Pension Reform and Asset Allocation: Evidence from Annuity Cuts to Retired Civil Servants in Taiwan

Cyrus C. Y. Chu[*] Po-Hsuan Hsu[**] Chin-Wei Yang[†]

March 16, 2026

Abstract

How do households reallocate assets when faced with a large permanent income shock? Using administrative tax data, we examine the asset allocation effect of a *retroactive* pension cut in Taiwan that is specific to retired civil servants. We show that these retirees increased their stock-to-wealth ratios by 10%, stock holdings by 7%, and reallocate toward stocks with higher returns (but not higher alphas or betas) in the past. Such increases in equity market exposure are more pronounced in families with higher child-raising loads and those do not own residential property. Moreover, they exhibited a heightened disposition effect, reduced their bank deposits and total wealth, but do not change their real estate position. Our large-scale evidence suggests that, consistent with prospect theory, retirees shifted to riskier assets in response to annuity cuts.

Keywords: pension reforms; retirement saving; permanent income shock; stock market participation; asset allocation; prospect theory; household finance.

JEL codes: D14, G11, G50, H55, J32

We thank Aizhan Anarkulova, Kuan-Ming Chen, Chun-Che Chi, Chun-Fang Chiang, James Choi, Tarun Chordia, Nicolae Gâleanu, Clifton Green, Wei Jiang, Will Mann, Tim McQuade, Terrance Odean, Hunghua Pan, Nishant Vats, Kai-Jyun Wang and seminar/brownbag participants at Emory University, National Tsing Hua University, National Taiwan University, and Washington University in St. Louis for valuable comments. We are grateful to the Fiscal Information Agency (FIA) of the Ministry of Finance, Taiwan, for providing us with our data. The project benefited from excellent research assistance by Emily Jen.

[*] Institute of Economics, Academia Sinica (cychu@econ.sinica.edu.tw).

[**] Department of Quantitative Finance and Department of Economics, College of Technology Management, National Tsing Hua University (pohsuanhsu@mx.nthu.edu.tw).

[†] Department of Economics, Washington University in St. Louis (chin-wei@wustl.edu).

1. Introduction

The allocation of household assets—particularly the share invested in risky ones—has been a core research question in household finance (Campbell, 2006; Beshears et al., 2018; Gomes, Haliassos, and Ramadorai, 2021; Campbell and Ramadorai, 2026). The holdings of risky assets are subject to various characteristics such as age, gender, health, wealth, and income (Rosen and Wu, 2004; Curcuru et al., 2010; Addoum, 2017; Choi and Robertson, 2020). Among all these characteristics, permanent income[1]— defined as the present value of future income—plays a particularly important role, as it determines households' lifetime resources (Campbell, 2006; Gomes, 2020).

However, as permanent income hinges on many factors and is difficult to measure, drawing causal inferences about its effect on asset allocations is challenging. We address this challenge by focusing on retirees, whose income sources are limited and for whom pension benefits constitute a major component of permanent income. Moreover, population aging has increased pension obligations across countries, triggering pension reforms that have already reduced benefits and foreshadowing further reforms and benefit cuts in the years ahead (Lindbeck and Persson, 2003; OECD, 2019, 2021, 2023). In the United States, for example, Social Security benefits for over 60 million retirees are projected to be cut by 23% by 2033 in the absence of policy intervention (Social Security Board of Trustees, 2025). Despite the pressing and long-lasting implications of these reforms for household financial decisions, there remains limited evidence on how pension reforms affect asset allocation behavior (Scharfstein, 2018; Zhang, 2021).[2]

Existing theoretical and empirical literature offers *opposite* predictions for the effect of pension reforms on retirees' asset allocations. On the one hand, standard life-cycle portfolio choice models predict that retirees *reduce* their exposure to risky assets following pension cuts. In particular, Merton (1971), Viceira (2001), and Calvet and Sodini (2014) imply that the optimal risky share declines in response to negative permanent income shocks. This theoretical prediction

[1] Throughout the paper, we use *permanent income* and *human capital* interchangeably to denote the present value of future labor income. In the context of this study, the concept primarily refers to the present value of guaranteed pension benefits prior to the reform.

[2] This gap in the literature can be attributed to (i) the lack of an appropriate identification strategy, and (ii) limited data on households' total wealth and asset allocation. Moreover, most reforms target the entire population or impose gradual changes over extended periods, challenging researchers' ability to design identification strategies.

is supported by the empirical evidence of Cocco, Gomes, and Maenhout (2005) and Calvet and Sodini (2014).

On the other hand, a growing body of empirical research documents pervasive behavioral biases in households' financial decisions that deviate from the predictions of standard economic models (Odean, 1998, 1999; Beshears et al, 2018; Stango and Zinman, 2023; Olafsson and Pagel, 2024, 2025). According to prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), individuals exhibit risk-seeking behavior when outcomes fall below a salient reference point. Consistent with this mechanism, prior studies show that individuals take on greater financial risk following perceived losses (Page, Savage, and Torgler, 2014; Lian, Ma, and Wang, 2019; Gomes et al., 2025). If a similar mechanism operates in the context of pension reforms, retirees facing pension cut relative to their pre-reform living standards may increase their allocations in risky assets.

To empirically test these opposing predictions, we exploit one of the most radical pension reforms in recent history—the pension reform of civil servants in Taiwan in 2017—together with comprehensive, administrative data of household assets. Under the reform legislation, the retirement annuities of civil servants in Taiwan will be drastically reduced: the income replacement rate will be reduced from the 75%-95% range to the 30%-62.5% range. Importantly, retirees outside of the public sector are totally unaffected during the reform period.

A key feature of this reform is that it is applied *retroactively* to civil servants who had already retired and were receiving monthly pension benefits at the time of implementation. This directly nullifies the government's promise and thus contravenes the usual "Grandpa Clause" in pension obligations. Because civil-servant pensions in Taiwan operate under a defined-benefit (DB) system and are paid as predictable monthly annuities, pension benefits constitute a large and stable component of retirees' human capital. As a result, the reform induces an abrupt, policy-driven reduction in permanent income. This institutional setting allows us to study households' financial responses to negative permanent income shocks without relying on strong structural assumptions typically required to infer permanent income from short panels of realized labor income (Cocco, Gomes, and Maenhout, 2005; Calvet and Sodini, 2014).

There are several important institutional features of civil servants in Taiwan. First, civil servants constitute a significant portion of employment in Taiwan. In 2017, there were 912,451

civil servants at work, which amounted to 8% of total employees. Secondly, being a civil servant is regarded as a stable job with a high entry barrier. Individuals who intend to serve in the government will need to pass rigorous examinations (the pass rate was only 9.31% in 2016) together with other corresponding training programs, if they are to qualify. After formal recruitment, while there are elimination mechanisms, it is rare for civil servants to be laid off due to poor performance or government restructuring. Thus, it is very common for civil servants to remain in government employment until their retirement age. (In 2020, the turnover rate of civil servants is only 0.68%.) Finally, civil servants will receive retirement annuities after they retire, which are determined based on their tenure and pre-retirement salary levels.[3] Before the pension reform in 2017, such annuities were considered to be generous.

To compile the data on the allocation of all households' assets, we rely on several administrative tax-related databases from the Fiscal Information Agency (FIA) of the Ministry of Finance, Taiwan. These databases cover individuals' income and wealth in six taxable asset categories, namely, houses (i.e., buildings), land, stock shares, bank deposits, bonds, and cars. We have managed to collect comprehensive, detailed data on almost all individuals' and households' occupations, wealth, and income in Taiwan from 2005 to 2021.

We design a difference-in-differences setting to examine whether retired civil servants react to the pension reform in terms of asset allocation differently from other retirees. We focus on households with only one working individual who retired before the pension reform,[4] and then divide our observations into two groups: those retiring as civil servants and those retiring from the private sector (as our treatment and control groups, respectively). In this setting, individuals' retirement decisions were not affected by the pension reform, and their annuities and pension plans are fixed and thus not subject to uncertainty absent the pension cuts.

[3] Although retired civil servants can choose to cash out their pension in a lump sum at upon retirement (which is irreversible), such an option is rarely exercised (less than 2% in 2016). The cash-out option is often chosen by individuals who left the civil service much earlier than regular retirement age and/or were not eligible for annuities due to not serving a sufficient tenure length. As our sample focuses on retirees whose retirement decision occurred before the reform, our analysis is not subject to these retirees' annuitization decisions. Also, there is only one pension account for civil retirees, so we are not subject to the cross-account annuitization such as discussed in Hurwitz and Sade (2025).

[4] Households with only one working individual are dominant in our retiring household population (75%). As the primary breadwinners in the sample are predominantly husbands, we further refine the sample to include only those whose husbands are aged between 55 and 70 years.

To measure a household's risky asset allocation, we focus our analysis on stock portfolios for several institutional reasons. First, it is common in the household finance literature to use stock holdings to proxy for risky assets (Calvet and Sodini, 2014; Addoum, 2017; Zhang, 2021; Gomes et al, 2025). Second, stocks are the most common and accessible class of risky asset for households in Taiwan. Third, unlike in the United States, Taiwan does not impose capital gains taxes on stock investments (but imposes a 0.3% transaction tax), which allows retired civil servants to adjust their portfolios without incurring taxes from short-term capital gains. As a result, concerns about tax-loss harvesting, tax-swap, and tax-induced trading distortions are largely absent in our sample.

We use the total value of stock holdings and stock-to-wealth ratio to measure a household's holding of risky assets (Calvet and Sodini, 2014; Addoum, 2017; Zhang, 2021; Gomes et al, 2025). These two measures are free from modeling and/or estimation errors, and they map directly into theoretical portfolio choice frameworks that characterize optimal risky asset demand (Merton, 1971; Viceira, 2001).[5] We find that, in comparison with other households, those of retired civil servants increase their stock-to-wealth ratios by more than 10% with statistical significance after the reform. In addition, retired civil servants increase their value of stock holdings by more than 7% with statistical significance after the reform.

Additional analyses indicate that there is no pre-trend in the treated group's (i.e., retired civil servants') stock holdings, supporting the view that the parallel trend assumption is satisfied. Furthermore, we perform three robustness checks. First, applying the pre-trend test proposed by Roth (2022), we confirm that our findings are robust to potential violations of the parallel trend assumption. Second, we form a matched sample of private sector households that closely resemble retired civil servants (especially the total wealth and the stock-to-wealth ratio) before the treatment. Using the matched sample, we estimate the effects of pension reform on households' stock holdings and find consistent results. Finally, an event-study analysis of civil servants' preferential deposit balances shows that the observed increase in stock holdings is much higher than the reduced interest income from preferential deposits.[6]

[5] Prior studies often measure stock holdings as a share of financial wealth due to data limitations, as they typically rely on brokerage account data. In contrast, we compute the share of stocks relative to total household wealth, leveraging our comprehensive data on all taxable assets. This measure aligns more closely with theoretical portfolio choice models, which characterize optimal risk exposure relative to total wealth rather than a subset of financial assets.
[6] Civil servants were eligible for preferential deposits with an 18% annual interest rate up to a cap based on the income replacement ratio formulas. Such an opportunity was gradually terminated after the reform. Nevertheless, preferential

Our empirical results support the reduced risk aversion in the loss domain as predicted by prospect theory. The pension reform forces retired civil servants to choose between preserving their existing low-risk savings while accepting a permanent reduction in income, or reallocating their assets toward riskier stocks in pursuit of higher returns. Maintaining the status quo implies accepting a certain loss relative to their previous consumption level, whereas shifting to a riskier portfolio offers the (mental) possibility of partially recovering that loss. Under prospect theory, the latter option becomes psychologically attractive because it provides a chance to "break even" rather than accept a guaranteed decline in lifetime income (Page, Savage, and Torgler, 2014; Lian, Ma, and Wang, 2019; Gomes et al., 2025).

We then implement an extensive list of tests to further examine a prospect theory explanation. We first examine changes in the composition of stocks held by retired civil servants: they tilt toward stocks with salient recent performance measured by past returns instead of stocks with higher alphas or betas in the past. In other words, retired civil servants are subject to a behavioral bias in the sense that, after the reform, they chase past-performer stocks instead of systematic risk premium that is rational.

We further examine the role of financial pressure, which likely reflects households' sensitivity to losses. Specifically, we stratify the sample by child-raising burdens and ownership of residential property. We find that the increase in equity exposure following the reform is significantly larger among households with higher child-raising loads and those without owning residential property. Because these households face greater consumption needs, they are more likely to perceive the pension cut as a substantial loss relative to their habitual consumption level. These heterogeneity patterns therefore provide supporting evidence that the portfolio response is driven by perceived financial losses.

Moreover, we examine whether the pension reform also amplifies common behavioral trading biases, in particular the disposition effect. The disposition effect refers to investors' tendency to sell winning stocks while holding on to losing stocks (Shefrin and Statman, 1985; Odean, 1998; Barber et al., 2007). Our empirical results indicate that retired civil servants exhibit

deposits were still available with a 9% annual interest rate (which is way above most assets' expected returns after risk adjustment) until 2020, but the increases in the stock-to-wealth ratio and stock holdings occurred in 2017-2020. We also exploit the variation of preferential interest rate across time to show that the magnitudes of preferential deposits withdrawal and increases in stock holdings do not align.

a stronger disposition effect following the pension reform: the gap between realized gains and realized losses widens by approximately 40%. Holding losing positions can be interpreted as a form of risk-taking behavior, as investors continue to bear downside risk in the hope that prices will rebound and losses can be recovered. Taken together, these results suggest that the pension reform not only increases households' willingness to take financial risk but also amplifies behavioral biases consistent with reference-dependent preferences.

We also validate retired civil servants' substantial permanent income loss after the reform by considering other dimensions of assets: In particular, we consider how households adjust their bank deposits, housing, and wealth. Treated households' deposits-to-wealth ratios and total wealth decrease by 22% and 4.1%, respectively, relative to those of other households following the reform. We find null effect on their real estate decisions, suggesting that affected households chose not to adjust their residential property to alleviate their financial pressure. These additional results collectively point to increased financial pressure faced by retired civil servants after the reform.

We have also considered several alternative explanations for the shift towards risky assets by retired civil servants after the reform. The first set of explanations is related to civil servants' time constraints, regulatory restrictions that prevent them from investing in stocks, and their lack of stock investment experience and knowledge. However, all these issues have existed before the reform for the following two reasons. First, since our sample only includes retirees who retire *before* the pension reform, these factors were already present before the policy change and cannot account for the discrete increase in stock holdings immediately after pension reform. Second, even prior to the reform, retired civil servant households are more likely to hold stocks (69.2%) than private sector ones (66.1%), suggesting limited participation experience is unlikely to be the main driver of the post-reform response. Another possibility is that our results are driven by stock market conditions. However, the Taiwan stock market index was fairly stable in 2017-2019 (and then increased since 2020), and we have observed a significant increase in retired civil servants' stock holdings since 2017.

Our paper contributes to several strands of the economics and finance literature. First, it adds to the analyses of the impact of pension reforms and retirement savings in several ways. Differing from prior research in this area that focuses on saving rates or contribution rates (Feldstein, 1974; Attanasio and Brugiavini, 2003; Choi, 2015; Zhang and Sialm, 2025) and incentivizing late

retirement (Fisher and Keuschnigg, 2010), we focus on risky asset allocation that has important implications for financial markets due to the aging population (especially in Asian economies with extremely low birth rates). As baby boomers approach and enter their retirement years, how retirees allocate their wealth and the resultant policy consequences has become an important research question (Beshears et al., 2011; Poterba, Venti, and Wise, 2011; Scharfstein, 2018). Our identification strategy is particularly effective because the pension reform we study is specific to civil servants and retroactively cuts annuities, while prior studies on pension reforms lack clear-cut treatment groups (Feldstein, 1974; Attanasio and Brugiavini, 2003; Attanasio and Rohwedder, 2003). Moreover, our administrative data are complete and comprehensive, while most prior studies tend to rely on surveys and/or selected samples.[7]

Second, this paper is related to a core research question in household finance: the relation between lifetime resources and risky asset holdings (e.g., Campbell, 2006; Curcuru et al., 2010; Gomes, 2020). Our finding does not support a positive relation between risky asset holdings and permanent income; instead, it is consistent with a risk-seeking behavior in the loss domain based on prospect theory of Kahneman and Tversky (1979) and Tversky and Kahneman (1992). Moreover, our large-scale, population-level results complement prior evidence based on experiments that may suffer from limited real impact, smaller sample size, and selection issues (Abdellaoui et al., 2008; Harbaugh et al., 2010; Page, Savage, and Torgler, 2014; Lian, Ma, and Wang, 2019).[8]

Lastly, it is noteworthy that most prior population-level analyses of comprehensive asset allocation are based on Scandavanian countries, such as the Finnish data in Grinblatt and Keloharju (2000, 2001) as well as the Swedish data in Calvet, Campbell, and Sodini (2007), Massa and Simonov (2006), and Calvet and Sodini (2014). In this paper, we present households' asset allocation from a new perspective. Taiwan households are featured for having high savings, owning residential property (78.6% own their residences), high family support, and low stock market participation (only half of the population had a stock account in 2021). The difference

[7] Even the largest survey samples have only 12,734 Canadian families in King and Dicks-Mireaux (1982), 32,212 Italian families in Attanasio and Brugiavini (2003), 22,000 families in Addoum (2017), and 18,469 individuals in Neelakantan and Chang (2010).

[8] Experiments often involve small stakes compared to real-life scenarios, the selection into sample raises concerns about external validity, and it is challenging to induce actual wealth loss in experimental settings due to inherent difficulties (Levitt and List, 2007; Harrison and Rutström, 2008; Wakker, 2010; Page, Savage, and Torgler, 2014).

between our finding and Zhang's (2021) that is based on U.S. state-level pension deficits suggests that cultural issues and societal features may play important roles in households' stock holdings (e.g., Osili and Paulson, 2008; Haliassos, Jansson, and Karabulut, 2017).

2. Institutional Background

In Taiwan, civil servants cover the employees of all branches of the government, including the military and public-school education (but not including employees working for state-owned enterprises or government-sponsored institutes). Prior to the 2017 reform, the pension system for civil servants in Taiwan was known for its generous benefits and early retirement ages. Operating as a defined-benefit (DB) system, the calculation of a civil servant's pension involves two components.[9] Firstly, the monthly pension and income replacement ratio are determined based on the duration of service. Secondly, civil servants are provided with the opportunity to save a capped amount in a preferential deposit account that offers an 18% annual interest rate. We provide more details on this in Appendix Section A.1. In general, civil servants are assured an income replacement ratio (i.e., the ratio of annuity including preferential interest income to pre-retirement income) between 75% and 95% (as shown in the top row of Table 1). This generous pension plan, however, creates a huge burden for the government: the total payout to civil servant retirees was 310.8 billion New Taiwan Dollars (NTD) in the year 2016.

On June 27, 2017, the "Civil Servants Retirement, Severance, and Dismissal Compensation Act" was passed by the Legislative Yuan (which is analogous to the two chambers in the U.S.). This pivotal 2017 pension reform aimed to reduce the government's financial burden imposed by the pension systems for military personnel and civil servants. The reform consisted of the following five major parts: (1) the normal retirement age was raised; (2) the pension calculation formula was adjusted; (3) the 18% preferential interest rate, which used to be a part of retired civil servants' annuities, was gradually reduced and eventually eliminated in 2021; (4) retired civil servants' reappointment was restricted; and (5) pension funding sources were adjusted. We provide more details in Appendix Section A.2.

Table 1 summarizes the income replacement ratios for Taiwanese civil servants under the pension system before and after the 2017 pension reform, by years of service. A significant

[9] The Public Officials Retirement Act.

reduction (22.75 to 30 percentage points) in the income replacement ratio was implemented in July 2018; in addition, the ratio was to be reduced by an increment of 1.5 percentage points every year from 2020 to 2029.[10] In 2029, the income replacement ratio will fall to the 30%-62.5% range (as shown in the bottom row of Table 1). As a result, the income replacement ratio will be cut by 27.5 to 45 percentage points in 2029, with civil servants with shorter lengths of service experiencing more severe cuts. In addition, the actual cut may in fact be deeper because the calculation does not account for the change from the base salary to the average base salary for the last fifteen years at work.[11]

To illustrate the magnitude of the shock, consider a middle-ranked civil servant who retired with 35 years of service. Prior to the reform, this individual received approximately $22,700 in annual pension benefits and $2,700 in preferential interest payments, for a combined annual income of about $25,400. Beginning in July 2018, the annual annuity was reduced to roughly $21,100 and is scheduled to decline further to approximately $17,000 by 2029.

This pension reform effectively reduced the financial burden for governments. For instance, the total payout to retired civil servants was reduced by 13.5 billion NTD in 2020.[12] The reform is expected to lower the government's obligation by 1.42 trillion NTD over the next 50 years.

3. Data and Summary Statistics

3.1 Data sources

Our main data source is the tax record databases collected by the Fiscal Information Agency (FIA) of the Ministry of Finance, Taiwan. These include: (1) the Nationwide Personal Property database, which consists of deposits, bonds, stocks, housing, land, and car ownership information (serving for property tax collection) from 2003 to 2021, and (2) the Personal Income Tax database, which consists of all taxable salaries, income from professional practice, bonuses, dividends, bank deposit interest, bond interest, and other personal income items in annual tax filings from 2001 to

[10] However, there is an exception. In order to guarantee a certain standard of living, individuals whose monthly pension falls below 33,140 NTD after the reform will receive a minimum of 33,140 NTD.
[11] Prior to the reform, the income replacement ratio was based on the salary before retirement. After the reform, the base for calculating the income replacement ratio gradually transitioned to the average base salary of the last fifteen years of employment. Consequently, if a civil servant received a promotion during his/her last fifteen years of employment, the average base salary would be lower than the initial base salary before the reform. As a result, the reduction in the annuity is actually larger than the range from 27.5 to 45 percentage points.
[12] Data Source: Ministry of Civil Service.

2021. All these datasets can be merged through unique anonymized ID numbers. The Nationwide Personal Property database provides *security-level* information, enabling us to identify which stocks each individual holds. Two key features of the Personal Income Tax database are noteworthy: first, the income filings are reported by employers, which enables us to extract the employer-employee linkages (and to identify individuals who are civil servants). Second, a detailed item on mortgage interest is recorded for tax deduction purposes, which allows us to estimate the outstanding mortgages of the households.

Our second data source is the household registration data collected by the Ministry of Interior, which includes essential demographic information such as unique anonymized ID for each person, the anonymized IDs of spouse and children, gender, birth date, death date, and marital status. These data allow us to form household relationships and merge them with the tax record data, thereby enabling us to investigate many detailed family characteristics that are related to the households' asset allocation choices and financial pressure.

We also collect the aggregate amount of outstanding mortgages and mortgage interest in Taiwan, which is published annually by the Joint Credit Information Center (JCIC). The JCIC is a non-profit organization whose main objective is to safeguard the security and stability of the financial system while also addressing the operational requirements of its member institutions. It collects, processes, and maintains the credit information of individuals and businesses, providing data for credit risk assessment and lending decisions.

We combine the JCIC's aggregate annual mortgage data with individual household deductions for mortgage interest to estimate the total outstanding mortgages for households. Following the approach adopted by Lien et al. (2021) to estimate mortgages using tax records in Taiwan, which is essentially the capitalization method proposed by Saez and Zucman (2016), we distribute the aggregate mortgage amount proportionally to each household based on its share of the household mortgage interest within the aggregate mortgage interest. We then calculate each household's wealth in terms of real estate as the assessed value of the building and land (which are separately taxed) minus the outstanding mortgage.

Lastly, we collect stock prices and returns from the Taiwan Economic Journal (TEJ) financial database. The TEJ database provides comprehensive firm-level information, including stock prices, outstanding shares, and trading volumes. By merging TEJ data with security-level

household stock holdings data using anonymized stock ID, we construct detailed household-level information on stock holdings, portfolio characteristics, and realized gains and losses.

3.2 Sample formation and summary statistics

Given our focus on the pension reform, we restrict our sample to single-earner families whose primary income earner retired between 2011 and 2016 for the following two reasons: first, these people retired before the pension reform so their retirement timing is not driven by the pension reform. Given that the pension reform is retroactively applied to former civil servants who had already retired, these retirees' annuities were cut permanently, which reduces their permanent income. Second, focusing on single-earner families helps us rule out confounding factors such as the spouse's income status and retirement decision (Cullen and Grueber, 2000).[13] More importantly, the majority (about 75%) of households with individuals that retired in the 2011-2016 period are single-earner families. Hence, this refined sample of our study is representative of the population. Since most breadwinners in single-earner families in Taiwan are husbands, we further narrow our sample to include only families with husbands aged between 55 and 70 years old. This sample filter also ensures that our sample consists primarily of civil servants who retired with annuities. Among the 8,868 civil servants who retired in the age of 55 or older in 2016, only 163 (1.8%) opted to cash out their pension as a lump-sum payment.

We define an individual as retired in year t if he or she satisfies one of two criteria: (i) the individual receives pension income in year t; or (ii) the individual is older than age 50, has been employed by the same employer for more than five years, and receives no payment from that employer in year t. We classify an individual as a civil servant if he or she received annual labor income exceeding NT$360,000—approximately the minimum annual salary—from public institutions for more than seven years. Based on this classification, we divide retiree households into two groups: those whose breadwinner retired as a civil servant (treatment group) and those whose breadwinner did not (control group).

[13] If we consider a dual-earner household as retired when one of the couples is retired, the spousal labor supply could introduce potential confounding factors (such as delaying her/his retirement). Conversely, if we define a dual-earner household as retired only when both partners are retired, we might end up with a highly selective sample. In addition, the evidence suggests that leisure complementarity plays a significant role when the two partners retire close to each other (Stancanelli and Van Soest, 2012; Michaud et al., 2020).

Our data compiled as discussed earlier lead to a comprehensive panel dataset comprising asset allocation, income, and various characteristics of households in Taiwan spanning the years from 2013 to 2021. We construct the following variables for each household (the detailed definitions of all variables are provided in Table A2 in the Appendix). The first set includes the following demographic variables: *Husband Age* denotes the age of the husband in the household; *Wife Age* denotes the age of the wife in the household; *Male Breadwinner* is an indicator variable that equals one if the primary income earner of the household is the husband and zero otherwise; and *Child Dependency* denotes the number of children below 24 years old in the household.

The second set includes the following household-level asset allocation variables: *Deposits* denotes the amount of household-level bank deposits; *Bond* denotes the amount of bond holdings of the household; *Stock Holdings* denotes the amount of stock holdings of the household; *I_stock* is an indicator variable that equals one if the household holds any stocks in a year and zero otherwise; *Present Value of Cars* denotes the present value of cars of the household; *Assessed Value of Real Estate* denotes the assessed value of building and land minus the outstanding mortgages of the household; *Owning Real Estate* is an indicator variable that equals one if the household holds any real estate in a year and zero otherwise; *Mortgage* denotes the outstanding mortgages of the household; *Total Wealth* denotes the total wealth of the household; *Deposits/Wealth* denotes the deposits-to-wealth ratio;[14] and *Stock/Wealth* denotes the stock-to-wealth ratio.

The third set includes the following variables about the characteristics of stock portfolios: α denotes the weighted average of the household stock portfolio's alpha under CAPM; β denotes the weighted average of the household stock portfolio's beta under CAPM; $\sum \epsilon^2$ denotes the weighted average of the household stock portfolio's idiosyncratic risk under CAPM; and *(Market Adjusted) Excess Return* denotes weighted average of the household stock portfolio's (market adjusted) excess return.

Table 2 presents the summary statistics of our full retiree sample before the pension reform, as well as the summary statistics for the treated and control groups. We acknowledge that the summary statistics of the two groups are statistically different – a common feature for population-

[14] In general, we extrapolate the amount of the deposits using the average deposit interest rate in Taiwan. However, since civil servants were offered an opportunity to save with an 18% interest rate in a preferential deposit account, we extrapolate their maximum interest income by the preferential interest rate so as not to overestimate their deposits.

level data given the large number of observations in our sample. We choose to use the full sample in our main analyses for data completeness and transparency; nevertheless, in a later robustness check, we also construct a matched sample in which treated and control households are more homogenous in almost all outcome variables of our regressions before the reform.

In Table 2, we find that civil servant households tend to hold more deposits but fewer risky assets relative to households with retirees from the private sector. Specifically, the deposits-to-wealth ratio and the stock-to-wealth ratio of civil servant households are 20.9% and 8.0%, respectively, whereas those of their private sector counterparts are 16.3% and 12.1%. On the other hand, bond holdings are negligible in both samples, as bond market participation in Taiwan is largely concentrated among households at the top of the wealth distribution.

4. Main Results

4.1 Stock trading patterns

Before turning to the econometric analysis, we first present the stock trading patterns of the treated and control groups as descriptive evidence for their responses to the pension reform. We calculate each household's annual transaction value based on annual change in stock holdings between consecutive years. We then average all households in each group in every year, and then demean or normalize this average using the sample mean and standard deviation in the same year. Panel (a) and Panel (b) of Figure 1 plot the trends in demeaned transaction values and normalized transaction values, respectively. The blue line represents civil servants (the treated group), while the red line represents private-sector households (the control group). The control group exhibits relatively stable transaction activity throughout the sample period. In contrast, transaction values for civil servants increase markedly after the reform, with a sharp rise in the years following the policy change in 2017. Consequently, the gap between the treated and control groups widens substantially in the post-reform period. These patterns provide preliminary evidence for retired civil servants' rebalancing of their stock portfolios in response to the pension reform.

4.2 Identification design

We estimate the following difference-in-differences regression to examine how households with retired civil servants adjust their asset allocation to the pension reform relative to others:

$$AssetAllocation_{it} = bCivilServant_i \times Post_t + X_{it}\Gamma + \mu_i + \delta_t \; or \; \sigma_{ct} + \epsilon_{it}, \qquad (1)$$

where $AssetAllocation_{it}$ denotes variables reflecting the asset allocation decision of household i in year t; $CivilServant_i$ is a binary variable, indicating whether the breadwinner of the household i was a civil servant before s/he retired; $Post_t$ is a time indicator which takes the value of one for the period since the pension reform (i.e., $t \geq 2017$) and zero otherwise. Our primary interest lies in the coefficient b, which captures whether treated households change their asset allocation more than control households do after the pension reform.

Our main outcomes are stock measures (the level of stock holdings and the stock-to-wealth ratio) rather than flow measures. Some studies use flow-based outcomes—such as net purchases of equity or changes in risky share to be decomposed into active rebalancing versus passive capital gains—to separately identify trading responses (Gomes et al., 2025). A potential concern is therefore that changes in our stock outcomes could partly reflect passive valuation effects rather than active portfolio rebalancing. Our difference-in-differences design mitigates this concern as long as both groups' passive capital gains grow at a similar rate and are thus differenced out: the pre-trend test in Section 4.4 validates such design.

X_{it} is a set of control variables that include *Child Dependency* (the number of children under 24 years old) and *ln(1+mortgage)* (the logarithm of outstanding mortgages) that reflect the household's financial burden, and fixed effects for the husband's age to capture the life cycles of households. Moreover, we control for an extensive list of fixed effects, including μ_i for household fixed effects, δ_t for year fixed effects, and σ_{ct} for city-year joint fixed effects. Lastly, ϵ_{it} represents the estimation error. We cluster the standard errors by household as estimation errors are likely to be correlated within each household.

It is worth noting that we do not intend to include too many control variables because almost all economic decisions are influenced by the pension reform. Thus, we should refrain from including those affected variables in our difference-in-differences regression analyses to avoid the "bad control" issue (Angrist and Pischke, 2009; Roberts and Whited, 2013).

As we control for household fixed effects, any time-invariant family-level unobservable characteristics such as the absolute risk aversion and culture, which might simultaneously affect household financial decisions, will be accounted for. The inclusion of year fixed effects absorbs all time-varying aggregate factors, such as business cycles or financial crises. Finally, the city-year joint fixed effects absorb all local economic, regulatory, and policy-related issues.

4.3 Stock holdings

Columns (1) to (3) of Tables 3 and 4 present the estimation results of Equation (1) when we consider two measures for risky asset allocation as the dependent variables: the stock-to-wealth ratio in logarithms (*ln(Stock/Wealth)*) and the total value of stock holdings in logarithms (*ln(Stock Holdings)*).[15] These two variables reflect the riskiness of retirees' asset portfolios, in terms of the relative amount and the absolute amount to total wealth, respectively, following prior literature on household finance.

In Table 3 for the stock-to-wealth ratio, we find that, relative to other retirees, retired civil servants significantly increase their stock weights after the pension reform. In Column (1), we only include our difference-in-differences term, $CivilServant_i \times Post_t$ as well as household and year fixed effects. The estimated coefficient of $CivilServant_i \times Post_t$ is 0.109, suggesting that, relative to other retirees, retired civil servants significantly increase their stock-to-wealth ratio by 10.9%.

In Column (2), we add more control variables including the number of children under 24 years old, outstanding mortgages, and husband age fixed effects to the regression. We find that the estimated coefficient of $CivilServant_i \times Post_t$ slightly decreases to 0.106, which suggests that our difference-in-differences estimation is robust to our control variables accounting for financial burdens and household life cycles. In Column (3), we replace year fixed effects with city-year joint fixed effects to control for all time-varying local factors. The estimated coefficient of $CivilServant_i \times Post_t$ is 0.104, which suggests that our difference-in-differences estimation is not sensitive to local factors. These three columns collectively suggest that, relative to other retirees, retired civil servants significantly increase the weight of stocks by more than 10% after the pension reform.

In addition, we find significantly positive coefficients for mortgages, which can be attributed to two possibilities. First, given the low mortgage rate in Taiwan, households may choose to invest

[15] These two measures reflect the intensive margin of stock market participation (Addoum, 2017; Zhang, 2021). We focus on a sample of households that had held stocks prior to the pension reform in order to leave out the extensive margin, which will be analyzed in our later analyses. In addition, bonds are much less popular among households in Taiwan, as shown in Table 1.

in stocks instead of paying off their mortgages. Second, richer families can afford to purchase more expensive apartments (with mortgages) and invest more in stocks at the same time.

We then present estimation results for Equation (1) using the total value of stock holdings in Table 4. The structure of Table 4 is the same as that of Table 3, and so we do not include any control variables in Column (1), but add all control variables in Column (2), and introduce city-year joint fixed effects in Column (3). All of these results suggest that, relative to other retirees, retired civil servants significantly increase their stock holdings by 7.6%. Such an estimate is equivalent to 125,000 NTD (about 4,000 USD) given that an average treated household holds stocks worth 1.6 million NTD (about 51,600 USD) prior to the reform as shown in the row labeled Conditional Stock Holdings (thousands) in Table 1. Table 3 not only confirms our results in Table 2 based on the stock-to-wealth ratio, but also points to a significant increase in treated households' investment in equity markets.

4.4 Alternative explanations

In this section, we further discuss an extensive list of alternative explanations for our baseline results. The first set of explanations is related to time constraints, financial literacy, and regulatory restrictions: civil servants may have heavy workloads and thus do not have time to analyze and invest in stocks before they retire. In addition, civil servants may be prohibited from or discouraged from investing in stocks due to conflicts of interest.[16] Moreover, they may consider their pension plan as secured permanent income. All of these will result in their lack of stock investment experience and lower financial literacy, leading to underinvestment in stock markets (Guiso, Haliassos, and Jappelli, 2002; Calvet, Campbell, and Sodini, 2007). However, all these issues existed *before* the reform and thus cannot explain the *change* in the retirees' stock holdings right after it. Furthermore, a higher ratio of civil servant households held stocks (69.6%) than private sector ones (66.1%) prior to the reform, as shown in Table 2. Moreover, our sample includes only retirees who retire before the pension reform; thus, if they need to hold more stocks after retirement, they should have done so before the event. With all these discussions, we rule out the aforementioned alternative explanations.

[16] Civil servants were restricted from holding stocks related to businesses supervised by their employment agency. See The Civil Servants Service Act.

Another potential explanation is that retired civil servants, for some reasons, decided to hold more stocks than other retirees when the aggregate equity market went up. As discussed earlier, the TAIEX index was relatively stable from 2013 to 2019 and experienced a significant increase between 2020 and 2021. However, we have observed a significant increase in retired civil servants' stock holdings since 2017, as shown in Figure 1 and other dynamic plots to be shown in the next section, which is way before 2020. This potential explanation is thus not supported.

4.5 Parallel trend assumption and potential pre-trend

The identification of our difference-in-differences approach lies in the parallel trends assumption: in the absence of the pension reform, civil servants and their private sector counterparts would have exhibited similar trends in their asset allocation. Although the assumption is not directly testable, we re-estimate Equation (1) by replacing the variable $Post_t$ with several relative time indicator variables ($I[t-2017=j], j=-4 \cdots 4, j \neq -1$) as follows:

$$AssetAllocation_{it} = \sum_{j=-4, j\neq -1}^{j=4} b_j CivilServant_i \times I\,[t-2017=j] + X_{it}\Gamma + \mu_i + \delta_t \; or \; \sigma_{ct} + \epsilon_{it,} \quad (2)$$

where $I[t-2017=j]$ is a set of relative time indicator variables. $I[0] = 1$ for all household-year observations in 2017, and zero otherwise. Following the same logic, $I[j] = 1$ for all household-year observations in $2017+j$, and zero otherwise. We use 2016 as the base year; thus, $I[-1]$ is not included. Our primary interest lies in the sequence of $\{b_j\}_{j=-4}^{j=4}$, which estimates the differences in outcome between the treated and control groups relative to the base year 2016.

Columns (4) and (5) of Tables 3 and 4 report the estimation results of Equation (2) for the stock-to-wealth ratio and the stock holdings, respectively. These results are visualized in Figure 2, which provides the graphical illustration of $\{b_j\}_{j=-4}^{j=4}$ of Column (4) in each table: Panel (a) is for Table 3 (the stock-to-wealth ratio), and Panel (b) is for Table 4 (stock holdings). As presented in Figure 2, we do not find statistically significant b_j before the treatment period, suggesting that there is no difference between the treated and control groups prior to the reform. These results confirm that there is no evidence of differential pre-trends and thus offers supportive evidence that the passive capital gains across groups are differenced out under our design. Moreover, our baseline results cannot be attributed to any confounding factors that explain the fundamental

differences between two groups of retirees because, if such factors exist, then we should have observed significant differences in the pre-reform period.

On the other hand, Figure 2 reveals a swift and substantial change in asset allocation following the pension reform. As soon as the reform was determined (2017, $j = 0$), but prior to the actual cut in the pension (2018, $j = 1$), the affected households raised their stock-to-wealth ratio and stock holdings. More importantly, retired civil servants kept raising their stock holdings because their income replacement ratio is decreasing by 1.5% annually. Four years after the reform (2021, $j = 4$), retired civil servants increased their stock-to-wealth ratio by 16.7% and stock holdings by 17.4%, suggesting that an average treated household increased stocks by 287,000 NTD (about 9,250 USD) after the reform. The magnitude of these increases is much higher than the difference-in-differences estimates in Columns (1) to (3) in Tables 3 and 4.

4.6 Robustness Checks

We conduct three robustness checks in this section to validate our difference-in-differences designs and results. First, we implement the pre-trend test proposed by Roth (2022), demonstrating that our findings are robust to potential violations of the parallel trend assumption. Second, we construct a matched control group that is similar to retired civil servants based on observable characteristics to show that our results remain consistent when using a more homogeneous control group. Third, we perform an event-study analysis on the preferential deposits of civil servants to demonstrate that our results are not driven by substitution from preferential deposits into stock holdings.

We acknowledge the potential power issue of our pre-trend test, and therefore conduct a robustness test proposed by Roth (2022). The results of the test are presented in Figure 3, where Panel (a) is for the stock-to-wealth ratio and Panel (b) is for stock holdings. First, we hypothesize a linear violation of the parallel trend. To achieve 80% (50%) statistical power to detect this, the linear pre-trend would need to have a small positive slope of 0.015 (0.01) for both of our main dependent variables (*ln(Stock/Wealth)* and *ln(Stock Holdings)*). If such a pre-trend were present, it would introduce a bias of 0.075 (0.05) four years after the pension reform (illustrated by the red line). However, these potential biases are significantly smaller than our actual estimates for *Civil Servant* × $I[t - 2017 = j]$, as shown in Figure 3.

In line with the expected trend, the test also provides the expected values of the coefficients conditional on passing the pre-test under the hypothesized trend (as depicted by the blue dashed line). The graphical analysis suggests that the hypothesis of an undetected pre-trend due to low power is unlikely, as the estimated coefficients from our model exhibit a different pattern compared to those estimated conditionally on the existence of the hypothesized pre-trend.

We acknowledge that the different characteristics between retired civil servants and other retirees in our full sample, and are aware of the potential issue that such differences may be driving our difference-in-differences results. In other words, other retirees may not be the best counterfactual for retired civil servants in the absence of the pension reform. To address this concern, we construct a matched sample by matching each retired civil servant family with their three nearest private sector counterparts using the Mahalanobis distance. This matching is based on the following observable characteristics in 2016, the year right before the pension reform: *Husband Age, Wife Age, Male Breadwinner, Child Dependency, ln(1+Deposits), ln(1+Stock Holdings), ln(1+Total Wealth), Deposits/Wealth, Stock/Wealth,* α , β , and $\sum \epsilon^2$. The three matched nearest neighbors of each retired civil servant family are then included as the matched control group in the matched sample.

Table 5 provides the summary statistics of the matched sample. Column (1) shows the sample mean of the treated group, Column (2) shows the sample mean of the matched control group, and Column (3) presents the results of a two-sample t-test of the null hypothesis that the two groups are the same in each characteristic. We find almost no statistical difference in asset allocations between the treatment group and the matched control group. Specifically, the two groups are reasonably homogenous in the total wealth (14,994 vs. 14,918), the incidence of stock holding (0.68 vs. 0.69), the stock-to-wealth ratio (0.08 vs. 0.08), the deposits-to-wealth ratio (0.20 vs. 0.20), proportion of gains realized (0.17 vs. 0.17), proportion of losses realized (0.10 vs. 0.10), portfolio characteristics (α, β, and *Excess Return*). We also find that, although the two groups appear significantly different in other demographic characteristics, those differences in mean are relatively small in economic magnitude.

We then estimate Equation (2) using the matched sample and present the results in Table 6 and Figure 4. We find no violation of the pre-trend test in figure, and the estimates are similar to the results from our full sample, indicating that civil servants increased their stock-to-wealth ratios

and stock holdings by 18.1%-18.2% and 17.6%-17.7%, respectively, four years after the reform. The fact that we find similar estimates using either the matched sample or the full sample suggests that the parallel trend assumption generally holds regardless of the initial differences in asset allocation.

Another potential concern is that civil servants switched from the preferential deposits with an 18% annual interest rate (which was gradually terminated after the reform) to stock holdings. With the removal of the risk-free yet high return from the preferential deposits, civil servants may have opted to switch their preferential deposits to stocks that carry higher expected returns. However, it is important to note that the preferential interest offer was still available at 9% until 2020, which is more favorable than expected annual dividend-adjusted stock returns in Taiwan. In spite of this, we observed persistent increases in stock holdings and the stock-to-wealth ratio in 2017-2020 (Figures 2 and 4). This pattern suggests that the observed portfolio reallocation is unlikely to be driven solely by a mechanical substitution away from preferential deposits.

To further address the concern about preferential deposits, we conduct an event-study analysis examining the evolution of preferential deposits vary across time and contrast their dynamics with the observed increase in stock holdings. Specifically, we estimate the level of preferential deposits using the preferred interest rate and interest income.[17] We then estimate the following Equation (3) using the subsample of civil servants:

$$PreferentialDeposits_{it} = \sum_{t=2013, t\neq 2016}^{t=2020} b_t \times I\,[t] + X_{it}\Gamma + \mu_i + \epsilon_{it,} \qquad (3)$$

where $PreferentialDeposits_{it}$ denotes estimated preferential deposits; $I[t]$ is a set of indicator variables for calendar year t; X_{it} is a set of control variables that include *Child Dependency*, *ln(1+mortgage)*, and fixed effects for the husband's age; μ_i are household fixed effects; and ϵ_{it} is the estimation error. Standard errors are clustered at the household level.

Table 7 reports the event-study estimates of preferential deposits based on Equation (3) and contrasts them with the implied increase in stock holdings. Column (1) reports the estimated

[17] The preferential interest rate was 18% prior to July 2018, was reduced to 9% between July 2018 and December 2020, and was discontinued starting in January 2021. Accordingly, we extrapolate preferential deposits using an annual rate of 18% before 2018, 13.5% for 2018, and 9% for the 2019–2020 period.

decrease in preferential deposits, and Column (2) reports the implied increase in stock holdings based on the estimates in Column 4 of Table 4. Importantly, the magnitude of the increase in stock holdings is substantially larger than the decline in preferential deposits. In 2018, the increase in stock holdings and the decrease in preferential deposits are 127,374 and 22,160, respectively. Therefore, we reassure that our results are not mechanical.

5. Why Would Retired Civil Servants Hold More Stocks?

5.1 Underlying mechanisms: rational models vs. prospect theory

We now discuss the mechanism underlying our empirical findings. As argued above, the annuity-based and defined-benefit nature of the pension system implies that pension benefits can be interpreted as a component of human capital or permanent income. Accordingly, our objective is to understand how a reduction in permanent income affects an investor's optimal allocation to risky assets.

The baseline framework for this question is the model of Merton (1971). Under complete markets, riskless labor income Y_t, and CRRA utility, the optimal share of wealth invested in the risky asset is given by

$$w = \left[1 + \frac{PV(Y)}{W}\right]\frac{\mu - r}{\gamma\sigma^2}, \tag{4}$$

where w denotes the optimal risky share; $PV(Y) = \sum_{n=0}^{\infty} Y_{t+n}(1+r)^{-n}$ is the present value of future labor income; W denotes the financial wealth; μ is the expected return on the risky asset; r is the risk-free rate; γ is the coefficient relative risk aversion; and σ is the volatility of the risky asset returns.

An important extension of the framework incorporates persistent habits, consumption commitments, or subsistence consumption (Brunnermeier and Nagel, 2008; Calvet and Sodini, 2014). In Calvet and Sodini (2014), the authors show that the optimal risky share admits the closed-formed expression when taking habits into account:

$$w = \left[1 + \frac{PV(Y) - \lambda X}{W}\right]\frac{\mu - r}{\gamma\sigma^2}, \tag{5}$$

where X denotes the persistent habit, consumption commitment, or subsistence level; $\lambda > 0$ is a constant such that λX captures the present value of sustaining the habit over the agent's lifetime.

Under both models, the effect of a change in permanent income on the risky share is

$$\frac{\partial \mathrm{w}}{\partial \mathrm{PV(Y)}} = \frac{1}{W}\frac{\mu - r}{\gamma\sigma^2} > 0. \tag{6}$$

Thus, these models predict that a reduction in pension income should lead civil servants to *decrease* their stock-to-wealth ratios following the pension reform—an implication that directly contradicts our empirical findings.

Our findings are consistent with the predictions of prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), which posits that individuals evaluate outcomes relative to a reference point and display asymmetric risk preferences around it—being risk-averse in the domain of gains and risk-seeking in the domain of losses. In our setting, the consumption level supported by the pre-reform annuity likely shaped civil servants' *consumption habits* over time and therefore served as a natural reference point. Because the pension system had provided stable and predictable annuity payments, many retirees plausibly formed expectations that this level of consumption would persist throughout retirement (Kőszegi and Rabin, 2006, 2007, 2009). The abrupt and retroactive pension reform therefore represents a negative shock relative to this habitual consumption benchmark.

This interpretation implies a change in the perceived payoff structure of portfolio choices. Maintaining savings in safe assets effectively locks in the lower post-reform consumption level, amounting to a certain loss relative to the established consumption standard. In contrast, reallocating wealth toward risky assets offers a possibility of partially offsetting the annuity shortfall. From the perspective of prospect theory, such a choice resembles a classic loss-domain gamble: accepting a sure loss versus taking risk for a chance to recover the reference level. A growing empirical literature documents that reference points are shaped by past consumption and expectations and that individuals often respond to perceived losses by increasing risk-taking (Simonsohn and Loewenstein, 2006; Bordalo, Gennaioli, and Shleifer, 2018; DellaVigna et al., 2017; Lian, Ma, and Wang, 2019). Consistent with this mechanism, we find that civil servants increase their exposure to equities following the pension reform.

It is noteworthy that the risk-seeking in the loss domain has been robustly demonstrated in experiments (Abdellaoui et al., 2008; Harbaugh et al., 2010; Barberis, 2013; Lian, Ma, and Wang, 2019), there is limited evidence in real-world scenarios. Experimental studies often involve smaller stakes than those found in real-life situations, the samples of experimental setting are often not representative, and inducing real wealth loss in an experimental setting is inherently difficult (Levitt and List, 2007; Harrison and Rutström, 2008; Wakker, 2010). Page, Savage, and Torgler (2014) could be the first to offer real-world evidence, but their study involved much smaller stakes (choosing between $10 AUD and a lottery scratch card worth $10 AUD) and a much smaller sample size (220 surveyed individuals) compared to the present study. Gomes et al. (2025) document related behavior in a field setting; however, their analysis is primarily descriptive and does not establish causal relationships.

Our study compliments this literature by providing novel quasi-experimental evidence on how households adjust risk exposure in response to substantial and permanent income losses—providing a rare real-world validation of prospect theory's predictions at scale.

5.2 Testing prospect theory

To further evaluate the prospect-theory explanation for our findings, we examine whether the response to the pension reform varies with households' financial pressure. Households facing tighter financial constraints are more likely to perceive the annuity cut as a substantial loss relative to their habitual consumption level and therefore may have stronger incentives to take financial risks. We conduct two heterogeneity tests based on proxies for households' financial pressure. First, we split the sample by the number of dependent children, which captures variation in household consumption needs. Second, we split the sample by household's ownership of residential property. Households with more dependent children and those without residential property are likely to face higher future spending—such as childcare and rent—and therefore tighter financial constraints. If the mechanism operates through reference-dependent preferences, the increase in equity exposure following the pension reform should be more pronounced among these households.

We first examine heterogeneity by the number of dependent children. Table 8 reports the estimates of Equation (1) after dividing the sample into three subgroups: households without children of dependency age, those with one dependent child, and those with two or more dependent

children. Columns (1)–(3) use *ln(Stock/Wealth)* as the dependent variable, while Columns (4)–(6) use *ln(Stock Holdings)*. Columns (1) and (4) correspond to households without dependent children, Columns (2) and (5) correspond to households with one dependent child, and Columns (3) and (6) correspond to households with two or more dependent children. The estimated coefficients on $CivilServant_i \times Post_t$ increase monotonically with the number of dependent children. For example, the coefficient rises from 0.090 to 0.193 in the specification using the stock-to-wealth ratio and from 0.073 to 0.125 in the specification using stock holdings when comparing households without dependent children to those with two or more. In economic terms, the estimated effect of the pension reform is roughly twice as large among households with multiple dependent children.

Table 9 presents a complementary heterogeneity analysis based on ownership of residential property. We divide the sample into households that own real estate and those that do not. Columns (1) and (3) report the estimates using *ln(Stock/Wealth)* and *ln(Stock Holdings)*, respectively, for households without residential property, while Columns (2) and (4) report the corresponding estimates for homeowners. The estimated coefficients on $CivilServant_i \times Post_t$ are consistently larger among households without residential property. For example, the coefficient on the stock-to-wealth ratio is 0.190 for non-homeowners compared with 0.100 for homeowners, and the corresponding estimates for stock holdings are 0.102 and 0.076, respectively. These patterns indicate that households without residential property—who are more likely to face additional rent expenditures—respond more strongly to the pension reform by reallocating their portfolios toward equities.

Taken together, the two subgroup analyses provide consistent evidence that the response to the pension reform is stronger among households facing greater financial pressure. These findings support the interpretation that the annuity cuts are perceived as a loss relative to households' habitual consumption levels, which in turn induces greater risk-taking in financial markets, consistent with the predictions of prospect theory.

5.3 The choices of stock characteristics

We next examine whether retired civil servants not only increased their overall exposure to the equity market but also altered specific features of the stocks they hold. We then estimate the following equation to analyze households' stock choices:

$$StockChoices_{it} = bCivilServant_i \times Post_t + X_{it}\Gamma + \mu_i + \delta_t \; or \; \sigma_{ct} + \epsilon_{it}, \qquad (7)$$

where $StockChoices_{it}$ denotes the cross-stock sum of a household i's stock holding weights in stock j in year t, multiplied by stock j's characteristics in year t-1. Thus, it reflects each household's stock choices in year t that is based on each stock's *past information*. All other variables are defined as in Equation (1).

We consider two sets of stock characteristics. The first set includes past excess returns and past market-adjusted excess returns, which capture recent stock performance. The second set includes model-based measures of stock quality and risk, namely CAPM alpha, market beta, and idiosyncratic risk.

We begin by examining whether treated households tilt toward stocks with stronger recent returns. For each stock, we compute annual excess returns by geometrically compounding monthly returns and subtracting the geometric mean of monthly risk-free rates. We then construct market-adjusted excess returns by further subtracting the annual market risk premium. Using these stock-level measures in year t-1, we aggregate them to the household-level in year t using households' portfolio weights in year t.

Table 10 reports the corresponding estimates of Equation (7). Panel A uses excess return as the dependent variable, while Panel B uses market-adjusted excess return. Across specifications, the coefficient on $CivilServant_i \times Post_t$ is positive and statistically significant when using raw excess returns. The coefficient remains positive, though economically smaller and statistically weaker, when past market-adjusted excess return is used. These results suggest that following the pension reform, treated households tilt toward stocks that had performed well in the recent past. In other words, retired civil servants appear to chase salient past winners.

We next examine whether this within-equity reallocation reflects rational selection of stocks. To do so, we estimate the alpha, beta, and idiosyncratic risk for each stock each year by applying rolling regressions over the past 36 months of monthly return data. Specifically, for each month, we estimate the following equations using a 36-month window ending in that month:

$$r_{s,t} - r_{f,t} = \alpha + \beta\left(r_{m,t} - r_{f,t}\right) + \epsilon_t, \tag{8}$$

where $r_{s,t}$ is the monthly return of stock s in month t; $r_{f,t}$ is the risk-free rate; $r_{m,t}$ is the monthly return of the market portfolio (approximated by the TAIEX index); and ϵ_t represents the

estimation error[18]. We repeat this rolling window estimation in each month and then take the average of the monthly estimates within each calendar year to obtain stock-year-level estimates of alphas, betas, and idiosyncratic risk. We then aggregate these stock-level measures to the household-year level using year-*t* trading weights and year-*t-1* stock characteristics.

We estimate Equation (7) with these model-based, portfolio-level risk measures as dependent variables, and report the results in Table 11. We include all the control variables throughout Column (1) to Column (6). Column (1) to Column (3) report the conventional two-way fixed effects estimates, whereas Column (4) to Column (6) replace year fixed effects with city-year joint fixed effects to account for all time-varying local factors.

For α and β, the coefficients of $CivilServant_i \times Post_t$ are close to zero and statistically insignificant throughout different specifications. These results indicate that treated retirees do not systematically shift toward stocks with higher historical abnormal returns or greater systematic market risk, consistent with the findings in Gomes et al. (2025).

For $\sum \epsilon^2$, the estimated coefficients of $CivilServant_i \times Post_t$ in Columns (3) and (6) are 228.23 and 249.27, respectively, which are both statistically significant at the 10% level. An increase in idiosyncratic risk can arise from two distinct mechanisms. First, if idiosyncratic volatility is associated with higher expected returns (Merton, 1987; Fu, 2009), households may deliberately select stocks with greater firm-specific risk in an attempt to compensate for income losses caused by the pension reform. Alternatively, higher idiosyncratic volatility may reflect deviations from mean–variance efficient portfolios. Under financial pressure, households may shift toward more attention-grabbing or salient stocks rather than systematically optimizing risk-return tradeoffs. [19]

Taken together, these results suggest that although retired civil servants increased their overall exposure to equities following the pension reform, they did not systematically reallocate toward stocks with higher alpha, greater systematic risk, or persistently superior risk-adjusted performance. Instead, the increase in portfolio risk appears to arise mainly from greater exposure to idiosyncratic volatility and a tilt toward stocks with strong recent performance. Once market-wide returns are

[18] To ensure sufficient data for precise estimation, we restrict our stock sample to those with at least 36 months of return history. In other words, newly listed (IPO) stock with less than three years of data are excluded from the analysis.
[19] Barber, Lee, Liu, and Odean (2009) show that stock investors in Taiwan suffer from frequent trading.

accounted for, the apparent return advantage disappears. This pattern indicates that households are unlikely to be engaging in mean–variance optimization within equities. Rather, they appear to shift toward stocks with salient recent performance signals, though even by doing so does not improve expected or risk-adjusted returns.

5.4 More behavioral biases?

A natural question is whether the pension reform not only affected portfolio allocation but also amplified behavioral trading biases among retail investors. We examine whether the annuity cuts strengthened the disposition effect, the well-documented tendency of investors to sell winning stocks too early while holding on to losing stocks for too long (Shefrin and Statman, 1985; Odean, 1998; Barber et al., 2007).[20]

To measure this behavior, we track households' year-over-year changes in stock holdings and the corresponding stock prices. This procedure allows us to identify realized gains, realized losses, paper gains, and paper losses.[21] Following Odean (1998), we construct two commonly used measures of the disposition effect: *the Proportion of Gains Realized* (PGR) and the *Proportion of Losses Realized* (PLR).[22] The PGR is defined as the ratio of realized gains to the sum of realized and paper gains, while the PLR is defined as the ratio of realized losses to the sum of realized and paper losses.

We first examine realized gains and losses directly. Table 12 reports the estimation results of Equation (1), where Panel A uses the natural logarithm of one plus *Realized Gains*, and Panel B uses the natural logarithm of one plus *Realized Losses* as the dependent variable. Column (1) reports the standard two-way fixed effects estimates without additional controls. Column (2) further includes *Child Dependency* and residential mortgage as covariates, and Column (3) replaces year fixed effects with city-year fixed effects to account for the time-varying local factors.

[20] Jin and Peng (2024) build a model in which an incorrect belief that small samples represent the properties of the underlying population can lead to the disposition effect.

[21] We acknowledge that, due to data limitations, we cannot observe transactions that occur between two yearly tax filings. Therefore, the indexes constructed here should be interpreted as reflecting transactions associated with long-term stock holdings.

[22] Odean (1998) defines the two ratios based on the number of stocks sold versus those held. In contrast, we construct the ratios using the value of stocks realized and the value of paper gains or losses, as investors may not fully liquidate a stock in a single transaction or a single year, and each share carries a different weight in the portfolio.

After controlling for the number of children under age 24, the estimated coefficients on the interaction term $CivilServant_i \times Post_t$ are approximately 0.256 for *ln(1+Realized Gains)* and 0.120 for *ln(1+Realized Losses)*, and are not sensitive to the inclusion of local economic controls. Prior to the pension reform, the average annual realized gains and losses for retired civil servants were NT$47,250 and NT$24,350, respectively. A back-of-envelope calculation suggests that the gap between realized gains and realized losses widened by approximately 40% following the pension cut.[23] To formally test whether the effects differ across gains and losses, we conduct a Wald test after separately estimating Column (3) for both outcomes. The test confirms that the differential effect of pension reform on realized gains versus losses is statistically significant at the 1% level.

Table 13 further evaluates the disposition effect using the PGR and PLR measures. Panel A reports results using PGR as the dependent variable, while Panel B uses PLR. The table structure mirrors that of Table 13. The estimated coefficients on $CivilServant_i \times Post_t$ are approximately 0.011–0.012 for PGR and 0.004–0.005 for PLR, corresponding to increases of roughly 5.8% and 2.9%, respectively. A Wald test again rejects the null that the two effects are equal at the 1% significance level.

Taken together, these results provide strong evidence that the disposition effect becomes more pronounced following the pension reform. When retired civil servants face tighter financial constraints due to annuity cuts, they exhibit a stronger tendency to realize gains while holding on to losing positions. In particular, retaining losing stocks is often interpreted as a form of risk-taking behavior, as investors continue to bear downside risk in the hope that prices will rebound and losses can be recovered. This pattern is consistent with our argument that the retired civil servants became risk-seeking after the pension cuts.

Finally, it is important to note that capital gains on stock investments are not taxed in Taiwan, although dividends and stock interest are subject to income taxation. Under this tax structure, a rational investor would generally prefer realizing capital gains rather than receiving dividends and would have little incentive to defer the realization of gains. Therefore, the disposition effect documented here cannot be attributed to tax-related motives such as short-term capital gains

[23] [47,250×(1+0.256) - 24,350×(1+0.120)]/(47,250-24,350) = 1.4006

taxation, tax-loss harvesting, or tax-swap strategies. Instead, the evidence points to behavioral explanations rooted in reference-dependent preferences.

6. Additional Asset Allocation Evidence

6.1 Stock market participation

In addition to the intensive margin of stock market participation, we also consider the extensive margin of stock market participation. We construct an indicator variable *I_stock* that equals one if a sample household holds any stocks in a specific year and zero otherwise. As shown in Table 1, 69.6% of treated households hold stocks, and 66.1% of control households hold them. This suggests that there was little difference in terms of holding risky assets between civil servant families and their counterparts before the pension reform.[24] We then estimate Equation (1) using *I_stock* as the dependent variable and using all households (regardless of whether they held any stocks before the pension reform or not) in our sample. Our estimation is based on a linear probability model because Probit and Logit model estimates are inconsistent due to the incidental parameter problem under a short panel with a large cross-section (Neyman and Scott, 1948; Wooldridge, 2010; Arellano and Hahn, 2006, page 1).

Table 14 presents the estimation results. Similar to previous tables, we do not include any control variables in Column (1), add all control variables in Column (2), and introduce city-year joint fixed effects in Column (3). The coefficient estimates of $CivilServant_i \times Post_t$ are 0.0042, 0.0047, and 0.0043 in Columns (1) to (3), respectively. All these estimates suggest that in response to the pension reform, the treated households' probability of participating in stock markets increases by approximately 0.4 percentage points. We acknowledge that this magnitude is small, especially in contrast to the large economic impact observed along the intensive margin in Section 4. Nevertheless, this result aligns with the "participation puzzle" (Haliassos and Bertaut, 1995), which describes the phenomenon that individuals do not enter the financial market despite economic theory predicting that they should hold risky assets regardless of their wealth or risk-aversion attitudes (Merton, 1969).

6.2 Deposits, housing, and total wealth

[24] We also find that the value of real estate held by treated households is similar to that of control households before the reform; nevertheless, the ratio of owning any real estate is higher among the treated group (94.2% vs. 89.2%).

In addition to the earlier analyses of risky assets, we examine how households adjust other components of their balance sheets following the pension reform. In particular, we study changes in bank deposits, housing holdings, and total household wealth.

We first investigate households' holdings of bank deposits, which are commonly used as precautionary savings. We estimate Equation (1) using the logarithm of the deposits-to-wealth ratio as the dependent variable and report the results in Table 15. Focusing on the deposits-to-wealth ratio allows us to examine how households reallocate their portfolios across asset classes, especially given that bank deposits remain one of the most prevalent forms of precautionary savings in Taiwan.

Across all specifications, the estimated coefficients on $CivilServant_i \times Post_t$ are approximately –0.22 and highly statistically significant. These estimates indicate that, relative to the control group, the deposits-to-wealth ratio of civil servant households declines by roughly 22% following the pension reform. This result is consistent with our earlier findings that households increase their exposure to equities: the reduction in deposits suggests that treated households partially finance their higher stock holdings by reallocating away from safe and liquid savings.

Turning to housing decisions, we estimate Equation (1) using measures of real estate holdings as the dependent variables. Table 16 reports the results. Panel A uses the logarithm of one plus the value of real estate holdings, while Panel B examines the probability of owning real estate. Across specifications, the coefficients on $CivilServant_i \times Post_t$ are small and statistically insignificant. These findings suggest that the pension reform does not have a measurable impact on households' housing investment decisions.

The absence of a housing response is economically intuitive. Housing transactions typically involve substantial adjustment costs, including transaction taxes, brokerage fees, and moving costs. As a result, households are less likely to adjust their housing positions in response to income shocks, especially when compared with financial assets such as stocks or deposits that can be rebalanced more easily. Consequently, the pension reform appears to affect households' liquid financial portfolios but not their housing holdings.

Finally, we examine the effect of the pension reform on total household wealth. Table 17 reports the estimates from Equation (1) using the logarithm of one plus total wealth as the dependent variable. Across specifications, the coefficient on $CivilServant_i \times Post_t$ is negative

and statistically significant. In the most comprehensive specification that includes city-year fixed effects, the estimates imply that total wealth of civil servant households declines by approximately 4% following the reform. Based on the average level of wealth in the sample, this corresponds to a reduction of roughly NT$550,000 relative to the control group.

We also find that child dependency and mortgage obligations are associated with lower total household wealth. Specifically, an additional child below age 24 reduces total wealth by roughly 2%, while a 1% increase in mortgage balances is associated with a 2.1% decline in household wealth. These patterns are consistent with the idea that household expenditures and debt obligations place downward pressure on wealth accumulation.

Taken together, these results indicate that the pension reform has meaningful effects on household balance sheets. Civil servant households respond to the annuity cuts by reducing deposits and reallocating their financial portfolios toward equities, while housing holdings remain largely unchanged due to the high adjustment costs associated with real estate transactions. At the same time, the reform leads to a measurable decline in total household wealth, confirming the substantial financial impact of the pension cuts.

7. Conclusion

In this paper, we provide novel, population-level evidence for how retirees' asset allocation responds to an unexpected deep cut to annuity. We analyze the impact of the 2017 civil servant pension reform in Taiwan, which retroactively cut the retirement annuities of civil servants from the 75%-95% range to the 30%-62.5% range. Using administrative tax record data covering all Taiwanese households and by designing a difference-in-differences approach, we find substantial increases in the intensity of stock market participation. Specifically, treated households increased their stock-to-wealth ratios by more than 10% and their stock holdings by more than 7%. Despite this shift toward equities, they did not increase their exposure to systematic market risk. Rather, they tilted their portfolios toward stocks with strong recent performance signals—higher past excess returns—without achieving superior expected or abnormal returns.

This pattern of asset reallocation is more pronounced among households with more dependent children and those without real estate holdings, who are likely to face greater financial pressure. The pension reform also amplifies the disposition effect among treated households—a common behavioral bias associated with risk-taking. In addition, treated households experience

significant declines in deposits and overall wealth, while their housing decisions remain largely unchanged.

The increased shareholdings among retired civil servants suffering from annuity cuts cannot be readily explained by the standard expected utility framework (Merton, 1971; Brunnermeier and Nagel, 2008; Calvet and Sodini, 2014). Instead, these behavioral responses are more consistent with prospect theory of Kahneman and Tversky (1979) and Tversky and Kahneman, (1992). Our evidence based on comprehensive population data complements prior studies based on experiments and surveys that may suffer from limited real impact, smaller sample size, and selection issues.

Moreover, our empirical investigation offers several important policy implications for shareholder protection, stock market regulation, and social welfare, which echoes the call of Gomes, Haliassos, and Ramadorai (2021) with regard to applying empirical results to the design of regulations. First of all, the increased stock investment of retired civil servants may enhance stock market liquidity and depth; however, these retail investors are subject to greater financial constraints and may thus trade more irrationally or too frequently. Second, given the aging of the population, the increase in the labor supply of civil servant retirees may be re-directed to other sectors of the economy to enhance social welfare. Third, while annuity cuts enhance the sustainability of pension systems and ease governments' financial burdens,[25] they also discourage talented young people from becoming civil servants, which may negatively impact the creativity and efficiency of governments in the long run. Finally, the annuity cuts have also introduced uncertainty into people's perceptions of government-backed pension plans, potentially reducing their incentive to continue to contribute to these plans. Such reduced incentives may lead to a decrease in short-term cash inflows into these plans and eventually hurt their sustainability.

[25] Moreover, prior studies also raise concerns on pension fund management and governance, which exacerbate the pension deficits in the U.S. (Andonov, Bauer, and Cremers, 2017; Andonov, Hochberg, and Rauh, 2018).

Appendix

A.1 The civil servants' pension system before the reform

The salary calculation within Taiwan's civil service operates within a points-based framework, where distinct ranks and levels are allocated specific salary points. These points form the foundation for determining a civil servant's monthly income. Generally speaking, a civil servant's monthly income is composed of four primary components:

i. Base Salary: This constitutes the core salary determined by the accumulated years of service and the associated salary points.

ii. Professional Allowance: Offered to civil servants with specialized skills, qualifications, or expertise relevant to their roles. It serves as an additional compensation for their professional proficiency.

iii. Position Allowance: Reflects the responsibilities and hierarchical position within the civil service. Higher-ranking positions or roles with greater responsibilities may receive this additional allowance.

iv. Remote Area Allowance: Provided to those serving in remote or special areas and overseas.

The fusion of these four components, namely, base salary, professional allowance, position allowance, and remote area allowance, constitutes the comprehensive monthly income of a civil servant in Taiwan. Typically, the base salary constitutes approximately half of the total monthly salary, serving as the foundational component of the compensation framework.

Prior to the 2017 reform, the pension system for civil servants in Taiwan was known for its generous benefits and early retirement ages. Operating as a defined benefit system, the calculation of a civil servant's pension involves a two-step process. First, the monthly pension and income replacement ratio are determined based on the duration of service. Secondly, civil servants are provided the opportunity to save in a preferential deposit account with an 18% annual interest rate. There are two distinct formulas used to determine the income replacement ratio:

$$\frac{\text{Monthly Pension} + \text{Preferential Interest}}{\text{Base Salary} \times 2} = 75\% + 2 \times (\text{Tenure} - 25)\%, \qquad (A)$$

where individuals with tenure of less than 25 years are assigned 25 years, and tenure is capped at 35 years.

$$\frac{\text{Monthly Pension} + \text{Preferential Interest}}{\text{Base Salary} + \text{Professional Allowance} + \text{Position Allowance} + \text{Year-end Bonus}/12} = 75\% + (\text{Tenure} - 15)\%, \qquad (B)$$

where individuals with tenure of less than 15 years are assigned 15 years, and tenure is capped at 30 years. The base salary is determined based on the individual's final salary prior to retirement.

Based on these formulas, the civil servant's pension is determined by the plan offering the lower preferential interest. Typically, Formula A is designed for higher-ranked officers, while Formula B caters to elementary civil servants. Irrespective of the two formulas employed, it is

evident that civil servants are guaranteed a minimum of approximately 75% of their monthly income while actively working, with the potential to reach up to 95% (as shown in the top row of Table 1).

A.2 Pension reform in relation to civil servants in 2017

The "Civil Servants Retirement, Severance, and Dismissal Compensation Act" was passed by the Legislative Yuan (which is analogous to the two chambers in the U.S.) on June 27, 2017, following its third reading. This pivotal 2017 pension reform has served as a substantial policy initiative, aiming to improve financial sustainability within the pension systems for military personnel and civil servants. Key components of the reform include the following:

- Increasing the Normal Retirement Age: The reform raised the normal retirement age for civil servants, ensuring that they retire later than before.
- Adjustment of the Pension Calculation: From July 2018, the calculation of the pension was modified to reduce the generous benefits that were previously granted.
- Elimination of the 18% Preferential Interest Rate: Civil servants were previously offered an 18% preferential interest rate. This was eliminated as it contributed to the financial imbalance in the system.[26]
- Restriction on Reappointment: Retired civil servants are limited when it comes to seeking reappointment in government positions, government-donated foundations, and government-invested companies. If their monthly salary in these subsequent roles surpasses the legally-defined basic wage, their pension will be suspended.
- Funding Mechanism: A new pension funding mechanism was introduced, transitioning from a purely pay-as-you-go system to a partially funded system.

From July 2018 onward, the pension calculation process became more straightforward. With the abolition of the 18% preferential interest rate, the formula for the income replacement ratio was modified as follows:

$$\frac{\text{Monthly Pension}}{\text{Average Base Salary} \times 2} = \begin{cases} 45\% + (\text{Tenure} - 15) \times 1.5\% - \min(Year - 2019, 10) \times 1.5\% \; if \; \text{Tenure} \leq 35 \\ 75\% + (\text{Tenure} - 35) \times 0.5\% - \min(Year - 2019, 10) \times 1.5\% \; if \; \text{Tenure} \geq 35 \end{cases} \quad (C)$$

In the updated formula, individuals with tenure of less than 15 years are assigned 15 years, and tenure is capped at 40 years. The "average base salary," initially calculated as the average base salary of the last five years at work starting from June 2018, is being gradually extended to the average base salary of the last 15 years of work by 2029.

Moreover, a significant reduction in the income replacement ratio occurred in June 2018, with the decrease in the rate fixed at 1.5% annually from 2020 to 2029. In 2029, the income

[26] The special interest rate was 18% until July 2018, was reduced to 9% between July 2018 and December 2020, and was discontinued from January 2021 onwards.

replacement ratio will be reduced to a range between 30% and 62.5% (as presented in the bottom row of Table A1). However, there is an exception: to guarantee a certain standard of living, in that individuals whose monthly pension falls below 33,140 NTD after the reform will receive a minimum of 33,140 NTD.

Table A2: Variable Definitions

Variable	Definition
Husband Age	The age of the husband in the household.
Wife Age	The age of the wife in the household.
Male Breadwinner	Takes a value of 1 if the primary breadwinner of the household was the husband and 0 otherwise.
Child Dependency	The number of children below 24 years old in the household.
Deposits	The amount of bank deposits of the household, which is extrapolated by taxable interest income, using the market saving interest rate in general. We extrapolated the preferential deposits of civil servants using the preferential interest rate offered.
Bond	The amount of bond holdings, which is extrapolated by taxable interest income.
Stock Holdings	The amount of stock holdings of the household. Publicly-traded stocks are valued at the market closing price on their ex-rights date (31 July if the ex-rights date is not available); also, non-publicly-traded stocks are priced at the net asset value per share (if available) or face value.
I_stock	Takes a value of 1 if the household holds any stocks and 0 otherwise.
Present Value of Cars	The present value of cars approximated by the documented engine size and brand.
Assessed Value of Real Estate	The value of housing and land values based on government assessments minus the estimated outstanding mortgages.
Owning Real Estate	Takes a value of 1 if the household holds any real estate and 0 otherwise.
Mortgage	The outstanding mortgages of the household. We distribute the aggregate mortgage amount proportionally to each household based on their share of the household mortgage interest within the aggregate mortgage interest.
Total Wealth	The total wealth of the household, calculated as the sum of Deposits, Bond, Stock Holdings, Present Value of Cars, and Assessed Value of Real Estate.
Deposits/Wealth	The deposits-to-wealth ratio, calculated as Deposits divided by Total Wealth.
Stock/Wealth	The stock-to-wealth ratio, calculated as Stock Holdings divided by Total Wealth.
Civil Servant	Takes a value of one if s/he has received an annual working income exceeding 360,000 NTD from public institutions for over 7 years and zero otherwise.
Post	A time indicator which takes the value of 1 for the period since 2017 and 0 otherwise.
Realized Gains	The monetary value of gains realized, identified through year-over-year changes in stock holdings and corresponding stock prices.
Realized Losses	The monetary of losses realized, identified through year-over-year changes in stock holdings and corresponding stock prices.
Paper Gains	The unrealized gains calculated based on year-over-year changes in stock holdings and corresponding stock prices.

Paper Losses	The unrealized losses calculated based on year-over-year changes in stock holdings and corresponding stock prices.
Proportion of Gains Realized	The ratio of realized gains to the sum of realized gains and paper gains.
Proportion of Losses Realized	The ratio of realized losses to the sum of realized losses and paper losses.
I[t-2017=j]	The relative time indicator, which takes a value of 1 if the observation year is 2017+j and 0 otherwise.
$\boldsymbol{\alpha}$	The weighted average of the household stock portfolio's α (intercept term) estimated under CAPM, based on the past 36 months of returns in the previous year.
$\boldsymbol{\beta}$	The weighted average of the household stock portfolio's β under CAPM, based on the past 36 months of returns in the previous year.
$\sum \boldsymbol{\epsilon^2}$	The weighted average of the household stock portfolio's $\sum \boldsymbol{\epsilon^2}$ under CAPM, based on the past 36 months of returns in the previous year.
Excess Return	The weighted average of portfolio excess return, based on the annualized return in the previous year.
Market Adjusted Excess Return	The weighted average of portfolio excess return minus annual market risk premium, based on the annualized return in the previous year.

References

Abdellaoui, Mohammed, Han Bleichrodt, and Olivier l'Haridon. "A Tractable Method to Measure Utility and Loss Aversion under Prospect Theory." *Journal of Risk and Uncertainty* 36 (2008): 245–66.

Addoum, Jawad M. "Household Portfolio Choice and Retirement." *Review of Economics and Statistics* 99, no. 5 (2017): 870–83.

Andonov, Aleksandar, Rob M.M.J. Bauer, and K.J. Martijn Cremers. "Pension Fund Asset Allocation and Liability Discount Rates." *The Review of Financial Studies* 30.8 (2017): 2555-2595.

Andonov, Aleksandar, Yael V. Hochberg, and Joshua D. Rauh. "Political Representation and Governance: Evidence from the Investment Decisions of Public Pension Funds." *The Journal of Finance* 73.5 (2018): 2041-2086.

Ang, Andrew, Robert J Hodrick, Yuhang Xing, and Xiaoyan Zhang. "High Idiosyncratic Volatility and Low Returns: International and Further US Evidence." *Journal of Financial Economics* 91, no. 1 (2009): 1–23.

———. "The Cross-Section of Volatility and Expected Returns." *The Journal of Finance* 61, no. 1 (2006): 259–99.

Angrist, Joshua D, and Jörn-Steffen Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton university press, 2009.

Arellano, Manuel, and Jinyong Hahn. "A Likelihood-Based Approximate Solution to the Incidental Parameter Problem in Dynamic Nonlinear Models with Multiple Effects." *Unpublished Manuscript*, 2006.

Attanasio, Orazio P, and Agar Brugiavini. "Social Security and Households' Saving." *The Quarterly Journal of Economics* 118, no. 3 (2003): 1075–1119.

Attanasio, Orazio P, and Susann Rohwedder. "Pension Wealth and Household Saving: Evidence from Pension Reforms in the United Kingdom." *American Economic Review* 93, no. 5 (2003): 1499–1521.

Badarinza, Cristian, John Y Campbell, and Tarun Ramadorai. "International Comparative Household Finance." *Annual Review of Economics* 8 (2016): 111–44.

Barber, Brad M., Yi-Tsung Lee, Yu-Jane Liu, and Terrance Odean. "Is the Aggregate Investor Reluctant to Realise Losses? Evidence from Taiwan." *European Financial Management* 13.3 (2007): 423-447.

Barber, Brad M., Yi-Tsung Lee, Yu-Jane Liu, and Terrance Odean. "Just How Much Do Individual Investors Lose by Trading?." *Review of Financial Studies* 22.2 (2009): 609-632.

Barberis, Nicholas C. "Thirty Years of Prospect Theory in Economics: A Review and Assessment." *Journal of Economic Perspectives* 27, no. 1 (2013): 173–96.

Beshears, John, James J Choi, David Laibson, and Brigitte C Madrian. "Behavioral Household Finance." In *Handbook of Behavioral Economics: Applications and Foundations 1*, 1:177–276. Elsevier, 2018.

Beshears, John, James J Choi, David Laibson, and Brigitte C Madrian. "Behavioral Economics Perspectives on Public Sector Pension Plans." *Journal of Pension Economics & Finance* 10, no.2 (2011): 315-336.

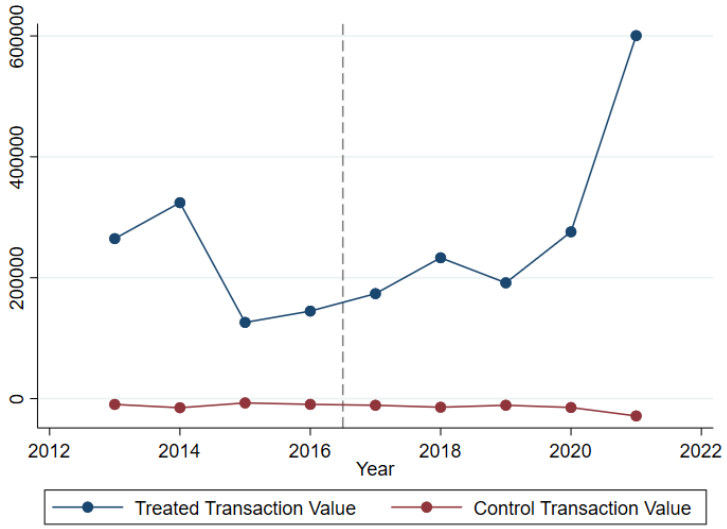
Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. "Diagnostic Expectations and Credit Cycles." *The Journal of Finance* 73, no. 1 (2018): 199–227.

Brunnermeier, Markus K, and Stefan Nagel. “Do Wealth Fluctuations Generate Time-Varying Risk Aversion? Micro-Evidence on Individuals’ Asset Allocation.” *American Economic Review* 98, no. 3 (2008): 713–36.
Calvet, Laurent E, John Y Campbell, and Paolo Sodini. “Down or out: Assessing the Welfare Costs of Household Investment Mistakes.” *Journal of Political Economy* 115, no. 5 (2007): 707–47.
Calvet, Laurent E., and Paolo Sodini. "Twin picks: Disentangling the Determinants of Risk-Taking in Household Portfolios." *The Journal of Finance* 69.2 (2014): 867-906.
Campbell, John Y. “Household Finance.” *The Journal of Finance* 61, no. 4 (2006): 1553–1604.
Campbell, John Y., and Tarun Ramadorai. *Household finance in retrospect and prospect*. No. w34621. National Bureau of Economic Research, 2026.
Choi, James J. "Contributions to defined contribution pension plans." *Annual Review of Financial Economics* 7.1 (2015): 161-178.
Choi, James J, and Adriana Z Robertson. “What Matters to Individual Investors? Evidence from the Horse’s Mouth.” *The Journal of Finance* 75, no. 4 (2020): 1965–2020.
Chiappori, Pierre-André, and Monica Paiella. "Relative Risk Aversion is Constant: Evidence from Panel Data." *Journal of the European Economic Association* 9.6 (2011): 1021-1052.
Cocco, Joao F., Francisco J. Gomes, and Pascal J. Maenhout. "Consumption and Portfolio Choice over the Life Cycle." *The Review of Financial Studies* 18.2 (2005): 491-533.
Cullen, Julie Berry, and Jonathan Gruber. “Does Unemployment Insurance Crowd out Spousal Labor Supply?” *Journal of Labor Economics* 18, no. 3 (2000): 546–72.
Curcuru, Stephanie, John Heaton, Deborah Lucas, and Damien Moore. “Heterogeneity and Portfolio Choice: Theory and Evidence.” In *Handbook of Financial Econometrics: Tools and Techniques*, 337–82. Elsevier, 2010.
DellaVigna, Stefano, Attila Lindner, Balázs Reizer, and Johannes F Schmieder. “Reference-Dependent Job Search: Evidence from Hungary.” *The Quarterly Journal of Economics* 132, no. 4 (2017): 1969–2018.
Feldstein, Martin. “Social Security, Induced Retirement, and Aggregate Capital Accumulation.” *Journal of Political Economy* 82, no. 5 (1974): 905–26.
Fisher, Walter H, and Christian Keuschnigg. “Pension Reform and Labor Market Incentives.” *Journal of Population Economics* 23 (2010): 769–803.
Fu, Fangjian. “Idiosyncratic Risk and the Cross-Section of Expected Stock Returns.” *Journal of Financial Economics* 91, no. 1 (2009): 24–37.
Gomes, Francisco, Michael Haliassos, and Tarun Ramadorai. “Household Finance.” *Journal of Economic Literature* 59, no. 3 (2021): 919–1000.
Gomes, Francisco, Portfolio Choice Over the Life Cycle: A Survey. *Annual Review of Financial Economics,* Vol. 12 (2020): 277-304.
Gomes, Francisco, Cameron Peng, Oksana Smirnova, and Ning Zhu. "Reaching for yield: Evidence from households." *Journal of Financial Economics* 168 (2025): 104057.
Grinblatt, Mark, and Matti Keloharju. “The Investment Behavior and Performance of Various Investor Types: A Study of Finland’s Unique Data Set.” *Journal of Financial Economics* 55, no. 1 (2000): 43–67.
———. “What Makes Investors Trade?” *The Journal of Finance* 56, no. 2 (2001): 589–616.
Guiso, Luigi, Michael Haliassos, and Tullio Jappelli. *Household Portfolios*. MIT press, 2002.
Haliassos, Michael, and Carol C Bertaut. “Why Do so Few Hold Stocks?” *The Economic Journal* 105, no. 432 (1995): 1110–29.

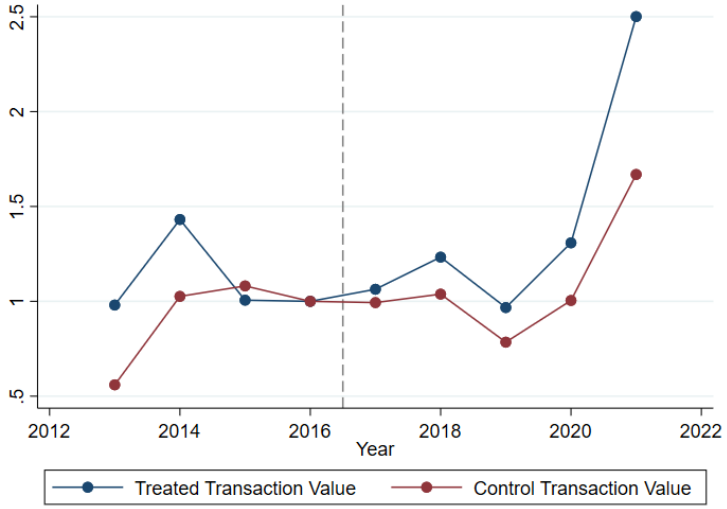
Haliassos, Michael, Thomas Jansson, and Yigitcan Karabulut. “Incompatible European Partners? Cultural Predispositions and Household Financial Behavior.” *Management Science* 63, no. 11 (2017): 3780–3808.
Harbaugh, William T, Kate Krause, and Lise Vesterlund. “The Fourfold Pattern of Risk Attitudes in Choice and Pricing Tasks.” *The Economic Journal* 120, no. 545 (2010): 595–611.
Harrison, Glenn W, and E Elisabet Rutström. “Risk Aversion in the Laboratory.” In *Risk Aversion in Experiments*, 41–196. Emerald Group Publishing Limited, 2008.
Hurwitz, Abigail, and Orly Sade. “Is One Plus One Always Two? Insuring Longevity Risk while Having Multiple Savings Accounts.” *Management Science* 71.5 (2025): 4474-4494.
Jin, Lawrence, and Cameron Peng. “The Law of Small Numbers in Financial Markets: Theory and Evidence.” 2024. NBER Working Paper No. w32519.
Kahneman, Daniel, and Amos Tversky. “Prospect Theory: An Analysis of Decision under Risk.” *Econometrica* 47, no. 2 (1979): 363–91.
King, Mervyn A, and LD L Dicks-Mireaux. “Asset Holdings and the Life-Cycle.” *The Economic Journal* 92, no. 366 (1982): 247–67.
Kőszegi, Botond, and Matthew Rabin. “A model of reference-dependent preferences.” *The Quarterly Journal of Economics* 121.4 (2006): 1133-1165.
———. “Reference-dependent risk attitudes.” *American Economic Review* 97.4 (2007): 1047-1073.
———. “Reference-dependent consumption plans.” *American Economic Review* 99.3 (2009): 909-936.
Levitt, Steven D, and John A List. “What Do Laboratory Experiments Measuring Social Preferences Reveal about the Real World?” *Journal of Economic Perspectives* 21, no. 2 (2007): 153–74.
Lian, Chen, Yueran Ma, and Carmen Wang. “Low Interest Rates and Risk-Taking: Evidence from Individual Investment Decisions.” *The Review of Financial Studies* 32, no. 6 (2019): 2107–48.
Lien, Hsien-Ming, Chung-Hsin Tseng, Tzu-Ting Yang, Hsing-Wen Han, and Kuang-Ta Lo. “The Wealth Distribution in Taiwan 2004-2014: Evidence from the Individual Wealth Register Data.” *Taiwan Economic Review* 49, no. 1 (2021): 77–130.
Lindbeck, Assar, and Mats Persson. “The Gains from Pension Reform.” *Journal of Economic Literature* 41, no. 1 (2003): 74–112.
Maestas, Nicole. “Back to Work: Expectations and Realizations of Work after Retirement.” *Journal of Human Resources* 45, no. 3 (2010): 718–48.
Mankiw, N Gregory, and Stephen P Zeldes. “The Consumption of Stockholders and Nonstockholders.” *Journal of Financial Economics* 29, no. 1 (1991): 97–112.
Massa, Massimo, and Andrei Simonov. “Hedging, Familiarity and Portfolio Choice.” *The Review of Financial Studies* 19, no. 2 (2006): 633–85.
Merton, Robert C. “Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case.” *The Review of Economics and Statistics*, 1969, 247–57.
Merton, Robert C. “Optimum Consumption and Portfolio Rules in a Continuous-time Model,” *Journal of Economic Theory,* Vol 3, Issue 4 (1971): 373-413.
Merton, Robert C. “A Simple Model of Capital Market Equilibrium with Incomplete Information,” *The Journal of Finance* 42, no. 3 (1987): 483-510.
Michaud, Pierre-Carl, Arthur Van Soest, and Luc Bissonnette. “Understanding Joint Retirement.” *Journal of Economic Behavior & Organization* 173 (2020): 386–401.

Neelakantan, Urvi, and Yunhee Chang. “Gender Differences in Wealth at Retirement.” *American Economic Review* 100, no. 2 (2010): 362–67.
Neyman, Jerzy, and Elizabeth L Scott. “Consistent Estimates Based on Partially Consistent Observations.” *Econometrica: Journal of the Econometric Society*, 1948, 1–32.
Odean, Terrance. “Are Investors Reluctant to Realize Their Losses?” *The Journal of Finance* 53, no. 5 (1998): 1775–98.
———. “Do Investors Trade Too Much?” *American Economic Review* 89, no. 5 (1999): 1279–98.
OECD. *Pensions at a Glance 2019*, 2019.
———. *Pensions at a Glance 2021*, 2021.
———. *Pensions at a Glance 2023*, 2023.
Olafsson, Arna, and Michaela Pagel. “Retirement Puzzles: New Evidence from Personal Finances.” *Journal of Public Economics* 234 (2024): 105103.
Olafsson, Arna, and Michaela Pagel. “The Ostrich in Us: Selective Attention to Personal Finances.” *Review of Economics and Statistics* (2025): 1-26.
Osili, Una Okonkwo, and Anna L Paulson. “Institutions and Financial Development: Evidence from International Migrants in the United States.” *The Review of Economics and Statistics* 90, no. 3 (2008): 498–517.
Page, Lionel, David A Savage, and Benno Torgler. “Variation in Risk Seeking Behaviour Following Large Losses: A Natural Experiment.” *European Economic Review* 71 (2014): 121–31.
Poterba, James, Steven Venti, and David Wise. “The Composition and Drawdown of Wealth in Retirement.” *Journal of Economic Perspectives* 25, no. 4 (2011): 95–118.
Roberts, Michael R, and Toni M Whited. “Endogeneity in Empirical Corporate Finance1.” In *Handbook of the Economics of Finance*, 2:493–572. Elsevier, 2013.
Rosen, Harvey S, and Stephen Wu. “Portfolio Choice and Health Status.” *Journal of Financial Economics* 72, no. 3 (2004): 457–84.
Roth, Jonathan. “Pretest with Caution: Event-Study Estimates after Testing for Parallel Trends.” *American Economic Review: Insights* 4, no. 3 (2022): 305–22.
Saez, Emmanuel, and Gabriel Zucman. “Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data.” *The Quarterly Journal of Economics* 131, no. 2 (2016): 519–78.
Sahm, Claudia R. “How Much Does Risk Tolerance Change?” *The Quarterly Journal of Finance* 2, no. 04 (2012): 1250020.
Scharfstein, David S. “Presidential Address: Pension Policy and the Financial System.” *The Journal of Finance* 73.4 (2018): 1463-1512.
Shefrin, Hersh, and Meir Statman. “The Disposition to Sell Winners Too Early and Ride Losers Too Long: Theory and Evidence.” *The Journal of Finance* 40.3 (1985): 777-790.
Simonsohn, Uri, and George Loewenstein. “Mistake: The Effect of Previously Encountered Prices on Current Housing Demand.” *The Economic Journal* 116.508 (2006): 175-199.
Stancanelli, Elena, and Arthur Van Soest. “Joint Leisure before and after Retirement: A Double Regression Discontinuity Approach,” 2012.
Stango, Victor, and Jonathan Zinman. “We Are All Behavioural, More, or Less: A Taxonomy of Consumer Decision-making.” *The Review of Economic Studies* 90.3 (2023): 1470-1498.
Tversky, Amos, and Daniel Kahneman. “Advances in Prospect Theory: Cumulative Representation of Uncertainty.” *Journal of Risk and Uncertainty* 5 (1992): 297–323.

Viceira, Luis M. "Optimal Portfolio Choice for Long-horizon Investors with Nontradable Labor Income." *The Journal of Finance* 56.2 (2001): 433-470.
Wakker, Peter P. *Prospect Theory: For Risk and Ambiguity*. Cambridge university press, 2010.
Wooldridge, Jeffrey M. *Econometric Analysis of Cross Section and Panel Data*. MIT press, 2010.
Zhang, Jinyuan. "The Impact of Public Pension Deficits on Households' Investment and Economic Activity." *Available at SSRN 3918170*, 2021.
Zhang, Hanjiang, and Clemens Sialm. "Firm Shocks and Retirement Savings." *Available at SSRN 5183691* (2025).



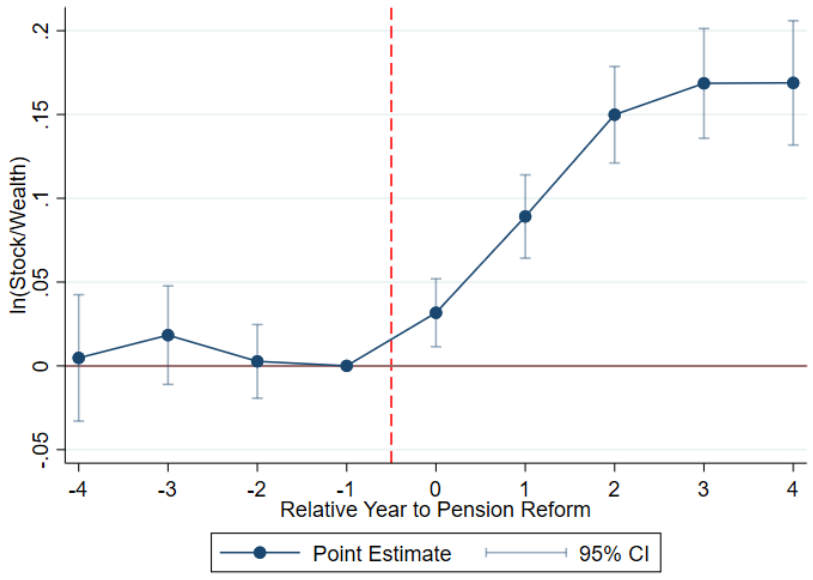
(a) Demeaned transaction value in different years



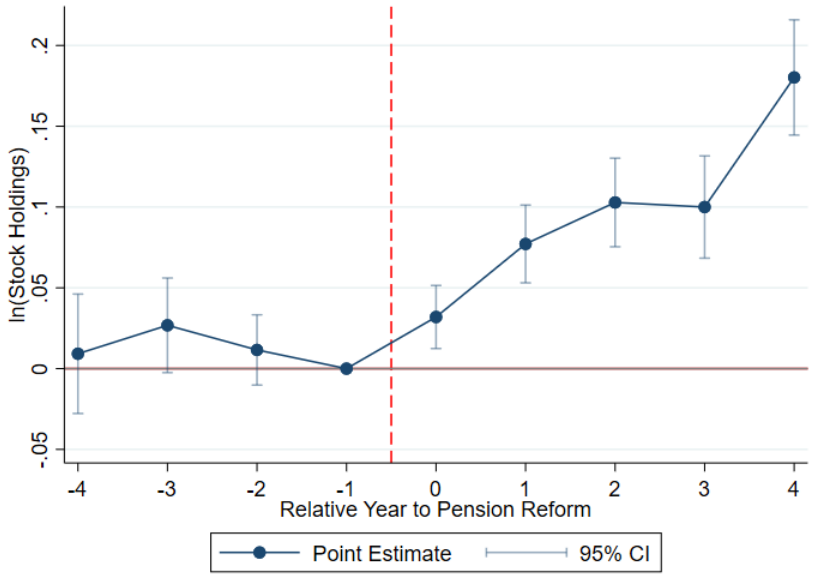
(b) Normalized transaction value in different year

Figure 1: Transaction Activity Around the Pension Reform

The figure provides the graphical illustration of transaction activity for the treated and control groups over time. Panel (a) plots the demeaned annual transaction values, while Panel (b) plots the normalized transaction values, where transaction values are scaled by the corresponding group's transaction value in 2016. The blue line represents civil servants (treated group), and the red line represents private-sector households (control group). The dashed vertical line indicates 2017, when the pension reform legislation was passed. Transaction values are constructed based on the change in stock holdings between consecutive years.



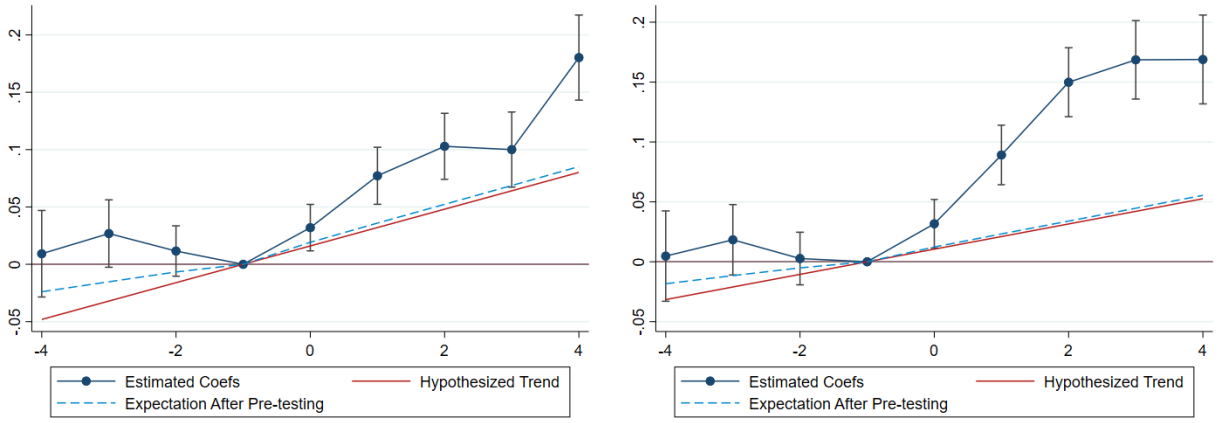
(a) Logarithm of stock-to-wealth ratio in different years



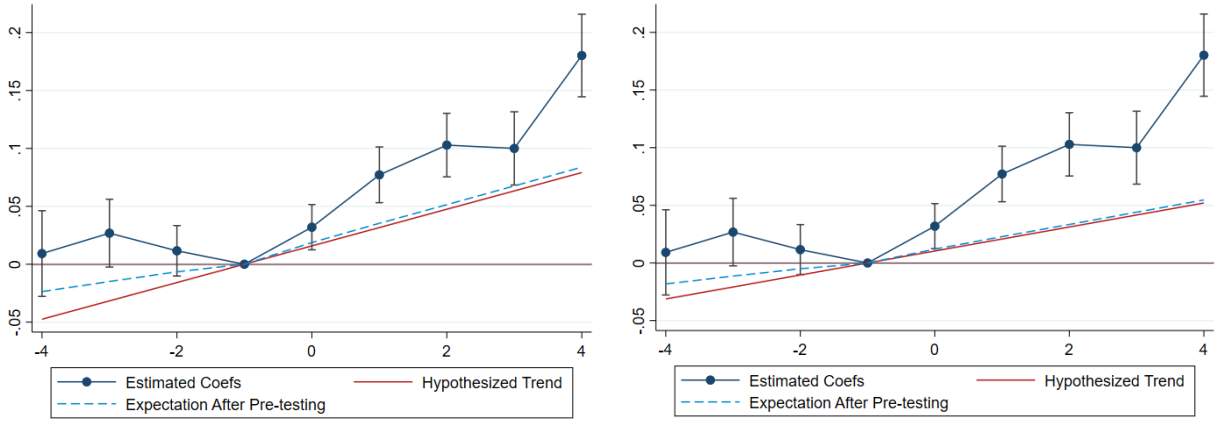
(b) Logarithm of stock holdings in different years

Figure 2: Effect of the 2017 Pension Reform on Stock Holdings

The figure provides the graphical illustration of $\{b_j\}_{j=-4}^{j=4}$ from Column (4) in Table 3 and Table 4, shown in Panel (a) and Panel (b), respectively. Panel (a) and Panel (b) depict the estimates of Equation (2) with the dependent variables *ln(Stock/Wealth)* and *ln(Stock Holdings)*, respectively. The dots represent the point estimates, and the bars denote the 95% confidence intervals. Relative Year 0 corresponds to 2017, when the reform legislation was passed, while Relative Year 1 corresponds to 2018, when the pension cuts for civil servants began.



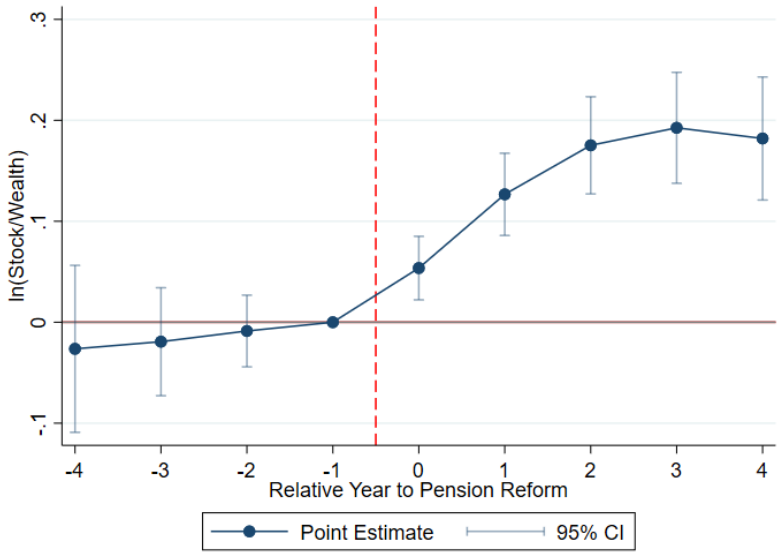
(a) Logarithm of stock-to-wealth ratio



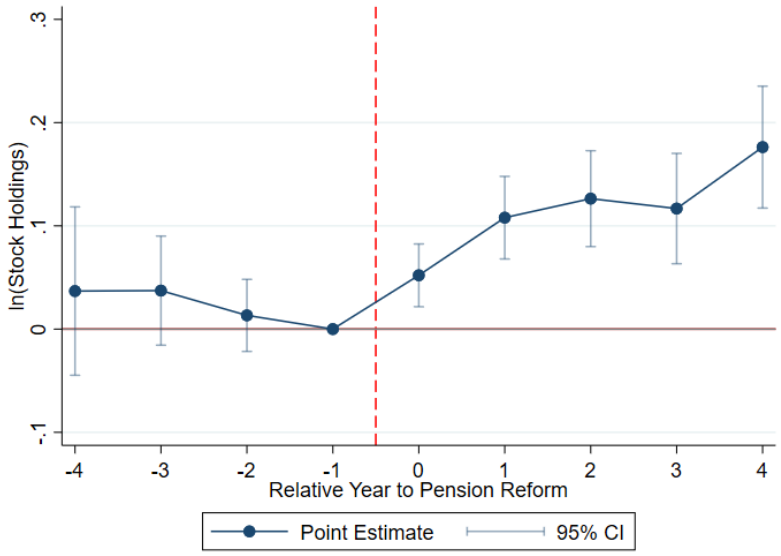
(b) Logarithm of stock holdings

Figure 3: Robustness Check for Pre-trend Testing

The figure presents the robustness test proposed by Roth (2022). We assume the existence of a linear trend and calculate the slope of the hypothesized trend based on 80% and 50% statistical power on the left and right plots, respectively. Panel (a) presents the results for *ln(Stock/Wealth)* and panel (b) presents the results for *ln(Stock Holdings)*. The horizontal axis denotes each year relative to 2017.



(a) Logarithm of stock-to-wealth ratio in different years



(b) Logarithm of stock holdings in different years

Figure 4: Robustness Check using Matched Sample

The figure provides the graphical illustration of $\{b_j\}_{j=-4}^{j=4}$ from Column (1) and Column (3) in Table 6, shown in Panel (a) and Panel (b), respectively. Panel (a) and Panel (b) depict the estimates of Equation (2) with the dependent variables *ln(Stock/Wealth)* and *ln(Stock Holdings)*, respectively, using the matched sample as a robustness check. The dots represent the point estimates, and the bars denote the 95% confidence intervals. Relative Year 0 corresponds to 2017, when the reform legislation was passed, while Relative Year 1 corresponds to 2018, when the pension cuts for civil servants began.

Table 1: Income Replacement Ratio Before and After the Pension Reform

Tenure	40	35	30	25	20	15
Income Replacement Ratio of (A)	95%	95%	85%	75%	75%	75%
Income Replacement Ratio of (B)	90%	90%	90%	85%	80%	75%
Income Replacement Ratio in July, 2018	77.25%	75%	67.5%	60%	52.5%	45%
Income Replacement Ratio in 2029	62.5%	60%	52.5%	45%	37.5%	30%

This table reports the income replacement ratios for Taiwanese civil servants under the pension system before and after the 2017 pension reform, by years of service. Prior to the reform, retirees were covered by one of two pension schemes (A or B), whose benefit formulas are described in Appendix A.1. The pension reform was legislated in 2017 and implemented starting in July 2018. Relative to the pre-reform regime, the reform reduced income replacement ratios by 22.75 to 30 percentage points upon implementation in 2018, depending on tenure. Replacement ratios are then further reduced by 1.5 percentage points per year starting from 2020, reaching the ultimate levels in 2029.

Table 2: Summary Statistics (2013-2016)

	N	mean	sd	p5	p25	p50	p75	p95
Panel A: Population								
Husband Age	456,158	61.09	4.23	55.00	57.00	61.00	64.00	68.00
Wife Age	456,158	57.63	5.32	50.00	54.00	58.00	61.00	66.00
Male Breadwinner	456,158	0.72	0.45	0.00	0.00	1.00	1.00	1.00
Child Dependency	456,158	0.31	0.65	0.00	0.00	0.00	0.00	2.00
Deposits (thousands)	456,158	2,777	9,000.5	0.00	0.00	174.43	2,229.8	14,624.5
Bond (thousands)	456,158	2.54	245.37	0.00	0.00	0.00	0.00	0.00
Stock Holdings (thousands)	456,158	2,091	48,330	0.00	0.00	50.00	864.90	6,841.30
Conditional Stock Holdings (thousands)	304,349	3,128	59,140.4	1.47	46.20	404.51	1,779.4	9,676.28
I_stock	456,158	0.66	0.47	0.00	0.00	1.00	1.00	1.00
Present Value of Cars (thousands)	456,158	144.82	378.28	0.00	0.00	0.00	145.27	692.98
Assessed Value of Real Estate (thousands)	456,158	10,680	127,875	0.00	1,527.5	4,348.2	10,254	34,615.77
Owning Real Estate	456,158	0.90	0.30	0.00	1.00	1.00	1.00	1.00
Mortgage (thousands)	456,158	293.10	2,828	0.00	0.00	0.00	0.00	1,639.94
Total Wealth (thousands)	456,158	15,695	168,263	2.17	2,436.7	6,789	16,162	50,026.40
Deposits/Wealth	438,064	0.17	0.86	0.00	0.00	0.03	0.26	0.74
Stock/Wealth	438,064	0.12	3.17	0.00	0.00	0.01	0.11	0.62
Realized Gains (thousands)	304,349	57.30	909.90	0.00	0.00	0.00	1.80	189.94
Realized Losses (thousands)	304,349	30.73	636.42	0.00	0.00	0.00	0.00	81.43
Paper Gains (thousands)	304,349	86.35	2,984.6	0.00	0.00	0.00	9.93	196.39
Paper Losses (thousands)	304,349	59.63	3,981.5	0.00	0.00	0.00	4.90	143.45
Proportion of Gains Realized	304,349	0.17	0.33	0.00	0.00	0.00	0.10	1.00
Proportion of Losses Realized	304,349	0.12	0.29	0.00	0.00	0.00	0.00	0.99
α	304,349	-0.71	0.98	-2.27	-1.26	-0.66	0.00	0.47
β	304,349	0.91	0.58	0.00	0.58	1.02	1.28	1.74
$\sum \epsilon^2$	304,349	6,098.3	14,664.4	0.00	205.44	1,844.3	6,862.1	25,028.9
Excess Return	304,349	4.01	27.18	-28.60	-7.30	0.00	11.24	42.90
Market Adjusted Excess Return	304,349	2.74	24.92	-23.14	-6.91	0.00	7.87	36.44
Panel B: Civil Servants								
Husband Age	48,087	61.90	4.368	55	58	62	66	69
Wife Age	48,087	58.68	5.280	50	55	59	63	67
Male Breadwinner	48,087	0.872	0.334	0	1	1	1	1
Child Dependency	48,087	0.278	0.607	0	0	0	0	2
Deposits (thousands)	48,087	3,345	6,860	0	0	800.4	3,228	16,384

Bond (thousands)	48,087	0.405	30.53	0	0	0	0	0
Stock Holdings (thousands)	48,087	1,158	5,214	0	0	63.60	748.1	4,969
Conditional Stock Holdings (thousands)	33,568	1,651	6,167	1.316	38.96	345.1	1,308	6,573
I_stock	48,087	0.696	0.460	0	0	1	1	1
Present Value of Cars (thousands)	48,087	145.9	314.7	0	0	0	190.8	658.0
Assessed Value of Real Estate (thousands)	48,087	10,265	25,169	0	2,184	5,234	11,227	33,551
Owning Real Estate	48,087	0.943	0.232	0	1	1	1	1
Mortgage (thousands)	48,087	274.3	1,452	0	0	0	0	1,758
Total Wealth (thousands)	48,087	14,913	28,823	521.8	3,658	8,364	17,741	47,713
Deposits/Wealth	47,397	0.209	0.983	0	0	0.108	0.348	0.767
Stock/Wealth	47,397	0.0801	0.440	0	0	0.00848	0.0787	0.403
Realized Gains (thousands)	33,568	47.25	432.1	0	0	0	4.511	188.4
Realized Losses (thousands)	33,568	24.35	405.3	0	0	0	0	81.00
Paper Gains (thousands)	33,568	48.52	462.6	0	0	0	11.94	182.5
Paper Losses (thousands)	33,568	37.74	510.8	0	0	0	6.201	136.7
Proportion of Gains Realized	33,568	0.189	0.343	0	0	0	0.199	1.000
Proportion of Losses Realized	33,568	0.135	0.303	0	0	0	0	0.995
α	33,568	-0.747	0.961	-2.260	-1.278	-0.721	0	0.495
β	33,568	0.976	0.534	0	0.737	1.055	1.290	1.749
$\sum \epsilon^2$	33,568	6,861	15,732	0	416.3	2,425	7,711	27,242
Excess Return	33,568	4.239	26.09	-28.21	-8.045	0	12.39	42.86
Market Adjusted Excess Return	33,568	2.928	23.64	-22.83	-7.238	0	8.570	36.61
Panel C: Private Sector								
Husband Age	408,071	60.99	4.200	55	57	61	64	68
Wife Age	408,071	57.50	5.308	50	54	57	61	66
Male Breadwinner	408,071	0.702	0.457	0	0	1	1	1
Child Dependency	408,071	0.315	0.658	0	0	0	0	2
Deposits (thousands)	408,071	2,710	9,218	0	0	120.8	2,102	14,329
Bond (thousands)	408,071	2.790	259.2	0	0	0	0	0
Stock Holdings (thousands)	408,071	2,201	51,066	0	0	49	883.1	7,084
Conditional Stock Holdings (thousands)	270,781	3,312	62,659	1.480	47.41	413.5	1,854	10,058
I_stock	408,071	0.661	0.473	0	0	1	1	1
Present Value of Cars (thousands)	408,071	144.7	385.1	0	0	0	134.6	700.4
Assessed Value of Real Estate (thousands)	408,071	10,729	134,923	0	1,452	4,241	10,123	34,736
Owning Real Estate	408,071	0.892	0.311	0	1	1	1	1
Mortgage (thousands)	408,071	295.3	2,948	0	0	0	0	1,624

Total Wealth (thousands)	408,071	15,788	177,626	0.279	2,305	6,591	15,969	50,372
Deposits/Wealth	390,667	0.163	0.840	0	0	0.0211	0.243	0.734
Stock/Wealth	390,667	0.121	3.358	0	0	0.0117	0.114	0.652
Realized Gains (thousands)	270,781	58.55	952.6	0	0	0	1.537	190.1
Realized Losses (thousands)	270,781	31.52	659.5	0	0	0	0	81.48
Paper Gains (thousands)	270,781	91.03	3,160	0	0	0	9.703	198.5
Paper Losses (thousands)	270,781	62.34	4,217	0	0	0	4.736	144.3
Proportion of Gains Realized	270,781	0.169	0.330	0	0	0	0.0859	0.999
Proportion of Losses Realized	270,781	0.122	0.291	0	0	0	0	0.990
α	270,781	-0.709	0.981	-2.274	-1.261	-0.652	0	0.472
β	270,781	0.903	0.580	0	0.546	1.016	1.274	1.744
$\sum \epsilon^2$	270,781	6,004	14,524	0	179.2	1,777	6,756	24,803
Excess Return	270,781	3.987	27.31	-28.62	-7.184	0	11.08	42.90
Market Adjusted Excess Return	270,781	2.720	25.07	-23.20	-6.870	0	7.766	36.42

This table presents the summary statistics for the entire sample before the pension reform, as well as for civil servants (the treated group) and their private sector counterparts (the control group). The numbers without parentheses are the mean coefficients and the numbers within parentheses are the standard deviations. *Husband Age* denotes the age of the husband in the household; *Wife Age* denotes the age of the wife in the household; *Male Breadwinner* denotes whether the primary breadwinner of the household was the husband; *Child Dependency* denotes the number of children below 24 years old in the household; *Deposits* denotes the amount of household bank deposits; *Bond* denotes the amount of bond holdings of the household; *Stock Holdings* denotes the amount of stock holdings of the household; *Conditional Stock Holdings* reports the amount of stock holdings of the household that had held stock prior to the pension reform; *I_stock* denotes whether the household holds any stocks; *Present Value of Cars* denotes the present value of cars of the household; *Assessed Value of Real Estate* denotes the assessed value of houses and land minus the outstanding mortgages of the household; *Owning Real Estate* denotes whether the household holds any real estate; *Mortgage* denotes the outstanding mortgages of the household; *Total Wealth* denotes the total wealth of the household; *Deposits/Wealth* denotes the deposits-to-wealth ratio; *Stock/Wealth* denotes the stock-to-wealth ratio; α denotes the weighted average of the household stock portfolio's alpha under CAPM; β denotes the weighted average of the household stock portfolio's beta under CAPM; $\sum \epsilon^2$ denotes the weighted average of the household stock portfolio's idiosyncratic risk under CAPM; and *(Market Adjusted) Excess Return* denotes weighted average of the household stock portfolio's (market adjusted) excess return. All variables are defined in Table A2 in Appendix.

Table 3: Effect of the 2017 Pension Reform on the Stock-to-Wealth Ratio

	(1) ln(Stock/ Wealth)	(2) ln(Stock/ Wealth)	(3) ln(Stock/ Wealth)	(4) ln(Stock/ Wealth)	(5) ln(Stock/ Wealth)
Civil Servant × Post	0.1090***	0.1063***	0.1042***		
	(0.01180)	(0.01179)	(0.01183)		
Child Dependency		-0.001343	-0.003296	-0.001356	-0.003260
		(0.005906)	(0.005911)	(0.005904)	(0.005910)
ln(1+mortgage)		0.0218***	0.02181***	0.0218***	0.0218***
		(0.000476)	(0.000475)	(0.000476)	(0.000475)
Civil Servant × $I[t-2017=-4]$				0.004741	0.01029
				(0.01924)	(0.01930)
Civil Servant × $I[t-2017=-3]$				0.01834	0.02241
				(0.01499)	(0.01505)
Civil Servant × $I[t-2017=-2]$				0.002690	0.002987
				(0.01121)	(0.01126)
Civil Servant × $I[t-2017=0]$				0.0317***	0.0314***
				(0.01034)	(0.01039)
Civil Servant × $I[t-2017=1]$				0.0891***	0.0882**
				(0.01268)	(0.01273)
Civil Servant × $I[t-2017=2]$				0.1499***	0.1508***
				(0.01469)	(0.01472)
Civil Servant × $I[t-2017=3]$				0.1686***	0.1674***
				(0.01671)	(0.01676)
Civil Servant × $I[t-2017=4]$				0.1689***	0.1677***
				(0.01892)	(0.01901)
Husband Age FE	-	Y	Y	Y	Y
Household FE	Y	Y	Y	Y	Y
Year FE	Y	Y	-	Y	-
City-Year FE	-	-	Y	-	Y
Observations	793,922	793,922	793,922	793,922	793,922

This table examines the impact of the 2017 pension reform on the stock-to-wealth ratio of the civil servant families. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variable is the natural logarithm of *Stock/Wealth*, which reflects the intensity of financial market participation. Column (1) to Column (3) report the estimates of Equation (1), while Column (4) and Column (5) report the estimates of Equation (2). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 4: Effect of the 2017 Pension Reform on Stock Holdings

	(1) ln(Stock Holdings)	(2) ln(Stock Holdings)	(3) ln(Stock Holdings)	(4) ln(Stock Holdings)	(5) ln(Stock Holdings)
Civil Servant × Post	0.0762***	0.08014***	0.07609***		
	(0.01141)	(0.01142)	(0.01147)		
Child Dependency		-0.007333	-0.009516	-0.007408	-0.009543
		(0.005821)	(0.005824)	(0.005820)	(0.005823)
ln(1+mortgage)		-0.0005172	-0.0005764	-0.0005467	-0.0006044
		(0.0004288)	(0.0004288)	(0.0004288)	(0.0004288)
Civil Servant × $I[t-2017=-4]$				0.009202	0.01154
				(0.01885)	(0.01890)
Civil Servant × $I[t-2017=-3]$				0.02682*	0.02916*
				(0.01494)	(0.01499)
Civil Servant × $I[t-2017=-2]$				0.01158	0.01189
				(0.01109)	(0.01115)
Civil Servant × $I[t-2017=0]$				0.03195***	0.03010***
				(0.009958)	(0.009997)
Civil Servant × $I[t-2017=1]$				0.07717***	0.07414***
				(0.01228)	(0.01232)
Civil Servant × $I[t-2017=2]$				0.1028***	0.1008***
				(0.01398)	(0.01401)
Civil Servant × $I[t-2017=3]$				0.1000***	0.09539***
				(0.01614)	(0.01619)
Civil Servant × $I[t-2017=4]$				0.1802***	0.1746***
				(0.01820)	(0.01832)
Husband Age FE	-	Y	Y	Y	Y
Household FE	Y	Y	Y	Y	Y
Year FE	Y	Y	-	Y	-
City-Year FE	-	-	Y	-	Y
Observations	797,573	797,573	797,573	797,573	797,573

This table examines the impact of the 2017 pension reform on the stock holdings of the civil servant families. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variable is the natural logarithm of *Stock Holdings*, which reflects the intensity of financial market participation. Column (1) to Column (3) report the estimates of Equation (1); Column (4) and Column (5) report the estimates of Equation (2). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 5: Summary Statistics of Matched Sample

	(1) Civil Servants	(2) Private Sector	(3) Difference
Total Wealth (thousands)	14994.08	14918.00	-76.08
I_stock	0.68	0.69	0.01*
Stock/Wealth	0.08	0.08	0.00
Deposit/Wealth	0.20	0.20	0.01
Realized Gains (thousands)	42.93	42.75	-0.18
Realized Losses (thousands)	17.96	12.55	-5.40
Paper Gains (thousands)	48.17	54.49	6.32
Paper Losses (thousands)	19.43	22.96	3.53*
Proportion of Realizd Gains	0.17	0.17	0.00
Proportion of Realized Losses	0.10	0.10	-0.00
α	-0.87	-0.88	-0.01
β	0.96	0.96	-0.00
$\sum \epsilon^2$	6436.12	5912.39	-523.72**
Excess Return	-9.32	-9.66	-0.34
Market adjusted Excess Return	1.13	0.80	-0.34
Deposit (thousands)	3075.79	3376.96	301.17***
Bond (thousands)	0.02	0.97	0.95**
Stock Holdings (thousands)	1100.65	1225.89	125.24**
Conditional Stock Holdings (thousands)	1608.74	1769.64	160.90*
Present Value of Cars (thousands)	146.66	149.33	2.67
Assesed Value of Real Estates (thousands)	10670.97	10164.86	-506.11*
Owning Real Estates	0.94	0.97	0.03***
Mortgage (thousands)	290.71	269.25	-21.46
Husband Age	62.21	62.06	-0.15***
Wife Age	59.03	58.91	-0.12*
Male Breadwinner	0.88	0.87	-0.01*
Child Dependency	0.27	0.26	-0.01
Observations	16835	49449	66284

This table presents the summary statistics for the matched sample before the pension reform. The matched sample is constructed by matching each retired civil servant family with their three nearest private sector counterparts using the Mahalanobis distance. This matching is based on the following observable characteristics in 2016, the year right before the pension reform: *Husband Age, Wife Age, Male Breadwinner, Child Dependency, ln(1+Deposits), ln(1+Stock Holdings), ln(1+Total Wealth), Deposits/Wealth, Stock/Wealth,* α *,* β *,* and $\sum \epsilon^2$. The three matched nearest neighbors of each retired civil servant family are then included as the matched control group in the matched sample. Column (1) shows the mean of the treated group, Column (2) shows the mean of the matched control group, and Column (3) presents the results of a two-sample t-test of the null hypothesis that the two groups are the same. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 6: Robustness Check based on A Matched Sample

	(1) ln(Stock/ Wealth)	(2) ln(Stock/ Wealth)	(3) ln(Stock Holdings)	(4) ln(Stock Holdings)
Child Dependency	-0.008603	-0.01011	-0.01910	-0.02050*
	(0.01238)	(0.01236)	(0.01229)	(0.01227)
ln(1+mortgage)	0.02221***	0.02197***	-0.0003086	-0.0005205
	(0.001165)	(0.001166)	(0.001075)	(0.001075)
Civil Servant × $I[t-2017=-4]$	-0.02634	-0.02180	0.03685	0.04265
	(0.04221)	(0.04226)	(0.04161)	(0.04171)
Civil Servant × $I[t-2017=-3]$	-0.01926	-0.01961	0.03728	0.03877
	(0.02728)	(0.02741)	(0.02696)	(0.02715)
Civil Servant × $I[t-2017=-2]$	-0.008661	-0.006452	0.01331	0.01434
	(0.01811)	(0.01816)	(0.01781)	(0.01786)
Civil Servant × $I[t-2017=0]$	0.05366***	0.05273***	0.05211***	0.05162***
	(0.01606)	(0.01607)	(0.01551)	(0.01555)
Civil Servant × $I[t-2017=1]$	0.1267***	0.1252***	0.1080***	0.1075***
	(0.02078)	(0.02082)	(0.02040)	(0.02046)
Civil Servant × $I[t-2017=2]$	0.1752***	0.1737***	0.1264***	0.1253***
	(0.02455)	(0.02459)	(0.02369)	(0.02373)
Civil Servant × $I[t-2017=3]$	0.1926***	0.1922***	0.1168***	0.1177***
	(0.02803)	(0.02810)	(0.02726)	(0.02733)
Civil Servant × $I[t-2017=4]$	0.1820***	0.1807***	0.1763***	0.1766***
	(0.03109)	(0.03114)	(0.03013)	(0.03019)
Husband Age FE	Y	Y	Y	Y
Household FE	Y	Y	Y	Y
Year FE	Y	-	Y	-
City-Year FE	-	Y	-	Y
Observations	126,678	126,678	127,106	127,106

This table examines the impact of the 2017 pension reform on the stock holdings of the civil servant families, using the matched sample as a robustness check. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The table report the estimates of Equation (2), with the dependent variable being the natural logarithm of *Stock/Wealth* in Column (1) and Column (2) and the dependent variable being the natural logarithm of *Stock Holdings* in Column (3) and Column (4). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 7: Robustness Check of Preferential Deposits

	(1)	(2)
	Preferential Deposits	*Stock Holdings*
Year = 2013	13,987.0***	15,192.4
Year = 2014	10,062.8***	44,276.8
Year = 2015	5,358.9***	19,116.6
Year = 2016		
Year = 2017	2,374.0*	52,726.0
Year = 2018	-22,160.3***	127,374.7
Year = 2019	-101,082.3***	169,802.8
Year = 2020	-144,972.4***	165,100.0
Observations	116,588	797,573

This table examines the impact of the 2017 pension reform on the amount of preferential deposits and stock holdings of the civil servant families. Column (1) reports coefficients from an event-study regression of preferential deposits, controlling for mortgage, child dependency, husband age, and household fixed effects. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. Column (2) lists the implied increase in stock holdings (in NTD) calculated from the difference-in-differences estimates from Column 4 of Table 4. All variables are defined in Table A2 in Appendix.

Table 8: Effect of the 2017 Pension Reform on Intensity of Stock Holdings – Subgroup Analysis based on Child-raising Loads

# Children	0	1	≥2	0	1	≥2
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(Stock/ Wealth)	ln(Stock/ Wealth)	ln(Stock/ Wealth)	ln(Stock Holdings)	ln(Stock Holdings)	ln(Stock Holdings)
Civil Servant × Post	0.09048***	0.1424***	0.1936***	0.07378***	0.1167***	0.1253*
	(0.01308)	(0.03801)	(0.06923)	(0.01257)	(0.03685)	(0.06500)
Child			0.006403			-0.004440
			(0.02141)			(0.02038)
ln(1+mortgage)	0.02142***	0.02411***	0.02251***	-0.0006304	0.0004557	-0.0008785
	(0.0005193)	(0.001447)	(0.001949)	(0.0004644)	(0.001268)	(0.001683)
Husband Age FE	Y	Y	Y	Y	Y	Y
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	631906	109421	52595	634827	109917	52829

This table examines the impact of the 2017 pension reform on the stock-to-wealth ratio and the stock holdings of the civil servant families by dividing the sample into subgroups. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variable is the natural logarithm of *Stock/Wealth*, or else the natural logarithm of *Stock Holdings*, which reflects the intensity of financial market participation. The table reports the estimates of Equation (1). Column (1) and Column (4) focus on the sample of households without children of dependency age, Column (2) and Column (5) focus on the sample of households with one child of dependency age, and Column (3) and Column (6) focus on the sample of households with two or more children of dependency age. Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 9: Effect of the 2017 Pension Reform on Intensity of Stock Holdings – Subgroup Analysis based on Owenership of Residential Property

Residential Property Ownership	N	Y	N	Y
	(3) ln(Stock/Wealth)	(4) ln(Stock/Wealth)	(1) ln(Stock Holdings)	(2) ln(Stock Holdings)
Civil Servant × Post	0.1900***	0.09993***	0.1016**	0.07551***
	(0.06140)	(0.01178)	(0.04910)	(0.01174)
Child Dependency	0.04201*	-0.01030*	0.03608*	-0.01112*
	(0.02305)	(0.005900)	(0.02187)	(0.005982)
ln(1+mortgage)	0.01337***	0.02299***	0.003911	-0.0007677*
	(0.004100)	(0.0004717)	(0.002836)	(0.0004336)
Husband Age FE	Y	Y	Y	Y
Household FE	Y	Y	Y	Y
Year FE	-	-	Y	Y
City-Year FE	Y	Y	-	-
Observations	76003	717919	76319	721254

This table examines the impact of the 2017 pension reform on the stock-to-wealth ratio and the stock holdings of the civil servant families by dividing the sample into subgroups. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variable is the natural logarithm of *Stock/Wealth*, or else the natural logarithm of *Stock Holdings*, which reflects the intensity of financial market participation. The table reports the estimates of Equation (1). Column (1) and Column (3) focus on the sample of households without ownership of a house, and Column (2) and Column (4) focus on the sample of households with ownership of a house. Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 10: Effect of 2017 Pension Reform on Excess Return

	(1)	(2)	(3)
		Excess Return	
Panel A:			
Civil Servant × Post	0.8921***	0.9074***	0.9083***
	(0.2259)	(0.2261)	(0.2274)
Child Dependency		-0.3700***	-0.3464***
		(0.1320)	(0.1320)
ln(1 + mortgage)		0.005821	0.006461
		(0.01164)	(0.01164)
		Market Adjusted Excess Return	
Panel B:			
Civil Servant × Post	0.3911*	0.4181*	0.3870*
	(0.2198)	(0.2199)	(0.2213)
Child Dependency		-0.1844	-0.1676
		(0.1288)	(0.1288)
ln(1 + mortgage)		0.003182	0.003503
		(0.01142)	(0.01142)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	797,573	797,573	797,573

This table examines the impact of the 2017 pension reform on the excess return of stock portfolios of the civil servant families. The sample period is from 2013 to 2021. The dependent variable is *Excess Return* in Panel A, and *Market Adjusted Excess Return* in Panel B. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 11: Effect of the 2017 Pension Reform on Risk Exposure (CAPM)

	(1)	(2)	(3)	(4)	(5)	(6)
	α	β	$\sum\epsilon^2$	α	β	$\sum\epsilon^2$
Civil Servant × Post	0.003491	-0.004249	228.23*	0.001259	-0.003650	249.27*
	(0.009087)	(0.003954)	(131.22)	(0.009136)	(0.003969)	(130.43)
Child Dependency	-0.01118**	-0.004548**	-127.06**	-0.01083**	-0.004583**	-129.62**
	(0.004575)	(0.001928)	(62.328)	(0.004577)	(0.001929)	(62.613)
ln(1+mortgage)	-0.000023	0.00006612	-1.5516	-0.0000027	0.00004784	-1.5603
	(0.000352)	(0.000145)	(5.0617)	(0.0003522)	(0.000145)	(5.0669)
Husband Age FE	Y	Y	Y	Y	Y	Y
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	-	-	-
City-Year FE	-	-	-	Y	Y	Y
Observations	797573	797573	797573	797573	797573	797573

This table examines the impact of the 2017 pension reform on the stock portfolios of the civil servant families. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variables are portfolio alpha α, market beta β, and idiosyncratic risk $\sum\epsilon^2$, under the Capital Asset Pricing Model. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 12: Effect of the 2017 Pension Reform on Realized Gains and Losses

	(1)	(2)	(3)
Panel A		ln(1+Realize Gains)	
Civil Servant × Post	0.2255***	0.2521***	0.2566***
	(0.03706)	(0.03667)	(0.03681)
Child Dependency		-0.1052***	-0.1086***
		(0.01849)	(0.01850)
ln(1+mortgage)		0.001870	0.001752
		(0.001553)	(0.001554)
	(1)	(2)	(3)
Panel B		ln(1+Realize Losses)	
Civil Servant × Post	0.1016***	0.1206***	0.1209***
	(0.03130)	(0.03105)	(0.03119)
Child Dependency		-0.03775**	-0.04081***
		(0.01527)	(0.01528)
ln(1+mortgage)		-0.001460	-0.001504
		(0.001367)	(0.001368)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	797573	797573	797573

This table examines the impact of the 2017 pension reform on the realized gains and losses among retired civil servant households. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variables are *ln(1+Realized Gains)* in Panel A and *ln(1+Realized Losses)* in Panel B, which capture patterns of stock-selling behavior. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 13: Effect of the 2017 Pension Reform on the Disposition Effect

	(1)	(2)	(3)
Panel A	Proportion of Gains Realized		
Civil Servant × Post	0.009554***	0.01146***	0.01157***
	(0.002702)	(0.002682)	(0.002692)
Child Dependency		-0.004517***	-0.004806***
		(0.001337)	(0.001338)
ln(1+mortgage)		0.000153	0.000144
		(0.0001176)	(0.0001176)
	(1)	(2)	(3)
Panel B	Proportion of Losses Realized		
Civil Servant × Post	0.004060*	0.005319**	0.005285**
	(0.002383)	(0.002372)	(0.002381)
Child Dependency		-0.00174	-0.00192
		(0.001210)	(0.001212)
ln(1+mortgage)		-0.0000268	-0.0000309
		(0.0001104)	(0.0001104)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	797573	797573	797573

This table examines the impact of the 2017 pension reform on the disposition effect among retired civil servant households. The sample period is from 2013 to 2021, and we focus on a sample of households that had held stocks prior to the pension reform so as to leave out the effect of the pension reform on the retirees' participation in stock markets here. The dependent variables are *Proportion of Gains Realized* (PGR) in Panel A and *Proportion of Losses Realized* (PLR) in Panel B, which capture patterns of stock-selling behavior. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated

Table 14: Effect of the 2017 Pension Reform on Stock Market Participation

	(1)	(2)	(3)
	I_stock	I_stock	I_stock
Civil Servant × Post	0.004295***	0.004759***	0.004396***
	(0.001426)	(0.001428)	(0.001428)
Child Dependency		-0.0006491	-0.0006704
		(0.0007123)	(0.0007138)
ln(1+mortgage)		-0.00001474	-0.00001169
		(0.00005423)	(0.00005419)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	1,247,556	1,247,556	1,247,556

This table examines the impact of the 2017 pension reform on the financial market participation of the civil servant families. The sample period is from 2013 to 2021. The dependent variable is *I_stock*, which reflects the extensive margin of financial market participation. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 15: Effect of the 2017 Pension Reform on the Deposits-to-Wealth Ratio

	(1) ln(Deposits/Wealth)	(2) ln(Deposits/Wealth)	(3) ln(Deposits/Wealth)
Civil Servant × Post	-0.2266***	-0.2293***	-0.2259***
	(0.008617)	(0.008592)	(0.008613)
Child Dependency		0.002404	0.003106
		(0.005292)	(0.005290)
ln(1+mortgage)		0.01458***	0.01464***
		(0.0004135)	(0.0004131)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	630241	630241	630241

This table examines the impact of the 2017 pension reform on the deposits-to-wealth of the civil servant families. The sample period is from 2013 to 2021. The dependent variable is the natural logarithm of *Deposits/Wealth*, which reflects the precautionary savings relative to the total wealth of the household. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in the parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 16: Effect of the 2017 Pension Reform on Real Estate

	(1)	(2)	(3)
Panel A		ln(1+Real Estate)	
Civil Servant × Post	-0.01462	-0.002979	-0.005093
	(0.01362)	(0.01361)	(0.01369)
Child Dependency		-0.008281	-0.007545
		(0.007931)	(0.007950)
ln(1+mortgage)		-0.02067***	-0.02068***
		(0.0006092)	(0.0006092)
Observations	1,234,275	1,234,275	1,234,275
	(1)	(2)	(3)
Panel B		Owning Real Estate	
Civil Servant × Post	-0.003147***	-0.001603	-0.001483
	(0.001188)	(0.001174)	(0.001183)
Child Dependency		0.0003214	0.0004363
		(0.0006201)	(0.0006215)
ln(1+mortgage)		-0.007140***	-0.007137***
		(0.0001128)	(0.0001128)
Observations	1,247,556	1,247,556	1,247,556
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y

This table examines the impact of the 2017 pension reform on owning real estate of the civil servant families. The sample period is from 2013 to 2021. The dependent variable is the natural logarithm of value of real estate in Panel A, and a binary variable *Owning Real Estate* in Panel B. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.

Table 17: Effect of the 2017 Pension Reform on Total Wealth

	(1) ln(1+ Total Wealth)	(2) ln(1+ Total Wealth)	(3) ln(1+ Total Wealth)
Civil Servant × Post	-0.04455***	-0.03682***	-0.04103***
	(0.009575)	(0.009552)	(0.009689)
Child Dependency		-0.02075***	-0.02084***
		(0.006520)	(0.006535)
ln(1+mortgage)		-0.02134***	-0.02137***
		(0.0003342)	(0.0003342)
Husband Age FE	-	Y	Y
Household FE	Y	Y	Y
Year FE	Y	Y	-
City-Year FE	-	-	Y
Observations	1240588	1240588	1240588

This table examines the impact of the 2017 pension reform on the amount of total wealth of the civil servant families. The sample period is from 2013 to 2021. The dependent variable is the natural logarithm of one plus *Total Wealth*. Column (1) to Column (3) report the estimates of Equation (1). Standard errors are clustered at the household level and are shown in parentheses. The estimated coefficient p-values are indicated using the following notation: * p<0.10, ** p<0.05, *** p<0.01. All variables are defined in Table A2 in Appendix.