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Annuity Risk: Volatility and Inflation Exposure in Payments from Immediate Life Annuities

Chris Soares
Mark Warshawsky

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Abstract: Some researchers have raised concerns about significant volatility in initial payments from fixed immediate life annuities and the subsequent inflation risk during the retirement period. This paper investigates these concerns using recent high frequency data. It finds that while there is significant volatility in initial payments from nominal fixed annuities, phased purchases of fixed annuities can reduce their volatility. It also finds that an inflation-adjusted annuity may address both the volatility and inflation risk problems. The results are applicable to current discussions about Social Security reform and trends toward the defined contribution type of pension plan.

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The authors are with the US Department of the Treasury. Any views expressed, however, are those of the authors alone and not necessarily those of the Treasury Department. We appreciate helpful comments from conference participants and John Ameriks, Jeffrey Brown, James Duggan, and Kent Smetters, and assistance with data from Norman Carleton and Ron Koenecke at Treasury, and Stephen Goss, Alice Wade and Felicitie Bell at the Social Security Administration.

Trends in Retirement Plans: Defined Benefit to Defined Contribution

Over the last two decades, there has been a steady movement, gathering speed, around the world, in both public and private sectors, toward the defined contribution type of retirement plan and away from the defined benefit type. Much research has been done on the reasons for this shift; the primary causes have been identified as increased labor mobility, the possibility of higher returns on assets held in a defined contribution plan account, fewer distortions in work incentives, reduction in regulatory burden, and the flexibility usually gained in the distribution of assets during the working and, especially, retirement years. The defined benefit plan type generally offers the promise of lifetime (annuity) benefit payments during retirement, closely related to the level of earnings experienced during the working years (most typically, in the years just before retirement).[1] Defined contribution plans, on the other hand, offer market returns on contributions and broader options for distribution of accumulated balances.

In the face of the strong forces leading to the dominance of the defined contribution plan type, a legitimate set of questions can be posed: are certain types of risks being assumed, perhaps unknowingly, by holders of defined contribution retirement plans? Are these risks, in some measurable sense, unduly large? Are there mechanisms available, at reasonable cost-benefit ratios, to control or modify these risks? Are the risks acceptable in light of the additional flexibilities obtained?

This short paper focuses on the volatility, over time, of initial monthly payments from individual immediate life annuities, as well as the inflation risk experienced after annuitization. Such annuities are those most relevant and available to participants in defined contribution pension plans and individual retirement accounts. We examine a recent time horizon, 1983 through 2002, as relevant to current and likely future economic and policy conditions. We also record high frequency results – monthly since the beginning of 1983 through December 2002 and daily since the beginning of February 2002 through December 2002 – in order to get a better sense of the actual volatility of income from life annuities that might be experienced by households timing their retirement and purchase of life annuities, or who are aware of the outcomes of other similarly situated individuals. The daily simulations are also compared to actual daily payments over the period from a AAA-rated life insurance company, which provides a rough gauge of how well our model tracks actual market outcomes.

We examine fixed nominal annuities, fixed increasing annuities (whose payments increase with the rate of inflation expected at the time of annuity issue), and since 1998, inflation-adjusted annuities. The latter two products do not currently widely exist in the United States, but certainly are within the realm of practical and technical possibility, and are shown to illustrate methods of handling post-retirement inflation risk. We also consider a phased purchase of fixed nominal annuities over a three-year period prior to

[1] These annuity payments are sometimes fixed in nominal terms or sometimes increase, usually with some measure of consumer prices.

retirement. Volatility is measured primarily by the standard deviation of monthly payments, and their percentage change over one-year periods.

It should be noted that the evaluation of risk for the defined contribution plan type is relative because, despite its notional stability, the defined benefit plan type is also subject to risk. In the case of private plans, insolvency or inadequate prefunding can reduce pension payments. In the case of government plans, demographic and political risk could result in reductions to expected benefits. In either case, contributions to a defined benefit retirement plan that are made prior to vesting or retirement can be lost in the event an individual dies or no longer works. By contrast, in most defined contribution plans, contributions are generally quickly vested and bequeathable.

There is a strong public policy interest in retirement plans, whether those directly sponsored by public sector entities for all workers and families or their employees, those sponsored by private sector entities for their employees, or those purchased by individuals and households for themselves. The public interest can be stated as a desire to assure financial security in retirement, at a reasonable cost and level of risk, with the maximum possible flexibility. This public interest is implemented in the form of direct sponsorship, tax incentives, insurance guarantees, and regulatory restrictions, guidelines, and oversight.

Defined Contribution Plans: The Distribution Phase and Immediate Life Annuities

The defined contribution plan type is subject to certain risks, potentially borne by the plan beneficiary, both in the accumulation and distribution phases. In the accumulation phase, these risks include the possibility of poor investment performance and, depending on plan rules, the use of assets for purposes other than the fundamental one of a primary pension plan: financial security in retirement.

The distribution phase is less studied and understood. Most defined contribution plans in the United States offer little structure to the distribution of assets. Although life annuities are sometimes offered by the plan, they are almost never mandated. Clearly this state of affairs offers maximum flexibility, but it also exposes the retired household to the risk of outliving its assets if the household is not otherwise covered by a defined benefit plan or does not have a significant stock of asset holdings. As has been formally demonstrated by Mitchell, Poterba, Warshawsky and Brown (1999) and by Ameriks, Veres, and Warshawsky (2001) using expected utility and asset return simulation methodologies, respectively, longevity risk is substantial and the insurance value of a life annuity is significant compared to the alternate strategy of phased withdrawals of assets.

Moreover, there is a potential moral hazard problem in old age: if the retired household mistakenly employs its assets in excess spending or poor investments, it will have to fall back on a social safety net provided by government welfare programs or private charity. In fact, largely to prevent these problems and to reduce adverse selection (explained below), life annuities are mandated in primary defined contribution pension plans in the United Kingdom. In discussions of reforming of the United States Social Security system by establishing personal accounts, annuities are prominently mentioned as a distribution mechanism (Report of the President's Commission, December 2001, p. 56).

Whether made available in a defined contribution pension plan or purchased as an individual product sold in the voluntary market, two specific areas of concern have been highlighted about fixed immediate life annuities: they are costly for many potential annuitants, and they are risky.

The first concern has been investigated intensively in a series of published articles, many collected in the volume by Brown, Mitchell, Poterba, and Warshawsky (2001). These authors confirm that immediate life annuities sold in a voluntary market are subject to adverse selection: that is, the tendency of individuals in poor health (with impaired longevity prospects) to avoid life annuities. This tendency leads to an increase in annuity prices of about 10 percent as insurers must anticipate annuitants with a longer expected lifespan than average individuals in the general population. In addition, there are administrative and sales costs embedded in annuity prices, particularly for those annuities sold in the individual (as opposed to the group) market. Yet the authors also find that an index of actuarial fairness (or money's worth as they call it) of individual annuities has improved substantially over the decades of the 1980s and 1990s. A recent finding on this score, in Poterba and Warshawsky (2000), indicated that, using projected annuitant mortality and government bond rates as the benchmark, life annuities issued in the individual market in the United States, by some hundred insurance companies, in 1998 have had an average money's worth of nearly one. [2]

Burtless (2000) has expressed the second concern. The risk referred to here is not that, once a fixed life annuity is purchased, regular income payments will not be paid. Rather, it is the risk that at the point in time they retire, workers may find it expensive to purchase nominal fixed annuities because annuity prices will be, in some sense, too high (owing to interest rates being, in some sense, too low). Also, if they purchase fixed nominal annuities, workers will be exposed to the risk of uncertain future inflation. Burtless claims that these risks, combined with the more conventional investment risk in the accumulation phase, are so significant and daunting that "they challenge the ability of a pension system based solely on individual accounts to deliver reliable income replacement in old age" (p. 9).

To back up this claim, Burtless produces calculations of account balances and annuity income, based on certain assumptions and annual data on asset returns, interest rates, and price inflation over the period from 1871 through 1999. In his empirical work, Burtless emphasizes the variability of asset returns, and hence the variability of account

[2] A prescription for reducing the cost of adverse selection in immediate annuities is to combine long-term care insurance ("LTCI") with the life annuity. The reduction in cost occurs because the integrated product attracts those individuals with lower-than-average life expectancies so that they gain access to LTCI not otherwise available to them. See Murtaugh, Spillman, and Warshawsky (2001) for empirical evidence on this point.

[4] Our inflation forecast series uses the Blue Chip survey for 1983 through 1991Q1, the Livingston survey for 1990Q2 and 1991Q2, and the Survey of Professional Forecasters for the remainder the time period investigated. See http://www.phil.frb.org/files/spf/cpie10.txt.

balances at the point of retirement. He also mentions, however, the importance of fluctuations in long-term interest rates which determine annuity prices. He notes that the simulated account balance/ labor earnings ratio was about the same for a worker who retired in 1982 as one who retired during the Great Depression. Yet Burtless found that the replacement rate provided by the defined contribution plan of the 1982 retiree was about two-thirds larger because interest rates (and hence, annuity income) were so much higher in the early 1980s than in the early 1930s.

Empirical Evidence: Simulated and Actual, Monthly and Daily

In return for a single premium to the insurance company, the fixed nominal annuity pays a constant stream of payments, generally monthly, to an individual, or, in the case of a joint-and-survivor annuity, a couple. An increasing annuity is also a nominal annuity, but its payments increase at a fixed rate determined at the time of purchase. Finally, an inflation-adjusted annuity has payments that increase with the rate of inflation actually experienced. Obviously, increasing and inflation-adjusted annuities will have lower initial payments than the fixed annuity for a given premium.

Our simulated annuity payments are produced by a model which considers the annuitant mortality rates projected using Social Security cohort tables and the full term structure of implied spot interest rates based on Treasury securities at the end of every month (or day) during the period of our analysis. (See the Appendix for more details.) For the most part, we use simulated annuity payments because data on actual prices on life annuities issued to 65-year-olds is not available for most of the time horizon for the frequencies we desire, nor for the annuity types (increasing and inflation-adjusted) we imagine for the United States. The simulated annuity payments reflect the factors determining the changes in annuity prices over time – interest and mortality rates. For the monthly simulations shown below, we consider only straight life annuities, that is, those annuities whose payments stop when the annuitant dies. In the daily simulations, because of the nature of the product for which we have actual payment data, we consider annuities with guarantee periods; that is, annuities whose payments continue for the length of the guarantee period if the annuitant dies before the end of the period and for life if the annuitant dies after the end of the guarantee period.

Monthly Simulations: Volatility in Initial Payments

Figure 1 shows the monthly payment per $100,000 single premium for nominal immediate fixed life annuities, simulated over the period 1983 through 2002, issued to 65-year-old male and female individuals and couples. We focus on the joint-and-survivor annuity because most households enter retirement as married couples. For example, the payment was as high as $1,148 for a joint-and-survivor annuity issued to a 65-year-old couple in May 1984, and as low as $535 in September 2002. Over the entire time period, the monthly nominal initial payment for a joint-and-survivor annuity averaged $742 and had a standard deviation of $131.

Besides range and deviation, another way of showing the volatility of annuity payments is to calculate one-year differences in monthly payments from nominal immediate fixed joint-and-survivor annuities simulated over the 1983-2002 period. This statistic might also be considered a measure of envy or regret resulting from the ill-timed purchase of a life annuity. As seen in Figure 2, one-year differences are volatile and can be large – as high as +21% in September 1994 and as low as -28% in March 1986.

Figure 3 shows the source of the volatility of annuity payments – interest rates. Although in our simulated pricing for nominal and increasing annuities we employ the entire horizon of implied spot interest rates derived from the full maturity spectrum of Treasury securities traded at the end of the month over the period 1983-2002, in the figure we only show one illustrative rate – the implied spot rate for a bond maturing in the twentieth year. Here we convert the annuity payment from monthly to annual to achieve comparability with interest rates. Clearly, annuity payments track interest rates fairly closely, and show similar volatility.

The volatility in nominal interest rates can come from many sources, including changing inflation expectations. Hence, we decided to investigate whether a nominal fixed annuity with monthly payments increasing based on a forecast of experts of long-range (10-year average) inflation at the time of purchase would exhibit less volatility.[4] In addition, we wanted to see whether this increasing annuity would adequately address inflation risk during the retirement period, another aspect of annuity risk.

Figure 4 shows the initial monthly payment per $100,000 single premium for nominal immediate life annuities increasing with an initial 10-year inflation forecast, simulated over the period 1983 through 2002, issued to 65-year-old male and female individuals and couples. We again focus on the joint-and-survivor annuity because most households enter retirement as married couples. For example, the initial payment was as high as $779 for a joint-and-survivor annuity issued to a 65-year-old couple in May 1984, and as low as $406 in September 2002. Over the entire time period, the monthly nominal initial payment for a joint-and-survivor annuity averaged $526 and had a standard deviation of $72.

The increasing annuity does not reduce the volatility of initial payments. As indicated above, the range and standard deviation of payments are large. Also, as shown in Figure 5, the one-year differences in monthly initial payments from immediate fixed increasing joint-and-survivor annuities simulated over the 1983-2002 period exhibits considerable volatility. The one-year differences can be large – as high as +26% in September 1994 and as low as -33% in March 1986 – actually greater volatility than the nominal fixed annuity. Of course, the increasing annuity has longer duration than the nominal fixed annuity.

Finally, we consider an alternate strategy to reduce volatility in initial payments from nominal fixed (and increasing) annuities, namely, phased purchases over a short time period. In particular, we consider a three-year purchase period, represented here by averaging the simulated nominal payments over the same month in three consecutive years. In Figure 6, we show one-year differences in initial monthly payments from a three-year phased purchase of nominal joint-and-survivor immediate fixed annuities. The volatility is reduced considerably – the worst observation is about -13% in June 1987, and, more recently, one-year differences were rarely over 6% in either positive or negative directions.

Monthly Simulations: Inflation Risk

Figure 7 illustrates how well an increasing annuity did during the 1983-2002 period in covering inflation risk.[5] As indicated in the figure, forecasts by experts consistently overestimated 10-year inflation until late 1998. Hence, an increasing annuity did a more than adequate job of covering inflation risk, at least according to recent experience. The trade-off for a rate of increase above actual inflation would have been an initial monthly payment lower than necessary.

An obvious solution to the problem of post-retirement inflation risk is an inflation-adjusted immediate life annuity. Such annuities exist in the United Kingdom and it is technically possible to issue them in the United States owing to the existence since 1997 and 1998 of Treasury inflation-protected securities (TIPS). Nevertheless, these annuities are not widely issued in the United States.[6] Moreover, evidence produced by Brown, Mitchell, and Poterba (2001) from the United Kingdom indicates that the money's worth of inflation-adjusted annuities is worse than nominal annuities. This likely owes to the absence of inflation-protected corporate securities, whose yields would be higher than Treasury securities. Inflation-adjusted corporate securities would be the natural preference of insurance companies skilled in investing in the corporate bond and mortgage markets and issuing such insurance products.

It should be noted that our annuity pricing methodology is more limited in the inflation-adjusted case than in the nominal cases, because the time period of analysis only begins in 1998 when 30-year TIPS were first issued, and a full term structure of implied real spot rates is impossible to calculate. Also the current TIPS market has somewhat limited depth. Several important caveats result: Our estimates of prices of inflation-adjusted annuities are probably lower (payments higher) than would obtain in an actual market, and the volatility of our simulation results might differ from that of an actual inflation-adjusted annuity.

In Figure 8, the initial monthly payment per $100,000 premium is compared with the payment on a nominal fixed annuity. Obviously, the initial payment for the inflation-adjusted annuity is lower, but it covers inflation risk and it is also substantially less volatile, at least over the period for which we have data. This lower volatility is also exhibited in Figure 9, where the one-year differences in initial monthly payments are shown for the inflation-adjusted annuity. The maximum one-year differences is under 10% in either a positive or negative direction, a reduction of over 45% relative to the maximum one-year differences for the nominal fixed or increasing annuity over the same time period.

[5] Actually, for the years since 1993, the jury is still out, as we had to insert the forecasted inflation rate for quarters where we do not yet have actual experience.
[6] The Thrift Savings Plan does offer US federal government employees the choice of annuities indexed to the CPI up to 3% annual changes, and one major insurer issues to the public an inflation-adjusted annuity.

Table 1 summarizes the main results of our monthly simulations.

Daily Simulations and Actual Observations

To get a rough idea of how well our model simulates payment amounts, we compare our results to actual annuity payment data. In Figure 10, we show simulated monthly payment rates from annuities issued on a daily basis. In particular, we show the monthly initial payment per $100,000 single premium for nominal immediate fixed life annuities, simulated over the period February 1, 2002 through December 31, 2002, issued to 65-year-old male and female individuals and couples. Unlike the monthly statistics in Figures 1 through 9, here we consider immediate life statistics with guarantee periods – 10 years for individuals and 20 years for couples. We again focus on the joint-and-survivor annuity because most households enter retirement as married couples.

In Figure 11, we show monthly payment rates on joint-and-survivor nominal fixed immediate life annuities actually available over the Internet issued by an AAA-rated life insurance company. Clearly rates are changed frequently, but not as often as daily (although the frequency does appear to pick up toward the end of the period), and hence volatility is somewhat lower than we have simulated. We use a money's worth calculation to judge how close our payments come to those of this particular company. Figure 12 shows the money's worth ratios (actual payment over simulated payment) in a relatively small band around 1.0. As interest rates increase, the money's worth ratios decline somewhat; apparently, this insurance company lags changes in interest rates slightly in its annuity pricing. A money's worth ratio so close to one is surprising because the insurance company must cover its expenses and make a profit. It is feasible here, however, because the insurance company likely invests in long-term corporate securities earning yields higher than the interest rates based on Treasury securities that we use. It is also possible that this insurance company has alternative, less conservative, mortality views than ours, which are based on the Social Security Administration's intermediate projections of improvements in life expectancy. In any case, our simulations follow the level and trend in the actual payment data very closely.

Strategies and Possible Policy Implications

We posed a set of questions at the beginning of this paper, on whether the risks arising from defined contribution plans are too large, are avoidable, or are worth the trade-off for other advantages obtained. As applied to life annuities, we transposed these questions mainly in terms of the volatility of initial retirement payments, over time, produced by annuities. Clearly the volatility of fixed and increasing annuity income over the recent time horizon is generally not as large as that cited by Burtless when he compared the early 1930s and early 1980s. Nevertheless, by some measures (for example, annual differences), it can be significant. What are the options available to reduce the effect of this volatility, while still obtaining the considerable advantages of defined contribution plans?

As we saw in the prior section, because of the lower volatility of real interest rates, inflation-adjusted annuities have much lower volatility than nominal fixed and increasing annuities, and hence represent lower risk in the sense that we are discussing. In addition, these annuities have the obvious advantage of providing excellent coverage for post-retirement inflation risk. Probably an important challenge to inflation-adjusted annuities is public understanding and appreciation of the size and scope of inflation risk over a potentially extended retirement period. Another challenge to these annuities is that currently the only securities that are inflation-protected in the United States are issued by the Federal Government; owing to lower returns on government securities than yielded by private securities, annuities backed by these securities would tend to offer lower payments. This is an area worthy of further exploration by financial engineers and researchers.

Another option is to phase the purchase of fixed annuities over a short period of time. As we saw in the prior section, this smoothing of purchases reduces the volatility of initial annuity payments over time. There is presumably some increase in administrative costs and complexity from this strategy, but automation could reduce these costs substantially. It is consistent with phased retirement, an important new trend in labor force participation at older ages. Moreover, it can be implemented with the purchase of annuities with staggered deferral periods, so that payments begin all at once. A close variant of this strategy would be a one-time purchase of an immediate variable life annuity with the underlying investment pool a diversified collection of medium-term fixed income securities.

A modest step toward smoothing the volatility of initial payments could be accomplished without needing a phase-in purchase by having the insurance company smooth its immediate annuity payment rates by basing annuity prices on moving averages of long-term interest rates over short time periods, say three or four months. Although it may be difficult to require this in the individual market, where the competitive pressure to achieve the highest possible current payment rates leads to mark-to-market pricing, some modest smoothing should be possible to achieve in immediate contracts negotiated with group retirement plans, at a cost. In particular, the insurance company can pursue hedging strategies using interest rate futures and options extending three months, or alter its investment strategy appropriately. As explained in Poterba and Warshawsky (2000), the prices of annuities purchased by the Thrift Savings Plan for its beneficiaries through a bid-out group contract are based on a three-month moving average of government bond interest rates.

Additional research is warranted into other approaches to mitigate annuity risk and promote investment diversification generally. There may be a place for immediate variable annuities based on more volatile asset classes, such as equities or real estate. Of course, there is no volatility in the initial payments from immediate variable annuities, as the initial payment is based on a fixed assumed interest rate, usually four percent. The volatility from such annuities occurs after the initial payment, when the underlying asset portfolio changes value, and indeed that is the advantage of fixed annuities, whether nominal or inflation-adjusted – they offer more predictability in the stream of income received during retirement.

Further research into the annuity risk and diversification properties of reverse annuity mortgages could also prove fruitful. Finally, investigation is needed into the diversification effects of other asset classes in the accumulation phase, both in the individual account held as part of the defined contribution plan, and in the household's net worth held outside of formal retirement plans, especially owner-occupied housing. In particular, it would be helpful to know more about the appropriate role of bonds and other interest-rate sensitive investments in a dynamic investment strategy for an accumulation portfolio, as retirement is approached.

Appendix

We use the following formula to derive the monthly payment A from a \$100,000 premium immediate annuity:

$$(1) \qquad A = \frac{100{,}000}{\sum_{t=1}^{599} \frac{M_t}{[(1+i_t)^{1/12}]^t}}$$

where M_t is the probability that a person will live t months after exact age 65 conditional on having lived to age 65, and i_t is the interest rate in period t.

The nominal interest rates used in the annuity calculations come from a Treasury Department summary file of implied spot rates derived on a daily basis from treasury security yield curves. The file contains rates at six month intervals out to 30 years (we use the last rate in the series to discount after age 95) for dates beginning in late 1982. We use the rates on the last business day of the month in our calculations.

The appropriate mortality rates to use in the calculation are cohort rates for the annuitant population. Because the only published mortality tables for the annuitant population are period tables, we use the method of Mitchell *et al.* (1999) to convert the annuitant period tables to cohort tables. We assume that the ratio of cohort mortality risk (for the birth cohort age 65 in the reference year) to period mortality risk (in the year the individual turns 65) for a given age is the same for the annuitant population as that for the Social Security area population. Specifically,

$$(2) \qquad AC_t^a = \frac{SC_t^a}{SP_{t+65}^a} AP_{t+65}^a$$

where AC is the annuitant cohort mortality, SP is the SSA period mortality, and so on, a is the age, t is the mortality table year, $65 \le a \le 115$, and $1918 \le t \le 1937$. (Note that this is equivalent to assuming that the decline in mortality risk between a person age x in year y and a person age x in year $y + (x - 65)$ will be the same in the annuitant population as projected for the Social Security area population.) These assumed cohort annuitant mortality rates are then converted to the conditional rates found in equation (1).

We created annuitant period life tables for 1984-1999 by linearly interpolating between the published 1983 IAM Basic period life tables and the Annuity 2000 basic tables.[7] We 'grew' annuitant tables for 2001 and 2002 from the Annuity 2000 table by applying the same change in mortality at each age as found in the SSA period tables for those years. The SSA period tables came from the background data for the 2002 Social Security Trustees' Report (TR02).[8]

[7] Data from Society of Actuaries web site: www.soa.org/tablemgr/tablemgr.asp.
[8] TR02 mortality tables include actual mortality for 1983-1999 and projected mortality for 2000-2001.

Because we want the calculations to represent the price of an annuity as it would have been calculated at a particular date (i.e., without the benefit of hindsight with regard to mortality outcomes), we need cohort tables that are generated from data available in the year of presumed purchase. We had cohort tables for 1935 to 1937 from the 2000 to 2002 Trustees' Reports, respectively. We created a 1927 cohort table by interpolating between 1925 and 1930 tables published in a 1992 SSA Actuarial Study. To anchor the cohort series, we created a cohort table for 1983 by first interpolating between period tables for 1980-2040 published in a 1983 SSA Actuarial Study, and then compiling the appropriate mortality rates for the 1918 (age 65 in 1983) birth year. Finally, we interpolated between the 1918, 1927 and 1935 cohort tables to fill in the missing years.

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Table 1. Simulated Initial Monthly Payments, Joint & Survivor Annuity, 1983-2002

	Nominal	Increasing	Phased Purchase	Inflation-Adjusted*
Average	$742	$526	$736	$492
Standard Deviation	$131	$72	$104	$21
Range	$535 - $1,148	$406 - $779	$578 - $1014	$437 - $529
Max. One-Year Difference	-28% / +21%	-33% / +26%	-13% / +5%	-10% / +7%

* April 1998 to December 2002

Figure 1
Monthly Payment per $100,000 Single Premium
Nominal Immediate Fixed Annuity: 1983-2002 Simulations

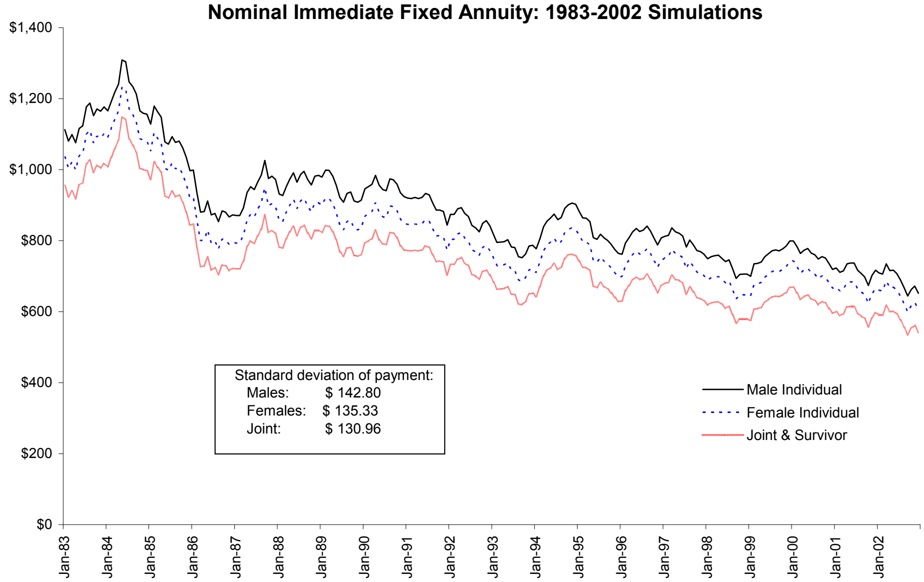


Figure 2
One-Year Differences in Monthly Payments
Nominal Immediate Fixed Joint & Survivor Annuity:
1983-2002 Simulations

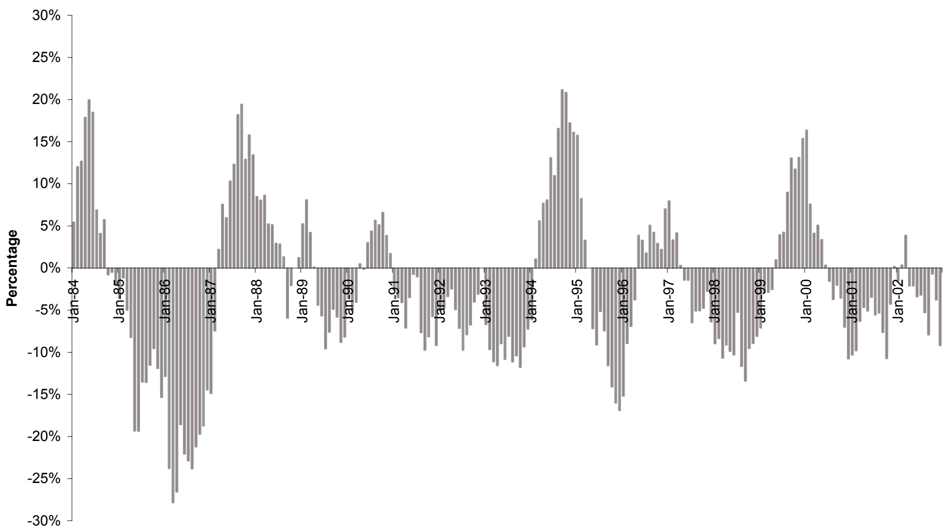


Figure 3
Interest Rates and Annual Payment as Percentage of Single Premium
Nominal Immediate Fixed Joint & Survivor Annuity:
1983-2002 Simulations

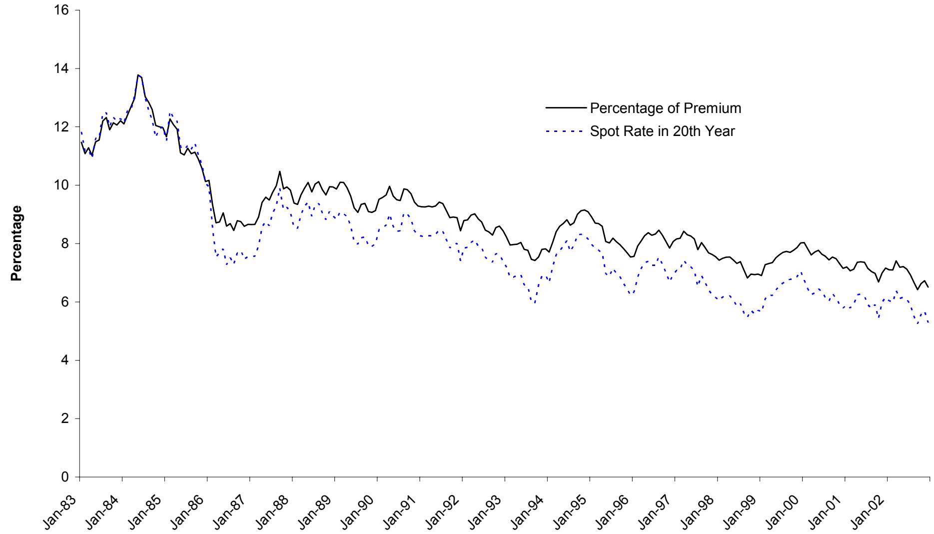


Figure 4
Initial Monthly Payment per $100,000 Single Premium
Immediate Fixed Annuity Increasing with
Initial 10-year Inflation Forecast

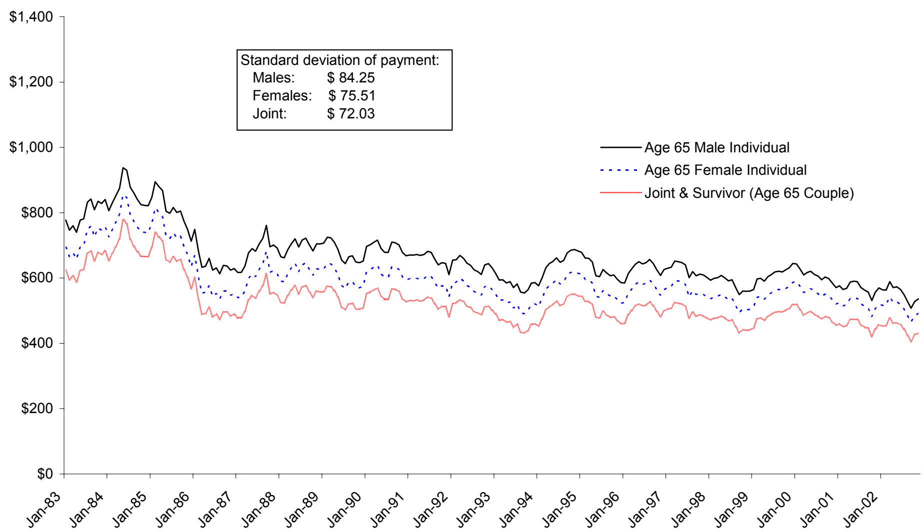


Figure 5
One-Year Differences in Initial Monthly Payments
Immediate Increasing Joint & Survivor Annuity:
1983-2002 Simulations

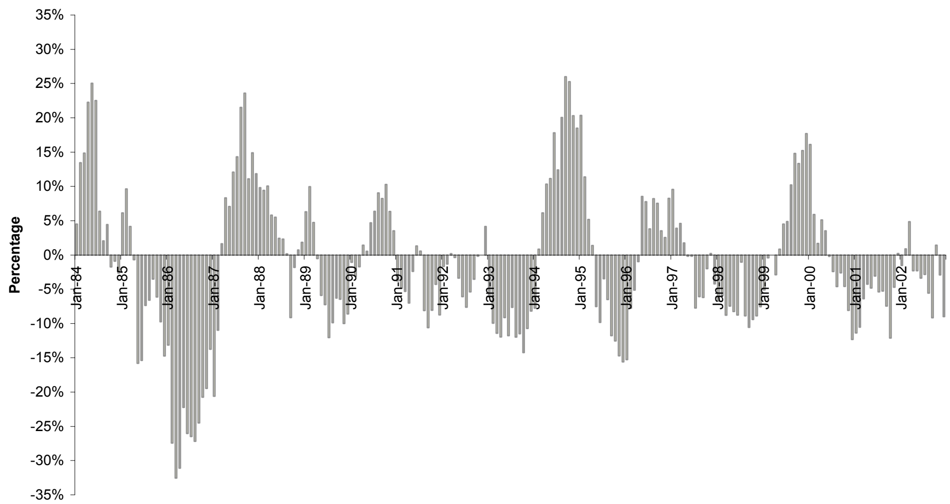


Figure 6
One-Year Differences in Initial Monthly Payments
Nominal Fixed Joint & Survivor Annuities Purchased over Three Years:
1983-2002 Simulations

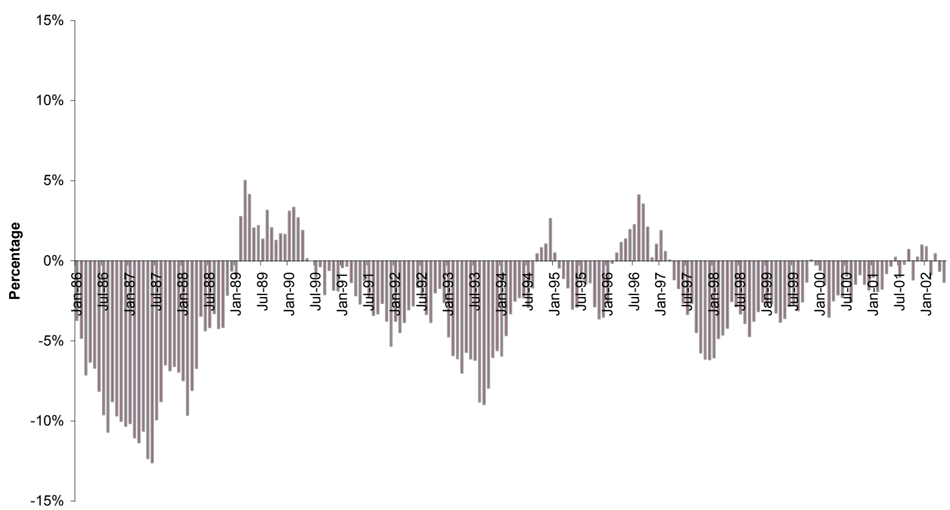
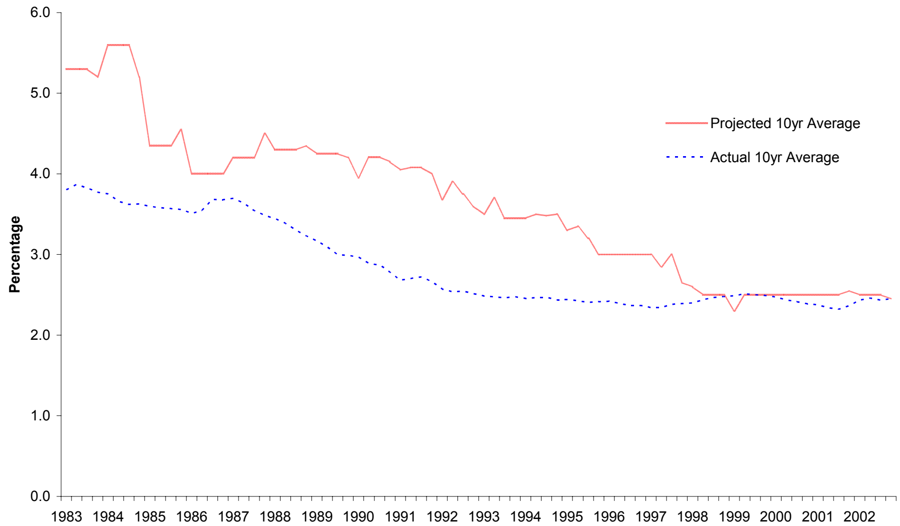


Figure 7
Actual versus Forecast 10-year Average CPI Inflation



Note: Beginng in 92q3, actual average incorporates 02q2 forecast.

Figure 8
Initial Monthly Payment per $100,000 Premium
Inflation-Adjusted Annuity: 1998-2002 Simulations

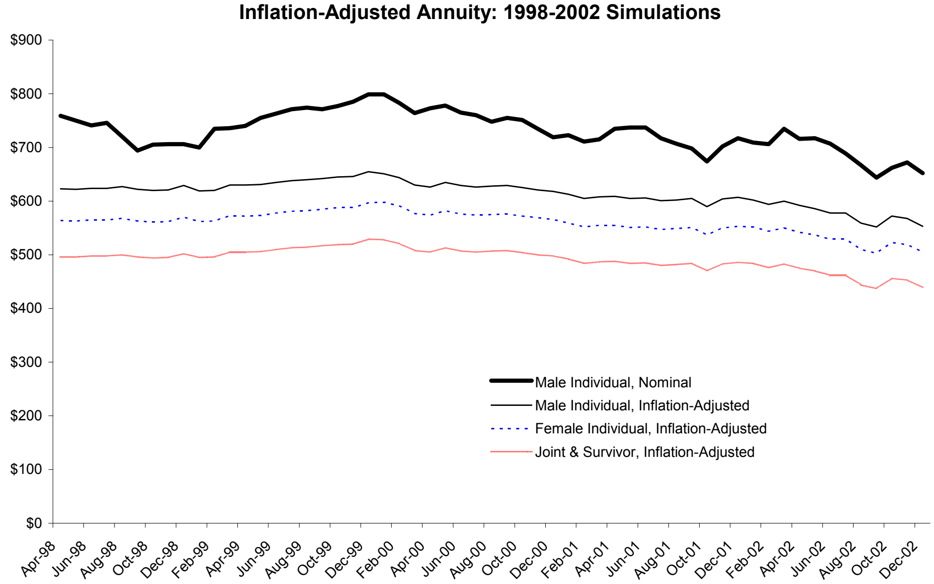


Figure 9
One-Year Differences in Initial Monthly Payment
Inflation-Adjusted Joint & Survivor Annuity:
1998-2002 Simulations

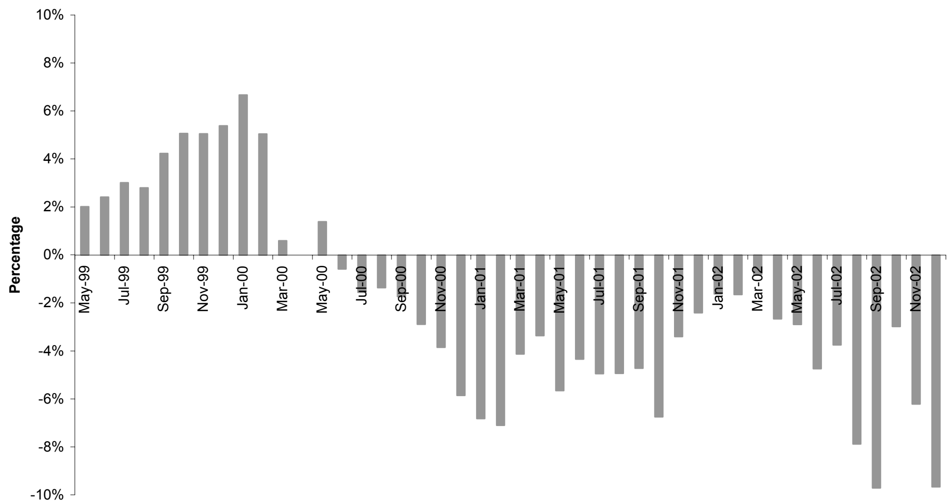


Figure 10
Monthly Payment per $100,000 Premium, Nominal Fixed Annuity
(with 120 month guarantee period for individuals, 240 months for J&S)
Daily Simulations, 2/1/02 to 12/31/02

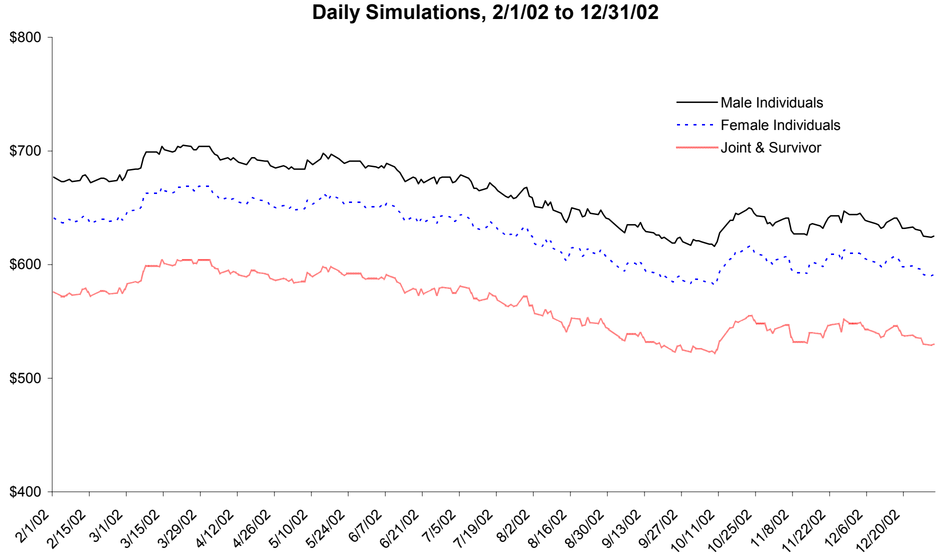


Figure 11
Monthly Payments per $100,000 Premium, Nominal Fixed Annuity
(120 month guarantee for individuals, 240 months for J&S)
Daily Internet Quotes, AAA-rated Life Insurance Company, 2/1/02 to 12/20/02

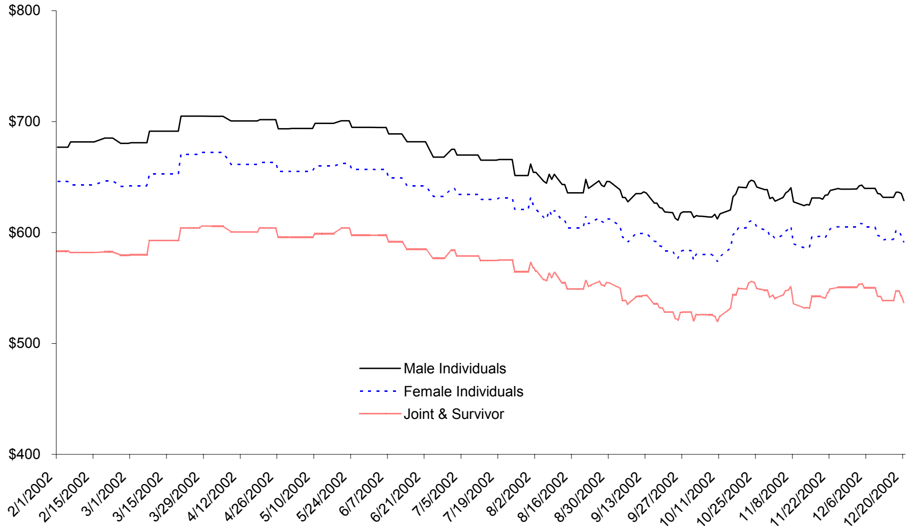


Figure 12
Daily Money's Worth Ratios, Nominal Fixed Annuity
(actual payment / simulated payment)