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CEBI WORKING PAPER SERIES

Working Paper 17/22

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ISSN 2596-447X

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Department of Economics
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Do Tax Subsidies for Retirement Saving Impact Total Private Saving? New Evidence on Middle-income Workers*

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Version: November 1, 2022

Abstract

We exploit exogenous variation from a pension reform in Denmark to estimate the effect of tax subsidies on total private saving. We present new evidence on individuals in the middle of the income distribution and show that a reduction in tax subsidies for retirement saving reduces total private saving. The reform changed the tax incentives for saving in the pension scheme that holds the highest tax advantage for middle-income workers in Denmark. We find that for each unit of reduced saving in this pension scheme, only 64 percent is substituted to other types of saving.

Keywords: Crowd-out, Savings, Retirement, Tax incentives, Household finance

JEL Codes: H24, H31, D14, G51

*We thank Søren Leth-Petersen and participants at the European Economic Association (EEA) Congress 2022, the Annual Congress of the International Institute of Public Finance (IIPF) 2022, Oslo Fiscal Studies' (OFS) workshop on Empirical Analysis of Tax Policy 2022, the Annual Meeting of Society of Economics of the Household (SEHO) 2022, and seminars at University of Copenhagen as well as audiences at The Danish Ministry of Finance, the Danish Central Bank, and Insurance and Pension Denmark for valuable comments and suggestions. The paper builds upon our master's thesis from 2020. The activities of the Center for Economic Behavior and Inequality are financed by the Danish National Research Foundation grant DNRF134.

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1 Introduction

Governments spend substantial resources on tax subsidies for retirement accounts to encourage private retirement saving. But can governments actually impact total private saving using tax subsidies? Or do tax subsidies simply cause a shift of saving between different types of savings accounts? The literature suggests that tax subsidies in retirement accounts are ineffective at impacting total saving at the top-end of the income distribution. We study a policy for a pension scheme that targets individuals in the middle of the income distribution and find different results.

Tax subsidies for saving in retirement accounts only increase private saving if the change in retirement saving does not fully crowd out other types of saving. Chetty et al. (2014) were the first to estimate the effect of tax incentives on total saving through the use of high-quality administrative data and exogenous variation from legislative changes. Andersen (2018) examines the same question using another source of exogenous variation. Both papers examine individuals at the top-end of the income distribution, and neither paper can reject full crowd-out. The results in the literature thus imply that tax subsidies leave private saving unchanged. Yet, there is no empirical evidence on the crowd-out responses of workers in the middle of the income distribution. These workers are of particular interest as they are more likely to have little savings and they are, therefore, likely to be key targets for the government when the goal is to increase private saving.

In this paper, we use an unexploited source of variation and high-quality administrative data to estimate the effect of tax subsidies on total private saving of middle-income workers. We thus contribute to filling an important research gap and provide new answers to the question about the effect of tax subsidies on saving behavior. We analyze the effects of a reform of one of the most popular private voluntary pension schemes among middle-income workers in Denmark: the "Age Pension scheme" (*Aldersopsparing* in Danish). Private voluntary retirement saving accounts constitute one of three pillars in the Danish pension system along with the state-provided defined benefit plan and employer-administered defined contribution ac-

counts. The system is similar to those of other developed countries. The age pension scheme is popular because it provides the largest tax benefit among available pension schemes for middle-income workers. Originally, there was a tax subsidy for contributions to the age pension scheme that was the same across cohorts. In 2018, the Danish Government passed a bill that changed the contribution limits to the age pension scheme. For workers with more than five years to the retirement age, the annual contribution limit was reduced by 80 percent, and contributions above the limit are subject to a tax penalty. The policy change represents a reduced tax subsidy for retirement saving for those contributing to the age pension scheme. Thus, the reform induces exogenous variation in workers' incentives to contribute to the age pension scheme.

The reform provides an ideal setting for analyzing the causal effect of tax incentives due to a high degree of salience and comprehensible incentives. We use comprehensive population-wide Danish administrative data with information on individual saving, income, assets, and liabilities, and we construct treatment and control groups based on contributions prior to the reform. We then compare the changes in private saving between the two groups. Our data allow us to provide a complete description of a worker's savings portfolio. Individuals with original contributions above the new contribution limit are affected by the reform and assigned to the treatment group, while individuals with contributions below the limit are unaffected by the reform and assigned to the control group. We use the variation induced by the reform to measure how changes in age pension contributions led to changes in other savings accounts. We estimate two relevant crowd-out parameters: Substitution between the age pension scheme and other retirement accounts, and substitution between the age pension scheme and all financial accounts, including retirement accounts.

We show that the reduction in tax subsidies causes individuals to reduce age pension contributions, total retirement saving, and total saving. We estimate a crowd-out of retirement saving of 20 percent. Only one fifth of the reduction in age pension contributions is thus shifted to other retirement accounts, on average, resulting in a significant decrease in

private retirement saving. The effect is about a third of previous estimates in the literature (Chetty et al. (2014) and Andersen (2018)). We estimate a total crowd-out of 64 percent. Hence, a reduction in tax subsidies in this setting causes a statistically significant decline in total private saving, and, by implication, a consumption effect of 36 percent on average. Our results thereby imply that changes in tax subsidies can, in fact, affect private saving behavior.

Our paper contributes to the literature on saving behavior and the effectiveness of retirement saving policies by adding new evidence on the saving response of workers in a part of the income distribution where there is not a lot of evidence. The literature was pioneered by important early contributions by Poterba, Venti, and Wise (1995), Poterba, Venti, and Wise (1996), Engen, Gale, and Scholz (1996) and Gale and Scholz (1994). However, the empirical studies were challenged by data limitations and methodological concerns and were unable to provide a clear answer to the causal effect of tax incentives on total saving (Bernheim (2002)). Our results build on many papers that find an effect of tax subsidies on retirement saving itself (e.g., Attanasio and Rohwedder (2003), Gelber (2011), Friedman (2017), and Lavecchia (2019)), but the only estimates on total private saving are close to or at full crowd-out for high-income individuals (Chetty et al. (2014) and Andersen (2018)). A recent paper by Goodman (2020) presents evidence of less than full crowd-out using a change in catch-up eligibility for contributions to the U.S. Roth pension scheme at age 50, but he does not observe non-retirement assets and liabilities directly. Our crowd-out estimates do not suffer from the same measurement challenges and also present evidence from a sample that is representative of the working age population at large.

Our results also relate to the literature on defaults in saving decisions and active and passive saving behavior. Previous estimates show that there is a large share of passive savers who are unresponsive to tax incentives in retirement accounts (Chetty et al. (2014) and Andersen (2018)). The literature on defaults shows evidence that defaults significantly increase saving within retirement accounts (e.g., Madrian and Shea (2001) and Thaler and

Benartzi (2004)). Overall, the previous crowd-out responses in the literature support the arguments for defaults or automatic enrollment in retirement saving decisions (Choi et al. (2002), Beshears et al. (2007), Benartzi and Thaler (2007) and Carroll et al. (2009)). We find a very small share of workers who display passive saving behavior, which could suggest that the share of passive savers can be low when people face a tax penalty.

The paper proceeds as follows. Section 2 introduces the institutional setting, and section 3 describes the data. Section 4 presents the empirical framework. Section 5 shows the results, and section 6 covers robustness. Finally, section 7 offers concluding remarks. Unless otherwise stated, all figures and tables are own calculations based on data from Statistics Denmark.

2 Institutional Setting

In 2018, the Danish government implemented a reform that changed the contribution limits for the age pension scheme. The reform thereby provides exogenous variation in workers' incentives to contribute to this particular pension scheme, which we use to set up a research design for estimating causal effects of tax incentives on saving behavior.

The Danish pension system is similar to the pension systems in other developed countries and consists of three pillars: A state-provided defined benefit plan, employer-administered defined contribution accounts, and private voluntary retirement accounts. Contributions can be made through employer-administered accounts or private voluntary accounts. Within these accounts, the Danish pension system offers three types of defined contribution schemes: Annuity pensions (*ratepension* in Danish), life-long pensions (*livrente*), and age pensions (*aldersopsparing*).[1]

We focus on the age pension scheme, where contributions are not tax deductible but payouts are tax-free. This is contrary to the annuity and life-long pension schemes where

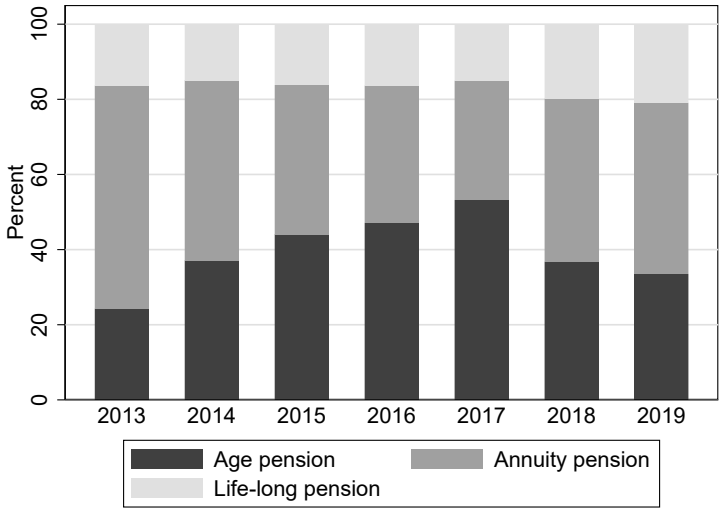
[1]We use "age pension scheme" as a translation of *aldersopsparing*. This term is not to be confused with *folkepension* (basic state pension), which is the universal payment from the state-provided defined benefit plan.

contributions are tax deductible but payouts are taxed. The taxation scheme of an age pension account can thus be compared to that of a Roth account in a U.S. retirement plan. The age pension scheme provides the highest return for individuals facing low marginal tax rates when they work and high marginal tax rates at retirement. These workers typically have income in the middle of the income distribution; while they are not subject to the top tax rate when they work, i.e., they face a low marginal tax rate, they may receive public benefits at retirement for which additional taxable income will lead to benefit reductions, i.e., they face a high effective marginal tax rate due to clawback of means-tested public benefits.[2] The Danish Ministry of Finance estimates that the age pension scheme gives a 5 to 13 percent higher return relative to the annuity pension scheme or the life-long pension scheme for middle-income workers (The Danish Ministry of Finance (2018)). Thus, saving in an age pension account, a "back-loaded" retirement account, provides the highest net tax advantage.[3] The age pension scheme was introduced in 2013 and had become the most popular private retirement saving scheme by size of contributions in 2017, cf. figure 1.

[2]Clawback of public benefits at retirement represents reductions in means-tested public benefits at retirement that may result from an increase in contributions to an annuity or life-long pension scheme today because it increases taxable income at retirement. It is estimated that more than 60 percent of workers in Denmark can expect clawback at retirement due to reduced payouts of either supplemental pension benefits (*ældrecheck* in Danish), the pension supplement (*pensionstillæg*), or housing benefits (*boligydelse*) (DaneAge Association (2019)).

[3]The taxation of returns is the same in all Danish pension schemes and favorable compared to saving in financial assets or the like. Returns and interest are taxed by the pension returns tax (the PAL tax), which is 15.3 percent, compared to a capital tax of between 27 percent and 42 percent.

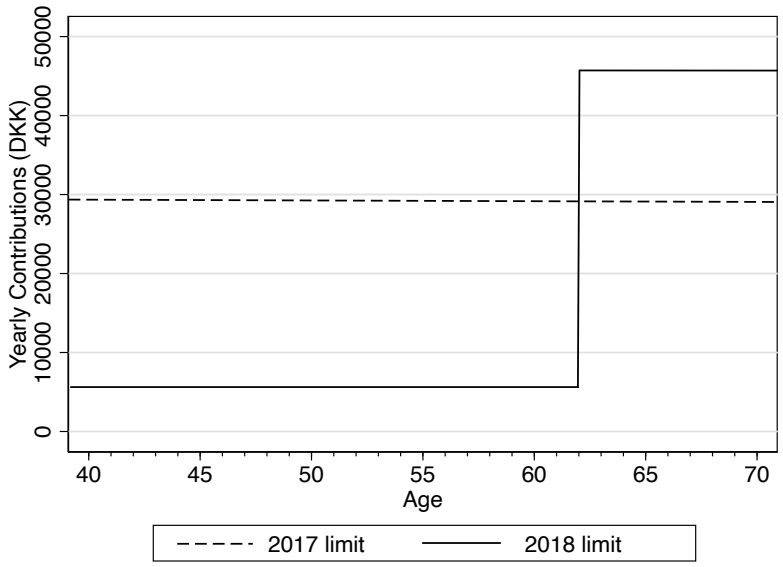
Figure 1: Private Retirement Contributions



Notes: This figure shows the distribution of private retirement saving in the Danish working age population (residents in Denmark aged 18-65 in 2017, excluding the self-employed and their spouses). All contributions are measured post-tax. The figure is replicated in appendix figure C.1 for the subsample of individuals aged 18-58.

In December 2017, the Danish government passed a tax reform that changed the contribution limits to the age pension scheme. The changes were implemented in January 2018. Figure 2 shows the changes in contribution limits. Before the legislative changes, it was possible to contribute 29,600 DKK (4,700 USD) per year to an age pension scheme. This contribution limit increased to 46,000 DKK (7,300 USD) per year for individuals with five or fewer years to the official retirement age and reduced to 5,100 DKK (800 USD) per year for individuals with more than five years to the retirement age. In 2018, individuals aged 62 have five years to the official retirement age. Limits before and after the reform are shown in appendix table C.1. The limits were imposed by making it expensive to contribute more than a given limit by subjecting all contributions above the limit to an additional tax of 20 percent. We focus on the group of individuals who faced a reduced contribution limit.

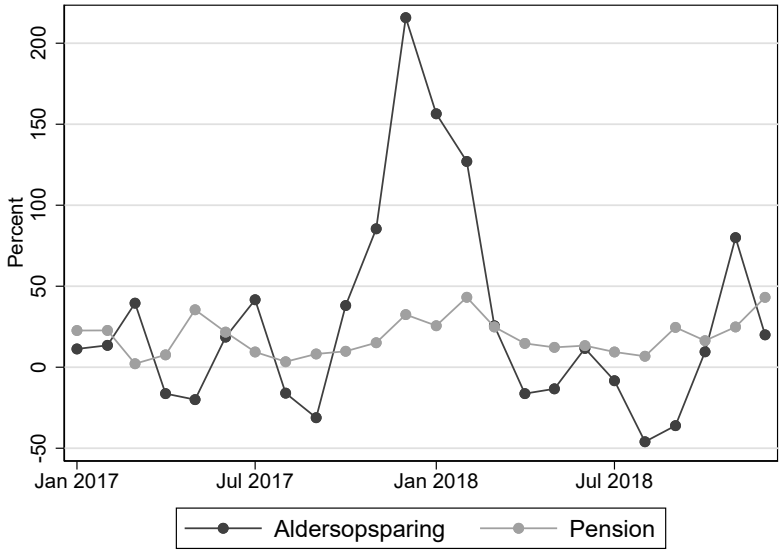
Figure 2: Illustration of the Changes in the Age Pension Scheme



Notes: In 2018, the contribution limit was reduced to 5,100 DKK for individuals with more than five years to the official retirement age and increased to 46,000 DKK for individuals with five or fewer years to the retirement age. This implies that individuals aged 62 or more can contribute more to the age pension scheme in 2018, while individuals younger than 62 can contribute less.

We find evidence of significant awareness of the reform from data on Google searches related to the age pension scheme. Searches for the term "aldersopsparing" (age pension scheme) spike around the passing of the reform in December 2017 and in the beginning of 2018, cf. figure 3. The spike in searches indicates that this salient change in incentives provides an ideal setting for identification of the causal effects of tax incentives on private saving.

Figure 3: Excess Google Searches: "Aldersopsparing" and "Pension"



Notes: The figure is based on data from Google Trends of monthly indices of search intensity for the terms "aldersopsparing" (Age Pension) and "pension" (Pension). Excess searches are calculated as the percentage difference between the total number of searches in a given month and the average number of total searches in that month in 2014-2016. Using this approach, we account for seasonality, e.g., due to filing of annual tax returns.

3 Data

Data Description. We use register data from Statistics Denmark for the full adult population of Denmark and combine registers that contain detailed information on retirement contributions, income, assets, liabilities and demographics. The variables are based on third-party reports, ensuring the highest possible data quality. For example, earnings and pension contributions are reported by employers and pension funds to the tax authorities.

We focus our analysis on age pension contributions, annuity pension contributions, life-long pension contributions, bank deposits, stocks, shares in mutual funds, bank debt (including state education loans, credit card debt and other loans), and mortgage debt, as individuals can easily save into one of these accounts or repay debt. They are also the most often used

modes of saving.[4] For the financial variables, we only observe every individual's end-of-year balance of assets and liabilities. Thus, while retirement contributions are flow variables, the asset and liability balances are all stock variables. Because our analysis is concerned with saving and dissaving, we convert the stock variables into flow variables by calculating the year-on-year changes. The constructed flow variables have a substantial degree of noise. For example, the purchase timing of durable goods and services creates noise in the bank deposits variable (the purchase of a new car at the end of the year rather than at the beginning of the next year generates fluctuations in the observed flows). We reduce the noise by censoring the financial variables by the 5th and 95th percentile.

As for retirement contributions, contributions to the annuity and life-long pension schemes are measured pre-tax in the registers while contributions to the age pension scheme are measured post-tax because they are subject to taxation at different points in time. The age pension scheme is a taxation-taxation-exemption (TTE) scheme where contributions are taxed, return on investment is taxed, and payouts are exempt from taxation. In contrast, annuity and life-long pensions are exemption-taxation-taxation (ETT) schemes. All other saving variables are measured post-tax.

Our analysis yields meaningful results only if we account for the difference in tax treatment of saving in different pension schemes. An individual has to reduce consumption by 1,000 DKK today to save 1,000 DKK in a TTE scheme because contributions are paid from already taxed income. However, he only has to reduce consumption by $1,000 \cdot (1 - \tau)$ DKK today to save 1,000 DKK in an ETT scheme, where τ is the marginal tax rate of ETT retirement contributions, because contributions are tax deductible. In order to obtain comparability, we multiply pre-tax contributions by $(1 - \tau)$ so all the retirement variables will be measured post-tax. The taxation reflects how contributions to annuity and life-long pension schemes

[4]There are some assets that we do not record when we base our analysis solely on register data. We do not observe cash holdings and investments in luxury objects, both of which can be considered to be savings. For our estimation samples, however, these alternative savings are considered small as cash holdings are becoming rarer in Denmark and investments in luxury objects are less likely to occur among middle-income individuals compared to high-income individuals.

would be taxed marginally at the time of contribution if they were to be put in an age pension scheme instead. Marginal tax rates cannot be observed directly in the registers so we compute τ based on the tax rates of the Danish tax system, which is described in appendix A.

Sample Description. In an ideal experiment, we would randomly select a group of individuals eligible to use the age pension scheme and compare saving of the eligible and ineligible individuals. Such a randomized experiment is not feasible in practice. Instead, we use variation in eligibility from the reform-induced change in contribution limits for individuals with more than five years to the official retirement age.

Individuals who contributed more than the new limit (5,100 DKK) before the reform are assigned to the treatment group, while individuals with contributions just below are assigned to the control group. The individuals in the treatment group will be incentivized to reduce their contributions to avoid the tax penalty. Identification of a treatment effect requires an implicit assumption that saving preferences would not change after the assignment year in the absence of the reform. This assumption seems plausible as few individuals change their level of retirement saving annually. We provide evidence that supports the plausibility of this assumption in section 5. Treatment status is assigned on the basis of contributions in 2016 to ensure that any potential announcement effect of the reform in 2017 does not confound the analysis. We also exclude individuals with contributions at or above 28,000 DKK prior to the reform to avoid so-called limit contributors, whose contributions place them at a corner solution of their optimization problem.[5]

We further restrict the treatment group to individuals contributing above 10,000 DKK (thus 4,900 DKK above the new limit of 5,100 DKK) since we are interested in substitution patterns, and individuals with higher savings have larger incentives to re-optimize after the reform. In addition, this restriction makes the monotonicity condition (see section 4) more

[5]The pre-reform contribution limit was 28,900 DKK (2016). Limit contributors' latent level of saving, i.e., their preferred level of saving in a world without the contribution limit, is higher than the observed level of saving, which could potentially confound the interpretation of the resulting crowd-out estimates. If we include limit contributors, the parallel trend assumption no longer holds, and we therefore exclude them to focus on "typical contributors" and to be able to compare two similar groups.

plausible, and it yields higher R^2-coefficients in the first stage regressions. The control group consists of individuals with contributions larger than 2,000 DKK but lower than the new limit of 5,100 DKK. We do not include individuals with contributions below 2,000 DKK because we want the control group to consist of "typical contributors" with significant contributions to the age pension scheme who are comparable to the treatment group.[6]

We want to arrive at a sample of typical contributors who are affected by the reform and a comparable control group. The trimming process from the raw data is summarized in appendix table C.2. First, individuals with self-employment as their primary employment and their spouses are excluded from the sample because they face different saving incentives. Second, individuals who are not present in the register on pension contributions or who are not in the population in the entire period between 2014 and 2018 are excluded.[7] Third, individuals aged 59 or older in 2018 are excluded from the sample. All individuals in the sample are 18 or older, and we choose 58 as the upper limit to avoid including individuals who face different incentives as a result of an increase in the contribution limit induced by the other part of the reform. Fourth, we exclude individuals who have positive employer-administered age pension contributions in 2014-2018. The contribution limit applies to the sum of private and employer-administered contributions, and we therefore exclude individuals with employer-administered contributions in order to ensure that we focus on private saving behavior.[8] Finally, we only include individuals with positive contributions to the age pension scheme prior to the reform (2014-2017). This restriction further reduces the risk of capturing labor market factors, such as unemployment or unforeseen events, and it supports the plausibility of the identification assumption of unchanged saving preferences. When we restrict the sample to individuals with positive contributions in the years prior to the reform,

[6]Neither of these sample restrictions affect the conclusions from the empirical analysis.

[7]To be present in the register on pension contributions, individuals must have non-zero retirement contributions (either private or employer-administered) in some pension scheme in all years.

[8]The restriction that individuals must not have employer-administered contributions only applies to the age pension scheme. Employer-administered contributions to the annuity pension scheme and the life-long pension scheme are still included. This is important when our goal is to investigate an effect on total saving and total retirement saving.

it means that we consider individuals who have already actively chosen to save for retirement in this pension scheme. The restriction is necessary in order to consider individuals who can potentially be affected by the reform, which is an inherent limitation of any local study such as ours. But it allows us to study the effect of a change in tax incentives at the margin for a sample of individuals in the middle of the income distribution.

Summary statistics of the resulting estimation sample, treatment group, and control group are presented in table 1 along with the Danish working age population (the full sample).[9] The working age population is defined as residents in Denmark aged 18-65 excluding the self-employed and their spouses.

The characteristics of the workers in the estimation sample show that the sample represents savers in the middle part of the income distribution. The first two rows of table 1 show that average gross income and average disposable income among workers in the estimation sample are both slightly below but close to those of the full sample. The share of top tax payers is lower in the estimation sample. Appendix figure C.2 shows the distributions of gross income in the full sample and in the estimation sample.

Figure 4 depicts the distribution of contributions to the age pension scheme before and after the reform for the estimation sample. The spikes in contributions around 6,000 DKK and 12,000 DKK might indicate a common rule-of-thumb behavior of contributing 500 DKK or 1,000 DKK a month. The distributions show how nearly all saving that was above the new contribution limit before the reform shifted to or below the limit in 2018.

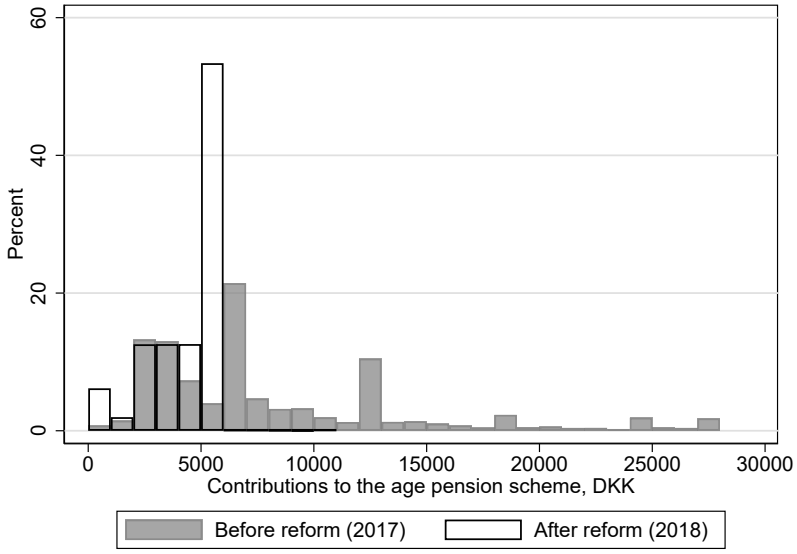
[9]The table is replicated in appendix table C.3 with means from 2016.

Table 1: Summary Statistics

	Full sample	Estimation sample	Treatment group	Control group
Income				
Gross income (DKK)	418,493	374,683	392,625	361,415
Disposable income (DKK)	287,929	266,993	281,540	256,236
Top tax payers (share)	0.169	0.072	0.079	0.066
Pension contributions				
Age pension contributors (share)	0.122	1.000	1.000	1.000
Age pension (DKK)	1,630	8,560	15,249	3,613
Annuity pension (DKK)	10,694	8,377	8,808	8,059
Life-long pension (DKK)	15,033	14,130	15,607	13,038
Assets and liabilities (stock)				
Bank deposits (DKK)	131,068	107,371	138,152	84,609
Stocks (DKK)	32,264	12,678	20,083	7,203
Share in mutual funds (DKK)	418,713	23,845	39,238	12,462
Bank debt (DKK)	229,278	82,275	69,662	91,602
Mortgage debt (DKK)	952,218	429,996	447,399	417,127
Liquidity constrained (share)	0.484	0.471	0.369	0.547
Demographics				
Age	43.414	46.077	47.559	44.982
Male (share)	0.502	0.315	0.314	0.315
Married (share)	0.497	0.594	0.638	0.562
Unemployed (share)	0.177	0.148	0.118	0.170
High school (share)	0.085	0.047	0.046	0.047
Vocational training (share)	0.356	0.469	0.448	0.485
Short tertiary (share)	0.058	0.054	0.055	0.054
Middle-long tertiary (share)	0.209	0.235	0.262	0.215
Long tertiary (share)	0.193	0.043	0.056	0.034
Number of observations	2,371,395	30,702	13,052	17,650

Notes: The means reported are from 2017, i.e., the year before the pension reform was implemented. The full sample is defined as residents in Denmark aged 18-65 excluding the self-employed and their spouses. Gross income includes labor income, public transfers, and capital income excluding employer-administered pension contributions. All pension contributions are measured post-tax. An individual is considered liquidity constrained if the savings in his/her bank account in 2016 are lower than two times his/her monthly disposable income. An individual is considered unemployed if he/she has been unemployed for at least two months in a given year. The education variables are dummies that indicate the highest completed level of education.

Figure 4: Annual Contributions to the Age Pension Scheme Before and After the Reform



Notes: The figure shows the distribution of annual contributions to the age pension scheme in 2017 and 2018 in the estimation sample, described in section 3. The new contribution limit is 5,100 DKK in 2018.

4 Empirical Framework

We estimate crowd-out by comparing saving of the treatment and control groups.[10] We use the variation induced by the reform to measure how changes in age pension contributions led to changes in other savings accounts. This instrumental variable approach includes a first stage equation (the effect of the 2018 reform on age pension contributions) and a second stage equation (the change in other saving variables following the change in age pension contributions). We thereby overcome the endogeneity challenge that arises when saving in the age pension scheme and saving in other accounts are determined simultaneously. Let $A_{i,t}$ denote

[10]The theoretical framework in the literature is based on a life-cycle model with consumption and saving, where individuals choose to consume or save in a savings account according to which choice yields the highest return. See Friedman (2017) for a review. When a subsidy is reduced, the lower return on saving corresponds to an increase in the price of consumption in period 2 relative to consumption in period 1. The price increase incentivizes the individual to shift consumption towards period 1 and therefore reduce savings, which is a negative substitution effect. At the same time, the reduced subsidy also implies lower life-time wealth of the individual, which incentivizes the individual to reduce consumption in both periods and therefore increase saving, which is a positive income effect. The effect of the reform is therefore theoretically ambiguous, and an empirical analysis is required to investigate the effect of the change in incentives on total saving.

an individual's age pension contributions in year t and let $S^F_{i,t}$ denote an individual's post-tax saving in a different financial account F (annuity pension, life-long pension, bank deposits, stocks, shares in mutual funds, bank debt repayments, or mortgage debt repayments). We include individual level fixed effects and a matrix of individual-specific controls, $X'_{i,t}$, and estimate the following specifications using a 2SLS estimator:

$$A_{i,t} = \lambda_i + \beta \text{post}_{i,t} + \delta \text{post}_{i,t} \times \text{treat}_i + X'_{i,t}\beta_X + \eta_{i,t} \tag{1}$$

$$S^F_{i,t} = \lambda_i + \beta \text{post}_{i,t} + \phi_F(-A_{i,t}) + X'_{i,t}\beta_X + \varepsilon_{i,t}. \tag{2}$$

In these equations, δ is the average change in age pension contributions among the individuals treated by the policy, and ϕ_F is the crowd-out parameter of interest. ϕ_F uncovers the local average treatment effect, LATE, and thus identifies the causal link between saving in the age pension scheme and saving in another account, F, for those reducing contributions as a result of the reform (Imbens and Angrist (1994)). We have added a minus in the second stage to ease the interpretation of the crowd-out parameter. Thus, the estimates of ϕ_F show how reductions in age pension contributions induced by the 2018 reform were offset by increases in other types of saving. The inclusion of individual level fixed effects implies that we control for potential time invariant confounders. We cluster standard errors at the individual level to allow for correlation between individual errors over time.

Our analysis only produces consistent estimates of the causal effects when the following conditions hold. First, the instrument ($\text{post}_{i,t} \times \text{treat}_i$) must have a clear effect on age pension contributions, i.e., individuals in the treatment group must change their age pension contributions significantly more after the reform than individuals in the control group. This condition holds if δ is significantly different from zero in the first stage equation, which is a testable assumption that we return to in section 5. The exclusion of individuals contributing close to the limit of 5,100 DKK further strengthens the instrument because the incentive to adjust saving is stronger for individuals who save a lot, due to the proportionality of the tax

penalty.

Second, the instrument must be uncorrelated with any other determinants of the dependent variable. In our quasi-experimental design, the only change in a financial account that is different between the treatment group and the control group in 2018 should result from changes in age pension contributions, given that the groups are otherwise comparable. To our knowledge, there is no other contemporary legislative change that should affect the saving behavior in only the treatment or control group. Therefore, we assume that this second condition is fulfilled.

Third, ϕ_F can only be interpreted as the mean effect for the compliers if individuals in the treatment group have a higher probability of reducing age pension contributions compared to the control group (the monotonicity condition). This third condition is deemed plausible given that only individuals contributing above the new contribution limit face a tax penalty if they do not change their contributions. The restricted assignment also increases the plausibility of this assumption as individuals with higher saving will face a larger penalty in absolute terms and would have been more likely to continue contributing above the limit had the reform not been implemented.

Figure 5a illustrates the association between the policy and contributions to the age pension scheme as described by the first stage equation.[11] For each year between 2015 and 2019, we plot mean individual age pension contributions ($A_{i,t}$) for the treatment and control groups. Until 2018, age pension contributions in the two groups seem to follow a common trend. In 2018, age pension contributions drop sharply for the treatment group relative to the control group, which illustrates a large effect of the 2018 reform on age pension contributions. We therefore expect mean age pension contributions of the treatment group to follow a trend similar to that of the control group in the absence of a policy reform.

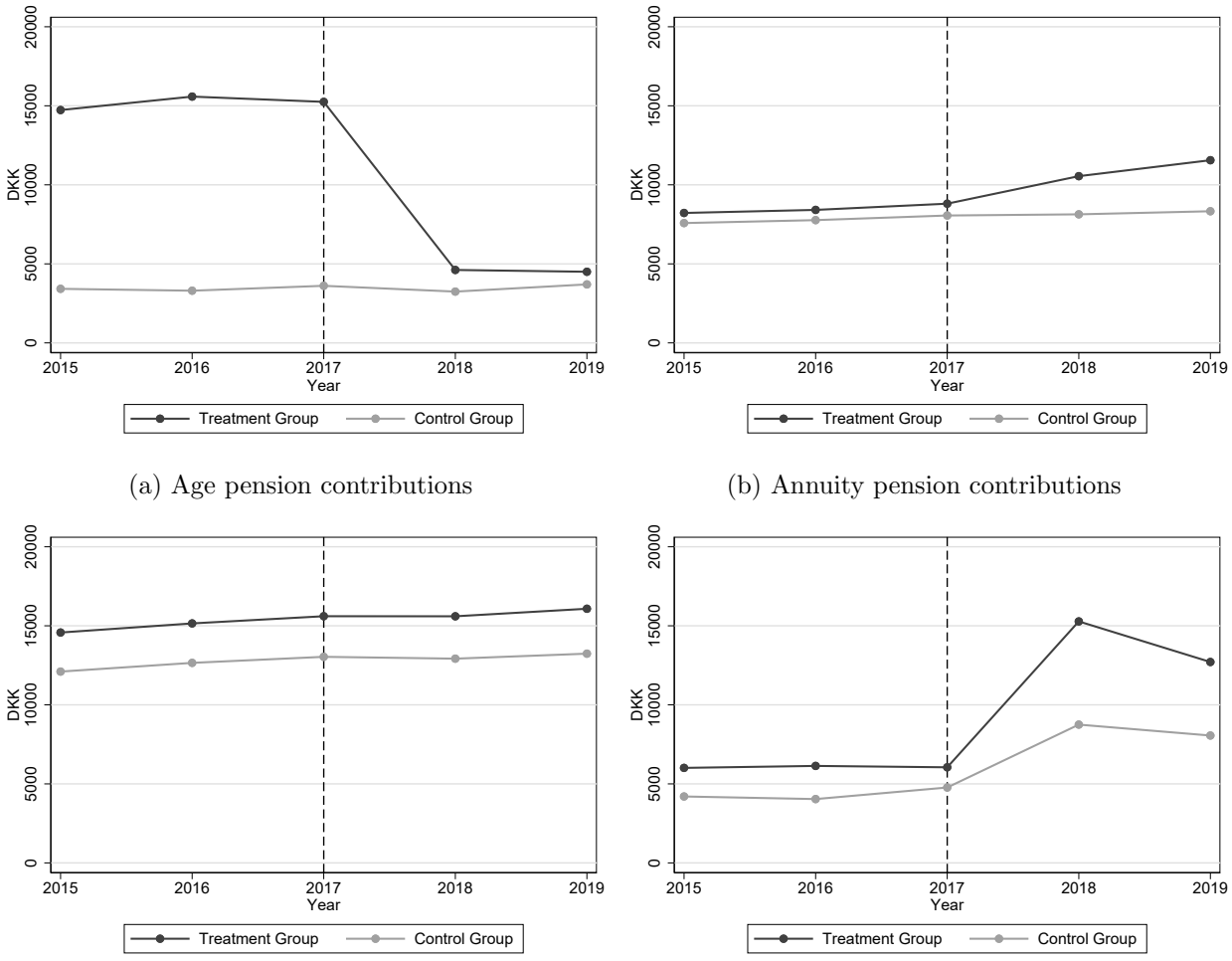
Figures 5b-6d illustrate the reduced form equations, i.e., the association between the policy and contributions to other forms of saving. For each year, we plot mean individual

[11] This corresponds to a difference-in-differences estimator.

post-tax saving ($S_{i,t}^F$) for the two groups. Figure 5b shows that mean individual annuity contributions of both groups are parallel until 2017. From 2017 to 2018, the treatment group increases mean annuity contributions significantly relative to the control group. The same pattern appears for saving in bank deposits (figure 5d). The patterns thus indicate that some of the saving previously contributed to the age pension scheme might be substituted towards annuity contributions and bank deposits. The two groups appear to have the same development in mean life-long contributions (figure 5c), stocks (figure 6a), share in mutual funds (figure 6b), repayments of bank debt (figure 6c), and mortgage debt repayments (figure 6d). We therefore assume that the two groups would have continued to follow the same trend in all saving variables in a world without the reform.[12] The parallel pre-trends for all outcomes indicate that the design is valid. A given crowd-out effect (ϕ_F) can then be interpreted as the treatment effect on a financial account, F, divided by δ from the first stage (conditional on individual level fixed effects and controls).

[12]Including the individuals with contributions just above 5,100 DKK does not significantly change the trends, cf. appendix figures C.3 and C.4.

Figure 5: Mean Retirement and Financial Saving in the Estimation Sample



(a) Age pension contributions

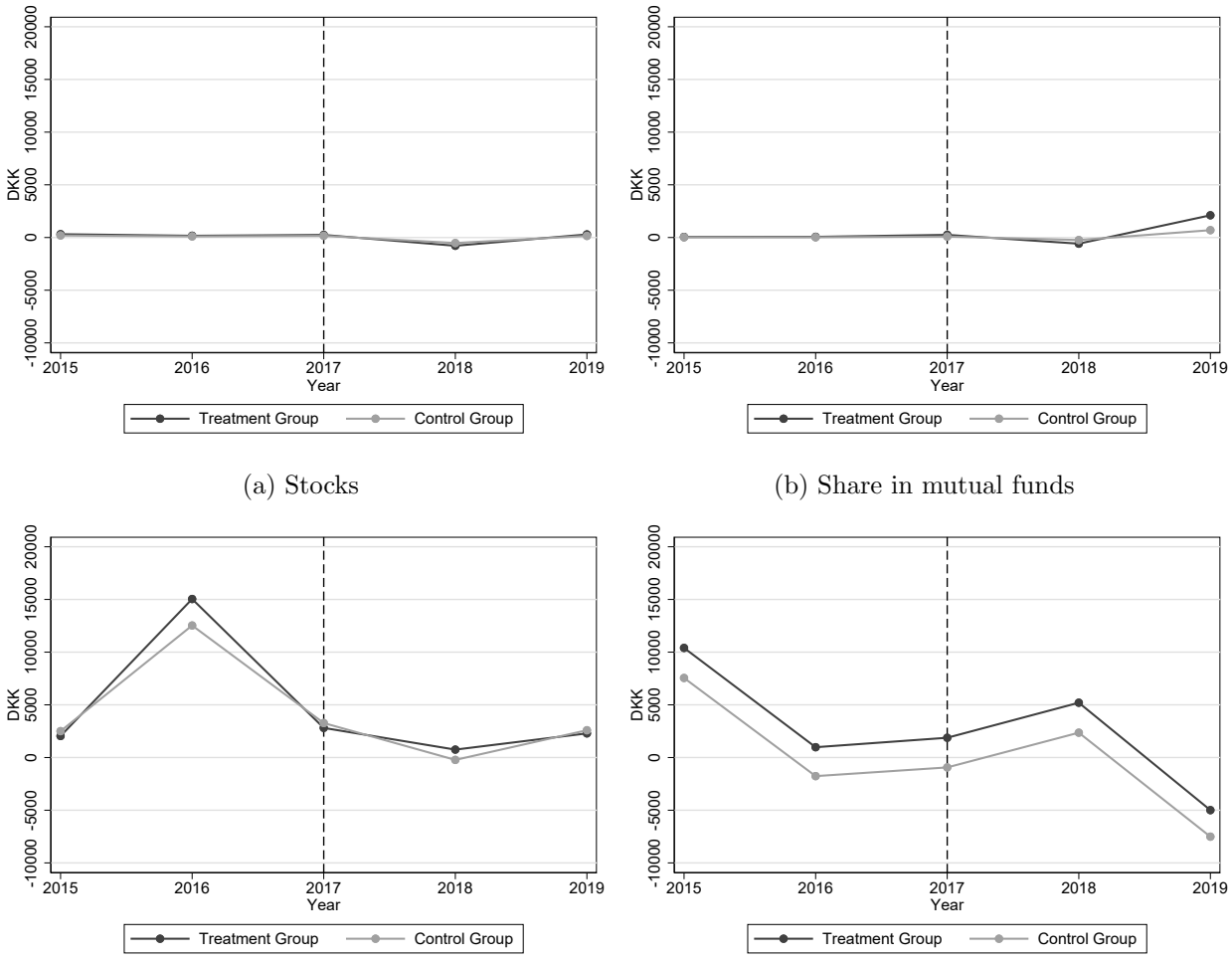
(b) Annuity pension contributions

(c) Life-long pension contributions

(d) Bank deposits

Notes: Each figure shows average retirement saving or financial saving in the treatment and control groups from 2015 to 2019. All saving variables are measured post-tax. Treatment assignment is based on contributions to the age pension scheme two years prior to the reform, where individuals in the treatment group contributed 10,000-28,000 DKK and individuals in the control group contributed 2,000-5,100 DKK.

Figure 6: Mean Financial Saving in the Estimation Sample



(a) Stocks

(b) Share in mutual funds

(c) Bank debt

(d) Mortgage debt

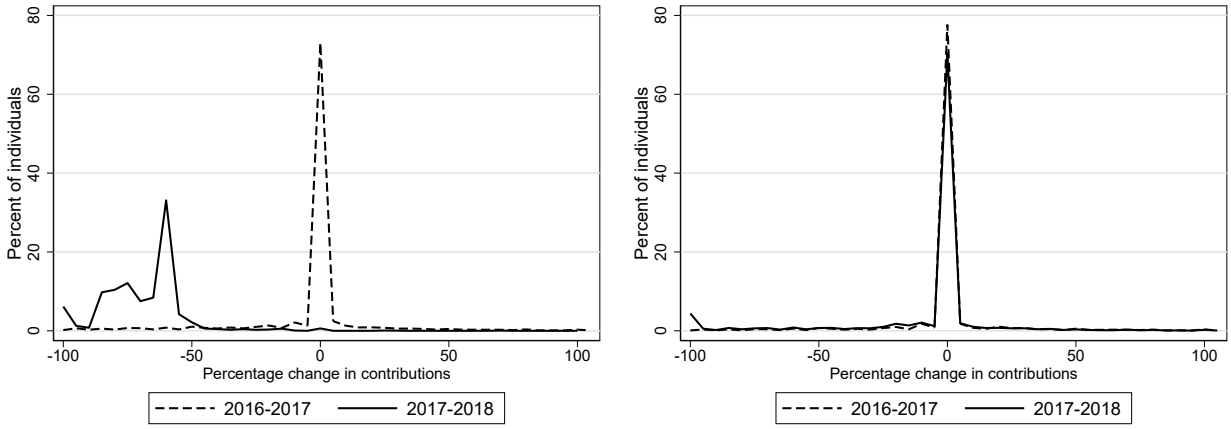
Notes: Each figure shows average retirement saving or financial saving in the treatment and control groups from 2015 to 2019. All saving variables are measured post-tax. Treatment assignment is based on contributions to the age pension scheme two years prior to the reform, where individuals in the treatment group contributed 10,000-28,000 DKK and individuals in the control group contributed 2,000-5,100 DKK.

5 Results

Compliance. Identification relies on awareness of and compliance with the reform. In figure 7, we show that there is almost 100 percent compliance with the reform. The figure illustrates the percentage change in age pension contributions for the treatment and control groups separately. It is evident from the panels that both the treatment and the control groups

essentially leave their age pension contributions unchanged from 2016 to 2017, indicated by the mass at zero in both panels. At the time of the reform, the distribution of relative changes in the control group remains the same, while the distribution shifts for the treatment group. The unchanged contributions to the age pension scheme in the control group endorse the implicit identification assumption of unchanged preferences for saving in the absence of the reform. From 2017 to 2018, the majority of the treatment group reduces age pension contributions by at least 50 percent, and there is little to no mass around zero in the treatment group. Thus, there is almost 100 percent compliance to the reform. This finding backs up the awareness of the incentives provided by the reform and thereby strengthens identification of a causal effect.

Figure 7: Percentage Change in Age Pension Contributions



(a) Treatment Group (b) Control Group

Notes: This figure exhibits the distribution of relative changes in contributions to the age pension scheme from 2016 to 2017 and from 2017 to 2018 for the treatment group and the control group. Each point in one of the connected lines represents the floor of bins with a width of 5 percent, i.e., the point at 0 percent represents individuals with changes in the range [0.00,0.05[.

Change in age pension contributions. Next, we show how the policy change affects contributions to the age pension scheme. We find that the lowered contribution limit led to a mean reduction of 10,364 DKK in contributions to the age pension scheme for the treated

individuals, corresponding to a reduction of 68 percent, cf. table 2.[13] These results represent the first stage association described in equation (1). The result is significant at the 1 percent level, which means that the null hypothesis of a zero effect of treatment is rejected. Excluding control variables does not change the results, which is evidence of the comparability of the treatment and control groups. Furthermore, the large coefficient of determination of 0.66 validates the explanatory power of the instrument to investigate crowd-out.

Table 2: Effect of the Policy Change on Age Pension Contributions

	Main results	Without controls
	(1)	(2)
ATT	-10,364***	-10,371***
	(46.124)	(46.101)
Controls	Yes	No
R^2	0.66	0.66
Observations	122,808	122,808
Clusters	30,702	30,702

Notes: This table presents OLS estimates of the change in age pension contributions induced by the 2018 reform using the specification in equation (1). The ATT is the difference between the change in contributions of the treatment group and the change in contributions of the control group from 2017 to 2018. Controls include marital status, gross income, education level, and unemployment. Standard errors, reported in parentheses, are clustered at the individual level. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

Crowd-out of saving. Table 3 provides evidence on whether the estimated reduction in contributions to the age pension scheme is offset by increases in contributions to other retirement accounts or other financial (non-retirement) accounts. We estimate two relevant total crowd-out parameters: Crowd-out within retirement accounts and total crowd-out across both retirement accounts and non-retirement accounts. The former describes the degree of substitution within the pension system, and the latter describes the degree of substitution

[13]The coefficient implies that the new contribution limit led to a mean reduction of 10,364 DKK in contributions to the age pension scheme. The pre-reform average contribution level was 15,249 DKK, cf. table 1, and would, in the counterfactual scenario, have fallen to 15,031 DKK, following the same trend as the control group, cf. appendix table C.4. By implication, the reform thus led to an estimated average reduction of 68 percent.

between saving and consumption. If the parameter of total crowd-out is significantly smaller than one, total saving is reduced. Table 3 presents the 2SLS estimates of ϕ_F using the regression specification in equation (2). Column (1) shows the main results, and columns (2)-(4) present results from robustness checks that are discussed in section 6. All crowd-out results are estimated with control variables. The total crowd-out estimates do not depend on the inclusion of controls, cf. appendix table C.5. The first column presents the main results.

The first key result is the finding that only 20 percent of the reduction in age pension contributions is substituted within the pension system, i.e., to either annuity pensions or life-long pensions. We can reject retirement crowd-out larger than 0.23 at the 95 percent confidence level. Thus, the reform results in a significant decrease in private retirement saving. The estimates show that the majority of the substitution takes place from the age pension scheme to the annuity pension scheme.

The second key result is the estimate of less than full crowd-out of saving. We estimate a total crowd-out of 0.64 and reject crowd-out larger than 0.81 at 95 percent confidence. Thus, in this setting we find a statistically significant decline in total private saving, which by implication corresponds to a consumption effect of 36 percent, on average.[14] The estimates show that the decrease in age pension contributions is primarily offset by increases in annuity pension contributions and saving in bank deposits.

[14]Crowd-out results with different definitions of the treatment group with and without restrictions are shown in appendix table C.5. The point estimates are very similar across samples, but if we include individuals with contributions closer to the limit, the precision of the estimates of total crowd-out decreases.

Table 3: Crowd-out Results

	Explanatory variable: Age pension contributions			
		Robustness:	Robustness:	Robustness:
	Main results	Not liq. constr.	Mean reversion	Retirement subsidy
Dependent variable	(1)	(2)	(3)	(4)
Annuity pensions	0.173***	0.176***	0.172***	0.185***
	(0.006)	(0.008)	(0.006)	(0.007)
Life-long pensions	0.026*	0.027	0.015	0.028***
	(0.013)	(0.018)	(0.014)	(0.007)
Bank deposits	0.477***	0.506***	0.508***	0.459**
	(0.054)	(0.093)	(0.054)	(0.058)
Stocks	-0.033***	-0.038***	-0.031***	-0.024***
	(0.003)	(0.006)	(0.003)	(0.002)
Share in mutual funds	-0.041***	-0.102***	-0.037***	-0.029***
	(0.001)	(0.007)	(0.002)	(0.002)
Bank debt repayments	0.043	0.012	0.048	0.044
	(0.048)	(0.052)	(0.047)	(0.054)
Mortgage repayments	0.008	-0.054	-0.030	-0.015
	(0.049)	(0.063)	(0.048)	(0.056)
Retirement crowd-out	0.199	0.203	0.186	0.214
95 pct. CI	[0.170,0.227]	[0.164,0.242]	[0.159,0.217]	[0.195,232]
Total crowd-out	0.636	0.502	0.646	0.648
95 pct. CI	[0.462,0.811]	[0.252,0.753]	[0.473,0.819]	[0.455,0.841]
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
N	122,808	64,920	115,172	102,648
Clusters	30,702	16,230	28,793	25,662

Notes: This table presents 2SLS estimates of the crowd-out parameters using the following estimation equation: $S^F_{i,t} = \lambda_i + \beta \text{post}_{i,t} + \phi_F(-A_{i,t}) + X'_{i,t}\beta_X + \varepsilon_{i,t}$, where $S^F_{i,t}$ represents post-tax saving in a financial account F of an individual i at time t. The independent variable in all specifications is age pension contributions instrumented by $\text{post}_{i,t} \times \text{treat}_i$. Thus, the estimates show how reductions in age pension contributions induced by the 2018 reform were offset by increases in other types of saving. Controls include marital status, gross income, education level, and unemployment. Standard errors, reported in parentheses, are clustered at the individual level. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. The estimate of retirement crowd-out is a sum of the crowd-out estimates on annuity pensions and life-long pensions (standard errors are obtained using the sum of annuity and life-long pensions as the dependent variable). Similarly, total crowd-out is the sum of all estimates. The two total crowd-out estimates may not sum to exactly the same as the immediate summation due to rounding. Instead of asterisks illustrating the significance levels, the squared brackets show 95 percent confidence intervals (CI) for the two total crowd-out estimates. Columns (2)-(4) present results for three robustness checks described in section 6.

The above findings add new evidence to the literature on the influence of tax incentives on saving behavior. In particular, Chetty et al. (2014) and Andersen (2018) are unable to reject a total crowd-out of one. In both papers, the crowd-out is mainly driven by substitution between retirement schemes of approximately 60 percent. Chetty et al. (2014) report a point estimate of total crowd-out of 0.95 and a lower bound of the 95 percent confidence interval of 50 percent. The findings in the current literature have thus led to the conclusion that tax incentives are not effective at impacting saving. Friedman (2017) reviews the literature and argues that the ineffectiveness arises because many individuals are inattentive to tax policy when they choose their level of saving and that the savers who respond to tax incentives are not those with the greatest savings inadequacy. While the previous literature has found full crowd-out of saving for high-income individuals, our results suggest that tax incentives can, in fact, result in significant changes in private saving. The estimated substitution between retirement schemes is about one third of the findings in the literature (Chetty et al. (2014) and Andersen (2018)), which implies a significant outflow of funds from the pension system and thus a reduction in workers' expected payouts upon retirement. As a result, the workers reduce both private savings to be received upon retirement as well as life-time savings.

6 Robustness

The role of liquidity. Liquidity constrained individuals can have different saving preferences. They may generally save less than the average worker, explaining their low liquid holdings, or they may prioritize saving more, out of precaution, when their circumstances change. From the summary statistics, we note that there is a smaller share of liquidity constrained individuals in the treatment group compared to the control group. To test that this does not confound our analysis, we check whether the results differ if we only consider individuals who are not liquidity constrained. We assume that people are not liquidity constrained if their bank account savings in 2016 are greater than two times their monthly disposable income.

The trends in retirement variables and financial variables in this subsample are shown in appendix figures C.5 and C.6, and they show the same patterns as the main sample. For those who are not liquidity constrained, we find a total crowd-out of 0.50, and the result of 20 percent substitution between retirement schemes endures, cf. column (2) in table 3. Hence, the conclusions are unaffected.

Mean reversion. Most people do not significantly change their saving on a year-to-year basis, as evidenced by figure 7. Yet, if some individuals included in the treatment group happened to save more (or less) than usual in the year of treatment assignment, we could be worried about the effects being driven by mean reversion. To test that mean reversion does not drive our findings, we estimate crowd-out only for the subsample of individuals who contribute persistently above the thresholds of our treatment group assignment, i.e., contribute more than 10,000 DKK to the age pension scheme in all years prior to the reform and not just 2016. The results are shown in column (3) of table 3, and we see that the conclusions do not change.

Political environment. In February 2018, the Danish Government passed another bill that slightly increased the tax subsidy on savings in the annuity and life-long pension schemes. The increased subsidy applies to contributions up to 70,000 DKK per year. The initiative was targeted at individuals who could be in the same saving range as our sample. This reform could bias our results if the treatment and control groups were affected differently by the subsidy, which we do not expect. As a test, we exclude all individuals who contributed more than 70,000 DKK to a tax-deductible pension scheme prior to the reform, and we still find a retirement crowd-out of 20 percent and total crowd-out of 0.65, cf. column (4) in table 3. We therefore conclude that the introduction of the new retirement subsidy does not confound our analysis.

Alternative identification strategy. The crowd-out estimates of this paper are local average treatment effects and are potentially only informative about the behavior of the sample of individuals below the age of 58 who face a lower contribution limit. It is possible that the

LATE could be different at different ages or contribution levels. To test this possibility, we estimate a different LATE using an alternative identification strategy based on the age cutoff at 62 years, where individuals below the age of 62 face the lower contribution limit after the reform, while individuals above the age of 62 face a higher contribution limit. The strategy is described in detail in appendix B. We find similar substitution patterns, cf. appendix table B.1.

7 Concluding Remarks

This paper shows that the lower tax subsidies for saving in retirement accounts following a Danish pension reform in 2018 caused a reduction in both pension contributions and total saving. While previous literature suggests that tax subsidies are ineffective at impacting total saving for high-income individuals, we find less than full crowd-out of saving for a sample of middle-income workers who contribute to the age pension scheme. Specifically, we find only 20 percent substitution within the pension system, which is a third of the size of previous results in the literature, and a total crowd-out of 64 percent. This finding of less than full crowd-out implies that the lower contribution limit led to a reduction in total saving for the workers.

We are, to the best of our knowledge, the first to document an example of this kind of saving response by individuals in the middle of the income distribution. Thus, our study adds new evidence to the literature on the causal effects of tax incentives for retirement saving on wealth accumulation. We also find a large share of compliers as almost every affected individual changes his/her retirement saving in response to the reform. This differs from the results in Chetty et al. (2014) and Andersen (2018), who find only 20 percent of "active" savers, defined as those who change their retirement contributions in response to changes in tax incentives. The group of individuals studied in our paper have actively opted into a specific pension scheme and may thus be considered more "active" than the population at

large, but the results suggest that the share of active savers depends on the setting and the people affected.

In general, tax incentives only increase saving if individuals respond actively and if crowd-out of other forms of saving is less than one. In our study, both conditions are fulfilled. However, the fact that both conditions are fulfilled does not automatically imply that tax subsidies are the most efficient policy tool to increase individual saving rates compared to default saving schemes, which several studies (e.g., Chetty et al. (2014)) point out give the highest saving rate per dollar spent on government subsidies. The question of which tool is the most efficient remains an empirical question for further research.

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Appendix

A Marginal Tax Rates

In this section, we present the calculation of marginal tax rates. We use the marginal tax rate to account for the difference in tax treatment of saving in different pension schemes. In Denmark, individuals can save in the age pension scheme, a taxation-taxation-exemption (TTE) pension scheme where contributions are taxed, return on investment is taxed, and payouts are exempt from taxation, or in the annuity pension scheme or the life-long pension scheme, which are both exemption-taxation-taxation (ETT) pension schemes, where contributions are exempt and payouts are taxed. We can only compare changes in saving in the age pension scheme to changes in the annuity pension scheme or life-long pension scheme if we calculate the marginal tax rate an individual faces if he/she chooses to save in a TTE scheme instead of an ETT scheme.

We compute the marginal tax rate $\tau_{i,t}$ for every individual in a given year using the following equation that captures relevant aspects of the Danish tax legislation. When a worker shifts saving from an ETT scheme to a TTE scheme, the contributions are subject to the bottom tax and the top tax (if the worker's income is in the top tax bracket).[15] In addition, there is a municipal tax, a church tax and a health system contribution. The worker can also receive an employment allowance and a job allowance which lower these three tax rates. Finally, there is a pension allowance which increases the three tax rates when an individual saves less in an ETT scheme:

$$\tau_{i,t} = \text{bottom tax}_{i,t} + \text{top tax}_{i,t} + (\text{municipal tax}_{i,t} + \text{church tax}_{i,t} + \text{health system contribution}_{i,t}) \cdot (1 - \text{employment allowance}_{i,t} - \text{job allowance}_{i,t} + \text{pension allowance}_{i,t}).$$

The tax legislation and the method used to derive the equation are described by the Danish

[15] Contributions to both types of schemes are subject to the labor market tax (which is 8 percent); therefore, we exclude that from the calculation.

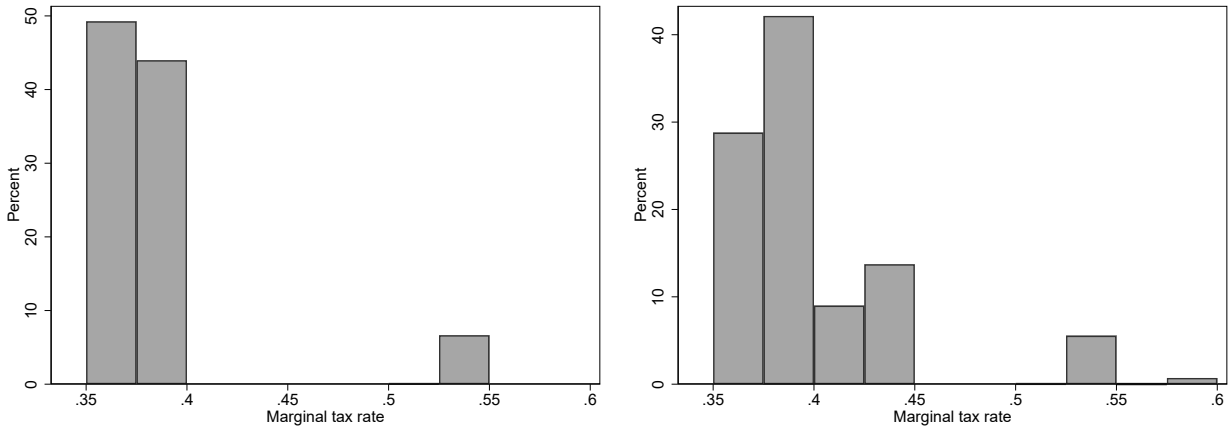
Ministry of Taxation (The Danish Ministry of Taxation (2020b)). In the administrative data, we observe every individual's taxable income and tax brackets. We use this data to predict every individual's marginal tax rate with a high degree of precision. The official tax rates are provided in table A.1. We compute a marginal tax rate of contributions to the annuity pension scheme and life-long pension scheme of between 35 percent and 45 percent for most individuals in the sample, cf. figure A.1.

Table A.1: Calculation of Marginal Tax Rates - Tax Rates in Denmark

	2015	**2016**	**2017**	**2018**	**2019**
Bottom tax	8.08	9.08	10.08	11.13	12.13
Top tax	15	15	15	15	15
Municipal tax	24.904	24.909	24.913	24.913	24.926
Church tax	0.709	0.702	0.693	0.683	0.677
Health system contribution	4	3	2	1	0
Employment allowance	8.05	8.3	8.75	9.5	10.1
Job allowance	0	0	0	2.5	3.75
Pension allowance low	0	0	0	8	8
Pension allowance high	0	0	0	20	22
Employment allowance max.	26,800	28,000	30,000	34,300	37,200
Income at employment allowance max	332,919	337,349	342,857	361,053	350,495
Pension allowance contribution limit	-	-	-	70,000	71,500
Max. contribution to annuity pension scheme	51,700	52,400	53,500	54,700	58,500

Notes: This table presents the tax rates from the Danish Ministry of Taxation (The Danish Ministry of Taxation (2020a)) that are used to calculate the marginal tax rate $\tau_{i,t}$ that reflects how contributions to annuity and life-long pensions would be taxed marginally at the time of contribution if they were put in an age pension scheme instead. For simplicity, we assume that the job allowance rate is zero in 2018 and 2019 and that everyone has the average municipality tax.

Figure A.1: Marginal Tax Rates in the Estimation Sample



(a) 2017 (b) 2018

Notes: These graphs show the distribution of the marginal tax rate $\tau_{i,t}$ that reflects how contributions to annuity and life-long pensions would be taxed marginally at the time of contribution if they were put in an age pension scheme instead.

B Alternative Identification Strategy

The crowd-out estimates of this paper are local average treatment effects and are potentially only informative about the behavior of the sample of individuals below the age of 58 who face a lower contribution limit. It is possible that the LATE could be different at different ages or contribution levels. To test this possibility, we estimate a different LATE using an alternative identification strategy.

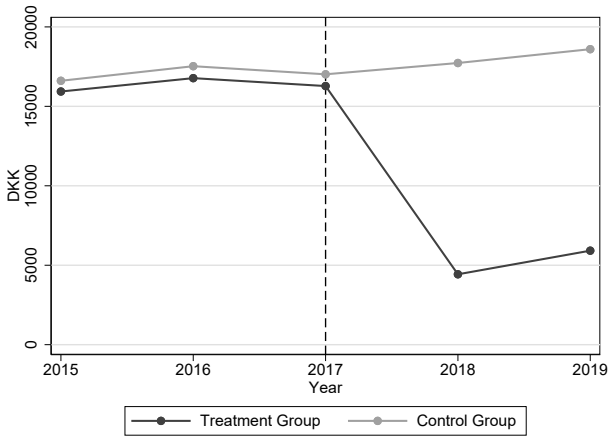
The alternative identification strategy involves the same empirical framework but a disjointed sample compared to our main estimation sample. Rather than exploiting the variation created by the new contribution limit of 5,100 DKK, we exploit the fact that individuals with five or fewer years to the retirement age are unaffected by the smaller contribution limit. Hence, treatment is assigned based on age rather than size of contributions. The treatment group consists of individuals aged 58-62, who face a lower contribution limit as a result of

the reform, and the control group consists of individuals aged 62-64.[16] Thus, no individuals are present in both the main sample and the alternative sample. Individuals with less than five years to retirement are allowed to contribute *more* compared to the pre-reform level of 28,900 DKK (2016 level). We therefore restrict the sample to contributions above 10,000 DKK but no larger than 28,000 DKK to avoid considering individuals who saved a lot prior to the reform and now face an incentive to further increase their saving. Summary statistics for the alternative sample are shown in appendix table C.6.

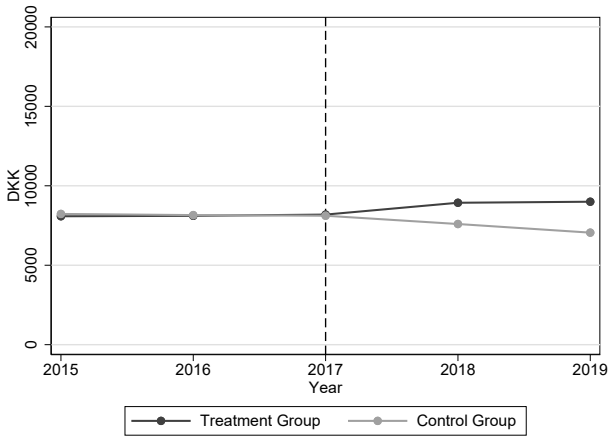
Based on the graphical evidence in figures B.1a-B.2d, we see a large effect of the 2018 reform on age pension contributions and again assume that the two groups would have continued to follow the same trend in all saving variables in a world without the reform. This allows us to identify the crowd-out effect, ϕ_F.

[16]The groups are constructed based on age in 2018 such that no treated individuals reach age 62 and no control individuals retire.

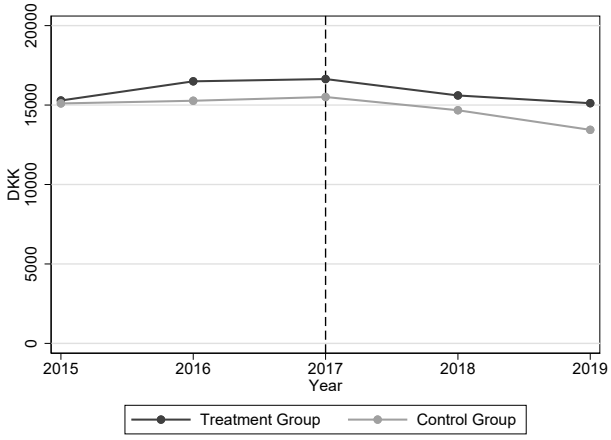
Figure B.1: Mean Retirement and Financial Saving - Alternative Identification Strategy



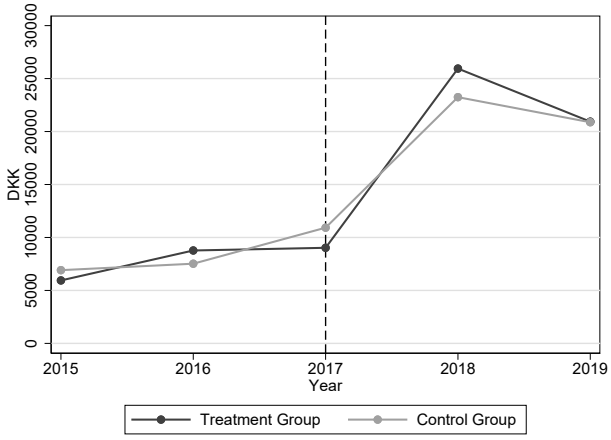
(a) Age pension contributions



(b) Annuity contributions



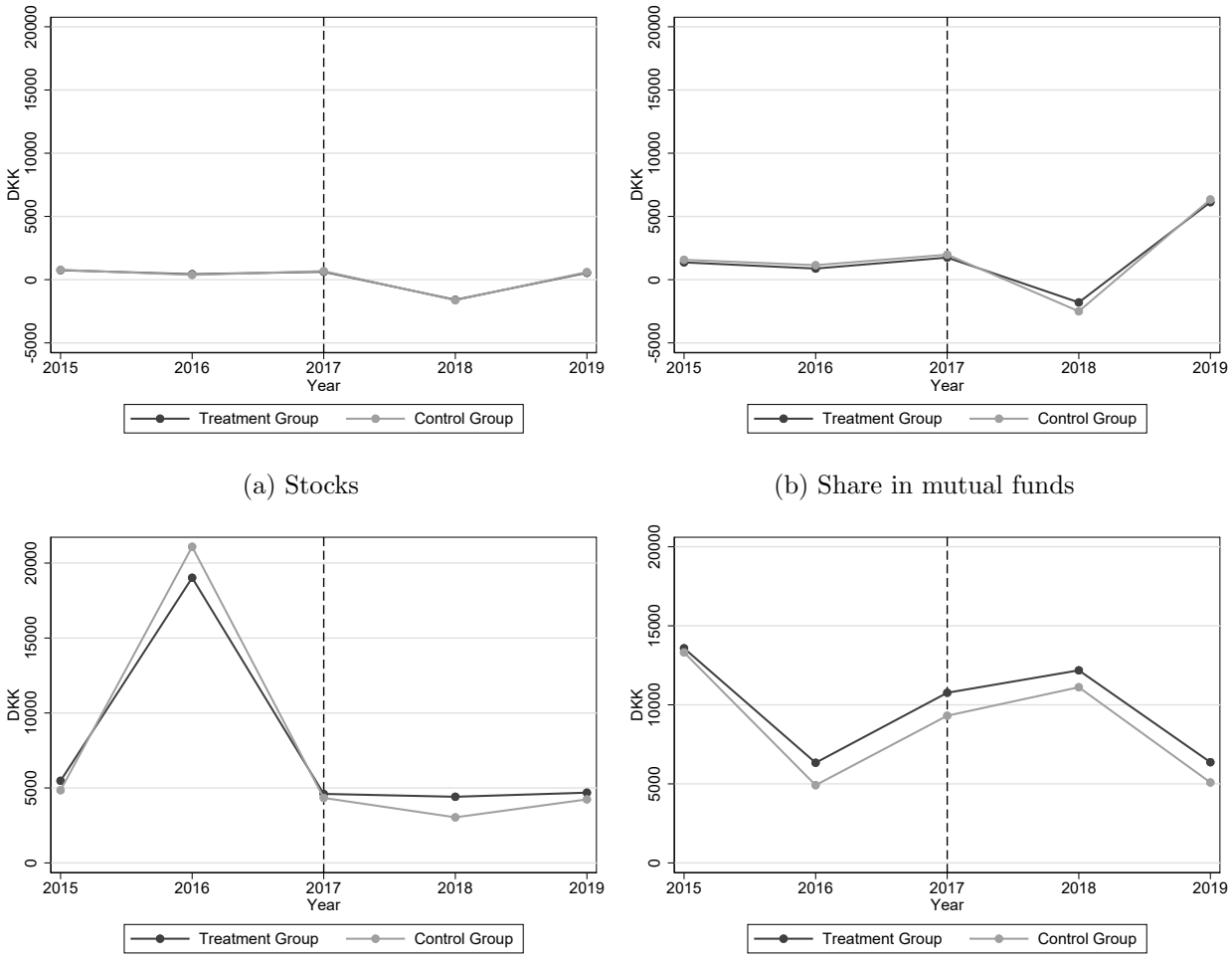
(c) Life-long contributions



(d) Bank deposits

Notes: Each figure shows average retirement saving or financial saving in the treatment and control groups from 2015 to 2019 for the alternative sample. All saving variables are measured post-tax. Treatment assignment is based on age, where individuals aged 58-62 are assigned to the treatment group and individuals aged 62-64 are assigned to the control group.

Figure B.2: Mean Financial Saving - Alternative Identification Strategy



(a) Stocks

(b) Share in mutual funds

(c) Bank debt

(d) Mortgage debt

Notes: Each figure shows average retirement saving or financial saving in the treatment and control groups from 2015 to 2019 for the alternative sample. All saving variables are measured post-tax. Treatment assignment is based on age, where individuals aged 58-62 are assigned to the treatment group and individuals aged 62-64 are assigned to the control group.

In column (2) of table B.1, the estimates show that the crowd-out results are robust to the alternative strategy as we find a retirement crowd-out parameter of 0.11 and a total crowd-out parameter of 0.59. The results also show the same retirement substitution pattern, where the majority of substitution takes place from the age pension scheme to the annuity pension scheme.

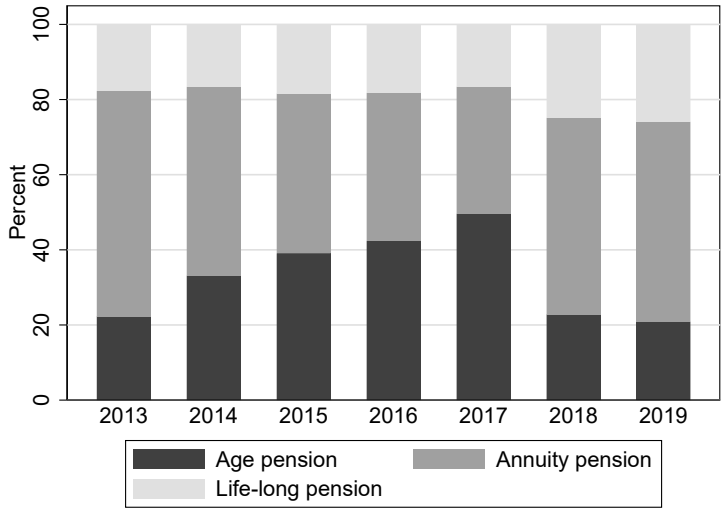
Table B.1: Crowd-out Results: Main Results and Alternative Identification Strategy

	Explanatory variable: Age pension contributions	
		Robustness:
	Main results	Different sample
Dependent variable	(1)	(2)
Annuity pensions	0.173***	0.106***
	(0.006)	(0.012)
Life-long pensions	0.026*	0.001
	(0.013)	(0.026)
Bank deposits	0.477***	0.260
	(0.054)	(0.163)
Stocks	-0.033***	0.003
	(0.003)	(0.014)
Share in mutual funds	-0.041***	0.074***
	(0.001)	(0.024)
Bank debt repayments	0.043	0.141**
	(0.048)	(0.072)
Mortgage repayments	0.008	0.002
	(0.049)	(0.036)
Retirement crowd-out	0.199	0.108
95 pct. CI	[0.170,0.227]	[0.053,0.163]
Total crowd-out	0.636	0.589
95 pct. CI	[0.462,0.811]	[0.232,0.945]
Controls	Yes	Yes
Individual FE	Yes	Yes
N	122,808	20,020
Clusters	30,702	5,005

Notes: This table presents 2SLS estimates of the crowd-out parameters using the following estimation equation: $S^F_{i,t} = \lambda_i + \beta \text{post}_{i,t} + \phi_F(-A_{i,t}) + X'_{i,t}\beta_X + \varepsilon_{i,t}$, where $S^F_{i,t}$ represents post-tax saving in a financial account F of an individual i at time t. The independent variable in all specifications is age pension contributions instrumented by $\text{post}_{i,t} \times \text{treat}_i$. Thus, the estimates show how reductions in age pension contributions induced by the 2018 reform were offset by increases in other types of saving. Controls include marital status, gross income, education level, and unemployment. Standard errors, reported in parentheses, are clustered at the individual level. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. The estimate of retirement crowd-out is a sum of the crowd-out estimates on annuity pensions and life-long pensions (standard errors are obtained using the sum of annuity and life-long pensions as the dependent variable). Similarly, total crowd-out is the sum of all estimates. The two total crowd-out estimates may not sum to exactly the same as the immediate summation due to rounding. Instead of asterisks illustrating the significance levels, the squared brackets show 95 percent confidence intervals (CI) for the two total crowd-out estimates. Column (2) presents results for the alternative identification strategy described in section B.

C Additional Tables and Figures

Figure C.1: Private Retirement Contributions, Residents Aged 18-58



Notes: The figure shows the distribution of private retirement saving in the full sample restricted to ages 18-58 in 2017, excluding the self-employed and their spouses. All contributions are measured post-tax.

Table C.1: Contribution Limits of the Age Pension Scheme (DKK)

	2014	2015	2016	2017	2018	2019
More than five years to retirement	28,100	28,600	28,900	29,600	5,100	5,200
Less than five years to retirement	28,100	28,600	28,900	29,600	46,000	48,000

Table C.2: Summary of the Trimming Process for the Estimation Sample

	Number of individuals left after data step		
Data step	Absolute	Pct. of previous step	Pct. of raw data
Raw data (full population 18-68 years old)	3,259,648	100.0	100.0
i) Exclude self-employed or their spouses	3,122,394	95.8	96.8
ii) Exclude individuals not in registers 2014-2018	1,835,435	58.8	56.3
iii) Age restrictions, 18-58 years old	1,507,494	82.1	46.2
iv) Zero employer-paid contributions	1,202,530	79.8	36.9
v) Positive contributions prior to the reform	67,326	5.6	2.1
vi) Interior optimum prior to reform	56,185	83.5	1.7
vii) In treatment group or control group	30,702	54.6	0.9

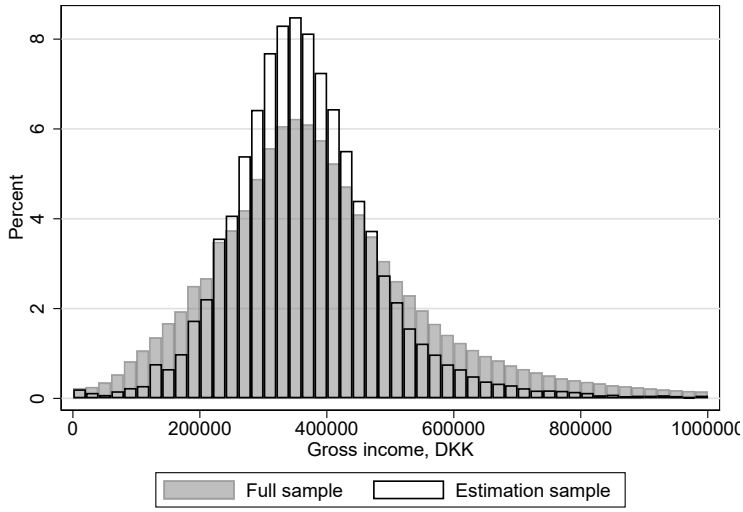
Notes: The data steps are described in section 3.

Table C.3: Summary Statistics 2016

	Full sample	Estimation sample	Treatment group	Control group
Income				
Gross income (DKK)	418,493	374,683	392,625	361,415
Disposable income (DKK)	287,929	266,993	281,540	256,236
Top tax payers (share)	0.169	0.072	0.079	0.066
Pension contributions				
Age pension contributors (share)	0.122	1.000	1.000	1.000
Age pension (DKK)	1,630	8,560	15,249	3,613
Annuity pension (DKK)	10,694	8,377	8,808	8,059
Life-long pension (DKK)	15,033	14,130	15,607	13,038
Assets and liabilities (stock)				
Bank deposits (DKK)	131,068	107,371	138,152	84,609
Stocks (DKK)	32,264	12,678	20,083	7,203
Share in mutual funds (DKK)	418,713	23,845	39,238	12,462
Bank debt (DKK)	229,278	82,275	69,662	91,602
Mortgage debt (DKK)	952,218	429,996	447,399	417,127
Liquidity constrained (share)	0.484	0.471	0.369	0.547
Demographics				
Age	43.414	46.077	47.559	44.982
Male (share)	0.502	0.315	0.314	0.315
Married (share)	0.497	0.594	0.638	0.562
Unemployed (share)	0.177	0.148	0.118	0.170
High school (share)	0.085	0.047	0.046	0.047
Vocational training (share)	0.356	0.469	0.448	0.485
Short tertiary (share)	0.058	0.054	0.055	0.054
Middle-long tertiary (share)	0.209	0.235	0.262	0.215
Long tertiary (share)	0.193	0.043	0.056	0.034
Number of observations	2,371,395	30,702	13,052	17,650

Notes: The means reported are from 2016. The full sample is defined as residents in Denmark aged 18-65 excluding the self-employed and their spouses. Gross income includes labor income, public transfers, and capital income excluding employer-administered pension contributions. All pension contributions are measured post-tax. An individual is considered liquidity constrained if the savings in his/her bank account in 2016 are lower than two times his/her monthly disposable income. An individual is considered unemployed if he/she has been unemployed for at least two months in a given year. The education variables are dummies that indicate the highest completed level of education.

Figure C.2: Distribution of Gross Income in the Full Sample and the Estimation Sample



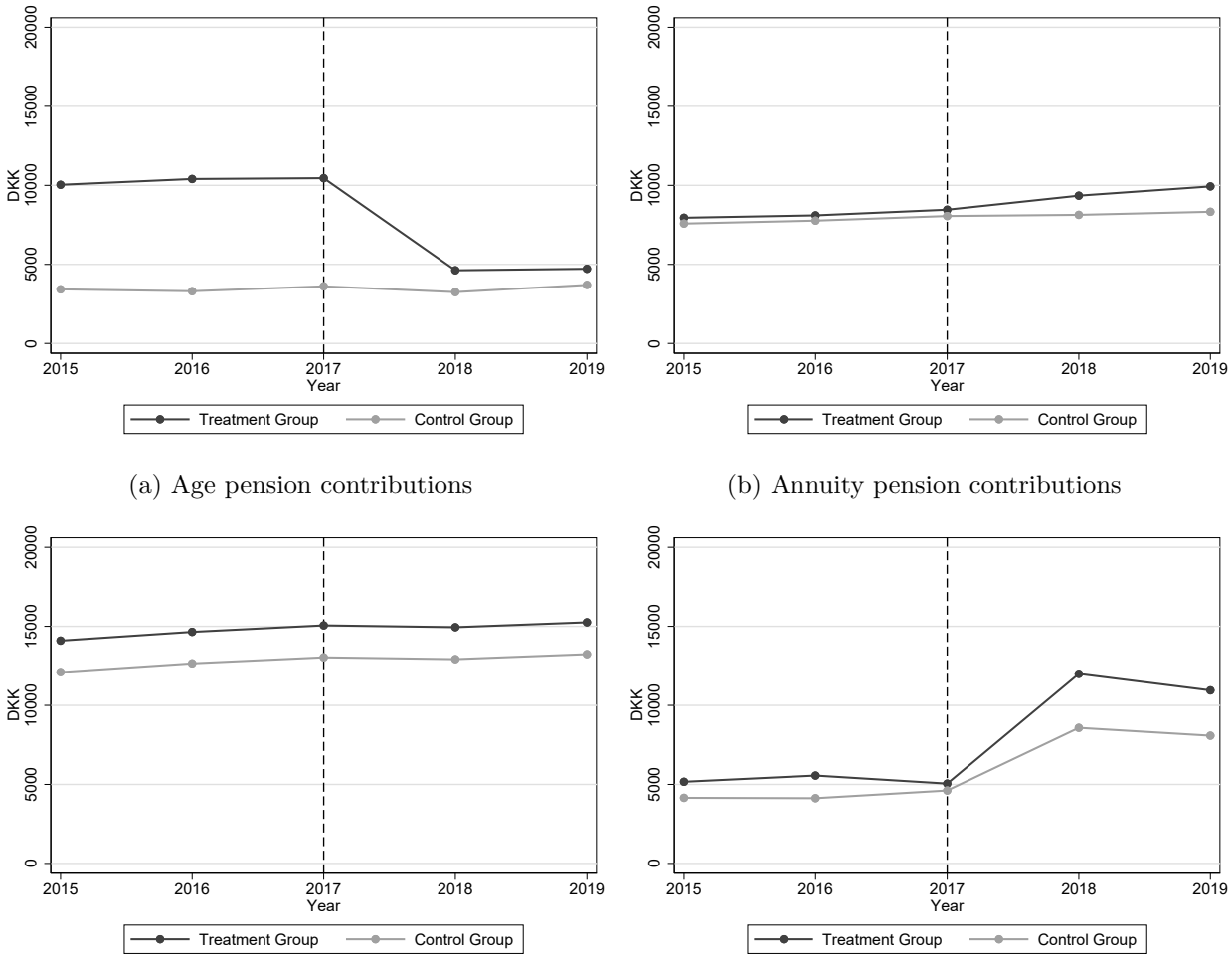
Notes: This figure shows the distribution of gross income in the full sample restricted to ages 18-65 in 2017, excluding the self-employed and their spouses, as well as the estimation sample, cf. section 3.

Table C.4: Effect of the Policy Change on Age Pension Contributions - Full Table

	Main results	Without controls
	(1)	(2)
ATT	-10,364.086***	-10,371.690***
	(46.124)	(46.101)
post	-218.247***	-200.249***
	(10.193)	(9.361)
Married	340.490***	-
	(63.720)	-
Unemployed	-145.970***	-
	(40.899)	-
Gross income	0.001***	-
	(0.000)	-
High school	14.605	-
	(245.053)	-
Vocational training	69.452	-
	(143.277)	-
Short tertiary	-211.349	-
	(283.590)	-
Middle-long tertiary	222.419	-
	(219.756)	-
Long tertiary	633.014***	-
	(318.756)	-
Controls	Yes	No
R^2	0.66	0.66
Observations	122,808	122,808
Clusters	30,702	30,702

Notes: This table presents OLS estimates of the change in age pension contributions induced by the 2018 reform using the specification in equation (1). The ATT is the difference between the change in contributions of the treatment group and the change in contributions of the control group from 2017 to 2018. Controls include marital status, gross income, education level, and unemployment. Standard errors, reported in parentheses, are clustered at the individual level. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

Figure C.3: Mean Retirement and Financial Saving - Sample Including All Contributions From 5,100 DKK



(a) Age pension contributions

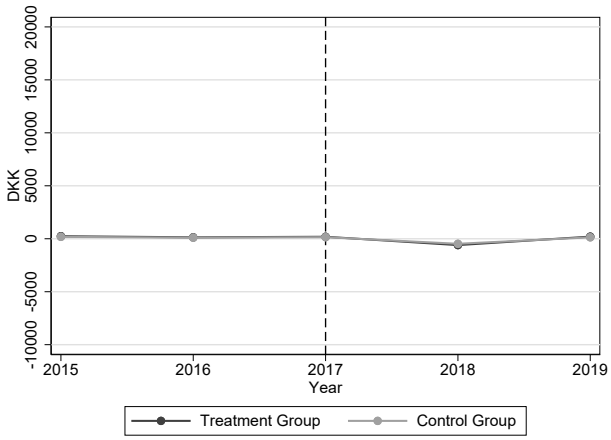
(b) Annuity pension contributions

(c) Life-long pension contributions

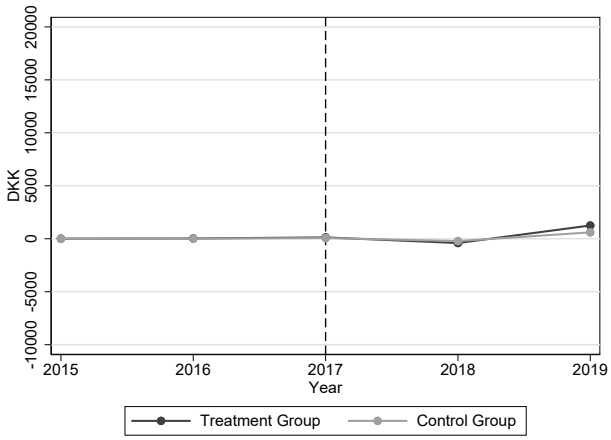
(d) Bank deposits

Notes: All saving variables are measured post-tax.

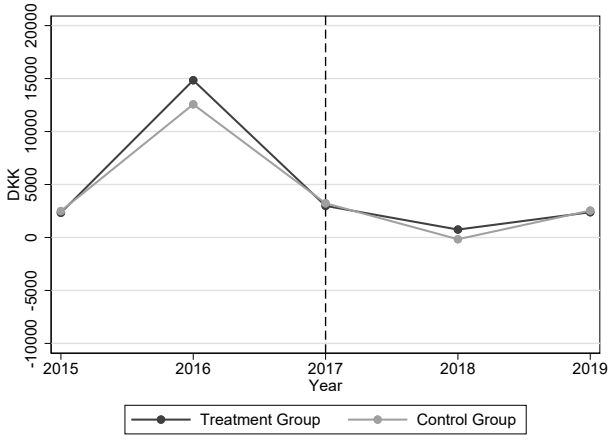
Figure C.4: Mean Financial Saving - Sample Including All Contributions From 5,100 DKK



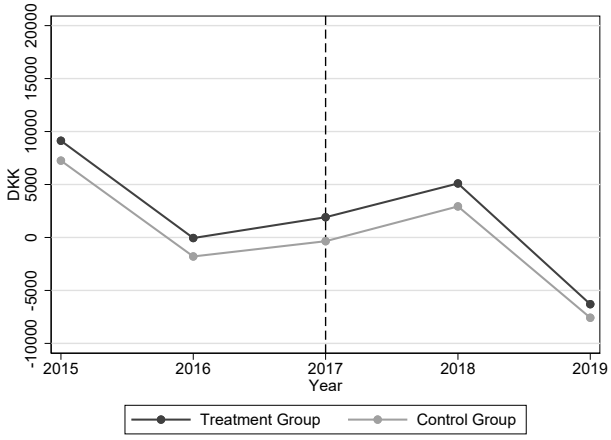
(a) Stocks



(b) Share in mutual funds



(c) Bank debt



(d) Mortgage debt

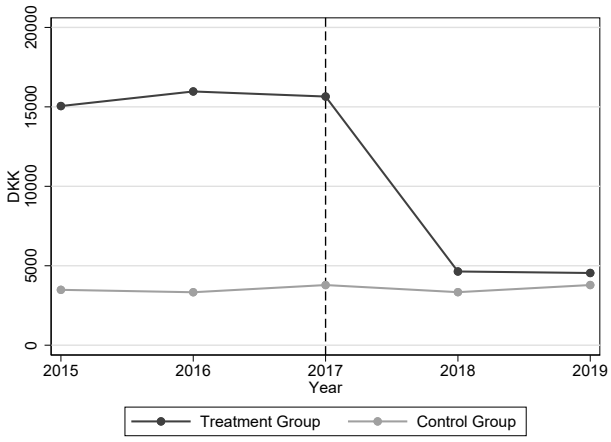
Notes: All saving variables are measured post-tax.

Table C.5: Crowd-out Results Without Controls and With Different Samples

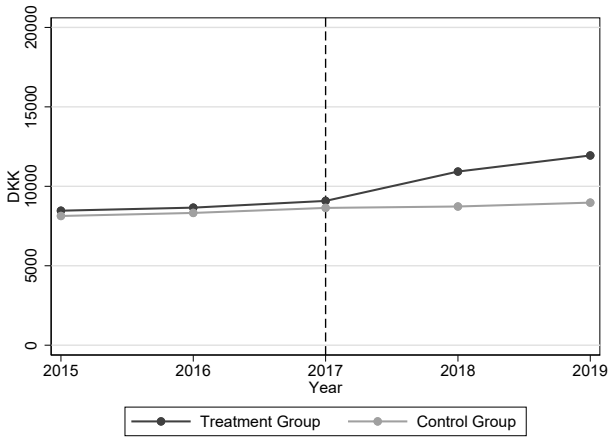
	Explanatory variable: Age pension contributions			
	Main sample	Without controls	Medium restriction	Unrestricted
Dependent variable	(1)	(2)	(3)	(4)
Annuity pensions	0.173***	0.167***	0.171***	0.162***
	(0.006)	(0.006)	(0.006)	(0.008)
Life-long pensions	0.026*	0.016	0.026*	0.020
	(0.013)	(0.013)	(0.013)	(0.017)
Bank deposits	0.477***	0.463***	0.467***	0.461***
	(0.054)	(0.054)	(0.057)	(0.076)
Stocks	-0.033***	-0.033***	-0.034***	-0.031***
	(0.003)	(0.003)	(0.003)	(0.004)
Share in mutual funds	-0.041***	-0.041***	-0.043***	-0.039***
	(0.001)	(0.002)	(0.002)	(0.002)
Bank debt repayments	0.043	0.043	0.039	0.050
	(0.048)	(0.048)	(0.052)	(0.076)
Mortgage repayments	0.008	0.004	0.029	0.024
	(0.049)	(0.049)	(0.051)	(0.071)
Retirement crowd-out	0.199	0.184	0.196	0.182
95 pct. CI	[0.170,0.227]	[0.156,0.211]	[0.168,0.224]	[0.146,0.218]
Total crowd-out	0.636	0.612	0.656	0.647
95 pct. CI	[0.462,0.811]	[0.445,0.793]	[0.470,0.834]	[0.390,0.904]
Treatment Group definition	10,001-28,000	10,001-28,000	7,500-28,000	5,100-28,000
Controls	Yes	No	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
N	122,808	122,808	138,024	195,816
Clusters	30,702	30,702	34,506	48,954

Notes: See notes for table 3. Columns (3) and (4) include estimation results for samples with different definitions of the treatment group. Column (3) includes all contributions above 7,500 DKK, and column (4) includes all contributions above 5,100 DKK.

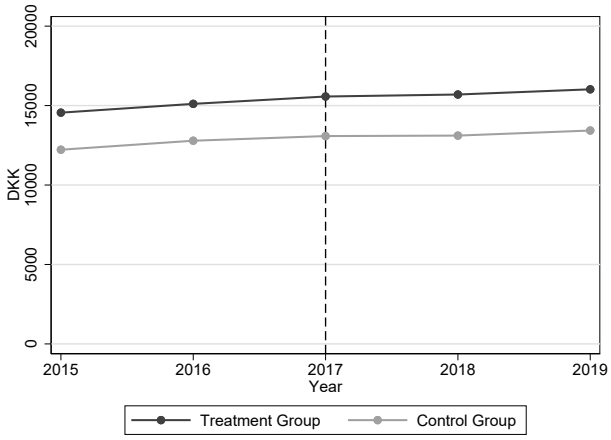
Figure C.5: Mean Retirement and Financial Saving - Sample of Not-Liquidity Constrained Individuals



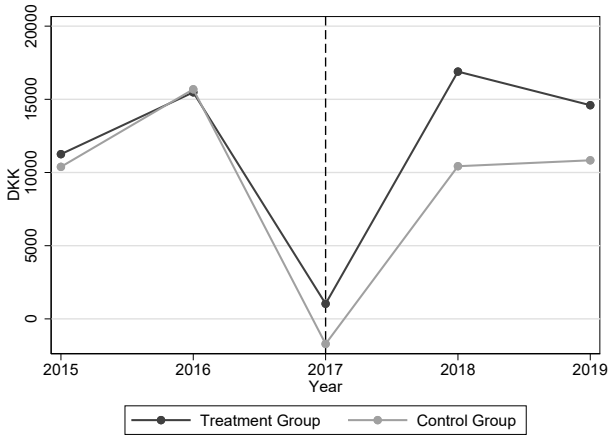
(a) Age pension contributions



(b) Annuity pension contributions



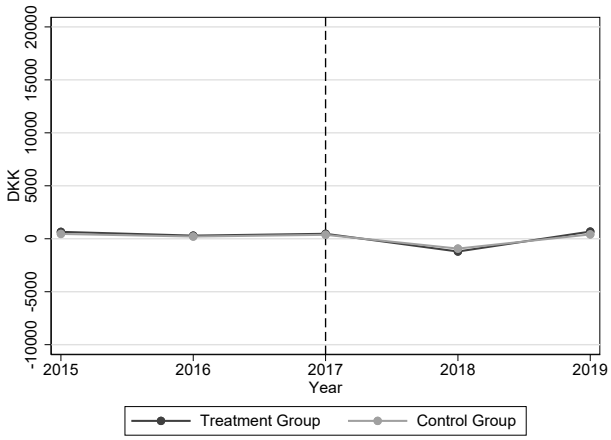
(c) Life-long pension contributions



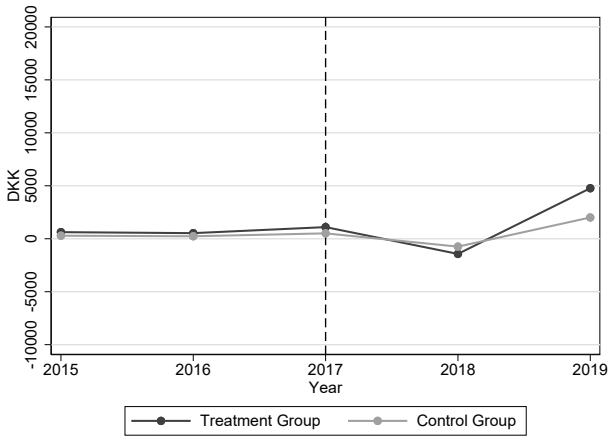
(d) Bank deposits

Notes: All saving variables are measured post-tax.

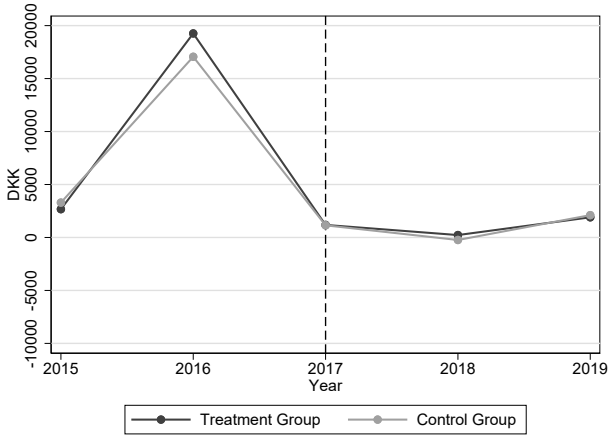
Figure C.6: Mean Financial Saving - Sample of Not-Liquidity Constrained Individuals



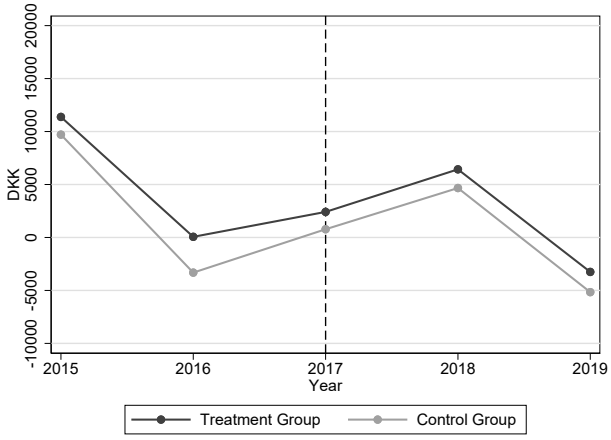
(a) Stocks



(b) Share in mutual funds



(c) Bank debt



(d) Mortgage debt

Notes: All saving variables are measured post-tax.

Table C.6: Summary Statistics - Alternative Identification Strategy

	Full sample	Estimation sample	Treatment group	Control group
Income				
Gross income (DKK)	418,493	382,321	381,648	383,726
Disposable income (DKK)	287,929	274,398	273,841	275,562
Top tax payers (share)	0.169	0.074	0.069	0.084
Pension contributions				
Age pension contributors (share)	0.122	1.000	1.000	1.000
Age pension (DKK)	1,630	16,517	16,278	17,016
Annuity pension (DKK)	10,694	8,165	8,189	8,115
Life-long pension (DKK)	15,033	16,272	16,638	15,509
Assets and liabilities (stock)				
Bank deposits (DKK)	131,068	172,450	166,133	185,651
Stocks (DKK)	32,264	31,066	24,643	44,487
Share in mutual funds (DKK)	418,713	67,155	60,324	59,492
Bank debt (DKK)	229,278	61,229	62,060	59,492
Mortgage debt (DKK)	952,218	372,065	380,820	374,668
Liquidity constrained (share)	0.484	0.312	0.322	0.292
Demographics				
Age	43.414	59.581	58.510	61.818
Male (share)	0.502	0.340	0.323	0.374
Married (share)	0.497	0.691	0.705	0.663
Unemployed (share)	0.177	0.136	0.122	0.165
High school (share)	0.085	0.033	0.034	0.031
Vocational training (share)	0.356	0.443	0.468	0.393
Short tertiary (share)	0.058	0.047	0.051	0.038
Middle-long tertiary (share)	0.209	0.219	0.207	0.245
Long tertiary (share)	0.193	0.035	0.031	0.043
Number of observations	2,371,395	5,005	3,385	1,620

Notes: The means reported are from 2017, i.e., the year before the pension reform was implemented. The full sample is defined as residents in Denmark aged 18-65 excluding the self-employed and their spouses. Gross income includes labor income, public transfers, and capital income excluding employer-administered pension contributions. All pension contributions are measured post-tax. An individual is considered liquidity constrained if the savings in his/her bank account in 2016 are less than two times his/her monthly disposable income. An individual is considered unemployed if he/she has been unemployed for at least two months in a given year. The education variables are dummies that indicate the highest completed level of education.