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RESUME

I papiret analyseres sammenhængen mellem opsparing i private pensioner og bruttogæld i danske husholdninger. Ved at udnytte en uventet reduktion i skattefradraget ved pensionsindbetaling viser analysen, at afdrag på gælden øges, når skattefordelen på pensionsområdet reduceres. På den baggrund konkluderer vi, at fradragsberettigede pensionsordninger kan påvirke opbygningen af gæld i husholdningerne. På linje med den seneste forskning finder vi, at skattefradrag ved opsparing i private pensioner kun har en begrænset effekt på den samlede opsparing i husholdningerne. Modsat tidligere studier er vi imidlertid i stand til at skelne mellem effekten på finansielle aktiver og passiver. Det har været muligt, fordi vi som noget ekstraordinært har haft adgang til detaljerede oplysninger om alle realkreditlån i Danmark. Ved hjælp af det eksogene stød til pensionsbeskatningen viser vi, hvordan en markant reduktion i frivillige pensionsbidrag delvist modgås af et øget afdrag på realkreditgæld.

ABSTRACT

Measuring the effect of an unanticipated reduction in tax credits on pension savings, this paper shows that individuals tend to make extraordinary repayments on their debt when saving in retirement accounts becomes less attractive. We conclude that tax-favoured retirement accounts could affect gross debt accumulation. In line with recent studies, we show that tax subsidies for saving in pension accounts only affect total individual savings to a limited extent, but unlike prior research this paper distinguishes between the effects on financial assets and liabilities. As a particular feature, we have gained access to comprehensive information on all mortgage loans in Denmark. Exploiting the exogenous shock to pension taxation, we demonstrate how a sharp reduction in voluntary pension savings is partly offset by increased repayments on mortgage loans.

Do Tax Incentives for Saving in Pension Accounts Cause Debt Accumulation? Evidence from Danish Register Data

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December 2015

Abstract

Measuring the effect of an unanticipated reduction in tax credits on pension savings, this paper shows that individuals tend to make extraordinary repayments on their debt when saving in retirement accounts becomes less attractive. We conclude that tax-favoured retirement accounts could affect gross debt accumulation. In line with recent studies, we show that tax subsidies for saving in pension accounts only affect total individual savings to a limited extent, but unlike prior research this paper distinguishes between the effects on financial assets and liabilities. As a particular feature, we have gained access to comprehensive information on all mortgage loans in Denmark. Exploiting the exogenous shock to pension taxation, we demonstrate how a sharp reduction in voluntary pension savings is partly offset by increased repayments on mortgage loans.

Keywords: Pension Savings, Household Debt, Mortgage Loans

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1. Introduction

Alongside other developed countries, Denmark has been subject to discussion in recent years because of high debt-to-income ratios in the household sector. The concerns are related to potential negative implications of indebted households on macroeconomic stability and economic growth. The life-cycle literature struggles to document whether tax-favoured pension accounts affect household debt accumulation (Bernheim, 2002). Macro- and micro-level studies suggest that gross debt and financial assets, including pension wealth, are closely correlated, primarily through their link to income (Andersen et al., 2012b,a; Isaksen et al., 2014). However, accumulation of pension wealth and gross debt could be connected through a direct causal link for two specific reasons. Firstly, larger pension wealth enables households to service their debt far into retirement. Secondly, taxpayers can deduct both pension contributions and interest payments on outstanding debt in their salary before taxes are paid. To our knowledge, little research has been done to investigate the potential causality between pension savings and debt and this paper attempts to do exactly this.

This paper studies the effect of an unanticipated reduction in tax credits on pension contributions that causes voluntary pension savings to decrease substantially. However, this reduction is almost fully offset by increased repayments on debt and savings in non-retirement accounts. Despite the fact that the measured effect applies to high income earners only, we consider the findings as important contributions to a growing literature that struggles to document the drivers behind household debt accumulation.

Household leverage tends to have significant impact on consumer behaviour. Mian et al. (2013) provide evidence based on disaggregated household data that leverage and asset price shocks can translate into demand-driven recessions. They show that price shocks are more harmful to private consumption if households are highly leveraged. These results are further established by Andersen et al. (2014) who use Danish micro data to show how leveraged households tend to adjust spending downwards in the aftermath of a recession in order to align consumption with their non-leveraged peers. Thus, highly indebted households could prolong the recovery period that follows an economic crisis and put a drag on economic growth (Cecchetti et al., 2011; Jorda et al., 2013). All these findings suggest that we should attempt to explain the causes of the observed build-up of household debt.

We depart from the extensive literature on crowd-out in non-retirement accounts. It

is well documented that tax subsidies for pension savings increase savings in retirement accounts because they provide direct savings motives within the pension system. There is, however, some discussion over the effect of such tax incentives on total individual savings. Hubbard (1984); Venti and Wise (1990); Hubbard and Skinner (1996); Poterba et al. (1995, 1996) find that tax incentives for saving in pension schemes increase total individual savings, while Evans (1983); Gale and Scholz (1994); Engen et al. (1994, 1996); Gale (1998); Attanasio and DeLeire (2002); Attanasio and Rohwedder (2003); Chetty et al. (2014) show that pension savings are crowded out by taxable savings. Such crowding-out implies that tax deductions on contributions for pension schemes make people shift savings from taxed saving accounts to tax deductible pension accounts, leaving total individual savings unchanged. Most recently, Chetty et al. (2014) find that only few individuals respond actively to tax incentives by reshuffling savings between saving accounts, while the majority seems not to respond to tax incentives at all. This indicates that some groups are more likely to respond than others, e.g. high income groups with highly developed financial literacy (Lusardi, 2006). Thus, we must be aware of the external validity of our results when we examine the impact of tax subsidies for saving in pension accounts.

Despite a comprehensive literature on crowd-out in non-retirement accounts, there seems to be limited evidence on how subsidies for saving in pension accounts affect individual gross debt. We revisit the question of crowd-out in non-retirement accounts using unique micro data on bank credits and mortgage loans allowing us to examine the interplay between retirement savings and gross debt. Specifically, we measure if individual gross debt is reduced as saving in pension schemes become less attractive.

We test the hypothesis that individuals offset reduced pension contributions with increased savings in taxable accounts or by making extraordinary repayments on their debt. This is done by measuring individual responses to an unexpected tax reform that affected tax subsidies on pension contributions significantly. Specifically, this paper investigates whether individuals increase repayments on bank debt or mortgage loans as tax credits on pension contributions are reduced. The reform affected individuals with relatively large pension contributions, indicating that our estimates apply to high income earners.

In contrast to other studies in the literature on household savings behaviour, this paper provides detailed balance sheet coverage, including comprehensive data on gross debt. Danish

public administration data allows us to draw almost the full picture of savings in pension accounts and financial liabilities in the household sector. Based on unique individual identifiers several data sources are merged into one data set with information on individual income, pension contributions, financial balances, mortgage loans and a broad set of personal characteristics. We exploit a sharp change in Danish tax subsidies for pension savings to generate exogenous variation to pension savings behaviour. The aim of the reform was to limit the usage of annuity pension schemes in favour of life-long schemes. The former is a scheme in which retirees receive a final number of yearly instalments, whereas the latter pays out smaller annuities as long as the owner lives. The life-long pension scheme is thus partly an insurance scheme which is less useful for speculative purposes, i.e. tax avoidance. The reform induced a threshold of 100,000 Danish Krones (DKr) on yearly contributions for annuity pension schemes in 2010. Taxpayers that prior to this reform paid annuity pension contributions larger than 100,000 DKr experienced an unanticipated decrease in the amount of money that could be deducted in their income before paying taxes. Conditional on this fact and conditional on year and individual fixed effects, we argue that variations in annuity pension contributions are exogenous. Combining a difference-in-differences and two-stage-least-squares research design, we measure if changes in voluntary pension contributions led to significant changes in financial liabilities after reform implementation.

The results show that the reduced tax subsidy for annuity pensions in 2010 caused individuals to reduce total voluntary pension contributions significantly, indicating a very limited substitution for alternative retirement accounts. However, 19 øre (Danish for cents) of each 1 DKr reduction in private pension contributions were used for increased repayment of mortgage debt, while 61 øre were saved in taxable accounts.

This paper contributes to the literature by providing empirical evidence that reductions in tax subsidies for pension contributions cause high income earners to reduce gross debt. We show that mortgage repayments and pension contributions are considered substitutes and illustrate how mortgage repayments increase when taxation on pension savings becomes less favourable to taxpayers.

The remainder of the paper is organised as follows. Section 2 conceptualises the interplay between pension wealth and debt repayments. Section 3 describes the data, while the identification strategy and empirical model specifications are explained in section 4 and 5,

respectively. Results and robustness tests are presented in section 6 and section 7 concludes.

2. The Household Savings Decision

In this section, we set out a conceptual framework to think about the interplay between savings in pension accounts and household debt. A natural starting point is the thorough review on these matters given by Bernheim (2002).

Standard life-cycle theory states that rational agents plan to smooth future consumption by accumulating savings, while being in the working age. Consider the period-to-period budget constraint facing the individual decision maker where equation (1) describes accumulation of net savings ($A_t - A_{t-1}$). Y_t is income, C_t is consumption and i is the after-tax interest rate.

$$A_t = A_{t-1} + [Y_t - C_t](1 + i) \tag{1}$$

$$A_t = S_t + P_t + D_t \tag{2}$$

Consider Y_t and C_t fixed, households then face a portfolio allocation problem illustrated by equation (2). Agents can save in taxable saving accounts (S_t), tax-deferred retirement accounts (P_t) or by repaying outstanding debt (D_t), which all yield different after-tax returns. Unexpected reductions in net of tax returns from saving in retirement accounts would cause the agent to reduce pension contributions, increase taxable savings or repay debt. Engen and Gale (1996, 1997) investigate substitution between retirement savings and debt, specifically, showing evidence of a positive causal relationship. Due to sparse data, however, they cannot uncover the mechanisms explaining the effects. Poterba et al. (1998) do cohort analysis—using the same data as the aforementioned study—and find no support for causal links between savings in retirement plans and mortgage debt. They argue that the cohort approach controls sufficiently for heterogeneity, claiming that earlier studies have been unable to do so.

Most recently, Amromin et al. (2007) investigate potential tradeoffs between contributing to pension schemes and accelerating mortgage debt prepayments. They set up a theoretical measure of marginal tax-arbitrage profit and use survey data to show that a significant number of households opt for the sub-optimal choice and favour debt prepayments, i.e. they forego a tax-arbitrage opportunity. This indicates that a link between retirement savings and

mortgage debt accumulation could indeed exist, but they cannot show any form of causality between pension and debt accumulation.

The link between retirement savings and debt clearly remain ambiguous. Also, the standard model has been challenged by empirical studies, showing how individuals do not fully respond to unexpected shocks. By Madrian and Shae (2001) for instance, who demonstrate how default decisions—such as automatic enrolment into pension schemes and pre-determined contributions rates—tend to affect individual savings behaviour, which is not consistent with standard theory. Also, Chetty et al. (2014) document that less than 20 percent of a group who are confronted with a change in tax incentives for saving in retirement accounts actually adjust their savings.

Our paper differs from existing studies in the literature by having access to far more detailed information on both pension and debt data. Firstly, we consider public administrative data rather than survey data. Administrative data have the advantage that they provide many observations and objective information about wealth and savings decisions. Secondly, we use information on all mortgage loans provided by Danish mortgage institutions. This ensures more precise measurements of mortgage debt repayments than in former studies because we observe actual repayments on mortgages, whereas prior papers have only been able to measure total debt repayments for homeowners. Finally, we exploit exogenous variation from a Danish pension reform to show that pension and debt could be causally related.

To sum up, we expect that Danish homeowners could be considering pension wealth and repayments of debt as substitutes. The quantitative importance of this link is, however, an empirical question that remain unresolved.

3. Data

Panel data from several Danish administrative registers are merged, using anonymised personal identifiers. This includes information on income, pension contributions, financial assets and liabilities in banks and mortgage institutions, covering everyone residing in Denmark. All data are reported by third parties—such as financial intermediaries—eliminating risks of self-reporting bias. As a particular feature we have gained access to new data with information about all mortgage loans in Denmark for the period 2009-2013. These data are reported directly from mortgage banks, allowing us to measure actual repayments and

mortgage loan modifications. Unlike Chetty et al. (2014), who solely include non-mortgage debt, this analysis uses detailed mortgage data to uncover links between savings in pension accounts and mortgage debt accumulation. It is important to include mortgage data when investigating individual saving behaviour as mortgage loans on average constituted 72% of individual Danish gross debt in 2009.

All remaining variables cover the period 2003-2013. The sample is restricted to individuals between 18 and 59 years of age, simply because we want to identify savings behaviour among those in the working age. We remove individuals who are self-employed, including their partners, as they are not fully subject to the reform. Also, people not fully liable to taxation in Denmark are removed. All individuals are restricted to have at least 25,000 DKr of gross income each year and we censor gross income at the 99th percentile. Also, we censor pension contributions as share of gross income at the top 99th percentile, while annual changes to taxable savings as share of gross income are censored at both the 1st and the 99th percentile. Changes to net debt to banks are, however, characterised by enormous fluctuations and are therefore censored at the 10th and 90th percentile. Micro data are notoriously known for noise due to extreme observations resulting in very long tails to the distributions. By censoring the full sample, we eliminate much of this noise and we ensure that calculations of the means are much more in line with the medians. The full panel includes 1,773,911 individuals.

3.1. Pension Contributions

The Danish pension system is comparable to most retirement systems in developed countries. It has three pillars consisting of a state-provided defined benefit scheme (DB), occupational defined contribution schemes (DC) and voluntary pension savings accounts (DC). This setup is analogous to the US retirement savings system reflecting Social Security, 401(k)'s and IRA's, respectively. Within the second and third pillar, the Danish retirement system offers three types of pension schemes: annuity, capital and life-long schemes. Contributions for all schemes are tax deductible, but they differ in pay-out profile and taxation. The annuity scheme is paid out in annuities during a final time span of 10-25 years and payments are

taxed as regular income. The capital scheme is paid out as a lump-sum and taxed at 40%.[1] The life-long scheme is also paid out in annuities and taxed as regular income, but pay-out continues until the owner dies. Contributions from occupational schemes are generally set through collective bargaining agreements between employers' associations and workers' unions. Employers contribute to all three types of schemes and employer-paid contributions constituted just above 90 percent of total pension contributions in 2009. The sum of employer-paid and individual contributions for capital pension schemes is tax deductible up to a certain limit. This limit increases over time and amounted to 46,000 DKr in 2009. At that point, no subsidy thresholds existed for annuity and life-long schemes.

In 2010, a tax reform induced a tax subsidy cap on contributions for annuity pension schemes. This reform implied that the sum of employer-paid and individual contributions for annuity pension schemes was tax-deductible only up to 100,000 DKr. This sharp change in taxation on pension savings provides an ideal quasi-experimental research design to identify pension systems effect on individual savings behaviour. Data on annual contributions for pension accounts come from the Danish tax authorities and all contributions are reported by pension funds to the tax authorities in order to allow the owners to obtain tax deductions.

We focus on voluntary retirement savings (third pillar) only as they fully reflect individual savings behaviour. Second pillar savings are managed by employers and pension funds, while third pillar savings are managed only by the owner himself. Contributors for voluntary schemes are personally responsible that they are eligible for the tax subsidy. If for instance an individual's employer-paid contributions for annuity schemes amounts to 100,000 DKr in the reform year the employee must know that any additional (voluntary) contributions for annuity schemes are not tax deductible. This fact makes unanticipated shocks to tax subsidies on pension schemes a good source of exogenous variation to private pension savings behaviour. In order to illustrate the magnitude of the reform impact, annuity pension contributions summed to 32.8 billion DKr in 2009 (1.9% of GDP). Measuring all contributions starting from 100,000 DKr and above in this year, we capture 20% of the total amount.

We draw a subsample for further analysis by using the induced contribution threshold

[1] This scheme was abolished in 2013. A new scheme (Alderspension) was introduced, but contributions for this pension scheme were not tax deductible at pay-in.

in 2010 as a kink for assignment. Specifically, the subsample includes individuals who had total annuity pension contributions close to the 100,000-kink in 2008. Individuals with total annuity pension contributions within an interval of 50,000 DKr above or below the threshold were assigned as treated and non-treated, respectively. The sample includes 35,215 individuals and we elaborate on the assignment process below.

3.2. Taxable Savings

Taxable savings include all savings in non-retirement accounts such as bank deposits, bond and stocks minus financial liabilities in banks. This measure excludes mortgage debt consistent with former studies in the literature. Information on outstanding mortgage loans allow us to define individual mortgage debt repayments. This main variable of interest ensures that we capture almost the full financial balance of the individuals considered.

Data on Danish mortgage loans holds useful information on the terms of the mortgages, including outstanding principal, time to maturity, coupon rates, deferred amortisation options, adjustable or fixed rate, loan-to-value rates etc. What is particularly useful is the ability to calculate exact annual repayments on outstanding debt, allowing us to measure behaviour of mortgage owners very precisely. To our knowledge, no paper has earlier been able to do this due to data limitations. Mortgage repayments are defined as changes to the nominal outstanding debt. In the first year of the panel, individual repayments are calculated using the formula for annuities.

Considering bank debt we define a net-of-deposits measure—that is total bank debt minus total bank deposits—in order to avoid interference from collateralised banking products offered by some Danish banks.[2] Measurement errors potentially occur in the data when borrowers with such loans repay debt as this could appear as increased bank deposits rather than reductions in bank credits. Using our defined net measure makes it irrelevant which type of bank loan the borrower has. Data on bank loans and deposits comes from the Danish Tax Authorities.

[2]These loans (prioritetslån) are mortgage loans offered by banks and backed by mortgage deeds rather than by mortgage bonds as in Danish mortgage institutions. Such collateralised bank credit works as revolving credit on which interests will be charged on the balance.

3.3. Descriptive Statistics

Table 3.1 shows summary statistics for the full sample, the treated and the non-treated, covering the period 2003-2009. The treatment and control groups differ substantially from the full sample mean in all variables. This is a consequence of the fact that the policy that we evaluate targets people who have relatively high income and are relatively wealthy. We measure savings behaviour of individuals who contribute a total of 70,000–100,000 DKr for pension schemes annually, while the total population mean is 30,000 DKr. Similarly, contributions for voluntary pension schemes are 22,000–28,000 DKr annually in our group of interest compared to a full population mean of around 3,000 DKr. Clearly, the results in this paper confine to population groups with above average propensity to save in voluntary pension schemes.

Given our identification strategy, the treatment and control groups differ in pre-reform annuity pension contribution levels by definition. Pension contributions are highly correlated with income through labour market pension schemes, leading us to expect that mean income in the groups would also differ significantly. Moreover, income is generally correlated with financial wealth, which suggests that nominal values of non-retirement saving variables would also differ substantially. In order to show that pre-reform savings behaviour of the treated and non-treated was not different, we follow Heckman and Hotz (1989); Leth-Petersen (2010) and test the assumption that the treated and non-treated are in fact comparable. This is done by a two-sample t-test (table 3.1) and by performing graphical inspections (next section) of pre-reform trends in savings. Specifically, we test for equal means in annual growth rates in non-retirement savings and debt variables for the whole pre-reform period available. Based on this we cannot reject equal means, showing that our assumption of comparable groups is not violated. To further verify this, we also do two-sample t-tests on nominal changes in non-retirement savings and debt variables, returning the same results, cf. table 3.1.

The time period is characterised by substantial negative growth in financial assets, net debt to banks and mortgage debt, cf. table 3.1. We attribute this to the global, financial recession. However, the treated individuals experienced a smaller decrease in financial asset accumulation than the population mean, indicating that these individuals have relatively larger financial wealth. The same applies to mean growth in mortgage debt across the pre-reform period, as a smaller decrease for the treated indicate larger mortgage debt levels.

Table 3.1: Summary Statistics 2003-2009

	Full Sample		Treated		Non-treated		
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p-value**
			Flows (1,000 DKr)				
Gross Income	327,768	162,706	626,194	194,075	506,591	159,858	<0.000
Total Pension	29,573	59,196	105,168	72,348	69,077	46,460	<0.000
Privat Pension	3,131	15,158	28,495	33,153	22,333	27,101	<0.000
Financial Assets	2,123	249,651	14,054	220,958	7,486	230,257	0.108
Net Debt to Bank	6,309	254,988	2,616	354,435	3,048	337,890	0.923
Mortgage Debt	31,544	237,081	50,642	378,005	44,348	299,616	0.174
			Growth Rate (%)				
Financial Assets	-51.3	40.0	-13.1	49.9	-21.8	47.0	0.168
Net Debt to Banks	-3.8	75.9	-6.3	90.7	-6.4	89.2	0.398
Mortgage Debt	-3.8	7.8	-1.6	10.0	-1.7	9.9	0.694
Individuals	1,773,911		7,866		27,349		

Notes: The difference in total pension contributions and voluntary pension contributions are employer-paid pension contributions. Flows and growth rates are means over the entire pre-reform sample period, 2003-2009. Reported p-values reflect probability of a two-sample t-test of equal means between the treated and non-treated.

Source: Own calculations based on administrative data from Statistics Denmark.

Negative growth in net debt to banks—that is total bank debt less deposits—was, however, larger for the treated than the population average, but we consider this as an indication of low levels of net debt to banks in the treatment group.

4. Identification Strategy

In this section, we explain how the Danish 2010 pension reform is ideal for measuring individual responses to tax incentives. Figure 1a shows histograms of total contributions for annuity pension schemes in 2008 and 2010, using data of the full Danish population. We focus on contribution levels nearby the introduced 100,000 DKr-kink in order to visually confirm any behavioural response to the reform. Illustrating that contributions tend to bunch heavily close to the kink in 2010 compared to 2008, this figure suggests that the Danish population changed savings in annuity pension schemes as the reform was implemented. We exploit this exogenous variation in annuity pension savings to measure causal relations between saving in retirement accounts and non-retirement accounts, including debt repayments.

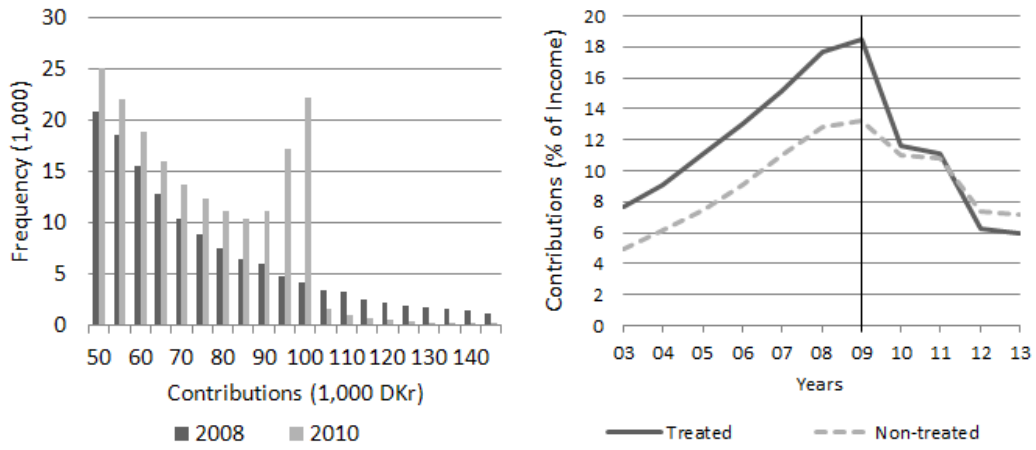
We assign a treatment group of individuals, who were expected to change behaviour because of the pension tax reform and compare their cash flow of savings with that of a control group, who were not expected to change behaviour. The treated and the non-treated are assigned strictly based on their historic contributions for annuity pension schemes and we use the introduced contribution threshold of 100,000 DKr as kink in the assignment process. First, we assign individuals into treatment if they had total contributions for annuity pensions exceeding 100,000 DKr in 2008—that is, two years prior to the reform year. Individuals with total annuity contributions of less than 100,000 DKr are assigned as controls. Identification is based on the assumption that the treated and the non-treated have similar savings preferences and only differ by prior contributions for annuity pension schemes. This quasi-randomisation around the kink implies that identification of responses is strongest close to the kink. It is less likely that individuals with very large contributions share savings preferences with individuals characterised by very limited contributions. Common trends are therefore easier to assume when assignment takes place very close to the kink. We prefer an assignment window of 50,000 DKr on each side of the 100,000 DKr-kink when assigning the two groups. In the robustness section, we show that the results are robust to changes in window size.

The identifying assumption rests on common trends in pension contributions for the treated and the non-treated in the pre-reform period. Figure 1b illustrates that this is not violated by graphical inspection. The figure shows the sum of contributions for occupational an individual annuity schemes each year measured as share of gross income. The solid lines reflect the treated, while the dashed lines indicate behaviour of the control group. The figure is constructed by calculating means of annual contribution ratios for each group. Contribution trends for annuity schemes in the treatment and control group are almost identical in the years before reform implementation. This fact is crucial for further quantification of the reform effects and we conclude that the identification strategy is appropriate and the common trend assumption is not violated. The treated reduced savings in private pension schemes substantially compared to the non-treated in 2010 and we exploit this fact to measure substitution for alternative types of savings or debt reductions.

The treated and the non-treated are assigned prior to the reform announcement, which ensures no self-selection bias. The assignment indicators are approximations of true treatment or control behaviour conditional on the change in pension taxation. This allows us to compare

reform responses under very few assumptions. Danish house prices underwent substantial changes in the time period considered. By excluding pre-reform homeowners from the sample—and thereby only considering individuals who were renters shortly before reform implementation—we find exactly the same trends in total and voluntary pension contributions (see appendix).

Figure 1: Contributions for Annuity Pension Schemes



(a) Full Sample

(b) Treatment Sample

Note: Figure 1a shows histograms of the sum of employer-paid and voluntary contributions for annuity pension schemes before and after the Danish 2010 pension reform. Figure 1b shows the sum of employer-paid and voluntary contributions for annuity pension schemes as % of gross income. This is calculated as annual means for the treatment and control groups.
Source: Own calculations based on administrative data from Statistics Denmark.

Given the fact that pension contributions and income are highly correlated, we report annual contributions for pensions and other savings as share of gross income. This ensures that income growth does not disrupt our comparison of pension savings between the two groups. One potential caveat from doing this is, however, that employers could decrease annuity pension contributions and increase salaries as a result of the reform. This would decrease private pension contributions measured as share of income without employees actually change pension saving behaviour. In the result section we show, however, that this denominator effect does not drive our results.

Assignments to the treatment and control groups are performed one year prior to the

reform announcement. This means that reform implementation and announcement took place in year t and $t-1$, respectively, while assignment into treatment was performed in year $t-2$. One could imagine that both the treated and non-treaded would increase contributions in year $t-1$ in order to fully utilise the tax subsidy before the introduction of the contribution threshold. This does, however, not seem to be the case. Nonetheless, contributions are almost identical for the treated and non-treated in the announcement year.

Ideally, trends in pre-reform contributions should align completely between the treatment and control groups. Minor misalignments could reflect the risk of misallocating individuals to either treatment or control. Specifically, if a true treatment person by mistake is allocated into control she would falsely cause the average contributions in the control group to increase and the average contributions in the treatment group to decrease. Misallocation of individuals is possible as assignment into treatment is performed only in year $t-2$. Should some individuals have significantly different contributions in year $t-2$ compared prior years, they would be misallocated and cause misalignment in both pre- and post-reform contribution averages. Problems with misallocation are not uncommon in quasi-experimental designs, but it does not seem to be a significant concern in this analysis. This can be tested by removing individuals in the very vicinity of the assignment kinks. The idea is that misallocation is less likely to occur as the distance between the lower bound of the treatment interval and the upper bound of the control interval increases. Using a donut-hole approach, we remove individuals with less than a 2,500 DKr-distance to the kink while other assignment specifications are kept unchanged. Pre-trends are almost completely unchanged (see appendix). Notice also reduced contributions by the non-treated in the reform year. Assuming that the common trend assumption holds, this reflects that contributions for voluntary pensions generally decreased in the post-reform period.

In order to feel confident that the common trend assumption is not violated, we do additional graphical inspections of pre-trends in mortgage loan interest rates (see appendix). This test also exhibit very similar trends for the treated and non-treated prior to reform announcement, indicating that the groups were equally exposed to changes in housing costs. This support the assumption that the two groups are in fact comparable.

Our research design seems appropriate for identification and we turn to the empirical specification to quantify the reform effects.

5. Model Specifications

The empirical analysis is divided into three steps. First, we measure the reform response in voluntary annuity pension accounts. Second, we demonstrate how changes in voluntary contributions for annuity schemes affected total contributions for voluntary pension accounts. Finally, we show how total contributions for individual pension schemes affected savings in non-retirement accounts and gross debt.

We apply a difference-in-differences model according to Wooldridge (2009) to capture the change in annuity pension contributions induced by the policy change. The model quantifies the reform effect on the treated relative to the non-treated.

$$P_{i,t} = \alpha + \beta_1 Treat_i + \beta_2 Post_{i,t} + \delta Treat_i \times Post_{i,t} + X_i + \epsilon_{i,t} \tag{3}$$

$P_{i,t}$ is annual contributions to private annuity pension accounts. $Treat_{i,t}$ is an indicator that takes the value 1 for the treated and 0 for the non-treated. β_1 estimates the structural difference in $P_{i,t}$ between the treated and the non-treated. $Post_{i,t}$ is an indicator that takes the value 1 in 2010 and onwards, otherwise 0. This term measures the change in $P_{i,t}$ valid for both groups from the pre-reform to the post-reform period, i.e. macro effects. δ is the coefficient of interest as it measures the average change in $P_{i,t}$ across reform implementation conditional on treatment. $X_{i,t}$ is the vector of pre-reform controls[3] and $\varepsilon_{i,t}$ is the error term.

5.1. Measuring Substitution Effects

In order to identify substitution from voluntary annuity schemes to capital or life-long pension schemes, we apply a two-stage-least-square model (2SLS) consistent with Chetty et al. (2014). The first stage in this 2SLS-model is identical to equation (3). Stage two departs from stage one, but the dependent variable is replaced by $Z_{i,t}$ and the interaction term is replaced by the fitted values from equation (3).

[3]Control variables cover age and work experience measured in years and a list of 13 dummy variables including marital status, renters, housing cooperatives (andelsbolig), divorced within last two years, unemployed within last two years, geographical region of residence (North Denmark Region, Central Denmark Region, South Denmark Region and Region Zealand) and highest completed education (primary school, secondary school, vocational training education and tertiary education).

$$Z_{i,t} = \alpha + \beta_1 Treat_i + \beta_2 Post_{i,t} + \delta \hat{P}_{i,t} + X_i + r_{i,t} \tag{4}$$

$Z_{i,t}$ represents contributions for alternative types of private pension accounts, i.e. life-long or capital pensions. By instrumenting $\hat{P}_{i,t}$ with the interaction term $Treat_i \times Post_{i,t}$ the effects pertaining the Danish 2010 pension reform is isolated. The critical identifying assumptions are that $Cov(Treat_{i,t} \times Post_{i,t}, \hat{P}_{i,t}) \neq 0$ and $Cov(Treat_i \times Post_{i,t}, r_{i,t}) = 0$. The former assumption is fulfilled as δ is significant in equation (3). The latter is fulfilled if the common trend assumption holds and the shock to pension savings is in fact exogenous. Under graphical inspection in figure 1b we conclude that visual consistency is not violated. Fulfilment of visual consistency is possible only if the assumption of exogeneity holds.

This paper aims to identify causal links between pension savings and debt accumulation. In order to identify substitution from pension accounts to taxable accounts we adjust for the fact that pension contributions are reported pre-tax in the data, whereas taxable savings are reported post-tax. By adjusting annual pension contributions for taxes we obtain substitution estimates in after-tax measures only. The adjustment leaves us with the tax-adjusted private pension contribution $\hat{PTOT}_{i,t}(1 - \tau_{i,t})$. The value of $\tau_{i,t}$ reflects the marginal tax rate of individual i and $\hat{PTOT}_{i,t}$ is total voluntary contributions for pension accounts. As tax rates are partly set by the 98 Danish municipalities, marginal tax rates differ conditional on municipality of residence. Variations in tax rates across municipalities are, however, limited to a few percentage points which is why we make simplifying assumptions about the value of $\tau_{i,t}$. The progressive income tax system in Denmark causes individuals with income above a certain top tax threshold to pay an extra 15 percentage points on the margin. This threshold was 389,900 DKr in 2010. However, the marginal income tax rate cannot exceed a maximum of 51.5 %. Based on numbers from the Danish Ministry of Taxation, all individuals in our sample are assumed to be subject to a 42% marginal tax rate in 2010 unless their taxable income exceeded the top tax threshold. If they exceeded the threshold, marginal tax rates are increased to 51.5%, which applies to almost all individuals in the sample. The marginal tax rates for all years are shown in the appendix.

$$S_{i,t} = \alpha + \beta_1 Treat_i + \beta_2 Post_{i,t} + \delta \hat{PTOT}_{i,t}(1 - \tau_{i,t}) + X_i + r_{i,t} \tag{5}$$

Substitution of savings from private pensions to taxable accounts is measured by equation

(5). The explanatory variable $\hat{PTOT}_{i,t}$ is total contributions for voluntary pension schemes and this model has the same specifications as equation (4). The explanatory variable $\hat{PTOT}_{i,t}$ is now adjusted for taxes but still instrumented by the interaction term $Treat_i \times Post_{i,t}$. Notice that the tax adjustment only affects the magnitude of substitution and not the estimation accuracy. $S_{i,t}$ now represents savings in non-retirement accounts or reductions in debt.

6. Results

Table 6.1 show that the treated on average reduced voluntary contributions for annuity pension schemes by 9,200 DKr compared to the non-treated as the reform was implemented. The reform effects are quantified using equation (3), indicating that the reduction could take place in any year between 2010 and 2013. Relative to contribution levels prior to the reform, this reflect a 32% reduction in private annuity contributions for each treated individual in the sample. The model produces very precise estimates given high data quality and fairly large sample sizes. Standard errors are clustered on the individual level in order to allow for individual serial correlation.

Table 6.1: Change in Voluntary Contributions for Annuity Pensions, DKr

	Coefficient	Robust SE	p-value	95% C.I.	
δ	$-9,201$	238	0.00	$-9,667$	$-8,735$
$\delta_{subsample}$	$-10,448$	272	0.00	$-10,982$	$-9,915$

Notes: Standard errors are clustered on the individual level using 387,344 and 368,546 observations for the full sample and subsample, respectively. The subsample exclude employees with occupational annuity pension contributions exceeding 100,000 DKr prior to the reform.Control variables used cover age and work experience measured in years and a list of 13 dummy variables including marital status, renters, housing cooperatives (andelsbolig), divorced within last two years, unemployed within last two years, geographical region of residence (North Denmark Region, Central Denmark Region, South Denmark Region and Region Zealand) and highest completed education (primary school, secondary school, vocational training education and tertiary education).
Source: Own calculations based on administrative data from Statistics Denmark.

The reform caused the treated to reduce voluntary contributions for annuity pensions significantly and next we investigate if this reduction was offset by increased savings in

alternative retirement accounts.

6.1. Substitution within Pension Savings

Table 6.2 shows that only 10% of the reduction in voluntary contributions for annuity pensions was offset by increased savings in other retirement accounts. This indicates that 90% of the estimated reduction in private annuity contributions, which amounts to $0.90 \times 9,200 = 8,280$ DKr, exited the pension system completely. Relative to pre-reform levels, this is an average reduction in total voluntary contributions of approximately 29%.

Table 6.2: Reform Effects within Pension Accounts

	Private Life-long	Private Capital	Total Private
Voluntary Annuity	.038***	.062***	−.900***
	(.005)	(.012)	(.014)
Controls	Yes	Yes	Yes
Observations	387,344	387,344	387,344

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. The numbers reflect the effect from a 1 DKr reduction in voluntary annuity pension contributions. Also, see notes in table 6.1.
Source: Own calculations based on administrative data from Statistics Denmark.

Table 6.2 shows limited substitution between pension accounts. For each 1 DKr reduction in private contributions for annuity pensions total voluntary contributions were reduced by 90 øre. This reflects a 4 øre substitution for life-long accounts and a 6 øre substitution for capital pensions. These results are robust for exclusion of individuals who are assigned as treated solely because of employer-paid contributions that exceeded 100,000 DKr. in the pre-reform period, indicating that the measured effect comes from individual saving decisions (see appendix).

The findings show that tax subsidies for saving in annuity accounts have significant impact on the propensity to save in third pillar pension schemes. It turns out that higher income groups would rather reduce total contributions for voluntary pension accounts significantly than invest in pension schemes with less flexible features than the annuity scheme offered up to 2010.

Chetty et al. (2014) examine the effects of a shock to tax credits on capital pensions ten years before the policy shock evaluated in this paper. They find crowding-out effect of approximately 50%, meaning that a 1 DKr reduction in contributions for private capital pensions was offset by an increase of 50 øre in annuity and life-long pension schemes. Our crowding-out estimates are substantially larger, which is possibly caused by the fact that this paper considers individuals with larger income and financial wealth than in Chetty et al. (2014).

High income groups could be less likely than low income groups to consider annuity, life-long and capital schemes as close substitutes. All schemes are equally illiquid forms of savings, but they differ in other characteristics. While annuity schemes had no tax-deductible contribution cap up until 2010, capital pension schemes were only tax deductible up to a certain limit. This cap on capital pensions is more restrictive for high income groups than low income groups ceteris paribus. Life-long pension schemes are inherently insurance schemes as they pay out in small instalments until the owner dies, while annuity schemes pay out in larger instalments over a finite period. Life-long schemes are therefore less favorable for taxpayers who aim for tax avoidance through pension schemes. We test if both claims are supported by applying our research design on a Danish 2012 pension reform almost identical to the one evaluated in this paper. Specifically, the annuity pension contribution threshold was reduced from 100,000 DKr in 2010 to 50,000 DKr in 2012. Compared to the 2010-reform, the 2012-reform was expected to affect lower income groups also. Estimates based on the 2012-reform show that a 1 DKr drop in voluntary annuity pension contributions led to a 82 øre reduction in total contributions for voluntary pension schemes. This reflects substitution for life-long and capital schemes of 5 and 12 øre, respectively (see appendix). These findings support that crowding-out by alternative pension schemes tend to be larger for lower income groups.

We also expect that the share of active savers is larger for high income groups than low income groups because high income earners on average tend to be more educated and characterised by more sophisticated financial literacy (Bernheim and Scholz, 1993; Bernheim and Gerrett, 2003; Lusardi, 2006). We measure this by assigning a subgroup of passive savers, which includes treated individuals who did not change savings behaviour even though they were confronted with new tax rules. Specifically, the subgroup of passive savers are

individuals from the treatment group who kept annuity pension contributions unchanged after reform implementation. By doing this, 28% and 32% of the treated are assigned as passive savers in 2010 and 2012, respectively. This indicate that relatively high income earners, who experienced a shock to tax incentives in 2010, responded marginally more actively than lower income groups, who were confronted with new taxation rules in 2012. The difference is not substantial, but it seems fair to conclude that 1/3 of the treated in this paper responded passively to tax incentives, while 2/3 responded actively. For comparison, the sample considered in Chetty et al. (2014) includes individuals with lower income than any sample in this paper and they found that roughly 1/5 responded actively to tax incentives.

Our conclusion is that the Danish 2010 pension reform led to only limited substitution of savings between pension accounts. We continue the analysis by investigating if the treated increased savings in non-retirement accounts or reduced debt in order to offset the substantial reduction in the privately manage pension contributions.

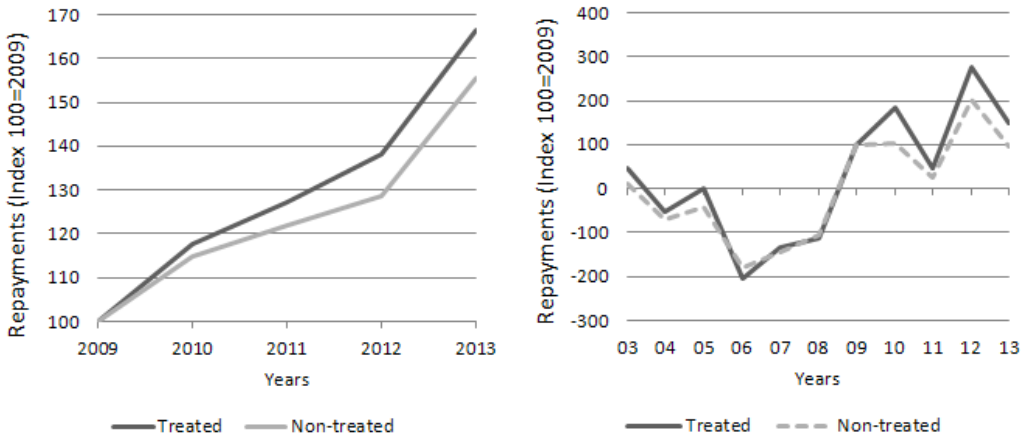
6.2. Substitution for Debt Repayments

We have shown that total contributions to voluntary pension schemes decreased significantly in 2010 for individuals who were confronted with a change in tax rules. The figures 2a and 2b illustrate that these very same individuals increased repayments on both mortgage debt and net debt to banks in the same time period. These figures are constructed by calculating annual means for each group and then indexing repayments to 100 in 2009.

In order to test if increased debt repayments are in fact caused by the reform, we use the 2SLS-model in equation (5) to isolate variation derived directly from the 2010 pension reform. Table 6.3 shows significant substitution from private pension accounts to mortgage debt repayments, indicating that the treated used a share of their former pension contributions for deleveraging. Based on the applied identification strategy, this implies that tax subsidies for pensions have significant effect on household debt levels. This substitution effect uncovers new and more detailed knowledge about the interplay between retirement savings and savings in non-retirement accounts. Specifically, this result suggests that the reduction in private retirement savings are not only offset by increased savings in non-retirement accounts but also increased repayments on financial liabilities.

The reform caused mortgage debt repayments to increase by 19 øre for each 1 DKr reduction in private pensions when measured after taxes. Also, non-retirement saving

Figure 2: Debt Repayments



(a) Mortgage Debt

(b) Bank Debt

Note: Figures 2a and 2b are constructed by calculating means of annual debt repayments. Both figures are indexed to 100 in 2009.

Source: Own calculations based on administrative data from Statistics Denmark.

accounts were increased significantly by 61 øre. Adding up these numbers shows that 80% of the reduction in voluntary pension accounts were offset by increased savings in taxable accounts or repayments of debt. Our estimates indicate that 20% of the reduction in private pension savings were used for consumption or savings in cash, cars, yachts or home improvements as none of these are included in the data.

Columns 2a and 2b in table 6.3 are subsets of column 2. They show that 40 out of 61 øre represent substitution for financial assets, while 21 øre reflect increased repayments on net debt to banks. The latter is, however, measured with less precision.

Alongside Evans (1983); Engen et al. (1994, 1996); Chetty et al. (2014), we find evidence of very low interest elasticity on savings. To our best knowledge, this paper is, however, among the first to demonstrate that tax subsidies on savings in pension accounts could have causal effects on mortgage debt accumulation.

Table 6.3: Effects from Reducing Voluntary Pension Contributions by 1 DKr

	Taxable Saving Accounts		Residual	Taxable Accounts (excl. mortgages)	
	Repayments on Mortgage Debt	Taxable Accounts (excl. mortgages)		Financial Assets	Repayments on Bank Debt
	(1)	(2)	(3)	(2a)	(2b)
Private Pension	.192**	.608***	.200	.397***	.211
	(.093)	(.217)		(.129)	(.185)
Controls	Yes	Yes	Yes	Yes	Yes
N	176,054	387,344	387,344	387,344	387,344

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. Column 3 (Residual) covers savings not included in the data, e.g. cash, cars, yachts etc., as well as other durable and non-durable consumer goods. Also, see notes in table 6.1.
Source: Own calculations based on administrative data from Statistics Denmark.

6.3. Heterogeneity in Response

In order to explain what could be driving causality between pension savings and mortgage repayments, we use equation (5) to estimate the substitution effects for specific subsamples. Table 6.4 reports how much mortgage debt repayments and savings in non-retirement accounts increased for each 1 DKr decrease in private pension contributions caused by the reform.

Estimates in column 1 of table 6.4 are identical to the findings in table 6.3, showing that each treated individual increased mortgage debt repayments by 19 øre and non-retirement savings by 61 øre for each 1 DKr reduction of private pension contributions. The columns 2-5 show heterogeneous substitution effects when applying different subsample restrictions. Mortgage owners who before the reform had outstanding balances exceeding the sample median tend to reduce the debt by 34 øre and increase savings in non-retirement accounts by 58 øre (column 2). This effect is not driven by an overrepresentation of highly indebted individuals in the treatment group as above-median and below-median individuals are equally distributed between the treatment and control group.

Column 3 shows that individuals with very high loan-to-value ratio (LTV) reduced their mortgage loans by nearly four times the effect of the full sample mean. High LTVs reflect mortgages exceeding 80 percent of the collateralised property value. For each 1 DKr reduction in private pension contributions they reduced mortgage debt by 77 øre. Due to large standard

Table 6.4: Effects from Reducing Voluntary Pension Contributions by 1 DKr

	Total	Large Mortgages	High LTV	Loan Converters	ARM Borrowers
	(1)	(2)	(3)	(4)	(5)
Mortgage repayments	.192**	.338**	.773***	.345*	.293***
	(.093)	(.141)	(.297)	(.199)	(.105)
Controls	Yes	Yes	Yes	Yes	Yes
N	176,054	93,437	33,935	47.695	108,262
Taxable Accounts	.608***	.581*	−.407	−.288	.521*
(excl. mortgages)	(.217)	(.323)	(.562)	(1.06)	(.304)
Residual	.200	.081	.634	.943	.186
Controls	Yes	Yes	Yes	Yes	Yes
N	387,344	205,577	74,663	47.695	238,198

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. Subsample definitions are as follows. Large mortgages include individuals with mortgage debt levels above the sample median. High LTV reflect individuals for whom mortgage debt levels exceed 80 percent of the property value. The property values are reported by the mortgage institutions. Loan converters represent mortgage owners who after reform implementation replaced their old mortgage loan with a new loan. ARM borrowers have at least one adjustable rate mortgage. All characteristics are based on pre-reform values in order to avoid endogeneity in response. Residual covers savings not included in the data, e.g. cash, cars, yachts etc., as well as other durable and non-durable consumer goods. Also, see notes in table 6.1.
Source: Own calculations based on administrative data from Statistics Denmark.

errors on the crowd-out parameters for this group we cannot conclude much on their total savings response.

Considering individuals who took up a new mortgage to replace the old loan (refinancing) after the reform implementation, we find a substitution effect of 35 øre (column 4). This supports our findings that pre-reform mortgage owners in the treatment group used former pension savings to prepay real credit loans as they refinanced during the period 2010-2013. The Danish mortgage system allows mortgage owners to make extraordinary payments on their mortgages in two ways. Firstly, they are entitled to prepay the entire real credit bond *at par* any time before the loan matures, allowing them to exploit changes in market interest rates and thereby reduce funding costs. The buyback is financed by the proceeds of a new mortgage loan with lower coupon rate, implying that monthly interest payments would decrease. However, this would result in increased outstanding principal because the

price of the new loan is probably below par (see Leth-Petersen, 2010). In our estimation period, interest rates were clearly decreasing (see appendix), indicating that any refinancing would result in lower interest payments and larger principal relative to the old loan. We interpret the result in column 4 exactly as the net effect of refinancing, showing that mortgage owners did in fact use former pension savings to reduce outstanding mortgage balances on average by refinancing. Secondly, mortgage owners can reduce outstanding mortgage balances by performing a one-off payment to the mortgage institution or by increasing monthly repayments. This is favourable to the borrower if the size of e.g. the one-off exceeds corresponding transaction costs from doing it.[4]

By looking further into the group who refinanced their loan in the period 2010-2013, we find additional evidence that homeowners used the reform to bring down mortgage principals. We divide them into two types. One type that replaced a deferred-amortisation loan with an ordinary mortgage with amortisation. The second type did the opposite and refinanced into a deferred-amortisation loan. This stratification supports our result in column 4, indicating an overall reduction in mortgage debt. Specifically, we find that the treated increased mortgage debt repayment to a larger extent than the non-treated regardless of the type of refinancing (see appendix).

Lastly, we find that borrowers who had adjustable rate mortgages (ARMs) prior to the reform did indeed increase mortgage repayments as a consequence of the pension reform. The estimated substitution is significant and amounts to 29 øre (column 5). The constellation of ARMs imply that repayments automatically increase as interest rates decrease. However, this effect is cancelled out because of our empirical approach, i.e. the treated and non-treated are equally subject to mechanical effects caused by decreasing market interest rates. We also find statistical significant evidence that this group substituted 52 øre to savings in non-retirement accounts, which is quite similar as the full sample effect.

These results imply that deleveraging is mostly driven by individuals with large principal, high LTV or adjustable rate mortgages. We cannot fully conclude that mortgage debt

[4]Personal financial benefits from repaying (mortgage) debt was heavily discussed in Danish popular monthly magazines about personal finance, e.g. *Dine Penge, Penge og Privat økonomi* and newspaper articles from *Berlingske* and *Jyllands-Posten* for the period 2010-2013. This indicate that the general public was not unaware of potential capital gains from decreasing pension savings and increasing debt repayments.

repayments are derived from refinancing, increased monthly repayments or one-offs. However, our findings do not reject an overall effect of increased mortgage debt repayments caused by the pension reform.

6.4. Robustness

The results are robust to three types of robustness tests, including placebo interventions, variations in assignment window around the kink and relaxing restrictions to the data trimming process. Documentation for the tests can be found in the appendix.

In order to test whether the reform effects are unique for the treated individuals we induce placebo laws in the model setup. Running regressions on non-existing laws allow us to test if the documented substitution effects are actually unique for the treatment group. This robustness test is well-known in the quasi-experimental literature as it provides evidence that the estimates do not reflect confounding factors. Specifically, we shift assignment of treatment both upwards and downwards, testing individuals that prior to the reform had total contributions for annuity pensions of either strictly more or less than the actual induced threshold. A placebo law above the actual kink is set as a false contribution threshold of 200,000 DKr, while the placebo law below the actual kink is set as a false threshold at 50,000 DKr.The placebo law below the actual kink tends to violate the common pre-trend assumption. This is because individuals with very low annuity pension contributions are not likely to have identical savings preferences as individuals with very high contributions. This placebo law includes both very high and very low contributors. In order to circumvent this problem, we use more narrow assignment windows when people are allocated into the treatment and control group. We use symmetric intervals of 25,000 DKr around the low placebo law-threshold. The tests show no sign of significant substitution. Based on this, the applied identification strategy seems to isolate the actual reform effect on the treated.

Secondly, we test if variations in assignment interval sizes affect regression results. Widening assignment intervals from 50,000 to 100,000 DKr return very precisely estimated substitution effects. Also, substitution from voluntary pensions to mortgage debt repayments become slightly significant for the 2012-reform as the intervals increase. This supports the finding that substitution from pensions to mortgage debt repayments are driven by high income groups. The effects fade out if intervals become too small. This is not surprising as

narrow intervals reduce sample size and thus increase standard errors. Narrow intervals are tested at 25,000 DKr.

Thirdly, estimated substitution effects are based on some data restrictions such as censoring the very long tails of the distributions. By relaxing these restrictions, substitution effects still prove to be significant. However, the magnitude of substitution increases as do the standard errors. By censoring all data at the 1st and 99th percentile rather than using 10th and 90th percentiles for changes in bank debt less deposits, substitution from private pension accounts to total taxable savings yields -1.42. This result is significant at a 1%-level and verifies the measured shift of savings from pensions towards taxable savings accounts, but the magnitude of the effect is not reliable given statistical noise from extreme account fluctuations.

7. Conclusion

In this study, the potential link between pension wealth and debt accumulation in households is investigated by exploiting a Danish 2010 pension tax reform which unexpectedly reduced tax credits on pension contributions for high income earners. Specifically, a pension contribution threshold was introduced, reducing the size of contributions possible to deduct before the salary is paid out. This exogenous shock to tax incentives for saving in retirement accounts is used to identify whether pension savings could be shifted to gross debt reductions on the individual level.

Based on very detailed public administration panel data, this paper applies a difference-in-differences research design to measure the reform effects on savings outcomes. We compare how savings in pension accounts and repayments of gross debt change for two groups of individuals; those likely to respond to the change in pension taxation and other who were not expected to change pension savings behaviour. We find a 29% reduction on average in private pension contributions compared to pre-reform contribution levels. Our estimates show, however, that the reduction was almost fully offset by increased mortgage repayments and savings in non-retirement accounts.

As a particular feature, we used detailed data on all mortgage loans in Denmark to show that taxation of pension savings affects individual repayments on mortgage debt. We show that 19% of the reduced savings in pension accounts was offset by extraordinary

repayments on mortgage debt, while 61% was shifted to savings in non-retirement accounts. The remaining 20% could not be accounted for, indicating that this part was used for consumption or savings in cash, cars, yachts, home improvements etc. Individuals with large outstanding debt or high loan-to-value ratios seem to drive the measured substitution between pension wealth and mortgage debt.

Our findings contribute to the speculations over how household debt and pension savings are linked. Knowing that excessive household debt probably has adverse effects on economic growth and macroeconomic volatility, this paper could prove useful for policymakers that aim at stabilising macroeconomic outcomes. Showing significant empirical evidence of a shift in savings between pension accounts and mortgage debt, we suggest that more work should be invested in uncovering causal effects of pension taxation on household debt accumulation.

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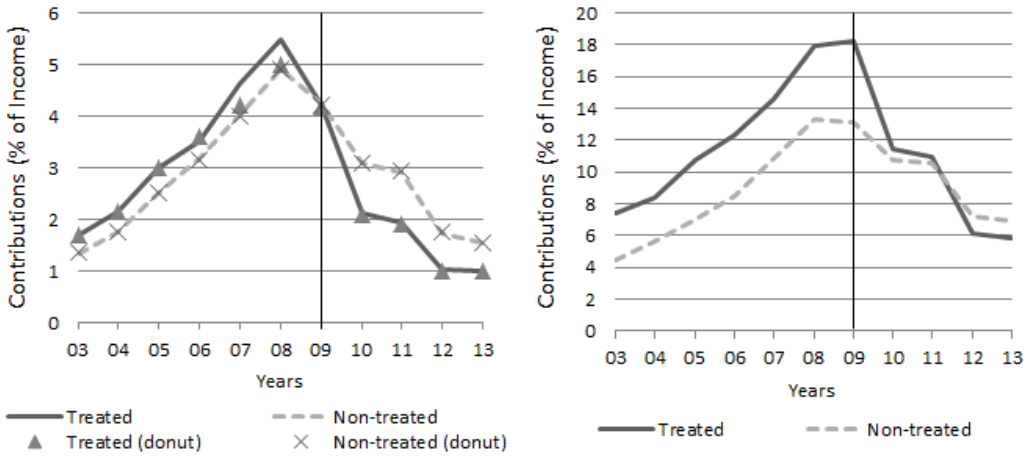
Appendix A. Pension Contributions

Figure A.3: Contributions for Pension Schemes



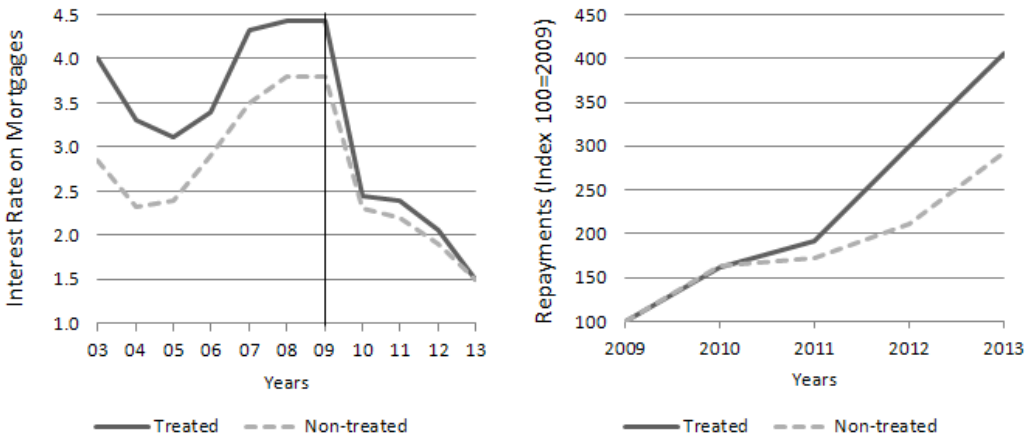
(a) Voluntary Annuity (b) Total Annuity (non-homeowners)

Note: Contributions are measured as share of gross income and constructed by calculating means each year for the groups. Misallocation of treated and non-treated is tested by a donut hole approach. The test relies on graphical inspection of figure A.3a. In order to assume that misallocation is not a concern, the lines labelled "donut" cannot deviate from lines without this label. The donut label implies that individuals in the very vicinity of the 100,000 DKr-kink are removed, i.e. individuals within 5,000 DKK-window around the kink are removed. Figure A.3b shows the sum of occupational and voluntary contributions for annuity schemes for renters, i.e. all homeowners are excluded.

Source: Own calculations based on administrative data from Statistics Denmark.

Appendix B. Variables Related to Homeownership

Figure B.4: Variables Related to Homeownership



(a) Implicit Interest Rate on Outstanding Mortgage Loans

(b) Repayments on Mortgages Loans Converted by the Borrower in 2010 or later

Note: Figure B.4a shows the implicit interest rate on mortgage loans. This is defined as total interest payments on mortgage loans divided by total outstanding debt (market value) at the beginning of each year. Figure B.4b shows repayments on mortgage loans by individuals that took up a new loan to replace the old within the period 2010-2013. Both figures are constructed by calculating annual means for the treatment and control groups.
Source: Own calculations based on administrative data from Statistics Denmark.

Figure B.5: Repayments on Mortgage Loans that are Converted after Reform Implementation

(a) Repayments on Mortgages Converted to Amortisation

(b) Repayments on Mortgages Converted to Non-amortisation

Note: The figures B.5a and B.5b show repayments on mortgage loans by individuals that took up a new loan to replace the old as the Danish 2010 Pension Reform was implemented in 2010. The latter show repayments by borrowers who replaced amortisation-free loans with loans characterised by amortisation in 2010 or later. The latter shows repayments by borrowers that replaced their old mortgages with new amortisation-free mortgage loans. Both figures are constructed by calculating annual means for the treatment and control groups.
Source: Own calculations based on administrative data from Statistics Denmark.

Appendix C. Test for Exclusion of Occupational Contributions larger than 100,000 DKr

Table C.1: Reform Effects within Pension Accounts

	Private Life-long	Private Capital	Total Private
Voluntary Annuity	.039***	.056***	−.905***
	(.005)	(.012)	(.014)
Controls	Yes	Yes	Yes
N	368,546	368,546	368,546

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. The numbers reflect the effect from a 1 DKr reduction in voluntary annuity pension contributions. Also, see notes in table 6.1. Individuals with pre-reform occupational contributions exceeding 100,000 DKr are excluded in this table. This shows that changes to individual contributions drive the observed reduction in annuity pension contributions in 2010.
Source: Own calculations based on administrative data from Statistics Denmark.

Appendix D. Substitution within Pension Accounts in 2012

Table D.1: Reform Effects within Pension Accounts

	Private Life-long	Private Capital	Total Private
Voluntary Annuity	.054***	.122***	−.824***
	(.010)	(.023)	(.026)
Controls	Yes	Yes	Yes
N	370,689	370,689	370,689

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. Also, see notes in table 6.1. Estimates show the substitution effect within pension schemes as the tax deductible threshold for annuity pension schemes was reduced from 100,000 to 50,000 DKr in 2012.
Source: Own calculations based on administrative data from Statistics Denmark.

Appendix E. Placebo Interventions

Table E.1: Effects from Reducing Voluntary Pension Contributions by 1 DKr

	Placebo threshold (50,000 DKr)			Placebo threshold (200,000 DKr)		
	(1)	(2)	(3)	(4)	(5)	(6)
Pension	.184	.456**	−.379	.503	7.66	−2.42
	(.124)	(.225)	(.246)	(.774)	(11.5)	(8.09)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	283,619	624,005	624,005	17,789	39,143	39,143

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. Columns 1-3 denote repayments on mortgage debt, repayments on net debt to banks and effects on total savings, respectively, for a placebo intervention at 50,000 DKr. Columns 4-6 denote repayments on mortgage debt, repayments on net debt to banks and effects on total savings, respectively, for a placebo intervention at 200,000 DKr.
Source: Own calculations based on administrative data from Statistics Denmark.

Appendix F. Test for Various Assignment Windows

Table F.1: Effects from Reducing Voluntary Pension Contributions by 1 DKr

	Narrow Assignment Window (25,000 DKr)			Wide Assingment Window (100,000 DKr)		
	(1)	(2)	(3)	(4)	(5)	(6)
Pension	.008	−.066	−.339	.201***	.073	−.470***
	(.215)	(.425)	(.492)	(.034)	(.081)	(.096)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	73,996	162,802	162,802	646,170	1,421,712	1,421,712

Notes: Standard errors included in parentheses are clustered on the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent level. Columns 1-3 denote repayments on mortgage debt, repayments on net debt to banks and effects on total savings, respectively, for a narrow assignment window, corresponding to 25,000 DKr. Columns 4-6 denote repayments on mortgage debt, repayments on net debt to banks and effects on total savings, respectively, for a wide assignment window, corresponding to 100,000 DKr.
Source: Own calculations based on administrative data from Statistics Denmark.

Appendix G. Marginal Tax Rates

Table G.1: Marginal Tax Rates

	Tax Rate	Top Tax Rate	Top Tax Threshold	Tax Subsidy Rate
	(1)	(2)	(3)	(4)
2003	43	59	295,300	33.32
2004	43	59	304,800	33.31
2005	43	59	311,500	33.55
2006	43	59	318,700	33.55
2007	43	59	327,200	33.55
2008	45	59	335,800	33.55
2009	45	59	347,200	33.55
2010	42	51.5	389,900	33.64
2011	42	51.5	389,900	33.66
2012	42	51.5	389,900	33.65
2013	42	51.5	421,000	33.63

Notes: The tax rate, top tax rates and top tax thresholds reflect Danish taxation laws at the given point in time. The rates are simplifications of a progressive taxation system. All individuals are assumed du be subject to the tax rate unless their taxable income exceed the top tax threshold. If this is the case, top tax earners are subject to the top tax rate. Individual interest payments on outstanding debt is subject to a tax subsidy rate (column 4).
Source: Danish Ministry of Taxation.