish level. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4. House price growth and cumulative personal debt changes by homeowner type

	ΔTotal debt	ΔMortgage	ΔTotal non-mortgage debt	ΔCredit card debt	ΔUnsecured loans
	(1)	(2)	(3)	(4)	(5)
			Panel A		
Equity withdrawer	149.10***	157.80***	-8.67*	1.21***	-10.58**
	(33.91)	(34.09)	(4.63)	(0.39)	(4.22)
House trader	339.10***	320.70***	18.39*	2.05***	14.05
	(78.85)	(77.48)	(9.74)	(0.77)	(8.69)
Amortizer	-105.70*	-124.70**	19.05	2.75	21.64
	(57.29)	(52.84)	(20.14)	(2.20)	(19.79)
Renter			5.53*	1.20**	5.25*
			(3.28)	(0.53)	(2.94)
			Panel B		
Equity withdrawer	169.40***	157.80***	-11.78**	-0.00	-13.54***
	(35.49)	(34.09)	(5.01)	(0.63)	(4.38)
House trader	362.50***	320.70***	13.95	0.87	9.56
	(79.92)	(77.48)	(10.65)	(0.88)	(9.28)
Amortizer	-111.40*	-124.70**	15.30	1.63	17.34
	(57.47)	(52.84)	(21.81)	(2.25)	(21.25)

Notes: This table reports the effect of house price growth on cumulative personal debt changes during the period July 2010–July 2014 using homeowner type subsamples. Panel A reports the estimates of the coefficient on house price growth in regression equation

$$\Delta Debt^{j}{}_{ict_1-t_2} = \beta HPGrowth_{ct_1-t_2} + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2}$$

Panel B reports the estimates of the coefficient on the interaction term between house price growth and homeowner in regression equation

$$\Delta Debt^{j}{}_{ict_1-t_2} = \beta_1 HPGrowth_{ct_1-t_2} * Homeowner_i + \beta_2 HPGrowth_{ct_1-t_2} + \beta_3 Homeowner_i + \gamma X_{ict_1-t_2} + \mu_{ict_1-t_2}$$

In Panel A, only one type of homeowner or renters are included in a regression analysis. In Panel B, each regression analysis includes one type of homeowner and renters as the control group, while the regression specification in Column (2) in Panel B is only for the corresponding type of homeowner. The dependent variables are the differences of debt balances (total debt, mortgage, total non-mortgage debt, credit card debt, and unsecured consumer loans) between July 2010 and July 2014. Debt balances are measured in thousand SEK. House price growth is the parish-level house price growth between July 2010 and July 2014. Controls in Columns (1)–(5) in both Panel A and Panel B also include other individual characteristics: the individual's credit score and age in July 2010, and the difference of the individual's disposable income between July 2010 and July 2014. Standard errors are in the parentheses. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 5. House price growth and time series dynamics of personal debt composition by homeowner type

	Total debt	Mortgage	Total non-mortgage debt	Credit card debt	Unsecured loans
	(1)	(2)	(3)	(4)	(5)
Equity withdrawer	821.60***	852.40***	-30.76***	-0.30	-26.10***
	(123.60)	(123.70)	(5.83)	(0.76)	(5.22)
House trader	835.50***	858.20***	-22.67***	-1.22	-21.65***
	(130.70)	(131.00)	(8.07)	(0.99)	(6.99)
Amortizer	906.30***	929.20***	-22.91	-4.55	-23.63
	(199.70)	(200.30)	(17.13)	(2.89)	(15.82)

Notes: This table reports the estimates of the interaction term of $HPGrowth * Homeowner$ in regression equation

$$Debt^{j}_{ict+1} = \beta_1 HPGrowth_{c,t-36,t} * Homeowner_i + \beta_2 Homeowner_i + \gamma X_{ict} + \theta_{ct} + \mu_{ict}$$

using homeowner type subsamples. Each subsample includes one type of homeowner and renters as the control group. The dependent variables are debt balances (total debt, mortgage, total non-mortgage debt, credit card debt, and unsecured consumer loans) in month $t+1$, measured in thousand SEK *HPgrowth* measures the cumulative three years' house price growth until month t at the parish level. *Homeowner* is a dummy variable that equals one if individual i is a homeowner and zero if individual i is a renter. This variable is time invariant during the sample period. Controls in Columns (1)–(5) in both Panel A and Panel B also include other individual characteristics: the individual's credit score and age in July 2010, and the individual's disposable income of individual i in month t. All regression specifications have parish-month fixed effects. Standard errors are in parentheses and clustered at the parish level. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6. Home equity withdrawal and non-mortgage debt paying down

	ΔCredit card debt		ΔUnsecured loans		Δ Total non-mortgage debt	
	(1)	(2)	(3)	(4)	(5)	(6)
EW dummy	-0.0733***		-9.6240***		-9.6980***	
	(0.0240)		(0.8430)		(0.8400)	
EW size		-0.0000		-0.0298***		-0.0298***
		(0.0000)		(0.0070)		(0.0070)
Homeowner	0.0022	0.0002	0.3130***	0.2520***	0.3150***	0.2530***
	(0.0025)	(0.0024)	(0.0325)	(0.0560)	(0.0325)	(0.0562)
Additional controls	YES	YES	YES	YES	YES	YES
Parish-Month FE	YES	YES	YES	YES	YES	YES
Observations	2,439,785	2,439,785	2,439,785	2,439,785	2,439,785	2,439,785
Adjusted R^2	-0.006	-0.006	-0.006	-0.003	-0.006	-0.003

Notes: This table reports the results of regression

$$\Delta Debt^{j}_{it+1} = \beta_1 EquityWithdrawal_{it} + \beta_2 Homeowner_i + \gamma X_{it} + \theta_{ct} + \mu_{it}$$

Only EWs and renters are included in the analysis. The dependent variables are the differences of debt balances (credit card debt, unsecured debt, and total non-mortgage debt) between month t and month $t+1$, measured in thousand SEK. We use two equity withdrawal measures: (1) *EW dummy*; (2) *EW size*. *EW dummy* is a dummy variable that equals one if an individual withdrew home equity of at least 20,000 SEK in month t. *EW size* is the home equity withdrawal amount in terms of thousand SEK if *EW dummy* equals one. *Homeowner* is a dummy variable that equals one if individual i is a homeowner and zero if individual i is a renter. Additional controls include the disposable income of individual i in month t, and the individual's credit score and age in July 2010. Standard errors are in parentheses and clustered at the parish level. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7. Home equity withdrawal and entrepreneurial investment

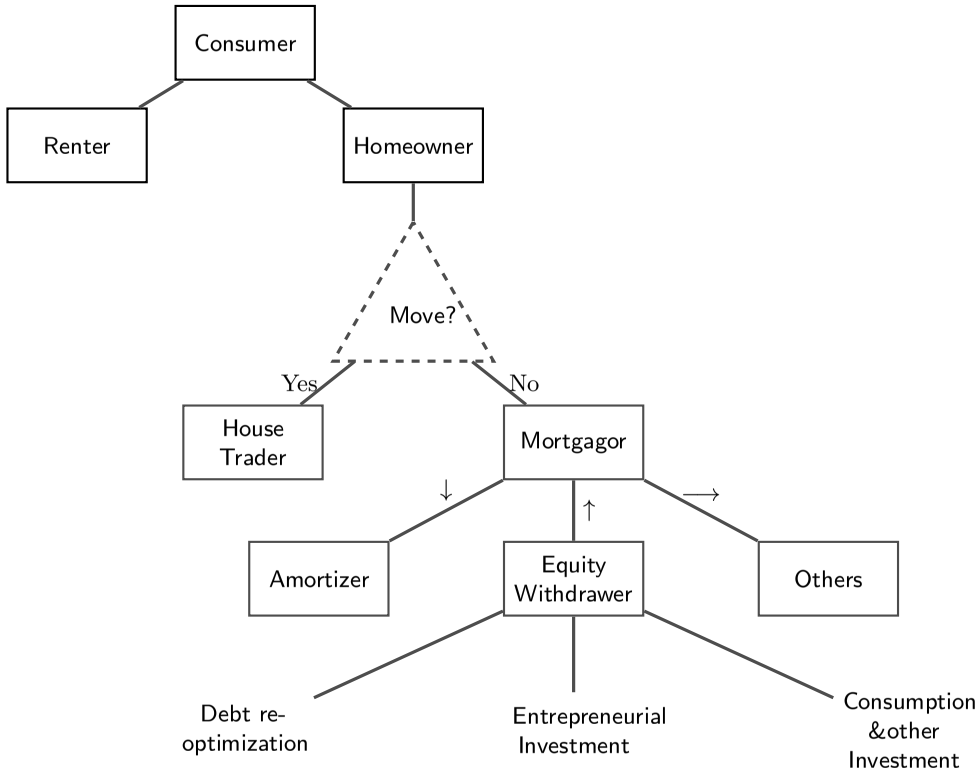
	Becoming self-employment			
	(1)	(2)	(3)	(4)
EW dummy	0.00027*		0.00028	
	(0.00016)		(0.00017)	
Ln(EW size)		0.00006*		0.00006
		(0.00003)		(0.00007)
Homeowner	0.00011***	0.00011***	0.00009 **	0.00009 **
	(0.00004)	(0.00004)	(0.00004)	(0.00004)
Additional controls	YES	YES	YES	YES
Municipality-Year FE	YES	YES	NO	NO
Parish-Month FE	NO	NO	YES	YES
Observations	2,183,465	2,183,465	2,183,465	2,183,465
Adjusted R^2	0.000	0.000	0.013	0.013

Notes: This table reports the results of regression

$$Entry_{it+1} = \beta_1 EquityWithdrawal_{it} + \beta_2 Homeowner_i + \gamma X_{it} + \theta_{tc} + \mu_{it}$$

using a linear probability model. Only EWs and renters are included. The dependent variable is a dummy that equals one if individual i becomes self-employed in month $t+1$. We use two equity withdrawal measures: (1) *EW dummy*; (2) $Ln(EW\ size)$. *EW dummy* is a dummy variable that equals one if an individual withdrew home equity of at least 20,000 SEK in month t. $Ln(EW\ size)$ is the logarithm of home equity withdrawal size (thousand SEK) if *EW dummy* equals one. *Homeowner* is a dummy variable that equals one if individual i is a homeowner and zero if individual i is a renter. Additional controls include the logarithm of the disposable income of individual i in month t, and the individual's credit score and age in July 2010. Standard errors are in parentheses and clustered at the municipal level in Columns (1)–(2) and at the parish level in Columns (3)–(4). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

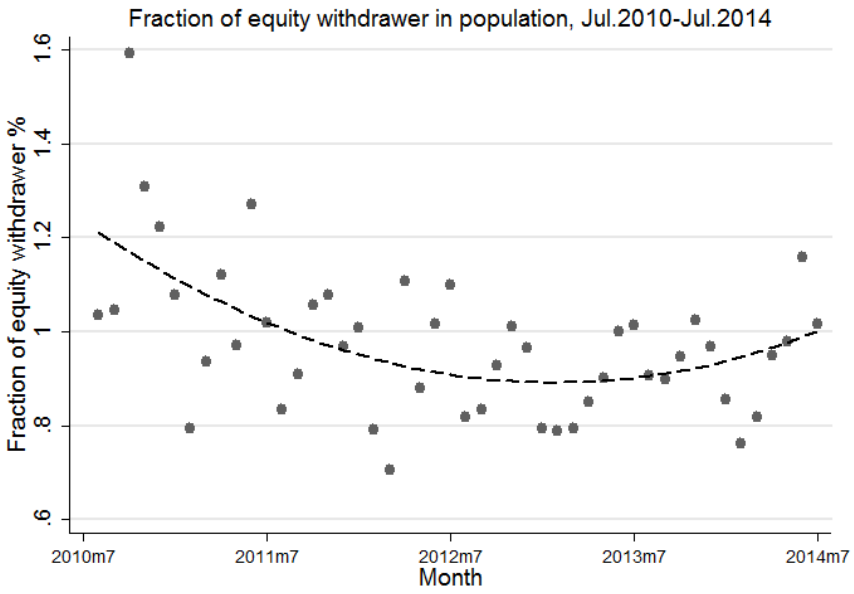
Figure 1. Flowchart for homeowner categorization



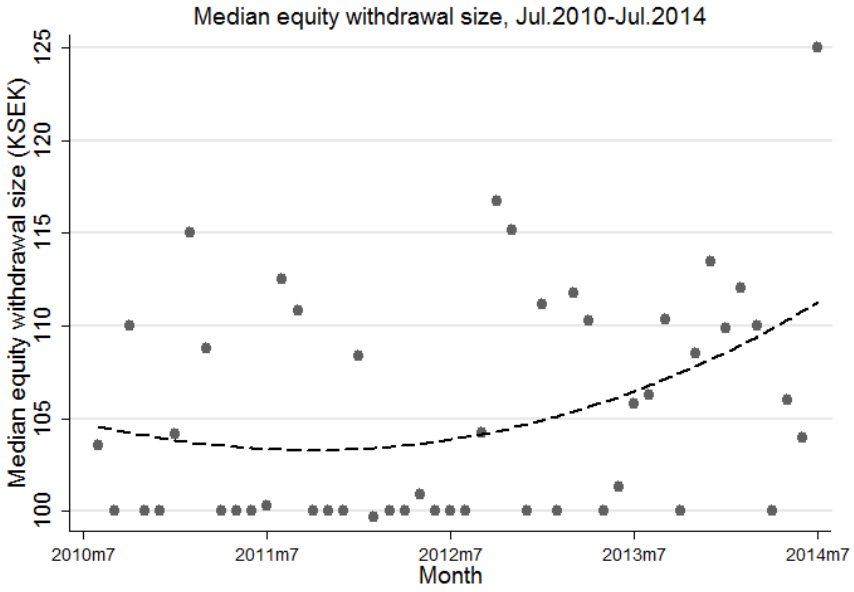
Notes: This figure illustrates the process for categorizing homeowners based on their moving decisions and mortgage changes.

Figure 2. Equity withdrawal dynamics, July 2010–July 2014

(a)



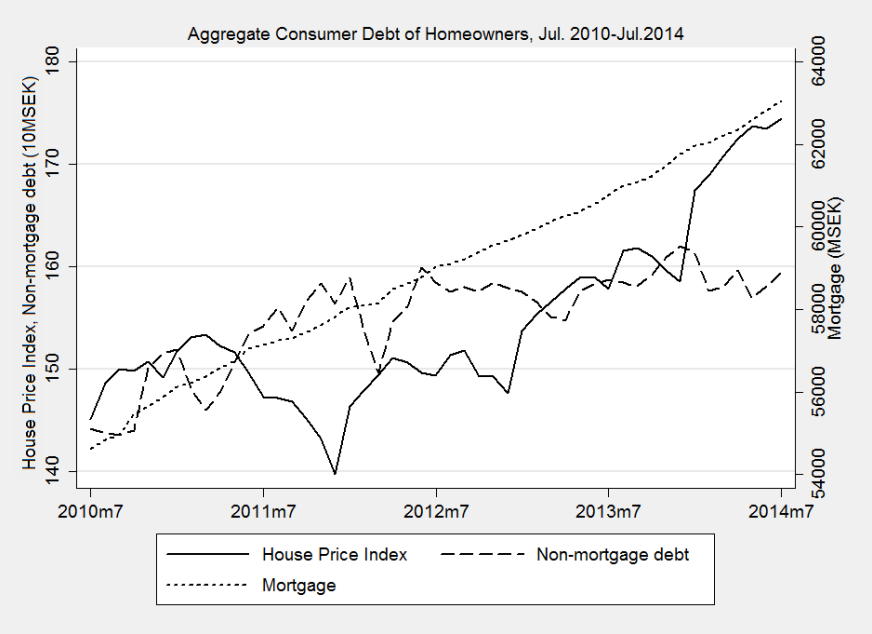
(b)



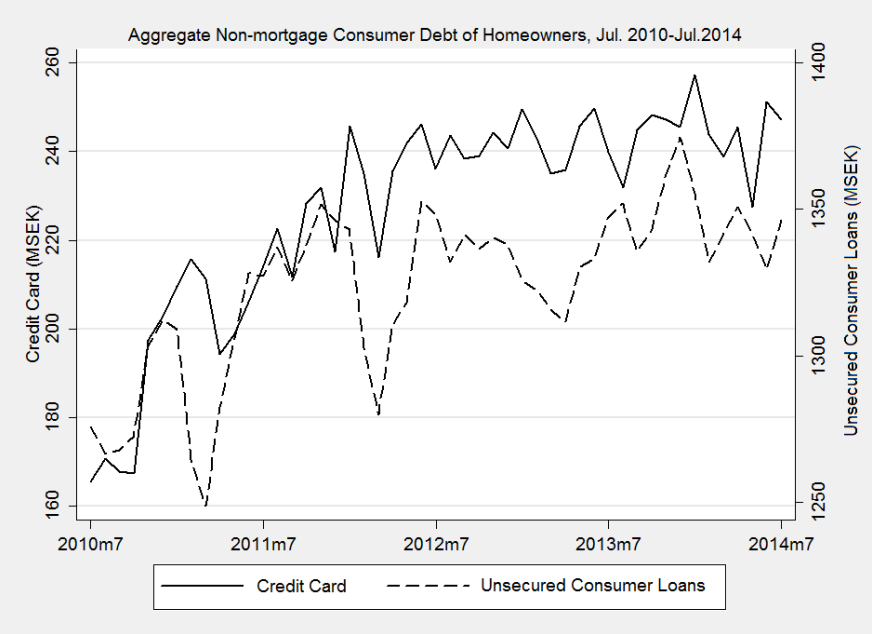
Notes: Figure(a) presents the fraction of EWs in the full sample during the period July 2010–July 2014. Figure(b) presents the median equity withdrawal size in terms of thousand SEK for the full sample during the period July 2010–July 2014.

Figure 3. Aggregate consumer debt for homeowners, July 2010–July 2014

(a)



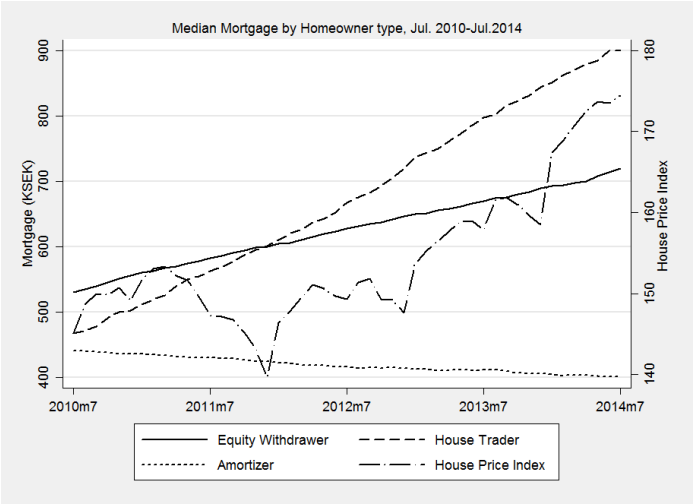
(b)



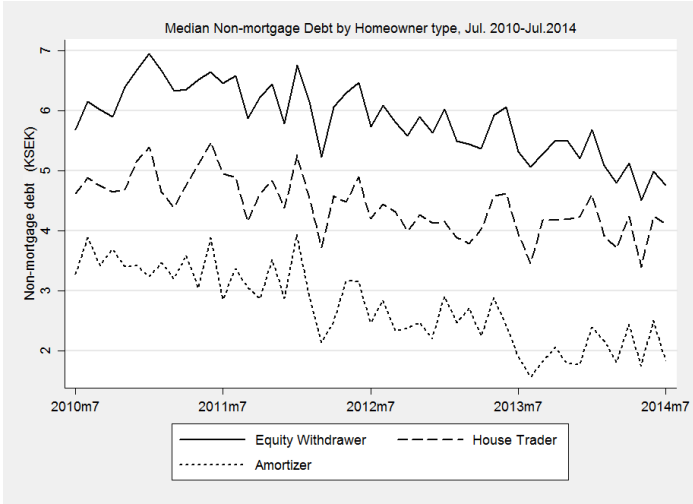
Notes: Figure(a) presents aggregate mortgage and non-mortgage debt of homeowners in the full sample during the period July 2010–July 2014. Figure(b) presents aggregate credit card debt and unsecured consumer loans of homeowners in the full sample during the period July 2010–July 2014.

Figure 4. Individual consumer debt by homeowner type, July 2010–July 2014

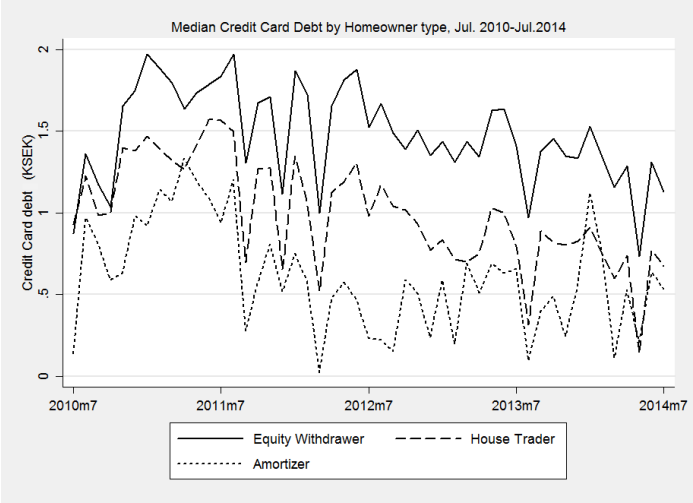
(a) Mortgage



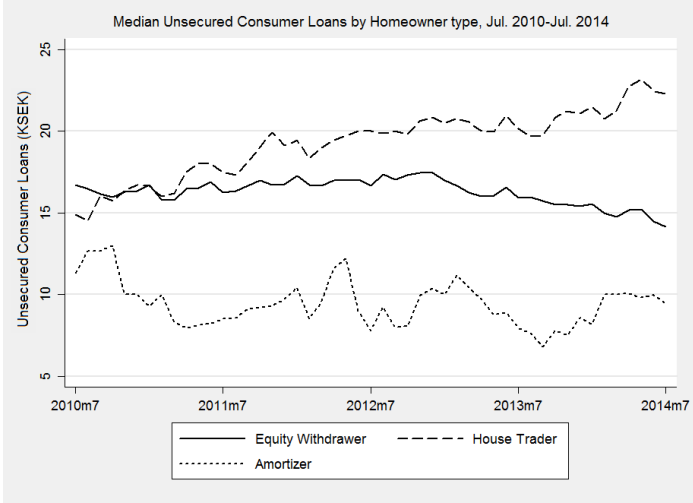
(b) Non-mortgage



(c) Credit card debt



(d) Unsecured consumer loans



Notes: This Figure presents the dynamics of the median size of consumer debt by homeowner type and debt type for the full sample during the period July 2010–July 2014.

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