JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS VOL. 41, NO. 4, DECEMBER 2006

Do Behavioral Biases Vary across Individuals? Evidence from Individual Level 401(k) Data

Julie R. Agnew*

Abstract

This paper investigates whether some individuals are prone to behavioral biases in their 401(k) investments. Using demographic data and allocation information for over 73,000 employees, I examine two allocation biases and a participation bias. The findings suggest that higher salaried employees tend to make significantly better choices. Participants who earn $100,000 hold 12.7% less in company stock, are 3% less likely to follow the framing $1/n$ heuristic, and are 37.7% more likely to participate than those earning $46,000. Women make better choices in two of the three cases and I find evidence of mental accounting.

I. Introduction

There is a growing literature that suggests an individual's investment decisions are affected by behavioral biases. Researchers explain financial decisions based on behavioral theories such as excessive extrapolation, loyalty, and familiarity (Benartzi (2001), Cohen (2004), and Huberman (2001)). Data from 401(k) plans provide a fertile ground for examining these behavioral biases because participants, who represent a diverse population of working individuals, are faced with the same choice environment. At the 401(k) plan level, ample evidence exists that behavioral biases can be overcome or made worse by 401(k) plan design

*Agnew, julie.agnew@mason.wm.edu, The College of William and Mary, Mason School of Business Administration, PO Box 8795, Williamsburg, VA 23187. I thank an anonymous large benefits provider for providing the 401(k) plan data and Stefan Bokor for his immense help in organizing the data. I thank Pierluigi Balduzzi, Hendrik Bessembinder (the editor), John Boschen, Alicia Munnell, Eric Jacquier, Peter Gottschalk, Shlomo Benartzi, and Jeff Pontiff (associate editor and referee) for their careful comments and insight. In addition, Jim Poterba, Josh Rauh, Henry Richardson and Steve Utkus were very helpful. I thank conference participants from the Retirement Research Consortium Fourth Annual Conference, the 2002 Financial Management Association Conference, and the Frank Batten Young Scholars Conference. In addition, I thank participants in seminars held at Boston College, Drexel University, the Federal Reserve Board of Governors, George Washington University, Georgia Tech, The College of William and Mary, the University of Georgia, and the University of Richmond. I gratefully acknowledge financial support from a dissertation fellowship from the Center for Retirement Research. Any errors are my own. The research reported herein was performed pursuant to a grant from the U.S. Social Security Administration (SSA) funded as part of the Retirement Research Consortium. The opinions and conclusions are solely mine and should not be construed as representing the opinions or policy of the SSA or any agency of the Federal Government. This paper was previously circulated under the title "Inefficient Choices in 401(k) Plans: Evidence from Individual Level Data."

(Benartzi (2001), Choi, Laibson, Madrian, and Metrick (2001)). Markedly less attention has been paid to these biases at the individual level. The outstanding questions are: does the propensity to follow behavioral biases vary across individuals and are there common characteristics that matter? Previous literature does not adequately address these questions, and this gap provides the motivation for this paper.

This paper takes a deeper look into three behavioral biases by providing new estimates of their severity at the individual level and by examining whether certain types of individuals are prone to these biases. I examine two allocation biases, following naïve diversification strategies and investing in company stock, and a participation bias, opting not to participate in the company sponsored 401(k) plan. Using a new dataset representing over 73,000 eligible participants, this is the first paper to jointly model these three biases as functions of individual characteristics and to provide the opportunity to assess the relative influence of these characteristics on these choices. This paper improves on and complements previous analyses of the two allocation biases mainly because the majority of past studies use plan level data that can lead to aggregation bias in the results and the studies do not address individual level heterogeneity in decisions.[1] This study takes advantage of individual level allocation data. These data overcome the aggregate data problems and provide the opportunity to more strongly test new behavioral theories, such as loyalty and its influence on company stock investment.

The principal finding suggests that higher salaried employees tend to make significantly better choices in all three cases. Specifically, I find participants who earn \$100,000 hold 12.7% less in company stock, are 3% less likely to follow the $1/n$ heuristic, and are 37.7% more likely to participate than those earning the average wage of \$46,000. Women also appear to make better choices in two of the three cases, viz., 401(k) participation and investment in company stock. This suggests that behavioral biases do vary across individuals and highlights that plan level analysis will suffer from an omitted variable bias. The paper also finds more direct evidence of mental accounting related to company stock holdings. Until now, this theory has only been studied at the plan level.

These findings suggest that empirical research should control for individual level heterogeneity and that more research into why salary and gender matter is needed. On a practical level, these results can help plan sponsors identify high risk individuals with a view toward improving plan design. The results may also be helpful in the current Social Security debate over personal accounts by providing demographic insights into investor behavior. Finally, these results have relevancy beyond the 401(k) literature and the broader implications are discussed in the Conclusion.

The paper begins with a consideration of the allocation topics because compared to the participation choice, there has been relatively little research devoted

[1] Huberman and Jiang (2006) use individual level data in their analysis of how the number of investment funds offered affects equity investment. They analyze how many people follow the $1/n$ heuristic, but do not focus their discussion on the influence of individual characteristics. The study also does not investigate how the mental accounting of company stock affected the $1/n$ strategy. Choi, Laibson, Madrian, and Metrick's (2004) company stock allocation study uses individual level demographic data with past company stock returns. They focus their discussion on whether participants practice "feedback" investing and not on the role of individual characteristics on this decision.

to the allocation biases at the individual level. The first topic studied is the naïve diversification bias. Naïve diversification strategies can result when individuals are faced with complicated decisions that cause them to fall back on simple rules of thumb. This paper investigates one naïve strategy called the "framing $1/n$ heuristic." This strategy is considered irrational because investors divide their contributions evenly among the number (n) of investment options offered. They do so regardless of the menu of investment options presented and thus are influenced by the fund choices available. My paper finds that salary and employment tenure are negatively related to this practice. I address a similar heuristic that is considered rational, "the conditional $1/n$ heuristic," and find highly compensated individuals are 7.4% more likely to follow this rule.

Turning to the second allocation bias, company stock investment, evidence suggests that despite recent scandals individuals continue to invest heavily in company stock. In fact, Hewitt Associates LLC (2003) reports from a sample of 1.5 million 401(k) plan participants in 2003 that the average company stock balance was 41%, and the NASD recently issued a company stock warning to investors (NASD (2005)).

This paper examines the links between individual characteristics, past company stock returns, and company stock allocations. The influence of past company stock performance and plan design on company stock holding is already well documented in the literature (Benartzi (2001), Choi, Laibson, Madrian, and Metrick (2004), Liang and Weisbenner (2002), and Sengmuller (2002)). This study contributes to the literature by analyzing the additional link between individual characteristics and company stock holdings while controlling for past performance. The individual level data I use offer more demographic detail than in past research, and the returns are more precisely calculated than those used in plan level studies. I find a one standard deviation increase in short-term returns increases company stock holdings by 8% and that short-term returns matter more than long-term returns. In addition, I find that company stock allocations are greater for males, decrease with salary, and are higher for employees in non-corporate divisions.

Finally, since lack of participation stands out as one of the most obvious investment mistakes an individual can make, I include a brief study of participation choice for completeness. My findings are consistent with previous studies, and I find that the probability of participating increases with age, job tenure, and salary.

The paper is organized as follows. Section II summarizes the dataset. Section III describes the plan design and the asset allocation choices. Section IV summarizes the demographic and employment characteristics of all the participants eligible to participate in the plan. Section V and VI present the empirical results associated with naïve diversification and company stock holdings, respectively. Section VII discusses the participation level in this plan, and Section VIII presents the Conclusion.

II. Data

This paper uses a detailed database supplied by an anonymous large benefits provider. The cross-sectional data are from one large 401(k) plan with over

73,000 eligible employees.[2] The plan is sponsored by a global consumer product company and the entire sample is used to investigate the participation decision.

The study of the allocation biases is based on a smaller subsample of "active" participants. This paper defines an active participant as a plan eligible participant who made a contribution to the plan during the first two weeks of August 1998. The dataset includes each active participant's contribution allocation and for most of these individuals the actual date that this allocation was chosen. For this allocation date, company stock returns over various prior periods are calculated. A total of 28,793 participants are considered active participants.

Of these active participants, the allocation date is missing for 5,814 individuals who were enrolled in the plan prior to 1992 and did not change their contribution allocations after this date. The data are missing because the current administrator took over the plan in 1992 and was not provided information regarding the design of the plan prior to this date. Thus, it is possible that a different set of fund choices may have been available prior to 1992 or that an employer match may have been offered. Since features like these can influence choice, this group might behave differently than participants who make allocation decisions after 1992 (Benartzi (2001), Benartzi and Thaler (2001)).

The missing allocation decision date means that estimating company stock returns prior to the allocation decision is not possible, nor is it possible to estimate the individuals' ages and the number of years employed at the time of the allocation decision. Therefore, these individuals are eliminated from the sample leaving 22,979 active participants for the analysis.[3]

One of the most important features of the data is detailed demographic information. For each eligible participant, the individual's participation status, salary, birth date, date of employment, compensation status, and gender are available.

Finally, three additional features of these data deserve mention. First, the asset allocations of the contributions are broken down at the individual level. Aggregate contribution plan data can blur the results if high contributing participants invest differently from low contributing participants. The effect of large contribution levels is analogous to the influence of large market capitalization stocks on a value-weighted index. Furthermore, aggregation can exaggerate very weak relations at the individual level. This is called aggregation bias. Huberman and Jiang (2006) use a simulation to demonstrate how aggregation bias can amplify individual level findings in 401(k) plans. Second, these data are from one plan. While multiple plan data are appropriate for studying across-plan variation, they can create a potential for omitted variable bias related to plan design or plan educational efforts. Analyzing one plan eliminates this concern. A final advantage of the data is that allocations are based on contributions not asset balances. Asset performance can move asset allocations based on asset balances away from the participant's intended allocation. Contribution allocations do not suffer from this potential bias.

A disadvantage of this dataset is that information regarding participants' assets outside of the plan is not available. Another drawback of the dataset is that

[2] An eligible employee is an employee who may participate in the 401(k) plan if he chooses.

[3] Separate analyses of the allocation biases including and controlling for this subgroup were completed. These analyses are not reported here, but the findings are qualitatively the same.

it is missing some variables that have been shown to impact asset allocation decisions such as marital status, education, and financial literacy (for example, see Agnew, Balduzzi, and Sunden (2003), Sunden and Surette, (1998), and Dwyer, Gilkeson and List (2002)).

III. Plan Design and Asset Choices

In this plan, each participant may allocate his retirement fund contributions among four different investment vehicles: an equity income fund, an S&P 500 index fund, a guaranteed income contract fund (GIC), and company stock.[4] Participants have the option to change their contribution allocations daily. The company offers no financial incentive for investing in company stock nor does it offer an employer match. The absence of an employer match is an advantage because it eliminates any confounding effects caused by the match design.

IV. Demographic and Employment Characteristics of Eligible Participants

Panel A of Table 1 describes the demographic and employment characteristics of the eligible participants. These participants may or may not contribute to the plan. Age and time employed are measured as of August 1998, while salary is the 1997 annual salary. In contrast, age and time employed are measured as of the allocation decision date in the later nonparametric and regression analyses. Individuals in this data sample are predominately male (78%) with an average age of 37 years. It is noteworthy that the participants have relatively long average job tenures (eight years), which may indicate strong company loyalty. The median time employed is almost five years and is approximately one year greater than the 1996 national median of nearly four years (CPS (1997)).

Participants in the company work in one of four divisions. A majority of the participants (99%) work in two large consumer product manufacturing divisions, Division 1 and Division 2. The Corporate Division employs 1% of the 401(k) participants and 140 employees work for the Other Division.

Participants earned mean 1997 salaries of approximately $37,700. Table 2 compares the plan's median salary by age group to the median salary of the U.S. population, and shows that participants in this plan earn more than the general population. However, the relation between salary and age is similar between the two groups.

Table 1, Panel B presents the same statistics as Panel A for the active participants subsample. The ratio of males to females and the distribution of employees in each division is the same as the whole sample. However, the mean age and

[4] A GIC fund, sometimes called a stable value fund, is a common offering in 401(k) plans. The fund invests in GICs that are lending contracts between insurance companies and 401(k) plans. The 401(k) plan lends the insurance company money over a fixed period of time. The insurance company then can invest in the money in securities. In return, the insurance company pays interest to the 401(k) plan on the loan. The insurance company guarantees the contracted interest payments and assumes all market, credit, and reinvestment risk. The insurance company profits by generating profits greater than the guaranteed interest it pays out to the plan. Typically, investors interested in preserving capital and earning a steady income invest in GICs. These investments are considered low risk.

TABLE 1

Descriptive Plan Statistics

Panels A and B of Table 1 present general statistics for the eligible participants and the active only participants, respectively. Panel A reports the contribution status (as of August 1998), gender, age in years (as of August 1998), time employed in years (as of August 1998), division of employment, and 1997 annual salary for the sample of eligible participants to the plan. An individual is considered eligible if he has the option to participate in the company plan. Participants are considered contributing (active) if they contributed to the plan during the first two weeks of August 1998. Panel B presents the same statistics for the active only subsample. This panel also includes statistics related to compensation status, which equals yes if the individual is considered by law a highly compensated individual. Percentages may not add up to 100% due to rounding.

	Obs.	%	Mean	Std.	Min.	Max.
Panel A. All Eligible Participants (active and inactive)						
Contribution Status						
Participants not contributing	44,906	61				
Participants contributing	28,793	39				
Total eligible participants	73,699	100				
Gender						
Female	15,904	22				
Male	57,795	78				
Age (as of 8/98)	73,699		37.44	9.80	18.04	95.62
Years Employed (as of 8/98)	73,699		8.01	8.04	0.01	60.24
Division						
Corporate	494	1				
Division 1	30,392	41				
Division 2	42,673	58				
Other	140	0				
1997 Annual Salary	73,699		$37,672	$26,095	$15,000	$2,200,000
Panel B. All Active Participants						
Gender						
Female	4,958	22				
Male	18,021	78				
Age (as of 8/98)	22,979		38.13	8.65	18.92	70.37
Years Employed (as of 8/98)	22,979		8.84	7.31	0.10	44.38
Highly Compensated Individual						
Yes	1,883	8				
No	21,096	92				
Division						
Corporate	270	1				
Division 1	10,337	45				
Division 2	12,318	54				
Other	54	0				
1997 Annual Salary	22,979		$45,961	$28,716	$15,600	$781,790

TABLE 2

Age/Salary Structure for U.S. Population and 401(k) Sample

Table 2 presents a comparison between the median salary by age group for the U.S. population at large and the 401(k) plan participants included in the eligible participants sample and the active only subsample. The source for the U.S. population is CPS (1997).

	Median 1997 Salary		
Age Range	U.S. Population	401(k) Eligible Participants	401(k) Plan Active Participants
Under 35 years	$22,846	$28,300	$36,852
35–44 years	$30,880	$36,327	$40,838
45–54 years	$33,106	$37,112	$41,223
55–64 years	$29,434	$36,422	$40,336
65+ years	$21,032	$24,149	$37,797

time employed of the participants in the subsample are slightly higher than the total sample. The median time employed is nearly two years longer than the whole sample (6.45 years versus 4.77 years), suggesting that many new employees have not yet joined the plan.[5] Another interesting difference between the two samples is that the mean salary is close to $8,000 larger in the active sample, suggesting that individuals with higher salaries tend to participate in the plan. This is supported in Table 2 where the median salaries for each age group in the subsample are consistently higher than the total sample and the U.S. population. Table 1, Panel B also presents statistics for the number of participants considered to be highly compensated individuals, a legal designation based on salary and company ownership. This status affects how much participants can contribute, but does not restrict their allocation decisions.[6] In this plan, approximately 8% of the sample is considered highly compensated.

Table 3 describes the demographic characteristics by division for the total sample and the active subsample. The main difference between the four divisions in both samples appears to be salary distributions. Employees of the two smallest divisions make significantly higher salaries than employees in the other divisions. The Corporate Division's mean salary is approximately $97,000 for the total sample, while the Other Division's mean salary is approximately $129,000 in the total sample. These salaries compare to approximately $40,000 and $35,000 earned in Divisions 1 and 2, respectively. Employees in the two small divisions also earn significantly more in the 10th and 90th percentiles of their sample. Except for the Corporate Division, the divisions are predominately male. The groups do not differ significantly in terms of average age or time employed. Consistent with the earlier results, the active subsample salaries are higher than the salaries reported in the total sample.

V. Naïve Diversification

A. General Findings

In this section, three diversification heuristics are studied. The first, the framing $1/n$ heuristic, is considered a naïve strategy because individuals distribute their contributions equally among the n choices available. As a result, allocation decisions are influenced by available fund choices and can be considered irrational. Benartzi and Thaler (2001) show that this strategy can lead to large ex ante welfare losses when the portfolio chosen does not correspond to an individ-

[5] Although the database codes all the participants as immediately eligible, it is possible that there might have been a duration of time before eligible employees could join the plan. This would result in older ages and longer tenures for the active sample.

[6] Each year employers must identify employees who are considered to be highly compensated. This information is used by the IRS to determine whether the 401(k) plan meets nondiscrimination tests, which are designed to insure that tax breaks derived from participating in 401(k) plans are not limited to wealthy employees. According to the IRS website, http://www.irs.gov/publications/p560/ch01.html, a highly compensated employee either owned more than 5% of the employer's capital or profits at any time during the year or the preceding year, or for the preceding year received compensation above a specified level. In 2003, the salary limit for the preceding year was $90,000. The IRS also indicates that the employer may choose to consider those employees ranked in the top 20% by compensation as highly compensated.

TABLE 3

Descriptive Plan Statistics by Division

Table 3 breaks down each division by demographic information for the total sample in Panel A and the active only sample in Panel B. Panel A reports gender, 1997 annual salary, age (as of August 1998), time employed (as of August 1998), and time enrolled in the plan (as of August 1998). In addition to those statistics, Panel B reports the percent of the sample that is 100% invested in company stock and compensation status (HCE). HCE stands for highly compensated individual.

Panel A. All Eligible Participants (active and inactive)

Division	No. of Employees	% of Division Male	Mean Age (years)	Mean Time Employed (years)
Corporate	494	51	42.76	11.80
Division 1	30,392	85	37.18	9.32
Division 2	42,673	74	37.56	7.03
Other	140	86	40.95	10.49

	Salary			
Division	Median	Mean	10th Percentile	90th Percentile
Corporate	$57,000	$97,343	$31,000	$190,000
Division 1	$34,920	$39,737	$20,000	$59,330
Division 2	$31,769	$35,210	$19,760	$52,100
Other	$148,250	$129,393	$81,005	$160,000

Panel B. All Active Participants

Division	No. of Employees	% of Division Male	Mean Age (years)	Mean Time Employed (years)	% Division 100% Invested in Company Stock
Corporate	270	47	41.92	10.98	10
Division 1	10,337	81	37.58	9.64	21
Division 2	12,318	77	38.51	8.11	26
Other	54	85	40.66	9.85	15

	Salary				
Division	Median	Mean	10th Percentile	90th Percentile	% of Division HCE
Corporate	$64,000	$95,681	$35,000	$190,000	40
Division 1	$39,645	$47,134	$25,688	$72,200	9
Division 2	$38,752	$43,496	$25,771	$63,800	6
Other	$155,000	$135,127	$90,190	$160,000	98

ual's risk preferences.[7] I also analyze the modified $1/n$ heuristic where individuals treat company stock as a separate asset class. In the modified version of the framing heuristic, individuals choose their company stock allocation, then divide their remaining funds among the remaining options available. The final heuristic, the conditional $1/n$ heuristic, refers to the practice of dividing allocations evenly among the chosen funds. The number of chosen funds may be smaller than the number of funds offered. Huberman and Jiang (2006) argue that, unlike the framing $1/n$ heuristic, the conditional $1/n$ heuristic can be rational and is consistent with k-fund separation theories.

In this study, analyses of the heuristics are complicated by the fact that company stock is an option in this plan. Huberman and Jiang (2006) choose to exclude company stock allocations in their calculations. As mentioned in the Introduction, any investment in company stock is considered inefficient in my study. Thus, an investor who follows the conditional $1/n$ heuristic *and* includes company stock

[7]To illustrate, suppose that a 401(k) offers 10 investment choices that include nine equity funds and one money market fund. An individual following the $1/n$ heuristic would allocate 10% of his contributions to each fund resulting in a 90% allocation to equities. It is clear that this allocation would not be optimal for everyone, and especially for a participant nearing retirement.

in his investment choices is not making a rational decision. Therefore, I refine Huberman and Jiang's (2006) definition of the conditional $1/n$ heuristic to only include individuals who divide their contributions evenly ($\pm 1\%$) among the n funds they choose and do not invest in company stock. In contrast, an individual is considered to be following the framing $1/n$ heuristic if he puts 25% ($\pm 1\%$) of his contribution into each of the four funds. These two groups are mutually exclusive. Participants who follow the modified $1/n$ rule invest in all four funds and divide their non-company stock options equally.

I find a small percentage of participants in the overall plan following the framing $1/n$ heuristic, which is consistent with Huberman and Jiang (2006). In fact, less than 4% follow the framing $1/n$ heuristic and only 5% follow the modified $1/n$ heuristic. On the other hand, I find nearly 8% follow the conditional $1/n$ rule (excluding all company stock holders and one-fund holders). I find that most participants (35%) allocate their entire contribution to only one fund and that a majority (66%) of those participants invest their entire contribution in company stock. If I broaden my definition of the conditional $1/n$ heuristic to include one-fund investors not invested in company stock, then the percent of my sample following this rule increases to 20%.

B. The Modified $1/n$ Heuristic

Using aggregate 401(k) plan data, Benartzi and Thaler (2001) find that individuals treat company stock as an asset class separate from other 401(k) investments. As a result, some participants appear to follow a modified version of the $1/n$ heuristic by making their company stock allocation separate from their investment in other equities. Benartzi and Thaler find that participants then split their non-company stock investment evenly among the non-company stock options, which is a form of mental accounting (Thaler (1999)). In this paper, the behavior is referred to as the modified $1/n$ heuristic.

My analysis provides stronger tests of this practice. First, the tests in this paper are based on contribution allocations rather than asset balance allocations and, therefore, the influence of fund performance on allocations is not a concern. Second, the individual level data allows for the calculation of the allocation of non-company stock holdings by individual rather than by plan, permitting the examination of the distribution of company stock holdings across individuals and avoiding aggregation bias (Huberman and Jiang (2006)).

The analysis begins with an examination of the mean and median allocations to each fund in Table 4. The first two columns of Table 4 list the mean and median allocations to each fund and the last two columns list the modified mean and median allocations to each fund. The modified allocations are simply the percent allocated to the particular non-company stock investment vehicle divided by the total invested in non-company stock investment vehicles. The first subsample includes all participants who invest in all four funds and comprises roughly 13% of the sample. Notice that the results tend to support the modified $1/n$ heuristic with modified allocations close to one-third, which equates to evenly splitting non-company stock contributions among non-company stock assets. The same exercise is repeated for subsamples of investors that hold three funds including

company stock. The results again tend to support Benartzi and Thaler's (2001) assertion that some individuals treat company stock as a separate asset class and as a result slightly modify how they follow the $1/n$ rule.

TABLE 4

Asset Allocations and Modified Asset Allocations

Table 4 presents the allocations and modified asset allocations for investors who hold company stock and invest in either two or three additional assets. The modified allocations reflect the percentage of the non-company stock holdings the asset class represents. Percentages may not add up to 100% due to rounding.

	Allocation			
Investment Vehicle	Mean	Median	Mean Modified	Median Modified
Invest in All Assets (3,011 obs.)				
Company Stock	32%	25%		
Equity Income Fund	23%	25%	34%	33%
S&P 500 Index Fund	25%	25%	36%	33%
GIC	20%	20%	30%	33%
Invest in Company Stock, Equity Income, and GIC Fund (279 obs.)				
Company Stock	41%	47%		
Equity Income Fund	30%	25%	51%	50%
S&P 500 Index Fund				
GIC	29%	25%	49%	50%
Invest in Company Stock, Equity Income, and S&P 500 Index Fund (4,084 obs.)				
Company Stock	38%	34%		
Equity Income Fund	30%	30%	48%	50%
S&P 500 Index Fund	33%	30%	52%	50%
GIC				
Invest in Company Stock, S&P 500 Index, and GIC Fund (560 obs.)				
Company Stock	44%	50%		
Equity Income Fund				
S&P 500 Index Fund	29%	25%	52%	50%
GIC	27%	25%	48%	50%

Histograms provide additional detail. To illustrate, Figure 1 displays histograms using the sample of participants who invest in all four funds, and shows the frequency of company stock holdings and modified and unmodified holdings of the three non-company stock investment vehicles.

Looking at the histograms in Figure 1, the difference between the unmodified allocation graphs (on the left) and the modified allocation graphs (on the right) is striking. The unmodified histograms for the non-company stock funds have several probable allocations. However, the modified frequencies are strongly centered at 33%, suggesting that after adjusting for company stock holdings, these individuals allocate their remaining assets evenly among the other funds in accordance with Benartzi and Thaler's (2001) assertion that some individuals treat company stock as a separate asset class and slightly modify how they follow the $1/n$ rule. Results for the other subsamples presented in Table 4 are similar and available from the author.

C. Econometric Analysis

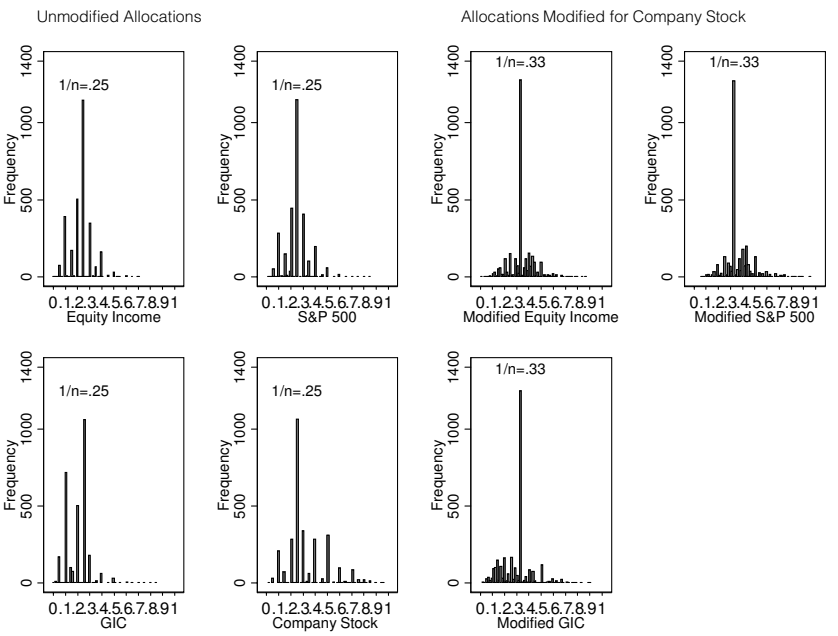
The final empirical question related to naïve diversification is which type of person is most likely to follow the different heuristics? Since two strategies are considered potentially irrational and the conditional $1/n$ heuristic is considered potentially rational, I would not expect the same type of individual to follow each. To test this, four dummy variables are constructed: a framing $1/n$ heuristic dummy, a modified $1/n$ heuristic dummy, a conditional $1/n$ heuristic dummy

FIGURE 1

Histograms

These histograms display the frequency of participants' allocations (in decimals) to each fund. The reported allocations (unmodified) and the allocations adjusted for company stock holdings (modified) are presented. The modified allocations represent the relative amount allocated to the non-company stock funds.

Sample Invests in All Four Funds (3,011 observations)



excluding one-fund investors, and a conditional $1/n$ heuristic dummy including one-fund investors not invested in company stock. These dummies equal one if the individual follows the particular heuristic and zero if not.

Table 5 displays the results of a probit analysis using the $1/n$ dummy variables. For each $1/n$ variable, two regressions are run each with a different compensation variable. The marginal effects of salary and employment tenure are significant and negative for the two framing regressions. In contrast, salary and time employed are positive for both the conditional $1/n$ heuristic and its broader definition. This suggests that high salary individuals and participants with longer job tenures are less likely to follow the potentially irrational framing $1/n$ rule, while on the other hand these same individuals are more likely to follow the potentially rational conditional $1/n$ rule. To highlight this finding, in the framing and modified $1/n$ regressions an average participant who earns \$100,000 would be 3% less likely to follow the rule than an average participant earning \$46,000. Similarly, a highly compensated individual is 2% less likely to follow the rule. Conversely, a highly compensated individual is 7.4% more likely to the follow the broad definition of the conditional $1/n$ rule. One explanation for this behavior is that the higher salaried individuals are more educated and therefore less likely to rely on simple rules for investing. Regarding job tenure, it is possible that

employees' understanding of their plan's investment options increases with their time on the job. Thus, this better understanding decreases the likelihood that they will need to fall back on the $1/n$ rule.

TABLE 5

Marginal Effects from Probit Regression ($1/n$ heuristic)

Table 5 presents the marginal effects calculated from the results of a probit regression. The dependent variable equals one if the individual follows the specific heuristic defined in the table. Male is a dummy variable equal to one if the participant is male, zero otherwise. Salary is the annual 1997 salary (unit: $10,000). Age is the age of the participant at the time the allocation decision is made (unit: years). The marginal effect of age takes into account a nonlinear effect of age. Time Employed equals the time the participant has been employed at the time the allocation decision is made (unit: years). Compensation Status is a dummy variable that equals one if the individual by law is considered highly compensated, otherwise it equals zero. Division # and Other are dummy variables that equal one if the participant is in that division. The Corporate Division is the omitted dummy. Robust standard errors, reported in parentheses, are adjusted for heteroskedasticity. The pseudo R^2 is the log-likelihood value on a scale from zero to one, where zero corresponds to the constant only model and one corresponds to perfect prediction (a log-likelihood of zero). **,* indicate significance at the 1% and 5% levels, respectively.

$$\text{The model : Prob(Y= 1)} = \Phi(\beta_0 + \beta_1\text{Male} + \beta_2\text{Age} + \beta_3\text{Age}^2 + \beta_4\text{Time Employed} + \beta_5\text{Salary (or Compensation)} + \beta_6\text{Division 1} + \beta_7\text{Division 2} + \beta_8\text{Other})$$

	Possibly Inefficient Decision				Possibly Efficient Decision			
Heuristic Name Dependent variable equals one if . . .	Framing $1/n$ (dF/dx) 25% is invested in each of the four funds offered.		Modified $1/n$ (dF/dx) Individual invests in all four funds and non-company stock holdings are equally split.		Strict Conditional $1/n$ (dF/dx) Individual invests $1/n$ among the n funds chosen and company stock investment is not allowed. Equals zero if a one-fund investor.		Broad Conditional $1/n$ (dF/dx) Individual invests $1/n$ among the n funds chosen and company stock investment is not allowed. Equals one if a one-fund investor.	
Independent Variables	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Male[a]	0.0000	−0.0014	0.0009	−0.0006	0.0024	0.0038	0.0037	0.0059
	(0.0032)	(0.0032)	(0.0035)	(0.0036)	(0.0044)	(0.0044)	(0.0064)	(0.0064)
Age	0.0003	0.0002	0.0002	0.0001	0.0015**	0.0016**	0.0023**	0.0025**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
Time Employed	−0.0014**	−0.0016**	−0.0018**	−0.0020**	0.0009**	0.0010**	0.0019**	0.0020**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0005)	(0.0005)
Salary	−0.0057**		−0.0057**		0.0047**		0.0075**	
	(0.0009)		(0.0009)		(0.0006)		(0.0009)	
Compensation Status[a]		−0.0197**		−0.0191**		0.0511**		0.0742**
		(0.0041)		(0.0049)		(0.0080)		(0.0108)
Division 1[a]	0.0176	0.0280	0.0104	0.0221	0.0339	0.0193	−0.0054	−0.0230
	(0.0172)	(0.0175)	(0.0175)	(0.0175)	(0.0183)	(0.0169)	(0.0235)	(0.0228)
Division 2[a]	0.0081	0.0181	0.0013	0.0131	0.0276	0.0127	−0.0245	−0.0433
	(0.0163)	(0.0159)	(0.0171)	(0.0166)	(0.0174)	(0.0164)	(0.0237)	(0.0231)
Other[a]	dropped	dropped	dropped	dropped	0.0636	0.0460	−0.0141	−0.0265
					(0.0529)	(0.0477)	(0.0530)	(0.0503)
No. of Obs.	22,925	22,925	22,925	22,925	22,979	22,979	22,979	22,979
Pseudo R^2	0.0181	0.0119	0.0163	0.0115	0.0161	0.0143	0.0131	0.0124

[a] dF/dx is for a discrete change of the dummy variable from zero to one.

VI. Company Stock Allocations

A. Cost of Holding Company Stock

I now focus on the issue of the cost of holding company stock. The well-publicized stories of employees losing their nest eggs after Enron and WorldCom

collapsed provide strong anecdotal evidence that investing in company stock is costly. But is it possible to actually quantify the costs of holding company stock for average investors? Recent studies attempt to do this and agree that the cost of holding stock is large. For example, Meulbroek (2002) calculates the cost of holding company stock as the percent of the stock market's value that is sacrificed by not being fully diversified. In the case where 10% of the pension is invested in company stock, she calculates a cost of 25% for AMEX firms.[8] In addition, Poterba (2003) quantifies what a log-utility investor would be willing to forego in the value of a portfolio that is entirely invested in the S&P 500 compared to investing in portfolios with various percentages of company stock investments. He finds that his investor would be indifferent between foregoing 57% of the S&P 500 portfolio value for a portfolio invested solely in company stock. Poterba's findings motivate the analysis that follows.

B. General Findings

Consistent with anecdotal evidence, participants in the company's 401(k) plan show a definite tendency to invest in company stock. The overall mean allocation to company stock holdings in this plan is quite high (45%) compared to the 10% legal maximum defined benefit plans may hold. The large average allocation might be partially explained by the above normal price performance of the plan's company stock. In this study, the company stock had an annualized stock price return just over 20% over the 10-year period ending on December 31, 1997 compared to a S&P 500's annual return of 14.7% over the same time period. Benartzi (2001) shows that firms with relatively high long-run returns have higher company stock allocations than poorly performing firms. I will also control for past company stock returns in the regression analysis presented later in this section.

The general patterns of company stock allocations also deserve mention. An interesting feature of the data is that despite the absence of restrictions on the participants' allocations, 75% of the allocations are clustered within one percentage point of 0%, 25%, 50%, 75%, and 100%. Furthermore, there is a clear tendency for many of the participants (48%) to invest either all or none of their contributions in company stock.

It is also interesting to examine the amount allocated to company stock in this plan in terms of total dollars rather than percents. To calculate a rough estimate of this number, several simplifying assumptions are made. First, each individual's 1998 contribution amount is assumed to be equal to the number of dollars he contributed in 1997. The 1997 contribution amount is supplied in the dataset. This probably is a conservative estimate of 1998 contributions. However, the alternative to annualizing the August 1998 contributions is problematic because determining the frequency of the contributions (weekly or biweekly) is difficult. Finally, it is assumed that the allocation percentages that the individuals chose for their August 1998 contributions were held constant throughout 1998. Given the documented inertia in 401(k) plans, this should be a reasonable assumption for

[8]This assumes that the pension assets represent 75% of the individual's wealth and that the individual has a 15-year holding period. This figure equals 14% for NYSE firms and 36% for NASD firms.

most participants. By multiplying the estimated 1998 total dollar contributions by the 1998 company stock percent allocation, an estimated company stock allocation in dollars is calculated for each individual. Summing the estimated dollar allocations across individuals provides an estimate of the total dollars contributed to company stock. From this calculation, it is estimated that approximately $24.7 million was allocated to company stock. This is 39% of the estimated $63.4 million contributed to the plan in total. This percentage is very close to the 42% that Benartzi (2001) reports in his study of aggregate data from 103 401(k) plans.

C. Nonparametric Analysis

This section presents a nonparametric analysis of the data that will complement the regression analysis to follow. Table 6 reports the company stock allocations based on demographic characteristics. The non-normal distribution of the company stock holdings makes standard summary statistics, such as means and standard deviations, less meaningful descriptors of the data. Therefore, in addition to these statistics, Table 6 reports the proportion of each demographic category that invests in six different investment ranges: 0%, 1%–25%, 26%–50%, 51%–75%, 76%–99%, and 100%. A simple test of proportions within each demographic category and investment range is used to test whether a statistically significant difference exists. If demographic characteristics do not matter, then a statistically significant difference in proportions should not be found. For example, under the null hypothesis gender does not matter. Therefore, the proportion of women investing 100% of their contributions to company stock should not be statistically different than the proportion of men investing 100% of their contribution to company stock. The bold row in each category is considered the base category and is used in each test of proportions. Table 6 reports the results of the test of proportions.

The first demographic category tested is gender. Empirical evidence suggests that gender may proxy for financial education or risk tolerance. For example, research shows that when a measure of financial education is not available, gender may serve as an effective proxy for it. Dwyer, Gilkeson, and List (2002) find that women typically have less financial knowledge than men and that educational disparities can substantially explain the gender differences they find in risky mutual fund allocations.

Indeed, there is broad evidence suggesting that individuals overall lack a general understanding of the risks associated with company stock investment and that education may explain much of the variation in financial aptitude. A recent John Hancock Financial Services' survey (1999) highlights how individuals misread the risks of the market. In the survey, respondents on average think that a diversified stock fund is more risky than an investment in company stock. Similarly, Benartzi (2001) reports that 83% of respondents to a Morningstar survey believe that the overall stock market is riskier than company stock. When this sample is limited to individuals with a high school education or less, this number increases to 93%. Thus, while company stock investment may seem to be irrational, closer examination reveals it may be rational given an individual's financial knowledge.

TABLE 6

Summary Statistics of Company Stock Holdings

Table 6 reports summary statistics for company stock holdings based on demographic characteristics. The sample is the active only sample. In addition to the mean and median allocations, the table presents the proportion of each demographic category invested in each of the six investment ranges. The first row of each demographic category (bold) is considered the base category. Within each investment range and demographic category, a test of proportions is run. **,* beside the proportions denote a statistically significant difference from the base category at the 1% and 5% levels, respectively. Percentages may not add up to 100% due to rounding.

Demographic Category	Obs.	Percent of Sample within Each Investment Range						Company Stock Allocation	
		0%	1%–25%	26%–50%	51%–75%	76%–99%	100%	Median	Mean
All	22,979	24.7%	15.3%	27.7%	6.9%	2.1%	23.3%	40.0%	44.9%
Sort by Gender									
Male	**18,021**	**24.8%**	**15.1%**	**27.4%**	**6.8%**	**2.2%**	**23.7%**	**40.0%**	**45.2%**
Female	4,958	24.4%	16.3%*	28.8%*	7.1%	1.7%*	21.7%**	40.0%	43.8%
Annual Salary									
Under $25,000	**1,976**	**21.7%**	**16.7%**	**26.7%**	**6.0%**	**1.5%**	**27.4%**	**50.0%**	**48.3%**
$25,000–$49,000	15,369	23.4%	14.8%*	27.7%	6.9%	2.2%*	25.0%*	50.0%	46.8%
$50,000–$74,999	3,749	24.9%**	17.2%	29.6%*	7.3%	2.2%*	18.7%**	35.0%	41.7%
$75,000–$99,999	919	35.2%**	15.3%	27.4%	7.1%	1.3%	13.7%**	25.0%	34.2%
$100,000+	966	42.2%**	13.4%*	22.9%*	5.9%	1.0%	14.6%**	25.0%	31.8%
Highly Compensated Individual									
Yes	**1,183**	**36.3%**	**14.7%**	**25.8%**	**6.6%**	**1.2%**	**15.5%**	**25.0%**	**34.8%**
No	21,096	23.7%**	15.4%	27.9%*	6.9%	2.2%**	24.0%**	40.0%	45.8%
Age									
Under 35 years	**11,075**	**21.8%**	**6.2%**	**28.2%**	**7.4%**	**2.5%**	**24.0%**	**49.9%**	**46.7%**
35–44 years	8,075	26.4%**	15.1%*	27.3%	6.9%	1.7%**	22.5%*	40.0%	43.7%
45–54 years	3,144	28.5%**	13.4%**	27.5%	5.3%**	1.9%	23.4%	40.0%	43.4%
55–64 years	679	35.1%**	13.0%*	26.4%	4.9%*	1.3%	19.4%**	30.0%	38.3%
65+ years	6	66.7%**	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	14.0%
Time Employed									
0–2 years	**7,359**	**21.4%**	**17.2%**	**27.5%**	**5.7%**	**1.8%**	**26.4%**	**49.9%**	**47.4%**
3–5 years	4,571	22.8%	16.5%	28.9%	7.4%**	2.2%	22.3%**	40.0%	45.1%
6–10 years	4,497	24.0%**	14.8%**	28.2%	8.3%**	2.7%**	22.1%**	40.0%	45.2%
11–15 years	2,914	28.7%**	13.7%**	27.6%	7.4%**	1.9%	20.8%**	40.0%	42.3%
16–20 years	2,118	30.5%**	12.2%**	26.7%	7.6%**	2.0%	21.1%**	40.0%	42.2%
21–25 years	948	32.7%**	12.8%**	25.5%	5.3%	1.3%	22.5%**	34.0%	40.9%
26–50 years	572	34.6%**	10.7%*	27.3%	3.7%*	2.1%	21.7%*	30.0%	39.9%
Division									
Corporate	**270**	**35.9%**	**23.0%**	**27.4%**	**3.3%**	**0.4%**	**10.0%**	**25.0%**	**28.8%**
Other	54	42.6%	13.0%	25.9%	3.7%	0.0%	14.8%	20.0%	30.9%
Division 1	10,337	26.4%**	16.3%**	28.3%	6.6%*	1.9%	20.5%**	35.0%	42.2%
Division 2	12,318	23.0%**	14.4%**	27.3%	7.1%*	2.3%*	25.9%**	50.0%	47.6%

Lack of financial knowledge may also lead to misperceptions of how 401(k) information is used. For example, those lacking financial knowledge may suspect that their managers are monitoring their company stock holdings. They may fear that a low investment in company stock signals to their employers that they "lack commitment," which will, in turn, harm their job prospects. As a result, their large investment in company stock may be a rational decision based on misinformation.[9]

If gender is a proxy for differences in financial knowledge, then men might be expected to invest less in company stock than women. On the other hand, empirical research finds that men are more likely to invest in riskier assets or trade more in riskier assets than women leading to the opposite conclusion (for

[9]I thank Hendrik Bessembinder for this insight.

example, Agnew, Balduzzi, and Sunden (2003), Barber and Odean (2001), and Sunden and Surette (1998)).[10]

The tests of proportions support the latter. In all but two percent ranges, there is a statistically significant (albeit economically small) difference in the proportion of men investing in each investment range than women. The most significant difference between the proportion of women and men investing in company stock is at the 100% investment range. Observe that 24% of the men allocate their entire contribution to company stock compared to 22% of the women and that this difference is significant at the 1% level. Although the medians are equal, the mean allocation to company stock by men is 45% compared to 44% for women.

Interestingly, the gender differences obtained here are weaker than those Clark, Goodfellow, Schieber, and Warwick (1999) find. In their study of several 401(k) plans, men invest an average of 41% to company stock compared to 27% for women. These differences in findings could be a result of different plan designs or varied long-run company stock performance across plans.

The next two sections of Table 6 demonstrate the influence of compensation level, either salary or compensation status, on company stock investment. Compensation is considered positively related to financial knowledge and suggests the hypothesis that employees who earn relatively high salaries or are considered highly compensated should hold less company stock.

Alternatively, compensation may be a proxy for an employee's opportunities for stock-based compensation. Generally, greater opportunities exist for higher salaried employees to receive stock-based compensation than for their lower wage counterparts. This is the case in this company.[11] Research shows that highly paid executives are concerned about diversifying their company stock holdings but are often reluctant to sell their stock-based compensation. As a result they find sophisticated ways to hedge their holdings. Results from Ofek and Yermack (2000) suggest that executives diversify their company stock holdings through the use of zero cost collars and equity swaps. Additional research shows that executives with high stock ownership negate much of the impact from their stock compensation by selling previously owned shares (Bettis, Bizjak, and Lemmon (2001)). Given the demonstrated lengths to which these senior managers go to diversify their holdings, one might expect to which they will hold smaller amounts of company stock in their 401(k) accounts.

The results support both theories. Table 6 shows a decrease from the lowest wage category to the highest wage category in the proportion of individuals allocating their entire contribution to company stock: 27% of the under $25,000 category invest their whole contribution to company stock compared to 15% of

[10] In terms of trading and turnover of equity investments, Barber and Odean (2001) find a significant difference between men and women. They find that men trade 45% more than women. However, using brokerage account data from 35,000 households, they find only a very small difference in equity ownership as a percent of net worth between males and females. On average, they find that women in their sample invest 13.3% of their net worth in equities compared to men who invest 13.2%.

[11] This company offers three plans. One plan is open to all full-time employees and the number of options available is based on earnings. The second and third plans are targeted at middle and senior management. The options in these plans are based on reaching performance goals. Thus, higher salaried and middle and upper management employees have more opportunities to earn stock options than lower salaried employees.

the $100,000 plus category. The reverse trend is observed in the proportion of individuals who invest nothing in company stock. Here, 22% of the under $25,000 category invest nothing in company stock compared to 42% of the over $100,000 group. This difference in proportions is significant at the 1% level, and supports results from Goodfellow and Schieber's (1997) study of 24 different plans where low wage earners are more likely than high wage earners to hold company stock. Table 6 also shows that highly compensated individuals make similar investment patterns.

Similar to gender, age may proxy for risk tolerance. Many life cycle theories predict that individuals will hold less risk in their financial portfolio as they age. Jagannathan and Kocherlakota (1996) suggest that young investors have a long stream of future income. As individuals age, this stream of future income shortens diminishing the value of their human capital. Therefore, they suggest that individuals should offset this decline in the value of their human capital by reducing the risk of their financial portfolio. Bodie, Merton, and Samuelson's (1992) model leads to a similar prediction. In their model, individuals can respond to low realized asset returns by increasing their supply of labor. However, labor flexibility generally declines with age. Therefore, similar to the previous model, older individuals are expected to hold more conservative investments in their financial portfolios.

Table 6 is consistent with the stated life cycle hypotheses. Note that age is measured at the time the allocation decision is made. The 65 plus age category is not discussed because it includes only six participants. Notice that as individuals age there is a downward trend in the proportion of participants investing their entire contribution to company stock. On the extreme ends, 19% of those between ages 55–64 invest their entire contribution to company stock compared to 24% of the participants under 35 years old. The difference in proportions is significant at the 1% level. This trend is reversed and significant in the proportions investing nothing in company stock.

Time employed may also proxy for risk tolerance, as well as loyalty or familiarity. The latter two theories would predict a positive relation. The results in Table 6 show that the percentage of participants that holds 0% in company stock increases with the time employed. A less marked decline is observed in the 100% category, but the proportion of each group that is 100% invested in company stock is still relatively less than the group of employees with zero to two years of work experience. Twenty-six percent of those with less than two years of experience invest their entire contribution to company stock compared to 22% of those with greater than 26 years of experience.

These findings are not consistent with loyalty and familiarity, but they are consistent with the prediction of the Degeorge, Jenter, Moel, and Tufano (2004) model. They use job tenure as a proxy for the firm specificity of an individual's human capital. These authors argue that an individual's firm-specific human capital grows with the time he is employed by a firm. As a result, the individual's need to diversify away from company stock increases with his job tenure.

The results show that the employee's company division also explains some variation in company stock holdings. One possible explanation is that the probability of earning stock-based compensation varies with divisions. For example,

a corporate division may have more employees eligible for stock-based compensation than a division mostly comprised of factory workers. Thus, the expected average allocation to company stock would be relatively lower in the corporate division compared to the other divisions. The occupation type may also provide information about the employee's education level beyond that obtained from salary information. It seems likely that a corporate division may be more heavily comprised of executives with college degrees, while a factory division may have a higher percentage of blue-collar workers with high school degrees. On the other hand, the division variables may also proxy for many other unobservables so care must be taken not to over interpret these results.

In this study, the predominant occupation does differ among divisions. A discussion with the benefits administrator indicates that the Corporate Division consists mainly of executives, while the employees of Division 1 and Division 2 tend to be factory workers. As predicted, Table 6 shows the Corporate Division has the lowest proportion of individuals investing their entire contribution in company stock and the highest proportion of individuals who invest nothing in company stock. These results support the theory that either the executives in the Corporate Division are limiting their company stock holdings to compensate for stock-based compensation or they are doing so because they have a relatively better understanding of the inherent risks of company stock investment. Another possible theory is that the factory workers are more loyal.

D. Econometric Analysis of Company Stock Holdings

The nonparametric evidence suggests that there are relations between the demographic variables and company stock holdings. This section will econometrically test for the joint effects of these factors on company stock allocations, and, in addition, it will control for the effects of past company stock performance.

Table 7 presents a two-limit censored regression model that tests the effects of the individual characteristics on company stock allocations.[12] Note, however, that the prevalence of company stock allocations clustered at 0%, 25%, 50%, 75%, and 100% makes it possible that the errors from the two-limit censored regression are not normally distributed. If this is true, the usual estimators based on the log-likelihood for this regression model are inconsistent (Greene (1997)). Therefore, as a robustness check, an ordered probit regression is also estimated using company stock allocations grouped into six categories (0%, 1%–25%, 26%–50%, 51%–75%, 76%–99%, and 100%). The ordered probit results support the findings from the two-limit censored regression model and are available from the author.

Two models are estimated, each with a different variable measuring compensation, and the results are reported in Table 7. Model 1 uses salary and Model 2 uses an indicator variable that equals one if the individual is considered a highly compensated individual and zero if not. The results suggest that men invest 3.0% more of their contributions to company stock than women, supporting the theory that men tend to make more risky asset allocation choices. Salary is also signif-

[12] Agnew, Balduzzi, and Sunden (2003) use this model to study the relation between demographic characteristics and equity allocations in one 401(k) plan.

TABLE 7

Two-Limit Censored Regression: Company Stock Allocations

Table 7 presents the results from a two-limit censored regression of company stock allocations (in decimals) against participant characteristics. Male is a dummy variable equal to one if the participant is male, zero otherwise. Salary is the annual 1997 salary (unit: $10,000). Age is the age of the participant at the time the allocation decision is made (unit: years). Time Employed equals the time the participant has been employed at the time the allocation decision is made (unit: years). Compensation Status is a dummy variable that equals one if the individual by law is considered highly compensated, otherwise it equals zero. Division # and Other Division are dummy variables that equal one if the participant is in the division. The Corporate Division is the omitted dummy. One-Year Co. Stock Return is the one year raw buy and hold return earned prior to the allocation decision. Robust standard errors, reported in parentheses, are adjusted for heteroskedasticity. **,* indicate significance at the 1% and 5% levels, respectively.

	Dependent Variable: Allocation to Company Stock (in decimals)	
Independent Variables	(1)	(2)
Constant	0.3057**	0.2275**
	(0.0856)	(0.0849)
Male	0.0299**	0.0225*
	(0.0109)	(0.0110)
Age	0.0010	−0.0023
	(0.0041)	(0.0040)
Age Squared	−0.0001	0.0000
	(0.0001)	(0.0001)
Time Employed	−0.0013	−0.0019*
	(0.0009)	(0.0009)
Salary	−0.0235**	
	(0.0023)	
Compensation Status		−0.1655**
		(0.0178)
Division 1	0.1074**	0.1668**
	(0.0402)	(0.0395)
Division 2	0.1968**	0.2590**
	(0.0402)	(0.0394)
Other Division	0.1182	0.1203
	(0.1109)	(0.1084)
One-Year Co. Stock Return	0.3987**	0.4001**
	(0.0856)	(0.0233)
Wald Test	647.97	663.33
p-Value	0.0000	0.0000
No. of Observations	22,979	22,979
Left Censored	5,684	5,684
Uncensored	11,951	11,951
Right Censored	5,344	5,344

icantly related to company stock holdings. The results suggest that for every additional $10,000 in compensation company stock holdings fall by approximately 2%. In this case, salary may be a proxy for financial education or the amount of stock-based compensation. The division of employment also has a significant role in company stock holdings. In Model 1 (2), relative to the Corporate Division, participants in Division 1 invest 11% (17%) more to company stock. Similarly, participants in Division 2 invest 20% (26%) more to company stock. The results support the hypothesis that either the executives in the Corporate Division are limiting their company stock holdings to compensate for stock-based compensation or they are limiting their company stock holdings because they have a relatively better understanding of the inherent risks in company stock investment. Interestingly, age and time employed are not significantly related to company stock

holdings in Model 1. Time employed has a very small negative influence on company stock holdings in Model 2.

Finally, the results support Benartzi's (2001) findings that past raw buy and hold returns are positively related to company stock holdings. He finds 10-year returns have the most significant influence, whereas I find short-term returns (one-year buy and hold returns) produce the most significant results (based on pseudo R^2s). I test returns over different periods ranging from one to 10 years. My results are supported by Sengmuller (2002) who finds two- to three-year returns are most closely related to company stock holdings. Most likely my ability to control for inertia by more precisely calculating the buy and hold returns for each individual causes the differences in results. Sengmuller (2002) also controls for inertia in his study.

In this analysis, the sample returns range from a minimum of negative 19% to a maximum of positive 78%. The average return is 28% with a standard deviation of 20%. The results of the regression predict that a one standard deviation increase in company stock returns will increase company stock holdings by 8.0%.[13] Interestingly, these results are contrary to what an optimal individual holding stock options would do in response to strong stock performance. An optimizing individual would reduce company stock holdings because the hedge ratios on awarded options increase with stock returns.[14]

VII. Plan Participation

Finally, the analysis turns to plan participation. Choosing not to participate in a 401(k) plan is the most obvious error an individual can make and is well researched in the literature. The literature shows a clear link between plan level and individual level characteristics. Munnell, Sunden, and Taylor (2001/2002) provide a summary of the findings and the behavioral explanations behind the results. Therefore, this section focuses primarily on how consistent my results are with previous findings and how they compare with the other results in this paper.

In this plan, of the 73,699 eligible participants in the total sample 39% made at least one contribution during the first two weeks of August 1998. This participation rate is low compared to other studies.[15] One reason might be that the definition of active participant in this study is fairly restrictive because it limits participants to those who made a contribution during the first two weeks of August 1998. Other studies use different definitions. For example, Clark and Schieber (1998) define an active participant as a person who makes at least one contribution in a single year.

At the individual level, the previous literature shows that salary, age, and time employed are related to participation. Low wage earners may be less likely

[13]These results are very close to Sengmuller's (2002) finding. He finds that after controlling for the effects of inertia, a positive one standard deviation change in one-year returns (22%) will result in an increase in company stock inflows of five percentage points by those considered "active changers."

[14]I thank the referee for making this point.

[15]For example, Clark and Schieber (1998) find that on average 73.5% of eligible employees participated in their 401(k) plans in their analysis of plan data from 19 firms with 700 to 10,000 employees. Similarly, Munnell, Sunden, and Taylor (2002) report a 72% mean participation rate among eligible employees using the 1998 Survey of Consumer Finances data.

to participate than high wage earners due to the greater liquidity constraints they bear, the reduced tax breaks they earn due to their lower tax brackets, and the higher replacement rates they earn from Social Security. The positive relation with age may be because people grow more interested in their retirement savings as time goes by. Finally, the positive relation between participation and time employed may be a result of individuals' vesting schedules increasing over time and their growing familiarity with the plan. For further discussion of why these characteristics might matter, see Munnell, Sunden, and Taylor (2001/2002).

To test whether a common factor exists that relates to the efficiency of all three choices and to examine whether participants in this study's plan behave similarly to participants in other plans, a probit regression of the participant's decision is modeled. Table 8 presents the findings. The findings are consistent with previous work and, most importantly, one characteristic, salary, is related to the efficiency of all three decisions (Tables 5, 7, and 8). In the participation regression, salary plays a large role. For example, compared to an average participant earning \$46,000, an average participant earning \$100,000 would be 37.7% more likely to participate. This same individual would be expected to hold 12.7% less in company stock and would be 3.0% less likely to follow the framing $1/n$ heuristic.

TABLE 8

Marginal Effects from a Probit Regression: 401(k) Participation Decision

Table 8 presents the marginal effects calculated from the results of a probit regression. The dependent variable equals one if the participant is an active participant in the plan and zero if not. Male is a dummy variable equal to one if the participant is male, zero otherwise. Salary is the annual 1997 salary (unit: \$10,000). Age is the age of the participant as of August 1998 (unit: years). The marginal effect takes into account a nonlinear effect of age. Time Employed equals the time the participant has been employed as of August 1998 (unit: years). Division # and Other are dummy variables that equal one if the participant is in the division. The Corporate Division is the omitted dummy. Robust standard errors, reported in parentheses, are adjusted for heteroskedasticity. The pseudo R^2 is the log-likelihood value on a scale from zero to one, where zero corresponds to the constant only model and one corresponds to perfect prediction (a log-likelihood of zero). **,* indicate significance at the 1% and 5% levels, respectively.

$$\text{The model : Prob(Y = 1)} = \Phi(\beta_0 + \beta_1\text{Male} + \beta_2\text{Age} + \beta_3\text{Age}^2 + \beta_4\text{Time Employed} + \beta_5\text{Salary} + \beta_6\text{Division 1} + \beta_7\text{Division 2} + \beta_8\text{Other})$$

Independent Variables	Participation (dF/dx)
Male[a]	−0.0398**
	(0.0047)
Age	0.0028**
	(0.0003)
Time Employed	0.0099**
	(0.0003)
Salary	0.0699**
	(0.0018)
Division 1[a]	−0.0036
	(0.0326)
Division 2[a]	0.0335
	(0.0324)
Other[a]	−0.3847**
	(0.0171)
No. of Observations	73,699
Pseudo R^2	0.1087

[a] dF/dx is for a discrete change of the dummy variable from zero to one.

In addition, gender plays a statistically significant role in two of the biases—participation and company stock allocations. In both cases, women make better choices, with women being 4% more likely to participate and expected to hold 2% or 3% less in company stock than men.

VIII. Conclusion

This paper examines the influence of individual characteristics on behavioral biases in 401(k) plan allocation decisions. With over 73,000 eligible participants, the database pertains to a single plan that consists of a diverse set of individuals who are presented with similar investment choices. The investment biases studied are the naïve $1/n$ heuristic and its variations, investment in company stock, and the decision not to participate in the plan.

The goal of this paper is to determine whether the propensities to follow biases vary across individuals and whether a common characteristic can be found. The 401(k) literature has already documented the importance of plan design, and this paper contributes to the literature by highlighting the importance of individual characteristics.

The principal finding suggests that higher salaried employees tend to make significantly better choices in all three cases. Women also appear to make better choices in two of the three cases, viz., 401(k) participation and investment in company stock. These findings highlight the need to control for individual heterogeneity in empirical work, and they indicate some directions for future research as well. For example, although several theories are presented in this paper to explain why gender and salary matter, additional work is needed to study these theories in detail. In particular, data on individual level financial literacy would be useful to understand the salary results. On a practical level, these results can help plan sponsors identify high risk individuals with a view toward improving plan design. The results may also be helpful in the current Social Security debate over personal accounts by providing demographic insights into investor behavior.

Finally, this research has implications beyond the 401(k) literature. For example, studies suggest that the empirical failures of the C-CAPM are a result of including non-market participants in the sample studied (see Brav, Constantinides, and Geczy (2002), Mankiw and Zeldes (1991), and Vissing-Jorgensen (2002)). This is because the C-CAPM, just like the I-CAPM, assumes that individuals participate in the markets. The theories also assume that individuals hold well-diversified portfolios. My study suggests that low salaried market participants are less likely to hold well-diversified portfolios because they tend to concentrate their assets in one security, namely, company stock. In addition, they are more likely to follow naïve diversification strategies, which generally will not result in a well-diversified portfolio. As a result, my findings suggest that a sample of higher income market participants is more likely to meet the diversification conditions established by the underlying C-CAPM and, thus, should perform better in an empirical analysis of the model.

References

Agnew, J.; P. Balduzzi; and A. Sunden. "Portfolio Choice and Trading in a Large 401(k) Plan." *American Economic Review,* 93 (2003), 193–215.

Barber, B. M., and T. Odean. "Boys Will Be Boys: Gender, Overconfidence, and Common Stock Investment." *Quarterly Journal of Economics,* 116 (2001), 261–292.

Benartzi, S. "Excessive Extrapolation and the Allocation of 401(k) Accounts to Company Stock." *Journal of Finance,* 56 (2001), 1747–1764.

Benartzi, S., and R. Thaler. "Naive Diversification Strategies in Retirement Saving Plans." *American Economic Review*, 91 (2001), 79–98.

Bettis, J. C.; J. Bizjak; and M. Lemmon. "Managerial Ownership, Incentive Contracting, and the Use of Zero-Cost Collars and Equity Swaps by Corporate Insiders." *Journal of Financial and Quantitative Analysis,* 36 (2001), 345–370.

Bodie, Z.; R. C. Merton; and W. F. Samuelson. "Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model." *Journal of Economic Dynamics and Control,* 16 (1992), 427–449.

Brav, A.; G. M. Constantinides; and C. C. Geczy. "Asset Pricing with Heterogeneous Consumers and Limited Participation: Empirical Evidence." *Journal of Political Economy,* 110 (2002), 793–824.

Choi, J. J.; D. Laibson; B. Madrian; and A. Metrick. "Defined Contribution Pensions: Plan Rules, Participant Decisions and the Path of Least Resistance." NBER Working Paper 8655 (2001).

Choi, J. J.; D. Laibson,; B. Madrian; and A. Metrick. "Employee Investment Decisions about Company Stock." In *Pension Design and Structure: New Lessons From Behavioral Finance,* O. S. Mitchell and S. Utkus, eds. New York, NY: Oxford University Press Inc. (2004).

Clark, R. L.; G. P. Goodfellow; S. J. Schieber; and D. Warwick. "Making the Most of 401(k) Plans: Who's Choosing What?" In *Forecasting Retirement Needs and Retirement Wealth*, O. Mitchell, P. B. Hammond, and A. M. Rappaport, eds. Philadelphia, PA: University of Pennsylvania Press (1999).

Clark, R. L., and S. Schieber. "Factors Affecting Participation Levels in 401(k) Plans." In *Living with Defined Contribution Plans,* O. S. Mitchell and S. J. Schieber, eds. Philadelphia, PA: University of Pennsylvania Press (1998).

Cohen, L. "Loyalty Based Portfolio Choice." Working Paper, University of Chicago (2004).

CPS. "Employee Tenure in the Mid-1990s." *CPS Publications*, January 30, 1997.

Degeorge, F.; D. Jenter; A. Moel; and P. Tufano. "Selling Company Shares to Reluctant Employees: France Telecom's Experience." *Journal of Financial Economics*, 71 (2004), 169–202.

Dwyer, P.; J. Gilkeson; and J. List. "Gender Differences in Revealed Risk Taking: Evidence from Mutual Fund Investors." *Economic Letters,* 76 (2002), 151–159.

Goodfellow, G. P., and S. J. Schieber. "Investment of Assets in Self-Directed Retirement Plans." In *Positioning Pensions for the Twenty-First Century,* M. S. Gordon, O. S. Mitchell, and M. M. Twinney, eds. Philadelphia, PA: University of Pennsylvania Press (1997).

Greene, W. H. *Econometric Analysis.* Upper Saddle River, NJ: Prentice-Hall, Inc. (1997).

Hewitt Associates LLC. *2003 Hewitt Universe Benchmarks—How Well Are Employees Saving and Investing in 401(k) Plans?* (2003).

Huberman, G. "Familiarity Breeds Investment." *Review of Financial Studies,* 14 (2001), 659–680.

Huberman, G., and W. Jiang. "Offering vs. Choice in 401(k) Plans: Equity Exposure and Number of Funds." *Journal of Finance,* 61 (2006), 763–801.

Jagannathan, R., and N. R. Kocherlakota. "Why Should Older People Invest Less in Stocks Than Younger People." *Quarterly Review* Federal Reserve of Minneapolis, Summer (1996), 11–23.

John Hancock Financial Services. *The Sixth Defined Contribution Plan Survey* (1999).

Liang, N., and S. Weisbenner. "Investor Behavior and Purchase of Company Stock in 401(k) Plans—The Importance of Plan Design." Working Paper, Board of Governors of the Federal Reserve System (2002).

Mankiw, G. N., and S. P. Zeldes. "The Consumption of Stockholders and Nonstockholders." *Journal of Financial Economics,* 29 (1991), 97–112.

Meulbroek, L. "Company Stock in Pension Plans: How Costly Is It?" Harvard Business School Working Paper 02-058 (2002).

Munnell, A. H.; A. Sunden; and C. Taylor. "What Determines 401(k) Participation and Contributions?" *Social Security Bulletin,* 64 (2001/2002), 64–75.

NASD Press Release. "NASD Warns Investors Too Much Company Stock Can Jeopardize Financial Future: Diversification is Key to Reducing Risk," February 17, 2005.

Ofek, E., and D. Yermack. "Taking Stock: Equity-Based Compensation and the Evolution of Managerial Ownership." *Journal of Finance,* 55 (2000), 1367–1384.

Poterba, J. M. "Lessons from Enron: Employer Stock and 401(k) Plans." *American Economic Review,* 93 (2003), 398–404.

Sengmuller, P. "Performance Predicts Asset Allocation: Company Stock in 401(k) Plans." Working Paper, Columbia University (2002).

Sunden, A. E., and B. J. Surette. "Gender Differences in the Allocation of Assets in Retirement Savings Plans." *American Economic Review,* 88 (1998), 207–211.

Thaler, R. H. "Mental Accounting Matters." *Journal of Behavioral Decision Making*, 12 (1999), 183–206.

Vissing-Jorgensen, A. "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution." *Journal of Political Economy*, 110 (2002), 825–853.