The Effect of Private Pensions on Household Saving: Evidence from Mandatory Employer-Provided Pension Reform

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Abstract

Population aging causes financial imbalance of the pay-as-you-go public pension (social security) program. To remedy this problem but also ensure the adequacy of retirement saving for employees, many countries complement or substitute for public pensions by regulating private pensions. This paper is the first to utilize national pension policy change as a natural experiment to identify the impact of employer pensions on household voluntary savings. Specifically, I evaluate the household saving response to mandatory employer pension reform in Taiwan, which mandates that all private sector employers contribute at least 6% of the wage to employees' individual pension accounts monthly since 2005. I use the workers in the unaffected sector as a comparison group and employ a difference-in-differences method to estimate the impact of the reform on household saving rate. My results suggest that making private pensions mandatory significantly reduces prime-age (20–50) household saving rate by 2.06% to 2.45% and imply the degree of substitutability between private pension and saving is about -0.51 to -0.61. Since private pensions only partially offset household saving, the mandatory private pension policy could effectively raise employees' retirement wealth.

Keywords: Household saving; Mandatory Employer Pension; Offset effect.

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1 Introduction

The use of mandatory private pensions becomes a popular way for governments to increase provision of pensions without much new public spending. Especially, population aging induces more need for pension provision, but also results in fiscal strain on a pay-as-you-go public pension (social security) system. Many developed countries have begun to complement or substitute for public pension by mandating private pensions[1]. For example, Australia and Netherlands have long traditions of compulsory private pension legislation[2]. This ensures that each worker is covered by a pension plan and, therefore, retains the retiree's standard of living (OECD, 2012). In order to raise the replacement rate of pension income and mitigate the fiscal burden of the social security system, the UK government also launched a mandatory employer pension scheme for all firms in October 2012. Moreover, the latest OECD Pensions Outlook suggests that its 34 membership countries making private pensions compulsory should be an essential policy to ensure that workers have adequate retirement saving in an era of tight fiscal budget constraints (OECD, 2012).

However, the ability of mandatory private pension schemes to raise employees' retirement wealth depends on the elasticity of substitutions between private pension and individual voluntary savings. If private pensions offset personal savings partially, such regulation of private pensions could increase workers' retirement savings. But, if private pensions can perfectly substitute for private saving, then legislation of compulsory private pensions may just generate deadweight loss[3] and fail to help employees accumulate more wealth for their retirement.

Previous studies focus mainly on the displacement effect of social security benefits and tax-deferred saving incentive programs on household savings[4]. However, surprisingly, very few works have obtained improvement in examining the impact of private pensions (ex: employer-provided/sponsored pensions, occupational pensions) (Gale et al., 2005)[5]. This paper fills this gap. I estimate the causal effect of

[1]According to OECD Pensions Glossary (2005), the definition of private pension is this: "A pension plan administered by an institution other than general government. Private pension plans may be administered directly by a private sector employer acting as the plan sponsor, a private pension fund or a private sector provider". The private pension plan usually is financed by employer's (employee) voluntary or mandatory contribution. Hence, employer-sponsored pensions or occupational pensions are a kind of private pension.

[2]Australia introduced a new compulsory occupational pension system, Superannuation Guarantee, in 1992 and it requires employers contribute a percentage of employee's salary into the worker's individual pension account (Tapia, 2008). Netherlands also has mandatory occupational pensions and more than 95% of employees are covered by this system (OECD, 2008a).

[3]For example, this deadweight loss may come from the administrative cost of implementing pension law or distortion of labour market.

[4]Regarding social security, see Feldstein (1974); Kotlikoff (1979); Euwals (2000); Attanasio and Brugiavini (2003); Attanasio and Rohwedder (2003); Feng et al. (2011); Aguila (2011); Banerjee (2011). For tax-deferred/advantaged saving incentive programs, see Poterba et al. (1995); Gale and Scholz (1994); Engelhardt (2001); Pence (2001).

[5]I will review the literature on the effect of private pensions on household saving in later paragraphs.

private pensions on household savings by analyzing a mandatory employer pension reform in Taiwan, which mandates that all private sector employers pay the minimum contribution, 6% of each employee's wage, to the workers' individual pension account monthly since 2005. Before the reform, most of private sector employees in Taiwan could not obtain employer-provided pensions when they retire. I use this pension revolution as an exogenous variation in private pension wealth for the affected workers and employ a difference-in-differences approach to overcome the potential endogeneity problems when estimating the effect of private pensions on household saving (Gale, 1998). I find this mandatory employer pension reform significantly reduces the household saving rate (as a percentage of disposable income) of private sector employees by 2.06% to 2.45% and implies that the elasticity of substitution between private pensions and household saving is about -0.51 to -0.61[6]. Since private pensions do not crowd out household saving completely, my results suggest that making private pensions compulsory can substantially raise workers' retirement wealth.

This paper contributes to the current literature in two important dimensions. Firstly, to the best of my knowledge, this paper is the first study using national policy change as a natural experiment to identify the causal effect of private pensions on household voluntary savings. Many early studies used Ordinary Least Square (OLS) regression to estimate the offset effect of private pensions on saving and their results were mixed. Many of them suggest that private pensions have a very small and insignificant effect on household saving (Cagan, 1965; Katona, 1965; Hemming and Harvey, 1983; Hubbard, 1986; Gustman and Steinmeier, 1999; Alessie et al., 1997). In contrast, a few studies find that private pensions may substantially crowd out 49% to 92% of other household savings (Munnell, 1976; Gale, 1998; Euwals, 2000). As Gale (1998) points out, the magnitude of OLS estimates may be upward biased toward zero since the estimated offset effects are confounded with unobserved heterogeneity in saving preference. For example, employees with a strong propensity to save for retirement may choose the jobs offering generous pension plans. This unobserved preference heterogeneity would introduce a positive correlation between private pension wealth and household savings. Hence, the OLS estimated saving offset effects of private pensions tend to be underestimated[7]. To obtain unbiased estimates of offset effect, we need to find the exogenous variation in private pension wealth that may be driven by exogenous policy change or instrument variables (IV). To my knowledge, only a recent study by Engelhardt and Kumar (2011) tries to solve this endogeneity

[6]Namely, my results imply a 10% increase in employer pension contribution (as a percentage of disposable income) offsets 5.1–6.1% of household savings (as a percentage of disposable income).

[7]In terms of absolute value.

problem[8]

They use U.S. employer-provided pension Summary Plan Descriptions, the legal description of pensions, matched to Health Retirement Survey (HRS) respondents, and then employ this detailed pension rule information to construct IV. Their OLS results reveal that private pension wealth has no effect on non-pension wealth, but IV estimates show that private pensions offset 53–67% of household saving, which is quite similar to my results. My methodology is different from their study. I exploit a reform-induced expansion of pension coverage for private sector workers in Taiwan as an exogenous change of employer-provided pension wealth and use unaffected sector, civil servants, and national enterprise workers as the comparison group to control other unobserved confounding effect. By using this difference-in-differences framework, I can also acquire consistent estimates of the effect of private pensions on employees' saving.

Secondly, compared with previous studies on public pensions[9], this paper exploits relatively radical and transparent policy change. The pension reform raises the coverage rate of employer-provided pensions for private sector workers from 44% to 100% in a very short time (Taiwanese Labour statistic, 2002–2007). In addition, private sector workers consist 85% of employees and more than 60% of labour force in Taiwan. Figure 1 reveals there is an salient change—up to 56% increase—in pension coverage for private sector employees after reform[10]. This sudden expansion of employer-provided pension coverage in Taiwan gives us a rare chance to estimate the average treatment effect (ATE) of private pensions on employees' saving behaviour.

The rest of the paper is organized as follows. Section 2 gives a brief overview of the employer pension

[8]Chetty et al.(2013) use Danish administrative data to investigate the effect of employer-provided pensions on employee's saving behaviour. They utilize the variation in employer pension contribution when employees switch jobs and find employer-provided pensions only much less offset 10%-15% of other household savings. Although they did many robustness check of their results, their crowding-out estimates may still be downward biased (at absolute value) since job switches are endogenous and the variation of employer pension contribution induced by firm switches may be correlated with employees' saving preference.

[9]Several recent studies (Attanasio and Brugiavini, 2003; Attanasio and Rohwedder, 2003; Feng et al., 2011; Banerjee, 2011) form their IV by exploiting changes to the rules of social security benefits, for example, the various increases in social security benefit eligibility age for different cohorts or changes to indexation of the benefit, to generate the convincingly exogenous variation in social security wealth across different cohorts and occupational groups and then estimate the offset effect of public pensions on saving. However, as Imbens and Angrist (1994) point out, when the treatment effect is heterogeneous the IV estimates are, indeed, a local average treatment effect (LATE), namely, they can represent only the average treatment effect of specific subgroup in the population (e.g., compliers, affected cohorts, or occupations). By contrast, the policy variation in this paper is relatively large and may be suitable for applying this pension-saving offset estimates to nationwide populations of employees.

[10]This measure could be the "lower bound" of policy variation, since the pension coverage rate indicates only the percentage of employees covered by employer-provided pension plans. It does not mean these covered workers are eligible for private pensions when they retire. Especially, prior to the reform, the vesting period for pension benefit is very long (25 years in the same firm) so many private sector workers cannot obtain their pension, even if their company offers a pension plan. The 2005 pension reform introduces immediate vesting and makes all private sector workers eligible for pension benefit after retirement. Therefore, the "true" increase in pension coverage induced by reform could be even larger than 56%. I will discuss this issue in Section 2 and Section 6.1.

system in Taiwan and introduces the context of the mandatory employer-provided pension reform in 2005. Section 3 presents the conceptual framework. Section 4 introduces the data and defines the treatment and control groups. Section 5 describes my empirical strategy. Section 6 analyzes the main results. Section 7 performs various specification checks. Section 8 discusses the distinct impact of reform across the saving rate distribution. Section 9 gives concluding remarks.

2 Policy Background

In 2005, the Taiwanese government implemented new labour pension legislation for private sector workers. Each private sector employer was mandated to pay the minimum contribution, 6% of each workers' wage, to employees' individual pension accounts monthly. Prior to the reform, the "old" private sector pension system was legislated by the Labour Standard Law established in 1984. The old pension scheme adopted the unfunded defined-benefit (DB) system. The employers "should" make flexible pension contribution, 2% to 15% of an employee's wage, to the retirement funds "owned by firms". However, the vesting period was very long. The employees had to stay in the same firm for 25 years or stay in the same firm for 15 years and reach 55 years of age. Since the average lifespan of companies in Taiwan is 13 years and the average job tenure is only 6 years (Yang and Luoh, 2009), most private sector employees, except for senior workers in big firms, did not expect to obtain their pensions. According to 2005 Taiwanese Labour Statistics[11], in 2004 (one year before reform), only 20% of the private sector retirees were eligible for employer-provided pensions and 10% of firms[12] followed the law to set up their company pension funds. To improve the coverage of private pensions, the Legislative Yuan (Taiwanese Congress) approved the New Labour Pension Law in July 2004 and implemented this new regulation one year later (July 2005). The main features of the new private pension regulation are as follows. Firstly, the new pension scheme is a funded defined-contribution (DC) system and introduces the compulsory employer-provided pension. The employers are mandated to make monthly pension contributions, at least 6% of an employee's wage, to the workers' individual pension accounts. Secondly, the new system provides immediate vesting, that is, the eligibility of the pension benefits is unrelated to worker's current job tenure. As a matter of fact, the employees' pension benefits are accumulated in their personal accounts[13] rather than firms' pension funds.

[11] It is published by Taiwanese Council of Labour Affairs.

[12] Most of them are big firms.

[13] But, workers can use the money in this account only after they retire and the retirement age is 60. Before retirement, the government helps employees invest their pensions and guarantees a minimum rate of return.

Consequently, under the new pension system, the employees can ensure they receive pensions when their employers pay the contribution monthly. Table 1 briefly compares the new and old private pension systems in Taiwan.

The new pension scheme is applied automatically to all private sector workers who participate in the labour market for the first time or switch their jobs after the reform. It also gives employees, continuing their current jobs after the reform, the option to stay on the old pension scheme or change to the new pension plan during the transition period (within five years after reform). After the transition period, each employee must select his or her private pension plan. The old pension scheme had a higher income replacement rate than the new scheme when workers become eligible for pension benefits. In addition, employees who switch to the new system have to give up all benefits amassed in the old pension system[14]. I expect only senior workers, who are close to retirement and accumulate substantial pension wealth in the company pension fund, are likely to continue with the old pension plan and would not be affected by the pension reform. As reported by 2006 Taiwanese Labour Statistics, the coverage rate of the new pension scheme decreases by workers' age. The coverage rate for employees under 50 years of age is 84%, but for workers over 50 drops to 48%[15].

In contrast to private sector workers, public sector employees, including civil servants and workers in national enterprises, have their own pension systems, which are not affected by 2005 pension reform[16]. Taking advantage of this institutional difference between two sectors, I use public sector workers as the control group to identify the causal effect of private pension provisions on household savings. In Section 6, I will examine the validity of the control group.

3 Conceptual Framework

In this section, I use a simple model to describe how employer pensions contribution affect household savings. In addition, the model solution represents "perfect offset" of employer-provided pensions on household savings. By comparing this 100% offset effect with the empirical results, I can infer the degree of substitution between private pensions and household savings, which is the main focus in previous studies and the debates among policy makers.

[14]Since workers may change their jobs in the future and cannot obtain these pension benefits under the old pension system, many employees may still switch to the new system, even if they accumulated some wealth in the old system.

[15]In old pension system, there is maximum tenure of pension contribution (30 years). After that, employees can change to new pension system.

[16]In fact, the public sector pension system did not make any change during my sample period (2002–2007).

Hence, I analyze a two-period life cycle model, where the only saving motive in prime age (first period) is for consumption during retirement (second period)[17]. I will perform a comparison of household saving in the following two policy regimes: (1) Post-reform: an economy where employers are mandated to offer pensions to their workers; (2) Pre-reform: an economy without employer-provided pensions[18]. The effect of employer-provided pensions on household saving is just the difference of household saving between two policy regimes.

3.1 A regime with mandatory employer pensions

Under a compulsory employer-provided pension regime, firms have to contribute a mandatory rate τ of wage W to the workers' pension. The compulsory employer-provided pension is a kind of mandated benefit offered by employers and such mandated benefit is like a tax imposed on firms. It is assumed that the labour market is perfectly competitive and employer-provided pensions do not affect labour productivity. Hence, this "pension tax" raises firms' per unit labour cost to $(1+\tau)W$ and shifts down the labour demands by τW.

As Summers (1989) points out, employers could shift the cost of mandated benefits to workers if employees also value these benefits. I assume workers fully value the pension benefit at cost, namely, employees treat employer-provided pensions as cash income (full tax/benefit linkages). As such, employees are willing to accept a dollar-for-dollar decrease in current wage to obtain future pension benefit. That is, firms can fully shift the pension cost to workers and the wage rate employees actually can get becomes $(1-\tau)W$. Therefore, employer pensions contribution can be treated as compulsory retirement saving for workers. A representative household (worker) optimizes his lifetime utility by solving the following problem:

[17]That is, this simple model does not include uncertainty and ignores precautionary motive saving.

[18]From Section 2, we know that prior to reform, most private sector workers in Taiwan were not covered by a pension plan and very few employees were eligible for employer-provided pensions when retiring. Therefore, I refer to an economy without employer-provided pensions as the pre-reform regime.

$$\begin{aligned} \max_{C_1,E_1,C_2} \quad & \log(C_1) + \log(E_1) + \beta \log(C_2) \\ \text{subject to} \quad & C_1 + S^1 = (1-\tau)WL_1 + (1-a)I \\ & C_2 = (1+r)S^1 + (1+r)\tau L_1 W \\ & L_1 + E_1 = 1 \end{aligned}$$

I assume the household has a log-utility and faces no uncertainty. It cares about the consumption in the first period (prime age) C_1, leisure time E_1, and consumption in the second period (retirement) C_2. Note that the superscript $d = 1$ represents the household saving in an regime with employer-provided pensions and $d = 0$ expresses the counterpart without them[19]. β is the discount factor for second period utility of consumption. Total time endowment is normalized to one and is used for leisure and labour supply. To finance the first period consumption, the household offers L_1 units of labour input to obtain current wage income $(1-\tau)WL_1$. The household also has non-labour income $(1-a)I$ (ex: transfer payments), where a is denoted as the share of labour income[20] to total household income (over lifetime) I. In the second period, the household retires and consumes its pension benefit $(1+r)\tau WL_1$ accumulated in the individual pension accounts. In addition, the household can also use the voluntary saving S^1 from the first period to finance its retirement consumption. I assume that the household would not leave any bequests and debt at the end of the life span (second period). Thus, the household does not hold any assets in the beginning of first period and has to consume all wealth in the last period. Finally, the return of private pension and saving are assumed to be at the same interest rate r in both policy regimes.

By solving the above maximizing problem, we can easily derive the household saving rate SR^1 (as a percentage of income I) in a mandatory employer pension regime:

$$SR^1 = 1 - \frac{1}{1+\beta} - \tau a \tag{1}$$

[19]In this simple model, since employers could fully shift pension cost to employees, there is no employment effect. Only household saving and current wage workers actually get are affected by employer-provided pension. Other variables are the same in both policy regimes.

[20]Labour income includes current wage income and future pension benefit. That is, $WL_1 = aI$.

3.2 A regime without employer pensions

For an economy without employer-provided pensions, the only difference is that firms are free of providing pension for the employees ($\tau = 0$) and then there is no need for them to shift pension cost by reducing current wage. At the same time, the household would not receive any pension benefit after retirement and would use its prime-age voluntary savings only to finance retirement consumption. The optimal household saving rate SR^0 in a regime without employer-provided pensions becomes

$$SR^0 = 1 - \frac{1}{1+\beta} \tag{2}$$

Therefore, the perfect offset of mandatory private pension on household voluntary saving is just the difference between (1) and (2).

$$\Delta^{Pension} = SR^1 - SR^0 = -\tau a \tag{3}$$

Expression (3) represents the perfect offset effect of private pension on household saving rate, which depends on the pension contribution rate τ and the labour income share a, respectively. Many reasons can explain why a private pension could not completely offset household savings. For example, other than saving for retirement, a household may have a precautionary saving motive to insure against income fluctuation (uncertainty). In addition, a private pension is indeed not a perfect substitute for household saving, since pension wealth is not liquid asset. Finally, households may be poor at making intertemporal decisions and are likely to misunderstand the value of pension benefits (Summers, 1989) or some of them are passive savers (Chetty et al. 2013). Nevertheless, this simple model still can help us determine the mechanism of how employer-provided pensions affect household saving decisions. In Section 6, I will compare expression (3) and my difference-in-differences result to infer the elasticity of substitution between private pension and household saving.

4 Data and Sample

4.1 Data

In order to calculate household saving rate and identify the targeted sample, we need data recording detailed information on household income, consumption, and household members' occupations. I use

the Taiwanese Survey of Family Income and Expenditure (TSFIE), conducted annually since 1976 by the Taiwanese Directorate-General of Budget, Accounting and Statistics (DGBAS). The TSFIE is an ongoing repeated cross-section income and consumption data set that follows the progress of a nationwide representative sample of Taiwanese households. Its sample size is around 14,000 households and 55,000 individuals each year. The TSFIE contains detailed information on household wage income, non-wage benefit, capital gains on real estate and financial assets, consumption of durable and non-durable goods, tax expenditure, transfer income and expenditure. It also has household members' occupations and working status. I use this information to obtain household saving rates and define the treatment and control group.

4.2 Treatment and control groups

In contrast to the previous studies (Aguila, 2011; Chou et al., 2003), which define the treatment group by the head's sector, I identify the treatment group by using detailed household members' sectoral information in TSFIE. Hence, the treatment group consists of the households with at least one member working in the private sector and no one working in the public sector. In the same way, the control group contains those with at least one member working in the public sector and no one working in the private sector[21]. This arrangement is more suitable for Asian families, since we have larger family size and many other family members also participate in the labour market[22]. If we do not take each family member's sectoral choice into account, the estimates of policy impact will be biased toward zero when the head and other family members are opposite sector workers[23].

4.3 Sample

I employ 6 periods of TSFIE data from 2002 through 2007. Since the new private pension system was introduced in 2005, I use 2002–2004 and 2005–2007 samples to represent the periods before and after the pension reform, respectively. My sample is restricted to the treatment and comparison groups defined in the previous section. I also confine the sample to families headed by prime-age workers (20–50 years old)

[21]I also exclude the households whose family members are self-employed or work in the agricultural sector, since these sector workers often misreport their income and consumption (Gale, 1998; Attanasio and Rohwedder, 2003).

[22]In my sample period (2002–2007), the average number of family members is 3.88 people and more than one family members (1.69 people) have jobs.

[23]For example, the household head is a public sector worker and other family members are private sector employees. We would define this family as control group by using the head's sector as the criterion. However, this household's saving should be affected by pension reform since other family members are in the treatment group. These contaminated households are excluded from my sample. We allow only "pure" private (public) sector families in my sample. I will conduct robustness check on this issue in the Section 7.

for two reasons. First, the main purpose of this paper is to investigate whether the mandatory private pension provision can raise employees' retirement "wealth". Since the retirement wealth is comprised of the prime-age saving and the average retirement age of private sector workers in Taiwan is around 55 (Taiwanese Labor Statistic, 2005), it is better to focus on pre-retirement (prime-age) saving behaviour rather than old age. Secondly, the coverage rate of the new pension system decreases by workers' age; most employees under 50 years of age are covered by the new pension scheme. In contrast, for workers above 50, more than half of them still stay in the old pension system. Hence, this sample selection also can ensure that most of our treatment group really are affected by pension reform. Finally, to avoid the effect of outliers, I exclude households whose saving rate is above 100% or below −100%. Hence, the main sample includes 32,921 households. About 28,746 (87.31%) of households belong to the treatment group (private sector families) and 4,175 (12.69%) of households are the control group (public sector families).

4.4 Variables

The outcome variable of interest, household saving rate SR_i, is measured as the difference between household after-tax income and consumption expenditure divided by household after-tax income. The household income includes wage income and non-wage income (ex: non-wage benefit, asset returns, and transfer income). I subtract any income tax, capital tax, and employee mandates for health insurance from household income to get household after-tax income. The consumption expenditures contain spending on both durable and non-durable goods.

In the empirical analysis, I include several important control variables X_i: (1) Family chacteristics: head's age, head's age squared, head's education, head's gender; spouse's education; number of children under 18, number of members over 65, number of members above 18, number of working members, and living county dummies. (2) Industry & occupation: head's industry and occupation. (3) Household wealth: household non-wage income, housing assets[24].

5 Empirical Specification

In this section, I estimate a difference-in-differences model comparing the evolution of saving rate in private sector households and public sector households around the time of pension reform. This strategy

[24] A dummy variable for whether having own house and housing size.

will identify the impact of mandatory pension reform as long as there are no other reasons why saving behaviour would be changing, relatively, for private and public sector employees at this time. The following difference-in-differences regression is used for my main analysis:

$$SR_i = \beta^{DD} PENSION_i + \alpha PRIVATE_i + \gamma YEAR_i + X_i\psi + \varepsilon_i \tag{4}$$

Note that each household i can be observed only once since I use repeated cross-sectional data. I include $PRIVATE_i$, private sector dummy, $PRIVATE_i = 1$ represents treatment group (private sector households) and $PRIVATE_i = 0$ denotes control group (public sector households). $YEAR_i$ are year dummies for all sample period: 2002 to 2007. α measures unobservable time-invariant differences in saving rates between private and public sector households. γ captures year-fixed effect (common macroeconomic impact). Since the difference in observed covariates may lead to a distinct time trend of household saving rate between treatment and control groups, it is better to control the related covariates to eliminate the impact of other confounding factors affecting saving behaviour across groups. Moreover, controlling covariates can also reduce the residual variance of the regression and achieve more efficient estimates (Meyer, 1995; Vincenzo and Vincent, 2006). X_i is the covariates vector of observed household characteristics related to saving, suggested by previous studies (Aguila, 2011; Chou et al., 2003). ε_i is the error term.

The key variable $PENSION_i$ is a dummy indicating that household i is eligible for treatment (receiving mandatory employer-provided pension after reform), meaning that household i works in the private sector in the post-reform years 2005–2007[25]. Its coefficient β^{DD} is the standard difference-in-differences estimator. Since I have controlled group and year-fixed effects, β^{DD} measures the differential trend in average household saving rate among private sector workers relative to public sector in the post-reform years. I can refer the different evolution of household saving rate between two groups to the effect of mandatory pension reform on saving rate for private sector households if I impose the following identification assumptions: Firstly, the public and private sector households' saving rates should follow a common trend in the absence of pension policy change. Given this assumption, we can use the observable post-reform trend in saving rates for public sector households to impute the counterfactual evolution of private sector household saving rates after reform. This assumption can ensure that my results do not come from pre-reform different trends in household saving rate between treatment and control group.

[25] $PENSION_i = 0$ means the household i works in public sector or can be observed in the years 2002–2004.

Secondly, except for pension reform, no other shock over my sample period has a differential effect on both group household saving rates. That is, the differential evolution of saving rates for private and public sector households after 2005 should be mainly driven by pension reform. I cannot completely rule out some other shock during this period that may had distinct effect on savings across private and public households. However, given the magnitude of pension coverage change[26], it seems highly unlikely that other shock, if exists, could be the driving force for the relative shift in saving rate between two sector workers over this time period[27].

Thirdly, I assume there is no selection to treatment based on unobservables ε_i once I control observable covariates X_i. In other words, employees with high saving preference (unobserved) might not switch to private sector for obtaining employer-provided pension after reform[28]. This assumption can make sure my results are not driven simply by workers' self-selection to the treatment group after reform. Such a self-selection problem is unlikely to occur, since public sector employers offer more generous pensions to their employees than private sector employers even if pension reform substantially raises the most of private sector workers' employer-provided pension wealth. In Section 6, I will use three placebo tests to examine the credibility of these identification assumptions.

Two caveats to my estimating procedure have to be mentioned before analyzing the results. First, my identification strategy indeed analyzes the intention-to-treat effect instead of the average treatment effect on the treated. Since I do not have the individual-level data concerning workers' employer-provided pension coverage, I estimate the reduced form effects on all private sector workers (eligible population) rather than the workers who are newly covered by employer-provided pension (affected population). To recover the average treatment effect on treated, I need to divide β^{DD} by the proportion of truly affected private sector employees[29] (Bloom, 1984; Baker et al., 2008). If the fraction of truly affected workers is close to one, the intention-to-treat effect would approach the average treatment effect on those treated. In my sample (prime-age workers), over 84% of employees are covered by the new pension scheme. Furthermore, this reform may make 80% of private sector retirees newly eligible for employer-provided pensions. It is arguably that the fraction of affected employees is high. Hence, β^{DD} (intention-to-treat effect estimates)

[26]As mentioned in section 1, this reform raise the coverage of employer-provided pension from 44% to 100% in a very short time and make more than 80% of private sector employees eligible for employer-provided pension when they retire.

[27]In fact, during the entire sample period (2002 to 2007), there is no other policy affecting labour market and workers' saving behaviour. Furthermore, the economy of Taiwan over these years was stable and did not experience a recession. Thus, it is arguably sound to make this assumption.

[28]However, this self-selection problem may lead my estimates being underestimated.

[29]We also need to assume there are no externalities of pension reform for treated households.

may not be far from our quantity of interest: the average treatment effect on the treated. I will return to the specifics of this issue in Section 6.

Second, the correct computation of standard error is a crucial issue of difference-in-differences approaches. Since the policy variation I use is at the sector-year level, I present the robust standard errors clustered on the sector-year cells[30] to account for any dependence of the unobservable error within sector-year cells. Furthermore, in recognition of the small number of clusters, following CGM, (2008)'s suggestion, I adopt relatively conservative inference by using the $T(G-2)$ distribution rather than the standard normal distribution to form critical value and p-values[31]. For the small number of clusters, this correction may make substantial difference in inference results (Angrist and Pischke, 2009). In section 7, I will also use different levels of clustering (ex: cluster on sector/pre- and post-reform period) and various inference methods (ex: block bootstrap (BMD, 2004) ,wild bootstrap (CGM, 2008)) to address this issue.

6 Results

6.1 Summary statistic

Table 2 compares the trend of outcome variables and covariates between the treatment and control groups before and after reform. It also performs a simple DD estimate for each variable[32]. There are two things we can learn from Table 2. First, for private sector workers, household saving rate, household savings and wage income[33] significantly decrease after reform. However, the counterparts of public sector households remain the same. In fact, the average growth rate of per capita GDP in Taiwan during 2005–2007 is around 4%. Therefore, we should expect the wage income as well as household savings should not decrease in the absence of pension reform. The simple difference-in-differences estimates indicate that pension reform makes household saving rate, household savings and wage income of private sector workers significantly reduced by 1.35%, 38,045 NT$, and 35,818 NT$, respectively. Especially, it implies that

[30]There are two sectors (private/public sector) and six years (sample period 2002–2007). Therefore, I have $2 \times 6 = 12$ clusters.

[31]G is the number of clusters so G is 12.

[32]The simple DD estimates I employ here are

$$Variable_i = \delta^{DD} PENSION_i + \delta_1 PRIVATE_i + \delta_2 POST_i + \varsigma_i$$

where $PENSION_i$ and $PRIVATE_i$ are defined in Section 4. $POST_i$ is the dummy for post-reform period: 2005–2007. I focus on the DD estimates δ^{DD}.

[33]All of these variables are measured in 2007 New Taiwan Dollars.

pension reform leads to wage income being reduced by 5.31% and employers may fully shift the mandatory pension cost to the employees[34], which is consistent with the findings in Yang and Luoh (2009)[35].

Second, except for the above three variables, the simple difference-in-differences estimates reveal that other variables are not affected by pension reform. Thus, there is no composition change in covariates after reform.

6.2 Main results

Columns (1)–(3) of Table 4 display the difference-in-differences estimates for the effect of mandatory employer-provided pension reform on household saving rates of private sector employees. We find the coefficients on policy variable $\widehat{\beta}^{DD}$ are from -0.0198 to -0.0206 depending on the set of covariates, and all of them are significantly different from zero at the (less than) 1% level. My preferred specification (column 3) implies that pension reform makes the household saving rates of private sector employees fall by 2.06%. This is a sizeable decrease that amounts to around 10% of pre-reform household saving rate[36].

Note that this estimate is an intention-to-treat effect. To arrive at the average treatment effect on those treated, it must be divided by the proportion of truly treated workers. I propose two measures of this proportion. Firstly, as reported by 2006 Taiwanese Labour Statistics, we know that around 84% of workers below age 50 are covered by the new scheme. By using this number to represent the probability of treatment for my sample, the estimated average treatment effect on treated indicates pension reform leads to a 2.45% decline in household saving rate of private sector workers[37]. Secondly, I use the change in coverage rate of employer-provided pensions to get an estimate of the percentage of treated employees. As mentioned in Section 1, Figure 1 indicates that reform induces a 56% increase in the coverage rate of employer-provided pensions. The average treatment effect on treated estimate calculated by this method suggests making employer-provided pension compulsory reduces household saving rate by 3.68%[38]. I prefer the first estimate than the second one since, due to the very long vesting period of the old pension scheme, many covered employees still fail to get back their pension when retiring. In fact, before the reform, only 20% of retired private sector workers are eligible for employer-provided pensions. The estimate of the proportion of truly treated workers by using the second method could substantially underestimate the

[34]This is a simple calculation: $3.5818/67.343 = 5.31\%$, 67.343 is pre-reform wage income

[35]Yang and Luoh (2009) use 2003–2007 Manpower Utilization Survey (labour force survey data, like Current Population Survey in the United States) and find pension reform reduces hourly wage rate by 5.92%.

[36]The pre-reform household saving rate of private sector workers is 22%.

[37]This is just a simple calculation: $2.06\%/0.84 = 2.45\%$.

[38]This is just a simple calculation: $2.06\%/0.56 = 3.68\%$.

probability of treatment.

These estimates of reform impact on household saving rate can be used to estimate the elasticity of substitution between private pension and household saving, which is a main issue in previous studies. The simple two-period life cycle model in Section 3 tells us that the "complete offset" of household saving induced by employer-provided pensions depends on the employer's pension contribution rate τ and the labour income share a. The statutory employer's mandatory contribution rate τ is at least 6% of a worker's wage[39] and the average labour income share a for private sector household in my sample is around 67%[40]. By using the above information of model parameters, I can "calibrate" the perfect offset of household saving rate. The simple calibration implies this pension reform might implicitly mandate that private sector workers "save" 4.03% of their total household income for retirement. Comparing the estimates of reform impact with the calibrated perfect offset, we obtain that the implied degree of substitution between private pension and household voluntary saving is around -0.51 to -0.61[41]. That is, a one dollar increase in employer-provided pension can displace fifty-one to sixty-one cents of household saving.

6.3 Falsification tests

In this section, I utilize three falsification tests to check the validity of public sector households as a comparison group.

The first placebo test uses previous periods of (1999 to 2004) TSFIE data to see whether there exists a parallel trend of saving rate between private and public sector households before reform. I assign a fake policy change to 2002 and choose 1999–2001 and 2002–2004 as pre- and post-reform periods, respectively. Actually, during this period, there is no policy change affecting both sector workers' saving behaviour. If two groups of household savings have common trend before pension reform, we should expect the insignificance of "treatment effect" estimates $\widehat{\beta}^{DD}$ in the 1999–2004 sample. The result in Table 4 column (4) indicates that the $\widehat{\beta}^{DD}$ is -0.0088 and not significantly different from zero. This result implies that private and public sector household saving rates may share similar trends before 2005 pension reform.

Secondly, I use "less affected" private sector households whose heads work in the banking industry as a new treatment group[42] to examine whether there are other confounding factors affecting the saving rate of

[39] According to the 2006 Taiwanese Labour Statistic, most of employers pay only the minimum pension contribution, 6% of the workers' wage.

[40] I use the current wage income share to approximate this parameter.

[41] This is a simple calculation using intention-to-treat effect estimate: $-2.06\%/4.03\% = -0.51$ and average treatment effect on treated estimate: $-2.45\%/4.03\% = -0.61$.

[42] The comparison group is the same (public sector employees).

private and public sector households differently. Before pension reform, the private pension coverage rate of banking industry was particularly high, around 90% of the employees had an employer-provided pension plan (Taiwanese Labor Statistic, 2001)[43]. Pension reform should have much less impact on these workers. Hence, if there is no other shock, except for the pension reform, having a distinct impact on the saving rate of private and public sector employees, we should expect that the workers in private banks having no/less saving response to the reform column (5) in Table 4 indicate that the pension reform leads to small and insignificant reduction in the saving rate of households with heads working in private banking (point estimate is only -0.0056). To reinforce the finding in the above placebo test, I also replace the treatment group with households whose heads work in food service (ex: waiters in restaurants). The pension coverage rate of food service job before reform is only 29% and job mobility is high (Taiwanese Labor Statistic, 2001). Hence, in contrast to the banking industry, employees in food service industry have very little chance to get back their pension after retirement. Thus, the mandatory private pension provision should have larger negative impact on their saving rate. The column (6) in Table 4 shows that the pension reform makes the households with heads working in food service significantly decrease their saving rate by 3%, which is even larger than reduced amount for all private sector workers (in absolute terms). In sum, these placebo tests imply that pension reform may be the main reason that accounts for the differential trend in average household saving rate among private sector workers relative to the public sector after 2005.

The last placebo test uses the sample with household heads on the verge of retirement (head's age is above 51 years). Since the average age for retirement in Taiwan is around 55 and over half of 51–65 year-old private sector workers still accumulate their pension wealth in the old system, we would expect that their saving behaviour would have no/less response to mandatory employer-provided pension reform if there is no other shock affecting private and public sector workers' saving differently. The result in Table 3, column (5) confirms my conjecture that the point estimate of $\widehat{\beta}^{DD}$ is not significantly different from zero and indicates that the evolution of saving rate for the private sector employees close to retirement does not change after reform.

In general, the estimates in three falsification tests are sharply contrasted to the main results, providing credence to my estimated reform impact on household voluntary saving.

[43]These are the latest data of pension coverage rate for each industry. After 2001, the government was reluctant to release such statistics, since law enforcement of the old pension scheme was very bad.

6.4 Comparison with previous studies

My results reveal a substantial offset effect of private pensions on household savings and the estimated elasticity of private pensions to household saving is around −0.51 to −0.61. This finding is in accordance with the recent studies that employ an instrument-variable identification strategy to estimate the crowding-out effect of social security benefit or private pension on household saving/wealth.

Attanasio and Brugiavini (2003) explore the effect of social security reform in Italy and obtain an average elasticity of substitution between social security benefit and household saving as −0.35 to −0.71 (across all age cohorts: 20–65) and they find the substitutability is particularly high for employees aged 35–45 (close to −1). Using UK household data, Attanasio and Rohwedder (2003) find that the estimated crowding-out effect of social security benefit on household saving is not significant for the young cohort (20–31 year-olds) but the significant elasticity of substitution is around −0.65 to −0.75 for middle age households (43–64 year-olds).

For the literature on private pensions, as mentioned in Section 1, many earlier OLS estimates failed to find a saving offset effect of private pensions and might suffer from an endogeneity problem. The recent research by Engelhardt and Kumar (2011) is the only exception. They use Health and Retirement Study (HRS) data and construct IV for employer-provided pensions by exploiting detailed employer-provided pension plan supplement with HRS. In contrast to this paper, their HRS samples are households with head's age above 50 years old. However, it is still appropriate to compare their results with my difference-in-differences estimates since they estimate the effect of pension "wealth" on household "assets" (stock variable) rather than saving (inflow variable) and the retirement wealth mainly consists of prime-age saving. Actually, they find a similar magnitude of substitution between private pension wealth and household other assets, that is, private pension wealth offset half (53–67%) of non-pension wealth in the United States.

7 Specification Check

My estimation presented thus far shows clearly that pension reform reduces the private sector family saving rates by 2.06% to 2.45%. These results indicate a considerable elasticity of substitution of private pension for household saving, which is around −0.51 to −0.61. I also conducted three falsification tests to check the effectiveness of the control group and confirmed that public sector families may be a suitable control group. I now experiment with various specifications to examine the robustness of my results.

7.1 Different methods of statistical inference

In this section, I explore the robustness of my main results to alternative methods of statistical inference. Firstly, to account for temporal dependence in the error, I start by assuming the dependence is restricted to the pre- and post-reform periods. However, I find the standard error becomes even smaller than my main results, whose standard error is clustered on sector-year cells. The estimated pension offset effect $\widehat{\beta}^{DD}$ still significantly differs from zero at 1% level when using $T(G-2)$ distribution to obtain p-value[44] (see Table 5 column (2)).

Next, following Bertrand, Duflo, and Mullainathan (2004), I conduct block bootstrap procedure (clustered on sector-year cells). This method maintains the correlation structure within clusters by keeping samples that belong to the same cluster together in a block. Furthermore, instead of bootstrapping standard error, this method directly bootstraps t-statistics so I can only report p-value but not standard error. The result shows that the p-value of $\widehat{\beta}^{DD}$ computed by a block bootstrap is , which achieves 1% statistical significance level.

Finally, I also show results from the wild cluster bootstrap approaches[45] suggested in Cameron et al. (2008). This method aims at improving inference in cases with a small number of clusters and avoid the problem of inestimable coefficients by resampling the residuals rather than pairs of independent and dependent variables (ex: block bootstrap). Especially, inestimable problem is more serious in this paper since I have small clusters and the parameters of interest are indicator variables (difference-in-differences estimator $\widehat{\beta}^{DD}$), which will encounter the problem that resampling regressors are all 0 or 1. The p-value computed by this approach, as expected, is a bit larger (p-value is 0.007) but still at 1% significance level.

7.2 Nonparametric difference-in-differences

The restriction of my main results is that it imposes a strong linearity assumption. Moreover, the linear difference-in-differences regression does not require the treatment and comparison groups to have common support on the observable control variables X_i. If the treatment and control groups lack common support, the linear difference-in-differences model has to extrapolate outside the area of common support, based on the fitted value of linear regression. When employer-provided pensions have nonlinear effects on household saving, then the estimates of reform impact, based on linear difference-in-differences regression,

[44] G is the number of clusters so G is 4 in this case.

[45] Again, I cluster on sector-year cells.

might suffer from a misspecification problem. In this section, to relax the linearity assumption, I conduct a nonparametric difference-in-differences estimation by combining difference-in-differences estimator with propensity score matching (Heckman et al., 1997; Bundell et al., 2004; Aguila, 2011).

Nonparametric difference-in-differences is appealing for its imposing no restriction on function form. However, when the dimension of continuous covariates X_i increases, the nonparametric estimator would have a very slow convergence rate (Abadie and Imbens, 2006). This is a well-known problem, "curse of dimension", in nonparametric econometrics literature. The propensity score matching is a dimension-reduction method. Rosenbaum and Rubin (1983) show that instead of conditioning k-dimensional control variables X_i, we can still equalize the covariates distribution between treatment and control groups by conditioning on a single index propensity score $P(X_i)$ (the probability of household i being treated). By doing so, when conducting the nonparametric estimation, I can greatly reduce the computational burden and then speed up the matching process.

To ensure that the characteristics X_i of the treated and untreated samples have common support, I need to impose the following restriction on the propensity score $P(X_i)$:

$$P(X_i) = P[I_i = 1|X_i] < 1$$

where $P(X_i)$ is the propensity score for the sample i being treated. Hence, this assumption means no specific set of observed characteristics X_i can perfectly predict the treatment status I_i of any household i (ex: $P(X_i) = 1$), that is, there is overlap between treated and untreated samples at all values of X_i observed in the treated sample (eg: private sector households after reform). Since TSFIE is repeated cross-section data, there are two sources of nonrandomness—private and public sector households—before and after the pension reform; I need to estimate two propensity scores[46] for group and time to balance the distribution of the covariates X_i in all four subgroups[47].

Firstly, I use a logit model to estimate two propensity scores for belonging to private sector and being observed after reform, respectively[48] and then impose common support by restricting four subgroups

[46]Indeed, $P(X_i) = P_G(X_i) \times P_T(X_i)$. $P_G(X_i)$ and $P_T(X_i)$ are propensity scores for the sample in treatment group and after reform, respectively.

[47]The four groups are (1) private sector households in 2004–2007 (post-reform), (2) private sector households in 2002–2004 (pre-reform), (3) public sector households in 2005–2007 (post-reform), (4) public sector households in 2002–2004 (pre-reform).

[48]If I had panel data, I would just need to estimate propensity score for treatment and control samples, as in the usual case.

to have the same distribution of $P(X_i)$. Finally, I adopt kernel matching to implement nonparametric difference-in-differences estimation. Kernel matching constructs the counterfactual by using the weighted average of all control samples[49] around the neighbourhood for each treated sample. The neighbourhood is defined by bandwidth h_n and the different weights given to untreated observations within neighbourhood are computed by the kernel function $K(.)$. I choose bandwidth $h_n = 1.06\sigma N^{-1/5}$ suggested by Silverman (1986), where σ is the standard error of the propensity and N is the sample size of treatment group after reform (within common support). The kernel function $K(.)$ is from Epanechnikov[50]. The propensity score matching difference-in-differences estimator becomes

$$\widehat{\beta}^{PMDD} = \frac{1}{N}\sum_{i\in T_1}\left\{\left[SR_i^1 - \sum_{j\in T_0} w_{ij}^{T_0} SR_j^0\right] - \left[\sum_{j\in C_1} w_{ij}^{C_1} SR_j^0 - \sum_{j\in C_0} w_{ij}^{C_0} SR_j^0\right]\right\} \tag{5}$$

where $g \in \{T_0, T_1, C_0, C_1\}$ represent the sample of the private and public sector households before and after the pension reform and all of them are within common support. w_{ij}^g denotes the weight[51] to untreated household j when estimating the counterfactual saving rate of treated household i.

Because the complexity of standard error of propensity score matching difference-in-differences estimator (no closed form), I obtain the standard error with the bootstrap method in 1,000 replications with replacement. After imposing common support for 4 subgroups, only 1.5% of sample (500 observations) are outside of the common support. This result implies that the estimates in linear difference-in-differences may not be far from the nonparametric difference-in-differences results since most of observations lie in common support and not many matchings need to be estimated by linear extrapolation. The results in Table 5 column (1) show that the pension reform makes private sector household saving rates signifi-

[49]The control samples are from three subgroups: (1) private sector households in 2002–2004 (pre-reform), (2) public sector households in 2005–2007 (post-reform), (3) public sector households in 2002–2004 (pre-reform).

[50]The Epanechnikov kernel is this function:

$$K(x) = \frac{3}{4}(1-x^2)1\{|x| \le 1\}$$

[51]These weights are calculated by the Epanechnikov kernel function as below:

$$w_{ijt}^g = \frac{K\left(\frac{P(X_j)-P(X_i)}{h_n}\right)}{\sum_{j\in g} K\left(\frac{P(X_j)-P(X_i)}{h_n}\right)} \tag{6}$$

where $P(X_j) - P(X_i)$ measures the difference between the propensity score of treated household i and the counterpart of untreated household j. If $P(X_j) - P(X_i)$ is small it will give more weight on household j's saving rate when constructing counterfactual. In contrast, if $P(X_j) - P(X_i) \ge h_n$, the household j will receive zero weight since the sample j has very different observed characteristics with sample i.

cantly decrease by 2.64% and the implied elasticity of substitution between employer-provided pension and household saving is −0.66, which is higher than the estimates in linear difference-in-differences regression. However, both difference-in-differences estimates are not significantly statistically different.

7.3 Different definition of saving rate

Deaton and Paxson (2000) suggest that the household saving rate can be approximated by the difference between the logarithm of family after-tax income $\ln(Y)$ and logarithm of family consumption expenditure $\ln(C)$. Hence, I redefine my dependent variable, household saving rate, as $\ln(Y) - \ln(C)$. The column (5) of Table 5 shows that this specification is less precise[52] and yields a larger policy effect; the point estimate of $\widehat{\beta}^{DD}$ is −0.0254 and significantly differs from zero at 1% level (p-value is 0.007). The pension reform induces a 2.54% decline in household saving rate and the estimated elasticity of saving with respect to employer-provided pension is about −0.63.

7.4 Different definitions of treatment and control groups

In the third column (3) of Table 5 we follow previous studies (Aguila, 2011) and redefine the treatment and control groups by using household head's sectoral choice. As mentioned in Section 5.2, this specification should lead the estimates of pension crowding-out effect $\widehat{\beta}^{DD}$ upward biased toward zero when other family members have different sector jobs. As expected, I find the estimated reform impact is smaller, suggesting only 1.41% decrease in household saving rate, but still significantly differs from zero at 1% significant level, and the estimated degree of substitution between employer-provided pension and household saving is about −0.34.

7.5 Different sample periods

To eliminate the influence of any anticipated effect on my results, I exclude 2004 and 2005 TSFIE data. These two years are the new pension law passing year and the pension reform starting year. However, the result based on this new sample period is similar to my main result (see column (7) of Table 5).

[52] Standard error is 0.009.

8 Impact Across the Saving Rate Distribution

The estimates in the previous sections are "average" reform impact on workers' voluntary saving. I find mandating employer-provided pensions for their employees, on average, reduces prime-age workers' saving rate in treatment group by 2.06% to 2.45%. However, these estimates summarize the reform impact in a single number and cannot give us the "overall" reform impact on worker's saving behaviour if pension reform does not have a universal effect on each worker. This conjecture is highly possible since employees may have different pension coverage before pension reform. For example, before the reform, 90% of workers in private banking industry are covered by employer pension plan but less than 30% of employees in retail and food service have employer pension plan. And this job sorting behaviour can be

In this section, I explore the possible heterogeneity of saving response to mandatory employer-provided pensions across saving rate distribution. This analysis can give us a more complete picture of how mandatory employer-provided pensions affect workers' saving behaviour. It also provides a useful lesson (possible consequence) for the countries (e.g. UK) that also want to implement a similar mandatory employer pension policy.

8.1 Quantile differences-in-differences estimation

To examine how the effect of mandatory employer-provided pensions differs across households with different saving rates, I use a quantile difference-in-differences regression to estimate the policy effect on the "entire" distribution of private sector household saving rate. Since the impact of pension reform over unconditional distribution of household saving rate is our interest, I adopt a recently developed estimation technique of unconditional quantile regression (Firpo, Fortin and Lemieux, 2009) to obtain quantile difference-in-differences estimator for each quantile. The traditional quantile regression method (Koenker and Bassett, 1978) cannot estimate the treatment effect on unconditional quantiles. Firpo, Fortin and Lemieux (2009) address this issue by replacing outcome variable (household saving rate) with recentered influence function (RIF) and then conduct a standard OLS regression. The RIF in this paper is defined by

$$RIF(SR_i, Q_S(\theta)) = Q_S(\theta) + \frac{\theta - 1\{SR_i \leq Q_S(\theta)\}}{f_{SR}(Q_S(\theta))}$$

where $Q_S(\theta)$ is the θth quantile of household saving rate. $1\{.\}$ is an indicator function and $f_{SR}(Q_S(\theta))$ is the density of household saving rate at θth quantile. $\frac{\theta - 1\{SR_i \leq Q_S(\theta)\}}{f_{SR}(Q_S(\theta))}$ is the influence function for evaluating the effect on the estimates of quantile of changing one data point in the sample. The key feature of RIF is that the expected value of the RIF (conditional on covariates X_i) is equal to unconditional quantile of saving rate $Q_S(\theta)$. Applying this property, Firpo, Fortin and Lemieux (2009) show that we can obtain the estimates of covariates' unconditional quantile effect by simply using OLS regression of RIF on covariates. I estimate the following quantile difference-in-differences regression:

$$RIF(SR_i, Q_S(\theta)) = \beta^{DD}(\theta)PENSION_i + \alpha(\theta)PRIVATE_i + \gamma(\theta)YEAR_i + X_i\psi(\theta) + \varepsilon_i(\theta)$$

$\beta^{DD}(\theta)$ evaluates the treatment effect of pension reform on household saving rate at θth quantile. Compared with linear difference-in-differences estimation, to identify quantile treatment effect by using quantile difference-in-differences needs the more stringent common trend assumption. It requires a common trend to be held in each quantile in the household saving rate distribution.

The results in Table 6 imply that mandatory employer-provided pensions have significantly negative impact on the households at bottom and median of the saving rate distribution (10th percentile to 65th percentile) but have no impact on the top saving rate quantile (above 65th percentile). That is, the estimated reform impact in my main result concentrates on the households with low and median saving rates.

This result may reveal that employees' job sorting for employer-provided pensions exists before the reform, that is, employees with a stronger preference for saving (ex: people who like more consumption in the retirement) may choose the jobs offering more generous pension plans. Before the reform, such workers may already have high employer-provided pensions but also voluntary saving. In other word, these employees with high employer pension contribution may stay in relatively top quantile of saving distribution. Hence, the expansion of employer-provided pensions brought about by the reform should have less impact on these workers. This gives a possible explanation for the differential results at the top and bottom quantiles in Table 6.

9 Conclusion

This paper exploits the recent employer-provided pension reform in Taiwan as a natural experiment to investigate the impact of private pension provision on household voluntary savings. My results suggest that this reform significantly reduces household saving rates by 2.06–2.45% at the mean. This implies that the average elasticity of substitution between private pension and household voluntary savings is -0.51 to -0.61. Moreover, to examine the reform impact on the entire household saving rate distribution, I conducted unconditional quantile difference-in-differences estimation and found that most of the average policy effect is indeed concentrated on the bottom and median quantiles. This finding can be explained by employees' job-sorting behaviour for employer-provided pensions before the reform. In general, I find that private pensions can crowd out only half of household saving and similar findings are also found in previous studies on private pensions (Engelhardt and Kumar, 2011) or social security benefits (Attanasio and Brugiavini, 2003; Attanasio and Rohwedder, 2003). Therefore, my results suggest that mandatory private pensions could be an effective policy instrument to raise employees' retirement wealth.

However, one important caution should be noted in the interpretation of my results. The TSFIE data lack information about the pension coverage rate before reform and the choice of pension scheme after reform, hence I know only the eligible group of employees but not the truly affected population. For this reason, my difference-in-differences estimates indeed identify intention-to-treat effect but not average treatment effect on the treated. From the information of aggregate data, I find the reform may make 80% of private sector employees newly eligible for employer-provided pensions when retiring and 84% of employees are covered by a new pension scheme after reform. Hence, this pension reform actually affects the majority of private sector employees, which may substantially mitigate the bias of this data lacking problem on my estimates of the reform impact. Nevertheless, it is still worth linking administrative data from the government pension authority with TSFIE data to get more precise estimates of the pension-saving offset.

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Appendix

Table 1: Comparison between new and old pension systems

	New pension system	Old pension system
System	Defined contribution system	Defined benefit system
Law	Labour pension law	Labour standard law
Vesting period	Immediate vesting	The employees are required to stay in the same firm for 25 years or stay in the same firm for 15 years and become 55 years old
Employer's contribution	Mandatory rate: at least 6% of an employee's wage	Flexible rate: 2% to 15% of an employee's wage

Source: Taiwanese Council of Labour Affairs

Table 2: Descriptive statistics

	Private sector			Public sector			
	Pre-reform (2002–2004)	Post-reform (2005–2007)	Diff	Pre-reform (2002–2004)	Post-reform (2005–2007)	Diff	Diff-in-Diff estimates
Saving rate	0.22	0.207	−0.0128***	0.309	0.310	0.0006	−0.0135*
	(0.22)	(0.215)	[0.003]	(0.232)	(0.219)	[0.007]	[0.007]
Saving	27.431	25.793	−1.6377***	47.258	49.424	2.1668	−3.8045***
	(43.211)	(39.513)	[0.488]	(50.207	(52.625)	[1.596]	[1.424]
Wage income	67.343	65.664	−1.6791***	82.993	84.896	1.9027	−3.5818***
	(40.641)	(39.603)	[0.473]	(42.22)	(45.176)	[1.356]	[1.350]
Non-wage income	32.568	32.46	−0.108	45.467	46.581	1.1131	−1.2211
	(41.456)	(35.452)	([0.455]	(33.453	(31.149)	[1.009]	[1.260]
Consumption	74.739	74.691	−0.0487	85.276	86.968	1.6923	−1.741
	(37.31)	(35.067)	[0.427]	(36.852	(35.888)	[1.133]	[1.206]
Head's age	37.998	38.395	0.3963***	40.393	40.873	0.4794**	−0.0831
	(7.257)	(7.355)	[0.086]	(6.672)	(6.600)	[0.207]	[0.240]
Head's edu	12.045	12.401	0.3555***	14.267	14.543	0.2765***	0.079
	(3.041)	(2.908)	[0.035]	(2.404)	(2.441)	[0.075]	[0.097]
Spouse's edu	7.25	7.034	−0.2154***	9.494	9.522	0.0275	−0.2429
	(6.001)	(6.234)	[0.072]	(6.335)	(6.578)	[0.201]	[0.205]
% male head	0.775	0.762	−0.0129***	0.763	0.743	−0.0208	0.0079
	(0.418)	(0.426)	[0.005]	(0.425)	(0.437)	[0.013]	[0.014]
# of above 18	2.586	2.577	−0.0099	2.304	2.291	−0.0131	0.0032
	(1.1)	(1.067)	[0.013]	(0.876)	(0.808)	[0.026]	[0.035]
# of below 18	1.224	1.123	−0.1009***	1.364	1.292	−0.0715**	−0.0294
	(1.099)	(1.077)	[0.013]	(1.046)	(1.033)	[0.032]	[0.036]
# of above 65	0.27	0.306	0.0362***	0.229	0.235	0.0063	0.0299
	(0.558)	(0.592)	[0.007]	(0.529)	(0.533)	[0.017]	[0.019]
# of working	0.366	0.406	0.0404***	0.279	0.295	0.0165	0.0239
	(0.482)	(0.491)	[0.006]	(0.449)	(0.456)	[0.014]	[0.016]
County ID	12.659	12.801	0.1413	13.875	13.947	0.0721	0.0692
	(8.417)	(8.183)	[0.098]	(7.801)	(7.852)	[0.243]	[0.274]
Observations	14,425	14,321	28,746	2,299	1,876	4,175	32,921

[1] Standard errors in brackets

[2] *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[3] Saving rate is calculated by %

[4] Saving, income, and consumption are scaled in thousands of 2007 New Taiwan Dollars. The 2007 exchange rate is 1 US Dollars = 32.4 New Taiwan Dollars

Table 3: Descriptive statistics

	Private sector			Public sector			
	Pre-reform (2002–2004)	Post-reform (2005–2007)	Diff	Pre-reform (2002–2004)	Post-reform (2005–2007)	Diff	Diff-in-Diff estimates
Agriculture	0.015	0.014	−0.0005	0.006	0.004	−0.0024	0.0018
	(0.12)	(0.118)	[0.001]	(0.078)	(0.061)	[0.002]	[0.004]
Manufacturing	0.515	0.515	0	0.089	0.088	−0.0008	0.0008
	(0.5)	(0.5)	[0.006]	(0.284)	(0.283)	[0.009]	[0.016]
Service	0.471	0.471	0.0005	0.905	0.908	0.0031	−0.0027
	(0.499)	(0.499)	[0.006]	(0.293)	(0.289)	[0.009]	[0.016]
Profession	0.383	0.397	0.0137**	0.52	0.52	0	0.0136
	(0.486)	(0.489)	[0.006]	(0.5)	(0.5)	[0.016]	[0.016]
White collar	0.357	0.347	−0.0102*	0.305	0.308	0.0028	−0.0129
	(0.479)	(0.476)	[0.006]	(0.461)	(0.462)	[0.014]	[0.016]
Blue collar	0.26	0.257	−0.0035	0.174	0.172	−0.0028	−0.0007
	(0.439)	(0.437)	[0.005]	(0.38)	(0.377)	[0.012]	[0.014]
% of own house	0.84	0.857	0.0173***	0.89	0.901	0.0114	0.0059
	(0.367)	(0.35)	[0.004]	(0.313)	(0.298)	[0.010]	[0.012]
Observations	14,425	14,321	28,746	2,299	1,876	4,175	32,921

[1] Standard errors in brackets

[2] *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[3] Saving rate is calculated by %

[4] Saving, income, and consumption are scaled in thousands of 2007 New Taiwan Dollars. The 2007 exchange rate is 1 US Dollars = 32.4 New Taiwan Dollars

Table 4:
The Effect of Mandatory Private Pension on Household Voluntory Saving

	Saving rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period	2002-2007	2002-2007	2002-2007	1999-2004	2002-2007	2002-2007	2002-2007
Cohort	20-50	20-50	20-50	20-50	20-50	20-50	51-65
Treament group	private sector	private sector	private sector	private sector	banking	food service	private sector
Pension effect $\widehat{\beta}^{DD}$	-0.0198***	-0.0204***	-0.0206***	-0.0088	-0.0056	-0.0300***	0.0096
	[0.007]	[0.007]	[0.006]	[0.006]	[0.011]	[0.008]	[0.011]
Baseline mean	0.22	0.22	0.22	0.27	0.26	0.20	0.29
Family chacteristic	√	√	√	√	√	√	√
Industry & occupation		√	√	√	√	√	√
Household wealth			√	√	√	√	√
observation	32,921	32,921	32,921	33,726	5,984	9,239	8,219
R^2	0.241	0.245	0.257	0.257	0.300	0.301	0.295

[1] Standard errors clustered on sector/year in brackets

[2] *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[3] Family chacteristic: head?s age, age square, education, gender; spouse?s education; # of children under 18, # of members over 65, # of members above 18, # of working members, and living county dummies Industry & occupation : head's industry and occupation Household wealth: household total non-wage income; own house dummy;housing size

[4] Baseline mean is the saving rate for private sector households during pre-reform period

Table 5:
Empirical specification check

Specificationr	Saving rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Standard error sector/period cluster	Standard error block bootstrap	Standard error wild bootstrap	Nonparametric DID	Dependent var. ln(Y)-ln(C)	Treatment group head's sectoral choice	Different sample period
Pension effect $\widehat{\beta}^{DD}$	-0.0206***	-0.0206***	-0.0206***	-0.0264**	-0.0254***	-0.0141***	-0.0201***
	[0.001]	[0.006]	[0.002]	[0.013]	[0.009]	[0.006]	[0.007]
p-value	(0.001)	(0.001)	(0.007)	(0.05)	(0.001)	(0.007)	(0.001)
observation	32,921	32,921	32,921	32,421	32,921	34,749	21,944
R^2	0.269				0.265	0.265	0.271

[1] Robust standard errors in brackets
[2] *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[3] Family chacteristic: head?s age, age square, education, gender; spouse?s education; # of children under 18, # of members over 65, # of members above 18, # of working members, and living county dummies Industry & occupation : head's industry and occupation Household wealth: household total non-wage income; own house dummy;housing size

Table 6:
QUANTILE DD RESULTS

	Quantile of saving rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quantile	10%	25%	35%	50%	65%	75%	90%
Pension effect $\widehat{\beta}^{QDD}$	−0.0372***	−0.0282***	−0.0290***	−0.0207***	−0.0155*	−0.0061	−0.0074
	[0.011]	[0.007]	[0.007]	[0.007]	[0.008]	[0.009]	[0.013]
Observation	32,921	32,921	32,921	32,921	32,921	32,921	32,921
R^2	0.089	0.157	0.185	0.203	0.196	0.174	0.103

[1] Robust standard errors in brackets
[2] *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[3] Family characteristic: head's age, age squared, education, gender; spouse's education; # of children under 18, # of members over 65, # of members above 18, # of working members, and living county dummies. Industry & occupation: head's industry and occupation. Household wealth: household total non-wage income; own house dummy; housing size

Figure 1: Private Pension Coverage in Private Sector: 2002–2007