STAYING ON THE PATH TO A SECURE RETIREMENT:
USING THE ASSET-SALARY RATIO AS A RETIREMENT COMPASS

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ABSTRACT

The Asset-Salary Ratio (ASR) is a simple yet sophisticated metric that provides feedback on the likelihood a participant in a defined contribution plan system will have sufficient assets to generate adequate retirement income. Similar to the full-funding ratio of a defined benefit plan, the ASR provides an easily understandable measure for a participant to gauge whether she is "on-track" for accumulating sufficient retirement wealth. Applying this measure to a sample of TIAA-CREF participants, we find that, on average, participants had assets consistent with at least a 70 percent income replacement ratio; with this result holding across different ages, genders, and tenures. We find the largest factors for success, by orders of magnitude, are an adequate contribution rate and long tenure in the system. A portfolio weighted to equities is also beneficial but to a far lesser extent. We conclude that a goal of plan design should be to ensure adequate funding and early participation rather than creating incentives for participants to "chase returns". To this end, participant statements should include measures such as the ASR and retirement income projections in order for participants to make better, more informed choices.

INTRODUCTION

For better or worse, in the United States the defined contribution pension has become the dominant retirement plan model. Widespread adoption of this model has forced growth of individual responsibility for lifetime financial security and, with it, an explosion of tools with varying degrees of sophistication are now available to help individuals with managing their retirement savings, investment, and income risks. Assistance can range from expensive, highly customized advice to more inexpensive target-date maturity funds, automatic enrollment, and generic calculators, all in the service of encouraging appropriate retirement savings, asset allocation, rebalancing, and retirement income. The rationale is that if we can provide individuals with recommendations on how much to save and what to do with those savings, and *if they follow those recommendations*, then they will stand a better chance of creating an adequate income stream in retirement. In effect, they will be able to better manage their own retirement income risk.

The rise of the defined contribution pension has spawned a large research literature on the adequacy of retirement savings and ancillary questions. Given all of the tools, rules of thumb, and direct advice, we still have low confidence whether any of it actually 'works' in the sense of generating adequate retirement income. The consensus seems to be that individuals responsible for their own retirement security tend not to follow the 'rules' and expert recommendations. On average, they save too little, suffer from poor asset allocation and investment choices and, with notable exceptions (Scholz, Seshadri, and Khitatrakun 2006), most research suggests that they will end up with inadequate retirement income (perhaps further exacerbated by myopic choices about retirement savings withdrawal (Poterba, Venti, and Wise 1998, 2008; Poterba, Raugh, Venti, and Wise 2007).

So if the prevailing wisdom is correct, should we abandon the defined contribution model or is there a way to modify it up to make it effective for the increasing proportion of individuals who rely on it? Drawing on the rich 410k research experience, the 2006 Pension Protection Act included provisions for pension sponsors and providers to encourage participation (automatic enrollment) and diversify asset allocation (target-date maturity funds) for the purpose of increasing defined contribution nest eggs. A basic question is whether these legislative efforts are necessary or sufficient to enhance participant well-being in defined contribution savings plans? Theoretically, yes, if they result in a more secure retirement for the current generation of workers. However, in practice plan sponsors have significant latitude in the structure of plan design. It remains an open question if any defined contribution framework, with its multiple decision points, knowledge requirements, and now well-known participant behavioral tendencies, can help prepare households for an adequate and secure retirement. This chapter addresses this critical question in two ways:

1. What simple feedback can we provide so that an individual can estimate whether or not she is on target for generating adequate retirement income?

2. If it is possible to structure a program to promote retirement income adequacy while allowing for individual choice, where should we concentrate our efforts?

An adequacy feedback measure would need to be simple to gain widespread acceptance and usage. Fortunately, a simple measure called the Asset-Salary Ratio (ASR) provides a strong metric for gauging participant success. While the underlying algorithm for computing the ASR is sophisticated and similar to the full funding ratio for a defined benefit plan, the ASR is a single number that at any point in time allows the participant to measure savings adequacy against a set of benchmark numbers.

We use the ASR method to provide preliminary evidence of the adequacy of a defined contribution system. The preliminary evidence comes from an analysis of a new data set, which is a cross-sectional sample of TIAA-CREF participants containing individual contributions, asset allocations, accumulations, salaries, and other information for its defined contribution pension accounts. Applying the ASR to this data set, this chapter shows that certain individual decisions are particularly important in achieving adequate resources for generating adequate retirement income. These include, in order, contribution or savings rates, tenure or length of participation, and asset allocation. While the latter has

received considerable attention in the research literature and among practitioners, the first two elements are well known, but often ignored or avoided when considering defined contribution pension design.

THE ASSET-SALARY RATIO

How does Asset-Salary ratio (ASR) work? Using assumptions about future asset growth (returns), future contributions, and a retirement income goal (e.g., funding a guaranteed income stream), the ASR can be used to compare the ratio of assets to salary required to hit a target Income Replacement Ratio (IRR) with a participant's actual ASR at any point in time. Based on earlier work reported in Leibowitz et al (2002), the ASR reflects, but is not identical to, concepts and methods widely used to measure the overall funding status of a defined benefit pension plan, where, in concept,

(1)
$$FR_t = \frac{Assets_t}{PV\ Future\ Liabilities_t}\ X\ 100,$$

where the funding ratio (FR) at any point in time equals the plan assets divided by the present value (PV) of the plan's future liabilities. A defined pension plan's liabilities are essentially the sum of what it is obligated to pay individual participants over time in order to replace a certain percentage of their pre-retirement salaries or incomes.[1] For any individual participant, the IRR (the percentage of preretirement salary she will receive in retirement) will depend on length of service, size of pre-retirement salary or income, and a multiplication factor set by the plan. Theoretically, when $FR_t \geq 100$ the plan is considered well funded as long as the investment and actuarial assumptions that underlie it continue to be validated by subsequent experience. In contrast, when $FR_t < 100$, then the plan considered to be underfunded. The plan sponsor may be required to make contributions in order to bring the required level of assets up to match the estimate of discounted future liabilities. In other words, the funding ratio acts as a signal to the plan sponsor to indicate whether the plan is on track to meet its total defined obligations or whether circumstances have changed and action is needed. In this sense, funding ratio serves as an easily understandable metric for seeing if the plan is an efficient path for generating adequate retirement income for the participants.

In addition, the funding ratio has an inter-temporal dimension that reflects changes in current conditions, something that we can call "passage risk." For example, a pension plan is a long-horizon entity, so the risk of a long-term plan failure or shortfall ("outcome risk") should be of primary concern. But we may also be concerned about a sudden drop in market returns that temporarily (or not) lowers the funding ratio and whether it can recover. In this sense, the funding ratio can be used to examine how the plan fares or "passes" through time.

Similarly, our objective in creating the ASR is to incorporate a target based on a utility function and a "risk passage" assessment that is easy for an individual to understand. This is especially important in a defined contribution pension plan because, in the absence of the plan sponsor taking responsibility for funding adequacy, each defined contribution plan participant can be thought of as being their own plan sponsor and is therefore in charge of managing the risks associated with maintaining their own retirement solvency. The ASR can tell an individual, in the spirit of a defined benefit funding ratio, whether he or she is "on track" for achieving a personal retirement income goal.

Using the defined benefit funding ratio as a guide, the challenge for creating the ASR is on the implied liability portion rather than the known asset portion of the measure. The asset portion is fairly straightforward, since it is just the individual's current retirement assets. However, although we know that the defined contribution pension goal is to provide an income stream in retirement, a strictly analogous individual liability figure is not quite so transparent. Because the defined contribution plan sponsor does not make any pension income promises (unlike the defined benefit sponsor), what is that promise and how can we define it?

Creating a superior measure of liabilities would, perhaps, start with lifecycle consumption theory (Ando and Modigliani 1963; Browning and Crossley 2001) where household consumption is (or should be) smoothed across the working and retirement years. In actual fact, there are questions about how forward-looking households are or, if they are, to what

degree consumption smoothing is optimal (Bullard and Feigenbaum 2007). Nevertheless, inspired by the lifecycle concept, we can employ as a goal for retirement savings and investment the income replacement ratio (IRR), which is the proportion of preretirement income that an individual is able to replace through purchasing a guaranteed annuity at the time of retirement (Heller and King 1989, 1994). The IRR is, of course, closely related to the notion of a defined benefit funding ratio in that, for any individual at the point of retirement, retirement income is dependent on salary growth, investment returns, annuity purchase costs, contribution rates, and length of covered employment.

In higher education, calibrating an appropriate IRR objective might be done by reference to a long-standing joint statement by the American Association of University Professors and the American Association of Colleges that recommends educational institutions design pension plans to enable employees in higher education to replace about two-thirds of their pre-retirement, inflation-adjusted, annual salary through a combination of pension income, Social Security, and other personal savings (AAUP 1990). This is consistent with other research that suggests, based on consumption needs that retirees should, on average, aim to replace 70 to 80 percent of preretirement income (Reno and Lavery 2007). Thereby, a target IRR of 75 percent seems to be a reasonable objective.

Considering first the Social Security component, the actual Social Security IRR is inversely related to pre-retirement income. In 2007, for long-term labor-force participants, Social Security was calculated to replace about 40 percent of a $40,000 preretirement income, 35 percent of a $60,000 income, and about 20 percent of a $120,000 pre-retirement income (Reno and Lavery 2007). The latter amount is roughly representative of incomes for older higher education employees (The Faculty 2009). However, it should be noted that these replacement ratios are calculated based on individuals who are able to maximize their Social Security incomes. In practice, the accrual pattern for lifetime earnings in higher education tend to be skewed to later stages of working life, making actual Social Security IRRs for our sample fall between the latter two bounds.

Roughly speaking, then, we make a conservative assumption that Social Security will replace about 25 percent of pre-retirement income. If so, employer sponsored pensions and other household savings needs to be capable of generating a 50 percent IRR in order to meet the total 75 percent IRR standard. Of course, because of the Social Security effect, many low-income workers could choose a lower IRR target and very high-income workers would require a higher ratio to achieve an overall 75 percent replacement ratio. Individuals with substantial personal savings dedicated to retirement could use those savings to offset (reduce) the required pension plan IRR. For most Americans, however, most non-pension savings tends to be illiquid (housing) and is not a good source of income.

Assuming a 50 percent target replacement ratio for the employer pension, we can then solve for the other variables of importance – the contribution rate, years of service, investment earnings, and salary growth rates. Pulling these together, we have

$$(2) \qquad ASR_t = \frac{A_t}{S_t},$$

which says that the Asset -Salary Ratio (ASR) is the liability cost (assets) divided by an individual's annual salary (*S*) at *t* years before retirement (more precisely the individual's income over the last year). The ASR can be thought of in two ways: the existing ASR (for any individual, whatever it is now) or the ASR that would be *required* to achieve a target income replacement ratio. We can call this latter version the "Par" ASR.

How should we interpret or understand the ASR? First, the required or Par ASR is not constant. Because of the role of future contributions, the Par ASR must rise over time in order to arrive at the final ratio of assets to liabilities needed to fund the required retirement income. If there were no future contributions, then today's assets must be sufficiently large to fund a future guaranteed income that will replace the required portion of the future income. The prospect of future contributions, however, means that today's assets can be smaller by the amount of the discounted future value of those contributions and any earnings on those contributions. So the Par ASR will rise over time by the increase in contributions.

A more complete formal explanation can be found in Appendix A to this chapter.

In any event, if an individual knows his or her current or actual ASR and can roughly estimate the Par ASR ratio that would be *required* to fund retirement income years into the future, then he or she can see whether the current ratio

is adequate for retirement. Appendix A provides a detailed description of the mathematical relationships among the elements that make up the required Par ASR: the desired replacement ratio (IRR), pension contribution rate, investment rate of return on pension contributions, salary growth rate, investment rate of return on annuity assets, and the respective number of years remaining prior to and following retirement.

An individual who has an actual ASR equal to the required Par ASR is, other things being equal, "on track" for generating adequate retirement income. A person whose ASR is currently higher than the Par ASR now enjoys a *cushion* they can use to protect against unforeseen trends or events (larger-than-expected stock market declines, better-than-expected retiree life spans, etc.). However, a person who has an ASR lower than the required ratio may need to take corrective action (e.g., increase plan contributions, start other kinds of retirement savings, change investment strategies, moderate retirement plans, etc.) in an effort to increase assets and the ASR.

FIGURE 1: PERSONAL FUNDING RATIO

30-80% REPLACEMENT RATIOS
6% ASSET RETURNS, 25 YEAR ANNUITY @ 6%, 4% NORMAL SALARY GROWTH, 10% CONTRIBUTION
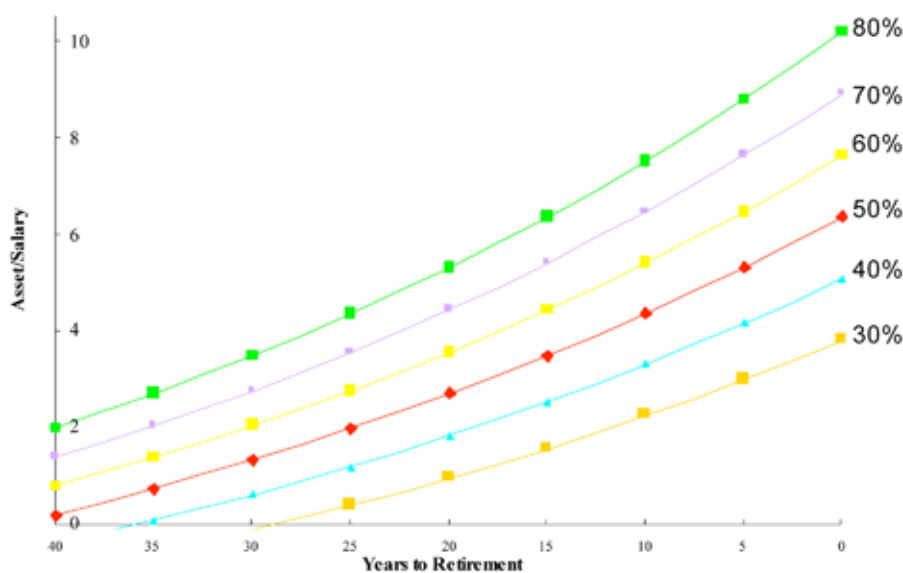
Based on funding a 25-year annuity at age 65 in 2007, as well as assumptions about salary growth and investment returns, Figure 1 illustrates the set of Par ASR curves for an individual who wishes to remain fully funded (at the target ASR) at each time or age through the date of retirement for different IRR targets.

Note that the Par ASR starts close to zero (early in the working career) and rises to about seven (at the retirement date). Over this period both income and assets are rising, but in order to adequately fund a retirement annuity, through a combination of contributions and returns, assets must grow faster than salary. This example is, of course, normative and hypothetical. The critical question is whether or not individuals actually achieve these ratios in practice.

THE ASR IN PRACTICE

Using the ASR approach, we examined the retirement savings adequacy of a subset of the TIAA-CREF participant population covered under institutional defined contribution plans in

2007. TIAA-CREF is principally a non-profit defined contribution retirement system owned by its 3.2 million individual participants. Like many other defined contribution providers, including 401(k) plans, it promotes plan structures of tax-deferred employer and employee contributions and diversified investments.

Unlike many 401(k) providers, TIAA-CREF also considers itself a true retirement system in that offers and encourages lifetime annuities, enables pension portability, and provides extensive financial education and advice. As of 2009, TIAA-CREF covered over 3.2 million participants in over 15 thousand retirement plans (primarily 403(b), 401(a), and 457(b)). Naturally, a system this large exhibits substantial variability along many dimensions, including retirement plan design, participant demographics, and participant decisions on contributions, asset allocation, and distribution options.

THE SAMPLE

From this system, we obtained asset, gender, tenure, and contribution rate information for a sample of about 77,000 employees at 71 institutions that vary by size, contribution rate, and control. By matching participants to the plan data, we were able to analyze participant choice relative to plan constraints, and to calculate variables such as salary and hence the ASR. Note that all participants in the sample are still contributing to a qualified TIAA-CREF retirement plan and, thus, are receiving income from an employer sponsoring a TIAA-CREF pension plan. In other words, none of the sample participants are fully retired.

The data have some significant limitations. Participants' wealth and income figures do not include assets and earnings outside of TIAA-CREF. This likely understates participants' total assets and income, especially for those current participants who participated in a pension plan outside of higher education and research institutions as well as those who have directed higher education retirement-related savings/contributions to other pension providers. In addition, these data include primary pension plans – some of which have voluntary features – as well as supplemental plans – all of which are voluntary. Participant account balances can include assets from multiple accounts that may represent jobs at many different institutions, each of which has different required and voluntary contribution rates. For example, measured contribution rates are only for the current employer. Fortunately, because we have access to individual plan document information we were able to reconstruct actual individual contribution rates – including employer match and voluntary plan rates. Table 1 provides some descriptive statistics for our sample population.

The average age of participants in the unrestricted sample is 48, with average tenure (i.e., number of years employed) of about 12.3 years. The sample is comprised of about 51 percent males, 44 percent females, and 5 percent unknown. Estimated average salary is around $72,100 and average retirement assets are about $307,000. The average actual ASR was about 2.9. Participants have several contribution sources for their respective retirement plans, including employer and/or employee (participant) contributions to a Retirement Annuity (RA) or a Supplemental Retirement Annuity (SRA). Employer contributions averaged about $6,550 to an RA and about $2,900 to an SRA. Participant contributions averaged about $2,800 and $2,300 to the RA and SRA respectively. Total contributions averaged about $11,900, with an average contribution rate of about 16.9 percent of salary.

TABLE 1: SAMPLE STATISTICS

VARIABLE	UNRESTRICTED			RESTRICTED		
	N	AVERAGE	ST DEV	N	AVERAGE	ST DEV
Gender	72,067			68,373		
Male	36,372			36,354		
Female	32,041			32,019		
Undefined	3,654			0		
Age		48.1	11.0		48.6	10.8
Tenure		12.2	9.2		12.8	9.0
Estimated salary		72,107	49,757.0		73,158	49,992
Total assets		306,577	381,406.0		321,989	385,227
Asset-Salary ratio		2.9	42.8		2.8	10.3
Total Contributions		11,854	10,003		12,178	10,111
RA Contributions						
Employer		6,547	4,640		6,836	4,570
Employee		2,821	4,368		2,951	4,443
SRA Contributions						
Employer		45	1,205		48	1,237
Employee		2,260	5,455		2,372	5,570
Contribution percent		16.9%	44%		16.9%	14.1%

Source: Author calculations

We encountered several issues with the unrestricted base sample. First, the sample contains a nontrivial percentage of participants with undefined gender. We excluded these observations because we are interested in understanding the relationship between gender and the ASR. Second, a handful of participants enjoy relatively high asset levels but very low levels of estimated salary, possibly because they are mostly, but not fully, retired. This combination can result in an ASR that is unreasonable high, so we further restricted our sample to exclude observations where the participant's salary is less than $5,000. Third, a handful of observations have negative values for contributions (due to recordkeeping corrections), so we excluded those, too.

The second set of columns in Table 1 display descriptive statistics of our restricted sample of 68,373 participants. The resulting sample is slightly older, higher income, and wealthier, but not significantly so, while the measure of the ASR is significantly improved (reduced dispersion) relative to the unrestricted sample. As noted in Leibowitz et al (2002), a number of factors affect the hypothetical ASR for a participant, including contributions, asset returns, age, tenure (again, number of years employed), and gender.

AVERAGE ASR AND KEY CHARACTERISTICS

We use a simple first-order analysis of the sample data to begin our analysis of the relationship between the ASR and various sample population characteristics.

Age. Table 2 shows average ASR by age cohort. As expected, contributions and income both rise with age, since plan rules set contributions as a percentage of income. Also, average ASR rises with age, suggesting the decision to delay retirement may have a strong effect on the ASR.

TABLE 2: FREQUENCY DISTRIBUTIONS BY AGE-GROUPS

AGE	N	AVERAGE CONTRIBUTIONS	AVERAGE ASSETS	AVERAGE TENURE	AVERAGE SALARY	AVERAGE ASR
Under 25	320	3,999	6,562	1.8	29,922	0.2
25-34	7,877	6,796	26,506	4.1	48,431	0.6
35-44	17,590	9,791	77,011	8.0	64,625	1.3
45-54	21,589	12,356	180,402	13.2	75,259	2.5
55-64	17,087	15,414	371,162	18.7	85,515	4.5
65-74	3,613	19,096	765,318	25.2	98,842	8.7
75-84	291	21,767	1,216,903	31.5	103,715	18.8
over 85	6	14,614	1,198,079	21.7	66,636	13.5

Source: Author calculations

Figure 2 provides additional information on average ASR by age cohort. It shows the actual average ASR for the total sample along with required Par ASRs for the 50 percent and 70 percent target IRRs (Par ASRs are similar to those in Figure 1, but have been arrayed by age rather than years to retirement).

**FIGURE 2: AVERAGE ASSET-SALARY RATIO BY AGE-2007**
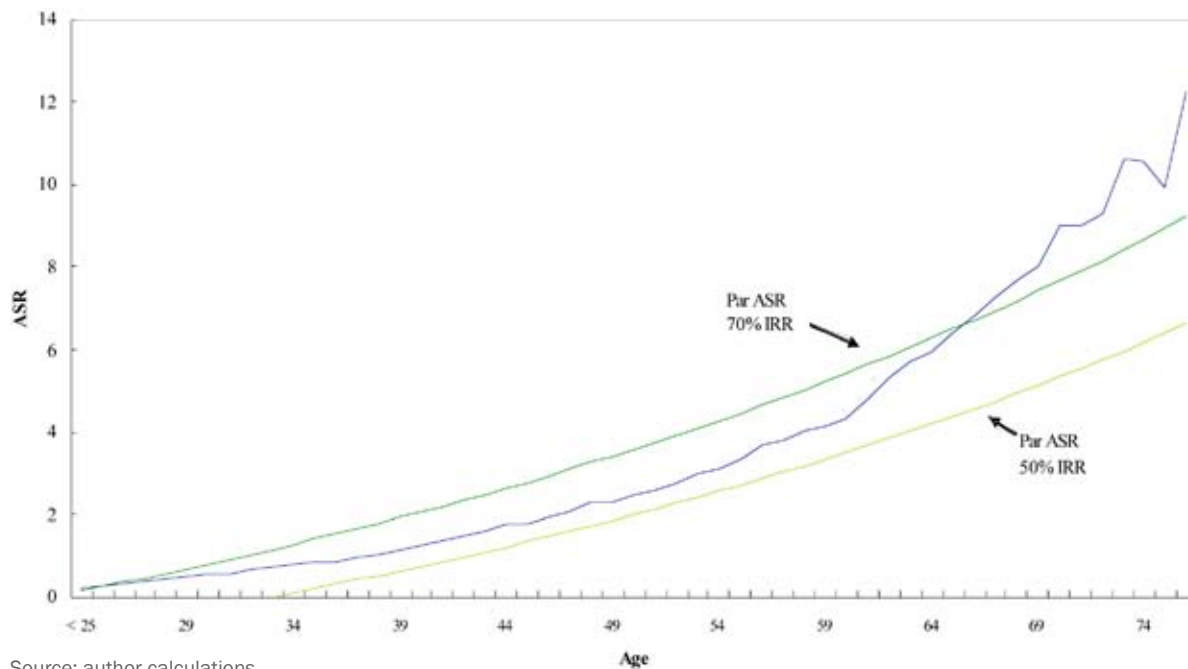
Source: author calculations

The entire average ASR curve lies entirely above the 50 percent Par ASR curve, suggesting that at the end of 2007 this sample population was in excess of being on-track for replacing more than 50 percent of their preretirement income. Older participants are doing even better in providing a cushion for unexpected portfolio shocks. For those age 61 and above the actual ASR rises rapidly until for those above age 65 it is consistently above the 70 percent Par ASR.

Age and Gender. Figure 3 splits the ASR by age and gender. For younger participants, there is no significant difference between males' and females' ASR.

**FIGURE 3: AVERAGE ASSET-SALARY RATIO BY AGE AND GENDER-2007**
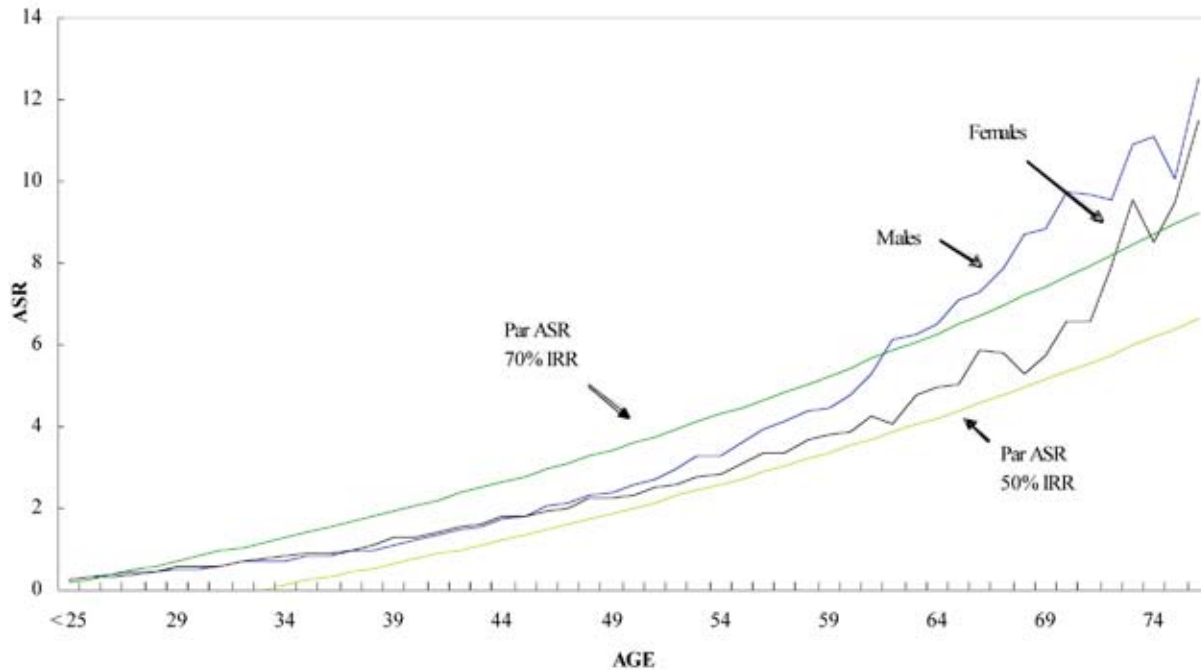
Source: author calculations

Average ASRs are approximately equal for younger cohorts, but begin to diverge for the baby boomers (those in their mid-to-late 40s or older). For the oldest baby boomers, females are significantly below males, with ASRs averaging about 75 percent of those for male counterparts. The gap increases substantially for the next cohorts, with females in the oldest cohort having ASRs of approximately half their male counterparts. However, older female ASRs are still in the range consistent with adequate financial resources.

We should note significant gender differences in our sample population as well as in higher education as a whole. For the baby boomers, females in higher education are skewed toward lower paying administrative jobs, while females in the younger cohorts are, on average, more likely than those in the older cohorts to be found in the higher paying faculty and managerial administrator ranks.

Tenure. For our sample, years of tenure is defined as years of participation in the TIAA-CREF system. Tenure is not identical with age since it need not be continuous. Rather, participants with the same tenure have the same number of years of active participation in a TIAA-CREF plan. As expected, participants with longer tenure have substantially higher ASRs, as illustrated in Figure 4, which shows ASR by tenure.

**FIGURE 4: AVERAGE ASSET-SALARY RATIO BY TENURE-2007**
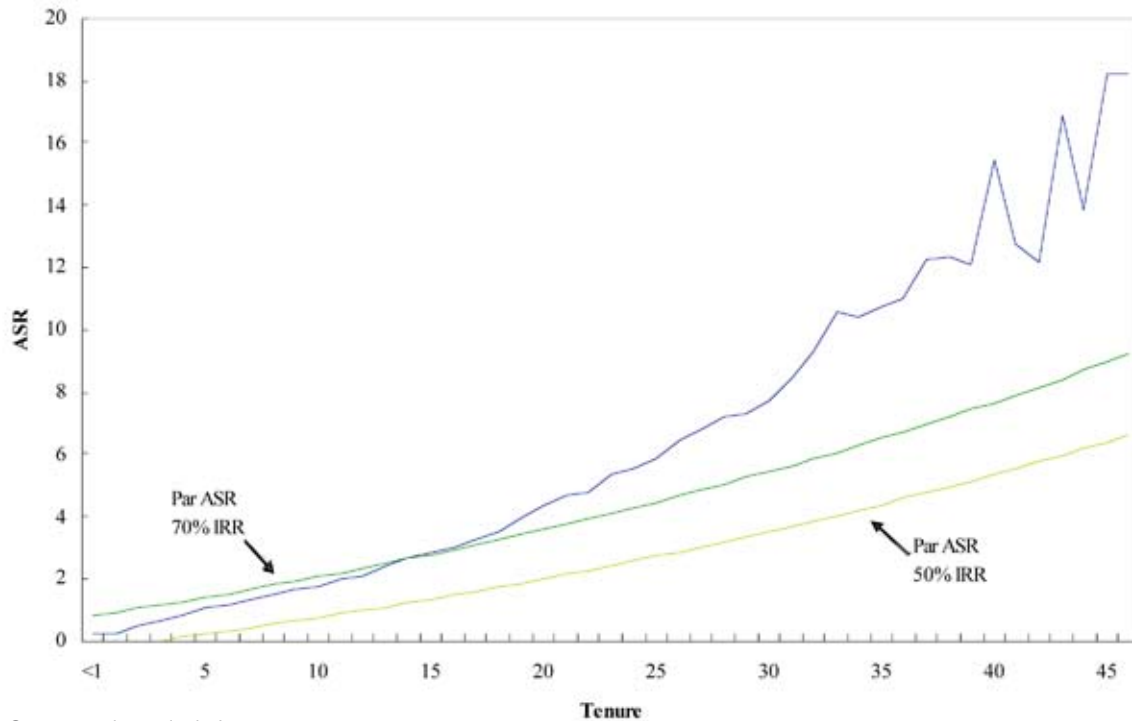
Source: author calculations

On average, all participants enjoy ASRs capable of funding an IRR of 50 percent or more. Strikingly, for those with tenure of 15 years or more, the ASRs rise above the 70 percent Par ASR curve, reaching ASRs of 10 or more for those with at least 32 years service.

Tenure and Gender. Figure 5 provides additional information by tenure and gender. Unlike the age-gender relationship, this figure shows differences across gender for participants who have the same total participation.

FIGURE 5: AVERAGE ASSET-SALARY RATIO BY TENURE AND GENDER-2007
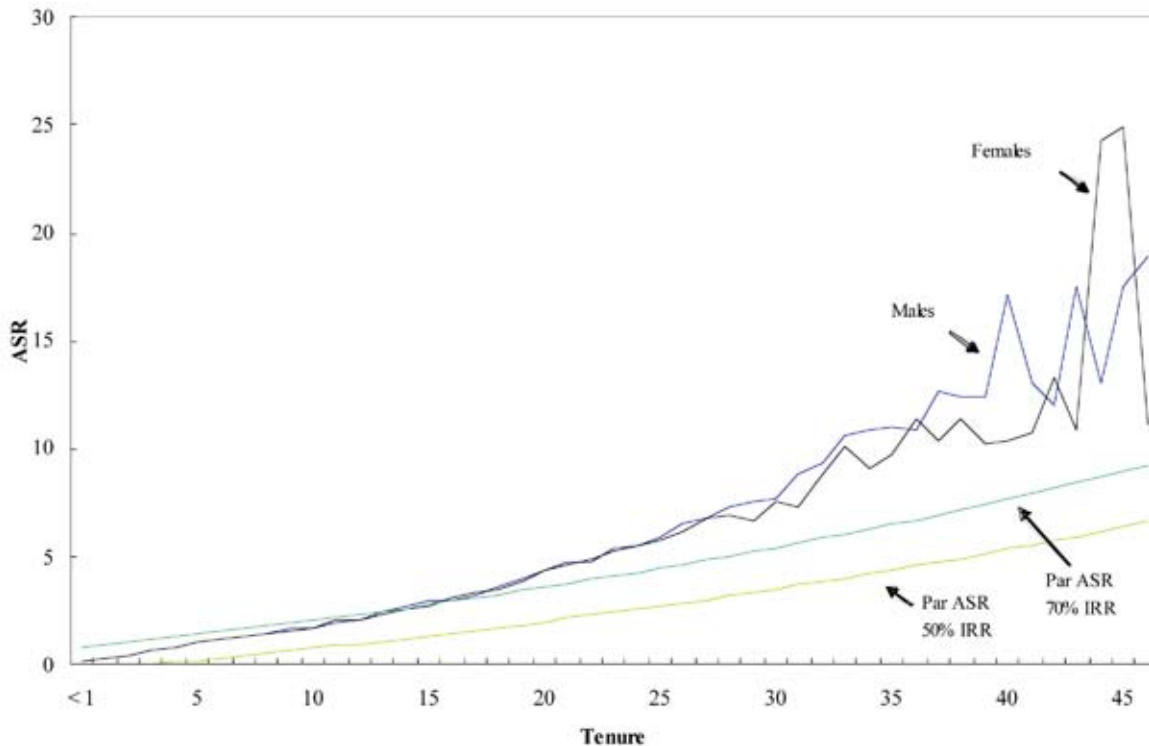
Source: author calculations

Like the age-gender results, males and females with less tenure have, on average, similar ASRs. However, comparing Figures 5 and 3, for older cohorts the tenure-gender divergence is far less distinct than the age-gender divergence. While ASRs for males with at least 27 years of participation are modestly higher than their female counterparts, a sharp and persistent tenure-gender distinction only emerges for cohorts with more than about 36 years of participation.

While these similarities and distinctions are intriguing, any inferences involving tenure require careful consideration. For example, a 65 year-old with 40 years of tenure has spent her entire career at institutions where TIAA-CREF is a provider. A person similar in every other aspect (particularly age) but with only 20 years of tenure in TIAA-CREF may have lower assets in the TIAA-CREF system, but she might have the same, more, or less total retirement assets from working in higher education or another job. In addition, some participants may roll-over assets from other plans while others leave them with the original plan. Consequently, we must be very cautious about inferences drawn using tenure data. Later on, we will turn to multivariate analysis of the ASR, which will allow us to examine the significance of tenure effects relative to other factors, such as age.

In the interim, we speculate cautiously about the relatively smaller tenure-gender effect compared to the age-gender effect. Women and men with similar tenures have had similar opportunities to save and invest in the TIAA-CREF system. In contrast, women and men of similar ages may not. Women, particularly older women, are more likely than men to have spent time out of the higher education labor force due to family reasons. While this may explain the difference between age and tenure effects, what isn't explained is why long-tenure women and men diverge at all. Perhaps, for example, long-tenure women are less likely to feel the pressure to maximize their contributions to the retirement plan.

Salary. Table 3 presents information on average ASRs by salary. As expected, average ASRs rise with salary, though less sharply than by either age or tenure.

TABLE 3: FREQUENCY DISTRIBUTIONS BY SALARY

SALARY	N	AVERAGE AGE	AVERAGE CONTRIBUTIONS	AVERAGE ASSETS	AVERAGE TENURE	AVERAGE ASR
Less than $40,000	15,473	45	4,738	62,202	8.9	2.8
$40,000-$59,999	17,158	46	8,183	107,742	10.5	2.1
$60,000-$79,999	13,974	49	11,625	183,766	13.0	2.6
$80,000-$99,999	8,663	52	15,395	304,534	15.9	3.4
$100,000-$119,999	4,741	53	18,851	401,485	17.5	3.7
More than $120,000	8,364	55	27,937	598,758	18.9	3.6

Source: Author calculations

One possible reason for this result is salary compression of faculty salaries, with younger faculty members increasingly receiving starting salaries close to (or on occasion in excess) of their older tenured colleagues. This effect is suggested by the tight grouping of average age and average tenure with the various salary bands. While average ASR rises slowly with salary, the effect is does not appear to be very strong.

Contribution Rates. The next two exhibits focus on average ASR by contribution rates. Figure 6 presents information on average ASR by total contribution rate. We define the total contribution rate as the sum of all employer and employee contributions divided by salary. Unsurprisingly, we find that average ASR rises strongly with total contribution rates, increasing more than five times between the lowest and highest savers. Even between the top two saving groups, the average ASR is 75 percent higher for the highest savers relative to the next group.

FIGURE 6: AVERAGE ASSET-SALARY RATIO BY CONTRIBUTION RATE-2007
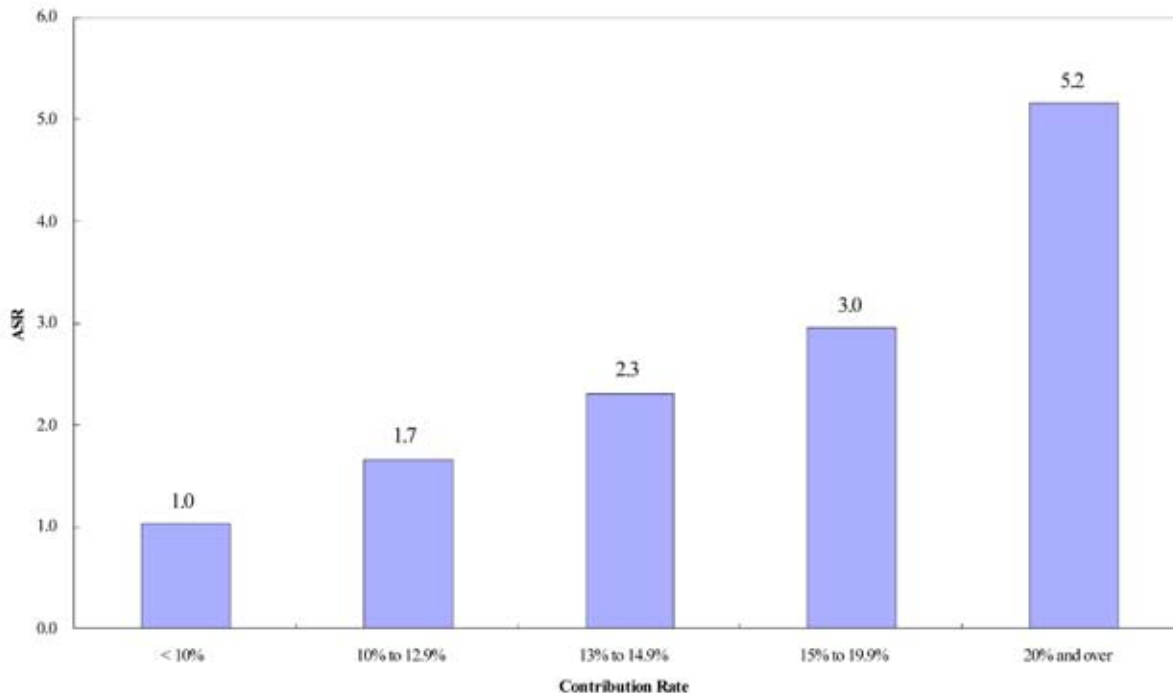
Source: author calculations

Figure 7 decomposes contributions by the basic Retirement Annuity (RA) and the Supplemental Retirement Annuity (SRA). RAs are individual contracts that are part of each institution's basic contributory or noncontributory qualified employer-based pension plan. SRAs are voluntary tax-deferred savings plans that may or may not involve an employer match. SRAs can be considered as similar to a 401(k) plan when it is used as a supplement to a basic employer retirement plan. For both the RA and the SRA, the contribution rate is defined as the sum of employer and employee contribution relative to salary.

FIGURE 7: AVERAGE ASSET-SALARY RATIO BY CONTRIBUTION RATE AND PLAN TYPE-2007
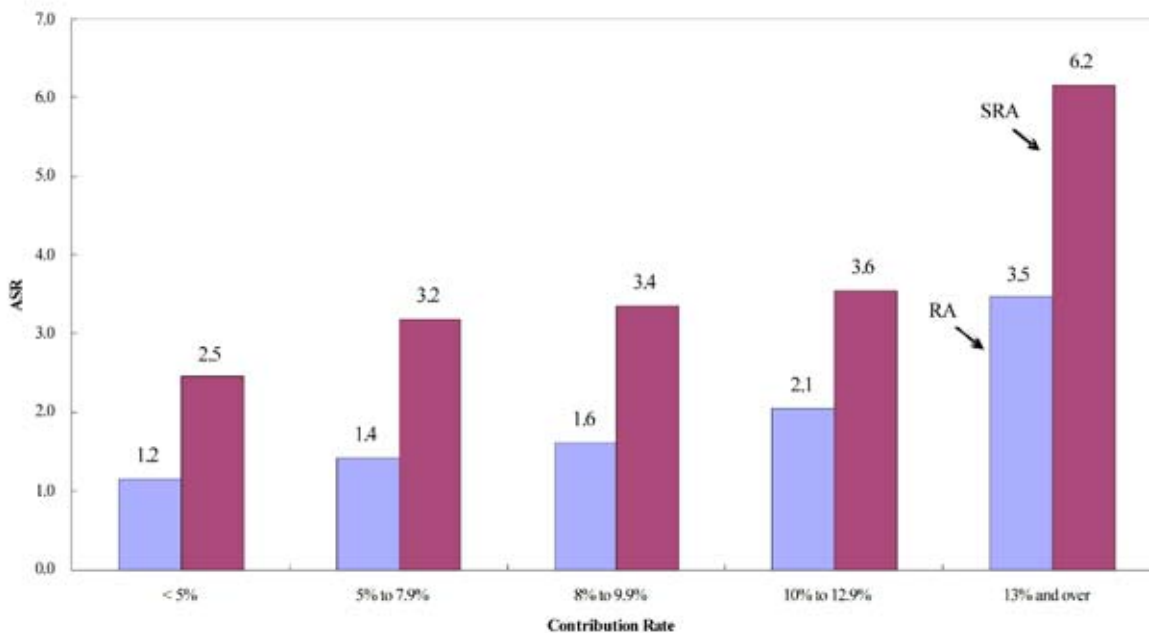
Source: author calculations

As with overall contributions, the ASR for RAs and SRAs rise dramatically with contribution rates. The SRA effect is particularly striking. At every rate, contributions to the SRA have a greater effect on average ASR than comparable RA contributions. This is likely due to the SRA's role as a supplementary plan, where SRA participation is almost always conditional on prior or concurrent participation in the basic RA plan.

To sum, different cuts of the data supports the hypothesis that in 2007 the average TIAA-CREF participant was "on track" for having sufficient assets to fund a 50 percent IRR. This seems to be hold for participants of all ages but, at older ages, men seem to have more of a cushion for unexpected shock relative to women. Several other factors appear to be correlated with retirement savings adequacy, including contribution rates, age, tenure, and, to a lesser extent, salary.

RETIREMENT FUNDING ADEQUACY IN ONE PENSION SYSTEM

The results of the previous section indicate that some factors, such as contribution rates, age, tenure, and gender, appear positively correlated with average ASRs. In this section we analyze the influence of these and other variables on participants' ASRs. We do this in two ways, first by exploring what factors may be most important in determining absolute variations in the ASR and second by examining what factors may determine deviations from the Par ASR curves.

For the analysis of absolute ASR, we employed ordinary least squares regression for which we defined the dependent variable as the natural log of the ASR (*lnASR*). As mentioned previously, we did not use any cases where gender could not be identified and reported contributions were negative. Beyond this, we used the entire sample as well as eliminating cases where it appeared that the ASR measures were extreme. For example, we eliminated all cases where the ASR was over 50 on the grounds that there might be measurement errors or temporarily low incomes reported in our sample snapshot. In the end, results improved slightly over analyses that included such data, but it did fundamentally alter overall conclusions.

Finally we restrict the sample to exclude individuals over the age of 75 and under the age of 25. The resulting sample has 67,324 observations.

For independent variables, we hypothesized that variations among individual ASRs in our cross section of TIAA-CREF participants might be explained by *age* (and *age squared*), *tenure* (and *tenure squared*), gender (*dFemale*), the natural log of the total contribution rate relative to salary (*ln TCpercent*), the natural logs of the proportion of assets held in equity (*ln Eq percent*), and the TIAA traditional account (*ln TIAA percent*), dummy variables for participant contributions to a Retirement Annuity (*dRAemployee*), or Supplemental Retirement Annuity (*dSRAemployee*), and interacted dummy variables of female with tenure (*tenure*dFemale*), and age with SRA contributions (*age*dSRAemployee*). Because of zero values for some percentages, only 48,778 observations are used in the final regression.

One of the strongest findings from the vast literature on asset allocation is that differences in portfolio returns are overwhelmingly determined by differences in portfolio allocations among major asset classes (Brinson, Beebower, Singer 1986). So it is possible that differences in the ASR could be explained by differences in asset allocation among TIAA-CREF participants. To explore this question, we used both the percent of total portfolio invested in equity (*lnEqpercent*) and the percent of total portfolio invested in the TIAA Traditional Annuity (*lnTIAApercent*), which is backed by a broadly diversified portfolio of fixed-income assets. These variables leave out allocations to bond funds and accounts as well to direct real estate. However, as a first pass, bonds and real estate comprise a small portion of most participants' portfolios.

In addition to asset allocation, we explore whether the ASR might be affected by employees' RA and SRA contributions separate from employer contributions. In many cases, and universally so for the SRA, employee contributions are dependent on an individual participant's decision about how much to save out of salary. Employee contributions are also constrained by IRS limits and affected by employer matching, but in the case of the RA can be voluntary and in the case of the SRA are completely voluntary. In essence, we are interested in seeing if different types of contributions are correlated with a greater likelihood of being on track for a secure retirement.

Table 4 reports the results of our regression of variations in the ASR on nine potential explanatory factors. Overall, this formulation explained about 82 percent of the variance observed in our sample of individual ASRs. All of the independent variables, except age squared and *ln (TIAA percent)* are significant at the 99 percent level, and the latter is significant at the 95 percent level. The estimated elasticities for most variables are relatively small, partly reflecting the fact that the ASR for the restricted sample averages 2.8 with a standard deviation of about 10 (see Table 1).

TABLE 4: OLS ANALYSIS OF ASSET-SALARY RATIO

DEPENDENT VARIABLE: ln (ASSET-SALARY RATIO)   lnASR

Root MSE		0.4417	R-Square	0.8251
Dependent Mean		0.5996	Adj R-Sq	0.8251
Coeff Var		73.6691		

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	t VALUE	Pr > |t|
Intercept	-0.158	0.044	-3.59	0.0003
Age	0.012	0.002	6.48	<.0001
Age squared	0.000	0.000	-0.65	0.5153
Tenure	0.153	0.001	161.31	<.0001
Tenure squared	-0.002	0.000	-81.12	<.0001
dFemale	0.031	0.008	4.15	<.0001
ln (TC percent)	0.748	0.005	142.36	<.0001
ln (Eq percent)	0.051	0.003	16.55	<.0001
ln (TIAA percent)	0.007	0.002	2.79	0.0052
dRAemployee	0.076	0.005	15.97	<.0001
dSRAemployee	0.254	0.022	11.49	<.0001
tenure*dFemale	-0.003	0.000	-6.89	<.0001
age*dSRemployee	-0.006	0.000	-14.83	<.0001

Source: Author calculations

Contribution Rates. For our sample, variations in current total contribution rate (*lnTCper*) had by far the largest effect on the ASR. For younger cohorts of participants, a larger contribution rate should naturally result in a higher ASR, cet. par. For older cohorts, the interaction of lifetime contribution rates and rates of return become important. In both cases, it seems that a higher current contribution rate is consistent with higher lifetime contribution rates and hence a higher ASR. When we separate out employee contributions, both basic pension plan RA contributions (*dRAemployee*) and voluntary supplemental contributions (*dSRAemployee*) have a positive effect. As expected, SRA contributions, which typically signal super-saving behavior, have a much larger impact relative to RA contributions. As expected, SRA contributions, which typically signal super-saving behavior, have a much larger impact relative to RA contributions. The exception to this is for older SRA contributors. Examining the interaction between age and SRA contributions, we believe that the negative relationship is explained by "catch-up" contributions. We believe that older participants with low ASRs are recognizing that they are behind target and are more likely to maximize the RA contributions and to also contribute to their SRAs in an attempt to catch-up to others in their age cohort.

Tenure. In addition to contribution rates, *tenure* has a relatively large effect on the ASR. Going from zero to ten years of participation increases ASR by about 1.3, with the tenure effect reaching a maximum at about 38 years of service. The main conclusion is that participating for a long time in an institution's plan is a good way of producing a healthy retirement nest egg. As with DB plans, however, there is a length of tenure where retirement is financially rational. Interestingly, the effect on the ASR of being female (*dFemale*) is less than expected. In our univariate analysis we saw that younger, shorter-tenured females had slightly higher ASRs then their male counterparts, while older, longer-tenured females at the oldest ages had lower ASRs than comparable males, on average. Our multivariate analysis shows the effect of being female as small and positive. However, the interaction of tenure with the female dummy results in a small but negative effect. Recalling that tenure is years of participation in the system but not necessarily contributing years, then we believe these

effects highlight the increased probability that females will have work stoppages in their careers. As a result, their lifetime contribution rates will tend to be lower, resulting in a lower ASR.

Asset Allocation. Asset allocation also seems to play a significant role in the size of the ASR, but it is confined to equities (*lnEqper*), where the effect is larger and highly significant, rather than TIAA Traditional (*lnTIAAper*), where it is relatively small and only marginally significant. Increasing the proportion of equities increases the ASR. The main conclusion is that a portfolio heavily weighted to equities helps a little towards being on track for adequate retirement income. Whether or not this cross-sectional effect holds up over time is uncertain and the subject of future research.

In sum, individual participants who participate longer, save more, and allocate more to equities enjoy higher ASRs than those who don't. These findings are relatively unsurprising and do more to confirm our beliefs than to change them. It is interesting that this simple formulation explains over 80 percent of the variation in the ASR among our sample of TIAA-CREF participants. Our research agenda includes being able to make further improvements to this analysis by looking at longitudinal data with lagged variables.

TRACKING THE PAR ASR

The final step in our analysis is to examine not what explains the level of the ASR, but rather what could explain positive and negative deviations from the Par ASR, which can be thought of as the "on-track" or "target" Par ASR. For this exercise we reformulate the dependent variable as a kind of tracking error around the Par ASR. In other words, what factors might explain the likelihood that a participant moves from one ASR path to the next?

To operationalize the dependent variable, we define ASRs over five threshold ranges: participants with an ASR greater than or equal to 80 percent, from 70 percent to less than 80 percent, from 60 percent to less than 70 percent, from 50 percent to less than 60 percent, and less than 50 percent. As before, the sample is restricted to participants aged 25 to 75, resulting in a sample of 67, 324 total and 48,788 usable observations.

Table 5 presents the results of the ordered probit regression with the ordered target PAR ASRs (*TASR*) as the dependent variable and the same independent variables used in the OLS regression. For this regression, all variables are highly significant and all but age have

TABLE 5: ORDERED PROBIT ANALYSIS OF THRESHOLD ASSET-SALARY RARIOS

DEPENDENT VARIABLE: THRESHOLD ASR

Log likelihood	-50,951			
VARIABLE	**PARAMETER ESTIMATE**	**STANDARD ERROR**	**Chi-Square**	**Pr > ChiSq**
Intercept	11.092	0.131	7,202.3	<.0001
Intercept 2	0.629	0.008	6,187.0	<.0001
Intercept 3	1.480	0.011	19,365.9	<.0001
Intercept 4	2.522	0.013	37,857.4	<.0001
Age	-0.411	0.006	5,513.5	<.0001
Age squared	0.003	0.000	2,455.9	<.0001
Tenure	0.286	0.003	7,826.1	<.0001
Tenure squared	-0.002	0.000	850.4	<.0001
dFemale	0.091	0.022	17.4	<.0001
ln (TC percent)	1.658	0.017	9,909.0	<.0001
ln (Eq percent)	0.156	0.008	347.3	<.0001
ln (TIAA percent)	0.038	0.006	37.1	<.0001
dRAemployee	0.180	0.013	189.9	<.0001
dSRAemployee	0.290	0.057	25.7	<.0001
tenure*dFemale	-0.009	0.001	42.6	<.0001
age*dSRAemployee	-0.008	0.001	49.2	<.0001

Source: Author calculations

coefficients with similar magnitudes and signs. As before, contribution rates and tenure have the largest effect on a participant's likelihood of moving up into the next highest ASR threshold. The overall contribution rate has the largest effect, with employee contributions to an RA or SRA increasing the probability that a participant will reach the higher threshold. As with the OLS regression, the exception is for the interaction of SRA with age, suggesting that older participants making SRA contributions are playing catch-up with their retirement savings.

The most significant difference between the OLS and probit analyses is that the *Age* coefficient is negative. Closer analysis of age and threshold reveals what may be life-cycle consumption effects for many participants because the proportion of individuals in the lower ASR thresholds starts low for young cohorts, rises for middle-aged cohorts, and then falls for older cohorts. We believe this may be attributable to many large purchases in the early middle-age part of a participant's life-cycle, such as student loan debt, child rearing, and home purchases that do not persist into late middle-age but may crowd out retirement saving.

Tenure increases the probability that a participant crosses into the next higher threshold. As before, the interaction of female and tenure suggests that longer tenured females are less likely to cross into higher thresholds. Given the importance of contributions, the results suggest that longer tenure women may not contribute at the same rate as men over time. As before, the asset allocation mix is important, with higher equity percents increasing the likelihood of achieving the next threshold. Likewise, the TIAA percent is also significant, slightly increasing the likelihood of reaching the next threshold.

The analysis indicates that participants with higher contribution rates and longer participation in the system are more likely to achieve higher ASR thresholds. The exception to this is longer tenured females. Employee contributions to an RA and SRA increase the probability of being in a higher threshold, with younger participants making SRA contributions have relatively greater likelihood than older SRA contributors of moving to a higher Par ASR. While higher equity proportions increase the likelihood of crossing a threshold, the overall effect of asset allocation is positive, but surprisingly small relative to the effect of contributions and tenure. The main implication is that chasing returns is no substitute for adequately funding a retirement plan over time.

CONCLUSIONS AND EXTENSIONS

Given the risks to individuals inherent in defined contribution pensions – in contrast with the more collective nature of risk in defined benefit pensions – it is important to understand how well individuals are faring in these plans. In other words, if individuals are responsible for managing their retirement savings, investments, and income, are they succeeding in creating the conditions for future financial security? To what extent are individuals managing their savings to produce an "adequate" retirement income?

Applying the simple yet sophisticated concept of the Asset-Salary Ratio (ASR) to a cross-sectional sample of participant assets, estimated salaries, and other data from TIAA-CREF, this chapter has spotlighted the determinants of retirement savings adequacy in a large defined contribution pension system. We found that, on average, individual TIAA-CREF participants of all ages, tenures, and genders are "on-track" for funding a fixed retirement annuity that, with Social Security, would replace at least 70 percent of pre-retirement income. In many cases, the ASR is consistent with providing a far higher IRR or effectively providing a significant cushion against economic shocks.

Having said that, our sample cross section was taken from the end of 2007, when equity markets were near all-time highs and many other assets, including bonds, real estate, and other alternatives were providing solid returns. Since that time, many asset markets have fallen and some, such as the equity markets, dropped about 55 percent (November, 2007, to March, 2009). By the end of February 2009, total aggregate TIAA-CREF assets had lost roughly 17 percent of their value (equity losses were tempered by investments in a guaranteed account, bonds, commercial real estate). If the average sample participant lost 17% after the end of 2007, then their ASR would have declined by the similar proportion. To take a simple snapshot, the average TIAA-CREF sample participant with 30 years tenure had at the end of 2007 an ASR of 8, consistent with a Par ASR for over 100 percent IRR. A 17 percent decline in assets would leave that hypothetical participant with an ASR of over 6.6, still well above the 70 percent ASR. Of course, this is merely indicative and speculative. A more valid test would be to obtain sample ASR data for the end of 2008 to see what actually happened to TIAA-CREF participants.

Returning to the actual sample ASRs and what might explain any success in achieving or exceeding the Par ASRs, we found that the biggest factors to success were contribution rates (as a percentage of salary), how many years an individual contributes and, to a lesser extent, the proportion of equities in the retirement portfolio.

Further, we found that longer tenure in the system and higher contribution rates are the most important factors for increasing the likelihood that a participant reaches various threshold ASRs. Having greater asset allocation weight in equities also increases the probability of success, but overall asset allocation is substantially less important than a lifetime of adequate contributions. While many plans offer generous employer contributions, we find that employee contributions to an SRA substantially increase the likelihood of achieving a higher ASR threshold. However, older participants contributing to an SRA are less likely to achieve a higher ASR, possibly due to life-cycle effects. Likewise, longer tenured females appear less likely to achieve a higher threshold ASR.

On the whole, these findings are good news for participants in one large defined contribution pension system. Are they good news for retirement savers and retirees in other defined contribution plans? Perhaps not. For example, on average, qualified defined contribution rates are in the range of 6-8 percent of salary rather than the 10-20 percent commonly found

for individuals in TIAA-CREF plans. Among the variables we looked at, contribution rates are the biggest determinant of hitting the Par ASR. For those individuals with a total contribution rate less than 10 percent, the average ASR was 1.0, far less than the number needed to fund an adequate retirement income. Further, this ASR is less than half of those with a contribution rate of 13-15 percent and a third of those with a contribution rate of 15-20 percent.

Another feature of many 401(k) plans is that individuals have not necessarily spent as long building up a retirement nest egg as TIAA-CREF participants. This occurs because 401(k) plans have only existed since the early 1980s and did not achieve deep market penetration until the mid-1990s. By contrast, TIAA-CREF has been in existence for over 90 years. To be fair, unlike TIAA-CREF defined contribution plans, 401(k) plans were originally designed to be supplements to qualified defined benefit plans. Similarly, TIAA-CREF's SRAs are designed as supplements to its basic RA plans. However, outside of higher education and research occupations, more and more workers are finding that their sole employment based retirement plan is a 401(k). And that 401k plan has not been redesigned to take into account the missing defined benefit plan. This chapter suggests that it is possible to design robust defined contribution plans that considerably increase the likelihood of achieving sufficient savings for generating adequate retirement income.

Another contribution of this chapter is to illustrate how using a simple funding ratio such as the ASR could help individuals set savings and investment goals as well as gauge whether they are on track for retirement. Such a measure could provide needed feedback that could encourage additional savings and realistic assessment of work tenure. Too often, there are few to no incentives or feedback mechanisms that can be used to assess activities that span decades. It is too easy to ignore the problem as intractable. Interim feedback in a simple form could assist individuals in linking future goals to current conditions and the necessary adjustments.

APPENDIX A²

The Asset/Salary Ratio

We have defined the *Asset/Salary Ratio* or ASR as the ratio of current retirement assets to current salary at time t years before retirement.

(A1)
$$ASR_t = \frac{A_t}{S_t}.$$

Where S is the salary earned over the previous year. The ASR can be thought of in two ways: the actual ASR or the Par ASR that would be *required* to achieve a target income replacement ratio.

Taking the latter, normative meaning of the ASR, we can say that without any future contributions (i.e., pension premiums) beyond the current moment, the *required* current level of assets or initial principal would be equal to the discounted present value of the cost of an annuity at retirement divided by future salary growth.

(A2)
$$A_t\,(No\ Contributions) = \frac{FV_A}{(1+r\ )}$$

where FV_A is the discounted present value of the cost of an annuity at retirement that would be sufficient to produce the desired income replacement ratio (IRR), and r is the rate of investment return on the existing assets.

If we add future pension contributions and any other incremental savings, then required current assets is reduced accordingly to

(A3)
$$A_t\,(with\ Contributions) = \frac{FV_A - FV_P}{(1+r)^t}$$

where FV_P is the accumulated value of annual premium payments (and any other retirement savings) at retirement. These in turn depend on initial salary, salary growth, and investment return on premiums such that

(A4)
$$FV_p = \sum_{n=1}^{t} PS_t (1+w)^{n-1}(1+$$

and w = nominal salary increase rate, including a real salary increase and an inflation component.

Substituting equation (B4) into equation (B3), the required assets size becomes

(A5)
$$A_t = \frac{FV_A - \sum_{n=1}^{t} PS_t (1+w)^{n-1}(1+r)^{n\cdot}}{(1+r)^t}$$

Now the future value of an annuity can be recast in terms of the income replacement ratio (IRR), salary, salary growth, and an annuity purchase cost:

(A6)
$$FV_A = \left[S_t (1+w)^t\, IRR \right]$$

where
$$AC = \frac{\left[1 - \left(\frac{1}{(1+r_{AN})^K} \right) \right]}{r_{AN}}$$

r_{AN} = investment rate of return on annuity assets, and
K = total number of years in the annuity.

Substituting equation (B

(A7)

$$A_t = \frac{S_t}{(1+r)^t}\left[\left[RR(1+w)^t\, AC\right] - \sum_{n=1}^{t} P(1+w)^{n-1}(1+r)^{t-n}\right]$$

Simplifying further yields the expression

(A8)

$$\frac{A_t}{S_t} = \frac{RR(1+w)^t\, AC}{(1+r)^t} - \frac{P(1+w)\left[(1+r)^t - (1+w)^t\right]}{(r-w)(1+r)^t}$$

or

A9)

$$ASR_t = \frac{A_t}{S_t} = RR*AC\left(\frac{1+w}{1+r}\right)^t - \frac{P(1+w)}{r-w}\left[1 - \left(\frac{1+w}{1+r}\right)^t\right]$$

There are at least two things to note about this characterization of the Asset/Salary Ratio. First, the annuity value is based on a date certain rather than a life annuity. If a life annuity is used then the annuity cost AC depends on the annuity's interest rate, i, the probability of a person age b at retirement of living to age $b+h$ (hPb), and on the last age in a mortality table, m, as follows:

(A10)

$$AC_b = \sum_{h=0}^{m-b} \frac{hPb}{(1+i)^h}$$

Second, the pre-retirement investment return, annuity investment return, and salary growth terms may all be different. If any of them are similar, the Asset/Salary Ratio equation collapses further. For example, if the pre-retirement investment rate of return and the salary growth rate are equal, then

(A11)

$$ASR_t = \frac{A_t}{S_t} = RR*AC - P*t$$

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(Endnotes)

1   There are a number of precise variations on a defined benefit funding ratio, some depending on how the liabilities are defined. For example, liabilities can defined as though the plan were to close today, with the need to pay all currently accrued liabilities, but no future liability buildup. Alternatively, they can be defined to include an estimate of the buildup in future liabilities (including assumptions about how long employees will continue to work, what they will get paid, etc.). In any case, the exact definition of liabilities isn't important for our purposes here.

2   This appendix is taken from (Leibowitz, et. al. 2002)

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