國立政治大學財務管理研究所

碩士學位論文

401(k)退休金計劃投資效率性與計劃特徵關係之研究

A Study of the Relationship between the Efficiency of 401(k) Plan and Plan Characteristics

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中華民國一〇八年六月

DOI:10.6814/NCCU201900118

摘要

本研究探討 401(k)退休金計劃的投資效率性與計劃特徵之關係。401(k)計劃的投資效率取決於信託人所提供的投資清單以及計劃參與者在投資清單中如何去選擇投資組合。然而過去文獻中提到 401(k)計劃中的雇主、信託公司和參與者存在行為偏誤，導致參與者做出不合理的投資決策而失去 401(k)計劃的投資效率。實證結果顯示僅有 0.3%的 401(k)計劃具有顯著的投資效率性，我們還發現前一期員工計劃中持有公司股票的佔比與計劃的效率性有顯著正相關；然而計劃信託公司的選擇以及投資清單數目的多寡與計劃的效率性並無顯著的關聯。

關鍵字：401(k)退休金計劃; 計劃效率性; 計劃特徵

DOI:10.6814/NCCU201900118

Abstract

This study tries to investigate whether the active investment strategy of 401(k) plans is more efficient than the passive investment strategy. Prior literature has documented some problems of behavioral bias in 401(k) plans. We argue that the existence of the behavioral bias will lead the irrational investment decision, and therefore a weak plan efficiency can be observed. We collect 2,688 401(k) plans and examine the relationship between the plan efficiency and plan characteristics. We empirically find that only 0.3% of plans can outperform market portfolios, indicating the active investment strategies of most 401(k) plans are not efficient. In addition, we find the plan efficiency is positively associated with the proportion of the company stock holding to total investments of a plan. However, the choice of trustees or the size of the investment menu has no significant effect on the plan efficiency.

Keywords: 401(k) plan; intersection test; plan efficiency; plan characteristics

DOI:10.6814/NCCU201900118

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1 Introduction

1.1 What is 401(k) plan?

401(k) plan is an employee's retirement savings plan in the USA that is only used by employees in private companies. Employees are free to choose to participate or not participate in the 401(k) plan. Participants can put a portion of their job salary every month to an individual retirement account in the 401(k) plan and withdraw the money after retirement. When employees put part of their salary into a 401(k) account, the employer of the company usually matches a certain amount of money into the employee's 401(k) account according to the proportion of how much the employee puts in. This employer's matching is used to be an incentive strategy for the employee in order to attract employees to put their wages into a personal account of 401(k) plan. Employees are not allowed to withdraw the money from 401(k) retirement account until they retire, but they can be free to use the money in the 401(k) account to invest these funds in most equities, bonds, funds and even the employer's company stock. While the investment options list of 401(k) plan, called by "investment menu", is formulated and provided by company employer and plan trustee, but which asset is chosen and how to invest is decided by the employee. Therefore, almost all investment risk is borne by the employee, not like the defined benefit plan which is that employers take all of the financial risks. In addition, the investment period is very long, so the employees in 401(k) plan must be more careful about investing the funds in 401(k) retirement account.

The incentive for 401(k) plan to attract employees to put their salaries into retirement plans is tax deduction. The amount that an employee transfer to a 401(k) account can be deducted from the income tax, and will be taxed when they are retired in old age. It's a good way to use the tax incentives for the elderly to attract the employee

DOI:10.6814/NCCU201900118

to invest in the 401(k) plan due to the high tax rate in the USA. Since the personal savings rate in the United States has always been lower relative to the high saving rate country like Taiwan, people tend to spend the money in the current period. The policy of tax incentives has created great appeal for both company employer and employees and is the main driver of today's 401(k) plan development. Coupled with the mature US capital market, lots of investment assets, the integrated financial regulations systems, these factors provide a suitable market for the long-term investment. That's what the US pension plan, including 401(k) plan, needs. Besides, pension funds have also become an important base of the US capital market. According to The Investment Company Institute (ICI), there is a total of 4.8 trillion US dollars in 401(k) accounts up to 2016, equivalent to a quarter of the total market value of S&P500, and these funds would inflow into the assets such as stocks and bonds to expand the US capital market. For the US capital market, 401(k) retirement plan fund enables many new high-quality companies to obtain long-term and stable money of funds from the capital market. Therefore, there is a win-win situation between 401(k) plan pension fund and the US capital market to help the beneficial development for each other.

1.2 Some problems in 401(k) plan

However, 401(k) retirement plan is not an absolutely perfect retirement plan, and there are some serious problems in the 401(k) system design. Under the structure of the defined contribution plan like 401(k) plan, the risk of investment is entirely borne by the employees.

But if the employees bear excessive investment risks, once the investment fails, it will lead to irreparable losses. When the plan participants retire, the amount in the

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retirement accounts is the employee's pension. Because of the uncertainty of market, the fund in 401(k) account may be possible to lose market value, so there is no guarantee of how much money the plan participants will be able to get from 401(k) plan. But, retirement pension funds are the only source of income for the employees' retirement life. They should not be exposed to too many risks. Therefore, their own investment ability is very important and they should pursue a more stable and conservative strategy for the long-term investment.

However, the investment ability of individual investors is generally not very good. First, the 401(k) plan provides too many fund choices, and according to actual investment performance statistics, the long-term performance of these expensive active funds is not good and unstable. High management cost is the main reason for low performance of a long-term investment. According to Brown, Liang, and Weisbenner (2007), most of the new funds added to the 401(k) plan are high-cost active-managed equity funds rather than low-cost equity index funds. As the number of fund options increases, the average portfolio expenses increase and the average portfolio performance is thus constrained by rising expenses. Secondly, individual investors often lack professional investment knowledge and do not understand how to diversify the asset allocation of long-term investment. Most investors tend to overweight their asset allocation on single or minority asset, and they are limited by the small number of funds, so it is hard for them to diversify their non-systematic risk across many different assets. In the past literature, Benartzi (2001) also mentioned that employees allocate too many total assets into company stocks. This is also a famous example in the 2001—Enron case. Enron, the seventh largest listed company in the US S&P500, temporarily declared bankrupt, and the market value of Enron's stock evaporated within one day. It also caused thousands of employee retirement accounts to go bankrupt

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because Enron's employees' retirement accounts invested up to 47% of Enron's company stock. It is a tragic example of "Put all thine eggs in the one basket", a non-diversified investment risks. Finally, most individual investors do not understand the "Life Cycle Hypothesis". As investors accumulate more wealth and gradually prepared for retirement, investment portfolios need to become more conservative as their future labor income value will decrease rapidly year by year. These are the main problems 401(k) retirement plan needs to face.

1.3 Background

The United States is a mature and developed country. Due to the aging society, the government needs to pay more fiscal expenditure for the increasing retired population and elderly population. But for these retired people, 401(k) retirement funds are the only source of income. Therefore, how to use the pension funds to invest wisely and properly managing the retirement saving is what every employee need. The original purpose of the 401(k) plan was good, providing employees and employer a retirement fund management system which can benefit each other.

However, as mentioned earlier, the 401(k) retirement plan is not an absolutely perfect retirement plan. As a defined contribution plan, the investment risk of 401(k) retirement account almost depends on the long-term investment ability of plan participants. But most of the investor lacks the professional investment knowledge and don't understand how to diversify their asset allocation of long-term investment. Thus, it is easy to produce the behavioral bias of investment strategy, resulting in the poor investment efficiency of 401(k) plan.

Therefore, through this study, I want to understand whether the historical

DOI:10.6814/NCCU201900118

performance of each 401(k) company's plan over the years is efficient or not. Is it true like the past literature shows that there are too many investment choices and non-diversified, resulting in poor returns and more risk.? Does “active investment strategy” provided by 401(k) plan have lower performance than investing market portfolios– namely, active investment strategy is an “inefficient” investment?

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2 Literature Review

401(k) plan is a type of defined-contribution retirement plan which allows an employee to choose how to use their salary between taking compensation in cash or deferring a percentage of it to a 401(k) account under the plan. Both Employee's contribution made to the plan and the performance of plan investments determine the participant's balance. Typically, the plan contributions are invested in the portfolio of mutual funds, which include stocks, bonds, and other investment assets. Employer and trustee provide the list of investment choices in 401(k) plan for its employees. Each employee allocates his savings to the various investment choices in the 401(k) plan.

Both the choices of investment list provided by the employer and the investment decision made by participants influence the portfolio performance in 401(k) plan. Previous empirical studies found there is some phenomenon in 401(k) plan about these two performance factors. Several papers have emphasized the existence of behavioral bias constrained the participants made the irrational investment decision.

In Benartzi and Thaler (2001), they find that some investor wants to diversify the portfolio and distribute their investment contributions evenly into the funds offered by the sponsor in the investment list of 401(k) plan. This naive diversification is called by "1/n strategy". They also find the proportion invested in stocks is highly correlated with the proportion of stock funds in the 401(k) plan. Employee would increase their risk exposure in equity when more stock funds are added to the investment list of 401(k) plan.

In Cohen and Schmidt (2009), it shows that mutual fund families can attract substantial cash inflows by becoming a 401(k) plan's trustee. Most of the investment

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asset options in 401(k) plan are provided by the plan's trustee and maybe their own funds to attract a large inflow of money in these family funds. Employees are only able to select and invest their retirement portfolio between these plan options. Besides, The plan trustee would not be changed often by sponsors. In their sample, the unconditional probability that a company will change trustees in a given year is around 3.4%. They also observe that there exists a factor correlative with the trustee relationship affecting mutual fund families' portfolio choice decisions, even causing potentially large costs. Mutual fund families have the motivation to be a 401(k) plan's trustee. Additionally, they indicate that through distorting its portfolio, the family violates its fiduciary duty as the trustee to provide the best investment plan list to its entire investors.

In Goldreich and Halaburda (2013), their results show that larger number of assets available for investment in a 401(k) retirement plan is empirically worse than the smaller number. Participants are able to have more investment option in the larger menus but some investment choices do not increase the overall quality of total 401(k) plan. The other paper, Iyengar, Huberman, and Jiang (2004), also mention that employee 401(k) plan participation rates fall as the number of fund options increase. So we can know that more number of funds in 401(k) plan may not surely lead to the higher quality of the investment menu. Whether adding asset may improve the quality of the menu depends on the value of the asset added to the plan. Their paper concludes that there is a negative relation between the number of investment options and the overall quality of plan due to choosers' behavioral biases or informational limitations. This result is explained by Brown, Liang, and Weisbenner (2007), they show that most of the new funds added to the 401(k) plan are high-cost active-managed equity funds rather than low-cost equity index funds. Since the average share of assets invested in low-cost stock index funds declines as the number of fund options increases, the

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average portfolio expenses increase and the average portfolio performance is thus suppressed.

In Huberman and Jiang (2006), they also propose a similar conception like “Naive diversification strategy”. They found that participants tend to distribute their contributions evenly into the funds they choose in order to diversify their retirement plan portfolio. If the number of funds in their 401(k) retirement plan increases, the participants would choose more number of funds to invest in, and they also increase their equity exposure in 401(k) plan as the relative weight of equity funds in the total offered investment menu increase. Namely, participants build their own retirement plan portfolio partly depending on the number of funds offered by the plan and the component of total asset in the 401(k) plan.

In Benartzi (2001), they find the important phenomenon in 401(k) retirement plans. Participants would invest a third of overall investment in company stock and a quarter of contribution annually in company stock. We can find company stock is the key role of 401(k) plans for most employees and employers. But this is not a good strategy for a diversification perspective because of overweight investment in company stock. In this paper, they also show the calculations of Brennan and Torous (1999), which proposes participants are better off holding cash than a portfolio that invests overweighted in company stock. Finally, the result demonstrates that allocations to company stock depend on history return but not a predicted future performance. Agnew, Balduzzi, and Sunden (2003) show the similar result that plan participants have inertia in asset allocation and most asset allocations are extreme (either almost all or almost none proportion in equities)

In Meulbroek (2005), they indicate that employees usually hold large numbers of

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company stock in their 401(k) retirement plans. However, holding too much company stock is not only risky but also costly. The cost of holding too much company stock is the loss in diversification, leading to significantly reduce the value of employee's holding. In other words, employees who hold more company stock are not well-diversified, their expected return of 401(k) plan portfolios are lower than the same risky, but well-diversified portfolios.

Through previous literature, we can find that there are many investment behavioral biases for participants in 401(k) retirement plan, such as "1/n Naive Diversification Strategies" or overweight proportion of total asset allocated in the company stock. In addition, There are some cases about the investment menu made by employer and trustee in 401(k) retirement plan. The more number of investment choices is provided, the less quality of overall plan gets and many mutual funds want to become the trustee of 401(k) retirement plans to attract large inflows into their own family funds. These problems may cause retirement employees to distort their portfolios, not have the best investment plan list, and can't rationally construct their optimal investment portfolio.

Because of the above-mentioned problems, I am wondering about the investment performance of investors in the 401(k) plan. And I also want to know whether many people have this "inefficient performance" investment portfolio. Will it be better to invest directly in the market index than invest in the investment list provided by the 401(k) plan? Therefore, through this thesis, I hope to know whether participants in the 401(k) plan would use wisely the investment list provided by the employer and trustee to construct an optimal investment portfolio, and the performance is better or worse than the market index return.

Elton, Gruber, and Blake (2006), served as the key paper, motivate me to come up

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with my research topic. The main point of the article is that the investment portfolio of 401(k)'s participants depends mainly on what assets are provided by the sponsor and what assets are chosen by participants. However, less literature research whether the investment asset choice is enough to be provided to participants. This paper further indicates that only about 53% of 401(k) plans provide sufficient investment options for participants to choose. Therefore, if participants only have the inferior set of the asset in 401(k) plan to choose, investors would be severely constrained in the efficiency of constructing investment portfolios, and even contribute to inefficient investments.

However, in Tang, Mitchell, Mottola, and Utkus (2010), they found that most companies and sponsors offer an efficient investment menu of 401(k) plan for participants, but most participants fail to make a choice and construct an effective investment portfolio, even resulting in a one-fifth reduction of participant's retirement wealth.

Since there are both positive and negative comments in the past research, discussing whether the investment menu of 401(k) plan provided by the sponsors can enable participants to construct efficient investment portfolios without any constraint. Therefore, I hope to conduct the research to understand whether the investment return of all 401(k) company's plan compared to the return of investing in market index is efficient/optimal or not.

There are some investment problem in 401(k) plan discussed by past literature such as overweight allocation of total investment in employer's company stock and the relationship between the number of funds in the investment menu provided by the sponsor and the performance of 401(k) investment plan, therefore I also want to do the related research discussing those problems and explain the result further.

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3 Data

3.1 401(k) plan data

The data source of my research is the United States Securities and Exchange Commission (SEC). I get every company that offers a 401(k) Plan from the SEC. The company's 11-K report annually reveals the financial data of the 401(k) retirement plan for the year-end of the company's fiscal date. In the 11-K report, The Statements of Net Assets Available for Benefits, like balance sheet, have the current total assets and liabilities of the 401(k) plan, and I get the amount of total investment in this statement as "Total Investment_Cover". In addition, the Schedule of Asset in the 11-K report records what kind of assets the 401(k) plan invested in, the number of funds, the cost of each asset and the current value of each asset. Then, I classify all assets into six kinds of funds: employer's company stock, domestic equity funds, international equity funds, balanced funds, bond funds, and other assets. Record the number of funds and current value of each category, and total current value of every asset is defined as "Total Investment_Detail". Finally, the larger of "Total Investment_Cover" and "Total Investment_Detail" is defined as "Total Investment" of 401(k) plan for the year.

The Statement of Changes in Net Assets Available for Benefits is like an income statement that reports on the current net assets of a pension fund. This statement shows profit and loss of the 401(k) plan's investment in the year, including interest income, dividend income...etc. There is also the number of contributions in the current year, including "Participant's Contribution", "Employer Matching Contribution", and "Rollover", which is the amount transferred from the original 401(k) plan with new employees joined from other companies during the year.

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The data obtained from each statement is recorded as “Total Investment”, “Total Contribution” and the number of funds and the current value of the six classified assets on each of the company's 401(k) plan. I also get the data of “Trustee” responsible for the company's 401(k) plan from 11-K report, which is the fiduciary responsibility for the assets of plan investment in the year, and the Schedule of Asset in the 11-K report is provided by employer and trustee to determine what asset options are invested by the employee in 401(k) plan, so trustee is a key role for the investment performance of 401(k) plan. With those data, we can use the current year “Total Investment” to deduct current year “Total Contribution”, divide by the previous year “Total Investment”, to get “Plan Return” of the company's 401(k) plan current year. We list the summary statistics of 401(k) plan in the panel A and panel B of Table 1 below:

<insert Table 1>

3.2 Industry classification data

In addition to the 11-K report data from the SEC, I also get each company's Standard Industrial Classification Codes (SIC code) from Compustat. Based on the company's four-digit SIC code, we further divide the company into 49 Fama-French industry classification. My data span 49 Fama-French industries. The summary data of each industry is as follows:

<insert Table 2>

From Table 2, we can see that the US companies offering 401 (k) plan are more concentrated in the Banking industry.

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3.3 Market index

In order to determine whether the investment performance of 401(k) plan is efficient or not, we need to hypothesize a suitable comparison group as an alternative investment portfolio. We learn from some literature to construct our alternative investment portfolio as a standard for 401(k) plan's efficiency.

Next, we describe in greater detail the index selection for constructing an alternative investment portfolio. All index data is from Bloomberg. First, for common stock, we divide the stock into value stock and growth stock, and by size advocated by Fama and French (1995), we classify the size of stock into two groups: large-cap and small-mid-cap. The four stock indexes are from MSCI, Stock index is divided into four groups: MSCI US large cap value index, MSCI US large cap growth index, MSCI US small plus mid cap value index, MSCI US small plus mid cap growth Index.

Secondly, for bonds, we divide the bond index into four categories: government bonds, corporate bonds, mortgage-backed securities, and high-yield bonds according to Blake, Elton and Gruber (1993), who found this division captured enough differences in return across most bond funds. For bond indexes, we use Barclays US Treasury Total Return index, Barclays US Corporate Bond Total Return index, Barclays US MBS Total return index, and Barclays US Corporate High Yield Total Return index.

These eight indexes construct the alternative investment portfolio to be a standard for efficiency. Four equity indexes and four bond indexes almost cover most of the common asset category. And this alternative investment portfolio can be seen as a market portfolio. In other words, the alternative investment portfolio is used as a standard of efficiency, it means that the "Whether 401(k) plan return exceeds the return of market portfolio or not?", so next we would like to check whether the company's

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401(k) plan give investors enough assets to construct portfolio on the market efficient frontier similar to that obtained by the 8 indexes. We list the annual return of 8 market index as the following Table 3:

<insert Table 3 >

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4 Methodology and Model

The method we use is the intersection test. The purpose of the intersection test is to test whether a particular set of assets is sufficient to generate the efficient frontier, given a risk-free rate, or whether improving the efficient frontier at a statistically significant level if the component index of the alternative investment portfolio is added.

4.1 Intersection test

Refer to DeRoon, Nijman, and Werker (2001), intersection is a test of the impact of restricting the intercept (alpha) in the following time-series model:

$$R_{i,t} - R_{\mathrm{f}} = \alpha_i + \sum_{k=1}^{8} \beta_{ik}(R_{kt} - R_{\mathrm{f}}) + \varepsilon_{i,t} \ , \quad (1)$$

where

$\mathrm{R}_{i,t}$: the return in the plan i in year t;

R_{f}: the risk free rate;

R_{kt}: the return on one of eight indexes in year t;

β_{ik}: the sensitivity of index k in the plan i;

We used some return variables, such as each 401(k) plan's annual return, the risk-free rate, and the eight market indexes return (construct the alternative investment portfolio as the market portfolio return). The calculation of each 401(k) plan's return is described in the previous chapter; and for the risk-free rate, we use the U.S. 10 year bond yield from Bloomberg. However, there is difficulty in running the regression. The

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eight market indexes we selected have the problem of multi-collinearity. The correlation coefficient matrix of the eight market indexes is as the following Table 4:

<insert Table 4>

Therefore, we select two market indexes that have more explanatory power in the original eight indexes as explanatory variables: US Treasury index and US large cap value index. So we change the model to:

$$R_{i,t} - R_{\mathrm{f}} = \alpha_i + \beta_{i1}(R_{1t} - R_{\mathrm{f}}) + \beta_{i2}(R_{2t} - R_{\mathrm{f}}) + \varepsilon_{i,t} \ , \quad (2)$$

where

$\mathrm{R}_{1,t}$: the return of US Treasury index in year t;

$\mathrm{R}_{2,t}$: the return of US large cap value index in year t;

Through the intersection test, it is easy to understand the logic of the intersection test model: if alpha is positive, it can be understood that the company's 401(k) plan return have abnormal return relative to alternative investment portfolio. We call this situation as "this plan is efficient" in our study. Further, only adding positive alpha assets into 401(k) plan can improve the efficient frontier of the portfolio by offering a higher return on the plan portfolio. Since most individual assets have positive or negative alpha and Adding any assets into portfolio has the potential to increase the efficiency of the portfolio, so statistical significance is important.

4.2 Efficiency

The α_i of each 401(k) plan i is obtained from model (2), which represents the

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part of plan *i* 's return that cannot be explained by the market return. That is, the measure of active investment efficiency (the investment return is better or worse than the market). For each plan *i*, we run the time-series regression to get the parameter of intercept in model (2), α_i. But in next efficiency to company stock model, we need to run panel regression for each plan *i* every year. So we create new variable, $\hat{\alpha}_{i,t}$ to represent the efficiency in plan *i* in year *t* by the following method:

$$\hat{\alpha}_{i,t} = \hat{\alpha}_i + \varepsilon_{i,t} \quad (3)$$

And $\hat{\alpha}_{i,t}$ is used as a measure of efficiency as a following study.

4.3 Plan characteristics – investment in company stock

Next, we further want to understand the relationship between 401(k) plan efficiency and the plan characteristics.

We first study the plan that invests most of the assets in their own company's stock. Because the past literature believes that investing most of total assets in the company's stocks is overweight allocation and not well-diversified, it would lead to inefficient investing. So we use the following panel data regression model to investigate the effects of plan efficiency and company stock:

$$\hat{\alpha}_{i,t} = a_1 + b_1 * CS_{i,t-1} + e_{i,t} \ , \quad (4)$$

where

$\hat{\alpha}_{i,t}$: the parameter of efficiency in the plan i in year t;

$CS_{i,t-1}$: the proportion of company stock in total investment in plan i in year $t-1$;

The relation between the proportion of company stock in total investment and plan

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efficiency can be seen in Model (4). We expect $CS_{i,t-1}$to be negatively related to plan efficiency. In the efficiency market, it is not a rational investment strategy for long-term investment to allocation most of the pension fund in a single asset, just like gambling. That may further worsen the efficiency of investment.

4.4 Plan characteristics – trustee

The past literature also discussed that trustee is a key role for the investment performance of 401(k) plan. Therefore, adding the dummy variable of each trustee to the model to examine whether the trustee of 401(k) plan will affect the investment efficiency of the plan. The model is as follows:

$$\hat{\alpha}_{i,t} = a_1 + b_1 * Trustee_{i,1,t} + b_2 * Trustee_{i,2,t} + \cdots + b_k * Trustee_{i,k,t} + e_{i,t} \quad , (5)$$

where

$\hat{\alpha}_{i,t}$: the parameter of efficiency in the plan i in year t;

$Trustee_{i,k,t}$: the dummy variable of trustee k in plan i in year t;

In model (5), the sample was reduced from the original sample to the 401(k) company within the S&P500. Through model (5), we expect that Trustee and plan efficiency may exist a negative linear correlation. In literature, we can see those fund companies have a strong intention to attract funds to become a 401(k) plan trustee; but for investors, having a trustee in 401(k) plan is not necessarily a good choice. Trustee may distort the investment choices in 401(k) plan and let participants can't construct their own optimal portfolio, further leading to worsening investment efficiency.

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4.5 Plan characteristics – number of funds

Finally, Goldreich and Halaburda (2013) mentioned that 401(k) plan which provides more number of funds may not be better than the plan which provides few number of funds, so the variable of total number of funds is added to the model (6) :

$$\hat{\alpha}_{i,t} = a_1 + b_1 * Fundnumber_{i,t} + e_{i,t} \ , \quad (6)$$

where

$\hat{\alpha}_{i,t}$: the parameter of efficiency in the plan i in year t;

$Fundnumber_{i,t}$: total number of funds in plan i in year t;

In model (6), the sample was reduced from the original sample to the 401(k) company within the S&P500. Through model (6), we can observe the correlation between the total number of funds and 401(k) plan efficiency. We expect that the total number of funds may have a positive impact on plan efficiency, although the literature found that 401(k) plan which provides more number of funds may not be better than the plan which provides few number of funds. We think when the number of assets in portfolio increases, there would be some assets that fall on the efficient frontier. Providing more investment options span more individual utility function and it would be able to satisfy more people's optimal portfolio. In the next chapter, we will discuss the regression results of each model.

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5 Empirical Results

5.1 Intersection test

We calculate the annual return of each 401(k) plan from 11-K report on SEC. Since sometimes data is not complete, this problem causes the outliers for the plan return, so we exclude these outliers and conduct the intersection test for the remaining 401(k) plan data. The results are shown in Table 5 below :

< insert Table 5>

In Table 5, we can see that in all 1,606 401(k) plans, there are 297 plans with positive intercept α_i and 5 significantly positive; but 1,309 with negative intercept α_i and 348 significantly negative.

We found that the statistically significant inefficiency of the plan (i.e., α_i is significantly less than 0) accounts for approximately 21.7% of all 401(k) plans, relative to 0.3% of the efficiency plan. Therefore, we can see that the efficiency of active investment strategy in most 401(k) plans is worse than that of investing market portfolio.

5.2 Plan characteristics – investment in company stock

Further, we investigate the relationship between the 401(k) plan efficiency and the plan characteristics. First, the setting of the explanatory variable is the proportion of the company stock investment in the previous period. We also use another similar variable to mimic $CS_{i,t-1}$: the proportion of the company stock contribution in total contribution in the previous period, $CScontribution_{i,t-1}$, which is equal to [Total Contribution $_t$ – Company Stock$_{t-1}$ *(1+R$_t$)] / Total Contribution $_t$. The R$_t$ data from CRSP represents the return of company stock in year t. We use these two variables respectively to run

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regression on the plan efficiency. The regression results are shown in the following Table 6 :

<insert Table 6>

Through the regression results, given the industry and time fixed effect, we can see that $CS_{i,t-1}$ is statistically significantly positively correlated with the plan efficiency. This result deviates from the past literature. The results show that the increase in the proportion of company stock in the previous period has significantly improved the plan efficiency, namely raises the abnormal plan return. We consider that it may be because employees work within the company and have a clear understanding of the company's operating status and inside information. Therefore, using the information advantage, the participant can add more company stock to their own 401(k) account before the stock price rise, further taking abnormal returns and beat the market return.

5.3 Plan characteristics – trustee

Next, We let trustee dummy variable run regression to plan efficiency. The results are as following Table 7 :

<insert Table 7>

From Table 7, we can see that in the 401(k) plan within S&P500, some trustees have a significant positive influence on the plan efficiency, such as Bank of New York Mellon, Voya Institutional Trust, The First National Bank of Boston, Key Trust Company of Ohio, T. Rowe Price Trust, Charles Schwab and Investors Bank and Trust; Trustees with significant negative impact are Wachovia Bank, Barclays, SunTrust and Citi. However, we can find the other trustees (covering almost 89% of all data), and the

DOI:10.6814/NCCU201900118

trustee effect on the plan efficiency is not significant. Therefore, we think that the choice of trustee has no statistically significant impact on the plan efficiency. 401(k) plan with trustee doesn't have great ability of investment management, and also doesn't distort the investor's portfolio to cause the inefficiency of the plan.

5.4 Plan characteristics – number of funds

Finally, we run the regression of the plan efficiency to the total number of funds. The results are as following Table 8:

<insert Table 8>

From Table 8 Panel A, we can see that in the 401(k) plan within S&P500, the total number of funds has no statistically significant effect on the plan efficiency; We further divide the data into five groups according to total number of funds, and detect whether the plan efficiency of the largest number and smallest number of funds is significantly different, the results are shown in Panel B, and the result of t-test shows that there is no significant difference between two groups.

We consider that because the plan which provides large number of funds give more investment options for investors, on the other hand, due to the expansion of plan menu size, plus that most investors generally lack professional investment knowledge, the phenomenon of “Naive diversification strategy” would reduce investment efficiency. Therefore, the positive and negative effects would offset each other, resulting in a lack of significant explanatory power for independent variable, total number of funds.

DOI:10.6814/NCCU201900118

6 Research Limits and Future Research

This study encountered some problems in data processing, which limits the intention of this study and the regression results. First, in terms of data processing, the data form of an annual 11-K report on SEC is disclosed differently. Sometimes it can be very detailed, sometimes it can be very simple or even blank. If the company has other employee saving plans, sometimes the company is possible only to disclose other saving plans, which would cause the time-series data interruption and data loss of 401(k) plan. In addition, the selection of 8 market indexes as an alternative investment portfolio faced the problem of multi-collinearity. In this study, we use only 2 market indexes to alleviate the problem of collinearity, but may not be the optimal alternative investment portfolio. In other words, using only 2 market indexes is not appropriate to be a standard of efficiency, I think there can be improved in future research.

We can expand the data sample or add other variables in the future, such as model (5), we can further study whether the trustee's annual ranking will also affect the plan efficiency? And model (6) can conduct more detailed research about total number of funds. To check whether the plan efficiency is related to the number of equity funds, bond funds or balanced funds? Namely, further using a more detailed plan characteristic to run a regression with the plan efficiency. Through this method, maybe we can understand the reasons that really affect the plan efficiency.

DOI:10.6814/NCCU201900118

7 Conclusion

In this study, we investigate the investment efficiency of the 401(k) plan. The investment efficiency of the 401(k) plan depends on : what the employer and trustee provide and what the participants choose. If the investors only have a poor portfolio in the 401(k) plan or the investors irrationally choose a non-optimal portfolio, it may lead to the inefficiency of 401(k) plan. We use the intersection test to check whether 401(k) plan can improve the efficient frontier at a statistically significant level if the component index of the alternative investment portfolio is added. Our result shows that the efficiency of active investment strategy in most 401(k) plans is worse than that of investing market portfolio.

We further investigate the relationship between the 401(k) plan efficiency and the plan characteristics. First, we find that the proportion of company stock in the previous period is statistically significantly positively correlated with the plan efficiency. We consider that employee has the advantage of information about their company, so they can allocate more company stock safely in their portfolio. Second, we discuss the relationship between trustee and plan efficiency. We think that the choice of trustee has no statistically significant impact on the plan efficiency. 401(k) plan with trustee doesn't have great ability of investment management, and also doesn't distort the investor's portfolio to cause the inefficiency of the plan. Finally, the investment menu size in 401(k) plan has no statistically significant effect on the plan efficiency.

DOI:10.6814/NCCU201900118

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DOI:10.6814/NCCU201900118

Table 1: Summary statistics

Panel A. Plan characteristics

Variables	Observations	Number of firms	Mean	Median	STD	Max	min
Total Investment	18,820	2,166	917,355,946	137,405,377	2,914,792,453	59,573,000,000	156,050
Total Contribution	18,820	2,166	59,207,364	13,093,823	165,564,451	3,336,000,000	945
Plan Return	18,820	2,166	-0.76%	0.29%	0.133	31.21%	-35.78%
Number of -							
Total funds	2,729	208	17	16	9.28	71	2
Domestic equity funds	2,729	208	5	5	3.78	43	0
International equity funds	2,729	208	1	1	1.32	10	0
Balanced funds	2,729	208	6	3	5.12	25	0
Bond funds	2,729	208	3	3	2.41	22	0
Others	2,729	208	0	0	1.29	17	0
Company have Trustee	2,807	216					
Company have no Trustee	274	4					
Individual trustee of plan		67					

This table reports descriptive statistics for all variables of my study. The sample period is from 1995 to 2018. We exclude the plan return in all sample at the bottom and top 5% levels, because of the disclosure problem in 401(k) plan report on SEC.

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Table 1: Summary statistics

Panel B. Time-series data of 401(k) plan

Year	N	Total Investment ($000's)			Total Contribution ($000's)			Plan Return		
		Mean	Median	STD	Mean	Median	STD	Mean	Median	STD
1995	227	507,743	85,175	1,441,444	32,071	10,038	77,398	9%	10%	13%
1996	347	423,451	54,882	1,421,244	26,628	6,384	72,859	4%	6%	11%
1997	405	419,783	53,107	1,466,419	24,929	6,615	71,476	8%	9%	14%
1998	486	465,873	55,883	1,839,125	26,571	6,388	83,010	1%	2%	13%
1999	574	468,647	58,279	2,063,914	25,190	6,817	78,153	3%	4%	14%
2000	649	409,218	60,723	1,791,873	25,877	7,238	80,931	-10%	-12%	13%
2001	759	418,821	63,450	1,658,335	28,871	7,841	82,340	-12%	-14%	12%
2002	1,062	413,016	71,718	1,383,964	34,348	8,801	91,635	-16%	-18%	12%
2003	1,098	522,938	91,154	1,676,948	38,153	9,133	103,405	12%	13%	11%
2004	1,190	606,026	102,629	1,901,190	40,487	10,011	102,635	3%	3%	9%
2005	1,184	684,555	120,599	2,048,827	46,514	11,516	118,479	-2%	-3%	9%
2006	1,140	782,983	141,716	2,362,610	51,453	13,770	129,013	2%	2%	9%
2007	1,106	871,562	161,602	2,564,445	58,604	15,021	143,959	-4%	-3%	11%
2008	577	966,363	152,740	2,563,040	75,272	16,158	189,007	-26%	-29%	11%
2009	992	849,150	145,722	2,474,114	60,016	13,335	161,377	10%	12%	11%
2010	1,006	966,137	183,197	2,749,126	60,689	14,475	159,345	4%	4%	8%
2011	975	1,042,509	180,284	2,948,125	69,713	16,173	181,737	-8%	-9%	8%
2012	947	1,216,127	223,622	3,330,097	77,609	19,048	194,520	3%	3%	8%

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Panel B. Time-series data of 401(k) plan (continued)

Year	Month	Total Investment ($000's)			Total Contribution ($000's)			Plan Return		
		Mean	Median	STD	Mean	Median	STD	Mean	Median	STD
2013	900	1,458,701	271,413	3,992,112	85,026	20,793	212,042	10%	11%	8%
2014	874	1,582,718	308,630	4,206,611	92,789	23,979	224,738	-2%	-2%	8%
2015	827	1,560,934	302,249	4,220,455	101,003	25,748	243,092	-9%	-9%	8%
2016	771	1,726,696	338,899	4,530,546	108,227	27,340	262,502	-1%	-1%	8%
2017	702	2,047,382	439,821	5,353,810	117,053	32,732	282,961	7%	7%	7%
2018	22	2,588,170	624,424	6,202,812	192,862	55,590	566,324	-2%	0%	11%

This table describes the summary of time-series data of 401(k) plan. The sample period is from 1995 to 2018. We exclude the plan return in all sample at the bottom and top 5% levels, because of the disclosure problem in 401(k) plan report on SEC.

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Table 2: Industry distribution

Industry classification	FF49_factor	Number of firms
Agriculture	1	11
Food Products	2	43
Candy & Soda	3	2
Beer & Liquor	4	5
Tobacco Products	5	4
Recreation	6	6
Entertainment	7	18
Printing and Publishing	8	19
Consumer Goods	9	29
Apparel	10	20
Healthcare	11	39
Medical Equipment	12	39
Pharmaceutical Products	13	61
Chemicals	14	69
Rubber and Plastic Products	15	25
Textiles	16	10
Construction Materials	17	52
Construction	18	26
Steel Works Etc	19	36
Fabricated Products	20	6
Machinery	21	90
Electrical Equipment	22	30
Automobiles and Trucks	23	43
Aircraft	24	14
Shipbuilding, Railroad Equipment	25	6
Defense	26	7
Precious Metals	27	7
Non-Metallic and Industrial Metal Mining	28	10
Coal	29	4
Petroleum and Natural Gas	30	111
Utilities	31	128
Communication	32	108
Personal Services	33	30
Business Services	34	127
Computers	35	32

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Table 2 (continued)

Industry classification	FF49_factor	Number of firms
Computer Software	36	96
Electronic Equipment	37	90
Measuring and Control Equipment	38	29
Business Supplies	39	49
Shipping Containers	40	13
Transportation	41	69
Wholesale	42	79
Retail	43	144
Restaurants, Hotels, Motels	44	41
Banking	45	576
Insurance	46	131
Real Estate	47	11
Trading	48	49
Others	49	15

This table describes the industry distribution of total 401(k) plan in my study. Industry is classified by Fama-French standard.

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Table 3: The annual return of 8 market indexes

Year	Month	RF	YR_GB	YR_CB	YR_MBS	YR_HYB	YR_LV	YR_LG	YR_SMV	YR_SMG
1995	12	5.6%	18.4%	22.2%	16.8%	19.2%	36.4%	34.7%	27.2%	33.6%
1996	12	6.4%	2.7%	3.3%	5.3%	11.4%	19.8%	22.1%	19.3%	16.2%
1997	12	5.7%	9.6%	10.2%	9.5%	12.8%	28.8%	35.5%	32.9%	17.5%
1998	12	4.6%	10.0%	8.6%	7.0%	1.9%	12.9%	48.6%	-3.7%	12.1%
1999	12	6.4%	-2.6%	-2.0%	1.9%	2.4%	2.3%	39.1%	-2.0%	61.4%
2000	12	5.1%	13.5%	9.1%	11.2%	-5.9%	5.6%	-29.3%	19.2%	-19.1%
2001	12	5.1%	6.7%	10.3%	8.2%	5.3%	-8.9%	-22.9%	8.1%	-14.5%
2002	12	3.8%	11.8%	10.1%	8.7%	-1.4%	-17.9%	-28.6%	-10.5%	-26.1%
2003	12	4.2%	2.2%	8.2%	3.1%	29.0%	22.7%	26.2%	36.9%	44.1%
2004	12	4.2%	3.5%	5.4%	4.7%	11.1%	9.0%	5.2%	22.9%	14.4%
2005	12	4.4%	2.8%	1.7%	2.6%	2.7%	3.2%	2.2%	7.5%	11.7%
2006	12	4.7%	3.1%	4.3%	5.2%	11.8%	20.2%	8.0%	16.0%	10.2%
2007	12	4.0%	9.0%	4.6%	6.9%	1.9%	-1.5%	10.5%	-7.5%	13.6%
2008	12	2.2%	13.7%	-4.9%	8.3%	-26.2%	-37.4%	-37.3%	-36.6%	-44.5%
2009	12	3.8%	-3.6%	18.7%	5.9%	58.2%	12.1%	33.1%	30.9%	41.7%
2010	12	3.3%	5.9%	9.0%	5.4%	15.1%	10.1%	13.1%	20.5%	29.3%
2011	12	1.9%	9.8%	8.1%	6.2%	5.0%	-1.0%	1.6%	-4.1%	-3.2%
2012	12	1.8%	2.0%	9.8%	2.6%	15.8%	11.2%	15.4%	14.2%	15.9%
2013	12	3.0%	-2.7%	-1.5%	-1.4%	7.4%	28.1%	30.6%	30.7%	40.3%
2014	12	2.2%	5.1%	7.5%	6.1%	2.5%	9.0%	13.2%	8.0%	9.4%

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Year	Month	RF	YR_GB	YR_CB	YR_MBS	YR_HYB	YR_LV	YR_LG	YR_SMV	YR_SMG
2015	12	2.3%	0.8%	-0.7%	1.5%	-4.5%	-4.5%	3.7%	-5.2%	-1.9%
2016	12	2.4%	1.0%	6.1%	1.7%	17.1%	12.8%	4.6%	20.0%	7.8%
2017	12	2.4%	2.3%	6.4%	2.5%	7.5%	11.8%	28.1%	11.0%	21.9%
2018	12	2.7%	0.9%	-2.5%	1.0%	-2.1%	-9.2%	-2.5%	-14.2%	-7.2%

This table describes the summary of 8 market index return. The sample period is from 1995 to 2018. RF is the risk-free rate. YR_GB is the return of Barclays US Treasury Total Return index; YR_CB is the return of Barclays US Corporate Bond Total Return index; YR_MBS is the return of Barclays US MBS index Total return index; YR_HYB is the return of Barclays US Corporate High Yield Total Return index; YR_LV is the return of MSCI US large cap value index; YR_LG is the return of MSCI US large cap growth index; YR_SMV is the return of MSCI US small plus mid cap value index; YR_SMG is the return of MSCI US small plus mid cap growth Index.

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Table 4: Pearson correlation coefficient between the return of 8 market indexes

Abbreviation	the return of market index	GB	CB	MBS	HYB	LV	LG	SMV	SMG
GB	Treasury index	1							
CB	Corporate bond index	0.187***	1						
MBS	MBS index	0.848***	0.533***	1					
HYB	High yield bond index	-0.542***	0.653***	-0.173***	1				
LV	Large cap value index	-0.495***	0.189***	-0.407***	0.555***	1			
LG	Large cap growth index	-0.573***	0.110***	-0.482***	0.547***	0.749***	1		
SMV	Small-Mid cap value index	-0.548***	0.349***	-0.352***	0.721***	0.856***	0.513***	1	
SMG	Small-Mid cap growth index	-0.725***	0.068***	-0.611***	0.639***	0.730***	0.879***	0.657***	1

This table displays the Pearson correlation coefficients among these eight market indexes. The index data is from 1995 to 2018. We can find there is the problem of multi-collinearity in the return of eight market indexes we choose. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively.

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Table 5: Summary statistics of the plan efficiency for each 401(k) plan

	Total	$\hat{\alpha}_i > 0$	Efficient	$\hat{\alpha}_i < 0$	Inefficient		
Number of firms	1,606	297	5	1,309	348		
%	100%	18%	0.3%	82%	21.7%		
	Mean	STD	min	25th quantiles	Median	75th quantiles	MAX
$\hat{\alpha}_i$	-0.049	0.073	-0.695	-0.078	-0.044	-0.012	0.368

This table displays the distribution of the intercept for each 401(k) plan, which represent the abnormal return (efficiency) of each plan, in model (1) : $R_{i,t} - R_{\mathrm{f}} = \alpha_i + \beta_{i1}(R_{1t} - R_{\mathrm{f}}) + \beta_{i2}(R_{2t} - R_{\mathrm{f}}) + \varepsilon_{i,t}$ .The sample period is from 1995 to 2018. We exclude the plan return at bottom and top 5% levels, because of the disclosure problem in 401(k) plan report on SEC.

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Table 6: The relationship between plan efficiency and company stock

Dependent variable	$\hat{\alpha}_{i,t}$	$\hat{\alpha}_{i,t}$
Intercept	-0.064*** (-4.15)	-0.048*** (-2.84)
$CS_{i,t-1}$	0.012*** (3.89)	
$CScontribution_{i,t-1}$		>-0.001 (-1.63)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Observation	15,777	13,028
R square	0.141	0.148

This table shows the regression result of model (2) : $\hat{\alpha}_{i,t} = a_1 + b_1 * CS_{i,t-1} + \varepsilon_{i,t}$ for total sample over the period of 1995 to 2018. We use two methods to run OLS regression. Method 1 and 2 use the $CS_{i,t-1}$ and $CScontribution_{i,t-1}$ as independent variable respectively to represent the proportion of company stock in total plan investment by the end of last fiscal year. All models include industry and time fixed effects. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively.

DOI:10.6814/NCCU201900118

Table 7: Coefficient of individual trustee dummy variable

Panel A. List of each trustee dummy variable

Individual Trustee Name	Observation	Coefficient	t-value
The First National Bank of Boston	1	0.124	2.12**
Voya Institutional Trust	4	0.090	2.97***
UMB Bank	1	0.085	1.45
Security Trust	1	0.076	1.31
Key Trust Company of Ohio	3	0.069	2.02**
First Interstate Bank	1	0.051	0.85
Investors Bank and Trust	6	0.046	1.92*
Key Bank	5	0.043	1.58
LLC	3	0.042	1.24
Harris trust	1	0.040	0.68
INVESCO	2	0.035	0.84
Bank of New York Mellon	67	0.031	3.72***
T. Rowe Price Trust	113	0.031	4.32***
U.S. Bank	4	0.026	0.85
Charles Schwab	48	0.018	1.76*
Nationwide Trust	5	0.017	0.63
Fifth Third Bank	33	0.016	1.42
Bank of America	51	0.016	1.61
TRP	14	0.015	0.85
Merrill Lynch	39	0.012	1.15
Prudential Trust Company	30	0.012	1.01
Mercer Trust	44	0.011	1.01
Mellon Trust	66	0.011	1.25
Putnam Fiduciary	20	0.010	0.73
Wachovia	5	0.009	0.34
Vanguard	240	0.009	1.48
CG Trust	3	0.009	0.25
Chase Manhattan Bank	1	0.009	0.15
Comerica Bank	15	0.008	0.48
New York Life Trust	7	0.007	0.3
JPMorgan	78	0.007	0.9
Fidelity	830	0.006	1.18
State Street	301	0.005	0.85
American Stock Transfer and Trust	2	0.003	0.07

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Panel A. Coefficient of each trustee dummy variable (continued)

Trustee Name	Observation	Coefficient	t-value
Northern Trust	203	0.002	0.24
Scudder Trust	12	0.001	0.07
Regions Bank	17	0.001	0.06
Matrix Capital	1	-0.001	-0.01
Wells Fargo	68	-0.001	-0.13
Deutsche Bank	1	-0.002	-0.03
Ameriprise Trust	7	-0.004	-0.17
DWS Trust	9	-0.004	-0.21
Bankers Trust	13	-0.006	-0.37
Capital Bank	4	-0.008	-0.27
American Express Trust	25	-0.009	-0.74
Lincoln Financial Group Trust	3	-0.014	-0.4
Wilmington Trust	12	-0.015	-0.85
Institutional Trust Company	2	-0.018	-0.43
TNT	8	-0.021	-0.92
NBD Bank	9	-0.021	-1
Branch Banking and Trust	1	-0.025	-0.43
MG Trust	6	-0.028	-1.15
ING National Trust	3	-0.028	-0.81
Great-West Trust	5	-0.030	-1.13
SunTrust	18	-0.031	-2.11**
Wachovia Bank	12	-0.032	-1.8*
The Frank Russell Trust	1	-0.036	-0.63
National City Trust	7	-0.041	-1.63
Citi	6	-0.050	-2.02**
First Union National Bank of Georgia	1	-0.050	-0.85
Barclays	1	-0.115	-1.94*
No trustee	230		

Panel B. Summary of coefficient of each trustee dummy variable

	Significant Positive	Significant Negative	Not Significant
Proportion of total Obs.	10%	1%	89%

This table shows the OLS regression result of model (5) : $\hat{\alpha}_{i,t} = a_1 + b_1 * Trustee_{i,1,t} + b_2 * Trustee_{i,2,t} + \cdots + b_k * Trustee_{i,k,t} + \varepsilon_{i,t}$. We list the coefficient of each trustee dummy variable by descending order in Panel A. The Panel B of table displays the proportion of significant and not significant data. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively.

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Table 8: The relationship between efficiency and number of funds

Panel A.	$\hat{\alpha}_{i,t} = a_1 + b_1 * Fundnumber_{i,t} + \varepsilon_{i,t}$	
Dependent variable	Plan efficiency	
Intercept	-0.0367	
	(-1.48)	
$Fundnumber_{i,t}$	0.0002	
	(1.09)	
Industry FE	Yes	
Year FE	Yes	
Observation	2,426	
R square	0.234	
Panel B.	Large number	Small number
Variable	Plan efficiency	Plan efficiency
Mean	-0.010	-0.008
Std	0.067	0.065
Difference between large number and small number		
Mean	0.001	
t-value	0.29	

This table displays the OLS regression result of model (6) :$\hat{\alpha}_{i,t} = a_1 + b_1 * Fundnumber_{i,t} + \varepsilon_{i,t}$. In Panel A, We control the industry and time fixed effects. But the coefficient of $Fundnumber_{i,t}$ is not statistically significant. So we run Panel B to check whether plan efficiency of large number group and small number group is different or not. ***, **, and * indicate statistical significance at the 1, 5, and 10 % level, respectively.

DOI:10.6814/NCCU201900118