Mortgage Forgiveness and Household Spending:
Evidence from a Natural Experiment *

Sigurdur P. Ólafsson[1], Arnaldur Stefánsson[2], and Gylfi Zoega[2,3]

[1]Copenhagen Business School
[2]University of Iceland
[3]Birkbeck Business School, University of London

February 28, 2025

Abstract

We take advantage of a unique experiment that took place in Iceland in 2015. Following the collapse of the country's banking system in 2008, the authorities decided on a program of mortgage relief that in effect lowered the principal of mortgages overnight. What sets our experiment apart from others is that the debt relief program was financed by foreign creditors, that we have administrative data on all taxpayers in the country and that the mortgage relief was implemented many years after the end of the economic crisis when household balance sheets had been repaired. We measure the effect of the mortgage relief on the saving of every taxpayer in the country using households that were not eligible for debt relief as a control group. While a negative wealth effect on saving could have been expected, households amortized even more in response to the debt forgiveness. The increased amortization is due not only to lower interest costs but also to higher saving, mostly by highly leveraged and liquidity-constrained households.

Keywords: Mortgage relief, wealth, saving.

JEL Codes: D14, D31, E21, G51, H31

*We would like to thank seminar participants at Gothenburg University, Uppsala University, VATT, Linnaeus University, Reykjavik University, the Uppsala Center for Fiscal Studies and the IIPF. Any remaining errors are our own responsibility. This study was supported by the Icelandic Research Fund (Rannís), grant number: 207213-051.

1 Introduction

Debt has been a source of friction in societies dating back to ancient times. Although firms' owners can escape the burden of debt through bankruptcy, households have more difficulty escaping the debt bonds. Declaring bankruptcy deprives a family of a place to live, while struggling to pay debt creates family distress and often great unhappiness. Hudson and Goodhart (2018) describe how the Hammurabi dynasty in ancient Babylon canceled debt and was rewarded by loyal citizens, while Ancient Rome did not, causing disenfranchised indebted citizens to contribute to its collapse. In more recent times, the Biden-Harris administration implemented a student debt forgiveness program that has erased 3.6 million American loans[1] In the UK, the Labor Party plans to reduce graduates' monthly student loan repayments.

The obvious drawback of any debt moratorium is that one person's debt is another person's asset. While governments can relieve some citizens of their debt by imposing taxes on others, such measures tend to be met with opposition by the latter. In this paper, we describe a debt relief scheme where a government was in the unique position of being able to extract payment from foreigners, in particular foreign creditors that they do not have to fear at the voting booth. The experiment we describe is that of a Robin Hood "robbing" foreign investors and giving money to indebted citizens. This setting provides ideal grounds for testing whether debt relief actually lowers debt or, conversely, induces people to increase their spending by borrowing.

Our study also benefits from the use of administrative data containing the tax returns of all Icelandic taxpayers around the time of the debt relief. This enables us to measure each household's consumption as well as their purchases of housing and durables in the form of motor vehicles. Using administrative data has clear benefits over the use of credit card data, which are often used to study the consumption response to debt relief, because the fraction of transactions using credit cards may vary over the business cycle and may differ between age groups. There is also the issue of using cash to avoid having to pay

[1]See statement from the White House, 12 January, 2024 Statement from President Joe Biden on Early Student Debt Cancellation for Borrowers Enrolled in SAVE | The White House.

taxes, which is not unheard of in Iceland.

Moreover, in contrast to other studies of debt relief during the Great Recession, Iceland's debt relief program was not implemented until 2015 when the average household had recovered from the 2008 crash. The debt relief was designed to lower the principal of CPI indexed debt that had increased due to inflation after the collapse of the exchange rate in 2008. Figure 1 shows the ratio of a wage index to the CPI index, the latter being used to index mortgages. Note the drop in 2008 and 2009, which signifies the increased debt burden, and then the subsequent recovery, which shows the decline in the debt burden. The index is at the same level in 2015 as in 2007, indicating that there was no real need for debt relief in 2015. Thus the relief was akin to a helicopter drop of wealth taking the form a mortgate reduction.

We start by providing background to the mortgage relief operation, the prelude to the collapse of Iceland's banking system, and the recovery efforts that followed. We then survey the literature from other countries on the effect of debt relief on amortization and the purchase of consumer durables. We then delve into the mortgage relief as a natural experiment, and the timing and sequence of events, before describing our data. This is followed by the results of a survey in which respondents were asked what their response to mortgage relief had been. We then turn to our empirical analysis. The final section contains some concluding remarks.

2 Background

We study economic developments in Iceland, a country that became a symbol of the 2008 Great Recession when its banking system collapsed at the beginning of October 2008. The years before the collapse had been similar in many ways to the bubble years in London in the second decade of the 18th century or the 1920s in the United States or, for that matter, any other financial crisis. Increased credit coincided with rising stock prices, justified by stories about the reasons why times were so good.

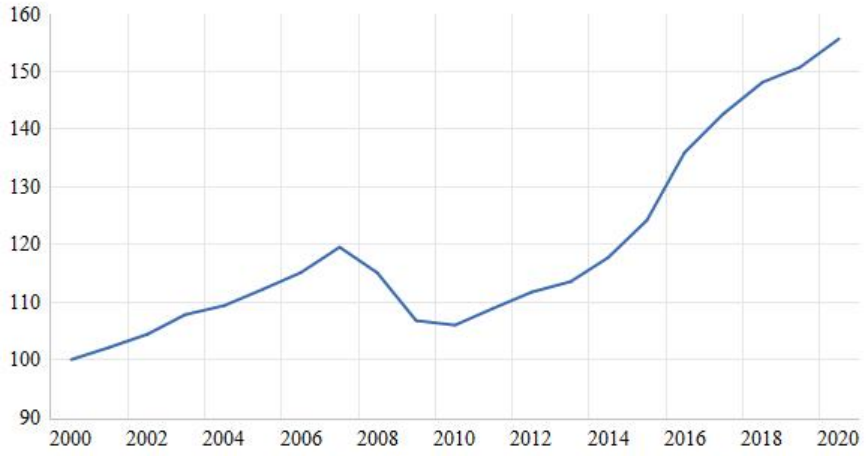


Figure 1: The ratio of Statistics Iceland's wage index to the consumer price index

This episode like so many other similar ones, starts with the privatization of a banking system. The government of Iceland, with a AAA rating, decided to privatize its three state banks after the turn of the century. By so doing, it effectively conferred upon these banks its good sovereign credit rating, which they used to accumulate foreign debt, expanding their balance sheets by around 50% per year from 2004 to 2008.[2] Most of this domestic credit creation, financed through foreign borrowing, was in the form of foreign currency loans to businesses and some households as well but most of the household debt was indexed to the CPI.[3] While the lion's share of the business loans were used to buy foreign businesses and assets, capital inflows through the banking system created a steady appreciation of the currency and a stock market bubble, with stock prices ballooning by a factor of ten between 2003 and 2007 and house prices doubling over the same period. Rising asset prices and a stronger currency bolstered private consumption and investment, resulting in persistent current account deficits that peaked at 24.2% in 2006. The sudden stop of capital inflows in 2008 – both in the run-up to the global financial crisis in spring 2008 and, especially, after the collapse of Lehman Brothers that September – caused the Icelandic currency to tank, the stock market to collapse, and the domestic currency value

[2]See Benediktsdottir et al. (2014) and Benediktsdottir et al. (2017).

[3]Businesses borrowed around 80% in FX loans and households around 80% in CPI-indexed loans. Of the remainder, car loans were mostly in foreign currencies.

of FX-linked and CPI-indexed debt to soar.

Financial crises are by definition debt crises, which explains some of the societal and political upheaval that tends to accompany them. Aliber et al. (2023) describes the turmoil in the House of Commons and British society following the bursting of the South Sea bubble in 1720 and similar episodes over the last three hundred years. Galbraith (1954) gives a vivid account of the 1920s and 1930s in the United States. Straumann (2019) describes the credit boom in Weimar Germany in the second half of the 1920s and the depression in the early 1930s, which were caused by the sudden stop of capital inflows from the United States and eventually brought the Nazis to power, with catastrophic consequences. In Iceland, bankers had been celebrated as national heroes in the years before the financial meltdown, only to become objects of contempt, even hatred, virtually overnight. Protesters threw paint at their houses, the media depicted them as criminals and a parliamentary investigative committee concluded that they were guilty of market manipulation and other violations. Many received prison sentences. Right-wing politicians managed to deflect some of the blame and anger to other countries that had chosen not to come to Iceland's rescue in the weeks before the collapse and had insisted on repayment of deposits collected in foreign branches of the failed banks. It is in the years that followed this debt crisis, turmoil and national anger and resentment towards bankers and politicians that we find our natural experiment in debt relief.

The left-leaning government that came into power in 2009, after the crash, implemented a few debt relief measures, including lowering outstanding mortgages to 110% of property values for homeowners who were underwater by more than 10%. While more comprehensive debt relief measures were being formulated by the government and the IMF, the country's supreme court ruled in 2010 that FX-linked loans had in fact been illegal. This came as a surprise because households and firms had been taking FX-linked loans for nearly a decade without any comments or doubts having been expressed by the legal profession. The obvious injustice of cancelling debt for some households – that is, those with FX loans – and not others – in particular, those with the CPI-indexed loans – set the stage for a populist political party to introduce proposals for the reduction of

CPI-indexed debt.[4] Normally, both forms of debt cancellation would have run into opposition from domestic creditors, but these were non-existent, as the banks had defaulted on their foreign debt.

What made mortgage relief popular among voters was the fact that it was financed through a tax on foreign investment funds. The operation was in the spirit of Robin Hood, and politicians justified it by claiming that foreign vulture funds had acquired the distressed assets at bargain prices. In effect, the government imposed a tax on the liabilities side of the failed banks' balance sheets. These liabilities represented assets owned by the various investment funds, or vulture funds, that had bought the distressed assets. The distressed assets in question were bonds issued by the banks before their collapse. Given the large size of the banks' balance sheets relative to Iceland's GDP, the tax rate could be kept very low. In effect, the debt cancellation was financed by foreign creditors who were trapped behind the locked gates of capital controls that had been imposed as part of an IMF program to prop up the currency.

3 Literature review

Following the global financial crisis, other countries also implemented measures to relieve homeowners of some of their debt burden. However, in those cases, the measures were implemented during times of distress, whereas in Iceland they were adopted later. In spring 2009, the United States government introduced the Home Affordable Refinance Program (HARP) to support homeowners with low housing equity levels, in order to lower their interest expense. HARP allowed eligible households with limited equity to refinance their mortgages at lower interest rates by providing a federal credit guarantee to lenders. The program was confined to those who had mortgages guaranteed by government-sponsored enterprises (GSEs), particularly Fannie Mae and Freddie Mac, and included households with a high loan-to-value ratio.

While the HARP debt relief program reduced the interest expense of eligible house-

[4]See Mudde and Kaltwasser (2017) on the definition of populist political movements.

holds, the Icelandic program also reduced the interest of their mortgage, thus lowering the interest expense. This enabled households in Iceland to respond to their increased wealth, as well as to benefit from lower monthly bills and more liquidity. We will therefore survey both the literature on HARP and research on the effects of household wealth on consumption.

Agarwal et al. (2023) take advantage of HARP to estimate the impact of lower interest payments on durable consumption using a large database of mortgages. They merge the mortgage data with data on each borrower's consumer credit records, making it possible to measure the effect of the lower interest payments on new auto purchases. They used a difference-in-differences (DID) approach to compare a treatment group of borrowers who were eligible for the program and refinanced their fixed rate mortgages under HARP to a control group that was not eligible, and they found that the treatment group benefited from interest rate savings of around 140 basis points. Lower interest expenditures affected auto purchase spending, with the increase in auto debt measuring around 24 percent of the amount saved on interest expense. The effect was stronger for borrowers with lower housing wealth and lower credit ratings, which received the largest reduction in interest rates. At a regional level, there was a positive relationship between the prevalence of the HARP program, on the one hand, and car purchases, credit card spending, and house prices, on the other, and a negative relationship with the level of foreclosures.

Abel and Fuster (2021) also study the effect of HARP but focus on the variation of eligibility within secured mortgages, in particular whether mortgages were guaranteed by a GSE before or after June 2009, the former being eligible for HARP. They find an increase in auto debt equaling around 20 percent of the interest payment reduction due to HARP. Their data allow them to calculate the effect of HARP on consumer spending other than car purchases. They find that borrowers benefiting from HARP responded to their reduced interest burden by accumulating new debt amounting to 60 percent of their monthly savings on mortgage payments, while the reduction in debt amounted to 40 percent of the savings, generating a net increase in debt accumulation of around 20 percent of the savings created by HARP. In general, HARP reduced the probability of

default, especially for borrowers with low credit scores, as in the study by Agarwal et al. (2023). These borrowers also tended to add to their auto and consumer debts to a greater extent than those with a better credit score.

The mortgage relief program reduced the interest expense of households, as well as increasing their wealth net of mortgage debt. Our study is therefore also related to the literature on the effect of changes in housing wealth on consumption. In a life-cycle model, higher house prices increase households' current wealth more than the present discounted value of future cost of living and can therefore be expected to increase consumption (Sinai and Souleles (2005)). Nevertheless, the permanent-income hypothesis would suggest that the consumption response to an increase in house prices is equal to the annuity value of the wealth changes, which amounts to a rather small consumption response. However, the presence of liquidity constraints can explain a stronger consumption response as higher house prices allow households to borrow more. Higher house prices also reduce the need for precautionary savings. In the Iceland case, the increase in net worth is caused by a reduction in debt, so the wealth effect should be even stronger, since increased wealth does not reflect higher future housing costs. In addition, reduced debt loosens borrowing constraints by boosting borrowing capacity. We now turn to some research on the wealth effect of house prices on consumption spending.

Aladangady (2017) use geographically-linked microdata that link households to regional housing supply elasticities to measure the causal effect of changes in house prices on consumer spending. Using the interaction between long-term real interest rates and housing supply elasticities as an instrument for house price growth, they find that a $1 increase in home values leads to a $0.05 increase in spending for homeowners but to a negligible change for renters. The instrumental variables (IV) method is used to remove the effect of factors that drive up house prices and spending for households with mortgages, those without a mortgage, and renters.[5] An increase in home values leads to the largest responses among credit-constrained households because higher house prices relax

[5]Guren et al. (2021) find less housing supply elasticity in the 2000s than in the 1980s and 1990s, implying that larger house price movements in the 2000s were responsible for the boom and bust occurring in that decade.

borrowing constraints by providing increased collateral. The authors interpret these results as showing the importance of collateral effects behind the response of consumption to housing wealth.[6]

The difficulty of finding clear causal effects has hampered much of the literature on the wealth effects of home equity on consumption. In contrast, our study has the benefit of an experiment in which the causal chain between debt relief and consumption is clear, since no other factors affect both debt relief and consumption. Thus, Campbell and Cocco (2007) found a large effect of house prices on consumption for both homeowners and renters, which can be interpreted as an indication that a common factor may drive both consumption and house prices. Attanasio et al. (2009) using U.K. data also found a relationship between rising house prices and the spending of both home owners and renters, which is consistent with the existence of a common factor. Finally, Carroll et al. (2011) found a strong relationship between housing wealth and consumption in aggregate data, but without being able to pin down the exact nature of the relationship.[7]

The effects of wealth on consumption have also been studied in other countries. Gan (2010) studies a large panel data set on housing wealth and credit card spending in Hong Kong. This author finds a stronger consumption response to housing wealth on consumption among households with multiple properties. Households refinancing their mortgages have a strong consumption response, indicating a relaxation of credit constraints. For those who do not refinance, the increased consumption appears to be due to a fall in precautionary savings. Other papers confirm the effect of the ability to access home equity on consumption. Agarwal and Qian (2017) studied the effect of a policy experiment in Singapore that decreased access to home equity by extending the minimum occupation period for public housing. They found, using DID, that the decrease in access to home

[6]There is substantial heterogeneity (over income, leverage and liquidity) in responses. For example, Mian et al. (2013) find that poorer and more leveraged households have a higher marginal propensity to consume (MPC) than others do and Aladangady (2017) finds that the MPC is highest among credit constrained households. This is easily explained: more leveraged households benefit from a relaxation of their collateral constraints, which allows them to borrow more, and having higher effective discount rates makes them more responsive.

[7]Carroll et al. (2011) found a substantially larger marginal propensity to consume from housing wealth than from financial wealth as did Case et al. (2005).

equity leads to lower consumption – in particular a fall in credit card spending – suggesting that home equity plays a consumption smoothing role. Leth-Petersen (2010) also studied the access-to-credit channel using the reform of the credit market in Denmark that allowed homeowners to use their housing equity as collateral for consumption loans. He found that the larger the amount of equity released, the stronger the consumption response. However, the effect is moderate, much weaker than in Agarwal et al. (2017).

In the context of our paper, it is interesting to compare the effect of lowering monthly payments and reducing the principal of a mortgage. Fuster and Willen (2017) study the predicament of households with negative equity and compare the efficacy of lowering their monthly interest payments, on the one hand, and reducing the principal of their mortgage, on the other hand, in reducing the probability of default. They find that cutting the required mortgage payment in half reduces the probability of default by about two-thirds. The effect of lowering payments turns out to be much stronger than that of lowering the loan-to-value ratio. Thus, cutting the mortgage payment in half has an equivalent effect on the probability of default as lowering the borrower's loan-to-value ratio from 145% to 95% holding the payment fixed. These results contradict Foote et al. (2012), who argued that the foreclosure crisis following the Great Recession in the US was not caused by increased mortgage interest payments on adjustable-rate loans.

Based on these studies, we might expect that the mortgage relief program in Iceland, which also reduced mortgage principal and therefore monthly interest expense, will increase household expenditure, especially the purchase of consumer durables such as cars. However, there are notable differences between the reform in Iceland and the experience of the other countries. First, the reduction in monthly interest expenses occurred only in the aftermath of the financial crisis, when most households' balance sheets had been repaired. Second, the relief was paid for by external parties, foreign vulture funds.

We next turn to describing the implementation of the debt relief program.

4 The mortgage forgiveness program

The government implemented the ambitious mortgage forgiveness program in 2015. The debt relief was determined to compensate for the increase in mortgage principal that occurred due to inflation indexation, exceeding the central bank's target of a 2.5% annual inflation rate. Thus, eligible households received a refund of 13% of the value of their mortgage in August 2010, up to a cap of 4 millon ISK (which was close to the average monthly disposable income at the time). Therefore, eligibility for debt forgiveness was restricted to households that, in 2008-2009, had CPI-indexed mortgages granted for the purchase of existing housing or the construction of new homes for their own use.[8] Iceland's parliament approved the measures in May 2014 and the tax authorities were asked to prepare facilities that would be used in the mortgage forgiveness operation.

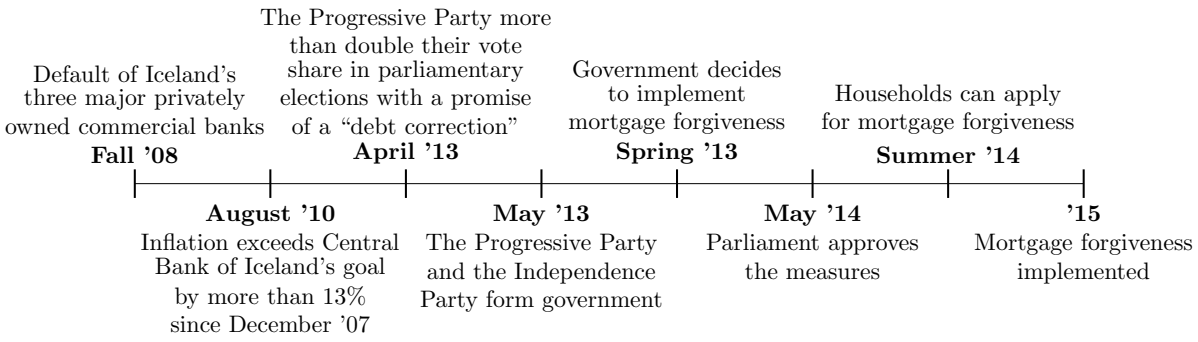
Individuals did not automatically have their debt reduced. To be eligible for mortgage forgiveness, they had to submit an application to the tax authorities between May 18 and September 1, 2014, listing their mortgage debt owed to one or more banks or pension funds. The amount of the forgiveness was then calculated for each household, and the results were announced to most applicants on November 11, 2014. As of December 23, households had three months to approve the calculation. From the borrower's point of view, their debt burden was lowered from the time they approved the measure. The Ministry of Finance and Economic Affairs estimates that 63,820 households were eligible for mortgage forgiveness. Our data show that 56,979 households benefited from the measure, giving an application rate of 89% among eligible households. Figure 2 gives the timeline for the main events.

From the timeline, we can infer that although expectations of debt forgiveness were created in May 2013, it was not until spring 2014 that parliament passed the legislation, which actually provided much less forgiveness than had been promised by the populist political party before the 2013 elections[9] Therefore, households were aware of the com-

[8] At the time, approximately 73% of household debt was inflation-indexed and another 16% was linked to foreign currencies.

[9] This is the Progressive Party, a centrist-agrarian political party.

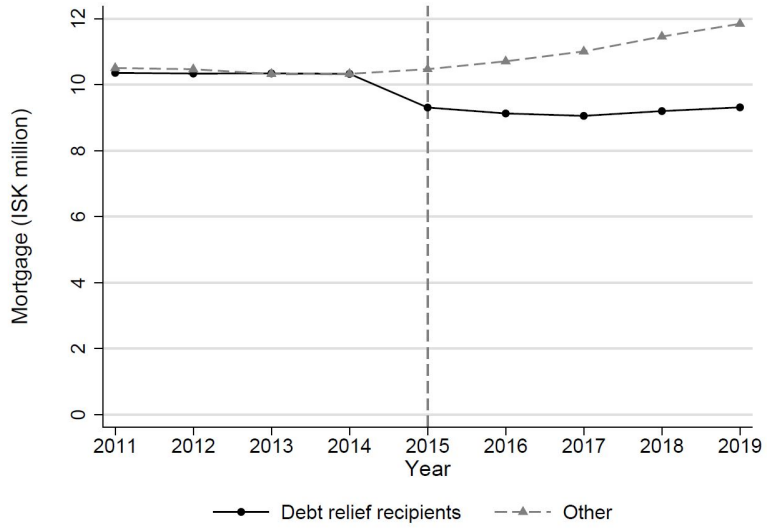
Figure 2: Main events leading up to the mortgage reduction



ing debt forgiveness program from May 2014 until the forgiveness was granted to most households in early 2015.

Figure 3 shows the effect of the mortgage forgiveness program on the group that benefited from it and the remaining households that did not. The latter group consists of households that had paid their mortgages by 2008 and those who bought their first property after 2009.

Figure 3: The effects of the mortgage scheme: comparison of treatment group and control group



Note: Figure 3 shows the yearly average mortgage for the treatment group of individuals who received mortgage forgiveness (black line and dots) and the control group (gray broken line and triangles) .

The average mortgage debt of the two groups is similar before 2015 but then falls in the treatment group in 2015 due to debt cancellation. Note that less than 10% of the debt is canceled. We will study the evolution of debt in the coming years, but Figure 3

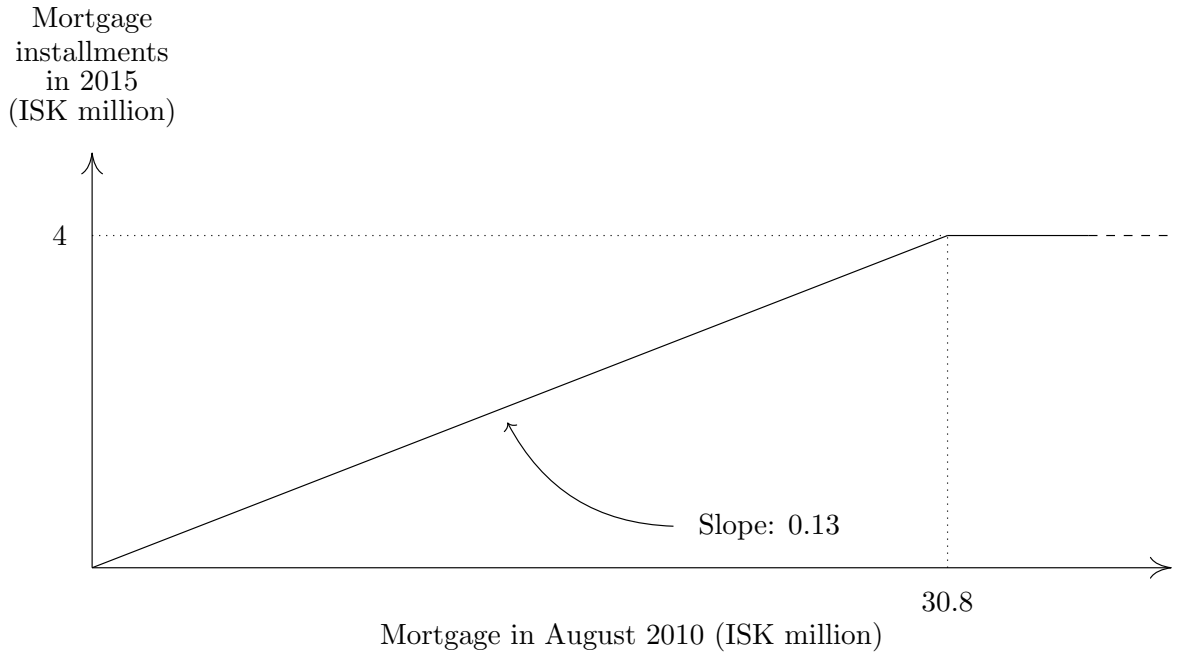
already suggests that debt forgiveness recipients did not respond by borrowing more, at least not enough to offset debt cancellation.

The debt forgiveness implemented in 2015 allows us to use DID to study the effects of reduced debt on the saving and consumption behavior of households. We use administrative data that include all taxpayers in Iceland. The data measure each household's level of debt, the value of housing, income (earnings, capital income, and benefits), and taxes, enabling us to calculate the level of consumption and saving for each household. We combine the data on tax returns with the data on how much each household received in the form of debt cancellation in 2015. The debt reduction program therefore provides a natural experiment, as it applied only to a subset of households and benefited some households more than others.

Households with an indexed mortgage registered in 2008 and/or 2009 were eligible for the debt forgiveness scheme. There was great uncertainty in 2013 about the terms of the mortgage forgiveness. As it turned out, indexed housing mortgages were written down by an amount equivalent to their increase due to inflation above 4.8% in 2008 and 2009. This is equivalent to a 13% adjustment to the consumer price index (CPI) used for the mortgage indexation in August 2010. The amount of the reduction was capped at ISK 4 million per household (EUR 27,000 average disposable income), but this maximum affected only 10% of households. Previous debt forgiveness, implemented by the left-wing government in 2009-2013, was deducted from the amount of debt canceled. Figure 4 shows the level of debt forgiveness as a function of the principal of CPI-indexed debt in August 2010. There is a linear relationship between the two up to ISK 4 million, which is the cap on the debt reduction. As explained above, the government-funded debt forgiveness was financed with the levy of a tax on the failed banks' estates, in effect by taxing foreign creditors.

As an additional measure, households with mortgages could use their Pillar 3 pension savings to lower their mortgages further without paying any income tax (maximum ISK 500,000 per household each year or EUR 3,400). The total scope of these actions was estimated to be around 150 billion ISK (1 billion euros) spread over a four-year period. Of

Figure 4: Prior mortgage reduction and the debt forgiveness scheme



Note: Figure 4 shows the 2015 debt forgiveness for which households were eligible based on their mortgage as of August 2010.

this amount, government-funded debt forgiveness was estimated at ISK 80 billion (EUR € 544 million), and the use of Pillar 3 savings was at ISK 70 billion (EUR € 475 million).

The mortgage forgiveness program reduced households' debt by directly paying down their debt. By reducing the principal of the mortgage debt, the mortgage relief lowered the required monthly amortization because the maturity of the debt was unchanged. Therefore, we could expect the amortization to decrease after the debt relief.

The forgiveness was paid first into mortgages that had lost their collateral following a forced sale. An example of this would be a lender that initiates foreclosure proceedings leading to the forced sale of a property. The lender is able to recover only a part of the outstanding loan balance, and therefore the remainder of the loan is unsecured. Second, after the financial crisis, a statutory amendment allowed households to reduce their debt service burden by deferring a portion of their mortgage payment. The difference between the contractual payment and the actual payment was transferred to a deferral account. The mortgage forgiveness was then paid into arrears and into these deferral accounts. The remaining mortgage forgiveness, if it exceeded ISK 200,000 (€ 1,360 at 2015 exchange

rates), was paid to the mortgages. In cases where no mortgages existed anymore, e.g. households no longer owned a home or all mortgages were fully paid up – the forgiveness was allocated towards loans secured by collateral in the property of another individual. Finally, if no such loans existed, the remainder was paid to households through a special personal tax credit applied in equal installments in 2015-2018.

The total sum of the mortgage forgiveness was ISK 79.4 billion, according to our data (€540 million). The data include four variables for the mortgage forgiveness, in addition to an ID variable for personal identification. They are as follows:

- Loan installments: ISK71.4 billion (89.9%)
- Special personal tax credit: ISK 5.9 billion (7.4%)
- Borrowed collateral: ISK 1.0 billion (1.3%)
- Mortgages without collateral: ISK 1.1 billion (1.4%)

In the following, we focus solely on loan installments, which account for almost 90% of total forgiveness. Table 1 shows that the lion's share of the mortgage forgiveness was implemented in 2015 and 5% of the total amount was paid out in the last week of 2014. A small minority saw their mortgage debt drop in 2016 and 2017.

Table 1: Mortgage forgiveness by year

	2014	2015	2016	2017
Relief amount (m. ISK)	3,410	67,713	270	1
Share of total amount	4.8%	94.8%	0.4%	0.0%

5 The data

We use a database comprising administrative tax records for all Icelandic taxpayers (individuals) aged 30-70, between 2006 and 2019 of individuals aged 30-70 years old. As

such, the sample covers a period of large macroeconomic fluctuations and significant uncertainty. It includes rapid growth rates leading up to the global financial crisis and the collapse of Iceland's banking system, followed by the post-crisis recovery. The data includes comprehensive third-party-reported information on multiple sources of income and various assets and liabilities, including bank deposits, real estate values, some financial assets, mortgage debt, and other liabilities. In addition, the data are merged with other administrative data and thus include socioeconomic information such as education, occupation, and information on loan repayments and interest payments.[10] In an appendix we outline in detail the information on income, unrealized capital gains, assets, and liabilities available in the Icelandic tax registries.

We use tax records to construct measures of each household's saving and consumption. First, we construct household income, assets, and liabilities measures by aggregating information between household members using unique household identifiers. Second, we calculate consumption for each household using the accounting identity that consumption of a household equals its disposable income minus changes in net wealth plus unrealized capital gains (Browning and Leth-Petersen (2003); Eika et al. (2020); Fagereng and Halvorsen (2017))

$$C_{it} = Y_{it} - \Delta W_{it} + \sum_{k} \Delta p_{kt} A_{ikt-1} \tag{1}$$

where Y_{it} is disposable income for individual i at time t, ΔW_{it} is the change in net wealth from the previous year and $\Delta p_{kt} A_{ikt-1}$ is unrealized capital gains on asset A_k.

Once consumption has been derived, saving is the part of disposable income that is not consumed

$$S_{it} = Y_{it} - C_{it} = \Delta W_{it} - \sum_{k} \Delta p_{kt} A_{ikt-1} \tag{2}$$

where S_{it} denotes saving by individual i at time t. By definition, income is either saved,

[10]The data are collected by Statistics Iceland and Iceland Revenue and Customs, which ensure the anonymity of the data.

thus leading to increasing net wealth, or consumed. However, net wealth is also affected by unrealized capital gains/losses, captured by the last term in the equation. To derive consumption from Equation (2), it is therefore necessary to distinguish between changes in net wealth due to unrealized capital gains, which do not change current consumption but do influence net wealth, and changes in net wealth due to a household's saving part of its income, which in turn reduces current consumption.

As a further illustration, consider a household whose only asset is the house in which they live. The household earns income that is used for consumption or to pay down its zero-interest-rate mortgage. In the absence of price changes, household consumption is accurately identified as the share of its income not devoted to paying down the mortgage. However, if the price of the home increases, then the wealth of the household is influenced not only by its income and consumption decisions but also by the unrealized capital gain on the real estate asset. Unless accounted for, the increase in net wealth due to rising home prices would lead to an overestimation of the household savings.

The Icelandic tax registers include information on the estimated market value of each household's real estate, allowing us to precisely measure consumption in the above example. The example above points to two key challenges in measuring consumption and saving using accounting identities (1) and (2). First, the method requires accurate information on all sources of income for households and their level of assets and liabilities. Second, to account for the effect of a household's asset portfolio on its consumption, we need information about the price and quantity of each asset in its balance sheet, or we need information about asset transactions for all of its assets. Such data are scarce, but third-party reported information from tax registries that covers labor income, capital income, various government transfers, and tax payments, plus housing values and mortgage principal, are hard to beat.

We used a balanced panel of people aged 30 to 70 years over the years 2010-2019. We focus on households who got their mortgage paid down, excluding those who benefited from the mortgage forgiveness through a special personal tax credit and those who had their unsecured debt reduced following foreclosure and a forced sale of their property. We

also exclude those who had the mortgage forgiveness paid into debt secured by collateral in the property of another individual.The remaining loan installments account for almost 90% of total forgiveness.

Table 2 shows the sample averages for the entire sample, the treatment group, which received mortgage forgiveness, and the control group, which did not receive any mortgage forgiveness, in 2014, the year before debt forgiveness.

Table 2: Summary statistics

	Full	Sample			
		Treatment & control	Control		Treatment
			Full	Property owners	
Mortgage relief *	.27	.43	0	0	.9
Age	45.2	48	46.7	49.4	49.4
Married (%)	49.4	65.5	52.2	71.5	80.1
# Children	.5	.8	.7	.8	.9
Female (%)	50	50	47.6	50.5	52.5
Disposable income *	3.5	4.37	3.95	4.76	4.84
Property *	12	16.01	11.59	20.43	20.89
Mortgage *	4.68	7.23	4.33	7.64	10.42
Net Wealth *	19.76	24.85	21.13	36.73	28.96
Individuals	271,804	147,272	77,184	43,802	70,088

Notes: * ISK million (1 ISK million ≈ 7600 USD). Averages for the year 2014.

Consider first the property owners in the control group. Here, the control and treatment groups are similar in terms of age, gender ratios and number of children, but differ in the proportion married, mortgage and net wealth. Thus, the treatment group has a higher share of married couples (cohabiting), has a higher mortgage, and lower net

wealth. There are smaller differences in disposable income and the value of the property, the treatment group having slightly higher income and more valuable property.

Now consider the full control group. The treatment group is slightly older, a much higher proportion is married, there are more children, proportionately more women, and, most importantly, it has much higher disposable income, the value of property is almost twice that of the control group, the mortgage more than twice as high, and net wealth also much higher.

Because households who benefited from the mortgage forgiveness had higher disposable income, more valuable property, and higher net wealth than those who did not, we can conclude that the debt forgiveness was regressive in nature. It primarily benefited higher income and higher net worth individuals who had larger balance sheets, both more wealth and higher mortgage debt, but also higher disposable income and net worth. This also makes our natural experiment different from other episodes of mortgage forgiveness in other countries.

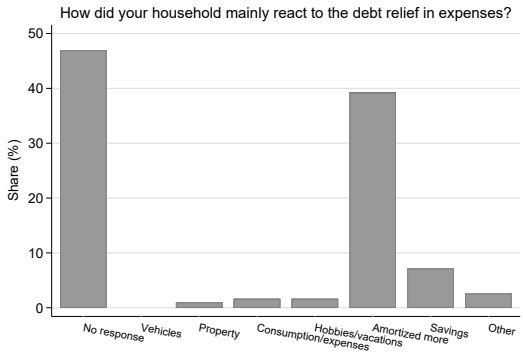
6 Survey

We start by using a survey conducted in 2021 to assess the effect of the mortgage relief on the propensity to save, in particular to amortize debt.[11] The survey included 946 individuals. In 2015, 35.4 percent of respondents worked in the private sector, 23.7 percent in the public sector, 13.3 percent were not employed, 13.8 percent were self-employed and 13.7 percent worked for nongovernmental organizations or did not specify their sector. We confine our sample to the 25-65 age group.

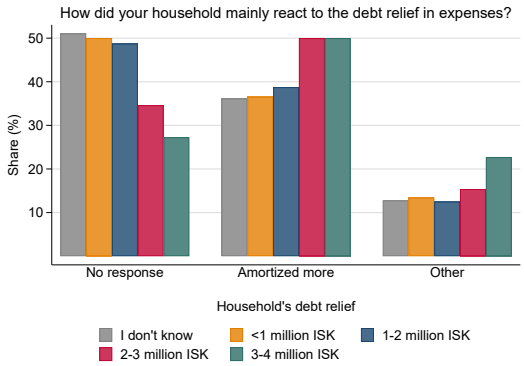
Figure 5 shows the results. Figure 5a shows how individuals responded to the mortgage relief through their expenditures and saving, including amortization of debt, while Figure 5b shows the proportion who decided to amortize more as a function of the level of debt relief in ISK millions.

[11]The survey was conducted by the company Maskina (maskina.is) for the purpose of this study between 27 September and October 2021.

Figure 5: Amortizations in the survey



(a) Response to debt relief (ISK million)



(b) Amortization as a share of debt relief

Figure 5 shows responses to the question "How did your household mainly respond to the debt relief?" Responses in Figure 5a: 1) Did not respond, 2) Bought a vehicle or a more expensive vehicle than I would have otherwise, 3) Bought property, 4) Increased consumption and/or other expenses, 5) Spent a larger amount on hobbies and/or vacations, 6) Amortized mortgages beyond the debt forgiveness, 7) Increased savings, 8) Other. Figure 5b shows the responses, pooled into only three categories, by the amount of debt relief

The pattern in Figure 5a is very clear: nearly 40% of the respondents decided to amortize more in response to debt relief, while more than 7% decided to save more. Very few increased their consumption. In Figure 5b, the pattern is also clear in that the individuals who received the most debt relief decided to amortize more of their debt. Of those receiving ISK 2-4 million, 50% decided to amortize more.

We next turn to the empirical analysis using tax data.

7 Empirical analysis

We estimate the effect of the mortgage relief in a difference-in-differences setting. Households who did not have any CPI indexed debt before the financial crisis did not receive any relief and serve as a control group, while those who did receive relief are the treatment group. More specifically this will be done using the popular Wald DID estimator, which is the DID of the outcome divided by the DID of the treatment,

$$\widehat{MP}_i = \frac{DID\ y}{DID\ DF}, \tag{3}$$

where DID is the difference-in-differences operator, y is the outcome of interest, and DF is debt forgiveness. Note that these are marginal propensities. Note that we can think of these as marginal propensities. That is, for each dollar received in debt forgiveness, DF, by how many dollars does the outcome y change.

7.1 Graphical Analysis

Before estimating the Wald-DID estimator, we explored whether the two groups had a common trend in the outcomes studied prior to the reform and whether these outcomes responded to the reform. For various outcomes, y_{ijt}, we estimate the following equation,

$$y_{ijt} = \alpha_0 + \alpha_1 DFR_j + \mu_t + \sum_{s \neq 2014} \delta_{jt} \mathbf{1}[s = t] \times DFR_j + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_{ijt} \tag{4}$$

where DFR_j is a dummy variable for those who received debt forgiveness, $\boldsymbol{X}_i$ is a vector of individual characteristics in 2014 and μ_t are time time fixed effects. In what follows, we show two sets of figures. First, outcomes for the treatment and the control group residualized on $\boldsymbol{X}_i$ and with α_1 added to the control group, so that the levels are same in 2014.[12] Second, we show estimates of δ_t with confidence intervals.

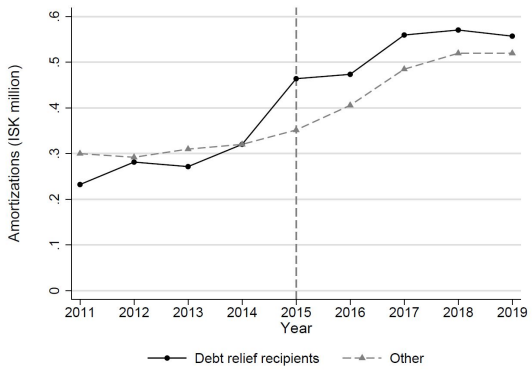
7.1.1 Main outcomes

Figure 6 shows the amortizations for the control and treatment group from 2011 to 2019. Note that these do not include the debt forgiveness itself. Figure 6a shows the amortizations in levels and 6c the corresponding DID estimates. The level of amortization had similar trends among debt relief recipients (treatment group) and other (control group) before debt forgiveness in 2015. Although the point estimates for the years 2011 and 2013 are not statistically insignificant from zero, the magnitudes are much smaller than for the response we estimate in the post-period. During the year of debt forgiveness, amortization in the treatment group increased sharply by around ISK 0.11 million, but

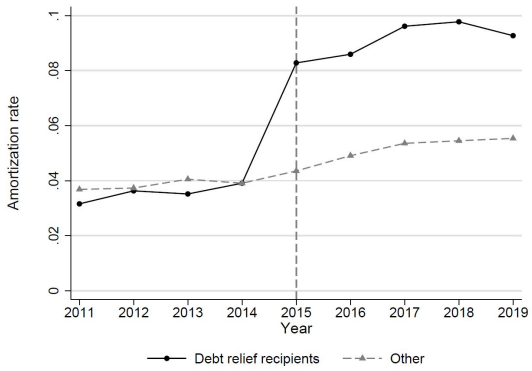
[12] That is, for the control group we show $\alpha_0 + \alpha_1 + \mu_t$, and for the treatment group we show the estimates of $\alpha_0 + \alpha_1 + \mu_t + \delta_t$

then dropped again in the years that followed, to ISK 0.07 million in 2016, and then gradually to ISK 0.04 million in 2019. Figures 6b and 6d show the ratio of amortizations to mortgage debt and the corresponding DID estimates, respectively. These tell a similar story as the level of amortizations shown above.

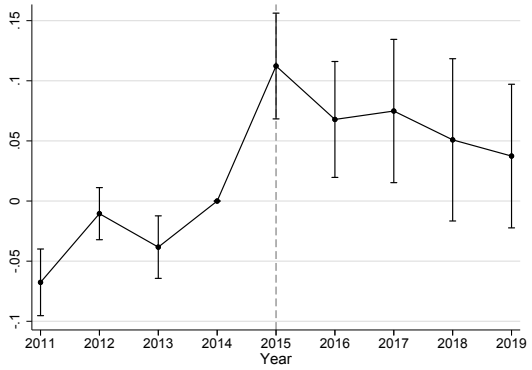
Figure 6: Amortizations



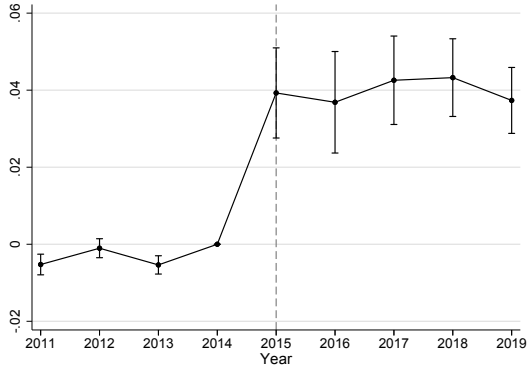
(a) Amortizations (ISK million)



(b) Amortization rate (out of debt)



(c) Amortizations (ISK million) DiD



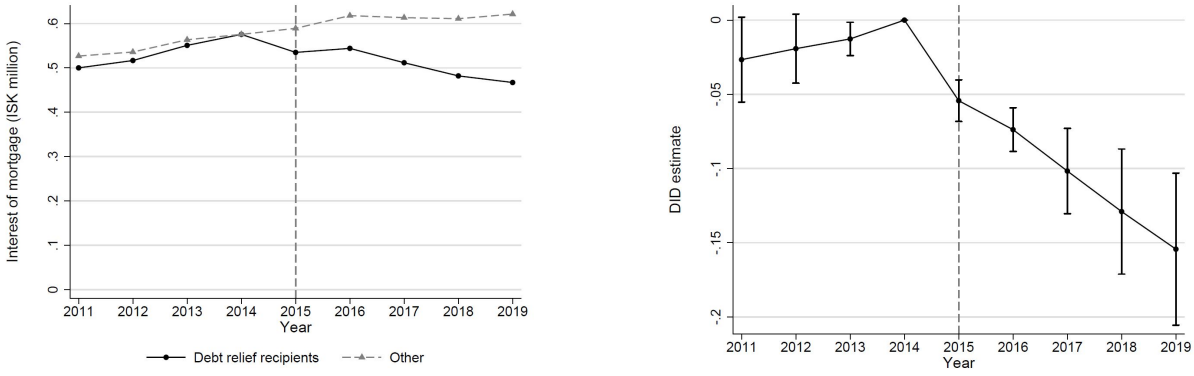
(d) Amortization rate (out of debt) DiD

Notes: The gray dashed lines in Figures 6a and 6b show $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t$ *from equation (4), while the black solid line shows* $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t + \hat{\delta}_t$. *Figures 6c and 6d show* $\hat{\delta}_t$ *with 95%-confidence intervals, based on standard errors clustered at the household level. Controls used are age, gender, marital status, and education. Marital status and education are fixed at their 2014 values. The grey dashed vertical line shows when the mortgage forgiveness was implemented. The amount received in debt forgiveness is not included above.*

Figure 7 shows the level of interest expenses in the control and treatment group (7a), and the corresponding estimates of DID (7b). Interest expenses were on a similar trend prior to the relief, but in 2015, interest expenses in the treatment group fell by ISK 0.05 million, and, consistent with the evidence on amortizations above, the difference gradually increased in the years to follow, and in 2019 interest expenses had fallen by

ISK 0.15 million (on an annual basis) in the treatment group.

Figure 7: Interest expenses



(a) Residualized group averages

(b) DiD

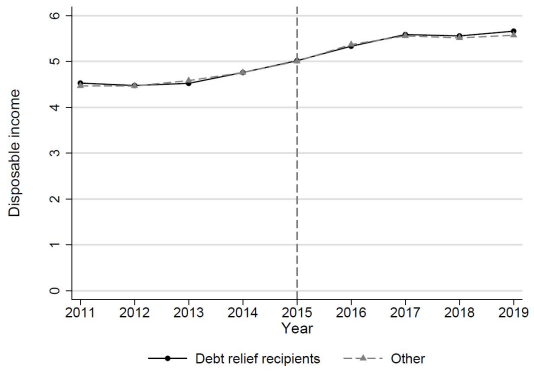
Notes: The gray dashed line in Figure 7a shows $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t$ from equation (4), while the black solid line shows $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t + \hat{\delta}_t$. Figure 7b shows $\hat{\delta}_t$ with 95%-confidence intervals, based on standard errors clustered at the household level. Controls used are age, gender, marital status, and education. Marital status and education are fixed at their 2014 values. The grey dashed vertical line shows when the mortgage forgiveness was implemented.

The evidence so far suggests that debt relief spurred recipients to reduce their debt in excess of the debt forgiveness they received. That is, the treatment group increased the amortizations of its debt after receiving the initial debt forgiveness. Recall that the mortgage relief itself had the direct effect of reducing monthly amortization, as described in Section 4 above. However, we need to dissect what is happening here. The story is that households responded by amortizing even more than what they received in debt forgiveness. The only direct effect the mortgage forgiveness had on households' budget set is through lower interest expenses of mortgages. The question is whether households simply responded by taking the amount they saved in interest expenses and used it to amortize or if they reduced their consumption to finance further amortizations, or even other types of saving.

Before dissecting the anatomy of households expenses in response to the debt relief, we want to rule out the possibility that there have been no shocks to other sources of income. Figure 8 shows that disposable income in the treatment and control group had a very similar trend between 2011 and 2019, suggesting that the only effect on the budget

of the households should be the lower interest expenses of the mortgages.[13]

Figure 8: Disposable income



Notes: The gray dashed line in Figure 8 shows $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t$ *from equation (4), while the black solid line shows* $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t + \hat{\delta}_t$.

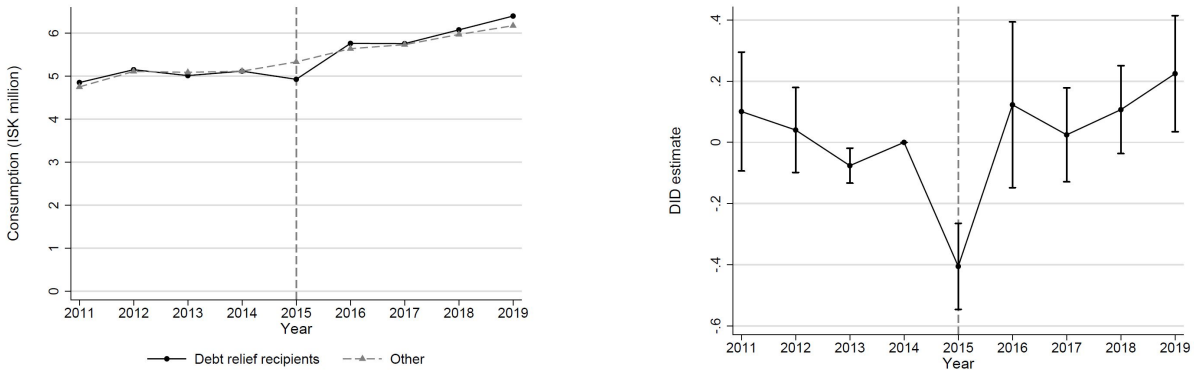
Figure 9 plots the level of consumption in the control and treatment group (Figure 9a and the corresponding DID estimates Figure 9b). There are no visible differences between the two groups except for a decrease in ISK of 0.4 million in 2015 for the treatment group. Furthermore, there may be evidence of consumption in the treatment group gradually increasing relative to the control group, and in 2019 we see a statistically significant difference of ISK 0.2 million. This evidence on the response to consumption coincides with the strong response to amortizations in 2015 seen in Figure 6. That is, the evidence suggests that in 2015, the year the debt forgiveness was implemented, households decreased their consumption to finance amortizations. However, in the years that followed, it is possible that the treatment partly used the extra leeway created by the lower interest expenses to save (amortize) and partly for consumption.

7.1.2 Other assets

Figure 10 shows the evolution of the value of vehicle ownership in the control and treatment group in 2011 to 2019 (Figure 10a, and the corresponding DID estimates in Figure 10b), the evolution of other debt than mortgages during the same period (Figure 10c,

[13]This measure of disposable income is defined and computed by Statisitcs Iceland's as all labor income, capital income, and other income, consisting of government transfers, pension income, grants and lottery winnings net of total direct tax payments.

Figure 9: Consumption



(a) Total consumption

(b) Total consumption DiD

Notes: The gray dashed line in Figure 9 shows $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t$ *from equation (4), while the black solid line shows* $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t + \hat{\delta}_t$*. Figure 9b shows* $\hat{\delta}_t$ *with 95%-confidence intervals, based on standard errors clustered at the household level. Controls used are age, gender, marital status, and education. Marital status and education are fixed at their 2014 values. The grey dashed vertical line shows when the mortgage forgiveness was implemented.*

and net wealth excluding property and mortgages in Figure 10d). The value of the vehicle stock of the treatment group increases relative to the stock of the control group (see Figures 10a and 10b). However, the level of other debt in the treatment groups also increased compared to the control group (see Figures 10c). Furthermore, there are no visible differences in the evolution of net wealth, excluding property and mortgages, between the two groups (Figure 10d). This may suggest that households receiving debt forgiveness responded by buying more expensive vehicles, but financed these purchases with car loans.

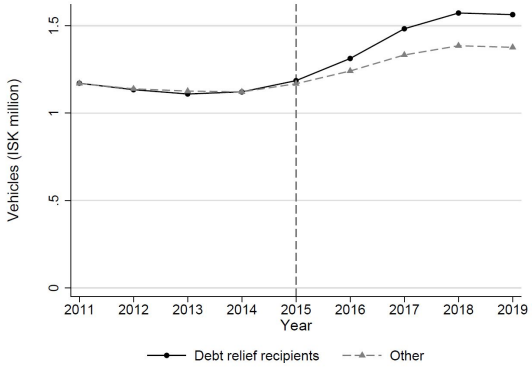
7.2 Marginal propensities

The marginal propensity, MP, is found by estimating the following specification,

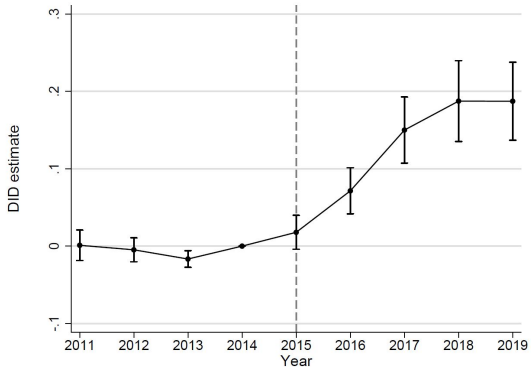
$$y_{it} = \beta_0 + \beta_1 DFR_{it} + \beta_2 \cdot P_t + MP \cdot DF_{it} + \boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_{it} \tag{5}$$

where DFR_j is a dummy variable for those who received a debt forgiveness, P_t is a post-relief dummy variable, DF_{it} is the amount of debt forgiveness that individual i's household received, and X_{it} is a vector of individual characteristics (only age thus far).

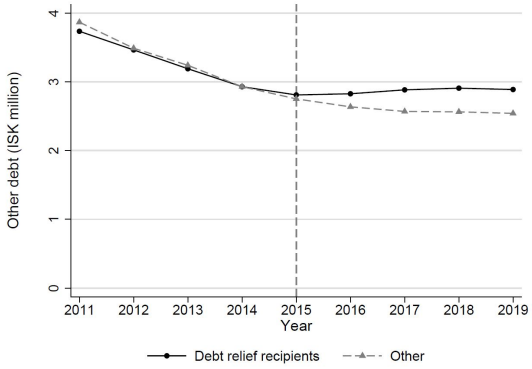
Figure 10: Ownership of cars and non-mortgage debt



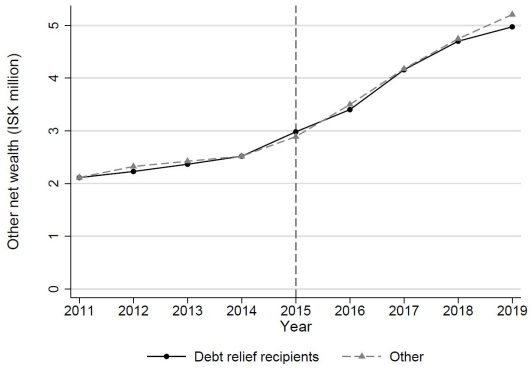
(a) Other assets (vehicles)



(b) Durable consumption (vehicles) DiD



(c) Debt, other than mortgages



(d) Net wealth excluding property and mortgages

Notes: The gray dashed lines in Figures 10a, 10c and 10d show $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t$ from equation (4), while the black solid lines shows $\hat{\alpha}_0 + \hat{\alpha}_1 + \hat{\mu}_t + \hat{\delta}_t$. Figure 10b shows $\hat{\delta}_t$ with 95%-confidence intervals, based on standard errors clustered at the household level. Controls used are age, gender, marital status, and education. Marital status and education are fixed at their 2014 values. The grey dashed vertical line shows when the mortgage forgiveness was implemented.

Before 2015, DF_{it} was zero for everyone. In and after 2015, DF_{it} is equal to the amount that the household received in 2015. In Wald-DID style, DF_{it} is instrumented with the interaction of the post-relief dummy and a dummy variable for those who received at least some mortgage relief, $P_t \times DFR_i$. In other words, the reduced form reads

$$y_{it} = \rho_0 + \rho_1 DFR_{it} + \rho_2 \cdot P_t + \rho_3 \cdot DFR_j \times P_t + \boldsymbol{X}_i \boldsymbol{\rho} + e_{it}, \tag{6}$$

and the first stage equation reads

$$DF_{it} = \pi_0 + \pi_1 DFR_{it} + \pi_2 \cdot P_t + \pi_3 \cdot DFR_j \times P_t + \boldsymbol{X}_i \boldsymbol{\pi} + \nu_{it} \tag{7}$$

This gives the Wald-DiD estimate of the effect of the mortgage relief on the outcome variable of interest from equation (3). Table 3 shows the results of estimating specification (5). Our results can be summarized as follows. First, as a consequence of debt forgiveness, household mortgage interest costs decreased. For every dollar of debt forgiveness, the annual mortgage interest costs of households decreased on average by 11 cents compared to the level in 2014. This drop in costs has in turn created a leeway for households to either consume or save more. Second, amortization increased by 6 to 7 cents for every dollar of debt forgiveness, showing that some households directed the relief toward paying down their principal debt obligations. For every dollar of debt forgiveness. Third, households also used other means to save than by lowering their mortgage principal. This can be seen by the fact that for every dollar in debt forgiveness, consumption decreased by 17 cents. Thus, households did not only use the extra leeway created by the debt relief through mortgage interest costs to amortize, they even cut back on consumption to save via other means.

Table 3: Marginal propensity estimates

	Mortgage interest cost		Amortization		Consumption	
			2SLS			
DF	-0.11***	-0.11***	0.06***	0.07***	-0.24***	-0.17***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.05)	(0.04)
P	0.03***	0.03***	0.09***	0.09***	0.84***	0.80***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
DFR	0.36***	0.36***	0.13***	0.13***	1.57***	1.50***
	(0.05)	(0.05)	(0.01)	(0.01)	(0.08)	(0.07)
			Reduced form			
DFR × P	-0.10	-0.10	0.05	0.06	-0.20	-0.15
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)
Controls		Yes		Yes		Yes
Observations	1,012,032	1,012,032	1,012,032	1,012,032	1,012,032	1,012,032
Individuals	126,504	126,504	126,504	126,504	126,504	126,504
Households	88,080	88,080	88,080	88,080	88,080	88,080

Note: Using a balanced panel spanning the years 2012-2019, consisting of individuals that were 30-70 years old in 2015. The first stage without additional controls is 0.88 with a standard error of 0.00, and the first stage with additional controls is 0.89 with a standard error of 0.12.

7.3 Marginal propensities by year

The results above show the average effects of the debt forgiveness on interest costs, amortizations and consumption between 2015 and 2019. Now, with each mortgage installment the principal will fall and thus interest costs, which in turn will create a leeway for either amortizing more or adjusting other means of saving or consumption. It is therefore interesting to further analyze the dynamics behind the averages. The marginal propensity

each year is found by estimating the following specification,

$$\begin{aligned} y_{it} =& \beta_0 + \beta_1 DFR_{it} + \beta_2 \cdot P_t + MP \cdot DF_{it} \\ &+ \sum_{j=2016}^{2019} \delta_j \cdot (DF_{it} \times 1[t = j]) + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_{it} \end{aligned} \tag{8}$$

where DF_{it} and $DF_{it} \times 1[t = j]$, are instrumented with $P_t \times DFR_i$ and $P_t \times DFR_i \times 1[t = j]$. Therefore, the marginal propensity in 2015 is MP, and the marginal propensity in year j is $MP + \delta_j$.

Table 4 shows the results of estimating specification (8). Our results can be summarized as follows. Over the years 2015-2019, mortgage interest costs dropped gradually from 5 cents for each dollar received in debt forgiveness in 2015 to 19 cents for each dollar received in debt forgiveness in 2019. This shows that households gradually reduced their interest burdens over time. Amortization initially increased substantially, peaking in 2016 at 15 cents for each dollar received in debt forgiveness, before stabilizing around 0.06 in subsequent years. Consumption saw an initial sharp decrease of -0.34 in 2015, indicating substantial savings efforts. However, this effect diminished and stabilized already a year later, the reduction in consumption had stabilized around zero, suggesting that households gradually adjusted their consumption patterns. However, since interest costs gradually decreased, this means that

Table 4: Marginal propensity estimates by year

	Mortgage interest cost		Amortization		Consumption	
DF	-0.05	-0.05	0.14	0.15	-0.34	-0.33
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
DF + DF $\times 1[t = 2016]$	-0.09	-0.07	0.07	0.08	0.06	0.10
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)
DF + DF $\times 1[t = 2017]$	-0.12	-0.11	0.07	0.08	-0.04	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.05)	(0.04)
DF + DF $\times 1[t = 2018]$	-0.16	-0.14	0.07	0.08	0.01	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.05)	(0.05)
DF + DF $\times 1[t = 2019]$	-0.19	-0.17	0.04	0.06	0.00	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.06)	(0.05)
Controls		Yes		Yes		Yes
Observations	1,012,032	1,012,032	1,012,032	1,012,032	1,012,032	1,012,032
Individuals	126,504	126,504	126,504	126,504	126,504	126,504
Households	88,080	88,080	88,080	88,080	88,080	88,080

Note: Using a balanced panel spanning the years 2012-2019, consisting of individuals that were 30-70 years old in 2015.

7.4 Heterogeneity analysis

We now turn to heterogneity analysis. For each heterogeneity analysis, we will split the sample into ten deciles on the basis of the specific dimension studied, and we estimate the response for each decile. First we explore heterogeneity with respect to the amount received in debt forgiveness.[14] We do this by estimating the following specification,

$$y_{ijt} = \alpha_0 + \alpha_1 DFR_j + \beta_d + \mu P_t + \delta_d D_d \times P_t \times DFR_j + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_{ijt}, \tag{9}$$

where D_d are decile dummies based based on the amount received in debt forgiveness. Figure 11 shows the heterogeneity in amortizations by the amount received in debt relief. The gray circle represents the control group, which does not receive any debt forgiveness, and by definition does not change its amortizations. The black dot represents the entire treatment group (all deciles combined). The position on the horizontal axis is the average debt forgiveness received in the treatment group. The position on the vertical axis is the average treatment effect of the reform on amortizations.[15] Each white circle represents one decile based on the amount received in debt forgiveness. For each decile, the position on the horizontal axis is the average debt forgiveness received in that decile, and the position on the vertical axis is the average treatment effect of the reform on amortizations in that decile. That is, the positions on the vertical are the estimates of δ_d from equation (9). The black line goes through the origin and has a slope found by estimating (5) with amortizations as outcome. We find that the relative change in amortizations increases linearly in debt forgiveness. That is, irrespective of the amount received in debt forgiveness, roughly the same share of that amount (0.12) is spent on increased amortization. Thus, the responses for the deciles are scattered around the fitted line.

Now we turn to heterogeneity in the marginal propensities to amortize. We will study

[14] That is, and for this analysis we split the sample into ten deciles based on the amount received in debt forgiveness.

[15] That is, the position on the vertical axis is δ from the following specification,

$$y_{ijt} = \alpha_0 + \alpha_1 DFR_j + \mu P_t + \delta P_t \times DFR_j + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_{ijt}.$$

the heterogeneity by the debt of households before debt forgiveness, disposable income, and liquidity (measured by bank deposits). In this analysis, we will thus divide the sample into ten deciles based on the dimension studied. Equation (5) is updated to include decile fixed effects, β_d, and these deciles are also interacted with DF_{it} so that we can estimate the marginal propensity for each decile, MP_d,

$$y_{ijdt} = \alpha_j + \beta_d + \alpha \cdot P_t + \sum_{\tau} MP_d \cdot DF_{it} \times D_\tau + \boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_{ijt}. \tag{10}$$

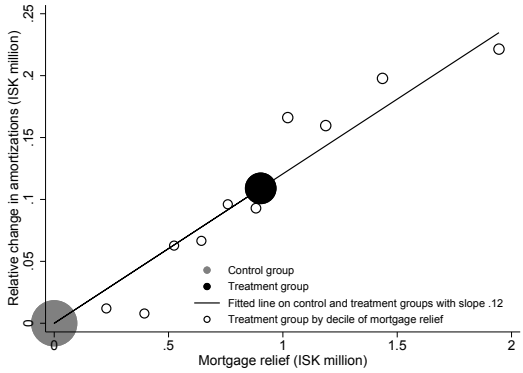
Furthermore, we now need one instrument per decile,

$$Z^d_{ijt} = \gamma_j + \beta_d + \gamma \cdot P_t + \mu^d \cdot DFR_j \times P_t \times D_d + \boldsymbol{X}_i\boldsymbol{\beta} + \epsilon_{it}.$$

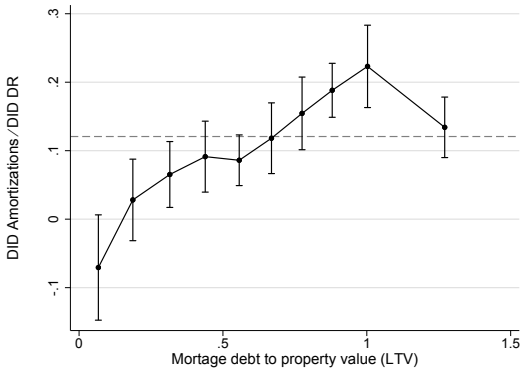
Figure 11b shows the heterogeneity in the marginal propensity to amortize out of debt forgiveness by the loan-to -value ratio. Each dot represents the marginal propensity estimated for one decile with 95% confidence interval. The response is monotonically increasing in debt between the first and ninth deciles. The point estimate for the first decile is negative and statistically insignificant, the point estimate for the sixth decile is at 0.11 (similar to the point estimate in the whole treatment group)and statistically significant, while the point estimate in the tenth decile is around 0.12. Figure 11c shows a weak positive slope of heterogeneity in the marginal propensity to amortize by disposable income. That is, high-income households amortized their debt more low-income households. Finally, Figure 11d shows a negative slope of heterogeneity in the marginal propensity to amortize by liquidity, where liquidity is measured by bank deposits. The slope is steepest in the lowest deciles, and the first, second, and tenth deciles are the only deciles that have point estimates that are stastistically significant from the point estimate for the whole treatment group. Thus, we have found that the amortization and consumption MP is driven by highly leveraged, high income, and liquidity constrained households.

Finally, we turn to heterogeneity the marginal propensity to consume out of debt

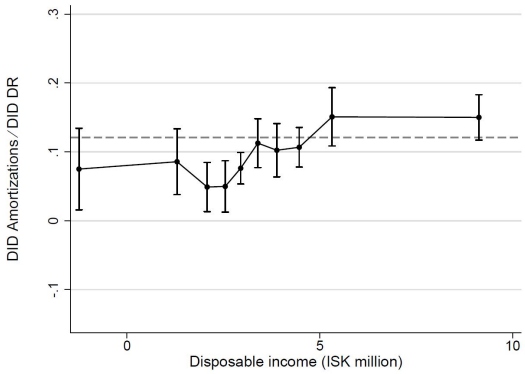
Figure 11: Amortizations heterogeneity



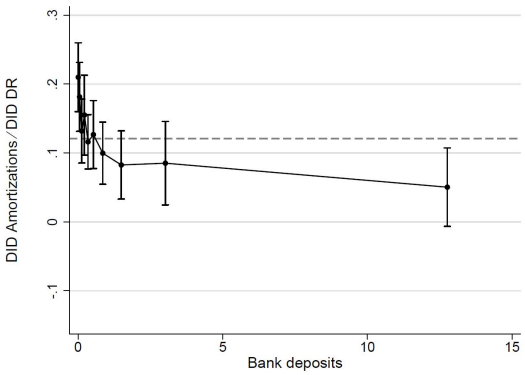
(a) By debt forgiveness



(b) By 2014 loan to value (LTV) ratio



(c) By 2014 income



(d) By 2014 liquidity (bank deposits)

Notes: Figure 11 shows heterogeneity in the amortizations response to the mortgage relief. The gray circle represents the control group, which does not receive any debt forgiveness, and by definition does not change it's amortizations. The horizontal position of the black dock is the average debt forgiveness received in the treatment group. The vertical position of the black is δ from the following specification,

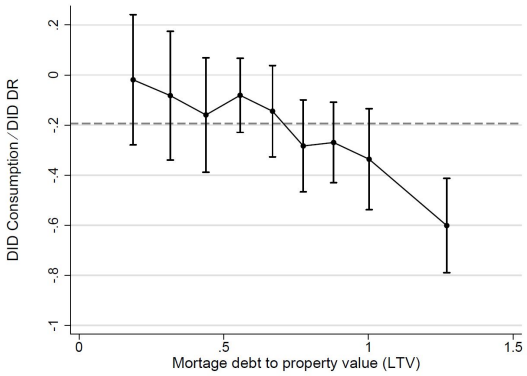
$$y_{ijt} = \alpha_0 + \alpha_1 DFR_j + \mu P_t + \delta P_t \times DFR_j + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_{ijt},$$

Each white circle represents one decile based on the amount received in debt forgiveness. The horizontal positions of the white dots are the average debt forgiveness received in the corresponding decile, and the vertical positions are the estimates of δ_d from equation (9). The black line is goes through the origin, and has a slope found by estimating equation (5) with amortizations as outcome. The gray dashed horizontal lines in Figures 11b, 11c and 11d represent the marginal propensity to amortize for the entire treatment group and are found by estimating equation (5). The black dots show the marginal propensities to amortize for each decile. The horizontal position of the black dots is the decile averages for each outcome, and the vertical position are the estimates of MP_d from equation (10). The solid black bars represent 95% confidence intervals, based on standard errors clustered at the individual level.

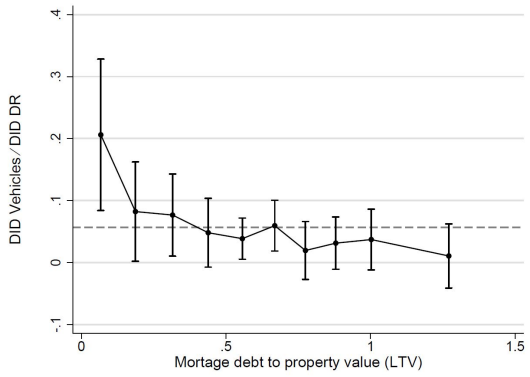
forgiveness. Figure 12 shows the heterogeneity of consumption. The DID estimates show that the difference between the decrease in consumption in the treatment group and the control group increases in the ratio of mortgage debt to property value. Thus, more

indebted households reduced their consumption more in response to debt relief. Figure 12b shows that the less indebted households increase their auto purchases more than the more indebted ones. This contrasts with the findings of the studies on the effect of the HARP reforms surveyed above.

Figure 12: Consumption heterogeneity by 2014 loan to value (LTV) ratio



(a) Total consumption by LTV ratio



(b) Durable consumption by LTV ratio (vehicles)

Notes: Figure 12 shows heterogeneity in the consumption response to the mortgage relief. In each figure, the position on the x-axis denote average values within each decile. The grey dashed horizontal lines represent the marginal propensity to amortize for the entire treatment group.The black dots show the marginal propensities to amortize for each decile. The solid black bars represent 95% confidence intervals, based on standard errors clustered at the individual level. Figure 12a shows heterogeneity in the consumption response with respect to the pre-relief LTV ratio. Figure 12b shows heterogeneity in the durable consumption response with respect to the pre-relief LTV ratio.

7.5 Robustness

As described in an earlier section, households with mortgages could use their third pillar pension savings to lower their mortgages further, that is, on top of the relief given by the government in 2015, without paying any income tax (maximum ISK 500,000 per household each year or €3,400). Although direct debt relief was more significant, the use of third pillar pensions was 45% of the total. However, note that this is savings used to lower mortgages, the government's contribution being not to tax the withdrawals.

In Appendix B, we plot the withdrawals from the third pillar pensions savings funds between 2011 and 2019 for both the treatment and control groups and do a difference-in-difference estimate with 2014 being the base year. The results show that the increase

in amortizations by the treatment group after the debt relief is not funded by pension wealth withdrawals.

Finally, in Appendix C, we changed the definition of the control group to include the subset of households in the original control group that owned a property in 2008 or 2009. A similar pattern emerges as in Figure 6, indicating that after debt forgiveness, there is a noticeable increase in amortizations in the treatment group.

8 Conclusions

We have studied the effect of the mortgage debt relief program implemented in Iceland in 2015, following the country's financial crisis in 2008-2010, using administrative data that includes all taxpayers in Iceland. We differ from earlier studies of mortgage relief in using administrative data that includes the tax returns of all tax payers enabling us to calculate their consumption and savings. The experiment itself is unique in two ways. First, the debt relief was financed by taxing foreign creditors so that the cost did not fall on domestic taxpayers. Second, the debt relief occurred seven years after the financial crash of 2008 when the debt-to-income ratios had recovered.

The debt relief was intended to compensate households for the rise in CPI-indexed mortgage principal, which was caused by the collapse of the currency and the ensuing price inflation. Eligibility for the debt relief was therefore restricted to households that had CPI-indexed mortgage loans in 2008-2009. Because some households did not have CPI-indexed mortgage debt at the time of the crash and those who did varied in terms of the level of debt, the mortgage relief program benefited some households and not others, and it benefited some more than others, providing us with a natural experiment.

Perhaps surprisingly, since the debt relief had the direct effect of reducing amortization due to the lowering of the principal, we found that households responded to the debt relief by amortizing even more when they received the debt forgiveness instead of reducing their saving due to a positive wealth effect and lower monthly interest payments. The degree of amortization turns out to be positively related to the level of the debt relief, the more

households received in relief, the more they amortized their debt. The amortization is also positively related to the loan-to-value ratio and to disposable income. It is declining in liquidity. Thus, high-income, leveraged households that benefited more from the mortgage relief increased their amortization of debt more than other households did. The only direct effect the mortgage forgiveness had on households' disposable income was through lower interest expenses on mortgages. As it turned out, households did more than use their interest savings to lower their mortgages further, they actually reduced their consumption to increase the amortization of debt.

While total consumption did not increase on average for those benefiting from the mortgage relief as compared to the control group, and it fell in 2015, their vehicle purchases increased by more, which is consistent with studies of the effect of debt relief following the Great Recession in the U.S., although only by a small amount. This rise is due mainly to an increase in primarily credit-financed car purchases by households with limited mortgage .

We conclude that by lowering monthly interest expense and increasing households' net worth, mortgage relief can induce households to increase their savings in order to lower their mortgages further instead of raising consumption, as has been found in studies of mortgage relief in other countries. Thus research on the HARP relief program in the U.S. found that households responded to lower interest payments by increasing their consumption expenditures. In contrast, it appears that households in Iceland, having seen their loan principal decline because of mortgage relief, discovered the utility of having lower debt. This could be because the mortgage relief in Iceland took place seven years after the banking collapse and five years after the end of the financial crisis when the need for such relief no longer existed while in the U.S. households benefited from HARP in the immediate aftermath of the 2008 crash.

References

Abel, J. and Fuster, A. (2021). How do mortgage refinances affect debt, default, and spending? evidence from harp. *American Economic Journal: Macroeconomics*, 13(2):254–291.

Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S., Piskorski, T., and Seru, A. (2017). Policy intervention in debt renegotiation: Evidence from the home affordable modification program. *Journal of Political Economy*, 125(3):654–712.

Agarwal, S., Amromin, G., Chomsisengphet, S., Landvoigt, T., Piskorski, T., Seru, A., and Yao, V. (2023). Mortgage refinancing, consumer spending, and competition: Evidence from the home affordable refinancing program. *The Review of Economics Studies*, 90(2):499–537.

Agarwal, S. and Qian, W. (2017). Access to home equity and consumption: Evidence from a policy experiment. *Review of Economics and Statistics*, 99(1):40–52.

Aladangady, A. (2017). Housing wealth and consumption: evidence from geographically linked microdata. *American Economic Review*, 107(11):3415–3446.

Aliber, R. Z., Kindleberger, C., and McCauley, R. N. (2023). *Manias, Panics, and Crashes: A History of Financial Crises*. Palgrave Macmillan.

Attanasio, O. P., Blow, L., Hamilton, R., and Leicester, A. (2009). Booms and busts: Consumption, house prices and expectations. *The Economic Journal*, 104(427):1269–1302.

Benediktsdottir, S., Danielsson, J., and Zoega, G. (2014). Lessons from a collapse of a financial system. *Economic Policy*, 26(66):183–235.

Benediktsdottir, S., Eggertsson, G. B., and Þórarinsson, E. (2017). The rise, fall, and resurrection of iceland: A postmorten analysis of the 2008 financial crisis. *Brookings Papers on Economic Activity*, pages 191–281.

Browning, M. and Leth-Petersen, S. (2003). Imputing consumption from income and wealth information. *The Economic Journal*, 113(488):F282–F301.

Campbell, J. Y. and Cocco, J. F. (2007). How do house prices affect consumption? evidence from micro data. *Journal of monetary Economics*, 54(3):591–621.

Carroll, C. D., Otsuka, M., and Slacalek, J. (2011). How large are housing and financial wealth effects? a new approach. *Journal of Money, Credit and Banking*, 43(1):55–79.

Case, K. E., Quigley, J. M., and Shiller, R. J. (2005). Comparing wealth effects: The stock market versus the housing market. *The B.E. Journal of Macroeconomics*, 5(1):1–32.

Eika, L., Mogstad, M., and Vestad, O. L. (2020). What can we learn about household consumption expenditure from data on income and assets? *Journal of Public Economics*, 189:104163.

Fagereng, A. and Halvorsen, E. (2017). Imputing consumption from norwegian income and wealth registry data. *Journal of Economic and Social Measurement*, 42(1):67–100.

Foote, C. L., Gerardi, K. S., and Willen, P. S. (2012). Why did so many people make so many ex post bad decisiosn? the causes of the foreclosure crisis. *Public Policy Discussion Paper 12-2. Federal Reserve Bank of Boston.*

Fuster, A. and Willen, P. S. (2017). Payment size, negative equity, and mortgage default. *American Economic Journal: Economic Policy*, 9(4):167–191.

Galbraith, J. K. (1954). *The Great Crash 1929.* Mariner Books.

Gan, J. (2010). Housing wealth and consumption growth: Evidence from a large panel of households. *The Review of Financial Studies*, 23(6):2229–2267.

Guren, A. M., McKay, A., Nakamura, E., and Steinsson, J. (2021). Housing wealth effects: The long view. *The Review of Economic Studies*, 88(2):669–707.

Hudson, M. and Goodhart, C. (2018). Could/should jubilee debt cancellations be reintroduced today? if not, what alternative measures of debt relief and redistribution might be possible? *Economics: The Open-Access, Open-Assessment E-Journal*, 12.

Leth-Petersen, S. (2010). Intertemporal consumption and credit constraints: Does total expenditure respond to an exogenous shock to credit? *American Economic Review*, 100(3):1080–1103.

Mian, A., Rao, K., and Sufi, A. (2013). Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics*, 128(4):1687–1726.

Mudde, C. and Kaltwasser, C. R. (2017). *Populism: A Very Short Introduction*. Oxford University Press.

Sinai, T. and Souleles, N. S. (2005). Owner-occupied housing as a hedge against rent risk. *Quarterly Journal of Economics*, 120(2):763–89.

Straumann, T. (2019). *1931: Debt, Crisis, and the Rise of Hitler*. Oxford University Press.

A Variables

Income: Our measure of household income includes labor income, capital income, income from pension funds, government transfers, and other income, such as lottery winnings. Naturally, tax registries do not include information on undeclared income. However, our consumption measure includes consumption in the informal sector as long as the income used for financing such consumption is declared. Unfortunately, we do not have information on inheritances.

Another source of income not reported in the tax registries is the income of homeowners from owner-occupied housing services. If a household buys an apartment it had previously occupied as renters, its consumption expenditures would drop by the amount of the rent they had paid before purchasing the home, while its consumption of housing services would remain unchanged. By adding the imputed rent for owner-occupied housing services to income, we obtain income and consumption measures that are comparable between renters and homeowners.[16]

Finally, we add this measure of imputed rent to a measure of disposable income defined and computed by Statistics Iceland as all labor income, capital income, and other income, consisting of government transfers, pension income, grants, and lottery winnings net of total direct tax payments.[17]

Net wealth: The tax records include information on the assets and liabilities of each household. The data on assets include ownership of real estate and vehicles, money in savings accounts, and stocks and bonds in equity funds, bond funds, or mixed funds. A key feature of Icelandic tax records is that direct ownership of stocks is not registered at market values. As a result, the level of assets of households is not affected by changes in the market value of stocks, unless the ownership of stocks is indirect through funds, in which case it is registered at market values. Although this is a drawback in general,

[16]Statistics Iceland estimates the value of owner occupied housing services using a simple user cost method. To compute imputed rent at the household level, we distribute the aggregate value of owner-occupied housing services across households according to each household's share of the total value of real estate.

[17]Specifically, imputed rent is added to capital income.

the fact that capital gains/losses in stocks are not observed in cases of direct ownership actually facilitates the accurate identification of household consumption and savings in years during which it does not engage in stock transactions. However, it can raise issues during the years in which they do engage in such transactions. This is discussed further in the following section.

Unrealized capital gains/losses: To derive consumption from Equation (1), it is necessary to distinguish between changes in net wealth due to unrealized capital gains, which do not change current consumption, but do influence net wealth, and changes in net wealth due to households saving some of their income, which reduces current consumption. This is a key challenge in determining the consumption and savings of households using tax records, as they typically contain information on the value of assets at the end of the year, but generally do not contain information on unrealized capital gains or the purchases and sale of assets.

A key difference between the Icelandic administrative data and, for example, data from other Nordic countries stems from the fact that stocks in direct ownership, as opposed to indirect ownership through funds, are not registered at market values. However, the measure of net wealth is not influenced by unrealized capital gains/losses in stocks that need to be accounted for. As long as households do not engage in transactions in individual stocks, we need not rely on any assumptions in this regard to accurately measure their consumption and savings.

However, such assumptions are needed for the ownership of financial assets through funds, such as equity funds, which are registered at their year-end market value. In this context, we follow Eika et al. (2020) in measuring unrealized capital gains/losses by assuming no intrayear transactions, and thus allowing for heterogeneous returns. However, we assume that unrealized capital gains on such financial assets are zero for those who own such assets in a given year but did not in the previous year. In such cases, an intrayear transaction clearly took place and likely drove the change in the value of the assets from one year to the next.

Real estate prices: Arguably, most households' largest unrealized capital gains/losses

stem from changes in the price of their real estate assets. The data set includes information on the market value of real estate for each household as estimated by Register Iceland (RI), a public institution responsible for maintaining a property register and national register in Iceland. RI estimates the market value of all real estate in Iceland each year, and its valuations form the basis for property taxes and inheritance taxes. Hence, the yearly change in RI's property valuation is a natural measure of capital gains/losses in real estate.

Although the above measure of price changes in real estate is accurate for the vast majority of households, challenges arise in the cases of households that engage in real estate transactions in a given year. Such transactions do not imply a change in a household's net wealth but merely a rebalancing of its asset portfolio. We do not have information on transactions in real estate and therefore must make assumptions. In particular, we assume no intra-year transactions for the vast majority of households. However, we assume that transactions occurred if the change in real estate assets is either at the top 5% or the bottom 5% of the distribution of changes in the value of real estate in a given year. In such cases, we assume that the transaction occurred in the middle of the year and that the price of the new real estate asset followed Statistics Iceland's property price index.

Loan indexation: A large share of household debt in Iceland is CPI-indexed, meaning that the loan principal is linked to the consumer price index. This is relevant for measuring consumption and savings, as indexation is a form of unrealized capital loss and therefore would lead to an overestimation of household consumption if not accounted for. We compute the indexation by summing a household's repayment of a loan and the change in the loan's principal. For nonindexed loans, repayments would explain all changes in the loan's principal, but for indexed loans, repayments are typically lower.

The mortgage forgiveness: The mortgage forgiveness itself constitutes an unrealized capital gain for the households that benefited from it, as it increased their net wealth without showing up in their disposable income. As such, it needs to be taken into account in identifying households' consumption and savings. We have data from the tax auhorities

on the forgiveness received by each household, which we merge with the data taken from the tax returns.

Durable consumption: Durable goods generate expenditures solely at the moment of purchase, but generate a flow of consumption services until they are replaced or scrapped. Although the tax registries do not include detailed data on durable consumption, they include the value of vehicles for each household, which is arguably the largest source of durable consumption for the average household after housing services, which we have already accounted for. According to Icelandic tax laws, vehicles are depreciated by 10% per year. We assume that the consumption flow of vehicles is equal to their depreciation value.

Consumption and saving: Finally, we measure consumption in the Icelandic administrative tax registries using Equation (1), which, considering the discussion above, takes the following form:

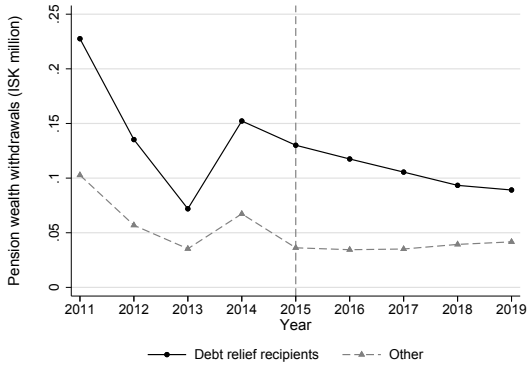
$$C_{it} \equiv Y_{it} - \Delta W_{it} + \Delta HP_{it} - Index_{it} + DC_{it} + MR_{it} \tag{11}$$

ΔHP_{it} denotes the change in real estate prices for household i in year t, $Index_{it}$ denotes the effect of loan indexation, DC_{it} is durable consumption in vehicles, and MR_{it} captures unrealized capital gains from the mortgage forgiveness. As before, saving is computed as the share of disposable income not consumed.

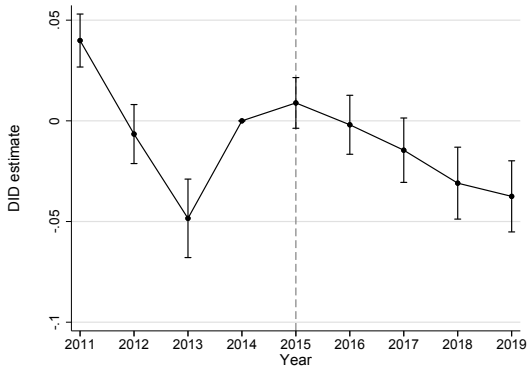
B Pension wealth withdrawals

Panel (a) in Figure 13 illustrates the withdrawals of pension wealth from third-pillar pension savings between 2011 and 2019 in both the control and treatment groups. Individuals under 60 years of age were eligible to make such withdrawals after the financial crisis to pay down mortgage debt. Panel b shows the corresponding DID estimates, using 2014 as the base year. Although the trends are not parallel between the two groups prior to the relief, making it inappropriate to draw conclusions about the causal effect of the debt

relief on pension wealth withdrawals, we can argue that the increase in amortizations following the debt relief is unlikely to have been funded with pillar-three pension wealth. From 2011 to 2019, recipients of debt relief consistently withdrew more pension wealth than the control group did. However, in the years following the debt forgiveness, the difference between the two groups narrowed.



(a) Pension wealth withdrawals (ISK m)



(b) Pension wealth withdrawals (ISK m) DiD

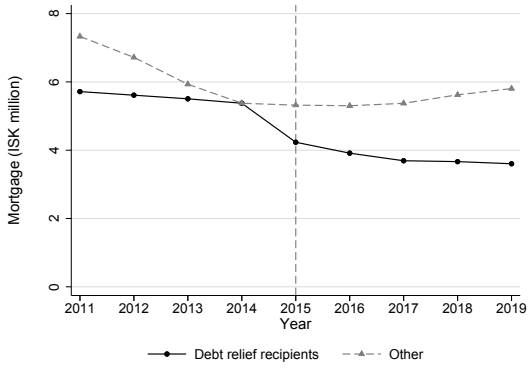
Notes: (a) are the group averages.

Figure 13: Pension wealth withdrawals

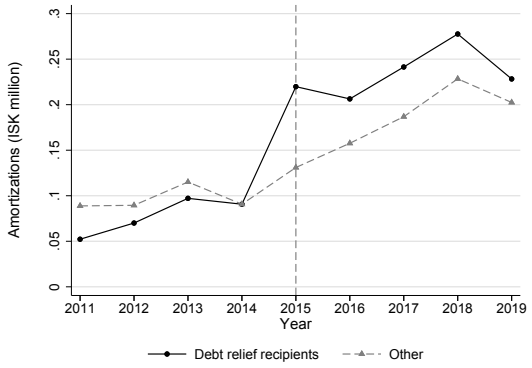
C Alternative control groups

Figure 14 shows residualized mortgages and amortizations for both the treatment group and the subset of households in the original control group that owned a property in either 2008 or 2009. From panel (a), it is evident that there was a slight difference in the trend of mortgages between the two groups before the debt forgiveness. However, examining the amortizations (panel b) reveals a pattern similar to that observed when the original control group in Figure 6 is used. Specifically, prior to the debt forgiveness, both groups exhibit a relatively similar trend in amortizations. However, after the forgiveness, there is a noticeable increase in the amortizations among households that received debt relief.

Residualized mortgages and amortizations for the treatment group and a subset of households in the original control group that owned a property without a mortgage in 2008



(a) Mortgages (ISK m)

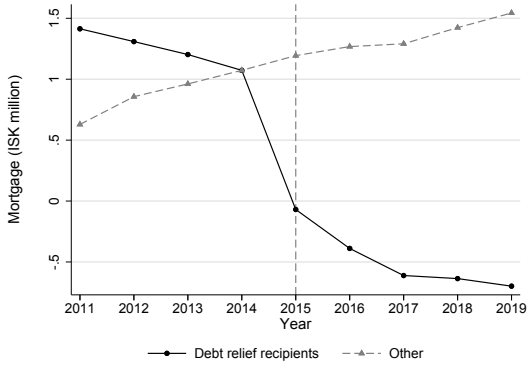


(b) Amortizations (ISK m)

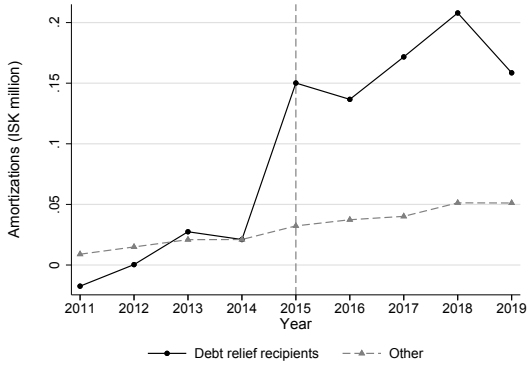
Notes: The control group consists of the subset of households in the original control group that owned property in either 2008 or 2009.

Figure 14: Only homeowners in control group

and 2009 are shown in Figure 14. These figures present evidence similar to that shown in Figure 13. In other words, in panel 14(a), it is clear that there was a slight difference in the trend of mortgages between the two groups before the debt forgiveness. However, analyzing the amortizations in panel 14(b) reveals a comparable pattern, mirroring what was observed when the initial control group was used (Figure 6). Specifically, prior to debt forgiveness, both groups exhibit a relatively similar trend in amortizations. However, after the forgiveness, there is a noticeable increase in amortizations among households who received debt relief.



(a) Mortgages (ISK m)



(b) Amortizations (ISK m)

Notes: The control group consists of the subset of households in the original control group that had debt-free property in 2008 and 2009.

Figure 15: Only debt-free house owners in control group