Auto-enrollment, Matching and Participation in 401(k) Plans

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October 1, 2014

Abstract

This study uses plan-level data from Form 5500s filed by plan sponsors annually with the Internal Revenue Service to analyze the effects of automatic enrollment and employer matching on 401(k) plan participation rates, and the effect of automatic enrollment on employer matching rates. The potential endogeneity of employer auto-enrollment/matching decisions is addressed exploiting the panel structure of the data. The results indicate that while both auto-enrollment and matching rates have a positive effect on plan participation rates, the effect of auto-enrollment is substantially higher. Moreover, auto-enrollment is found to have a positive and significant effect on match rates.

JEL classification: D14, G23, J32
Keywords: 401(k) Plans, Participation Rate, Auto-enrollment, Matching, Fractional Response Models, Unbalanced Panel Data

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How does the design of 401(k) pension plans affect employee participation rates? Is there a trade-off between 401(k) plan design features that may affect retirement savings outcomes? Finding a convincing answer to these questions is relevant both to plan sponsors and to policy makers. Plan sponsors could design their 401(k) plans better in order to attain certain objectives, such as developing stronger incentives for employee savings, offering more attractive benefit packages to recruit and retain higher-quality workers, and achieving a mix between employee elective deferrals and employer contributions that satisfies the IRC nondiscrimination requirements. Policy makers, concerned that many workers may be saving too little for retirement, may implement policies that promote participation effectively.

The 401(k) plan, today the most popular employer-sponsored retirement savings vehicle in the US, becomes a useful tool in promoting employees retirement savings only to the extent that eligible employees enroll in the plan. Accordingly, following concerns that the tax-deferred nature of 401(k) plans contributions would mainly attract highly compensated employees (HCEs), different policies have been implemented over time in an attempt to boost 401(k) participation among non highly compensated employees (NHCEs).[1]

First, mandatory nondiscrimination tests were introduced by the Tax Reform Act of 1984 and 1986. These tests provided particularly strong incentives for employers to encourage participation of NHCEs through matching contributions. The Small Business Job Protection Act of 1996 also encouraged the use of matching, introducing a safe harbor clause that allowed employers to avoid nondiscrimination testing if they provided a sufficiently generous match, i.e. a minimum match of 100% of the employee's contributions up to 3% of compensation plus 50% of the next 2%. However, under the same law, a safe harbor could be granted also to employers that would provide a non-elective contribution of 3% of pay to all eligible employees.

Second, the possibility for employers to automatically enroll 401(k) eligible employees – already introduced through a series in Internal Revenue Service (IRS) rulings over the period 1998-2000 – was strongly encouraged with the passage of the Pension Protection Act of 2006 (PPA '06). This law provided an optional nondiscrimination safe harbor[2], as well as protection from fiduciary liability and from state payroll-withholding laws for plans with automatic enrollment.

Despite the changes introduced in the 401(k) regulatory framework to incentivize plan participation, survey data show that the dramatic shift in employer sponsorship from

[1] An employee who either earned more than 105,000$ or owned more than 5% of the company in 2009 was considered HCE for 2010 plan year testing purposes. However, sponsoring employers have the option to limit HCEs to the top-paid 20% employees based upon the preceding year's compensation.

[2] A plan adopting the automatic enrollment safe harbor is required to defer a minimum 3% of employee compensation, increasing in annual unit increments up to 6%. Moreover, the plan requires either a minimum employer matching contribution of 100% on the first 1% of pay contributed by the participant, plus 50% on the next 5% of pay, or a non-elective 3% contribution.

defined benefit (DB) to defined contribution (DC) – 401(k) – plans over the last three decades has not been accompanied by a rise in participation among eligible workers (take-up rate). Data from the National Compensation Survey indicate that in 2012 (2009), still only 41% (43%) of the 59% (61%) eligible private industry workers participated in a 401(k) pension plan – corresponding to a 70% take-up rate. This figure is in stark contrast to the 89% (93%) take-up rate found for the 20% eligible workers covered by a DB plan (US Bureau of Labor Statistics, 2010, 2012). Similar take-up rate figures among 401(k) plans are provided by Purcell (2009) for earlier years – 69, 74 and 71% for 1998, 2003 and 2006, respectively – using data from the Survey of Income and Program Participation.

A large literature has addressed the issue of participation in 401(k) plans, analyzing the effects of 401(k) plan design on employee participation rates (see Madrian, 2013; Adams, Salisbury, and VanDerhei, 2013, for a review). Several studies have found that automatic enrollment dramatically increases participation in 401(k) plans (see, among others, Madrian and Shea, 2001; Choi, Laibson, Madrian, and Metrick, 2004; Beshears, Choi, Laibson, and Madrian, 2008).

By contrast, although a consensus has emerged that, among 401(k) plans with standard enrollment, employer matching positively affects participation, the magnitude of the findings varies considerably. Choi, Laibson, and Madrian (2004) conclude, from their review of the early literature, that having a match increases the probability of 401(k) plan participation – although the magnitude of this effect has not been decisively estimated –, whereas there is less certainty about the extent to which increasing an already positive match rate leads to further increases in 401(k) participation.

Such a wide range of findings, which is also true for the most recent studies, is mostly due to the data and/or to the source of employer match variation used for identification purposes, which also qualify their external and/or internal validity. The internal validity of most of the studies that exploit the naturally occurring match rate variation in cross-sectional representative samples is limited by concerns over either the potential endogeneity of the employer match rate (see, among others, Bassett, Fleming, and Rodrigues, 1998) or the validity of the instruments used to address this endogeneity issue (Even and Macpherson, 2005; Dworak-Fisher, 2011). By contrast, the studies that exploit arguably exogenous natural experimental variation in match rates are based on individual-level plan-specific data (Kusko, Poterba, and Wilcox, 1998; Choi, Laibson, Madrian, and Metrick, 2002, 2006), and therefore have limited external validity. Finally, the findings of studies that exploit the naturally occurring match rate variation in cross-sectional non-representative samples of 401(k) plans (Clark and Schieber, 1998; Clark, Goodfellow, Schieber, and Warwick, 2000; Huberman, Iyengar, and Jiang, 2005; Mitchell, Utkus, and Yang, 2007) are limited in both their internal and external validity.

A smaller but related literature using plan-level data from different sources has recently raised concerns over the negative effects that auto-enrollment might have on em-

ployer match rates, as a consequence of the increased employer's cost of matching employee contributions under auto-enrollment. Soto and Butrica (2009) and Butrica and Karamcheva (2012) find a significant negative correlation between employer match rates and automatic enrollment provisions. By contrast, VanDerhei (2010) provides descriptive evidence of the opposite correlation. The relevance of these diverging results is threatened, however, by concerns over the potential endogeneity of employers' auto-enrollment decisions that would limit their internal validity.

This study uses plan-level data from Form 5500s filed annually with the Internal Revenue Service (IRS) to analyze the effects of the most relevant 401(k) plan design features on plan participation rates. Following Papke (1995), which uses Form 5500 data from the 1986-1987 period, we exploit the panel structure of the most recent available data for the period 2009-2011 to address the potential endogeneity of the regressors of interest that would threaten the internal validity of the study. This time window is chosen to exploit a new feature of the 5500 form. Since 2009 – following PPA '06 enactment – employers sponsoring a 401(k) plan are required to report in the 5500 form the nature of the enrollment protocol adopted. This information is exploited to assess the effects of auto-enrollment on participation rates and on employer match rates in the population of US 401(k) plans. Moreover, this time window provides a unique opportunity to investigate the effects of arguably exogenous changes in employer matching policies that followed the 2008 recession – i.e. match suspensions and match reinstatements – on plan participation rates.

The contribution of this study to the literature is threefold. First, the study provides new evidence that sheds further light on the role of two key features of 401(k) plan design – employer matching and auto-enrollment – that are intended to have an indirect and direct impact, respectively, on participation rates. In line with most previous literature findings, while both auto-enrollment and match rates are found to have positive and significant effects, auto-enrollment is found to have a prominent role in boosting participation rates. Moreover, auto-enrollment is found to have a positive and significant effect on match rates. The latter result is in stark contrast with the evidence provided by earlier studies (Soto and Butrica, 2009; Butrica and Karamcheva, 2012), and suggests that a complementarity – rather than a trade-off – may be at work between these key 401(k) plan design features.

Second, the threats affecting the internal validity of most cross-sectional studies – represented here by the potential endogeneity of employer's auto-enrollment and matching decisions – are addressed exploiting the panel structure of the data to control for unobservable time-invariant plan/sponsor-specific traits potentially correlated with the regressors of interest. The fixed effects estimates of the participation rate equations reveal an upward bias of the OLS pooled estimates, consistent with the view that auto-enrollment and matching decisions are mainly driven by the employers' desire to offer an attractive benefit package to recruit and retain higher-quality workers. Moreover, while OLS estimates

based on pooled cross-sectional samples indicate that auto-enrollment has either a null or a negative and significant impact on match rates – a finding consistent with Soto and Butrica (2009) and Butrica and Karamcheva (2012) – the fixed effect estimates indicate a positive and significant effect.

Finally, the use of data on the population of US 401(k) plans provides the results of this study with the external validity lacking in earlier studies based on non-representative samples. A further advantage of using population plan-level data is that the large sample size attenuates the problem of time-variation within units of observation that typically affects fixed effect panel data estimators. Moreover, the period under consideration in this study was characterized by a substantial dynamics of auto-enrollment and matching employer policies: the former as a consequence of the PPA '06, the latter as a consequence of the economic crisis of 2008. The empirical analysis is carried out by type of 401(k) plan in order to provide a better characterization of plan design choices that may be specific to each plan type. The robustness of the results is further assessed using different model specifications and different samples. The fact that the findings on the impact of auto-enrollment and match rates on plan participation are in line with those of earlier studies – specially of the studies exploiting natural experimental variation in 401(k) plan design key features using non-representative samples – lends them further credibility while at the same time giving support to the external validity of the latter.

The rest of the paper is organized as follows. The next section provides some background on 401(k) plans most relevant design features that may affect plan participation rates and reviews the related literature. Section 3 describes the data. Section 4 illustrates the empirical analysis. Section 5 concludes.

1 Background

The rapid growth of 401(k) plans has profoundly changed the US pension landscape. Not only have these plans supplanted the traditional DB plans as the primary retirement savings vehicle; they have also raised concerns over their substantially lower take-up rates among eligible workers. This has led policy makers and academics alike to focus on two key features of 401(k) plan design – employer matching and auto-enrollment – that are intended to have an indirect and direct impact, respectively, on participation rates.[3]

A 401(k) plan legally is not a separate DC type of plan, but qualifies for tax purposes – under IRC section 401(a) – as a Profit Sharing (including Thrift-Savings) or Stock Bonus (including Employee Stock Ownership (ESOP)) plan, which contains a "Cash Or Deferred Agreement (CODA)". Although these legally different types of 401(k) plans share many

[3]Choi, Laibson, and Madrian (2004) provide a summary of the empirical evidence regarding other plan features that may act upon 401(k) participation rates, such as the availability of loans and the menu of funds offered.

similarities, in practice the choice of the sponsoring employer to offer a particular plan type depends on the degree of flexibility offered by each plan type as a tool for reaching the employer's objectives, as well as on the costs involved in setting up and administering the plan. For example, profit sharing and stock bonus/ESOP plans are typically aimed at fostering employee commitment to company goals. While a traditional profit-sharing plan allows employee to share in a company's success allocating profit-sharing contributions, a stock bonus plan/ESOP contributes cash and/or stocks to an account held on behalf of the sponsor's employees, providing them with an ownership stake in the company. ESOPs – in particular the *leveraged* type, which can borrow funds to acquire employer stocks – also offer a number of tax advantages, which have however to be weighted against the higher setup and administration costs.

Whatever legal setup is chosen for a plan containing a CODA, a common key element of 401(k) plans is that employees are required to contribute a portion of their salary – known as *elective deferral* – to the plan in order to participate.[4] Plan participants are always allowed *before-tax* elective deferrals, and, depending on the plan, may also be allowed *after-tax* and/or *Roth* deferrals.[5] The contributions of each participant are held in separate "deferral labeled" accounts for tax purposes. Before-tax deferrals are deductible from current-year income, but contributions – including matching and/or non-elective employer contributions –, interest, and capital gains accumulated in the individual account set up under the plan are taxed at ordinary income rates upon distribution. By contrast, after-tax and Roth deferrals are not deductible from current-year income. However, contributions – excluding matching and/or non-elective employer contributions –, interest, and capital gains accumulated into a Roth account held for at least 5 years are allowed tax-exemption if distributed under "qualified" circumstances (death, disability, or reaching age $59\frac{1}{2}$). A company might not match after-tax contributions, but among the types of contributions it does match, the match formula typically does not vary by the type of contribution. This invariance reduces the attractiveness of Roth and after-tax contributions if the employee's marginal 401(k) contribution dollar is being matched (Beshears, Choi, Laibson, and Madrian, 2013). Another factor affecting the attractiveness of Roth versus before-tax elective deferrals is whether employees are constrained by the contribution limits on 401(k) plans. In the calendar years 2009-2011, the combined before-tax and Roth contributions could not exceed $16,500. However, the plan does allow participants aged 50 and older to make *catch-up* before-tax and/or Roth deferrals up to

[4]Among the types of DC plan that qualify under the IRC and IRS regulations, Money Purchase plans are required to provide a determinable benefit, contributing a fixed % of employees' compensation, and therefore cannot include a 401(k) feature.

[5]Of all private sector workers who participated in 401(k) plans sponsored by medium and large companies in 2009, 26% were in plans that allowed Roth contributions. The share increases to 34% among employees participating in thrift-savings plans offered by medium and large companies (US Bureau of Labor Statistics, 2010).

an additional $5,500.[6]

Although sponsoring employers are not required to contribute to their 401(k) plans, they usually do. Employer contributions are tax-deductible up to the limit of 25% of eligible payroll for all contribution sources combined. They may be *non-matching* (or *non-elective*), made at the sole discretion of the employer, or *matching*, made by the employer in response to an elective deferral.[7] Non-matching contributions are typical in profit-sharing plans and may be structured as a variable or fixed profit sharing contribution. If a contribution is made, it has to be allocated to eligible plan participants based on an *allocation formula*.[8] Employers may offer matching contributions for two main reasons. First, matching contributions can be used to encourage participation by NHCEs, as a means to comply with non-discrimination tests.[9] Non-discrimination testing can be avoided in a particular plan-year if the sponsoring employer elects to comply with one of the available IRC safe harbors: with or without automatic enrollment, and with non-elective or matching contributions. Nondiscrimination rules are binding for many firms, and may affect plan design.

As an alternative explanation, employers may offer matching contributions to attract and retain higher quality workers. Ippolito (1997, 2002) suggests that firms match employee contributions to attract and retain workers with a desirable but unobservable attribute – a low discount rate. He provides empirical evidence that workers with lower discount rates are less likely to quit or call in sick, and generally receive higher performance ratings. Because matching provides a higher level of compensation to savers – i.e., those with low discount rates who choose to take advantage of the matching contribution –, a 401(k) plan with matching will help attract and retain them.

Employer matching contributions can be determined on a *formula basis* or be *discretionary* and be determined by the employer each year. Formula-based match can be

[6]In addition to the limits on employee contributions, there is a limit on the combined employer plus employee contribution to 401(k) accounts. During the plan years 2009-2011, this aggregate limit was set by the IRS at the lesser of $49,000 and 100% of employee compensation. It is typical that plans set up a lower employee compensation% limit, in order to prevent excess deferrals of HCEs that may result in the failure of nondiscrimination tests.

[7]Within these broad categories, there is a wider variety of types of employer contributions, based on whether the contributions are used for *non-discrimination testing* or for *safe harbor* purposes.

[8]Some formulas – such as age-weighted, integrated and new comparability – are designed to favor owners, older, long-term, highly compensated and key employees without being discriminatory.

[9]401(k) plans are required to pass two tests to ensure that they do not discriminate in favor of HCEs. The *average deferral percentage* (ADP) test compares HCEs and NHCEs average elective deferral percentages – including pre-tax and Roth, but excluding catch-up deferrals –, while the *average contribution percentage* (ACP) test – defined under IRC section 401(m) – compares HCEs' and NHCEs' average matching contributions plus after-tax deferrals. For most companies, the HCE average cannot be more than 2 % higher than the NHCE average. Failure of the ADP/ACP test indicates that there has been an excess elective deferral/matching contribution for the HCEs. In this scenario, the employer may bring the plan into compliance either by reducing the HCEs' elective deferrals – through corrective distributions and/or re-charachterization – or increasing the ADP/ACP of the NHCEs – through *qualified non-elective contributions* (QNEC) or *qualified matching contributions* (QMC).

single-tier – with employee elective deferrals matched at a flat rate up to a *match threshold*, defined as the maximum percentage of the employee compensation to which the match applies – or *multi-tier* – with different match rates applied to different match thresholds. Under other match designs, the match rate can be related to the employee's length of service or on the level of employee's deferrals. Finally, some plans cap the match amount to a pre-specified $ amount (i.e., $2,000). The wide variation in employer contributions is most evident in the design of employee matching-formulas. A recent study by The Vanguard Center for Retirement Research (2010) reports that, in a sample of more than 2,000 401(k) plans administered by Vanguard in 2009, more than 200 distinct match formulas were offered. Single-tier match formulas were the most popular – offered by 75% of plans –, while 17% of plans offered multi-tier formulas. Similarly, data from the 2009 National Compensation Survey (US Bureau of Labor Statistics, 2010) indicate that 62% of participants in 401(k) thrift-savings plans sponsored by medium and large firms were offered a single-tier match.

While in traditional economic models, the impact of a match on participation depends in part on the structure of the match, adding a matching contribution or increasing the generosity of the match should increase participation in 401(k) plans through a substitution effect. Consistent with these theoretical predictions, most of the studies find that matching increases 401(k) participation. However, the estimated magnitude of this effect varies widely, mainly because of methodological differences across the studies. Table 1 summarizes the findings of these studies, relating them to four methodological aspects: the data (representative survey/administrative or company data, cross-sectional or panel data), the unit of analysis (the employee or the plan), the definition of the employer match, and the estimation method.

Besides employer matching, another key feature of current 401(k) pension plan design usually adopted to increase plan participation is automatic enrollment. Although initially introduced in 1998, it was only after the enactment of the provisions included in the PPA '06 – from plan-years beginning on January 1, 2008 – that auto-enrollment was given a leg up. Employers sponsoring a 401(k) plan can currently offer their employees either a standard enrollment or an automatic enrollment protocol. Under the standard enrollment protocol, an active election on the part of the employees is required to *opt into* a 401(k) plan, the default being non-participation. By contrast, under the automatic enrollment protocol, an active election choice on the part of employees is required in order to *opt out* of 401(k) participation, the default being participation.[10] Under automatic enrollment, the employee is offered a default contribution rate, as well as a default investment.

[10] A third possible, although rarely used, enrollment protocol – described as *active decision* by Carrol, Choi, Laibson, and Madrian (2009) – avoids the default implicit in both the standard and automatic enrollment protocols by requiring employees to actively indicate their 401(k) participation within a specific time-frame, regardless of whether they want to enroll or not. Under this protocol, passively accepting a default is not an option.

Employees have to be notified in advance of the auto-enrollment protocol implementation, and be given the option to either opt out of participation or to elect a different contribution/investment default within a pre-defined time-frame.

Since its introduction, automatic enrollment has attracted growing attention in the 401(k) plan design research. The early studies adopt a natural experimental approach, exploiting longitudinal firm-specific data to identify the impact of the introduction of automatic enrollment by firms that previously used standard enrollment protocols on plan participation. A seminal study by Madrian and Shea (2001) analyzes the impact of the introduction of auto-enrollment for newly hired employees on the participation rates of a 401(k) plan offered by a large US company. Comparing participation rates of new hires with and without auto-enrollment, they find that the participation rate of employees with tenure between 3 and 15 months hired under auto-enrollment increases by 50 percentage points. This effect is found to be largest among the groups with the lowest participation rate under the standard enrollment regime: non-white, younger, and lower compensated employees. As the most likely explanation for these findings, Madrian and Shea (2001) suggest that automatic enrollment decreases the complexity of the 401(k) savings decision. The initial participation decision is simplified from one that involves evaluating different contribution and investment options to a simple comparison of two alternatives: non-participation versus participation under the auto-enrollment default contribution and investment. Such a simplification would reduce procrastination of the participation decision, particularly among younger employees. Following studies by Choi, Laibson, Madrian, and Metrick (2002, 2004, 2006) confirmed the dramatic impact that the choice between the two different 401(k) enrollment protocols has on 401(k) participation for three different companies – including the one previously analyzed by Madrian and Shea (2001) – that switched from a standard enrollment to an automatic enrollment protocol also at higher level of tenure. Although participation increases with tenure under standard enrollment, the difference in participation rates under the automatic and standard enrollment protocols – estimated in 50 percentage points at 6 months of tenure – remain substantial. Employees hired under automatic enrollment with 36 months of tenure were found to have participation rates at least 30 percentage points higher than employees hired under standard enrollment with the same tenure. Moreover, Choi, Laibson, Madrian, and Metrick (2004) and Beshears, Choi, Laibson, and Madrian (2008) documented similar effects on 401(k) participation rates when automatic enrollment is applied to previously hired but non-participating employees as well as to newly hired employees. A study by The Vanguard Center for Retirement Research (2001) also found large increases in 401(k) participation – between 9 and 17 percentage points, depending on whether automatic enrollment applies to only newly eligible employees or to all non-participating eligible employees as well – following the switch from standard enrollment to automatic enrollment at fifteen different client companies. In most of the Vanguard com-

panies, automatic enrollment was applied only to newly hired employees and was recently implemented. A limitation of this study is that it focuses on the impact of automatic enrollment on company-wide participation rates, rather than on the impact of participation rates by tenure. Therefore, the participation rates reported for companies with automatic enrollment include both employees who were subject to automatic enrollment (primarily low tenure employees), and those who were not. While, as a consequence, the estimated impacts are smaller than those documented by Madrian and Shea (2001), and Choi, Laibson, Madrian, and Metrick (2002, 2004, 2006), its general findings are broadly consistent with those reported by the latter studies.

More recent studies by Dworak-Fisher (2011) and Butrica and Karamcheva (2012) consistently find a positive association between auto-enrollment and plan participation rates – of about 7 percentage points – using a representative sample of 401(k) thrift-savings plans from different representative cross-sections of the National Compensation Survey – 2002/2003 and 2010/2011, respectively. While these estimates might not reflect the long-run estimates of automatic enrollment, given that the samples used might include several firms which just recently added an auto-enrollment feature, the comparable magnitude of the estimates obtained using the same data source collected over different time periods is somewhat reassuring, at least in this respect. Concerns are raised, however, by two other possible sources of bias. First, the estimates are likely downward biased as they do not account for the fact that auto-enrollment applies in most cases only to recently hired employees. Second, and most importantly, the estimates might be upward (downward) biased if the employer decision to adopt an auto-enrollment feature is positively (negatively) related to unobservable employee saving preferences.

The growing popularity and adoption of automatic enrollment plan designs continues to raise interest in the future role of matching contribution in effective plan design. Beshears, Choi, Laibson, and Madrian (2010) take two different approaches to evaluating the importance of the match in employer-sponsored savings plans that have automatic enrollment. First, exploiting the natural experimental variation in the match rate occurring in a firm that replaced its employer match of 25 % on the first 4 % of pay contributed to the plan with a non-elective employer contribution, they find that eliminating the employer match reduced participation by at most 5-6 percentage points. Second, exploiting naturally occurring variation in the match structure across a sample of nine firms with employer-sponsored savings plans with automatic enrollment, they find that a 1 percentage point increase in the maximum potential match as a fraction of salary is associated with a 2-4 percentage point increase in plan participation. The latter analysis is, however, potentially confounded by endogeneity between the generosity of the match and employee saving preferences and has limited external validity given the small number of firms included in their sample. However, based on these findings, Beshears, Choi, Laibson, and Madrian (2010) conclude that decreasing the match rate from the modal match

in employer-sponsored savings plans in the US of 50 % on the first 6 % of pay to 25 % on the first 6 % of pay (a reduction in the match rate of 25 percentage points) is predicted to reduce plan participation under automatic enrollment by 3-6 percentage points. These results confirm the earlier conclusion: increasing the match rate leads to small increases in 401(k) plan participation. This conclusion holds for plans with and without automatic enrollment.

Following concerns that employers might respond to the higher costs associated with automatic enrollment by reducing their matching contributions, a recent strand of the 401(k) plan design literature has focused on assessing whether a trade-off exists between the employer decision to adopt automatic enrollment and the generosity of the match rate offered. Soto and Butrica (2009) analyze the relationship between automatic enrollment and match rates using 2007 data on the largest (by assets) 401(k) plans from the Pensions & Investment database – containing information on whether an automatic enrollment feature was adopted – matched with other detailed plan-specific information their 5500 form filings. They find evidence of a negative association between auto enrollment and match rates, suggesting that employers might reduce match rates when they begin automatically enrolling participants. By contrast, VanDerhei (2010) report higher match rates in 2009 than in 2005 among the plans that had adopted automatic enrollment in a sample of large 401(k) plans from the EBRI database. A more recent study by Butrica and Karamcheva (2012) also finds evidence of a significant negative relationship between automatic enrollment and match rates using plan-level cross-sectional data from the 2010/2011 National Compensation Survey. Plans with automatic enrollment are found to have a first dollar match rate and a max mach rate 8.2 percentage points and 0.38 percentage points lower, respectively, than plans without an automatic feature. The inference that can be drawn from these controversial findings is however limited. First, and most importantly, all of these studies have a descriptive nature, as they do not address the potential endogeneity of the employer automatic enrollment decision. Second, they all have limited external validity. While the studies by Soto and Butrica (2009) and VanDerhei (2010) are based on samples of large 401(k) plans, the data used by Butrica and Karamcheva (2012), although representative of private sector establishments, do not include thrift-savings plans with no employer match, profit-sharing and stock bonus (including ESOP) plans.

This study uses 401(k) plan-level data from 2009-2011 5500 forms to analyze the effects of auto-enrollment and employer matching on 401(k) plan participation rates, and the effect of auto-enrollment on employer match rates. The potential endogeneity of employer auto-enrollment/matching decisions is addressed exploiting the panel structure of the data. Moreover, the empirical analysis is carried out by type of 401(k) plan in order to provide a more detailed characterization of plan design choices that may be specific to each plan type. The robustness of the results is further assessed using different model specifications and sample restrictions.

2 Data

The data used in this study are the *Form 5500 Annual Return/Report of Employee Benefit Plan (Form 5500)* filings for pension plan sponsors.[11] Filers are classified as either single-employer, multiemployer, multiple-employer or direct filing entities (DFEs).[12] Sponsoring employers are identified by their unique federal EIN number, while sponsored plans are identified by a unique PN number within each employer. This allows longitudinal matching of the plan filings, except in the rare event that a sponsor's EIN did change from year to year.

For the purpose of empirical analysis, we use the Form 5500 *Private Pension Plan (PPP) Research Files* provided by the Employee Benefits Security Administration (EBSA) of the US Department of Labor (DOL).[13] Data for the *PPP Research Files* is taken only from the main Form 5500 and Schedule H (Financial Information) for large plans (100 or more participants), and from Form 5500 - SF and Schedule I (Financial Information) for small plans (less than 100 participants).[14]

The main advantage of using the *PPP Research Files* rather than the raw Form 5500 data is that incorrect EINs, participant counts, contribution amounts, and other data issues are explicitly addressed. Moreover, duplicate filings are flagged, and can therefore be eliminated.[15] Through 2009, the *PPP Research Files* were designed to contain all filings of pension plans with 100 or more participants and a 5% sample of smaller plans, selected on the basis of digit patterns in the sponsor's EIN. Starting in 2010, the *PPP Research Files* were designed to contain all pension plan filings, regardless of size.

Our sample is limited to single-employer sponsored 401(k) plans with more than 100 participants observed during the period 2009-2011. This particular time window is chosen to exploit the most recently available data containing a new feature of the 5500 Form. Since 2009 – following PPA '06 enactment – employers sponsoring a 401(k) plan are required to report in the 5500 form if the plan provides for automatic enrollment. This

[11] While beginning January 1, 2010 all Form 5500 filings are required to be submitted electronically – through the *EFAST2* system – a substantial part of the 2009 filings were already submitted using this system, rather than using the traditional *EFAST* system. The original filings can be downloaded from https://www.efast.dol.gov/portal/app/disseminate?execution=e1s1.

[12] Single-employer plans are plans that are maintained by one employer or employee organization. Multi-employer plans are established pursuant to collectively bargained pension agreements negotiated between labor unions representing employees and two or more employers, and are generally jointly administered by trustees from both labor and management. Multiple-employer plans are plans maintained by more than one employer and are typically established without collective bargaining agreements. DFEs are trusts, accounts, and other investment or insurance arrangements that plans participate in and that are required to or allowed to file the Form 5500.

[13] Publicly available at http://www.dol.gov/ebsa/publications/form5500dataresearch.html.

[14] The raw Form 5500 data include further schedules with accompanying attachments, containing information that is not relevant to our empirical analysis. Beginning in 2009, small plans are allowed to fill a simplified Form 5500-SF rather than the main Form 5500 and its schedules.

[15] *PPP Research Files* exclude filings by direct filing entities (DFEs) and by one-participant plans.

information is used to define a time-varying dummy variable *Autoenroll* taking the value one for plans adopting an automatic enrollment protocol.

Another key feature of 401(k) plan design is represented by the employer match rate, as defined in the plan documents and communicated to eligible participants through a Summary Plan Description (SPD). As acknowledged by Papke (1995), a drawback of using Form 5500 data is that they do not contain information on the formula used by plan sponsors to determine their matching contributions. Plan sponsors are required to report only total employer contributions – differentiating between cash and non-cash contributions, but not between matching and non-elective contributions – and total employee salary deferrals – without separate indication of their before-tax, Roth or after-tax nature. However, although with individual participant data it would be preferable to know the marginal match rate facing each participant at each point in time, with plan-level data, an average match rate may be preferable (Papke, 1995). First, match formulas may be step functions of employee deferral levels or may be based on firm profitability. For example, the 401(k) plan may base some part of the match rate on the performance of the company – as it is typical in profit sharing plans – or offer a discretional matching contribution not explicitly defined in the SPD. Second, the average match rate includes any flat per participant contribution made by the employer and any corrective contribution the employer had to make to pass the anti-discrimination tests. Third, among the minority of plans electing a safe harbor status, safe harbor matching plans are the typical choice. Moreover, the PPA '06 has made the latter even more attractive for plans adopting an automatic enrollment protocol.[16] Finally, a company might not match after-tax contributions, but among the types of contributions it does match, the match formula typically does not vary by the type of contribution. Considering also that before-tax and Roth deferrals are usually a better deal than after-tax contributions,[17] the average match rate understatement that would follow from overstating the elective deferrals that can be matched by employer contributions should be negligible.

While an average match rate based on the ratio of employer to employee contributions may be overstated – therefore exceeding the marginal participation/contribution incentive facing each eligible participant – it may still represent a better indicator of the overall plan generosity, capturing contributory elements that would be overlooked by marginal

[16]The PPA's safe harbor maximum employer matching contribution is 3.5 % of compensation and, thus, may appear more attractive to employers because of the potential lower employer cost. Additionally, while existing safe harbor rules require full and immediate vesting on the employer contributions used to satisfy the safe harbor, the PPA's safe harbor allows plans to use two-year "cliff" vesting for employer contributions.

[17]This is true if the money is held in the 401(k) long enough to meet the Roth qualifying withdrawal criteria and investment earnings are positive. However, after-tax contributions may be more liquid before age $59\frac{1}{2}$ if the plan allows younger employees to make withdrawals from after-tax balances while still employed by the company without demonstrating financial hardship (see Beshears, Choi, Laibson, and Madrian (2013)).

match rates defined following plan match formulas (Papke, 1995). Moreover, if the average match rate were systematically overstated (or understated), the fixed effect panel data estimator would make it possible to eliminate this bias. In any case, given the attenuation bias that a measurement error in average match rates would introduce in its estimated coefficients, our results could still be considered as a lower bound of the impact of match rates on participation rates. As in Papke (1995), we therefore define an *average match rate* as the ratio of employer to employee contributions, as well as dummies that indicate match rate categories, to be used in the empirical analysis. Observations with match rates highest than the 95^{th} percentile are dropped from the sample. These observations roughly corresponds to plans offering match rates over $2 dollars for each $ contributed.

The participation (or take-up) rate, used as dependent variable in the participation equation, is the fraction of active (eligible) participants with an account balance. Plan sponsors are required to report in the main 5500 Form: the number of active (eligible) participants (A), the number of participants with an account balance (B), the number of retired or separated participants (receiving or not receiving benefits) (C), and the number of deceased participants (D). The participation rate is therefore defined as a ratio between the number of active (eligible) participants with an account balance – obtained by subtracting (C) and (D) from (B) – and the active (eligible) participants (A).

The Form 5500 data also includes further detailed information on other plan characteristics, such as whether the plan is a ERISA code 401(m) arrangement, whether it is intended to comply with Erisa 402(c) code for partial fiduciary liabilities relief, if participants are allowed to self-direct (partially or totally) their individual accounts, and, if so, whether a default investment account is provided for participant who fail to direct assists in their accounts. It also provides financial information, including the amount of outstanding participant loans and the administrative fees incurred by the plan for each plan-year. A complete description of the variables later used in the empirical analysis is reported in Table 2.

For the purposes of empirical analysis, a 401(k) plan is defined as a qualified Cash Or Deferred Arrangements under IRC sec. 401(k), that allows an employee to elect to have a portion of his or her compensation (otherwise payable in cash) contributed to a qualified *thrift-savings*, *profit sharing*, or *stock bonus/employee stock ownership plan (ESOP)*.[18] 5500 Form are filled following the IRS plan qualification definition, which does not distinguishes between thrift-savings and profit-sharing plans, considering them instead as varieties of the traditional profit sharing category. The distinction among these types of 401(k) plans may be however relevant in the empirical analysis, given that differences in plan design – including the practices followed by employers in matching employee deferrals – may respond to specific employer's objectives, and therefore affect the causal

[18] Although pre-Erisa money purchase plans were also allowed to adopt a 401(k) feature, they are excluded because they require a fixed employer contribution.

relationships under study.

The information reported in the 5500 form on plan characteristics – such as whether the plan has stock bonus/ESOP features, and whether an age-service/new comparability design for the allocation of profit-sharing contributions is adopted – is therefore combined with the information contained in the filer's plan name to classify qualified DC plans with a 401(k) feature as thrift-savings, profit sharing or ESOP/stock bonus (SB) plans.

Plan names including *profit sharing*, or related acronyms, and plans including a age-service/new feature are classified as profit sharing plans. Similarly, plan names including *employee stock ownership, stock bonus*, or related acronyms, and plans reporting SB or ESOP features are classified as ESOP/SB. The remaining 401(k) plans are classified as thrift-savings plans.

Tables 3 to 7 display descriptive statistics on the main sample (Sample 1), including all 401(k) plans with more than 100 participants, by plan type. Table 3 reports the match rate by plan size and plan-year: plans with more than 1,000 eligible are defined as large plans. Average match rates are generally higher in large plans. ESOPs offer the highest average match rates, followed by profit sharing plans. Irrespective of plan type, average match rates either remained stable or – mostly in large plans – showed a moderate increase during the observation period. Table 4 reports average match rates by enrollment protocol and plan-year. Except that for profit sharing plans, average match rates are found to be generally higher in plans with auto-enrollment, and increasing over the observation period. Table 5 reports auto-enrollment rates by plan size and plan-year: auto-enrollment rates are significantly higher in large plans than in small plans. Auto-enrollment rates are particularly high for ESOP/SB plans. For example, in 2011 about 45% of ESOP large plans were adopting auto-enrollment, against 33.5 and 31.5 % of profit-sharing and thrift-savings, respectively. This is due to the higher proportion of large plans in the ESOP/SB category. Table 6 presents the participation rate by enrollment protocol and plan-year. Participation rates are found to be substantially higher in auto-enrollment plans. This difference is particularly large for thrift-saving plans (20 percentage points), is slightly lower in profit-sharing plans (14-16 percentage points), and is substantially lower for ESOP (6-8 percentage points). This heterogeneity is hardly surprising, given that take-up rates are particularly low in thrift-savings plans (61-62%) compared to profit-sharing (70-71%), and in particular to ESOP (82-83%) in all plan-years. Finally, Table 7 presents descriptive statistics on the variables used in the empirical analysis, by plan type and enrollment protocol, for the pooled sample.

3 Empirical Analysis

The purpose of the empirical analysis is to identify the effects of automatic enrollment and employer matching on 401(k) plan participation rates, and the effect of automatic

enrollment on employer match rates. The analysis is performed at the plan level, and is limited to plans with more than 100 participants.[19] Because plan design decisions, like matching and automatic enrollment, are made at the plan level, the plan is the appropriate level of analysis. We first specify and estimate the plan participation rate equation as a linear model with additive heterogeneity:

$$y_{it} = \beta_0 + \beta_1 x_{i1t} + \beta_2 x_{i2t} + \gamma \mathbf{x}_{i3t} + \delta \mathbf{x}_{i4} + c_i + u_{it}, \qquad i = 1, 2, \ldots, n \qquad t = 1, 2, 3 \quad (1)$$

where y_{it} is the participation rate outcome for plan i; x_{i1t} is a measure of the employer match rate; x_{i2t} is a dummy indicating if the plan adopted an auto-enrollment protocol; $\mathbf{x}_{i3t}$ is a vector of other time-variant (-invariant) plan design features and firm specific characteristics, including time dummies and other aggregate time variables; the error term is composed by a time-invariant plan-specific component (c_i) and an idiosyncratic component (u_{it}).

Depending on the further structure imposed on the errors – and on wether the panel data structure is exploited – equation 1 can be estimated by pooled OLS (POLS), random effects (RE), or fixed effects (FE). In the presence of unobserved confounding factors (c_i), the explanatory variables in equation (1) will be correlated with the compound error term ($v_{it} = c_i + u_{it}$) and the POLS estimator (as well as the FGLS estimator derived from a RE estimating approach) will be biased and inconsistent.

Unbalanced panels cause no serious issues provided certain assumptions about selection hold (see Wooldridge, 2010a, chapter 19, for an in-depth treatment). In this respect, FE is more robust than RE in the sense that whereas FE allows arbitrary correlation between selection and c_i, with RE selection must be assumed uncorrelated with heterogeneity as well as with idiosyncratic shocks. However, none of these standard methods take into account the nature of the response variable y_{it}, which is defined as a proportion and can take any value in the zero-one interval, including end-point outcomes.[20] This would require a nonlinear modeling approach. For nonlinear models, RE easily adapts to unbalanced panels, but the selection assumptions are strong. Conditional MLE allows unbalanced panels only in a few cases. Finally, a FE approach (where the c_i is viewed as parameters to estimate) does not require a balanced panel, but still suffers from an incidental parameters problem with small T.

Fractional response models have been recently developed to estimate models of proportions in cross-sectional data (Papke and Wooldridge (1996)) and balanced panels which may be subject to unobserved heterogeneity and endogeneity (Papke and Wooldridge

[19]This implies that medium-sized plans in our sample are given the same weight of large and mega plans. By contrast, employee-level analysis is usually skewed toward plans feature and behavior of larger firms (see (Mitchell, Utkus, and Yang, 2006).)

[20]In our application, between 5% and 10% of the plan-year observations, depending on the type of 401(k) plan, has a participation rate equal to one.

(2008)). Moreover, Wooldridge (2010b,a) shows that nonlinear correlated random effects (CRE) models allow to handle the fractional response nature of the dependent variable as well as the unbalancedness of panel data. In fractional response models, the conditional expectation of the fractional outcome y_{it} is assumed to be of the index form:

$$E(y_{it}|\mathbf{x}_{it}, c_i) = \Phi(\mathbf{x}_{it}\beta + c_i), \qquad i = 1, 2, \ldots, n \qquad t = 1, 2, 3,$$

where the unobserved effect, c_i appears additively inside the standard normal cumulative distribution function, Φ. Whereas, given the strictly monotonic functional form, the elements of β give the direction of the partial effects, the magnitude of the latter depend on the level of the covariates and the unobserved heterogeneity. A popular measure of the importance of the observed covariates is to average the partial effects across the distribution of c_i, to obtain the Average Partial Effects (APE)(see Wooldridge (2005)). In the continuous covariate case, the APE with respect to x_{tj}, evaluated at $\mathbf{x}_t$ is:

$$E_c[\beta_j \phi(\mathbf{x}_t\beta + c)] = \beta_j E_c[\phi(\mathbf{x}_t\beta + c)].$$

In order to identify the APEs and, up to a positive scale factor, the β, three further assumptions are imposed.

The first assumption concerns the strict exogeneity of $\mathbf{x}_{it}$ conditional on c_i :

$$E(y_{it}|\mathbf{x}_i, c_i) = E(y_{it}|\mathbf{x}_{it}, c_i),$$

where $\mathbf{x}_i = (x_{i1}, x_{i2}, \ldots, x_{iT})$.

The second assumption is that selection is conditionally ignorable for all t, that is:

$$E(y_{it}|\mathbf{x}_i, c_i, \mathbf{s}_i) = E(y_{it}|\mathbf{x}_i, c_i),$$

where $\mathbf{s}_i = (s_{i1}, s_{i2}, \ldots, s_{iT})$ is a vector of selection indicators, with $s_{it} = 1$ if time period t can be used in the estimation (i.e. all the variables in equation (1) are observed for individual i at time t). This assumption implies that observing a data point in any time period cannot be systematically related to the idiosyncratic errors, u_{it}, whereas election s_{it} at time period t is allowed to be arbitrarily correlated with $(\mathbf{x}_i, c_i)$.

The third assumption allows for unobserved heterogeneity in the form of correlated random effects (CRE). Further, both the outcome and variance equation are allowed to depend on the number of observations within each sub panel T_i. In our application, we define a dummy assuming value one for plans with $T_i = 2$, whereas plans with $T_i = 3$ act as the reference category and plans observed for just one period are dropped fro the analysis. Allowing the unobserved heterogeneity to depend on exchangeable functions $\mathbf{w}_i$

– tipically sums (T_i) or averages ($\bar{x}_i$) – so that:

$$E(c_i|\mathbf{w}_i) = \sum_{r=1}^{T} \psi_r 1[T_i = r] + \sum_{r=1}^{T} 1[T_i = r] \cdot \bar{\mathbf{x}}_i \xi_r$$

is a linear function of the time averages with different coefficients for each number of periods, makes it possible to estimate the APEs over the subpopulation with $T_i \geq 2$. The conditional variance is also allowed to vary with T_i :

$$Var(c_i|\mathbf{w}_i) = \exp(\tau + \sum_{r=1}^{T-1} 1[T_i = r]\omega_r)$$

where τ is the variance for the base group, $T_i = T$, and each ω_r is the deviation from the base group. If the conditional distribution of the unobserved heterogeneity is also maintained to be normal, an estimating equation formulated as a response probability can be obtained as (see Wooldridge (2010a)):

$$Pr(y_{it} = 1|\mathbf{x}_{it}, \mathbf{w}_i) = \Phi[\frac{\mathbf{x}_{it}\beta + \sum_{r=1}^{T} \psi_r 1[T_i = r] + \sum_{r=1}^{T} 1[T_i = r] \cdot \bar{\mathbf{x}}_i \xi_r}{\exp(\sum_{r=2}^{T-1} 1[T_i = r]\omega_r)^{\frac{1}{2}}}],$$

which is directly estimable by heteroscedastic probit software,[21] where the explanatory variables at time t are $(1,\ \mathrm{x}_{it}, 1[T_i = 2] \cdot \bar{\mathbf{x}}_i, \ldots, 1[T_i = T] \cdot \bar{\mathbf{x}}_i)$ and the explanatory variables in the variance are simply the dummy variables $(1[T_i = 2], \ldots 1[T_i = T - 1])$. The corresponding average structural function can be estimates as:

$$\widehat{ASF}(\mathbf{x}_t) = N^{-1} \sum_{i=1}^{N} \Phi[\frac{\mathbf{x}_t\hat{\beta} + \sum_{r=1}^{T} \hat{\psi}_r 1[T_i = r] + \sum_{r=1}^{T} 1[T_i = r] \cdot \bar{\mathbf{x}}_i \hat{\xi}_r}{\exp(\sum_{r=2}^{T-1} 1[T_i = r]\hat{\omega}_r)^{\frac{1}{2}}}],$$

For continuous $\mathbf{x}_t$:

$$\widehat{APE}(\mathbf{x}_t) = \hat{\beta}_j \{N^{-1} \sum_{i=1}^{N} \phi[\frac{\mathbf{x}_t\hat{\beta} + \sum_{r=1}^{T} \hat{\omega}_r 1[T_i = r] + \sum_{r=1}^{T} 1[T_i = r] \cdot \bar{\mathbf{x}}_i \hat{\xi}_r}{\exp(\sum_{r=2}^{T-1} 1[T_i = r]\hat{\omega}_r)^{\frac{1}{2}}}]\},$$

Equation (1) is first estimated using OLS on the pooled unbalanced sample of all 401(k) plans observed for at least two periods. Three specifications of equation 1 are used. In the first specification (1), the average match rate enters linearly. In the second specification (2), the average match rate is replaced by a set of match rate dummies aimed at capturing possible non-linearities in the match-participation relationship. The omitted category is represented by plans that do not match elective deferrals. Finally, a third specification (3) – including only a match availability dummy – allows us to capture a phenomenon that was particularly relevant during the observation period: "match reinstatement" following a

[21] I use the `fhetprobit` Stata routine made available by Bluhm (2013).

"match suspension". Following the financial crisis of 2008-2009, many companies decided to suspend their match (Munnell and Quinby, 2010; Apte and Mcfarland, 2011). Starting in 2010, most of these companies reinstated their match. Our data allow us to observe this match reinstatement dynamics.

The results emerging from the POLS estimation exercise – reported in columns 2, 5, and 8 of Table 8 – are consistent with the descriptive findings reported in Table 6, indicating that plans with automatic enrollment have significantly higher participation rates – from 16.4 percentage points in thrift-savings plans to 10.1 percentage points in ESOP. Irrespective of plan type, the average match rate is also found to be positively and significantly related to the participation rate. Each 0.10 increase in the average match rate raises participation between 1 and 2.5 percentage points. The POLS estimation results on specification (2) – in column 5 – indicate a positive and significant non-linear match-participation relationship. Plans whose average match rates are more than \$ for \$ have the highest impact on participation rate – between 12 and 35 percentage points – when compared to plans with no match.

Among the control variables, results not reported in Table 8 show that plans offering loans – i.e. those plans having a positive outstanding participant loan amount in a plan-year – have higher participation rates (between 2 and 5 percentage points), while an increase of 100\$ of the average per participant administrative fees significantly reduces participation in the 0.5-1 percentage points range for thrift-savings and profit sharing plans. Participation rates are also significantly lower in plans offered as the only plan, as well as in collectively bargained and large plans. By contrast, plan participation rates are significantly higher for plans that were established before the 401(k) feature was introduced, in plans that offer to the participant limited or no account direction, and in ESOP (either leveraged or non leveraged) as well as in profit sharing plans.

While the POLS results presented in Table 8 represents a useful benchmark, they are likely biased, due to the potential endogeneity of key plan design features like matching and automatic enrollment. The bias would tend to be downward if employers' matching and auto-enrollment decisions were mainly driven by the need to increase the participation rate in NHCEs in order to pass non-discrimination tests. By contrast, if employers' plan design choices were mainly driven by the desire to attract and retain a higher-quality workforce, the bias would tend to be upward. We address this problem exploiting the panel structure of the data, and estimate – columns 3, 6, and 9 of table 8 – the same specifications by means of FE and CRE estimators (Fractional Heteroschedastic Probit (FHP)). The FE and FHP estimation results indicate that the impact of both auto-enrollment and match rates declines substantially from the OLS benchmark estimates, although remaining positive and strongly significant. APEs calculated following FHP estimation indicate that the impact is slightly higher when the fractional nature of the response variable is accounted for in the estimation process. Plans switching to auto-

enrollment have plan participation rates that are 5 to 6 and 6 to 7 percentage points higher in FE and FHP specifications, respectively. However, in interpreting this results it must be considered that this is likely a downwardly biased estimate of the causal effect of automatic enrollment, because most plans apply automatic enrollment only to new hires rather than extending auto-enrollment eligibility also to current eligible participants not participating in the plan.[22] Therefore, the participation rates reported for plans with automatic enrollment may include both employees who were subject to automatic enrollment (primarily low tenure employees), and those who were not. Despite the limitation implied by the lack of further auto-enrollment eligibility details in Form 5500 data, the results seem to be broadly consistent with the findings provided by Madrian and Shea (2001), Choi, Laibson, Madrian, and Metrick (2004), and Beshears, Choi, Laibson, and Madrian (2008), that are based on quasi-experimental variation in enrollment protocols in a few companies offering a 401(k) plan. An important finding of the FE/FHP estimation is that automatic enrollment becomes the plan design feature that has the strongest positive impact on participation rate. Match rate effects remain positive and significant for thrift-savings and profit-sharing plans but are substantially lower than in OLS – each 0.10 increase in the average match rate would increase participation between 0.2 and 0.4 percentage points. This result is consistent with Ippolito (1997, 2002)'s 401(k) plans theory that advocates the use of matching by employers as a workforce sorting device. By contrast, this finding is at odds with the findings of earlier studies that use instrumental variables (IV) to address match rates endogeneity. The IV match estimates provided by Even and Macpherson (2005), and Dworak-Fisher (2011) are rather consistent with the view that a failure to account for the possible influence of employee saving preferences on employer matching may lead to an understatement of the impact of matching on employee participation. However, the internal validity of these studies, as the same authors acknowledge, is threatened by the potential invalidity of the instruments used in the empirical analysis.

As previously mentioned, a difficulty with 5500 Form data is that the match rate is measured imprecisely, mainly because there is no distinction made between employer matching and non-elective contributions. If the measure of the match rate is based on the ratio of employer to employee contributions, the match rate will be overstated when employers make non-elective contributions.[23] However, if the average match rate were systematically overstated, the FE estimator would make it possible to eliminate this bias. In any case, given the attenuation bias that a measurement error in average match rates

[22] See The Vanguard Center for Retirement Research (2010).

[23] Although the inclusion of non-matched after-tax contributions in total employee contributions may work in the opposite direction, toward understating the average match rate, the fact that, since their introduction in 2006, Roth after-tax contributions – which are typically matched – are the more advantageous form of after-tax contributions, and that some plans either do not offer or match also after-tax contributions should prevent this from happening.

would introduce in its estimated coefficients, our results could still be considered as a lower bound of the impact of match rates on participation rates.

These results confirm that, overall, automatic enrollment seems to be for plan sponsors a more powerful tool than matching contributions in increasing participation rates. Moreover, the effect is slightly stronger when the fractional nature of the response variable is taken into account in the estimation process. However, to assess the robustness of the results presented so far, the estimation is repeated – and the results are available upon request from the author – over different samples including either single-employer sole 401(k) plans with more than 100 participants (Sample 2) or single-employer sole 401(k) plans with more than 100 participants and offering a match (Sample 3). Overall, the main results of this study seem to be robust across these different samples.

The last issue we address is how a switch to automatic enrollment affects employer matching contributions to the plan. Using cross-sectional data, (Soto and Butrica, 2009; Butrica and Karamcheva, 2012), and suggests that auto-enrollment decreases matching rates by approximately 3 percent. Their paper acknowledges the possibility that auto-enrollment could be endogenous in the matching rate equation. but notes the difficulty in finding appropriate instruments.

We use panel data to difference out any plan-specific characteristics that are correlated with both auto-enrollment and the level of match rates. That is, for example, suppose that plan sponsors design their 401(k) plans as a mean of developing stronger incentives for employee savings while achieving a mix between employee elective deferrals and employer contributions that satisfies the IRC nondiscrimination requirements. This nondiscrimination mix preference would lead both to greater auto-enrollment and to lower match rates so to maintain the cost, and, if not controlled for in the match rate regression, the estimated effects of auto-enrollment on contributions will be biased downwards.

Alternatively, plan sponsors could design their 401(k) plans as a mean of developing stronger incentives for employee savings while offering more attractive benefit packages to recruit and retain higher-quality workers. In this case, the attraction and retention desire leads both to greater auto-enrollment and to higher match rates, and, if not controlled for in the match rate regression, the estimated effects of auto-enrollment on contributions will be biased upwards. Which of these two counter-effects dominates remains an empirical issue. Panel data allows us to control for fixed effects representing unobserved plan-specific traits and eliminate any such bias. Estimation results from POLS and FE of the average match rate equation are presented in 12. When exploiting the natural cross-sectional variation in the pooled samples, automatic enrollment seems to have a negative and significant impact on match rates for profit sharing plans. However, when exploiting within plan inter-temporal variation to address the potential endogeneity of auto-enrollment, auto-enrollment is found to positively and significantly affect match rates. This result is in stark contrast with the evidence provided by earlier studies (Soto and Butrica, 2009;

Butrica and Karamcheva, 2012), and suggests that a complementarity – rather than a trade-off – may be at work between these key 401(k) plan design features for profit sharing plans. By contrast, for thrift-savings plan, auto-enrollment increases match rates by 1 percentage point both in the cross-sectional and in the panel estimates, while it does not significant affect match rates in ESOP/SB.

4 Conclusions

Using plan-level data from Form 5500s filed annually by plan sponsors, this study provides new evidence that sheds further light on the role of two key features of 401(k) plan design – employer matching and automatic enrollment – that are intended to have an indirect and direct impact, respectively, on participation rates in the population of US 401(k) plans.

The panel structure of the most recent available Form 5500 data – plan-years 2009-2011 – is exploited to address the potential endogeneity of the regressors of interest that would threaten the internal validity of the study. This time window is chosen to exploit the fact that, since 2009 – following PPA '06 enactment – employers sponsoring a 401(k) plan are required to report in the 5500 form filed annually with the IRS the nature of the enrollment protocol adopted. Moreover, during this period, following the financial crisis of 2008, many employers first reduced or suspended their employer match and later reinstated it. These match dynamics can be exploited in a panel data analysis to identify the effect of match reinstatements on plan participation rates.

The empirical analysis is carried out by type of 401(k) plan in order to provide a better characterization of plan design choices that is specific to each plan type. The robustness of the results is further assessed using different model specifications and different samples. The fractional nature of the dependent variable is accounted for in the estimation of the participation rate equation.

In line with most previous literature findings, while both auto-enrollment and match rates are found to have positive and significant effects, auto-enrollment is found to have a prominent role in boosting participation rates. Moreover, auto-enrollment is found to have a positive and significant effect on match rates, at least for some type of 401(k) plans. The latter result is in stark contrast with the evidence provided by earlier studies (Soto and Butrica, 2009; Butrica and Karamcheva, 2012), and suggests that, at least for some type of 401(k) plans, a complementarity – rather than a trade-off – may be at work between these key 401(k) plan design features.

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Table 1. Studies on the impact of matching/auto-enrollment on 401(k) plan participation

Study	Data	N	Estimation method	Dependent variable	Employer match definition	Marginal effects
Individual-level cross-sectional survey data						
Bassett, Fleming, and Rodrigues (1998)	Current Population Survey, 1993	5,658	LPM	Participation Dummy	Employer Match Dummy	0.09**
Even and Macpherson (2005)	Current Population Survey, 1993	3,884	Probit	Participation Dummy	Employer Match Dummy	0.077**
		3,884	Bivariate Probit	Participation Dummy	Employer Match Dummy	0.237** - 0.328**
		3,884	IV LPM	Participation Dummy	Employer Match Dummy	0.2384 - 0.5**
Engelhardt and Kumar (2007)	Health and Retirement Survey, 1991	1,042	IV Probit	Participation Dummy	Match Rate	0.183** - 0.22**
Plan-level cross-sectional survey data						
Dworak-Fisher (2011)	National Compensation Survey Plans, 2002/2003	587	BQMLE	Participation Rate	Log(Match Rate (%)), Log(Max. Match (%))	0.0396** - 0.0580**, 0.0013 - 0.4264**
		587	IV BQMLE	Participation Rate	Log(Match Rate (%))	-0.07 - 0.4264**
Butrica and Karamcheva (2012)	National Compensation Survey Plans, 2010/2011	1,200	LPM	Participation Rate (%)	Max. Match (%)	0.161
Plan-level cross-sectional administrative data						
GAO (General Accounting Office)	IRS Form 5500 Plans, 1992	4,006	OLS	Participation Rate	Average Match Rate Dummies	0.1035** - 0.3341**
Individual-level cross-sectional company data						
Clark and Schieber (1998)	19 Watson Wyatt Plans, 1994	59,203	Logit	Participation Dummy	Match Rate Dummies	0.28** - 0.47**
Clark, Goodfellow, Schieber, and Warwick (2000)	87 Watson Wyatt Plans, 1995	152,914	Logit	Participation Dummy	Match Rate (%)	0.03**
Huberman, Iyengar, and Jiang (2005)	647 Vanguard Plans, 2001	793,794	LPM, Probit	Participation Dummy	Match Rate up to 2% of Pay (%)	0.12**
Beshears, Choi, Laibson, and Madrian (2010)	9 Hewitt Auto-enrollment Plans, 2002-2005	44,279	LPM	Participation Dummy	Max. Match (%)	2.2** - 2.78**
	6 Hewitt Auto-enrollment Plans, 2002-2005	35,895	LPM	Participation Dummy	Max. Match (%)	1.778** - 3.752**
Plan-level cross-sectional company data						
Papke and Poterba (1995)	54 IRS Form 5500 Plans, 1987	37	OLS	Participation Rate	Match Rate	0.255**
		38	OLS	Participation Rate	Match Rate Dummies	0.42** - 0.71**
Mitchell, Utkus, and Yang (2007)	507 Vanguard Plans, 2001	507 (NHCE)	OLS	Participation Rate (%)	Match Rate up to 3% of Pay, Max. Match (%)	0.098**, 0.844**
		474 (HCE)	OLS	Participation Rate	Match Rate up to 3% of Pay, Max. Match (%)	0.049**, 0.281
Plan-level longitudinal administrative data						
Papke (1995)	IRS Form 5500 Plans, 1986-1987	8,672	OLS	Participation Rate	Average Match Rate Dummies	0.039** - 0.21**
		5,518	Fixed Effects OLS	Participation Rate	Average Match Rate Dummies	-0.01 - 0.014
Individual-level longitudinal company data						
Kusko, Poterba, and Wilcox (1998)	Buck Consultants Company X Plan, 1988-1991	12,000	Descriptive Statistics	Participation Rate Change	Match Rate Change (%)	No Change in Participation
Choi, Laibson, Madrian, and Metrick (2002)	Hewitt Company E Plan, 1996-2000	n.a.	Cox Proportional Hazard	Participation Hazard Ratio	Match Threshold Change Dummy	0.797
	Hewitt Company F Plan, 1998-2000	n.a.	Cox Proportional Hazard	Participation Hazard Ratio	Match Introduction Dummy	1.4642**
Beshears, Choi, Laibson, and Madrian (2010)	Hewitt Company A Auto-enrollment Plan, 2002-2003	645	LPM, Probit	Participation Dummy	Match Cohort Dummy	0.067** - 0.06**, 0.065** - 0.054**

Notes: ** significant at 1% * significance at 5%.

Table 2. Description of Form 5500 PPP research files variables

Variables	Type	Description
Participation rate	Ratio	Active (eligible) participants accounts/Active (eligible) participants
Plan design features		
Avg. match rate	Ratio	Average match rate = Total employer contributions/Total employee deferrals
Automatic Enrollment	Dummy	Plan provides for automatic enrollment of either newly hired or all employees
Employer match available	Dummy	Employer offers matching contributions (=1 if Total employer contributions>0)
Avg. match rate: 0.01-0.50	Dummy	Average match rate in the 0.01-0.50$ range for each $ of employee deferrals
Avg. atch rate: 0.51-1.00	Dummy	Average match rate in the 0.51-1.00$ range for each $ of employee deferrals
Avg. match rate: 1.01-1.50	Dummy	Average match rate in the 0.51-1.00$ range for each $ of employee deferrals
Avg. match rate: $>$ 1.50	Dummy	Average match rate above 1.50$ for each $ of employee deferrals
Sole plan	Dummy	Plan considered as the sole plan of a sponsor
Erisa 404 (c) plan	Dummy	Plan intended to comply with Erisa 404(c) (fiduciary liabilities relief)
Erisa 401 (m) plan	Dummy	Plan offers matching contributions and/or after-tax employee deferrals
No self-directed account	Dummy	Participants cannot direct the investment of a portion of their account assets
Partially self-directed account	Dummy	Participants can direct the investment of a portion of their account assets
Totally self-directed account	Dummy	Participants can direct the investment of all their account assets
Default investment accounts	Dummy	Plan uses *default investment accounts* for participants who fail to self-direct
Participant-directed brokerage option	Dummy	Participant-directed brokerage accounts provided as an investment option
Employer contrib. in employer securities	Dummy	Plan requiring all/part of employer contributions invested in employer securities
Corrective distribution	Dummy	A corrective distribution for excess deferrals has been made during the plan-year
Plan termination adopted	Dummy	A resolution to terminate the plan been adopted during this or any prior plan-years
Active (eligible) participants: $>$ 1,000	Dummy	More than 1,000 participants eligible to enrollment
Collective bargained plan	Dummy	Plan established under a collectively bargaining agreement
Profit sharing or ESOP specific plan design features		
ESOP: Leveraged	Dummy	ESOP borrowing fund to acquire employer's stocks
ESOP: Non leveraged	Dummy	ESOP not borrowing fund to acquire employer's stocks
ESOP: S corporation	Dummy	ESOP sponsor is a S corporation for the tax-year
Age-service weighted/New-comparability plan	Dummy	Allocations based on: age/service or participant classifications (new comparability)
Financial Variables		
Avg. salary deferral, per participant	1,000$	Average employee deferral, per participant
Avg. employer contribution, per participant	1,000$	Average employer contribution, per participant
Avg. assets, per	1,000$	Average assets, per participant
Avg. loan, per participant	1,000$	Average loan, per participant
Avg. fee, per participant	1,00$	Average administrative fees, per participant

Table 3. Avg. match rate by plan type, plan size, and panel year

	Panel year						Pooled	
	2009		2010		2011			
	Small	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
410 (k) Plan Type:								
Thrift-Savings	0.338	0.388	0.338	0.394	0.352	0.411	0.343	0.398
Profit Sharing	0.466	0.496	0.463	0.522	0.470	0.528	0.466	0.516
ESOP/SB	0.573	0.508	0.563	0.53	0.602	0.549	0.579	0.529
Total	0.384	0.416	0.384	0.428	0.396	0.442	0.388	0.429

Notes: Rates computed on an unbalanced sample including single-employer 401(k) plans with more than 100 participants observed for at least two periods.

Table 4. Avg. match rate by plan type, enrollment protocol, and panel year

	Panel year						Pooled	
	2009		2010		2011			
	Elective	**Auto**	**Elective**	**Auto**	**Elective**	**Auto**	**Elective**	**Auto**
410 (k) Plan Type:								
Thrift-Savings	0.34	0.369	0.339	0.368	0.352	0.385	0.344	0.375
Profit Sharing	0.468	0.459	0.469	0.447	0.477	0.451	0.471	0.451
ESOP/SB	0.536	0.54	0.537	0.562	0.569	0.578	0.546	0.563
Total	0.386	0.399	0.386	0.396	0.399	0.41	0.390	0.402

Notes: Rates computed on an unbalanced sample including single-employer 401(k) plans with more than 100 participants observed for at least two periods.

Table 5. Auto-enrollment rate by plan type, plan size, and panel year

	Panel year						Pooled	
	2009		2010		2011			
	Small	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
410 (k) Plan Type:								
Thrift-Savings	0.103	0.208	0.158	0.274	0.178	0.312	0.146	0.266
Profit Sharing	0.087	0.23	0.129	0.304	0.149	0.328	0.122	0.289
ESOP/SB	0.106	0.297	0.161	0.41	0.189	0.457	0.152	0.388
Total	0.097	0.219	0.148	0.291	0.167	0.327	0.137	0.28

Notes: Rates computed on an unbalanced sample including single-employer 401(k) plans with more than 100 participants observed for at least two periods.

Table 6. Participation rate by plan type, enrollment protocol, and panel year

	Panel year						Pooled	
	2009		2010		2011			
	Elective	**Auto**	**Elective**	**Auto**	**Elective**	**Auto**	**Elective**	**Auto**
410 (k) Plan Type:								
Thrift-Savings	0.619	0.818	0.617	0.818	0.613	0.818	0.614	0.824
Profit Sharing	0.712	0.848	0.708	0.850	0.698	0.854	0.706	0.851
ESOP/SB	0.820	0.906	0.830	0.905	0.830	0.912	0.826	0.908
Total	0.653	0.829	0.651	0.830	0.646	0.835	0.650	0.832

Notes: Rates computed on an unbalanced sample including single-employer 401(k) plans with more than 100 participants observed for at least two periods.

Table 7. Descriptive statistics, by type of 401(k) plan and enrollment protocol

	Thrift-Savings			Profit Sharing			ESOP/SB			All		
	Elective	Auto	Total	Elective	Auto	Total	Elective	Auto	Total	Elective	Auto	Total
Plan participation												
Participation rate	0.62	0.82	0.65	0.71	0.85	0.73	0.83	0.91	0.85	0.65	0.83	0.68
Eligible participants	685	1145	758	369	662	407	10,962	10,985	10969	704	1278	791.2
Eligible participants with account balance	368	927	457	227	555	270	8,051	9,765	8,539	415.4	1064.0	513.7
Financial variables												
Avg. salary deferral per participant (1,000$)	4.01	4.14	4.03	3.72	3.93	3.75	4.59	5.20	4.76	3.92	4.11	3.95
Avg. employer contribution per participant (1,000$)	1.33	1.57	1.37	1.84	1.94	1.85	2.45	2.83	2.56	1.52	1.71	1.55
Sole plan	0.85	0.77	0.84	0.92	0.86	0.91	0.53	0.32	0.47	0.87	0.78	0.86
Loans available	0.71	0.84	0.73	0.65	0.78	0.66	0.81	0.92	0.84	0.69	0.83	0.71
Avg. loan per participant (1,000$)	0.99	1.26	1.03	0.90	1.17	0.94	1.72	2.17	1.85	0.97	1.26	1.01
Avg. assets per participant (1,000$)	50.8	62.3	52.6	59.0	67.3	60.1	107.1	121.7	111.3	54.3	65.4	56.0
Avg. administrative fee per participant (100$)	0.76	0.65	0.74	0.96	0.81	0.94	0.92	0.73	0.86	0.83	0.70	0.81
Plan design features												
Automatic enrollment	0	1	0.16	0	1	0.13	0	1	0.28	0	1	0.15
Employer match available	0.78	0.83	0.79	0.80	0.84	0.81	0.91	0.97	0.93	0.79	0.84	0.80
Avg. match rate (ratio)	0.34	0.38	0.35	0.47	0.45	0.47	0.55	0.56	0.55	0.39	0.40	0.39
Avg. match rate: 0	0.22	0.17	0.21	0.20	0.16	0.19	0.089	0.029	0.072	0.21	0.16	0.20
Avg. match rate: 0.01-0.50	0.52	0.55	0.52	0.42	0.49	0.43	0.44	0.47	0.45	0.49	0.53	0.49
Avg. match rate: 0.51-1.00	0.21	0.22	0.21	0.23	0.22	0.23	0.35	0.40	0.36	0.22	0.23	0.22
Avg. match rate: 1.01-1.50	0.037	0.047	0.038	0.090	0.098	0.091	0.080	0.083	0.081	0.056	0.063	0.057
Avg. match rate: >1.50	0.015	0.012	0.014	0.051	0.029	0.048	0.044	0.017	0.036	0.027	0.017	0.026
No self-directed account	0.02	0.0095	0.016	0.035	0.013	0.03	0.06	0.03	0.05	0.025	0.011	0.023
Partially self-directed account	0.01	0.015	0.014	0.035	0.027	0.03	0.46	0.40	0.44	0.025	0.029	0.027
Totally self-directed account	0.97	0.98	0.97	0.93	0.96	0.94	0.48	0.57	0.51	0.95	0.96	0.95
Erisa 404 (c) plan	0.88	0.95	0.89	0.80	0.90	0.81	0.69	0.89	0.75	0.85	0.93	0.86
Erisa 401 (m) plan	0.89	0.93	0.90	0.83	0.89	0.84	0.89	0.96	0.91	0.87	0.92	0.88
Self-directed brokerage option	0.051	0.11	0.060	0.095	0.14	0.10	0.13	0.30	0.18	0.067	0.12	0.075
Default investment account	0.58	0.94	0.64	0.56	0.93	0.61	0.36	0.92	0.52	0.57	0.94	0.63
Employer contrib. in employer securities	0.0030	0.0079	0.0038	0.0014	0.0033	0.0016	0.20	0.22	0.21	0.0049	0.012	0.0060
Corrective distributions made	0.30	0.37	0.31	0.25	0.34	0.27	0.24	0.30	0.26	0.28	0.36	0.29
Sponsor member of a controlled group	0.30	0.38	0.32	0.26	0.32	0.27	0.46	0.63	0.51	0.29	0.37	0.30
Master plan	0.82	0.75	0.81	0.81	0.79	0.81	0.12	0.046	0.10	0.81	0.74	0.80
Collectively bargained plan	0.052	0.069	0.054	0.017	0.029	0.019	0.15	0.19	0.16	0.041	0.061	0.044
Plan established before 1981	0.072	0.11	0.078	0.20	0.26	0.21	0.28	0.36	0.30	0.12	0.16	0.12
Plan established between 1982 and 1999	0.61	0.64	0.61	0.56	0.56	0.56	0.61	0.50	0.58	0.59	0.61	0.60
Plan established after 1999	0.32	0.25	0.31	0.24	0.18	0.23	0.11	0.14	0.12	0.29	0.23	0.28
Plan termination adopted	0.0021	0.0014	0.0020	0.0023	0.0022	0.0023	0.0017	0	0.0012	0.0022	0.0016	0.0021
ESOP-specific plan design features												
ESOP: Leveraged	0	0	0	0	0	0	0.18	0.14	0.17	0.0023	0.0040	0.0025
ESOP: Nonleveraged	0	0	0	0	0	0	0.82	0.86	0.83	0.010	0.024	0.012
ESOP: S corporation	0	0	0	0	0	0	0.14	0.056	0.11	0.0017	0.0015	0.0017
Profit Sharing-specific plan design features												
Age/service - New comparability	0	0	0	0.22	0.19	0.22	0	0	0	0.077	0.057	0.074

Notes: Summary statistics computed on the pooled unbalanced panel including single-employer sole 401(k) plans with more than 100 participants and observed for at least two periods.

Table 8. Estimation results for all 401(k) plans

	(1)			(2)			(3)		
	POLS	**FE**	**FHP**	**POLS**	**FE**	**FHP**	**POLS**	**FE**	**FHP**
Autoenrollment	0.152**	0.058**	0.058**	0.151**	0.058**	0.066**	0.150**	0.058**	0.067**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.023)
Avg. match rate	0.220**	0.036**	0.043**						
	(0.002)	(0.002)	(0.003)						
Avg. match rate [0.01-0.50]				0.114**	0.020**	0.018**			
				(0.002)	(0.001)	(0.001)			
Avg. match rate [0.51-1.00]				0.200**	0.033**	0.031**			
				(0.003)	(0.002)	(0.002)			
Avg. match rate [1.01-1.50]				0.305**	0.042**	0.048**			
				(0.003)	(0.002)	(0.004)			
Avg. match rate [1.51-2.00]				0.311**	0.043**	0.048**			
				(0.004)	(0.003)	(0.006)			
Employer match available							0.157**	0.022**	0.02**
							(0.002)	(0.001)	(0.001)
Observations	152,161								

Notes: Dependent variable is plan participation rate (defined as a proportion). All specifications include controls for time-variant plan specific characteristics and year dummies. Pooled OLS (POLS) specifications include controls for time-invariant firm specific characteristics. Fractional heteroschedastic probit (FHP) specifications include controls for within-plan over-time average of time-varying plan characteristics. Estimates reported for Fractional Heteroscedastic Probit (FHP) are Average Partial Effects (APEs) and corresponding delta-method standard errors. All specifications are estimated on an unbalanced panel including single-employer sole 401(k) plans with more than 100 participants. Clustered standard errors in parentheses. * Significant at the 10% significance level. ** Significant at the 5% significance level.

Table 9. Estimation results for thrift-savings plans

	(1)			(2)			(3)		
	POLS	**FE**	**FHP**	**POLS**	**FE**	**FHP**	**POLS**	**FE**	**FHP**
Autoenrollment	0.162**	0.061**	0.07**	0.162**	0.062**	0.07**	0.162**	0.062**	0.07**
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Avg. match rate	0.247**	0.045**	0.052**						
	(0.003)	(0.003)	(0.004)						
Avg. match rate: 0.01-0.50				0.119**	0.020**	0.018**			
				(0.003)	(0.001)	(0.002)			
Avg. match rate: 0.51-1.00				0.205**	0.032**	0.032**			
				(0.003)	(0.002)	(0.003)			
Avg. match rate: 1.01-1.50				0.331**	0.044**	0.051**			
				(0.004)	(0.003)	(0.006)			
Avg. match rate: >1.50				0.343**	0.051**	0.06**			
				(0.007)	(0.005)	(0.01)			
Employer match available							0.157**	0.021**	0.02**
							(0.003)	(0.001)	(0.002)
Observations	99,145								

Notes: Dependent variable is plan participation rate (defined as a proportion). All specifications include controls for time-variant plan specific characteristics and year dummies. Pooled OLS (POLS) specifications include controls for time-invariant firm specific characteristics. Fractional heteroschedastic probit (FHP) specifications include controls for within-plan over-time average of time-varying plan characteristics. Estimates reported for Fractional Heteroscedastic Probit (FHP) are Average Partial Effects (APEs) and corresponding delta-method standard errors. All specifications are estimated on an unbalanced panel including single-employer sole 401(k) plans with more than 100 participants. Clustered standard errors in parentheses. * Significant at the 10% significance level. ** Significant at the 5% significance level.

Table 10. Estimation results for profit sharing plans

	(1)			(2)			(3)		
	POLS	**FE**	**FHP**	**POLS**	**FE**	**FHP**	**POLS**	**FE**	**FHP**
Automatic enrollment	0.131**	0.051**	0.058**	0.129**	0.051**	0.058**	0.124**	0.051**	0.058**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
Avg. match rate	0.188**	0.028**	0.033**						
	(0.003)	(0.002)	(0.004)						
Avg. match rate: 0.01-0.50				0.102**	0.021**	0.017**			
				(0.004)	(0.002)	(0.002)			
Avg. match rate: 0.51-1.00				0.188**	0.034**	0.031**			
				(0.005)	(0.003)	(0.003)			
Avg. match rate: 1.01-1.50				0.276**	0.041**	0.044**			
				(0.005)	(0.003)	(0.005)			
Avg. match rate: >1.50				0.280**	0.038**	0.038**			
				(0.005)	(0.004)	(0.007)			
Employer match available							0.153**	0.024**	0.021**
							(0.004)	(0.002)	(0.002)
Observations	50,658								

Notes: Dependent variable is plan participation rate (defined as a proportion). All specifications include controls for time-variant plan specific characteristics and year dummies. Pooled OLS (POLS) specifications include controls for time-invariant firm specific characteristics. Fractional heteroschedastic probit (FHP) specifications include controls for within-plan over-time average of time-varying plan characteristics. Estimates reported for Fractional Heteroscedastic Probit (FHP) are Average Partial Effects (APEs) and corresponding delta-method standard errors. All specifications are estimated on an unbalanced panel including single-employer sole 401(k) plans with more than 100 participants. Clustered standard errors in parentheses. * Significant at the 10% significance level. ** Significant at the 5% significance level.

Table 11. Estimation results for ESOPs

	(1)			(2)			(3)		
	POLS	**FE**	**FHP**	**POLS**	**FE**	**FHP**	**POLS**	**FE**	**FHP**
Automatic enrollment	0.103**	0.034**	0.038**	0.103**	0.034**	0.037**	0.102**	0.034**	0.038**
	(0.012)	(0.009)	(0.009)	(0.011)	(0.009)	(0.011)	(0.012)	(0.009)	(0.011)
Avg. match rate	0.100**	0.029**	0.031**						
	(0.012)	(0.010)	(0.014)						
Avg. match rate: 0.01-0.50				0.037	−0.004	−0.005			
				(0.021)	(0.011)	(0.011)			
Avg. match rate: 0.51-1.00				0.082**	0.009	0.009			
				(0.022)	(0.012)	(0.012)			
Avg. match rate: 1.01-1.50				0.120**	0.028	0.03			
				(0.023)	(0.015)	(0.021)			
Avg. match rate: >1.50				0.135**	0.031	0.023			
				(0.028)	(0.020)	(0.03)			
Employer match available							0.067**	0.000	−0.001
							(0.021)	(0.011)	(0.02)
Observations	2,358								

Notes: Dependent variable is plan participation rate (defined as a proportion). All specifications include controls for time-variant plan specific characteristics and year dummies. Pooled OLS (POLS) specifications include controls for time-invariant firm specific characteristics. Fractional heteroschedastic probit (FHP) specifications include controls for within-plan over-time average of time-varying plan characteristics. Estimates reported for Fractional Heteroscedastic Probit (FHP) are Average Partial Effects (APEs) and corresponding delta-method standard errors. All specifications are estimated on an unbalanced panel including single-employer sole 401(k) plans with more than 100 participants. Clustered standard errors in parentheses. * Significant at the 10% significance level. ** Significant at the 5% significance level.

Table 12. Avg. match rate determinants. POLS, FE

	Thrift-Savings		Profit Sharing		ESOP/SB		All	
	POLS	**FE**	**POLS**	**FE**	**POLS**	**FE**	**POLS**	**FE**
Automatic enrollment	0.011**	0.012**	−0.029**	0.013*	0.027	−0.002	−0.001	0.012**
	(0.004)	(0.003)	(0.008)	(0.006)	(0.027)	(0.022)	(0.004)	(0.003)
Sole plan	−0.061**	0.008*	−0.076**	0.018*	−0.017	−0.033	−0.064**	0.011**
	(0.005)	(0.004)	(0.010)	(0.008)	(0.034)	(0.030)	(0.005)	(0.004)
Eligible participants: >1,000	0.005	0.016**	−0.007	0.030*	−0.036	−0.034	−0.004	0.019**
	(0.005)	(0.005)	(0.012)	(0.014)	(0.035)	(0.054)	(0.005)	(0.005)
Loans available	−0.018**	0.001	−0.054**	0.007	−0.044	−0.059	−0.031**	0.003
	(0.004)	(0.003)	(0.007)	(0.006)	(0.044)	(0.040)	(0.004)	(0.003)
No self-directed account	0.048**	0.023*	0.069**	0.023	0.042	−0.061	0.059**	0.020*
	(0.013)	(0.010)	(0.018)	(0.016)	(0.064)	(0.051)	(0.011)	(0.009)
Partially self-directed account	0.073**	0.044**	0.135**	0.024	0.022	−0.008	0.099**	0.029**
	(0.017)	(0.012)	(0.018)	(0.017)	(0.027)	(0.029)	(0.011)	(0.009)
Erisa 404 (c) plan	−0.021**	−0.003	0.022**	−0.016*	−0.017	0.051	0.001	−0.008*
	(0.005)	(0.004)	(0.007)	(0.007)	(0.030)	(0.033)	(0.004)	(0.004)
Erisa 401 (m) plan	0.063**	0.034**	−0.006	0.026**	0.045	0.042	0.031**	0.030**
	(0.007)	(0.005)	(0.009)	(0.009)	(0.059)	(0.041)	(0.005)	(0.005)
Self-directed brokerage option	0.084**	−0.004	0.259**	−0.003	0.030	0.042	0.167**	−0.003
	(0.008)	(0.006)	(0.012)	(0.010)	(0.030)	(0.037)	(0.007)	(0.005)
Default investment account	0.018**	−0.010**	0.025**	−0.008	0.001	−0.013	0.019**	−0.009**
	(0.003)	(0.002)	(0.006)	(0.004)	(0.026)	(0.020)	(0.003)	(0.002)
Employer contrib. in employer securities	−0.064**	−0.022	0.067	0.041	0.017	−0.034	−0.031	−0.026
	(0.021)	(0.024)	(0.077)	(0.077)	(0.031)	(0.035)	(0.018)	(0.020)
Corrective distributions made	−0.089**	−0.002	−0.100**	−0.005	−0.029	−0.022	−0.093**	−0.003* *
	(0.003)	(0.001)	(0.005)	(0.003)	(0.022)	(0.013)	(0.002)	(0.001)
Avg. administrative fee per participant (100$)	−0.003*	−0.003**	0.005*	−0.003	0.001	−0.007	0.002	−0.003**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.010)	(0.007)	(0.001)	(0.001)
Age/service - New comparability			0.236**	0.053**			0.255**	0.051**
			(0.008)	(0.007)			(0.007)	(0.006)
ESOP: Leveraged					0.086*	0.036	0.060	0.047
					(0.034)	(0.038)	(0.033)	(0.036)
ESOP: S Corporation					0.070	0.174**	0.119**	0.150**
					(0.049)	(0.064)	(0.045)	(0.057)
Profit sharing plan							0.038**	
							(0.003)	
Plan established before 1981	0.121**		0.115**		0.057*		0.121**	
	(0.007)		(0.008)		(0.027)		(0.005)	
Plan established after 1999	0.011**		−0.055**		0.044		−0.010**	
	(0.004)		(0.007)		(0.038)		(0.003)	
Plan termination adopted	−0.082**	−0.010	−0.147**	−0.031	−0.592**	−0.124	−0.102**	−0.019
	(0.019)	(0.012)	(0.043)	(0.022)	(0.068)	(0.152)	(0.020)	(0.011)
Year 2010	0.001	−0.005**	−0.003	−0.007**	0.009	−0.002	−0.000	−0.006**
	(0.001)	(0.001)	(0.003)	(0.002)	(0.011)	(0.009)	(0.001)	(0.001)
Year 2011	0.018**	0.005**	0.006	−0.003	0.033*	0.016	0.013**	0.002*
	(0.002)	(0.001)	(0.003)	(0.002)	(0.014)	(0.009)	(0.002)	(0.001)
Constant	0.432**	0.321**	0.529**	0.437**	0.471**	0.552**	0.453**	0.365**
	(0.011)	(0.007)	(0.018)	(0.012)	(0.083)	(0.063)	(0.009)	(0.006)
Observations	99,145		50,658		2,358		152,161	

Notes: Dependent variable is average match rate. POLS specifications include controls for time-invariant firm specific characteristics. All specifications are estimated on an unbalanced panel including single-employer sole 401(k) plans with more than 100 participants. Clustered standard errors in parentheses. * Significant at the 10% significance level. ** Significant at the 5% significance level.