The Effect of Increasing House Prices on Household Debt in Sweden

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Bachelor Thesis

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Abstract:

By using data on house prices and household debt during the years 2010-2016 the paper aims to determine the effect of increasing house prices on housing debt and debt-to-income across Swedish municipalities. Via an IV approach we find a significant causal relationship between house prices and household debt. Dividing the populations based on net income and population size respectively, indicate that municipality characteristics dictate the relationship between rising house prices and borrowing behavior among households, and that the magnitude of the effect varies significantly within the country. We find a stronger tendency to increase debt to income ratio among households in both lower income municipalities and in municipalities with less population.

Keywords:
Household debt, Housing debt, Mortgages, House prices, Debt ratio, Instrumental variable

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I. Introduction

Rising house prices have been a major topic for policymakers and researchers in recent years. Whilst increasing house prices are arguably beneficial for existing homeowners, the aggregate impact on the wider economy remains less clear.

The aftermath of the 2008 financial crisis sparked a discussion regarding the potential dangers of rapidly increasing house prices. The area of concern in our analysis is the impact of increased house prices on household debt. Households in the US doubled their outstanding debt from the years 2002-2007. Increasing house prices, stemming from an increase in availability of mortgage credit, may have impacted leverage for already existing homeowners, allowing them to borrow via the home equity channel and push household debt to levels ultimately resulting in the global financial crisis. (Mian & Sufi, 2011)

Swedish households have increased their leverage in the form of debt over disposable income in recent decades (Rima.A Turk, 2015). Likewise, the total outstanding housing debt among households has increased. At the same time, house prices have also been on the rise, potentially being an underlying factor of the increased debt levels. On a global stage, the leverage among Swedish households consistently ranks among the top, along with some of its nordic peers (Trading Economics, 2021). The country also ranks high in the share of variable rate mortgages issued (Damien Puy & Kimiaki Shinozaki, 2022), increasing households' risk exposure to rising interest rates. In an economic climate where inflation requires policy rate hikes, the interest rate exposure among households will in large part dictate their ability to cope with changes in the economic climate.

Our paper aims to study the impact of increasing house prices on household leverage and housing debt, by analyzing house price development, housing debt and debt to income ratios in Swedish municipalities from 2010 to 2016. We also investigate whether the relationship between housing debt and house prices varies between municipalities with different per capita income levels and population size. Our empirical analysis is largely based on a unique data set completed by the credit reference agency UC on the request by the Swedish Central bank, published in 2017. Apart from that report, household debt on a municipality level has not been measured regularly in Sweden since the abandonment of the wealth tax in 2007 . The novel dataset provides an extraordinary opportunity to observe the debt development on a municipality level during the majority of the 2010´s.

Our empirical analysis shows a significant impact from house prices on household housing debt and debt to income. We find that a one percent increase in house prices results in a 0.5% increase in housing debt and a 0.24% increase in household leverage on an aggregate level across all municipalities. We also find evidence of different magnitudes in the relationship between prices and debt depending on municipality characteristics. Average net income in the municipality, as well as population size, appears to affect the households borrowing behavior in regards to house prices.

II. Theoretical background

Many papers have previously investigated the relationship between house prices and household debt. Mian and Sufi (2011) investigate the effect of rising house prices on household behavior in an American setting in the years 2002-2006, leading up to the financial crisis. They emphasize how rising house prices led to increased home equity-based borrowing for already existing mortgage takers, and thus increased household leverage, ultimately setting the scene for the economic downturn. They find that American households during the period increased their debt by 25 cents per dollar increase in home value, and that a one standard deviation increase in house prices results in a quarter standard deviation increase in the debt to-income ratio among households. Additionally, they report a stronger tendency to borrow via the equity based borrowing channel among households with borrowing constraints.

Foote, Lowenstein, Paul, and Willen (2016) argue against the results of Mian and Sufi (2011), concluding that the housing debt increase in the beginning of the 2000's occurred throughout the income distribution. They disregard the notion of housing debt being relocated to low income individuals, and show that the debt-to-income levels remained equal throughout the income distribution. They find that the accumulation of debt stemmed not from eased borrowing constraints but rather from expectations regarding increasing house prices.

Rima. A Turk (2015) studies the relationship between the housing market and the household debt in Sweden. Unlike Mian and Sufi (2010), Turk makes use of a three equation model in his analysis. The paper aims to determine the driving factors of debt and prices, by observing both short- and long-term dynamics in the housing market, and finds that the increase in home value is the main driver of the increase in household debt levels.

An important aspect to consider is how debt and house prices may be determined and affected jointly as a result of an omitted variable. Growth in expected income may be such a variable, resulting in an increase in borrowing as well as increased house prices (Muellbauer & Murphy, 1997). Mian and Sufi (2011) address the endogeneity problem by use of an instrumental variable (IV) in their model, namely, housing supply elasticity provided by Saiz (2010). The usage of housing supply elasticity as an instrument in examining the relationship between house prices and consumption or debt has been criticized. Mainly, the exogeneity of housing supply elasticity with regards to unobserved factors determining household consumption and borrowing has been questioned. Furthermore, housing supply elasticity is often only measured for specific areas, and for specific points in time, making usage of the instrument difficult for longer time periods (Graham & Makridis, 2023).

Our primary aim is to attempt a replication of the aforementioned paper by Mian & Sufi (2011) but applying the question to Sweden. The change of setting to Sweden in particular is deemed meaningful as the country's households have behaved similarly to households in the US in the years prior to the financial crisis. That is, house prices have increased at a high rate in Sweden during recent decades, whilst household debt has also increased. Therefore, in this thesis we expand the literature regarding the relationship between household debt and house prices by investigating the relationship in a new period and geographical setting, using a novel dataset. Additionally, we investigate the relationship on a municipality level, as we deem it likely that effects differ depending on municipality characteristics. Figures 1 through 7 display how house prices, housing debt, debt-to-income ratio and net income municipality level differ geographically across municipalities.

Debt, house price and income developments in Sweden

Debt to disposable income has seen a steady increase during the last two decades, in line with Nordic peers (Figure 8). Compared to the OECD average however, households have increased their leverage at a faster rate. Debt to total assets, on the other hand, has seen a decrease in the same time period (Rima A. Turk, 2015), indicating that the rising debt comes at the backdrop of increasing assets. The Swedish housing tax was removed in 2008, and with the tax deductible of 30% on mortgage payments, amortization is disincentivized. The absence of amortization requirements in the period also resulted in households not paying back their debt (Hull, 2017), resulting in an accumulation of household debt.

In the period subject to our analysis debt over disposable income has continued its increase, with a total growth rate of around 3,7% during 2010-2016, whilst the housing debt debt has seen a greater increase, of around 31%. Both debt-to-income and housing debt have increased less than house prices (Figure 9 and 10). The lesser growth in debt over disposable income likely reflects an increase in net income (Figure 11). Figure 12 and 13 displays strong increases in net income both in relation to house prices and housing debt. Figure 14 indicate that net income have increased differently within municipalities depending on their mean income over the period, and figure 16 show substantially different housing debt to net income ratios across municipalities with different population sizes.

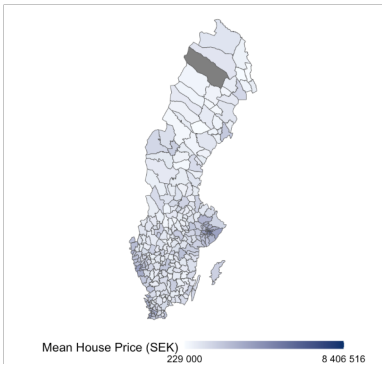


Figure 1. Municipality level mean house prices in 2010. Based on sample of 50,015 house sales.

Source: Svensk Mäklarstatistik.

Note: Grey areas indicate zero house sales.

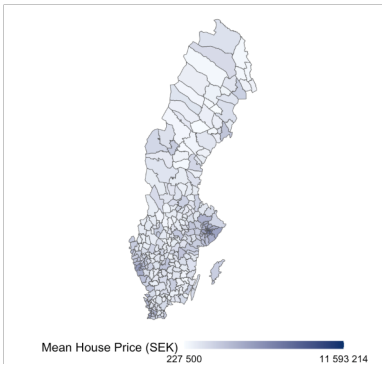


Figure 2. Municipality level mean house prices in 2016. Based on sample of 55,096 house sales.

Source: Svensk Mäklarstatistik.

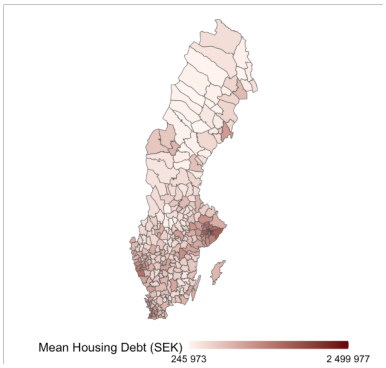


Figure 3. Municipality level mean housing debt for house owning households, 2010.

Source: Sveriges Riksbank.

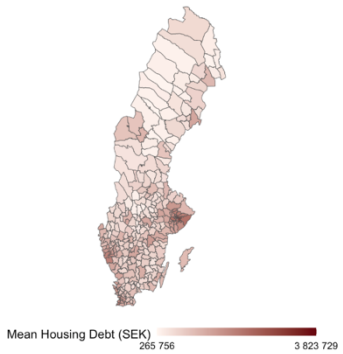


Figure 4. Municipality level mean housing debt for house owning households, 2016.

Source: Sveriges Riksbank.

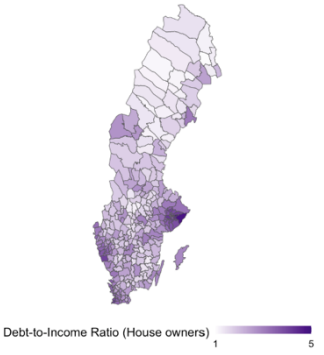


Figure 5. Municipality level mean debt-to-income ratio for house owning households, 2010.

Source: Sveriges Riksbank.

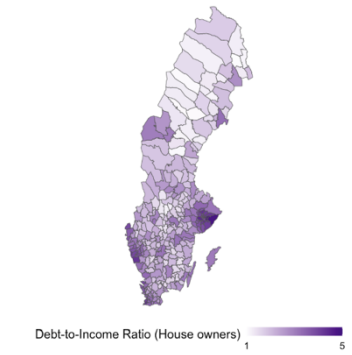


Figure 6. Municipality level mean debt-to-income ratio for house owning households, 2016.

Source: Sveriges Riksbank.

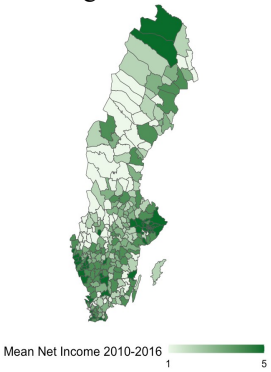


Figure 7. Municipality level mean net income per capita by quintiles, 2010-2016.
Source: Statistics Sweden

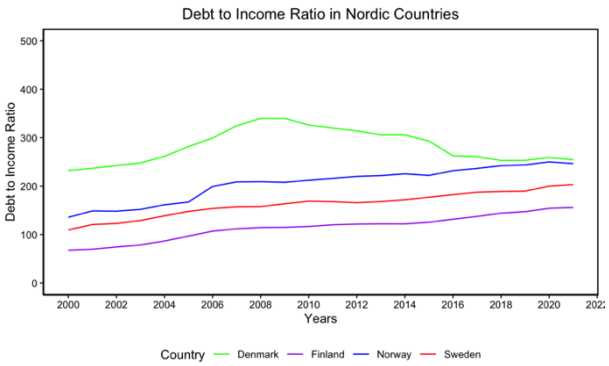


Figure 8. Change in debt-to-income in the Nordic countries
Notes: This figure plots the growth in the mean debt-to-income ratio for different Nordic countries.
Sources: OECD

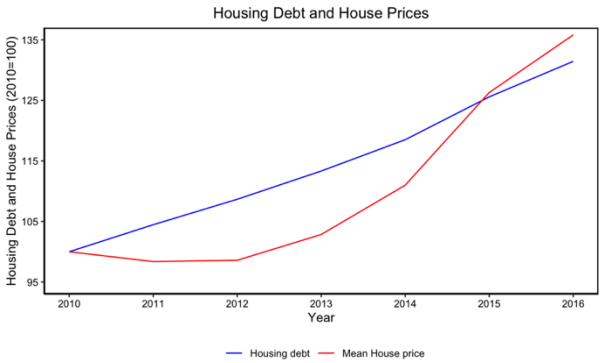


Figure 9. Growth in housing debt and house prices
Note: This figure plots the growth in mean housing debt for house owning households and the growth of mean house prices on an aggregate level. The growth of mean house prices is based on a sample of 355,661 house sales during the period. All values are inflation adjusted to 2010 prices.
Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

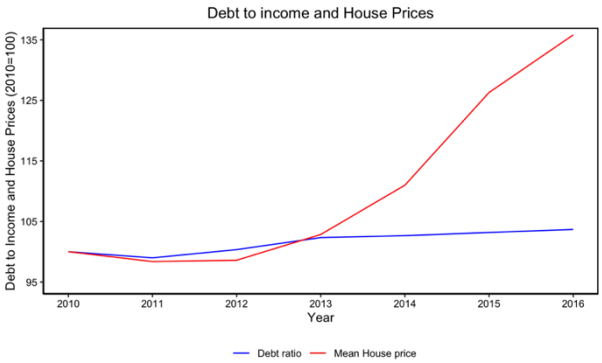


Figure 10. Growth in debt-to-income and house prices
Note: This figure plots the growth in the mean debt-to-income ratio for house owning households and the growth of mean house prices on an aggregate level. The growth of mean house prices is based on a sample of 355,661 house sales during the period. All values are inflation adjusted to 2010 prices.
Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

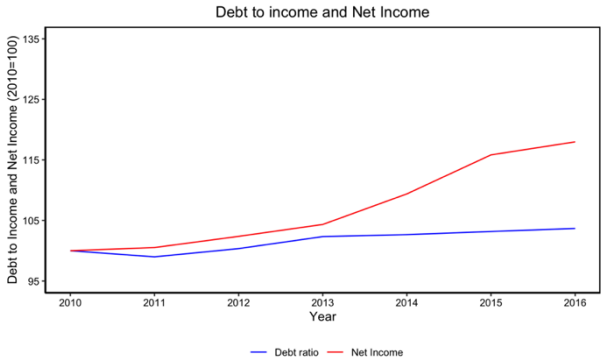


Figure 11. Growth in debt-to-income and net income
Note: This figure plots the growth in the mean debt-to-income ratio for house owning households and the growth of mean annual net income on an aggregate level. All values are inflation adjusted to 2010 prices.
Sources: Sveriges Riksbank, Statistics Sweden.

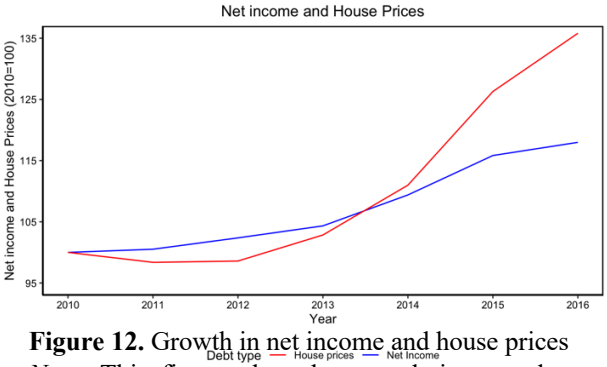


Figure 12. Growth in net income and house prices
Note: This figure plots the growth in annual net income and the growth of mean house prices on an aggregate level. The growth of mean house prices is based on a sample of 355,661 house sales during the period. All values are inflation adjusted to 2010 prices.
Sources: Statistics Sweden, Svensk Mäklarstatistik.

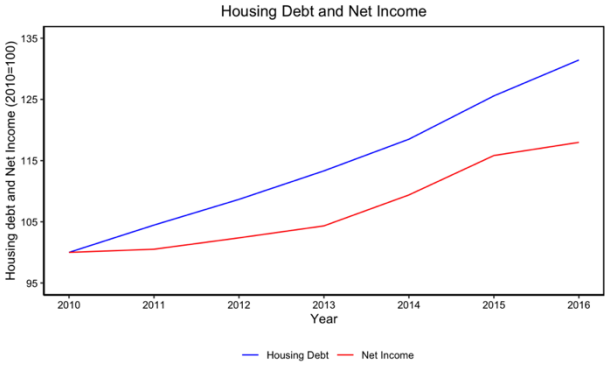


Figure 13. Growth in housing debt and net income
Note: This figure plots the growth in the mean housing debt for house owning households and the growth of mean annual net income on an aggregate level. All values are inflation adjusted to 2010 prices.
Sources: Sveriges Riksbank, Statistics Sweden.

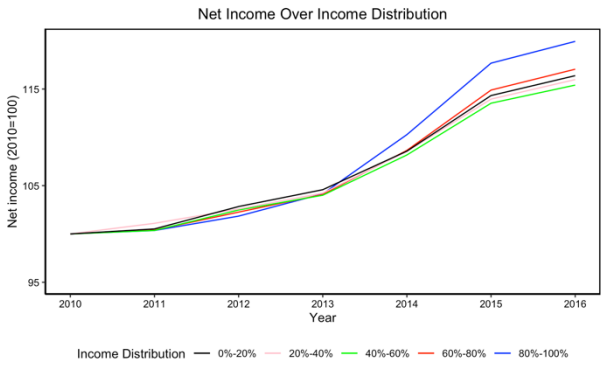


Figure 14. Growth in net income by municipality income category
Note: This figure plots the growth in mean per capita annual net income. Municipalities are divided into 5 categories based on their mean per capita annual net income. All values are inflation adjusted to 2010 prices.
Sources: Statistics Sweden

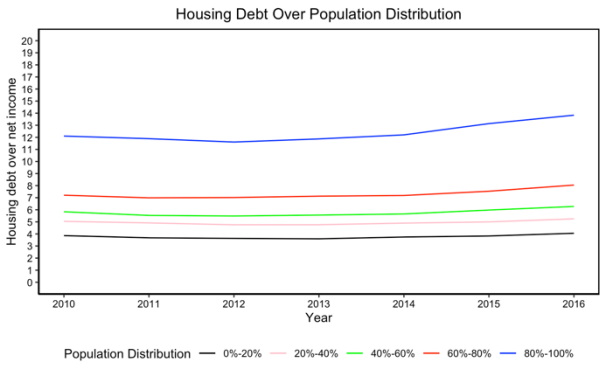


Figure 15. Housing debt over net income over the population distribution
Note: This figure plots the housing debt to net income over the population distribution. All values are inflation adjusted to 2010 prices.
Sources: Sveriges Riksbank, Statistics Sweden

III. Data and Summary Statistics

The dataset used in our analysis consists of detailed information on the level of Sweden's 290 municipalities during the years 2010-2016. Mortgage data for house owners is provided by Sveriges Riksbank. The analysis is based on all house owning households, regardless of house ownership form. Moreover, a mortgage or housing debt is defined as a loan with a house as security. The definition thus includes both loans taken to purchase houses and any additional loans taken backed by a house as security (equity extraction or borrowing via the home equity based borrowing channel). Data on house prices has been provided by Svensk Mäklarstatistik and provides prices on two types of houses: houses and vacation homes. We deem that adding the two categories together fits the Riksbank's definition of houses. The house price data includes the number of houses sold along with the mean sale price in each municipality during the period. Furthermore, the data on house sales is limited to houses sold by a realtor and includes 355,661 house sales in total. Data from Statistics Sweden on mean net income, mean age, population, the foreign-born population share, and the share of the population with at least a three-year university education is also used in the empirical analysis, as well as data from the Swedish Employment Agency on unemployment rates (all on a municipality and year level). All data expressed in monetary terms has been inflation adjusted to 2010 price levels in accordance with Statistics Sweden's consumer price index. In total our final dataset contains information regarding each variable in 2030 municipality-time combinations. We remove one municipality due to incomplete data, leaving us with observations from 289 municipalities. We consider the number of observations (2023) to be sufficient for the purpose of our analysis.

Table 1 - Variables Used in the Final Dataset

Municipality	Sweden's 290 municipalities
Year	2010-2016
Houses Sold	The number of houses sold in each municipality during each year
House Prices	The average sale price of sold houses in each municipality during each year
Mortgage Debt	The average loan with house as security in each municipality during each year
Net Income	The average yearly net income in each municipality during each year
Age	The average age in each municipality during each year
Population	The number of inhabitants in each municipality during each year
Unemployment	The percentage share of the workable population that is registered as unemployed in each municipality during each year
Education	The percentage share of the population that has at least a three-year university education in each municipality during each year
Foreign born	The percentage share of the population not born in Sweden in each municipality and year
Debt-to-Income Ratio	The average total debt-to-income ratio of house owners in each municipality during each year

Table 2 – Summary Statistics

Mean Mortgage, 2010 (SEK)	1,037,265
Growth in Mortgages, 2010-2016	0.314
Debt-to-Income Ratio, 2010	3.143
Change in Debt-to-Income Ratio, 2010-2016	0.037
Net Income, 2010 (SEK)	232,373
Growth in Net Income, 2010-2016	0.180
Mean House Price, 2010 (SEK)	2,367,155
Growth in House Prices, 2010-2016	0.358
Change Unemployment Rate, 2010-2016	-0.168

Note: National level summary statistics. Mean mortgage, growth in mortgages, debtto-income ratio, and change in debt-to-income ratio are given at a household level. Net income and growth in net income refer to the national per capita net income. Mean house price, growth in mean house price, and change in unemployment rate are at a national level. All values given in SEK are inflation adjusted to 2010 prices. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. The total number of observed municipality and period combinations is 2023.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Data Limitations

Much of the data used to execute our analysis is thorough and readily available through the aforementioned sources. However, the data obtained from these sources is not on an individual level. Instead, the information on all parameters is given as the average value for each municipality and year. This limitation does not impede the possibility of conducting an empirical analysis based on the data, however it does somewhat restrict our ability to replicate the study by Mian & Sufi (2011). In having data on a sample of individuals, their study could investigate developments in specific individuals' home debt and debt-to-income ratio, whilst controlling for factors such as the individuals credit score, age, and income. This conceivably allows for more precision in the effects they estimate in their study than looking at developments in municipalities containing average values for thousands of different individuals.

As stated, the data on household debt provided by Sveriges Riksbank is unique and an important contributing factor to our analysis. However, the data does limit our analysis to a certain extent. Since it is the only available source on household debt in Sweden during the last two decades, it only allows us to analyze the period of 2010-2016, leaving out recent years which have seen a shift in trends with regard to both house prices and interest rate policy, as well as the years of the Global Financial Crisis. Additionally, as the data does not categorize debt further than total housing debt for house owning households, we are unable to distinguish if the share of the increased housing debt in Sweden mainly stems from mortgages for new house purchases or from equity extraction during the period.

Moreover, for the purpose of this study we were not able to reconstruct an instrument like the one provided by Saiz (2010) and used by Mian & Sufi (2011) for application in a Swedish setting. This was due to data limitations. For that reason, we have opted to use municipality population as an instrumental variable in our model.

IV. Methodology

To find the causal effect of house prices on mortgage debt and the debt-to-income ratio, our study uses an instrumental variable approach comparable to that of Mian & Sufi (2011). As previously mentioned however, we have chosen to use the population of municipalities as our instrumental variable. The chosen instrument needs to meet two strict conditions to be considered valid: relevance and exogeneity. We perform a relevance test of the instrumental variable with the null-hypothesis and hypothesis:

$$H_0: \pi_1 = 0$$

$$H_1: \pi_1 \neq 0$$

To determine whether the instrument is relevant we run the following first-stage regression to determine if the instrument coefficient is significantly different from zero:

$$HP_{it} = \pi_0 + \pi_1 P_{it} + \pi_2 NI_{it} + \pi_3 ma_{it} + \pi_4 FB_{it} + \pi_5 U_{it} + \pi_6 E_{it} + a_i + a_t + \varepsilon_{it} \quad (1)$$

HP_{it} is defined as the mean house price in municipality i and year t, NI_{it} is the mean net income, ma_{it} is the mean age, FB_{it} is the level of the foreign-born population, U_{it} is the level of unemployment and E_{it} is the population level with at least three years of university education. The municipality population is the instrumental variable denoted P_{it}. The municipality and time fixed effects are denoted a_i and a_t respectively. ε_{it} is the error term. All variables denoted in capital letters are logarithmic.

Testing the exogeneity of our instrument cannot be done since it is not possible to test the correlation between a single instrumental variable and unobservable factors in the error term. Nevertheless, we argue the instrument can be considered exogenous given the circumstances. Firstly, the population of a given municipality and its change in population over time is likely to affect the demand for housing in that municipality. By extension, the housing demand will likely affect house prices in the municipality which in turn affects the level of debt house owners take on in their purchase. However, we argue that the households amount of debt is correlated to their municipality's population only through the population levels effect on house prices. We deem it unlikely that population levels are directly related to unobserved factors affecting households mortgage levels.

Furthermore, we include a number of control variables that reduce the risk of the instrument being correlated with omitted variables. For instance, the mean net income in each municipality could be correlated with both house owners amount of debt and how populated the municipality is. Additionally, the model includes fixed effects that control for municipality- and time-varying effects which have the potential of being correlated with both the instrumental variable and the dependent variable, further improving the likelihood that the exogeneity condition is met.

By means of the first-stage regression in (1), the predicted value of house prices, $\widehat{HP}_{it}$, is obtained on which we regress the mortgage level, HD_{it}:

$$HD_{it} = \beta_0 + \beta_1 \widehat{HP}_{it} + \beta_2 NI_{it} + \beta_3 ma_{it} + \beta_4 FB_{it} + \beta_5 U_{it} + \beta_6 E_{it} + a_i + a_t + \varepsilon_{it} \quad (2)$$

Likewise, to find the effect of the predicted value of house prices on the debt-to-income ratio, DI_{it}, the following regression is performed:

$$DI_{it} = \beta_0 + \beta_1 \widehat{HP}_{it} + \beta_2 NI_{it} + \beta_3 ma_{it} + \beta_4 FB_{it} + \beta_5 U_{it} + \beta_6 E_{it} + a_i + a_t + \varepsilon_{it} \quad (3)$$

Assuming the assumptions hold and that the coefficients β_1 of the predicted value in regressions (2) and (3) are significant, the regressions show a causal effect of house prices on house mortgage levels and on houseowners total debt-to-income ratio, as well as the magnitude of this effect.

Clustering

After conducting a Breush-Pagan test, heteroskedasticity was indicated within the error terms. To account for correlations and heteroskedasticity of standard errors, we make use of robust standard errors. The standard errors of our observations are clustered at the municipality level, in accordance with the study of Mian and Sufi (2011). Clustering standard errors contributes to mitigating the risk of biased standard errors which could affect the results of the analysis. By clustering the observations at the municipality level, more consistent standard errors are obtained, which may enable more reliable inference from our model.

Multicollinearity testing

To measure and estimate multicollinearity in the model we perform a VIF-test. Moderate correlation between the variables of the model may be expected, however a high level of multicollinearity in the model requires evaluation and possibly exclusion of one or more of the chosen variables. Conducted VIF test does not indicate high multicollinearity among the independent variables (appendix A).

Logarithmic transformation

To increase the performance of our model all variables except for the mean population age, ma_{ii}, are transformed logarithmically. This is done to address several possible concerns. Firstly, the relationship between the dependent and independent variables in our data are not suited for linear approximations when using absolute values from the observations, as observed in figures 16 through 19. Logarithmic transformation of the variables may improve the approximation of a linear relationship in the model. Furthermore, by using logarithmic variables the variance of residuals can be reduced, which to an extent reduces heteroskedasticity of the residuals. Additionally, the influence of extreme values in the regressions are lessened when transformed logarithmically. Moreover, the coefficient estimates of the analysis can be interpreted as the percentage change in the dependent variable for a one percent increase in the independent variables.

Robustness testing

In order to robustness test the validity of our results we run the same regression analysis on a manipulated dataset. In order to ensure that the effect is not isolated, or significantly magnified, by the major metropolitan areas, the three biggest municipalities in terms of population (Stockholm, Gothenburg and Malmö) are removed from the dataset. The results differ marginally and indicate that the effect is not inflated by the major metropolitan areas. See appendix B.

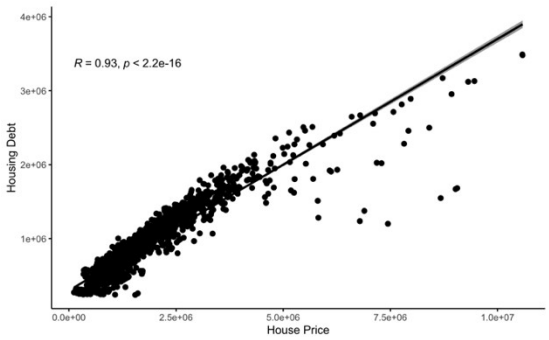


Figure 16. Correlation between housing debt and house prices

Note: This figure depicts the correlation between the mean household housing debt of house owning households and mean house prices on a municipality level. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. The total number of observations is 2023. All values are in SEK and inflation adjusted to 2010 prices. Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

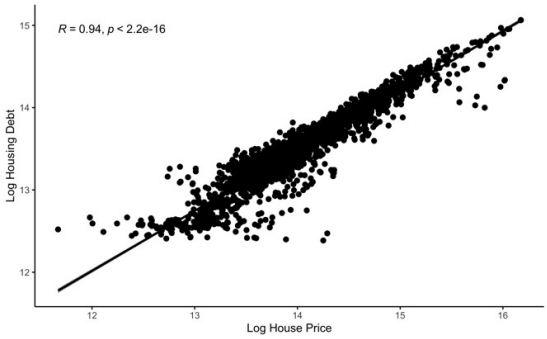


Figure 17. Correlation between Log housing debt and Log house prices

Notes: This figure depicts the correlation between the logarithmically transformed mean household housing debt of house owning households and the logarithmically transformed mean house prices on a municipality level. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. The total number of observations is 2023. All values are in log SEK and inflation adjusted to 2010 prices. Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

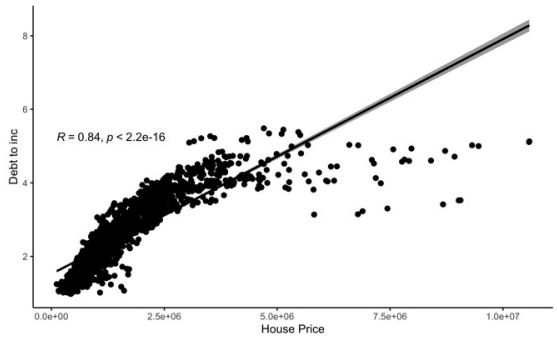


Figure 18. Correlation between debt-to-income and house prices

Note: This figure depicts the correlation between the mean debt-to-net income ratio of house owning households and mean house prices on a municipality level. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. The total number of observations is 2023. Household debt, net income and house prices are in SEK and inflation adjusted to 2010 prices. Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

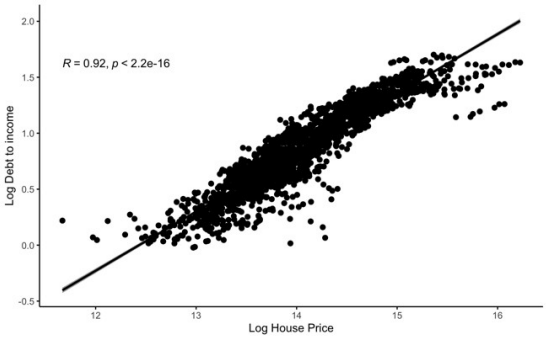


Figure 19. Correlation between Log debt-to-income and Log house prices

Note: This figure depicts the correlation between the logarithmically transformed mean debt-to-income ratio of house owning households and the logarithmically transformed mean house prices on a municipality level. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. The total number of observations is 2023. All variables are in log SEK and inflation adjusted to 2010 prices. Sources: Sveriges Riksbank, Svensk Mäklarstatistik.

V. Results

Table 3 - The Effect of House Prices on Household Borrowing
with Municipality and Time Fixed Effects

	Log House Prices 2010-2016	Log House Prices 2010-2016	Log Housing Debt 2010-2016	Log Debt-to-Income Ratio 2010-2016
	(1)	(2)	(3)	(4)
Log Population	1.204***	1.045***		
	(0.00068685)	(1.2409e-03)		
Instrumented Price			0.503***	0.243***
			(5.1675e-04)	(5.4214e-04)
Log Net Income		0.328***	0.185***	0.114***
		(9.3598e-04)	(3.3798e-04)	(3.4158e-04)
Mean Age		0.013***	0.013***	-0.013***
		(7.7993e-05)	(3.0627e-05)	(2.8885e-05)
Log Foreign Born		-0.146***	0.002***	-0.023***
		(3.1255e-04)	(2.1665e-04)	(2.0010e-04)
Log Unemployed		-0.076***	-0.010***	-0.015***
		(1.5444e-04)	(7.9120e-05)	(7.3479e-05)
Log Educated		0.187***	-0.114***	-0.159***
		(1.0697e-03)	(4.4813e-04)	(3.9983e-04)
Observations	2023	2023	2023	2023

Note: This table presents regression results on the effect of house prices on household housing debt and the household debt-to-income ratio for house owning households. All data on a municipality level. One municipality (seven observations) has been excluded as it had zero registered house sales in 2010. Standard errors are robust and clustered on municipality level.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Table 3 shows the results from regressions (1), (2), and (3), as well as a simple linear regression of logarithmically transformed house prices on logarithmically transformed municipality population levels (column 1). The results show that log-transformed population is a significant predictor of log-transformed house prices in the first-stage regression (1). Secondly, the instrumented house price obtained in regression (1) is found to be a significant predictor in both estimating the log housing debt, in (2), and the log debt-to-income ratio in (3). The coefficient estimates indicate that housing debt increases with 0.5 percent per one percent increase in house prices (column 3) and that the household debt-to-income ratio increases with 0.24 percent per one percent increase in house prices (column 4).

Table 4 - Interpretation of Logarithmically Transformed Regression Results

Change in HP	Change in housing debt	Share of real growth in housing debt 2010-2016**	Change in debt to income	Share of real growth in debt to income 2010-2016**
1%	0.5%		0.2%	
35.8*	16.6%	52.9%	7.7%	210.1%

* Total growth in house prices 2010-2016 with exclusion of municipalities with incomplete data
**Total growth in debt to income and housing debt between 2010-2016 with exclusion of municipalities with incomplete data.
Note: The table shows interpretations of the regression results in table 1.
The equation $\frac{Y_{New}-Y}{Y} \times 100 = ((1+x)^{\beta}-1) \times 100$ (Cornell University), where x denotes the change in the independent variable, and β denotes the regression coefficient, is used to convert the regression coefficients to percentage.

With the total increase in house prices, we calculate the total increase in debt attributable to increasing house prices. Given the total growth in house prices in the sample during the period of 35.8%, the estimates indicate that roughly 55% of the increase in housing debt is due to increasing house prices, holding all else equal. Likewise, the increase in house prices corresponds to an increase in the debt-to-income ratio of 7.7% during the period, or 210% of the real increase, if all else, including net income, is held constant.

Table 5 - The Effect of House Prices on Housing Debt with Municipality and Time Fixed Effects Across the Net Income distribution

	Log Housing debt 2010-2016				
	(1)	(2)	(3)	(4)	(5)
Income Percentile	0–20	20–40	40–60	60–80	80–100
Instrumented Price	0.177*** (0.00074780)	0.346*** (1.9621e-03)	0.417*** (1.1897e-03)	0.213*** (0.00280816)	0.039*** (0.00205668)
Log Net Income	0.505*** (0.00107853)	0.113*** (1.1533e-03)	0.180*** (1.2539e-03)	0.080*** (0.00110111)	0.294*** (0.00060887)
Mean Age	-0.007*** (0.00011723	-0.015*** (9.1313e-05)	-0.011*** (9.3921e-05)	-0.017*** (0.00011445)	-0.035*** (0.00013312)
Log Foreign Born	0.032*** (0.00034232)	-0.030*** (3.0729e-04)	0.040*** (3.9067e-04)	-0.067*** (0.00077075)	-0.100*** (0.00091180)
Log Unemployed	0.081*** (0.00030116)	0.026*** (2.3450e-04)	-0.041*** (1.8146e-04)	-0.028*** (0.00047118)	-0.018*** (0.00010636)
Log Educated	0.006*** (0.00144547)	0.245*** (1.3418e-03)	0.016*** (9.8987e-04)	-0.080*** (0.00097195)	-0.111*** (0.00154010)
Observations	404	404	404	405	406

Note: This table presents regression results on the effect of house prices on household housing debt for house owning households. The income category refers to the quintile a municipality is placed in based on its mean annual per capita net income in the years 2010-2016. All data is on municipality level. Standard errors are robust clustered on municipality level.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Table 5 presents the results of regression (2) when dividing the sample into five groups based on the mean annual net income per capita in each municipality over the period. Each group represents 20% of the income distribution.

The results indicate that the effect of house price changes on household housing debt differs depending on the income category of a municipality. The effect appears to be the lowest for municipalities in the highest income category (column 5), where an increase of 1% in house prices corresponds to a 0.39 % increase in housing debt. In the lowest income category (column 1) a 1% increase in house prices implies a 0.177% increase in housing debt. Moreover, the estimated effect is largest for municipalities in the mid income category (column 3), where an increase of 1% in house prices corresponds to a 0.417% increase in housing debt.

Table 6 - The Effect of House Prices on the Household Debt-to-Income Ratio
with Municipality and Time Fixed Effects Across the Net Income Distribution

	Debt-to-Income Ratio 2010-2016				
	(1)	(2)	(3)	(4)	(5)
Income Percentile	0–20	20–40	40–60	60–80	80–100
Instrumented Price	0.345*** (0.00060390)	0.300*** (0.00285498)	0.135*** (9.4808e-04)	-0.153*** (2.0612e-03)	-0.296*** (0.00177183)
Log Net Income	0.615*** (0.00089320)	0.149*** (0.00136781)	0.256*** (1.2831e-03)	0.159*** (8.7318e-04)	0.285*** (0.00054716)
Mean Age	-0.019*** (0.00011844)	-0.009*** (0.00012311)	-0.010*** (7.4799e-05)	-0.024*** (8.5949e-05)	-0.035*** (0.00011310)
Log Foreign Born	0.009*** (0.00033261)	-0.026*** (0.00036742)	0.035*** (3.2513e-04)	-0.116*** (5.5960e-04)	-0.096*** (0.00078815)
Log Unemployed	0.057*** (0.00026797)	0.013*** (0.00026538)	-0.017 *** (1.5979e-04)	-0.072*** (3.4753e-04)	-0.005*** (0.00010606)
Log Educated	-0.211*** (0.00122177)	-0.036*** (0.00126215)	-0.073*** (9.4953e-04)	-0.077*** (7.5559e-04)	0.532*** (0.00120263)
Observations	404	404	404	405	406

Note: This table presents regression results on the effect of house prices on the household debt-to-income ratio for house owning households. The income percentile refers to the quintile a municipality is placed in based on its mean per capita net income in the years 2010-2016. All data on the variables is on a municipality level. Standard errors are robust and clustered on municipality level.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Table 6 presents the results of regression (3) when dividing the sample into five groups based on the mean annual net income per capita in each municipality over the period. Each group represents 20% of the income distribution.

The results indicate that the effect of house price changes on households' debt to-income ratio differs depending on the income category of the municipality. The effect appears to be the highest for municipalities in the lowest income category (column 1), where an increase of 1% in house prices corresponds to a 0.345% increase in household mean debt-to-income ratio. The coefficient estimates of house prices decrease for higher income categories and indicate a negative relationship with household mean debt-to-income ratio for the two highest municipality income categories (columns 4 and 5). In the highest income category (column 5) a 1% increase in house prices implies a 0.296% decrease in household mean debt-to-income ratio.

Table 7 - The Effect of House Prices on Housing Debt
With Municipality and Time Fixed Effects Across the Population Distribution

Log Housing debt 2010-2016

	(1)	(2)	(3)	(4)	(5)
Population Percentile	0-20	20-40	40-60	60-80	80-100
Instrumented Price	0.352*** (0.0066512)	0.431** (0.00301140)	0.206*** (0.00673768)	0.381** (1.5535e-03)	0.786*** (8.0401e-04)
Log Net Income	0.390*** (0.00480123)	0.328*** (0.00147793)	0.073*** (0.00162919)	-0.026*** (1.2167e-03)	0.111*** (4.7449e-04)
Mean Age	-0.022*** (0.00015548)	-0.027*** (0.00015954)	-0.001*** (0.00013626)	-0.006 *** (9.3292e-05)	-0.021*** (3.6609e-05)
Log Educated	0.012*** (0.00270109)	-0.120 *** (0.00279505)	0.186 *** (0.00439318)	-0.188*** (1.1141e-03)	-0.466*** (7.5514e-04)
Log Unemployed	0.025*** (0.0013225)	0.019*** (0.00052029)	-0.029 *** (0.00021704)	-0.023 *** (1.3962e-04)	-0.020*** (8.0468e-05)
Log Foreign Born	0.027*** (0.0007319)	-0.059*** (0.00074750)	0.035*** (0.00111845)	-0.078*** (5.0375e-04)	-0.016 *** (2.2085e-04)
Observations	406	406	404	404	404

Note: This table presents regression results on the effect of house prices on the household debt-to-income ratio for house owning households. The population percentile refers to the quintile a municipality is placed in based on its number of inhabitants in the years 2010-2016. All data on is on municipality level. Standard errors are robust and clustered on municipality level.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Table 7 presents the results of regression (2) when dividing the sample into five groups based on the population of each municipality over the period, with each group representing 20% of the municipalities. Unlike with net income there is no apparent consistent trend. The population size of municipalities does however have a large impact on the effect of increasing house prices on housing debt. In the quantile with the highest population, the effect of a 1% increase in house price leads to a 0.786% increase in housing debt, more than twice the increase of the same percentage among households in municipalities with the lowest populations.

Table 8 - The Effect of House Prices on Household Debt-to-Income Ratio,
With Municipality and Time Fixed Effects over the Population Distribution

	Log Debt-to-Income 2010-2016				
	(1)	(2)	(3)	(4)	(5)
Population percentile	0-20	20-40	40-60	60-80	80-100
Instrumented Price Growth	0.912*** (0.00790576)	0.418*** (0.00203968)	0.154*** (0.00489519)	-0.210*** (1.6326e-03)	0.071*** (6.6470e-04)
Log Net Income	0.780*** (0.00502559)	0.278*** (0.00105164)	0.150*** (0.00119096)	0.257*** (1.3231e-03)	0.233*** (4.2664e-04)
Mean Age	-0.032*** (0.00017439)	-0.026*** (0.00013625)	0.013*** (0.00011156)	-0.022*** (8.4459e-05)	-0.010*** (2.8713e-05)
Log Educated People	-0.306*** (0.00244618)	-0.295*** (0.00191307)	-0.096*** (0.00313337)	-0.220** (1.0623e-03)	0.056 *** (6.4798e-04)
Log Unemployed	0.129*** (0.00149844)	0.007*** (0.00026067)	-0.016*** (0.00021341)	-0.025*** (1.3691e-04)	-0.032*** (7.1032e-05)
Log Foreign Born	-0.058*** (0.00076272)	-0.069*** (0.00060199)	0.022*** (0.00076555)	-0.103*** (4.3399e-04)	0.018*** (1.8464e-04)
Observations	406	406	404	404	404

Note: This table presents regression results on the effect of house prices on the household debt-to-income ratio for house owning households. The population percentile refers to the quintile a municipality is placed in based on its number of inhabitants in the years 2010-2016. All data is on a municipality level. Standard errors are robust and clustered on municipality level.
Sources: Sveriges Riksbank, Statistics Sweden, Svensk Mäklarstatistik, Arbetsförmedlingen.

Table 8 shows the results of regression (3) after dividing the municipalities on their mean distribution. As with the results from table 7, the results indicate that the effect of house price changes on household borrowing differs depending on the number of inhabitants within the municipality. Unlike with on housing debt, however, the effect on debt-to-income appears to be gradually decreasing with the population size. The effect is measured to be the greatest in the least populous municipalities (column 1) where an increase of 1% in house prices corresponds to a 0.912% increase in housing debt, whilst a 1% increase in house prices results in a 0.071% increase in debt to income among households in the most populated municipalities.

VI. Discussion

As shown in our results, an increase in house price has a significant effect on the level of housing debt and the debt-to-income ratio among house owning households in Sweden, in line with academic consensus. However, the magnitude of these effects is interesting when considering their economic implications. As previously mentioned, both house prices and household debt increased considerably in Sweden during the period of 2010-2016. Our findings suggest that 52.9% of the increase in housing debt is attributable to the growth in house prices during the period, keeping other parameters constant (Table 4). This result is in line with that of Turk (2015), in which the growth in home values was the main driver of the increase in household debt. Still, this suggests that a large portion of the growth in housing debt during the period has been caused due to other factors. For instance, net income per capita is one parameter showing a strong correlation with household housing debt, and its increase over the period is likely an important determinant for the growth in housing debt.

The data on household debt includes the mean housing debt for all house owning households during the period. This means that the effect of house prices on housing debt estimated in our results is an estimate of the effect on both mortgages taken on during the period and housing debt already accumulated prior to 2010. Hence, the growth in households' housing debt during the period of 31% (Table 2) consists of mortgages taken for new purchases of houses and new mortgages taken with already owned houses as security, so called equity extraction. Because of the lack of distinction in our debt data between mortgages taken for purchases of houses and equity extraction, it is not possible to accurately assess their respective share of the housing debt growth during the period. In this regard our analysis differs from that of Mian & Sufi (2011) in which changes in individuals' housing debts and house purchases were observed, making it possible to differentiate equity extraction and mortgages taken with the purpose of purchasing new homes. Although it is not possible to draw conclusions on home equity-based borrowing for already existing mortgage takers, given our results it is still possible that the growth in housing debt is to a large extent due to an increase in home equity-based borrowing. It could also be the case that equity extraction is more sensitive to house price increases than the estimate for the total accumulation of housing debt.

With our division of municipalities during the period into five groups based on their mean annual net income per capita, the results suggest that the estimated effect of house prices on household borrowing varies significantly between income categories (Table 5). This points to the fact that municipality characteristics affect the relationship between house prices and household debt. One noticeable finding is that a 1% increase in house prices in municipalities within the highest income category on average only corresponds to a 0.039% increase in housing debt. In contrast, the corresponding relationship estimate in the mid municipality income category is over ten times greater at 0.417%. This discrepancy suggests that with higher average incomes, house prices become a less important determinant in the amount of housing debt taken on by households. Instead, it could arguably appear as if higher incomes may allow households to take on more debt almost irrespective of house prices, due to already relaxed borrowing constraints. The low estimate of 0.177 for household in the lowest income quantile, amounting to less than half the estimated coefficient in the mid income category, could possibly be explained by a reversed position in terms of borrowing constraints. Lower income takers arguably have a tighter borrowing constraint. If that is the case, equity extraction could be

limited. The effect of increasing house prices on household debt for the lowest income category could hence be limited by the households' borrowing constraints, regardless of the increase in house prices.

Table 7 further emphasizes the finding that municipality characteristics have an influence on the effect of house prices on household debt. In grouping municipalities in accordance with their population levels it is evident that the estimated relationships vary significantly between the five groups. One noteworthy result is that a 1% increase in house prices in municipalities with the highest number of inhabitants on average corresponds to a 0.786% increase in housing debt. This estimate is 1.8 times greater than the second largest estimate of 0.431 (Category 2) and 3.8 times greater than the smallest estimated effect of 0.206 (Category 3). Although the underlying reasons for this discrepancy cannot be obtained based on our result, the significantly larger causal relationship between house prices and household debt in the most populous municipalities could stem from the high house prices in largely populated areas. Figures 1 and 2 display a visual representation of this, showing that house prices are higher in areas known to have higher populations. Figures 3 and 4 show that households in the most populated areas have substantially higher housing debt to net income ratio. This implies that households in well populated areas borrow heavily to afford their houses. If prices increase, households must borrow additional funds to purchase their homes since prices rise at a faster rate than net incomes (Figure 14). According to our data, less populated municipalities have a lower mean housing debt to income ratio (Figure 15). Increases in house prices in those municipalities may perhaps not require households to borrow additional funds to purchase their homes. The large discrepancy in housing debt to income between the most populated urban areas, such as Stockholm and Gothenburg, compared to the rest of the country, may serve as an explanation in why the coefficient estimate in column 5 stands out (Table 7).

The effect of house prices on the debt-to-income ratio is also uneven across the municipality income categories, unlike the findings of Foote. et.al which considered an American setting during the financial crisis. From the results in Table 6 we find that house prices have the greatest effect on the mean household debt-to-income ratio in municipalities with the lowest average net income levels during the period. This finding is in line with that of Mian and Sufi (2011), who argue that there was uneven effect in home equity borrowing during the financial crisis between low- and high-income individuals, concluding that households with borrowing constraints were the most inclined to make use of equity extraction when credit availability increased. Furthermore, the results suggest that the effect of house prices on household leverage is smaller the higher the mean income of a municipality is. One possible explanation for this finding could be that home purchasing in low-income municipalities results in households taking on more debt relative to their income than households in municipalities with higher average income. While this explanation is perhaps consistent with our findings, it does not clarify the results obtained regarding income categories 4 and 5 in Table 6. Those estimates suggest that an increase in house prices has a significant negative effect on the household debt to-income ratio keeping all other variables constant. Regarding these results one should note the assumption of a constant level of net income across municipalities during the period. Therefore, a plausible contributing reason behind the coefficient estimates of category 4 and 5 is that net incomes have increased to a larger degree in those municipalities during the period than in other municipalities. This is again supported by Figure 14, which plots the growth in mean net income across the net income distribution. According to Dieckelmann & Metzler

(2022), households with the lowest incomes are also probable to be the most financially vulnerable in times of economic hardship. The estimates in Table 6 suggest a higher inclination among households in lower income municipalities to increase their leverage as house prices rise. Consequently, such exposure may constitute a substantial risk in the event of economic shocks. Furthermore, if the portion of mortgages with a floating rate is high among lower income groups, the risks could be induced further.

Our non-uniform results continue when observing the effect of house prices on the household debt-to-income ratio when grouping municipalities according to their populations. The results in Table 8 show that households in the least populous municipalities on average experience an increase in their debt-to-income ratio of 0.912 percent per 1% increase in house prices. The estimated coefficient is more than two times greater than for municipalities in category 2 which have the second largest estimated coefficient of 0.412. The results suggests that the effect of house prices on household leverage is smaller the higher the population is in a municipality. However, our results indicate that the municipalities with the lowest populations are noticeably more inclined to increase their leverage when house prices rise compared to municipalities in the lowest part of the income distribution. This finding implies that municipalities with low populations may be at risk of considerably increasing their leverage in times of substantially increasing house prices.

VII. Further Research

The housing market and its effect on household debt levels and leverage is an economically important matter which ought to be subject to substantial examination. Given the large indebtedness of Swedish households, the country may pose higher risks in the event of shocks to the housing market or interest rates. For future research within the field, it is our understanding that a larger and more precise dataset is required. With a dataset on debt where a distinction is made between housing debt taken on for the purpose of new house purchases and equity extraction, an estimation of house prices' specifically on equity extraction can be determined. Additionally, our analysis is conducted on the effects of house prices on household debt for homeowners, due to data limitations, but large parts of the Swedish population lives in condominiums. Consequently, further research should also investigate how condominium prices may affect household debt levels and leverage in order to obtain a better understanding of the field as a whole. Perhaps most important for future research though, is performing an analysis based on individual level data. This would allow for more precise estimation of the effects on household debt and debt-to-income ratio, making it possible to control for how certain factors affect individuals, rather than grouping them to the municipality they reside in. As there are other factors influencing household debt than house prices, it would also be interesting to identify such variables and measure the magnitude of their effects. Additionally, investigating how such parameters affect various segments of the population differently may provide further understanding of the driving causes identified, as well as a notion of potential policy measures that should be taken to mitigate risks in the event of shocks to the housing market or interest rates. We found population to be a suitable instrument for the purpose of our analysis, however future research could make use of additional or other instrumental variables altogether, for which exogeneity is less likely to be doubted. Finally, a thorough investigation

into borrowing constraints in the Swedish housing market would provide further insights into why the housing debt among low-income takers are relatively insensitive to increasing house prices.

VIII. Conclusion

Our analysis provides evidence of a significant causal relationship between house prices and household debt. The unique data provided by the Swedish Central Bank allows us to estimate the magnitude of the effect of house prices on household debt on an aggregate level across all municipalities in Sweden during the period. We find that the majority of the housing debt increase stems from rising house prices, in line with the findings of Turk (2015), with house prices also significantly increasing the mean leverage across households.

We also find that municipality characteristics such as population size and average net income per capita result in a non-uniform effect of house prices on housing debt across municipalities. We find that dividing the municipalities into groups based on net income results in differing coefficient estimates within the group. This is also the case when performing our regressions on municipalities grouped based on population size. We find a stronger effect of house prices on the debt-to-income increase for households in lower income municipalities, which is in line with the findings of Mian and Sufi (2011), and for households lower in the population distribution. The large discrepancy found across municipalities indicates that certain parts of Sweden may be more at risk during economic downturns, and that households in certain municipalities are more inclined than others to increase their leverage considerably in Sweden during the years 2010-2016.

In order to quantify the risks associated with the increased leverage for households in lower income municipalities and in municipalities with smaller populations, we argue that individual household specific data on debt is required. The lack of public data on household debt across Sweden makes research difficult, marginalizing the possibility for academia to observe and analyze the levels of household debt in a country where variable rates and household leverage are notoriously high.

References

Christopher Foote, Lara Lowenstein, Paul, & Willen. (2016). Cross-sectional patterns of mortgage debt during the housing boom: Evidence and implications. *NBER Working Paper, 22985* Retrieved from https://www.nber.org/system/files/working_papers/w22985/w22985.pdf

Damien Puy, & Kimiaki Shinozaki. (2022, 22 August). Mortgage rates are rising: Should we be concerned? Retrieved from https://oecdecoscope.blog/2022/08/29/mortgage-rates-are-risingshould-we-be-concerned/

Dieckelmann, D., & Metzler, J. (2022). *Household inequality and financial stability risks: Exploring the impact of changes in consumer prices and interest rates.* (). Retrieved from https://www.ecb.europa.eu/pub/financialstability/fsr/special/html/ecb.fsrart202211_02~8c5b8be620.en.html

Graham, J., & Makridis, C. A. (2023). House prices and consumption: A new instrumental variables approach. *American Economic Journal: Macroeconomics, 15*(1), 411-443. Retrieved from http://ez.hhs.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=eoh&AN=2005535&site=ehost-live

Hull, I. (2017). Amortization requirements and household indebtedness: An application to swedish-style mortgages - ScienceDirect. *European Economic Review, 91* Retrieved from https://www.sciencedirect.com/science/article/pii/S0014292116301507

Interpreting regression coefficients for LogTransformed variables. (2012). (Cornell University). Retrieved from https://cscu.cornell.edu/wp-content/uploads/83_logv.pdf

Mian, A., & Sufi, A. (2011). House prices, home Equity—Based borrowing, and the US household leverage crisis. *American Economic Review, 101*(5), 2132-2156. doi:10.1257/aer.101.5.2132

Muellbauer, J., & Murphy, A. (1997). Booms and busts in the uk housing market. *The*

Economic Journal (London), 107(445), 1701-1727. doi:10.1111/j.1468-0297.1997.tb00076.x

Rima.A Turk. (2015). Housing price and household debt interactions in sweden. *IMF Working Papers, WP/15/276* Retrieved from https://www.imf.org/external/pubs/ft/wp/2015/wp15276.pdf

Saiz, A. (2010). The geographic determinants of housing supply. *The Quarterly Journal of Economics, 125*(3), 1253-1296. doi:10.1162/qjec.2010.125.3.1253

Trading Economics. (2021). Households debt to income . Retrieved from https://tradingeconomics.com/country-list/households-debt-to-income

Appendix A

Table 9 – VIF test results

Variable	VIF score fist stage	VIF score second stage
Predicted values		1.020068
Log population	2.672887	
Log net income	3.645817	3.631742
Log share educated	3.877338	1.980726
Log share unemployed	2.695178	2.532745
Log share foreign born	1.362035	1.258242

Note: this table presents the results from a conducted VIF test on the variables used in PLM regressions.

Appendix B

Table 10- The Effect of House Prices on Household Borrowing, 2SLS Instrumented Variable Approach, with exclusion of the 3 municipalities with the highest population

	Log House Prices	Log Total Housing Debt 2011-2016	Debt-to-Income Ratio 2011-2016
	(1)	(2)	(3)
Log Population			
	0.968***		
	(1.2969e-03)		
Instrumented Price Growth			
		0.502***	0.256***
		(5.8518e-04)	(6.1750e-04)
Log net income			
	0.240***	0.201***	0.146***
	(1.1484e-03)	(4.1612e-04)	(3.8951e-04)
Mean Age			
	-0.0003***	-0.006***	-0.012***
	(8.5232e-05)	(3.9798e-05)	(3.8034e-05)
Log Share Educated			
	0.259***	-0.108***	-0.184***
	(1.0864e-03)	(4.6835e-04)	(4.0953e-04)
Log Share Unemployed			
	-0.057***	-0.012***	-0.011***
	(1.6994e-04)	(8.0249e-05)	(7.2753e-05)
Log Share Foreign Born			
	-0.182***	0.020***	-0.026***
	((3.5787e-04)	(2.6326e-04)	(2.4973e-04)
Observations	2002	2002	2002

Note: This table presents regression results on the effect of house prices on the household debt-toincome ratio for house owning households, with the exclusion of the three biggest municipalities. All data is on a municipality level. SE are robust and clustered on municipality.