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A further examination of equity indexed annuities

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Abstract

Equity indexed annuities (EIAs) are deferred annuities that credit interest according to a formula tied to the performance of an underlying equity index. This research expands previous research, particularly that of Reichenstein (2009, 2011), by examining the distribution of returns that could have been created on a rolling monthly basis since 1928 for 11 through 15-year investment horizons. Second, we examine investment alternatives that include the options imbedded in EIAs. Third, rather than assuming constant cap rates we allow cap rates to vary with interest rates. We find that for long time horizons the opportunity costs of investing in EIAs is high.

JEL classifications: G2; Equity Indexed Annuities; Investments

Keywords: Indexed annuities; Equity indexed annuities; Investments

1. Introduction

Equity indexed annuities, hereafter EIAs, are deferred annuities that credit interest according to a formula tied to the performance of an underlying equity index. Academic research has been limited to explaining the complex financial product and calculating and comparing returns on EIAs with those of alternative investments. This research expands previous research, and particularly that of Reichenstein (2009, 2011), in three ways. First, rather than examining limited sub-periods of returns data, we examine the distribution of returns that could have been created since 1928. Second, unlike previous research, we also

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examine investment alternatives that include the options imbedded in EIAs. Third, unlike prior research, we allow cap rates to vary with interest rates. We find that for long time horizons alternative strategies dominate EIAs as an investment vehicle.

The article is organized as follows: Section 2 discusses EIAs, their features, and the underlying economics from the issuing insurance company perspective. Section 3 presents a summary literature review. Section 4 expands the work of Reichenstein (2009, 2011), whereas Section 5 furthers prior research by examining investment alternatives with options. Section 6 concludes the article.

2. EIA's background, contract features, and economics

Within the insurance industry deferred annuities are typically classified as *fixed* or *variable*. Variable annuities have investment returns that vary depending on the performance of the underlying subaccount investments. The choices of subaccounts are very similar to the choices available for mutual funds. Variable annuities also contain a "death benefit" where the beneficiary is guaranteed to receive at least the initial investment less any withdrawals. Variable annuities are treated as securities and are regulated by the SEC.

Fixed annuities are contracts wherein the insurance company guarantees fixed returns and payouts. During the accumulation period the contract earns interest at rates pre-specified by the insurance company or spelled out in the contract formula. They are very similar to Guaranteed Investment Contracts (GICs). Unlike variable annuities, fixed annuities do not have subaccounts with underlying investments. Fixed annuities have been around for quite some time, and most fixed annuities are not considered securities and are not regulated by the SEC.

Within the fixed annuity classification are traditional *fixed rate annuities* and *equity-indexed annuities* (EIAs).[1] Fixed rate annuities have a guaranteed minimum interest rate and a current rate. As the names imply, the guaranteed minimum is the lowest rate that will be credited to the contract value, whereas the current rate is usually adjusted annually based on market conditions and cannot be less than the guaranteed minimum. EIAs were originally introduced in 1995. EIAs differ from traditional fixed annuities in how interest is credited. For EIAs, the interest credited usually varies between zero and an upside amount that is determined by the contract formula, but that is linked to the performance, variously measured, of an underlying equity index, for example, S&P 500. EIAs are marketed as a way to participate in the market upside while being protected against the downside and while receiving a guaranteed minimum return.[2]

EIAs are complex financial products that typically bundle a deferred annuity with death benefits and annuity payout options. The number and variability of the features within a contract make them exceedingly complex. These features, including investment, regulatory, insurance, and tax attributes, have already been discussed at length in McCann (2008) and Reichenstein (2009). Consequently, only those aspects most pertinent to this research are repeated below.[3]

2.1. Interest crediting formulas and limits

In general interest is credited based on the percentage change in an underlying equity index. The percentage change reflects price appreciation only and does not include dividends. The two most common methods are point-to-point and monthly averaging. In the former, the percentage change between two points is calculated, typically on an annual basis, and the ending index value one period becomes the beginning index value for the next. The latter measures the percentage change in the index level from a starting date, usually the contract purchase date or anniversary date, to an average value over the subsequent period. Typically the average is calculated on a monthly basis.[4] This, and most of the prior research, examines annual reset, point-to-point interest calculations.

Contract owners generally do not receive an interest rate equal to the total percentage change in the index value, rather the rate credited is usually limited in one or more of several ways:[5] Most EIAs have a *cap rate* that limits the percentage change to be applied to the EIA. For example, a 3% cap means that the interest credit will be limited to 3% of the EIA contract value, regardless of how much the underlying equity index actually increased. For contracts with annual resets, insurance companies usually have the option to change the cap rates. Contracts may also specify a minimum cap rate for the contract term. In addition to a cap rate, a *participation rate* indicates what percentage of the index increase will be used to calculate the interest credit. For example, if the participation rate is 80% and the percentage change in the index is 6%, then 4.8% (80% $\times$ 6%) would be the rate used to determine the interest credit. Like cap rates, the initial participation rate is usually guaranteed and after the first year the insurance company has the option of changing the rate. With a *spread* or *margin*, the interest rate used to calculate the interest credit is determined by subtracting a "spread" or "margin" from the percentage change in the index. For example, if the spread is 2.5% and the percentage change in the underlying equity index value, however calculated, is 7%, then 4.5% (7% to 2.5%) would be used to determine the interest credit. Some contracts specify a maximum spread and some contracts will combine a spread with a cap. Finally, EIAs have a minimum crediting rate of 0%, which is one of the selling points.

2.2. Contract values

Most contracts have three different values: contract (accumulation) value, guaranteed minimum value, and cash surrender value. The *contract value* is a notional amount equal to the original premium amount plus any vested bonus plus interest credited, less withdrawals. The *guaranteed minimum value* is calculated as a percentage of the initial premium, and increases each year by the guaranteed minimum interest rate specified in the contract. This table of values is calculated at the time of the contract and does not change. The *cash surrender value* is usually the greater of the contract value less surrender charges, or the guaranteed minimum value. Surrender charges can start out as high as 20% and last 15 or more years. The actual cash surrender value over time will be higher than that included in the contract illustration page on contract date if the interest rate calculated from the index formula is greater than the guaranteed minimum interest rate.

There are some very important things to note. First, in many cases a contract will have a combination of the above limits. For example, a contract could have both a 6% cap and a 1.6% margin in the first year. The length of the surrender period and surrender percentages will also vary with these interest credit limits, leading to a myriad of possible contract combinations. Second, the caps, margins, and participation rates are typically guaranteed for only one year and then may be changed at the insurance company's discretion (see the economics of EIAs below). Third and really important is that there is a significant difference in the early years of a contract between the *contract value*, from which yields are calculated and reported to customers on annual statements, discussed in marketing efforts, and reported by VanderPal et al. (2011) and the *cash surrender value*, from which a true cash on cash yield should be calculated. The implication of this difference is that return comparisons should be made based on surrender values or should examine investment horizons greater than the surrender period.

2.3. Insurance features

Insurance features have already been discussed at length in Reichenstein (2009) and McCann (2008) and are not further discussed here.

2.4. The economics of EIAs

Below is an excerpt taken from American Equity's 2012 10-K report to shareholders that explains their business model:

> We specialize in the sale of individual annuities (primarily deferred annuities) and, to a lesser extent we also sell life insurance policies. Under accounting principles generally accepted in the United States, or GAAP, premium collections for deferred annuities are reported as deposit liabilities instead of as revenues. Sources of revenues for products accounted for as deposit liabilities are net investment income, surrender charges deducted from the account balances of policyholders in connection with withdrawals, realized gains and losses on investments and changes in fair value of derivatives. Components of expenses for products accounted for as deposit liabilities are interest credited to account balances, changes in fair value of embedded derivatives, amortization of deferred policy acquisition costs, other operating costs and expenses and income taxes.
>
> Earnings from products accounted for as deposit liabilities are primarily generated from the excess of net investment income earned over the interest credited to the policyholder, or the "investment spread." In the case of index annuities, the investment spread consists of net investment income in excess of the cost of the options purchased to fund the index-based component of the policyholder's return and amounts credited as a result of minimum guarantees. (American Equity 2012 10-K, pages 18–19)

Further, according to American Equity's 12/31/12 10-K, Note 5 to the financial statements, "On the respective anniversary dates of the index policies, the index used to compute the annual index credit is reset and we purchase new one-year call options to fund the next annual index credit. We manage the cost of these purchases through the terms of our fixed index annuities, which *permit us to change caps, participation rates, and/or asset fees,*

Table 1 Spreads of American Equity Annuities

	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Yield earned	5.28%	5.8%	6.06%	6.30%	6.20%	6.11%	6.14%	6.18%	6.28%	6.43%	6.91%
Cost of money	2.58%	2.77%	2.91%	3.26%	3.43%	3.51%	3.28%	3.38%	3.37%	3.46%	4.19%
Investment spread	2.70%	3.03%	3.15%	3.04%	2.77%	2.60%	2.86%	2.80%	2.91%	2.97%	2.72%
10-Yr treasury yield	1.97%	3.36%	3.85%	2.46%	3.91%	4.68%	4.37%	4.23%	4.38%	4.07%	5.2%

Source: American Equity 10-K's; U.S. Department of Treasury, Beginning of year 10-year yield.

subject to guaranteed minimums on each policy's anniversary date. By adjusting caps, participation rates, or asset fees, we can generally manage option costs except in cases where the contractual features would prevent further modifications." (Italics added)

American Equity and other companies selling EIAs, collect premiums from customers, which they treat as deposit liabilities, as would a bank, and then invest the money. Their investment portfolio consists mostly of highly rated corporate bonds, but also includes U.S. Treasury and government agency securities, state and municipal obligations, and mortgage-backed securities. Because equity securities are less than 0.5% of their portfolio, they buy one-year call options on the underlying indexes used in their EIA crediting formulas. They make profit by earning more on their investments than they have to pay their customers. This difference is called an "investment spread." As discussed above, the companies manage this investment spread by changing the caps, participation rates, and margin used to calculate the customers' interest credit. If yields on the underlying investment portfolio fall, or if call option premiums increase due to an increase in index volatility, the insurance company will change the limits to reduce the amounts credited to the customers' account values and maintain its spread between its "*cost of money*"—what it credits to the customers—and what it earns on their deposited funds.[6]

Because of a change in accounting rules, companies like American Equity now include the effect of derivatives' gains and losses with the underlying costs being hedged. Consequently, American Equity since 2001 explicitly discloses their "yield earned," their "*cost of money*," and their "investment spread." The "*cost of money*" represents what they have actually credited to their customers. There are a couple of significant points to note. First, these returns are lower than those reported in the VanderPal et al. (2011) studies discussed below because VanderPal's returns are based on contract values credited over successive five-year periods, whereas the returns actually credited to customers in the aggregate reflect reductions because of surrender charges or not receiving a full period interest credit. Second, it is important to note that customer returns depend more on bond yields than on underlying equity index values. As indicated in Table 1, "cost of money" is below 3.5% in both 2010 and 2012 despite S&P 500 returns in excess of 10% both years.

Table 1 above indicates that the *population* of American Equity's customers could have performed about as well over the last 11 years by simply purchasing 10-year Treasury securities. It is important to note that the credited rates in Table 1 are for the *customers as a group* and do not reflect the expected or actual rates for a *specific customer*. Rates for a specific customer will depend on that customer's contract specifications and on whether the customer incurs any surrender charges.

Reichenstein (2009) says “Since, by design, indexed annuities cannot add value through security selection, *all* EIAs *must* produce risk-adjusted returns that trail those offered by readily available marketable securities by their spread, that is by their expenses including transaction costs … we do not need empirical tests to state definitively that indexed annuities do not offer competitive risk-adjusted returns. Their structure ensures this is the outcome.” His essential point is that indexed annuities are simply repackaging returns that are already available to investors in the market place without adding any potential security selection or market timing value. The cost of this repackaging is the “spread.” In summary, the simple economics of EIAs is that investors are paying 2–3% annually in investor spreads to receive returns similar to those already available in the market, trivial insurance benefits, and to receive a no loss guarantee. This spread depends on yields on corporate and government bonds, policy acquisition costs (that include sales commissions paid and administrative costs), and option costs and is actively managed by the selling companies by changing caps and participation rate limits in the contracts after the first year. In higher yield environments, caps and participation rates will be higher for example. Currently, because bond yields are so low, caps and participation rates are lower. For example, most annual cap rates are currently in the 3–4% range.

3. Summary literature review

Reichenstein (2009) contains an in-depth review of most of the relevant and relatively little prior academic research into EIAs as investment products. Most of the previous empirical research on EIAs generally follows one of two methods typically used to analyze optimal withdrawal rates for retirement planning or to analyze pension plan shortfalls. One method uses Monte Carlo or similar simulations to create a probability distribution of possible outcomes, where the inputs for the simulations come from the historical return distribution over some time period.[7] The second method creates a distribution by examining all the returns that could have been generated from the actual history of returns.

In contrast, VanderPal, Marrion, and Babbel (2011) in their series of articles titled “Real World Index Annuity Returns” examine five-year returns actually credited to contract values for a sample of annual point-to-point with cap contracts. As discussed in Section 2 above, there is a significant difference between the contract value and realizable cash value, primarily because of surrender charges. Consequently, assuming their small sample selectively provided by one insurance company is representative, their returns are “real” only if surrender charges are ignored. Kuhlemeyer (2000) uses one, five, and nine-year point to point EIAs and also ignores the impact of surrender charges.

Huebscher (2011) provides an interesting critique of VanderPal, Marrion, and Babbel (2011) and further discusses Reichenstein (2009) and previous authors, indicating a real dichotomy in the research conclusions of the two groups of authors.

Table 2 below contains a summary of much of the prior research, indicating the time periods, methodology, and results/conclusions. Table 2 excludes research by Edwards and Swidler (2005) because, though they have similar features, equity linked certificates of deposit are different.

Table 2 Summary of Prior Research

Author(s)	Time period/return assumptions	Methodology	Results/conclusion
Collins, Lam, and Stampfli (2009)	1996–2008 (actual; 228 months of data)	Compare rolling seven year cumulative point-to-point and annual reset EIA payoffs with actual S&P 500 cumulative return	"EIA contract holder incurred significant opportunity cost during period . . . " "results highly sensitive to beginning and ending dates"
Collins, Lam, and Stampfli (2009)	1973–2008 (5,000 simulations using distribution statistics based on this time period)	Simulated payoffs on representative seven-year point-to-point and annual reset EIAs with various T-Bill and S&P500 combination portfolios	EIA's guaranteed cumulative return > 50% - 50% stocks-bills portfolio 16.1% of the time; maximum return < 50% - 50% portfolio 42% of the time
Kuhlemeyer (2000)	1925–1998	Random sample of 100,000 monthly returns with replacement to estimate EIA returns for one, five, and nine year point to point contracts	Finds the returns from EIAs to be less than exciting when compared with conventional alternatives
McCann and Luo (2006)	Simulations assuming mean S&P 500 return of 10% and SD of 20%	Compare simulated returns on a 10-year point-to-point EIA with 60% 10-Yr Treasury and 40% S&P 500	"96.9% of the time the investor is better off with Treasuries and stocks than with the EIA"
McCann (2008)	Simulations assume 12.5% expected annual S&P 500 return, 2.5% dividend yield	Compares simulated returns on a 14-year annual point-to-point, 4% monthly cap EIA with a 70% 14-Yr Treasury Strip and 30% S&P 500	"99.8% of the time the investor would be better off with the Treasury securities and stock than with the EIAs"
Reichenstein (2009)	1957–2008 Actual annual returns	Compares CAPM risk adjusted returns on various annual reset EIA contract types	Using an annual reset EIA with 7% annual cap, estimates an α of -1.92% and Sharpe ratio of -0.22
VanderPal, Marrion, and Babbel (2011)	1996–2010	Compute rolling five-year geometric average annual rates of return based on rates credited to a sample of annuity owners	5-year total returns based on credited rates outperform S&P 500 67% of time and 50% T- Bills/50% S&P 500 79% of the time

Unfortunately, a more direct comparison of the results of prior research is made more difficult not only by the differing time periods of study, but also by the fact that each study used EIA contracts with different characteristics. In reality, EIAs have several different contract variables that are not constant through time. The option to change contract values is valuable to the insurance companies and consequently ignoring this option likely biases the results in favor of the EIAs.

Table 3 Replication and extension of Reichenstein (2009)

Asset	Geometric average annual return	Ending wealth	Standard deviation	Sharpe ratio	α	β
1957–2008 originally reported by Reichenstein (2009) and replicated						
S&P 500	9.33%	$103.43	17.74%	0.31	0.0%	1.00
Treasury bills	5.27%	$14.45	0	0		
5-year Treasury notes	7.00%	$33.79	6.02%	0.31		
Annual reset - 7% cap	4.29%	$8.88	4.41%	−0.22	−1.92%*	0.17
Annual reset - 6% cap	3.72%	$6.70	4.05%	−0.38	−2.37%*	0.15
Annual reset - 5% cap	3.16%	$5.04	3.73%	−0.57	−2.82%*	0.13
1928–2012 (extended)						
S&P 500	9.48%	$2,210.14	20.50%	0.39	0.0%	1.00
Treasury Bills	3.55%	$19.32	0	0		
5-year Treasury Notes	5.37%	$85.35	5.13%	0.38		
Annual reset - 7% cap	4.11%	$30.78	4.58%	0.13	−0.01%**	0.16
Annual reset - 6% cap	3.56%	$19.61	4.23%	0.00	−1.0%*	0.14
Annual reset - 5% cap	3.01%	$12.44	3.92%	−0.14	−1.5%*	0.12

*significant at 1% level.
**significant at 10% level.

4. Extension of Reichenstein

Reichenstein (2009) regressed hypothetical annual returns from a variety of annual reset EIA contracts on the S&P 500 over the 1957–2008 period to estimate CAPM βs. His β estimates ranged from 0.10 for a 4% cap to 0.17 for a 7% cap.[8] He then shows that, on a CAPM risk-adjusted basis, EIAs underperform the S&P 500 and Treasury Bills by 2–3% from 1957 to 2008. The magnitude of this underperformance is completely consistent with the investment spreads discussed in Section 2 above. Reichenstein's analysis used annual January through December returns, assuming someone invested in January 1957 and remained invested through December 2008, to estimate CAPM βs, αs, and Sharpe ratios. It thus captures only one of many possible return sequences that would have actually been available to investors. We extend his original analysis in three ways. First, we use monthly data going back to 1928 and re-estimate his regression equations for the 7%, 6%, and 5% EIA with annual reset.[9] These results are reported in Table 3.

As indicated in Table 3, extending the time period to include the volatile and depressed 1930s increases the standard deviation and Sharpe ratio of the S&P 500. In addition, including the prior and most recent years when Treasury yields were significantly lower drives down the compound annual return on bills from 5.27% to 3.55%. Though the geometric average return over the extended period is slightly lower for the 7% cap EIAs (4.11% v. 4.29%), it nevertheless exceeds that on bills leading to a positive Sharpe ratio. The estimated αs for EIAs over the extended period were less negative and the estimated βs were essentially the same as in Reichenstein (2009). These changes make intuitive sense given the inclusion of several periods with negative equity returns.

Second, we create portfolios consisting of the S&P 500 and Treasury Bills and then calculate every possible 11 through 15-year sequence of returns that could have been generated on a rolling monthly basis during this extended time period. We choose 11–15 year horizons because, as discussed previously in Section 2 above, EIAs have surrender periods lasting 10 years and longer. Calculation of shorter horizon returns would have to account for early surrender penalties. We create equity/bill (EB) portfolios having the same systematic risk as the EIAs. Therefore, for example, the 7% cap EIA is compared with an EB portfolio consisting of 16% equity and 84% bills and having a β of 0.16 (see bottom of Table 3). Similarly, the 5% cap EIA is compared with an EB portfolio consisting of 12% equity and 88% bills and having a β of 0.12. An annual cost ratio of 0.3% is deducted from the S&P 500 raw annual return to convert it to a realistic mutual fund return, though in reality annual expenses and trading costs are currently closer to 0.05% for Vanguard's S&P 500 ETF and 0.17% for Vanguard's S&P 500 Index mutual fund.[10] We understand that neither EIAs nor ETFs existed before the 1990s, but nevertheless can calculate hypothetical returns for those products using the returns generated by history.

Third, unlike prior EIA research where caps are assumed to remain constant over the time period examined, we allow cap rates to vary with interest rates. Specifically, we assume the cap rate is equal to the Treasury bond yield plus 2.5%. As explained in Section 2 above, insurance companies have the option of changing many of the EIA contract features after the first year. In particular they change the participation rates, spreads, and cap rates to maintain their investment spreads. Because our benchmark EIA assumes 100% participation and no spread, we focus on changes in the cap rate. Insurance companies change cap rates in response to changes in interest rates. In particular, when interest rates are higher and their bond portfolios are earning more, they will raise cap rates. Similarly, as in recent history, when interest rates are low, cap rates will be lower.[11]

Using actual total monthly returns on the S&P 500 dating back to 1928 and assuming an annual expense ratio of 0.30%, *every possible sequence* of rolling 11-year, 12-year, and so on through 15-year holding period return, beginning at the end of every single month, was calculated.[12] For example, there were 889 sequences of rolling 11-year returns and 841 sequences of rolling 15-year returns. The ending value of a $1 invested in the hypothetical EB portfolio is then compared with the ending value obtained from investing $1 in a hypothetical EIA. The benchmark EIA assumes an S&P 500 Index annual point-to-point calculation with caps of 7%, 5%, and T-bond yield + 2.5%, respectively. The first two EIA calculations assume that the same cap remains in effect during the entire holding period.

For every possible 11 through 15-year holding period the hypothetical EB portfolio ending investment value is divided by the EIA ending value. A ratio of 1 indicates the two values are equal (breakeven), while a value greater than one indicates the hypothetical EB portfolio has a higher value than the EIA, and a ratio of less than 1 indicates the EB portfolio has a lower value. The result is a distribution of every possible value comparison (ratio) that could have been created since 1928 using actual historical returns. From this distribution percentiles are calculated and presented. The percentiles represent the percentage of times an observed ratio was less than (greater than) the reported ratio for percentiles below (above) the mean. The breakeven column represents the percentage of the time the EB portfolio fails to outperform the EIA.[13]

Table 4 Ending wealth ratio of S&P Index fund equity/bill (EB) portfolio to EIA

Years	Percentile − 0.16 β portfolio/7% cap EIA										EB portfolio value			
	1	5	10	25	50	75	90	95	99	*N*	BE	< $1	Min	95th%
11	0.73	0.79	0.83	0.98	1.12	1.29	1.64	1.76	1.84	889	27.4%	0.6%	$0.98	$2.86
12	0.72	0.79	0.84	0.99	1.14	1.34	1.72	1.83	1.92	877	25.8%	1.0%	$0.97	$3.15
13	0.73	0.78	0.83	1.01	1.17	1.42	1.76	1.89	1.99	865	24.2%	0.2%	$0.99	$3.36
14	0.71	0.78	0.84	1.03	1.20	1.51	1.81	1.95	2.05	853	23.7%	0.0%	$1.03	$3.61
15	0.70	0.78	0.86	1.05	1.23	1.60	1.87	2.00	2.10	841	22.2%	0.0%	$1.05	$3.96
	Percentile − 0.12 β portfolio/5% Cap EIA										EB portfolio value			
11	0.81	0.86	0.90	1.05	1.19	1.42	1.84	1.93	2.01	889	21.5%	0.2%	$1.00	$2.78
12	0.81	0.86	0.90	1.08	1.22	1.50	1.93	2.03	2.11	877	20.6%	0.3%	$0.99	$3.03
13	0.81	0.86	0.91	1.11	1.26	1.59	2.01	2.11	2.20	865	18.3%	0.0%	$1.01	$3.24
14	0.80	0.85	0.91	1.14	1.30	1.70	2.07	2.18	2.27	853	16.5%	0.0%	$1.04	$3.47
15	0.78	0.86	0.93	1.16	1.34	1.83	2.15	2.26	2.37	841	15.7%	0.0%	$1.06	$3.76
	Percentile − 0.16 β portfolio/(T-bond + 2.5%) Cap EIA										EB portfolio value			
11	0.82	0.87	0.90	1.01	1.11	1.24	1.36	1.41	1.47	889	22.6%	0.6%	$0.98	$2.86
12	0.82	0.86	0.90	1.03	1.14	1.27	1.41	1.46	1.52	877	20.3%	1.0%	$0.97	$3.15
13	0.83	0.86	0.90	1.04	1.17	1.31	1.45	1.50	1.63	865	20.3%	0.2%	$0.99	$3.36
14	0.83	0.86	0.91	1.05	1.19	1.36	1.49	1.56	1.76	853	19.0%	0.0%	$1.03	$3.61
15	0.82	0.87	0.92	1.07	1.21	1.39	1.55	1.62	1.76	841	17.4%	0.0%	$1.05	$3.96

BE, breakeven percentile (percentage of times wealth ratio <1).

As Table 4 indicates, the (EB) portfolio had a median value that ranged from 12% higher than a 7% cap EIA over an 11-year horizon to over 34% higher than a 5% cap EIA over a 15-year horizon. At the shortest horizon (11 year) and highest cap (7%) the EB portfolio was outperformed 27.4% of the time by the EIA. At this same time horizon and cap level, the EB portfolio returned at least 27% more than the EIA approximately the same percentage of the time. At the longest horizon (15 years) and lowest cap (5%) the EB portfolio was outperformed by the EIA only 15.7% of the time. At this same time horizon and cap level the EB portfolio returned at least 102% more than the EIA over 15% of the time.

For the variable cap EIA the mean cap over the time period was 7.2%, with a minimum value of 2.6% and a maximum of 18.9%. Comparing the same EB portfolio against the constant 7% cap EIA versus the variable cap EIA we find that the median wealth ratios are similar, but the wealth ratio using the variable cap EIA has a lower breakeven of about 5% for all holding periods, indicating it outperforms 5% fewer times. Thus, the constant cap assumption used in previous research biases the results in favor of EIAs.

Because one of the selling features of EIAs is the downside protection, Table 4 also indicates the percentage of times the EB holding period return was negative (i.e., ending value was less than $1), the minimum value of a $1 investment, and on the upside, the value of a $1 investment at the 95th percentile. As indicated in Table 4, for 14 and 15-year holding periods, EB portfolio returns were never less than 0. For the 15-year horizon the minimum return was 5% over all three portfolios. The far right column illustrates that 5% of the time

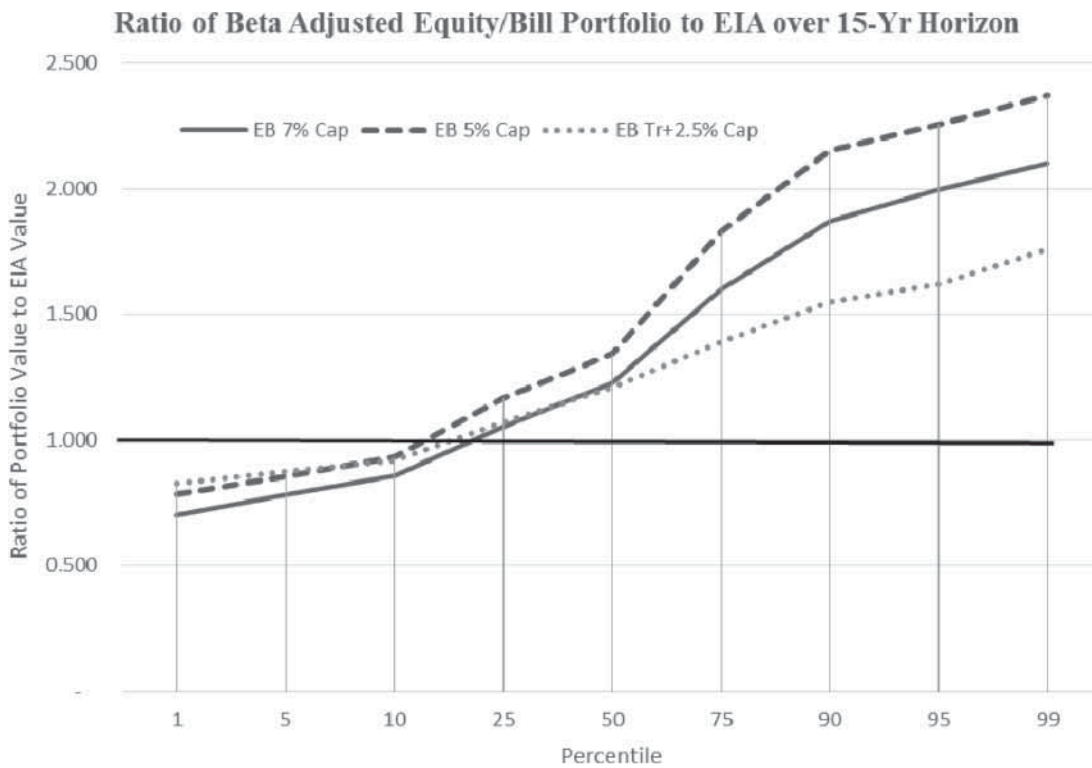

Fig. 1. Ratio of β adjusted equity/bill (EB) portfolio to equity indexed annuities (EIA) over 15 year horizon.

investors would have earned approximately 3.5 or more times their initial investment over the 14 and 15-year holding periods.

Fig. 1 plots the data from Table 4 above for the 15-year time horizon. For long horizon investors there appears to be a significant opportunity cost at stake for the down-side protection provided by the EIA. Recall that ratios less than one indicate the portfolio was outperformed by the EIA, not that the portfolio lost money. There were no negative 15-year holding period returns for any of the portfolios. The worst horizon-period performance occurred for the 12-year horizon, 0.16 β EB portfolio where 9 of 877 portfolios (1.03%) had negative returns, with the worst return being a loss of 2.7% of the initial investment. An equivalent 1% of the time this portfolio would have more than tripled an investor's money over a 12-year horizon.

While previous studies simply compared EIAs with an investment in the S&P 500 or mixture of the S&P 500 and Treasury securities, Reichenstein (2009) was the first to analyze EIAs on a CAPM systematic risk-adjusted basis. However, his CAPM risk-adjusted approach does not explicitly take into account one of the major features of an EIA which is the downside protection against negative returns. This is a significant selling point and may be very valuable to a set of extremely risk averse investors. However, as just discussed above, the most severe loss for an investor in the β adjusted EB portfolio was 2.3% over a 12-year horizon, and there were no negative horizon period returns for any of the β adjusted EB portfolios over 14 or 15-year horizons. Therefore, while negative returns were still possible in any given year(s), they occurred very rarely over long horizons.

Table 5 Ending wealth ratio of S&P Index fund and equity/put (EP) portfolio to EIA

Years	Percentile - EP portfolio/7% cap EIA										Portfolio value			
	1	5	10	25	50	75	90	95	99	N	BE	< $1	Min	95th%
11	0.55	0.69	0.85	1.12	1.49	1.81	2.06	2.28	2.59	829	15.8%	4.9%	$0.60	$3.93
12	0.55	0.72	0.88	1.20	1.55	1.88	2.18	2.38	2.71	817	14.0%	4.2%	$0.66	$4.31
13	0.54	0.75	0.92	1.22	1.64	1.97	2.31	2.51	2.83	805	13.8%	3.6%	$0.63	$4.86
14	0.56	0.75	0.94	1.27	1.69	2.04	2.43	2.69	2.94	793	12.1%	2.9%	$0.72	$5.35
15	0.57	0.75	1.00	1.36	1.72	2.13	2.57	2.77	3.38	781	9.9%	2.0%	$0.73	$6.10
	Percentile - EP portfolio/5% cap EIA										Portfolio value			
11	0.60	0.77	0.95	1.24	1.68	2.08	2.36	2.60	2.97	829	11.5%	4.9%	$0.60	$3.93
12	0.60	0.81	0.99	1.34	1.78	2.17	2.54	2.76	3.16	817	10.3%	4.2%	$0.66	$4.31
13	0.60	0.85	1.04	1.39	1.90	2.31	2.75	2.98	3.30	805	9.3%	3.6%	$0.63	$4.86
14	0.61	0.84	1.07	1.46	1.97	2.42	2.89	3.21	3.61	793	7.6%	2.9%	$0.72	$5.35
15	0.63	0.87	1.14	1.58	2.05	2.55	3.09	3.36	4.24	781	7.3%	2.0%	$0.73	$6.10
	Percentile - EP portfolio/(T-Bond 2.5%) cap EIA										Portfolio value			
11	0.63	0.79	0.91	1.10	1.38	1.71	1.96	2.12	2.26	829	15.7%	4.9%	$0.60	$3.93
12	0.64	0.84	0.95	1.14	1.44	1.77	2.05	2.18	2.41	817	14.3%	4.2%	$0.66	$4.31
13	0.64	0.86	0.97	1.20	1.49	1.86	2.14	2.26	2.42	805	12.2%	3.6%	$0.63	$4.86
14	0.65	0.87	0.99	1.24	1.55	1.91	2.24	2.38	2.70	793	10.8%	2.9%	$0.72	$5.35
15	0.67	0.90	1.02	1.30	1.58	2.00	2.32	2.51	2.90	781	9.1%	2.0%	$0.73	$6.10

BE, breakeven percentile (percent of times wealth ratio <1).

5. Further extension: Option strategies

To further extend some of the previous research, we also modeled the optionality aspects of an EIA. The downside protection feature of EIAs motivates comparing the performance of EIAs not with portfolios having the same systematic risk, but rather with investment alternatives that include both downside protection and upside potential. Thus, a simple first strategy consists of buying the S&P 500 and buying an at-the-money put option, that is, portfolio insurance. Second, the payoff for an EIA can be replicated with call options. For example, an annual reset EIA with a 7% cap will have a return in any one year equal to the maximum of the price appreciation on the S&P 500 up to 7%, and 0. Thus, the exact return from an EIA can be replicated by buying an at-the-money call option and writing a call option that is (1 + Cap %) out of the money. This second strategy consists of buying an at-the-money call option on the S&P 500, writing a call option on the S&P 500 that is (1 + Cap%) out of the money, and investing the remainder at the 5-year Treasury yield. We estimate option values using the Black-Scholes option pricing model (see Bodie et al., 2013). We estimate volatility from the previous 60-months standard deviation of returns, annualized. We use the actual dividend yield and Treasury-bill return over the option year (i.e., we assume the expected dividend yield is the actual yield over the period). We assume transaction costs equal 5% of the option values.

Table 5 contains the ratios of the equity/put (EP) portfolio ending wealth values to the EIA ending wealth for 11 through 15-year holding periods. In addition, Table 5 indicates the

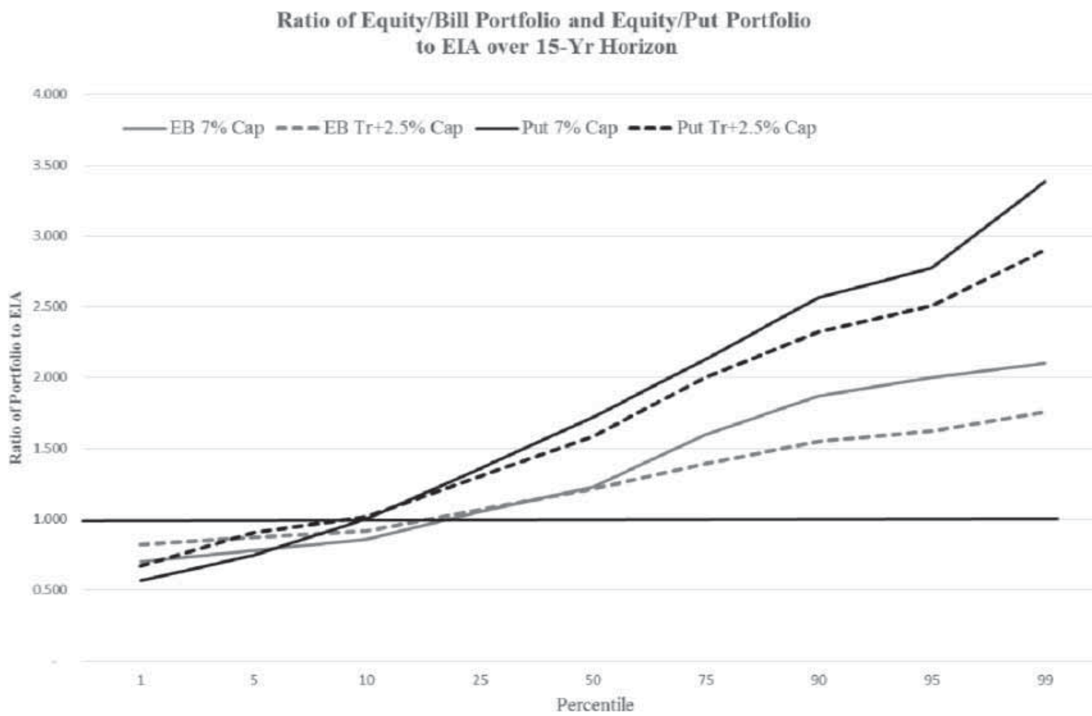

Fig. 2. Ratio of equity/bill (EB) portfolio and equity/put (EP) portfolio to equity indexed annuities (EIA) over 15 year horizon.

percentage of times the EP portfolio holding period returns were negative, the worst return, and on the upside the value of $1 invested in the portfolio at the 95th percentile. The EP portfolios had median values that ranged from 49% to 105% higher than the EIA. EIAs outperformed the EP portfolios from only 7.3% of the time for the 5% cap, 15-year horizon to 15.8% of the time for the 7% cap, 11-year horizon holding period. Although holding period returns for the EP portfolios were negative less than 5% of the time for all caps and holding periods, their worst downside ranged from losing 40% for the 11-year horizon to losing 27% for the 15-year horizon. On the upside, the 95th percentile returns ranged from 293% at the 11-year horizon to 510% for the 15 year horizon, or, alternatively, at the 95th percentile the EP portfolio resulted in ending wealth ranging from 2.28 to 3.36 times as high as the EIA. Relative to the β adjusted EB portfolio, the EP portfolio has both more downside and significantly more upside. This is also illustrated in Fig. 2 where the ratios of these portfolio values to EIAs for 15-year holding periods are shown.[14] Comparing Table 5 to Table 4, the EP portfolios are outperformed by EIAs only half as often for the fixed cap EIAs to two-thirds as often for the variable cap EIAs as the EB portfolios are outperformed, and in addition the EP portfolios have significantly more upside. However, the potential for loss is significantly higher for the EP portfolios. This result is because of consecutive down market years where investors earn nothing on the market but still have to pay expensive insurance (put) premiums.

The final strategy consists of replicating the EIA return by purchasing an at the money call and writing a call that is (1 + Cap%) out of the money and investing the remainder at the five-year Treasury yield. We assume a 5% transaction cost on both the purchased and written call. In a given year the total return from this strategy is the yield on the Treasury bond, less

Table 6 Ending wealth ratio of calls and bond (CB) portfolio to EIA

Years	Percentile - CB portfolio/7% cap EIA										CB portfolio value			
	1	5	10	25	50	75	90	95	99	N	BE	Mean	Min	Max
11	0.83	0.84	0.87	1.03	1.17	1.43	1.79	1.84	1.88	829	21.5%	$2.01	$1.07	$3.41
12	0.82	0.83	0.87	1.04	1.20	1.49	1.87	1.92	1.95	817	21.4%	$2.16	$1.09	$3.80
13	0.81	0.83	0.87	1.04	1.23	1.56	1.94	1.99	2.04	805	20.5%	$2.32	$1.10	$4.22
14	0.80	0.82	0.87	1.06	1.25	1.65	2.01	2.06	2.12	793	20.1%	$2.50	$1.15	$4.68
15	0.80	0.82	0.87	1.06	1.28	1.74	2.08	2.14	2.20	781	19.2%	$2.69	$1.20	$5.17
	Percentile - CB portfolio/5% cap EIA										CB portfolio value			
11	0.83	0.84	0.87	1.03	1.17	1.43	1.79	1.84	1.88	829	17.5%	$1.91	$1.07	$3.19
12	0.82	0.83	0.87	1.04	1.20	1.49	1.87	1.92	1.95	817	17.1%	$2.04	$1.11	$3.51
13	0.81	0.83	0.87	1.04	1.23	1.56	1.94	1.99	2.04	805	16.4%	$2.19	$1.12	$3.86
14	0.80	0.82	0.87	1.06	1.25	1.65	2.01	2.06	2.12	793	15.6%	$2.34	$1.16	$4.23
15	0.80	0.82	0.87	1.06	1.28	1.74	2.08	2.14	2.20	781	15.2%	$2.50	$1.20	$4.61
	Percentile - CB portfolio/(T-Bond + 2.5%) cap EIA										CB portfolio value			
11	0.91	0.92	0.95	1.07	1.16	1.31	1.48	1.51	1.54	829	14.5%	$2.05	$1.07	$4.03
12	0.90	0.92	0.95	1.08	1.18	1.35	1.52	1.56	1.58	817	14.4%	$2.21	$1.10	$4.58
13	0.90	0.92	0.96	1.09	1.20	1.38	1.57	1.60	1.63	805	14.3%	$2.38	$1.12	$5.13
14	0.90	0.92	0.96	1.10	1.23	1.44	1.62	1.64	1.68	793	13.5%	$2.57	$1.14	$5.76
15	0.90	0.92	0.97	1.11	1.25	1.49	1.66	1.69	1.72	781	13.6%	$2.77	$1.16	$6.35

BE, breakeven percentile.

the net option cost, plus the EIA return. Table 6 contains the ratios of the call/bond (CB) portfolio ending wealth values to the ending wealth from the EIA for 11 through 15-year holding periods. In addition, the table contains the breakeven, or percentage of the time the EIA portfolio outperformed the CB portfolio, as well as the mean, minimum, and maximum values of a $1 investment in the CB portfolio. It is important to note that the CB portfolio never lost money, and the minimum value over all caps and horizon periods was $1.07. The median value of the CB portfolio ranged from 17% to 28% higher than the EIA portfolio. These higher median returns translate into between 1.4% and 2% per year. The magnitude of these differences correlates well with the underlying economics discussed in Section 2 and illustrated in Table 1 if one were to invest in corporate as opposed to Treasury bonds. EIAs outperformed the CB portfolios approximately 20% of the time for the 7% constant cap and less than 15% of the time for the variable cap EIA.

We performed two additional robustness tests. First, option premiums are sensitive to the volatility measures assumed, and it is possible our estimate of volatility based on the prior 60 month volatility is not what is reflected in market option premiums. As a robustness check we also calculated option prices using two alternative measures of volatility and compared to the variable cap EIA. The first measure follows a similar approach to Edwards and Swidler (2005) and estimates an annual standard deviation using the previous 12 months and future 12 months standard deviations. There was no significant impact on the CB portfolio results and the EP portfolio actually performed just slightly better using the weighted historical and future standard deviations. As a second check, we used the implied volatility contained in the

Table 7 Comparison of ending wealth ratios: Whole period 1928–2012 vs. 1957–2012

	Equity/bill (EB) portfolio/(T-Bond +2.5%) cap EIA - 13 year horizon								
	1	5	10	25	50	75	90	95	99
Percentile									
1957–2012	0.83	0.87	0.91	1.04	1.14	1.28	1.40	1.46	1.55
1928–2012	0.83	0.86	0.90	1.04	1.17	1.31	1.45	1.50	1.63
% change	0.9%	1.2%	1.2%	0.3%	−2.0%	−2.9%	−3.3%	−2.4%	−5.0%
	Equity/put (EP) portfolio/(T-Bond +2.5%) cap EIA - 13 year horizon								
1957–2012	0.86	0.94	1.00	1.21	1.47	1.71	1.96	2.10	2.31
1928–2012	0.64	0.86	0.97	1.20	1.49	1.86	2.14	2.26	2.42
% Change	34.5%	10.0%	3.8%	0.8%	−1.1%	−8.0%	−8.6%	−6.8%	−4.5%
	Call/bond (CB) portfolio/(T-Bond +2.5%) cap EIA - 13 year horizon								
1957–2012	1.07	1.10	1.14	1.24	1.35	1.54	1.60	1.61	1.63
1928–2012	0.90	0.92	0.96	1.09	1.20	1.38	1.57	1.60	1.63
% Change	18.3%	19.2%	19.1%	14.1%	12.4%	11.2%	1.8%	0.5%	0.2%

CBOE volatility index, or VIX, which is based on real-time prices of options on the S&P 500. The VIX data are available beginning in 1990, and so this sample contains only about one-sixth as many rolling investment periods as our original sample. The median wealth ratios to the variable cap EIA using the VIX volatility measures were approximately 25% and 3% lower than the ratios obtained using our historical volatility estimates for the EP and CB portfolios, respectively. These results make intuitive sense because over this more recent time period the VIX volatility measures were approximately 4% higher than our estimates of volatility based on historical standard deviations, and thus the market was pricing options more expensively than our estimated volatility implied. For the EP strategy, portfolio insurance was more expensive and had a larger impact. For the CB strategy, both the purchased and written options were more expensive, and so the net effect was small.

As a second robustness test we examined the impact of using the 1957–2012 time period rather than our original 1928–2012 time period. There are a couple of reasons for doing so. Even though Ibbotson Associates (2013) reports equity returns linked back to 1928, as noted in Reichenstein (2009) the S&P 500 composite contained only 90 stocks before 1957. In addition, our original extended time period of 84 years includes 12 years, or 14%, from the Great Depression. If this is considered an anomaly or highly unlikely event, then our sample may be unduly influenced by it. We re-estimated the models for the 1957–2012 period using the variable cap EIA. Table 7 reports the results for the 13-year holding period, as these results were representative qualitatively of all the holding periods and quantitatively fell between the 11-year and 15-year holding periods. The table reports the percentage difference in estimated wealth ratios between the more recent period, 1957–2012, and our original sample period, 1928–2012. A positive percentage indicates that the estimated 1957–2012 period wealth ratios are higher and thus strengthen our original results. For the call/bond portfolio this is in fact the case; had we used the more recent time periods our results would

Table 8 Compound annual returns by holding period

	11 year holding period			13 year holding period			15 year holding period		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
7% cap									
EIA	4.3%	1.9%	6.6%	4.3%	1.6%	6.1%	4.3%	2.2%	6.2%
Equity/bills −0.16 β	5.8%	−0.1%	10.8%	6.1%	−0.1%	10.8%	6.3%	0.3%	10.3%
Calls/bond	6.6%	0.6%	11.8%	6.7%	0.7%	11.7%	6.8%	1.2%	11.6%
5% Cap									
EIA	3.2%	1.4%	4.9%	3.2%	1.2%	4.6%	3.2%	1.7%	4.6%
Equity/bills −0.12 β	5.5%	0.0%	10.4%	5.7%	0.1%	10.3%	5.9%	0.4%	9.8%
Calls/bond	6.1%	0.7%	11.1%	6.2%	0.9%	10.9%	6.3%	1.2%	10.7%
T-Bond yield + 2.5% cap									
EIA	4.6%	1.2%	9.5%	4.7%	1.0%	9.4%	4.8%	1.4%	9.3%
Equity/bills −0.16 β	5.8%	−0.1%	10.8%	6.1%	−0.1%	10.8%	6.3%	0.3%	10.3%
Calls/bond	6.7%	0.6%	13.5%	6.9%	0.9%	13.4%	7.0%	1.0%	13.1%
Equity/put	8.3%	−4.5%	15.4%	8.5%	−3.5%	14.6%	8.6%	−2.1%	15.5%

be stronger. For the EB and EP portfolios using the more recent period that excludes the Depression years strengthens our results for wealth ratios below the median and weakens them for those above. Intuitively, this result makes sense because the downside protection of the EIA would be more valuable in the severe negative equity returns of the Depression era.

Finally, Table 8 summarizes the various alternative portfolio strategies in a slightly different format by showing the mean, minimum, and maximum compound annual return of each strategy for 11, 13, and 15-year holding periods. As indicated in the previous tables, the put strategy has the highest risk, with both the highest possible compound annual return and largest possible loss, and the highest mean return. Over a 15-year holding period the put strategy has a mean compound annual return that is nearly 4% higher than the variable cap EIA. The call/bond portfolio has higher means, minimums, and maximums at all caps and holding periods and dominates the Reichenstein β adjusted portfolio strategy. The call/bond strategy has lower minimum and higher maximum compound annual returns than the EIAs, but also has mean compound annual returns that are approximately 2.3% to 3.1% higher than the EIAs, consistent with the economics discussed previously.

6. Conclusion

This research has extended previous research on equity indexed annuities by first extending the historical time horizon and return time-paths used by Reichenstein (2009), to examine portfolios of equity and Treasury bills having the same systematic risk as EIAs. Second, and perhaps more importantly, because EIAs are marketed as a product having downside protection and upside potential, we examine two approaches involving options. The first approach uses a portfolio consisting of equity and put options as portfolio insurance. The second approach creates a bond/call option portfolio where option positions are designed to mimic the payoff to EIAs. A third contribution of this research is to allow cap rates to vary with the level of interest rates, rather than to assume they are constant as in prior research. Our primary conclusion is summarized in part of the title to Collins et al., (2009), "downside protection, but at what cost?" The opportunity costs of investing in EIAs over long horizons compared with reasonable and implementable alternative strategies are quite high. There may be risk averse enough investors for whom the possible EIA returns make sense. However, at a minimum, these opportunity costs should be disclosed to potential investors at time of purchase.

Notes

1 The SEC treats equity index annuities as a separate class of annuity, along with variable and fixed. Furthermore, because performance does not depend on investments in a subaccount or separate account, these annuities are "exempt securities" under Section 989J of the Dodd Frank Act if they are issued in states that adopt the NAIC Suitability in Annuity Transactions Model. Because of the low interest rate environment some insurance companies are creating registered securities that merge the benefits of fixed and variable annuities.

2 Equity index annuity sales now comprise over half of the fixed annuity market, with $34 billion sold in 2012. Insured Retirement Institute 2013 Fact Book.

3 In addition to the investment aspect, there are tax and insurance aspects associated with EIAs. The potential tax and insurance benefits of EIAs are beyond the scope of this article.

4 Empirically, McCann (2008) constructed 241 10-year, month-by-month rolling time periods from 1975–2004 and found that the monthly averaging method resulted in a final wealth amount that was 44% lower than the annual point-to-point method.

5 See www.indexannuity.org/rates_by_carrier.htm for current rates and to get a sense for the number of products available. Surrender periods are not listed, but most EIAs have surrender periods between 10 and 15 years.

6 Because caps, participation rates, spreads, surrender periods, and other contract features differ from contract to contract, and because some features can be changed by the insurance company after the first year, modeling all the possible iterations of EIAs is beyond the scope of this article.

7 See also Carver (2013) for an application of Monte Carlo simulation to EIAs as a teaching assignment.

8 In the first year of Reichenstein's time period equity returns were negative so that the remaining years' cap is effectively the beginning cap as well.

9 We also re-estimate his original regressions for the 1957–2008 time period, to insure the integrity of our data and obtain the same results he reported (see Table 3). It should also be noted that the distribution of returns assumption, or alternatively, required utility function assumptions, necessary to support a CAPM analysis have been widely criticized in the literature. In a later section we attempt to account for the truncated returns of EIAs by modeling the option characteristics.

10 See either Yahoo Finance or Morningstar.com for expense ratios. For Vanguard S&P 500 ETF, see symbol VOO. For S&P 500 Index mutual fund, see symbol VFINX.

11 The variable cap had a mean of 7.2% over the time period, and consequently the variable cap EIA is compared with the same .16 β equity/bill (EB) portfolio that was compared with the 7% cap EIA.

12 The last *beginning* month would have been June 2003 because 10-year and greater holding period returns are not available after then. Thus, the history will include someone who bought in March 1999 and sold at the low in March 2009, but would not include someone who bought at the low in March 2009 and sold in March 2019. Thus the collapse in 2009 is getting captured in the history, but someone who bought in June 2003 and sold in June 2013 and doubled her money would not. Furthermore, note that Reichenstein (2009) calculated annual returns assuming an investor bought in January and sold in December of every year, and thus, captures only one of several possible sequences of annual returns represented by history.

13 Our holding periods contain overlapping periods and thus are not statistically independent. Consequently, our statistics are descriptive of returns that occurred for all possible sequences and are not probabilistic statements about likely future returns. Our tables report percentiles and not confidence intervals.

14 Only the 7% and variable cap are shown because the 5% cap adds little to the illustration.

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