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Retirement Saving Adequacy and Individual Investment Risk Management Using the Asset/Salary Ratio

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Abstract
This chapter uses the Asset-Salary Ratio (ASR) to examine the factors that increase the likelihood that defined contribution plan participants will have sufficient assets to generate adequate retirement income, similar to the defined benefit plan full-funding ratio. We apply this measure to a sample of TIAA-CREF participants, and we show that participant assets are on average consistent with at least a 70 percent income replacement ratio. Key factors explaining success are an adequate contribution rate and long tenure in the system; having a portfolio weighted to equities is beneficial but to a lesser extent. Thus good funding and early participation is more important than 'chasing returns.' Measures such as the ASR can help participants make more informed choices.

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Reorienting Retirement Risk Management

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Chapter 2

Retirement Saving Adequacy and Individual Investment Risk Management Using the Asset/Salary Ratio

P. Brett Hammond and David P. Richardson

The defined contribution (DC) pension has become the dominant type of retirement plan in the United States. Its widespread adoption has required individuals to take more responsibility for lifetime financial security, and has led to the development of many tools intended to help people manage their retirement saving, investment, and income risks. These tools range from expensive and highly customized advice to inexpensive target-date maturity funds, automatic enrollment, and generic calculators, all intended to encourage appropriate retirement saving, asset allocation, rebalancing, and retirement income. Their purpose is to provide individuals with recommendations on how much to save and what to do with that saving, and implicitly, the notion is that if people follow those recommendations, they will be more likely to have an adequate income stream in retirement. In effect, the tools are intended to help them better manage their own retirement income risk.

Despite the growth and popularity of such tools, rules of thumb, and direct advice, it remains unclear as to what actually works well. Often people fail to follow these 'rules' and experts' recommendations, saving too little and suffering from poor asset allocation and investment choices. Indeed, exacerbated by myopic choices about retirement withdrawals, the bulk of the economics literature suggests that many will end up with inadequate retirement income (Poterba, Venti, and Wise 1998, 2008; Poterba et al. 2007). A notable exception is Scholz, Seshadri, and Khitatrakun (2006).

So if the prevailing wisdom is correct, it is important to examine whether the DC model can be modified to make it more effective for the increasing proportion of covered participants. In the US case, the Pension Protection Act of 2006 made feasible provisions such as automatic enrollment and target-date maturity funds to enhance pension sponsors and providers willingness to boost DC saving. Yet more remains to be done, to make the

DC model simpler despite the system's multiple decision points, knowledge requirements, and now well-known participant behavioral tendencies.

In this chapter, we take up two points. First, we ask what simple feedback can be provided to help participants estimate whether they are on target to generate adequate retirement income. Second, we explore the right balance between retirement income adequacy and allowing for individual choice. We outline our proposed measure, called the asset/salary ratio (ASR), which we argue offers a robust metric for gauging participant success. The underlying algorithm for computing the ASR is sophisticated, and similar to the full funding ratio for a defined benefit (DB) plan, yet the exercise provides a single number that at any point in time allows the participant to measure saving adequacy against a set of benchmarks. We show, using a sample of Teachers Insurance and Annuity Association, College Retirement Equities Fund (TIAA-CREF) participants, that certain individual decisions are particularly important in achieving adequate resources for generating sufficient retirement income. These include, in order, contribution or saving rates, tenure or length of participation, and asset allocation. The latter has received considerable attention in the research literature and among practitioners, but the first two elements are often downplayed when considering DC pension design.

The ASR

Our goal is to determine whether a plan participant is on track to accumulate sufficient assets so as to hit a target income replacement rate (RR) after retirement. Using reasonable assumptions about future asset returns, future contributions, and a retirement income goal (e.g., funding a guaranteed income stream), the ASR reflects concepts and methods widely used to measure the overall funding status of a DB pension plan. In concept, the plan's funding ratio (FR) is defined as

$$FR_t = \frac{\text{Assets}_t}{\text{PV Future Liabilities}_t} \times 100 \tag{2.1}$$

where FR at any point in time equals the plan assets divided by the present value (PV) of the plan's future liabilities (Leibowitz et al. 2002). A DB 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 preretirement salaries or incomes.[1] For any individual participant, the RR (the percentage of preretirement salary he or she will receive in retirement) will depend on length of service, size of preretirement 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 $FR_t < 100$, the plan is considered to be underfunded, in which case 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, indicating whether the plan is on track to meet obligations, or when circumstances have changed and action is needed. In this sense, the funding ratio serves as an easily understandable metric for determining whether the plan is on a path to generate adequate retirement income for the participants.

In addition, the funding ratio has an intertemporal dimension that reflects changes in current conditions, something we call 'passage risk.' Since a pension plan is a long-horizon entity, the risk of a long-term plan inability to meet its targets ('outcome risk') should be of primary concern. But a sponsor should also be concerned about a sudden drop in market returns reducing the funding ratio, since this may determine whether the plan 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 the DC context because, in the absence of the plan sponsor taking responsibility for funding adequacy, DC plan participants can be thought of as being their own plan sponsors, and therefore they are in charge of managing the risks associated with maintaining their own retirement solvency. In the spirit of the DB funding ratio, the ASR can indicate to an individual whether he or she is 'on track' for achieving a personal retirement income goal.

In practice, the challenge for developing an ASR is to ascertain each individual's implied future liability stream and to develop assets to meet the target. But the DC plan sponsor does not typically make a specific pension income promise (unlike the DB sponsor), so determining the liability target is difficult. One approach would be to draw on economic life-cycle theory (Ando and Modigliani 1963; Browning and Crossley 2001), where the utility of consumption is smoothed across working and retirement years. Yet analysts have raised questions about how forward-looking households are or, if they are, to what degree consumption smoothing is compatible with actual behavior (Bullard and Feigenbaum 2007). Nevertheless, inspired by the life-cycle concept, we can employ as a goal for retirement saving and investment the RR, which we define here as 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 RR is, of course, closely related to the notion of a DB 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 RR objective might be done by reference to a policy statement from the American Association of University Professors (AAUP) and American Association of Colleges that suggests that educational institutions design pension plans that enable their employees to replace about two-thirds of their preretirement, inflation-adjusted, annual salary through a combination of pension income, Social Security, and other personal saving (AAUP 2006: 174). This target is roughly consistent with other research that suggests that retirees aim to replace 70–80 percent of preretirement income on average (Reno and Lavery 2007). Therefore, a target RR of 75 percent seems to be a reasonable objective.

Considering first the Social Security component, one's individual Social Security RR is inversely related to preretirement income. Thus, 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 preretirement income (Reno and Lavery 2007). The higher salary amount is roughly representative of incomes provided to older faculty in higher education (*The Chronicle of Higher Education* 2009). It should be noted that such a replacement rate assumes people are paid at this rate over their entire lifetimes; in reality, actual lifetime earnings in higher education are lower earlier on and rise in later life, making actual Social Security replacement rates somewhat higher.

In what follows, we make the conservative assumption that Social Security benefits replace about one-quarter of preretirement income. In this case, employer-sponsored pensions and other household saving must be capable of generating a 50 percent RR on average, to meet the 75 percent average RR standard. We acknowledge that many low-income workers might elect a lower RR target, while higher income workers might desire a higher RR. Individuals with substantial personal saving dedicated to retirement could use those assets to offset required pension saving. For most Americans, though, non-pension saving tends to be held in relatively illiquid housing, so it may not be easily accessible as a source of income.

On the presumption that the employer pension must provide a 50 percent replacement rate, it is now necessary to account for other important factors including contribution rates, years of service, investment earnings, and salary growth rates. Pulling these together, we have

$$\mathrm{ASR}_t = \frac{A_t}{S_t} \tag{2.2}$$

which says that the ASR is equal to the level of pension assets divided by the individual's annual salary (S) at the point *t* years before retirement.

There are in fact two variants of the ASR: a worker's existing ASR at date *t*, and what we call the Par ASR, or what is *required* to achieve a target income replacement rate. It is worth noting that the required or Par ASR is dynamic: 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 to be 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 opportunity to make 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.[2]

In any event, if an individual knows his or her current ASR and can roughly estimate the Par ASR required to fund retirement income years into the future, then he or she can evaluate whether the current ratio is adequate for retirement planning purposes. An individual who has an actual ASR equal to his required Par ASR, all else equal, could be considered to be on track for retirement adequacy. A person whose ASR is currently higher than the Par ASR now enjoys a cushion to protect against unforeseen trends or events (e.g., larger-than-expected stock market declines or better-than-expected retiree life spans). On the other hand, someone whose ASR is lower than his required ratio should consider corrective action, including increasing plan contributions, starting to save in other retirement vehicles, changing investment strategies, and rethinking retirement plans, so as to increase assets and the ASR.

To illustrate these concepts, we display in Figure 2.1 a family of Par ASR curves for an individual who seeks to remain fully funded (at the Par ASR) at each age through the retirement date; different RR targets are depicted. In this figure, we assume an employee seeks to fund a 25-year fixed annuity at age 65 in 2007. Alternatively, the employee could have funded a lifetime fixed annuity for about 6 percent less than a comparable 25-year annuity.[3] We chose to use the higher-cost option in order to eliminate any differences in life expectancy among the longest-lived individuals. Therefore, the ASR threshold calculation used in this chapter is more stringent relative to a calculation that uses a life annuity assumption.

The figure makes several additional assumptions, including constant nominal annual salary growth of 4 percent and annual investment returns of 6 percent. 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,

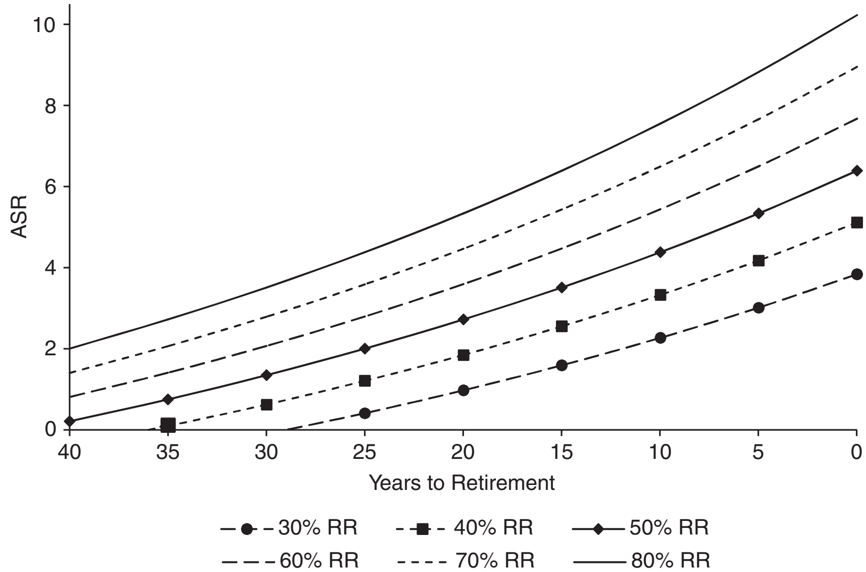

Figure 2.1 Personal funding ratios for 30–80% replacement rate (RR) targets.
Notes: Computations assume 6% asset returns, 25-year annuity at 6%, 4% nominal salary growth, and 10% contribution rate. *Source*: Authors' calculations; see text.

assets must grow faster than salary. Naturally, this example is hypothetical; next we turn to an examination of whether individuals in the real world achieve these ratios in practice.

ASR patterns in practice

We examine retirement saving adequacy of a sample drawn from the TIAA-CREF participant population, namely those covered by institutional DC plans in 2007 and managed by the TIAA-CREF system. This is a nonprofit DC retirement system owned by its 3.2 million individual participants, and it manages over 15,000 tax-deferred plans for employer and employee contributions and diversified investments. Unlike many 401(k) providers, TIAA-CREF also offers and encourages lifetime annuities, enables pension portability, and provides extensive financial education and advice.

From this system, we gathered data on assets, sex, tenure, and contribution rates for a sample of about 77,000 active employees at 71 institutions that varied by size, contribution rate, and employer type. We calculated

Table 2.1 Descriptive statistics for analysis sample

Variable	Unrestricted Mean	Unrestricted Standard Deviation	Restricted Mean	Restricted Standard Deviation
Age (years)	48.1	11.0	48.6	10.8
Tenure (years)	12.2	9.2	12.8	9.0
Estimated salary ($)	72,107	49,757	73,158	49,992
Total assets ($)	306,577	381,406	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[a]				
Employer ($)	6,547	4,640	6,836	4,570
Employee ($)	2,821	4,368	2,951	4,443
SRA contributions[b]				
Employer ($)	45	1,205	48	1,237
Employee ($)	2,260	5,455	2,372	5,570
Contribution as percent of salary (%)	16.9	44	16.9	14.1

[a] Stands for Retirement Account.
[b] Stands for Supplementary Retirement Account.

Notes: Sample size for unrestricted group is 72,067 (36,372 male, 32,041 female, 3,654 missing). Sample size for restricted group is 68,373 (36,354 male and 32,019 female).

Source: Authors' calculations; see text.

ASRs for this sample. We note that the wealth and income figures include only accumulations inside the TIAA-CREF system, which probably understates participants' total assets and income (especially for participants who have some other pension, as well as those who hold retirement-related pensions with other 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 may include assets from multiple accounts that may represent jobs at many different institutions, each of which had different required and voluntary contribution rates. Specifically, our estimate of contribution rates pertains only to the current employer. Fortunately, because we have access to individual plan document information, we have reconstructed employer match and voluntary plan contribution rates.

As is shown in Table 2.1, the average age of participants in the full sample is 48 with average tenure (number of years employed) at about 12 years. The sample is about 51 percent males, 44 percent females, with 5 percent unknown. Average salary stands at about $72,100 and average retirement assets are about $307,000. In our sample, the average actual ASR we computed was about 2.9, resulting from employer and/or employee contributions to Retirement Annuity (RA) and/or Supplemental Retirement Annuity (SRA) accounts. Annual employer contributions averaged about $6,550 to an RA and $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 total contribution rate of about 16.9 percent of salary.

For the analysis sample, we trimmed the data in a few regards. First, we omitted those with sex not available in the file. Second, we omitted a handful of participants with extremely high asset levels but very low salary on the grounds that they are mostly retired. Third, we restricted the sample to those with salary of at least $5,000. And last, a handful of observations was omitted due to negative contribution values (because of record-keeping corrections). The resulting sample of 68,373 participants is described in the second column of Table 2.1: it is slightly older, higher income, and wealthier (but not significantly so), and the ASR is less dispersed.

Correlates of ASR

Next we explore the relationship between the ASR and various sample population characteristics. Table 2.2 shows average ASR by age cohort. As expected, contributions and income rise with age, since plan rules set contributions as a percentage of income. In addition, the average ASR increases with age, suggesting that the decision to delay retirement may have a strong effect on the ASR. Figure 2.2 provides additional information

Table 2.2 Distribution of mean sample characteristics by age group

Age	*N*	Contributions ($)	Assets ($)	Tenure (years)	Salary ($)	ASR[a]
<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
≥85	6	14,641	1,198,079	21.7	66,636	13.5

[a] Stands for asset/salary ratio; see text.

Note: Sample size is 68,373.

Source: Authors' calculations; see text.

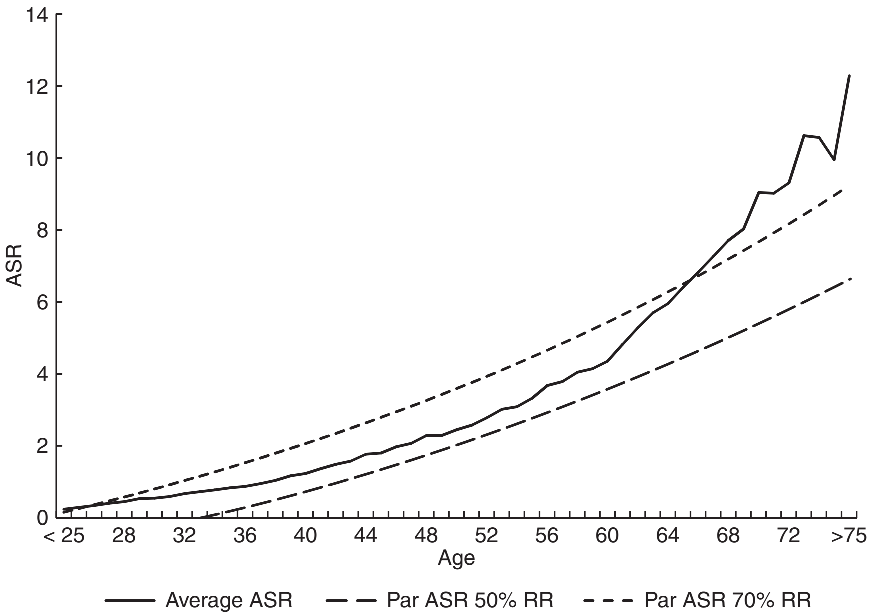

Figure 2.2 Average asset/salary ratio (ASR) by age. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

on average ASR by age, displaying actual average ASRs along with required Par ASRs for the 50 and 70 percent target RRs (Par ASRs are similar to those in Figure 2.1, but have been arrayed by age rather than years to retirement).

The results show that the entire average ASR curve lies entirely above the 50 percent Par ASR curve, suggesting that, at the end of 2007, this sample had more assets than needed to be on track for replacing more than 50 percent of its preretirement income. Older participants are doing even better in providing a cushion for unexpected portfolio shocks. For those aged 61 and above, the actual ASR rises rapidly, and for those above 65 it is consistently above the 70 percent Par ASR.

Figure 2.3 splits the ASR by age and sex. For younger participants, there is no significant difference between male and female ASRs. For older cohorts the results diverge: among baby boomers (those in their mid- to late 40s or older), females are significantly below males, with ASRs averaging about 75 percent of those for the men. The gap increases substantially for older cohorts, with females in the oldest cohort having ASRs of

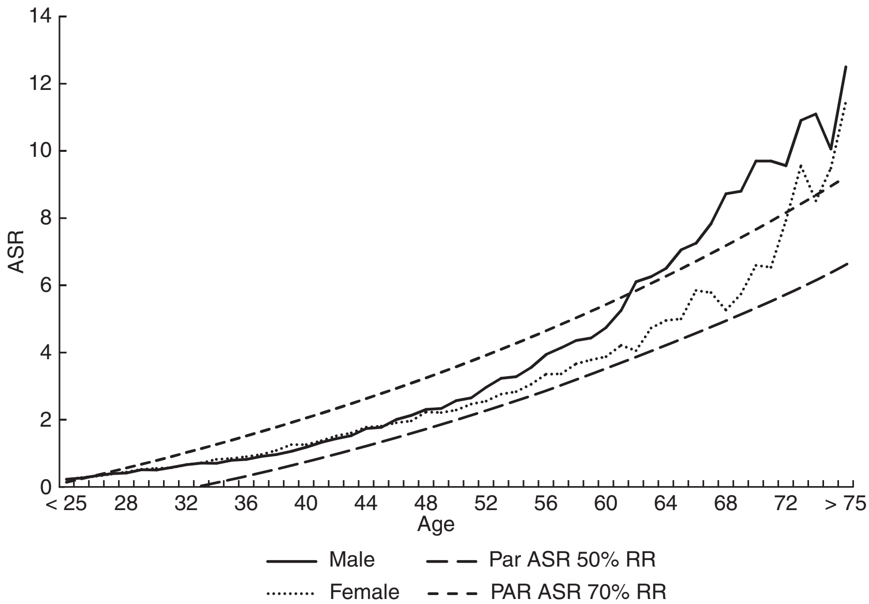

Figure 2.3 Average asset/salary ratio (ASR) by age and sex. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

approximately half those of their male counterparts. Nonetheless, older women's ASRs are still consistent with adequate financial resources. In other words, cohort sex differences in this sample are similar to those of the population as a whole.

We also identify differences by years of service, or what we call years of tenure in the TIAA-CREF system. Figure 2.4 shows that, on average, all participants enjoy ASRs capable of funding an RR of 50 percent or more, and participants with longer tenure have substantially higher ASRs. Strikingly, those with tenure of 15 years or more have ASRs above the 70 percent Par ASR curve, reaching ASRs of 10 or more for those with at least 32 years of service.

Figure 2.5 shows differences by sex and tenure in the system, and once again, males and females with less tenure have, on average, similar ASRs. But a comparison of Figures 2.3 and 2.5 shows a smaller tenure–sex difference than the age–sex divergence. ASRs for males with at least 27 years of participation are modestly higher than their female counterparts, while a sharp and persistent tenure–sex distinction only emerges for cohorts with more than about 36 years of participation.

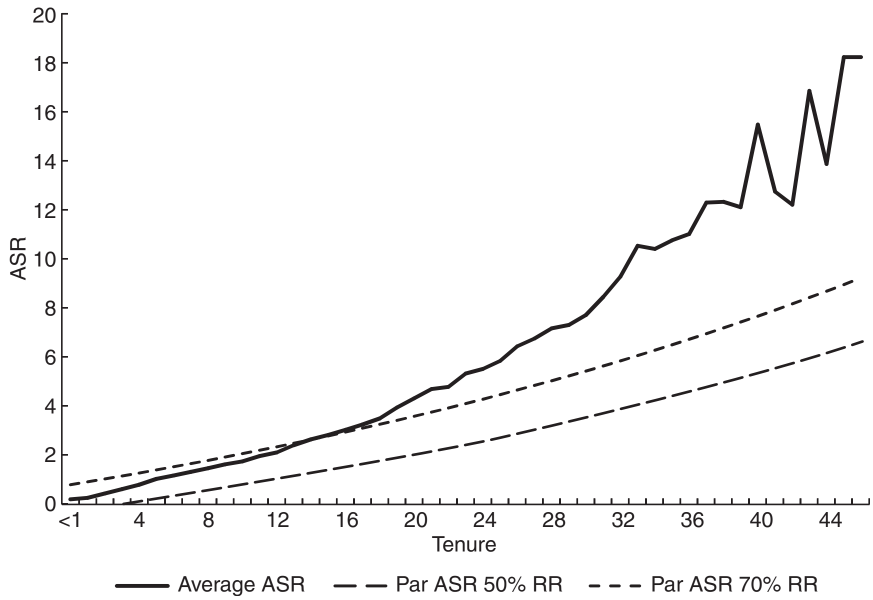

Figure 2.4 Average asset/salary ratio (ASR) by tenure. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

We want to emphasize that tenure comparisons are complex because some people have only participated in TIAA-CREF over their entire working lives, while others might have the same, more, or less total retirement assets from working job with different plans. Nevertheless, the sex differences remain interesting: women and men with similar tenures had similar opportunities to save and invest in the TIAA-CREF system, while women and men of similar ages might not. For instance, older women are more likely than men to have spent time out of the higher education labor force due to family reasons. What is harder to explain is why long-tenure women and men diverge; different family circumstances may play a role.

Table 2.3 presents information on average ASRs by salary and, as expected, average ASRs rise with salary, though less sharply than by either age or tenure. One explanation for this might be faculty salary compression, with younger faculty receiving starting salaries close to (or on occasion in excess of) those 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 ASRs rise slowly with salary, the effect does not appear to be very strong.

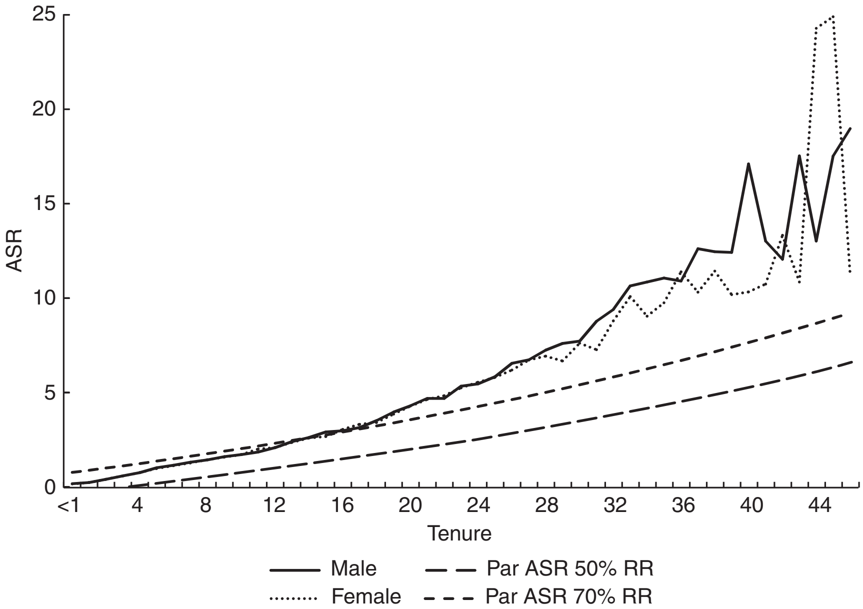

Figure 2.5 Average asset/salary ratio (ASR) by tenure and sex. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

TABLE 2.3 Distribution of mean sample characteristics by annual salary

Salary ($)	*N*	Age (years)	Contributions ($)	Assets ($)	Tenure (years)	ASR
<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
≥120,000	8,364	55	27,937	598,758	18.9	3.6

Note: See Table 2.2.

Source: Authors' calculations; see text.

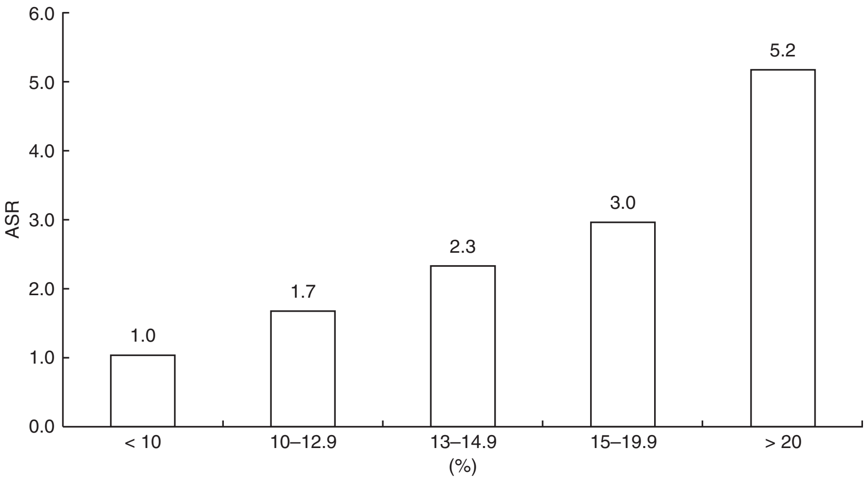

Figure 2.6 Average asset/salary ratio (ASR) by contribution rate. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

Next we turn to an examination of average ASRs by contribution rates; Figure 2.6 depicts average ASRs by total contribution rates, and Figure 2.7 decomposes contributions into the basic RA and the SRA. Defining the total contribution rate as the sum of all employer and employee contributions divided by salary, we see that the average ASR rises strongly with total contribution rates, increasing more than five times between the lowest and highest savers. Even comparing the top two saving groups, the average ASR is 75 percent higher for the highest savers relative to the next group. It is interesting that, as with overall contributions, the ASR for RAs and SRAs rise dramatically with contribution rates. But the SRA effect is particularly striking: at every level, 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 summarize, different cuts of the data support the hypothesis that the average TIAA-CREF participant was 'on track' in 2007 for having sufficient assets to fund a 50 percent RR. This holds for participants of all ages, but older men seem to have more of a cushion for unexpected shock relative to older women. Several other factors are correlated with retirement saving adequacy, including contribution rates, age, tenure, and, to a lesser extent, salary.

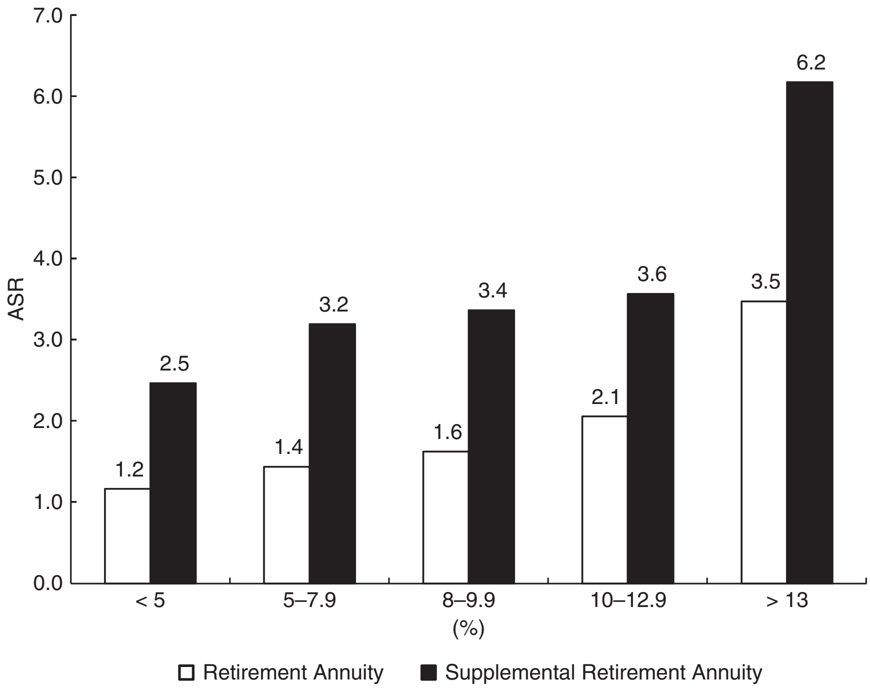

Figure 2.7 Average asset/salary ratio (ASR) by contribution rate and source. *Note*: See Figure 2.1 for definitions. *Source*: Authors' calculations; see text.

Multivariate analysis of retirement funding adequacy

Next we analyze in a multivariate setting the ways in which ASRs vary across the sample, both in absolute and deviation terms. For the first set of models, we use ordinary least squares (OLS) regression to link the dependent variable, the natural log of the ASR (ln (ASR)),[4] with a vector of explanatory variables, including age and age squared, tenure and tenure squared, sex (female), the natural log of the total contribution rate relative to salary (ln (TC percent)), the natural log of the proportion of assets held in equity (ln (Eq percent)) and the natural log of the TIAA traditional account (ln (TIAA percent)), dummy variables for participant contributions to a Retirement Annuity (RAemployee) or a Supplemental Retirement Annuity (SRAemployee), and interacted variables of female with tenure (tenure * female), and age with SRA contributions (age * SRAemployee).[5]

One of the strongest findings from the vast prior literature on asset allocation is that differences in portfolio returns are overwhelmingly determined by differences in portfolio allocations among major asset classes (Brinson, Hood, and Beebowerr 1986). So it may be that differences in the ASR could be explained by differences in asset allocation across participants. To explore this question, we use both the percent of participant's total portfolio invested in equity (ln (Eq percent)) and the percent of total portfolio invested in the TIAA Traditional Annuity (ln (TIAA percent)), 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, but in fact, bonds and real estate comprise a small portion of most participants' portfolios. We explore whether the ASR might be affected by employee RA and SRA contributions, separate from employer contributions. In many cases, and universally so for the SRA, employee contributions depend on the individual participant decision to save additional amounts out of salary. While employee contributions are constrained by IRS limits and affected by employer matching, in the case of the RA they can be mandated, while in the case of the SRA they are completely voluntary. In essence, we are interested in seeing whether different types of contributions are associated with being on track for a secure retirement.

Results for ASR levels

Regression results appear in Table 2.4, where we see that the explanatory variables account for about 82 percent of the variance observed, and all independent variables except age squared and ln (TIAA percent) are significant at the 99 percent level (the latter is significant at the 95 percent level). 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 2.1).

It is of interest to note that variations in total contribution rates (ln (TC percent)) have by far the most important influence on the ASR. This is sensible, since for younger participants, larger contribution rates should naturally result in higher assets, while for older participants, the interaction of lifetime contribution rates and rates of return become important. Both basic pension plan RA contributions (RAemployee) and voluntary supplemental contributions (SRAemployee) have positive effects on the outcome; also SRA contributions have a much larger impact except for older SRA contributors. We believe that the negative relationship with age can be explained by 'catch-up' contributions: older participants with low ASRs have recognized 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 with others in their age cohort.

TABLE 2.4 Multivariate OLS regression analysis of asset/salary ratio (ASR): dependent variable ln (asset/salary ratio)

Variable	Parameter estimate	Standard error	t value	Probability > |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
Female	0.031	0.008	4.15	<.0001
ln (TC percent)[a]	0.748	0.005	142.36	<.0001
ln (Eq percent)[b]	0.051	0.003	16.55	<.0001
ln (TIAA percent)[c]	0.007	0.002	2.79	0.0052
RAemployee	0.076	0.005	15.97	<.0001
SRAemployee	0.254	0.022	11.49	<.0001
Tenure * female	−0.003	0.000	−6.89	<.0001
Age * SRAemployee	−0.006	0.000	−14.83	<.0001
Root MSE	0.44			
Dependent mean	0.60			
Coefficient of Variance	73.67			
R-square	0.83			
Adjusted R-square	0.83			

[a] Stands for the natural log of the total contribution rate relative to salary.
[b] Stands for the natural log of the proportion of assets held in equity.
[c] Stands for the natural log of the TIAA traditional account.

Note: See Table 2.2.

Source: Authors' calculations; see text.

Tenure is also positively associated with larger ASRs. Going from 0 to 10 years of participation increases ASR by about 1.3, with the tenure effect reaching a maximum at about 38 years of service. Evidently participating for a long time in an institution's plan is a good way to build a healthy retirement nest egg. Interestingly, the female effect is small and positive, while the longer-tenured female effect is small but negative. We surmise that this is due to the increased probability that females had work stoppages in their past careers, leading to lower lifetime contribution rates and hence lower ASRs. We also find that for this population, having a high equity share (ln (Eq percent)) is associated with higher ASRs; whether this will hold in the future is uncertain.

In sum, individual participants who participated longer, saved more, and allocated more to equities enjoy higher ASRs than those who did not. While this may seem relatively unsurprising, this simple formulation explains over 80 percent of the variation in the ASR for our sample of TIAA-CREF participants.

Results on deviations from the Par ASR

Next we assess what influences observed deviations from the Par ASR, which we think of as the 'on-track' or 'target' ASR. To this end, we measure the tracking error around the Par ASR by defining ASRs over five threshold ranges: those with an ASR greater than or equal to 80 percent, 70 to less than 80 percent, 60 to less than 70 percent, 50 to less than 60 percent, and less than 50 percent. As before, the sample includes only participants aged 25 to 75, with 48,788 usable observations.

Table 2.5 presents the results of an ordered probit regression with the target Par ASR (Threshold ASR) as the dependent variable; the same independent variables used earlier are employed. Results indicate that all variables are highly statistically significant and all coefficients but age have coefficients with similar magnitudes and signs. As before, contribution rates and tenure have the largest effect on participants' 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 before, the exception is for the interaction of SRA with age, suggesting that older participants making SRA contributions are playing catch-up with their retirement saving.

One important difference with the prior results is that here the coefficient on age is negative. This is 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, a pattern perhaps attributable to student loan debt, child rearing, and home purchases early on, which 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, longer-tenured females are less likely to cross into higher thresholds, perhaps because they did not contribute at the same rate as men over time. As before, the asset allocation mix is important, with higher equity fractions boosting the likelihood of achieving the next threshold. Likewise, fixed income (ln (TIAA percent)) is also significant, slightly increasing the likelihood of reaching the next threshold. Nevertheless, the effect of asset allocation proves rather small, relative to the impact of contributions and tenure. The main implication is that chasing returns is no substitute for adequately funding a retirement plan over time.

TABLE 2.5 Multivariate ordered probit analysis of threshold asset/salary ratio (ASR): dependent variable threshold ASR

Variable	Parameter estimate	Standard error	Chi-square	Probability > chi-square
Intercept 1	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
Female	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
RAemployee	0.180	0.013	189.9	<.0001
SRAemployee	0.290	0.057	25.7	<.0001
Tenure * female	−0.009	0.001	42.6	<.0001
Age * SRAemployee	−0.008	0.001	49.2	<.0001
Log likelihood	−50,951			

Note: See Tables 2.2 and 2.4.

Source: Authors' calculations; see text.

Conclusion

We use the ASR to highlight factors associated with retirement saving adequacy in a large DC pension system. On average, our sample participants in a range of TIAA-CREF plans appear to be on track for funding a fixed retirement annuity that, with Social Security, will replace at least 70 percent of preretirement income. Furthermore, many appear able to do better, buying themselves higher replacement rates or having a significant cushion against economic shocks. Factors most predictive of success are contribution rate, years of participation in the system, and the fraction of equities in the retirement portfolio. Also those employees who contributed to their SRAs had substantially greater chances of meeting ASR targets.

One caveat to this analysis is that our dataset was collected in 2007, when equity markets were near all-time highs and many other assets, including bonds, real estate, and other alternatives were providing solid returns. In 2008 and 2009, financial markets were highly volatile; equity markets dropped by more than half and then rose again by about 60 percent through the end of 2009. Looking only at the period of decline from the beginning of 2008 through February 2009, aggregate TIAA-CREF assets lost roughly 17 percent of their value (equity losses were tempered by investments in a guaranteed account and fixed income). We estimate that, if the average sample participant lost 17 percent, his or her ASR would have declined by a similar proportion. An average participant with 30 years tenure would have had an ASR of 8 at year-end 2007, consistent with a Par ASR of over 100 percent RR. This 17 percent decline in assets would have left that hypothetical participant with an ASR of over 6.6, still well above the 70 percent ASR. Recall that our PAR ASRs assume a constant annual 6 percent investment return from a diversified portfolio of assets. At the end of 2007, the average TIAA-CREF participant's portfolio consisted of about 52 percent equities, 39 percent guaranteed and fixed income, 5 percent direct real estate, and 4 percent money market assets. Over the last 10 years (through the end of September 2009), a portfolio constantly maintained at these asset allocations would have returned about 3.1 percent per year, about half of the assumed total rate of return. A steady 3 percent rate of return would place a considerable burden on participants saving for retirement. One way to look at this is that the required ASR 15 years before retirement would rise from 3.5 times salary using the 6 percent return assumption to 5.8 times salary using a 3 percent return assumption, an increase of more than 65 percent. Another way to look at it is that a sustained multi-decade period of subpar returns would leave many participants unable to fund their target replacement incomes in retirement. In order to explore these and other issues, we intend to track what actually happened to TIAA-CREF participants in future work.

We would note that many other DC plans are less generous than most TIAA-CREF plans, so participants and policymakers must not be overly sanguine regarding these results. For instance, contribution rates across the private sector plan universe range from 6 to 8 percent of salary, rather than the 10 to 20 percent seen in many TIAA-CREF plans. Furthermore, high contribution rates are a key determinant of being able to hit one's Par ASR as we have shown. And even in our sample, employees contributing less than 10 percent had average ASRs of 1.0, far less than the number needed to fund an adequate retirement income. Another feature of many 401(k) plans is people have shorter plan tenure; private sector 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.

In sum, we have shown that it is possible to design robust DC plans that considerably increase the likelihood of achieving sufficient saving for generating adequate retirement income. We believe that our proposed measure, the ASR, can help individuals do a better job setting saving goals as well as gauge whether they are on track for retirement in a dynamic way. All too often, workers lack incentives or feedback mechanisms they can use to judge their progress to a goal. Providing interim and easily understandable feedback could be useful in helping participants link future goals to current conditions and make adjustments as necessary.

Appendix 2A More Detail on the ASR[6]

We define the ASR as the ratio of current retirement assets (A) to current salary (S) at time t years before retirement:

$$\text{ASR}_t = \frac{A_t}{S_t} \tag{2A.1}$$

where S is the salary earned over the previous year. In the chapter, we explain two different versions of this measure. 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:

$$A_t(\text{No contributions}) = \frac{\text{FV}_A}{(1+r)^t} \tag{2A.2}$$

where FV_A is the discounted present value of the cost of an annuity at retirement that would be sufficient to produce the desired RR, and r is the rate of investment return on the existing assets. If we allow positive future pension contributions and other incremental saving, then required current assets is reduced accordingly to

$$A_t(\text{With contributions}) = \frac{\text{FV}_A - \text{FV}_P}{(1+r)^t} \tag{2A.3}$$

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

$$\text{FV}_p = \sum_{n=1}^{t} PS_t(1+w)^{n-1}(1+r)^{t-n} \tag{2A.4}$$

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

Substituting Equation (2A.4) into Equation (2A.3), the required assets size becomes

$$A_t = \frac{\mathrm{FV}_A - \sum_{n=1}^{t} PS_t (1+w)^{n-1}(1+r)^{n-t}}{(1+r)^t} \tag{2A.5}$$

Now the future value of an annuity can be recast in terms of the RR, salary, salary growth, and an annuity purchase cost:

$$\mathrm{FV}_A = [\, S_t\,(1+w)^{\mathrm{t}}\,\mathrm{RR}\,]\mathrm{AC} \tag{2A.6}$$

where

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

r_{AN} = investment rate of return on annuity assets
K = total number of years in the annuity
RR = income replacement rate
Substituting Equation (2A.6) into Equation (2A.5) yields

$$A_t = \frac{S_t}{(1+r)^t}\,[[\mathrm{RR}(1+w)^t\mathrm{AC}] - \sum_{n=1}^{t} P(1+w)^{n-1}(1+r)^{t-n}] \tag{2A.7}$$

Simplifying further yields the expression

$$\frac{A_t}{S_t} = \frac{\mathrm{RR}(1+w)^t\mathrm{AC}}{(1+r)^t} - \frac{P(1+w)[(1+r)^t - (1+w)^t]}{(r-w)(1+r)^t} \tag{2A.8}$$

or

$$\mathrm{ASR}_t = \frac{A_t}{S_t} = \mathrm{RR} * \mathrm{AC}\left(\frac{1+w}{1+r}\right)^t - \frac{P(1+w)}{r-w}\left[1 - \left(\frac{1+w}{1+r}\right)^t\right] \tag{2A.9}$$

Two things should be noted about this characterization of the ASR. 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's age b at retirement of living to age $b + h$ (hPb), and on the last age in a mortality table, m, as follows:

$$\mathrm{AC}_b = \sum_{h=0}^{m-b} \frac{hPb}{(1+i)^h} \tag{2A.10}$$

Second, the preretirement investment return, annuity investment return, and salary growth terms may all be different. If any of them are similar, the ASR equation is further simplified. For example, if the preretirement investment rate of return and the salary growth rate are equal, then

$$\text{ASR}_t = \frac{A_t}{S_t} = \text{RR} * \text{AC} - P * t \tag{2A.11}$$

Notes

[1] For present purposes, it suffices to acknowledge that several different approaches may be taken to compute DB funding ratios, some of which depend on how plan liabilities are defined. For example, liabilities may be defined as though the plan were to close today, with the need to pay all currently accrued liabilities but no future liability buildup would be booked. 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.). For further detail, see McGill et al. (2005).

[2] The Appendix 2A provides a detailed description of the mathematical relationships among the elements that make up the required Par ASR: the desired income replacement rate (RR), 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.

[3] The 25-year fixed annuity is actually more expensive than a life annuity because it does not fully leverage pooled mortality risk the way a life annuity does. Under our assumptions, it is about 6 percent more expensive to buy the 25-year fixed annuity than the pure life annuity beginning at age 65.

[4] The OLS models eliminate 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. We also exclude individuals over the age of 75 and under the age of 25. The resulting sample has 67,324 observations.

[5] Because of zero values for some percentages, only 48,778 observations are used in the final regression.

[6] This appendix is derived from Leibowitz et al. (2002).

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