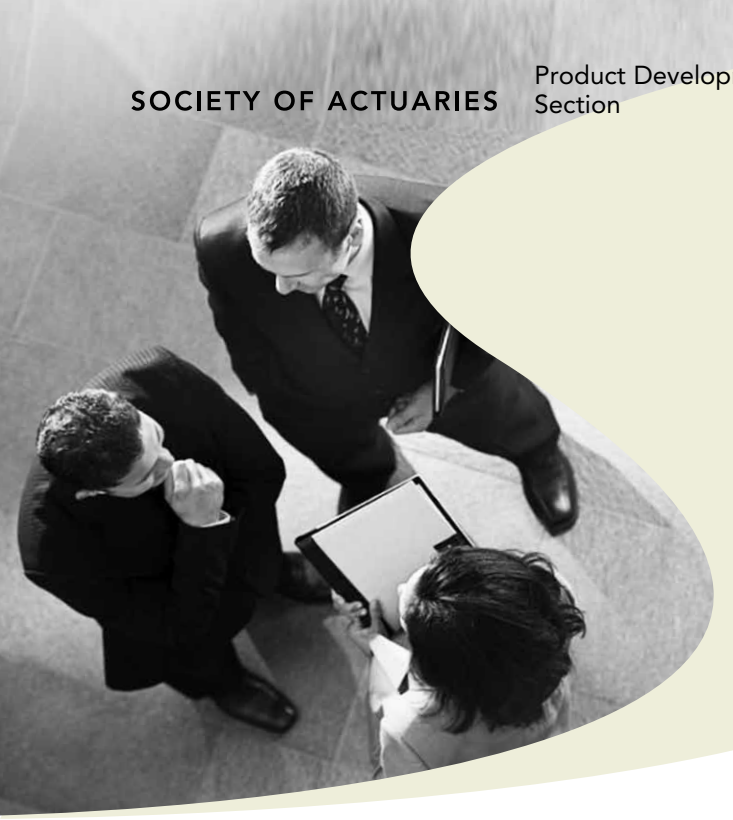
SOCIETY OF ACTUARIES Product Development Section



Product Matters!

ISSUE 81 | OCTOBER 2011

Correlation Risk

Empirical Study, Latest Research, and Implications to VA Hedging[1]

By Yuhong (Jason) Xue

In the variable annuity (VA) industry, hedging program effectiveness received heightened attention in the wake of the financial crisis in late 2008 and early 2009. With depressed equity prices, high volatility, and low interest rates all occurring at the same time, many VA dynamic hedging programs experienced hedge breakages characterized by large gaps between liability movements and hedge gains and losses. The VA hedging programs are designed to react quickly to equity and interest movements, but they don't deal with the so-called basis risk and correlation risk nearly as well; which are among the culprits that caused the hedge breakages.

The basis risk has been covered extensively in the VA hedging literature. But the correlation risk, although it partially contributes to basis risk, hasn't garnered the same attention among VA practitioners.

Correlation refers to the tendency of two or more random variables moving in concert. Correlation risk refers to the possibility that actual correlation diverges from the assumption. Sometimes correlation is also referred to as co-movement, dependence or association. In this article, we will use these terms inter-changeably.

Correlation risk in the context of VA hedging can be described as follows. Typically, the Greeks of the VA liability relative to a set of hedging indices are hedged. The Greeks are calculated assuming a certain degree of correlation among the indices based on historical returns. These correlations provide a benefit of diversification that reduces the impact of negative market movements on VA liability. However, sometimes under stressful market conditions like in 2008 and 2009, correlations between funds and between indices converged to one, reducing this diversification benefit and causing a large gap between liability movements and hedging results. In short, correlation risk stems from the fact that linear and constant correlations are assumed in the hedging models, while in real life, there is no such thing as constant correlation.

FOOTNOTES

[1] The author wishes to thank Mike Slipowitz, Corporate Chief Actuary of Guardian for providing valuable comments for this article.

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Actuaries
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Product Matters!

ISSUE 81 | OCTOBER 2011

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This newsletter is free to section members. Current-year issues are available from the communications department. Back issues of section newsletters have been placed in the SOA library and on the SOA Web site *(www.soa.org)*. Photocopies of back issues may be requested for a nominal fee.

2011 SECTION LEADERSHIP

Articles Needed for the Next Issue of *Product Matters!*

While all articles are welcome, we would especially like to receive articles on topics that would be of interest to Product Development Section members based outside of the United States.

Please e-mail your articles to Christie Goodrich or Paul Fedchak by 11/19/2011.

Letter to the **Editor**

I read your recent article in *Product Matters!* "Reflecting Risk in Pricing Survey," as well as the survey results, and wondered if I could trouble you with a few clarifications:

1. One survey finding was that >70 percent of respondents indicated they changed their primary profit measure in the last three years, primarily moving from IRR to EV/EVA/MCEV, but this didn't seem consistent with the responses where IRR is the dominant metric. Am I missing something here?

2. Do you have any prepared materials that show the profit measure ranking (or primary measure) using number or percentage of respondents choosing each ranking? I assume you are trying to weight responses given the rankings applied, but it would be useful to know relative importance beyond ranking. For example, for life companies, EV/EVA is fourth across the board, but I'm not sure if this is a distant fourth or a close runner-up.

3. In the survey report, there is frequent reference to larger companies' responses. Are there any prepared materials that break the results into large, or medium-to-large, responses? For example, it was noted that larger companies are more likely to move to EV type metrics, which makes sense given the cost of measuring this way. For these types of discussions, it would be useful to know how dominant a metric is for large companies. Similarly, it would be useful to know the percentage of large companies utilizing each of the risk assessment practices, as presumably smaller companies are more likely to use less sophisticated and internal analysis.

4. What is the difference between ROI and IRR? The definitions are identical in the Definitions section of the survey results. If similar, should ROI rankings be combined with IRR when considering ranking of measures?

Submitted Anonymously

Response from the author, Donna Megregian:
I will answer these in the same order as they appear above:

1. Per the report, not all participants completed all questions in the survey. For this particular issue, 184 of 256 responses indicated they had moved to a new profit measure in the last three years. However, only 71 responses provided the detail of which measure they moved away from and 77 responded which one they have moved to or intend to move to. Of the 71, 22 indicated they are moving away from IRR. The Devil is in the details. See the chart on the next page for further details on the breakdown of profit measure choices. Twenty-two responses moving away from IRR would not impact the overall IRR ranking as #1 for life and annuity.

2. Going back to the data, the same chart as mentioned previously shows responses without weighting the response by where it fell in the ranking. In other words, the numbers in the chart on the next page show how many responses chose a given profit measure as #1 choice, #2 choice, etc. Please note this reflects life and annuity companies ONLY (not all participating companies). Although breakeven year is not chosen as the primary profit

CONTINUED ON **PAGE 4**

Profit Measure - Life and Annuity	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10+
Break-Even Year	18	67	123	110	25	11	0	0	0	1
Combined Ratio	1	8	2	2	1	0	0	0	0	1
Contribution to Surplus Ratio	16	32	26	27	25	4	0	0	1	0
Embedded Value / Economic Value Added	88	88	40	36	3	11	0	0	0	0
Expected Loss Ratio	8	11	4	3	0	6	1	0	0	0
Internal Rate of Return	279	111	70	26	14	3	0	0	0	1
Market Consistent Embedded Value Ratio	61	32	19	12	0	0	0	1	0	0
Other Ratio	23	8	3	5	0	0	0	0	0	0
Premium Margin	115	211	89	25	11	4	0	0	0	0
Return on Assets Ratio	23	48	25	22	0	1	0	0	0	1
Return on Capital Ratio	30	5	25	21	11	0	0	0	0	1
Return on Equity	57	48	56	18	14	0	10	3	0	0
Return on Investment	89	34	2	1	0	0	0	0	0	0
Return on Liabilities	0	10	6	0	0	0	0	0	0	0
Revenue Margin Ratio	2	17	10	0	3	2	0	0	0	1
Risk Adjusted Return on Capital	55	21	18	3	11	0	3	0	0	0

measure (#1 column), it is a third or fourth level consideration for many companies, so you can see how this measure would translate to #3 in a weighted system.

3. There is no material readily available for larger versus smaller companies without duplicating the report in its entirety by size. In general, when the overall response varied notably from the size, the report made note of it. If there isn't a note in a particular section, generally, the size of the company didn't change the overall top choices.

4. IRR and ROI is just a semantics difference (possibly depending on where in the world you work among other things.). Certainly IRR would be more solidified as the primary profit measure if ROI and IRR responses were combined. □

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Session 78 Panel Discussion

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Actuarial Standards of Practice are the guideposts to our professionalism. This session will focus on how certain ASOPs apply specifically to product development actuaries.

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Chairperson's Corner: **Thanks to All**

By Mitch Katcher

Mitch Katcher, FSA, MAAA, is principal with Deloitte Consulting LLP. He can be contacted at mkatcher@deloitte.com.

By the time you read this article, we will have completed our Society of Actuaries elections. Our new President-elect, board members, and section council members will be known. For those of you involved as candidates, thank you for deciding to make time in what I am sure is a very busy schedule to try and help us make a difference. For those of you who participated in the balloting, thank you. As they say, you cannot make a difference if you do not take the time to vote.

I want to first recognize several leaders in the Product Development (PD) Section. I want to thank each one for their tireless efforts in helping our section bring value to its members. Christie Goodrich has worked tirelessly on the Product Development newsletter. I can tell you from firsthand experience that she is tenacious in getting people to volunteer to write articles, turn them in on time and does all of it in such a nice manner that you feel like you are letting her down if you do not meet your obligations. Paul Pflieger has led our efforts for PD webcasts and Web updates. It is no easy task to get people to speak for a webcast, but Paul has had good success in helping us put on some very interesting and timely webcasts. Vera Ljucovic was elected to a one-year term last year. Vera is the only Canadian on the committee so she brings a unique perspective to our meetings.

I am very excited about the excellent slate of Product Development Section candidates we put forth for you to vote on. I am sure that any three of them will make our section stronger and I appreciate their leadership in raising their hands to serve the PD membership.

I wrote in my very first Chairperson's Corner, "This is a very challenging time to be involved with product development. The challenges of growing in a marketplace with record-low interest rates, continued volatility in the stock market and limited new capital is more daunting than ever. There are also challenges from regulations around the impact of financial reform, issue of retained assets, role of STOLI, etc. This makes it an ideal time for actuaries to continue to grow their knowledge and network, and the Product Development Section is the forum to come to for these opportunities." It is amazing how 12 months later; so much of this is still true. The section has tried to help our members deal with these daunting issues through our research, newsletter articles, and sessions at the Life & Annuity Symposium and the Annual Meeting. However, I feel like we could still do more. But we need to hear from you, our members. We need to know if we are hitting the mark, missing the mark or there are additional marks we should be aiming at. So I ask you all to provide feedback to the section so we can make sure we are adding as much value to our members as possible.

And finally, this will be my last article as the Chairman of the Product Development Section. I want to thank everyone for the support I have received. The SOA staff who sit on our section, Christie Cook and Mike Boot help tremendously with PD section activities. At the October meeting, I officially hand the gavel over to the very capable hands of Donna Megregian. She is also a tireless contributor and I wish her great success leading us forward. □

-Mitch

Illustration Testing: **Results from a Survey**

By Donna Megregian

The fall is a popular time for many companies to be thinking about their illustration testing. This is according to a survey initiated by Milliman regarding various aspects of illustration testing. This survey obtained responses from 23 companies, and showed that December and January are the most popular times for companies to file their annual certifications for illustration testing, which generally takes one to three months to complete. This article will provide some of the information from that survey to offer some considerations to actuaries during their illustration testing process.

The survey asked a variety of questions related to demographics, new business, in-force, experience assumptions, and product-specific questions. One impetus for the survey was the recent initiation of revamping the life illustration practice notes, with an intended completion of the revision to be in 2012. The practice notes were revised in 2009 to coincide with the earlier revision of Actuarial Standard of Practice (ASOP) 24. Since publication of the ASOP revision and practice notes, a few sessions at Society of Actuaries (SOA) meetings have centered around illustration testing. Not surprisingly, many questions were generated from these sessions (both during and after). Without clear guidance from the ASOP or the illustration testing model regulation (the Model Reg), the practice notes try to provide insight into current practices. Practice notes cannot interpret the ASOP and the Model Reg directly so many nuances are left to reasonable actuarial judgment. Now that the Model Reg is more than 14 years old (borrowing phraseology from a presenter at the 2011 life and annuity symposium), some may consider illustration testing to be a difficult teenager to deal with.

New Business And In-Force Testing

More than half (12) of the companies in the survey indicated they are finding that illustration testing requirements are restricting pricing design. Companies have resorted to changing product elements such as credited rates and spreads, as well as increasing policy loads, cost of insurance (COI) rates, and premiums. Ten companies in the survey reported no need for a change in their product designs because of the regulation.

Some companies include substandard policies, riders, policy loans, or some combination of those features in their new business/in-force testing. Materiality may play some part in the inclusion or exclusion of these policy features, but often including these features increases the accumulated cash flows for the product. Therefore, excluding them may be conservative, but including them helps in situations where a scale is close to not passing or barely failing.

Most companies (17) stress-test their disciplined current scale (DCS) during the new business pricing process, but only eight reported doing so during the in-force testing process. Stress-testing the DCS can provide insight as to when the DCS may fail. Although certifications may only need to be done once a year outside of the initial filing of a product, the DCS must be in compliance with the Model Reg throughout the year. Stress-testing the DCS may give the illustration actuary comfort that small changes in experience will not cause the illustrated scale to be insupportable.

Four companies reported using distributions of surplus to support their DCS. This pertains to ASOP 24, Section 3.7 and Practice Notes Question P9. Key to this assumption is the company's intent and ability to support the DCS with surplus, and documentation should be obtained by the illustration actuary that the company will continue to do this. Illustration actuaries reported getting verification from the board or an officer to support the distribution of surplus.

CONTINUED ON **PAGE 8**

Donna Megregian, FSA, MAAA, is a consulting actuary with Milliman, Inc. She can be contacted at donna.megregian@milliman.com.

Eight companies reported that they have needed to change their DCS because of in-force testing, five reported changing only the DCS and illustrated scales and not the currently payable scale, and three reported changing all three scales. The reasons companies made adjustments were:

- In order to reflect changes observed in experience (5),
- To realign future profitability with original pricing goals (3), and
- Adjusted to the extent needed to pass the tests (1).

Of the companies that made changes to the currently payable scale, three reported some sort of resistance by the states and/or policyholders when the non-guaranteed elements were being changed.

Assumption Development And Product Issues

With regard to premium persistency, many companies (12) do allow policies to lapse because of inadequate premium when performing the lapse support test. Four companies reported forcing policies to pay the minimum required to keep the policy in-force, while six companies reported the modeled premium is more than adequate to keep the policy in-force. Four companies also reported that they do not use any kind of premium persistency assumption. The Practice Notes Question M7 discusses some of the ambiguity related to this particular assumption, and ASOP 24 indicates consideration should be given toward this assumption, but neither the ASOP nor the Model Reg clearly say that this assumption is included or excluded when changing the persistency assumption after Year Five.

Nine companies indicated they weight their mortality assumption with reinsurers, industry data, or consultant data. Seven companies indicated they have credible mortality data, and the other must use some sort of actuarial judgment. In all cases, the illustration actuaries must be sure not to include explicit or implicit mortality improvement in the mortality assumption for illustration testing.

The majority of companies (15) in the survey indicated they use fully allocated expenses for illustration testing. Seven companies use a generally recognized expense table (GRET) and one company uses marginal expenses. Ten companies indicated that expense assumptions are not necessarily the same between in-force and new business. Only two of the 23 companies indicated that expenses were consistent between pricing, illustration testing, and asset adequacy testing.

Five companies indicated that they use letters of credit (LOC); however, one of the five does not include this cost in illustration testing. Some reasons for not including explicit LOC costs were:

- GRET expenses are used and include LOC costs already,
- LOCs are part of the general corporate costs and accounted for through fully allocated expenses, and
- LOCs are included in reinsurance costs and not considered separately.

There does not appear to be a consensus on whether LOC costs should be included, but likely this is driven by varying situations that lead to an overall LOC debate. Inclusion or exclusion and their rationales related to LOC costs should be clearly documented.

Across all interest-sensitive products (IUL, ULSG, CAUL, fixed premium UL, par whole life, and ISWL), most actuaries are mainly concerned about the investment return affecting illustration testing results. Second-highest concern was mortality for all these products except for ULSG where persistency ranked higher than mortality. The sustained low interest rate environment is impacting the pricing spread for many products as portfolio rates continue to drift downward for many companies.

Conclusion

The Model Reg's goal has always been to ensure that illustrations are not misleading or have the ability to mislead the consumer about the product about to be purchased. It is also meant to ensure that after the sale of the product, companies do not promise more than they can deliver. Keeping the letter and spirit of the law intact may help illustration actuaries make decisions regarding the scales they ultimately end up signing off on—does it mislead or not mislead? That is the question. ◻

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2011 **Life And Annuity Symposium Recap**

By Rob Stone

Robert P. Stone, FSA, MAAA, is a consulting actuary with Milliman Inc., Indianapolis, IN. He can be reached at rob.stone@milliman.com.

The Society of Actuaries presented the second Life & Annuity Symposium May 16–17, 2011 at the Sheraton in New Orleans, La. The meeting drew 500 attendees, another strong showing for this recently revamped meeting. In addition, seven sessions were virtual offerings, permitting Web attendance for those unable to travel to New Orleans.

The meeting was again organized around four tracks, including a Risk Track, Product Track, Management/Professionalism Track and a Financial Track. Forty-six total sessions were presented, offering attendees an opportunity to earn up to 15 CPD credits.

The event kicked off on May 15 with a golf outing enjoyed by 20 participants at the Stonebridge Golf Club. Over the course of the meeting, optional networking opportunities were provided in the form of a hot breakfast sponsored by the Product Development Section, a cooking school and an organized group dinner.

Sessions sponsored or jointly sponsored by the Product Development Section included:

- Product Update: ULSG and Term UL
- Variable Annuity Products and Practices Update
- Principle Based Reserves and Capital, Model Management: Is it Possible
- Does Anyone Else Want to be Illustration Actuary This Year?
- Automated Underwriting as Tool for Mid-Market Growth
- Simplified Issue/Guaranteed Issue Market Update
- Regulatory and Tax Update for Product Actuaries
- Measuring and Improving Profitability
- Traditional Term Products, Market Consistent Pricing
- Historical Rates of Mortality Improvement and Tools for Future Improvement
- Fixed Annuity Trends and Issues
- Understanding and Reacting to this Turbulent Economy
- Tax Issues for Product Actuaries

Managing Knowledge Workers: How Do You Best Manage Actuaries?

Following the Symposium, the Product Development Section sponsored a full-day seminar on Insights Into the Pricing of Policyholder-Related Assumptions. The agenda for this post-seminar focused on recent developments and best practices on setting behavioral assumptions for product pricing exercises.

Overall the meeting was well-received. According to the Society of Actuaries, the average rating of the meeting was four out of a five-point scale. The section would like to extend its thanks and appreciation for all the volunteers who made this meeting a success. ◻

> “The average rating of the meeting was four out of a five point scale.”

Level Term Lapse Rates – **Lessons Learned Here and in Canada**

By Vera Ljucovic

For such a simple product, term insurance has always attracted a lot of attention and effort by the industry over the years. It's certainly hard to ignore a product with annual sales of $1.3 trillion face amount covering 75 percent of the individual life market (25 percent by premium). Add to that everything from product design changes, to reserving changes, to sophisticated underwriting enhancements, to price wars that would make a used car salesman look meek—the term insurance marketplace in the United States has been anything but dull!

All of these changes have had a significant impact on level term lapses, which are emerging much lower in the past decade than in prior years. Understanding these market forces is key to interpreting historical lapse results across issue eras and determining which are most applicable to your company and product.

Product Design

Long before blood testing and preferred underwriting, term plans were very simple in design. Most products were Annually Renewable Term (ART), were based on attained age premiums and varied only by gender. The 1970s saw the introduction of a select and ultimate version of these plans with the attraction of lower rates. Rates declined further by the 1980s with the introduction of level term plans with a period of very low level-term rates followed by a steeply increasing ART premium scale designed to take advantage of nonforfeiture laws at the time.

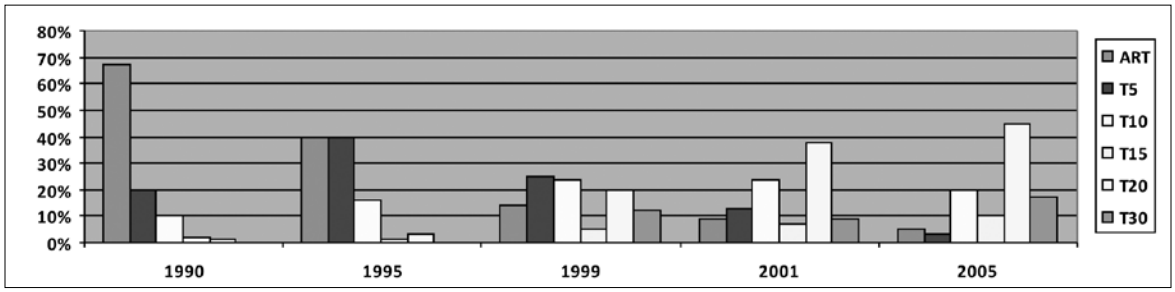
Level Term 5 and 10 plans were the earliest forms offered. Term 20 became very popular in the mid-1990s followed by Term 15 and Term 30 plans in the early 2000s. The chart below shows the evolution of term products over the past 20 years. In 1990, 67 percent of policies sold were ART and less than 10 percent were level term 10 or longer (20 percent T5). By 2001 only 9 percent of sales were ART and level term sales rose to 78 percent (+13 percent T5). Term 5 dropped to only 3 percent by 2005 and the dominance of longer level term plans continues today.

Rate Competition

In addition to the introduction of low rates on the level term design, the 1990s also saw lower rates for the better preferred risk classes. These market changes spurred growth in the replacement activity of term plans with policyholders trading in older and more expensive plans for the new cheaper versions. The term market became extremely competitive by the late 1990s with companies changing premium rates as frequently as weekly in order to maintain market share. As the term wars intensified, some companies began increasing the ART rates in order to recoup some of the premiums lost from the level period, leading to even steeper ART premium scales.

Regulation

Prior to Regulation XXX effective Jan. 1, 2000, net level premium reserve methods were in effect. Some term writers valued their term liabilities using the unitary version of this method which generated lower



Source: The Market for Term Insurance, 2006 Update. LIMRA. Figures grossed up to exclude "other" category.

CONTINUED ON **PAGE 12**

reserves and in some cases, lower premiums. Despite the introduction of XXX which aimed to curtail this practice and significantly increase level term reserves, retail premium rates continued to decline with the help of aggressive reinsurance rates and the capital markets providing reserve relief. As level term rates continued to fall, the practice of recouping lost premium revenue via increased ART rates continued.

2008 Credit Crisis

The 2008 credit crisis significantly increased the cost of funding redundant XXX reserves, affecting the cost and supply of both the coinsurance support from the reinsurers, and financing solutions from the capital markets. Increased costs were passed to the direct writer and ultimately to the policyholder through increased premiums. The economy had begun to stabilize and LOC costs began to drop somewhat from record highs, but the very recent economic issues in the United States, Japan and Europe could reverse that again.

The chart below illustrates the change in average term premium in the U.S. market from 1996 to present. In the first quarter this year rates declined for the first time since 2002.

Impact On Lapse Rates

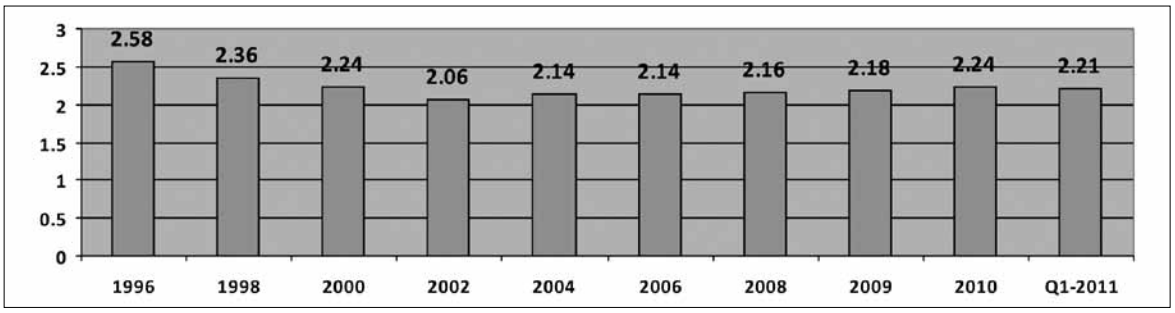
The fiercely competitive term market starting in the mid 1990s, combined with the move to level term plans and preferred underwriting classes, led to higher replacement activity in the 1990s than in previous generations. This was followed in the early- to mid-2000s with a drop in replacement activity as a result of increasing term premium rates and lack of major product design changes. Not surprisingly then, lapse rates on level term plans issued in the past decade are emerging much lower than they were in the early- to mid-1990s, creating two very distinct cohorts.

Similarly, shock lapse experience at the end of term is emerging much differently between the same two cohorts. The ART rate scale post end of term has also been influenced by the market changes with rates much steeper on products issued in the late 1990s and beyond. End of term shock lapse experience on recent plans is emerging higher than the older generation plans.

Lapse Experience

So, how low are they? And how high are they at the end of term? There is some limited data on the end of term from the SOA/RGA study published in July 2010 which we've heard a lot about. The July 2009 LIMRA study provides the only available industry lapse data during the level period (the updated study is due out this summer). The results combine all issue years so we can't isolate the experience on the newer plans, although the study exposures are weighted towards the newer plans, particularly in the earlier durations. Lapse rates start out high in the early durations and begin to level off after the initial few years to a rate that remains fairly level from duration six or so right through to the end of the experience data. We'll call this the "ultimate" level period lapse rate and industry results are as follows:

- Term 10 – 6 percent,
- Term 15 – 4 percent,
- Term 20 – 3 percent, and
- Term 30 – not available.



Source: LIMRA quarterly U.S. individual sales reports. Average premium rates per 1,000 face amount.

Anecdotal evidence suggests that the lapse experience on the "new generation" business is lower than the industry rates shown previously, but data is limited, particularly on the Term 20 and longer plans, to durations 12 or 13 since these products have only been around since the late 1990s. So we don't yet know whether the ultimate lapse rates will drop even further.

We have seen some variation in early duration lapse rates by company which could be due to a number of company specific factors:

- Whether a product was overly competitive at issue,
- Agency relationship to the company,
- Treatment of not-takens or declines,
- Agency compensation and persistency programs, and
- Treatment of the premium grace period in first year lapses.

Lapse rates generally decrease as the level term period increases, although we are aware of slightly higher lapse rates on Term 30 than Term 20. This may be attributed to a greater tendency to lapse the higher premium Term 30 vs. Term 20 plans, as well as the introduction of Secondary Guarantee UL products (SGUL) in the market in the 2000s which offered a more attractive longer term guarantee to some policyholders. Term 30 plans have also been successfully partnered with a return of premium rider and became popular in the mortgage market. The housing crisis of 2008 may have caused increased lapse activity on these products.

Other general observations of level period lapse rates include:

- Lapse rates generally decline by issue age,
- Lapse rates are lowest for the best preferred class,
- Lapse rates for smokers are much higher than non-smokers,
- Lapse rates by gender are fairly similar, and
- Lapse rates on joint lives are lower than single lives.

Like any new product, the new generation of level term plans posed challenges to pricing actuaries since little credible data was available to support many of the assumptions. The dramatic change in the lapse experience between the cohort of level term business issued in the 1980s and early 1990s compared to those issued after this time highlights the danger of assuming past experience will continue. In Canada we fell into a similar trap in the design of the Term to 100 plan as described below.

The Canadian Experience

Term to 100 (T100) was a very popular product in Canada when it launched in the early 1980s. It satisfied consumers' needs by providing life insurance protection for the lifetime of the insured at very low cost due to:

- Historically high interest rates,
- Relatively high assumed lapse rates where past experience was nonexistent,
- Guaranteed level premiums until age 100, and
- No cash surrender values.

In the early years T100 was the industry darling, quickly outpacing sales targets and becoming one of the leading products in the Canadian insurance industry. But things changed quickly in the 1990s when rapidly declining interest rates and the emergence of lower than assumed lapses contributed to significantly higher prices on new plans. Actual lapses were less than 2 percent in the ultimate durations compared to pricing lapse rates in the 6 percent range, as policyholders quickly realized the value of the option in their policies and the returns forfeited on lapse. Price increases passed to the consumer on new plans were in excess of 50 percent in some cases and a sharp decline in sales quickly followed.

Canadian actuaries realized the T100 product was substantially lapse supported—i.e., the product had level premiums and no cash values, so the higher rate of ultimate lapsation the lower the reserve. Lapses are explicitly recognized in the calculation of reserves in Canada, unlike the United States, and interest rates are no longer prescribed in Canada as they are in the United States.

CONTINUED ON **PAGE 14**

Vera Ljucovic, FSA, FCIA, MAAA, is AVP, Risk Analysis & Research with Canada Life Reinsurance. She can be contacted at Vera_Ljucovic@canadalife.com.

Therefore, the reserves for T100 are sensitive to the assumed level of investment return and the assumed level of lapses. Since the term premiums are guaranteed it is the insurance companies who ultimately bear the lapse risk. Canadian insurers were hit hard early on as reserves under Canadian GAAP are principles-based and are required to be adjusted to reflect actual experience as it emerges, which dramatically increased reserves and reduced net income.

Even those insurers who reinsured a substantial percentage of the risk via YRT arrangements were not as well protected as they thought as not only was T100 lapse supported, but death supported as well by virtue of the level direct premiums. Ironically, when the reinsurers' YRT premium exceeded the level premium collected by the insurer, the cedant in many cases would be better off when the actual mortality rates exceeded the expected mortality.

The T100 experience was a costly lesson for the industry and actuaries are now acutely aware of the dangers of lapse and death supported products. Although the Canadian valuation non-forfeiture laws led to these product designs, we should still be aware that similar risks do lurk in the U.S. industry's lapse supported products—including No-Lapse Guarantee UL policies, long-term care and return of premium term plans. We also noted earlier that the later duration lapses on Term 20 and 30 plans which are trending to rates almost as low as those seen on T100. Little actual lapse experience exists at the later durations and the Canadian experience may be a good starting point.

The most recent industry lapse experience on Canadian T100 and Level COI UL policies were published in October 2007 covering observation years 2002–2004. T100 lapse rates fell to 2 percent by duration 8 and leveled off to 1 percent by duration 12. Lapse rates on level COI UL plans drop to 2 percent by duration 10 and remain fairly level thereafter. For copies of these studies, please contact the Canadian Institute of Actuaries at (613) 236-8196 or *secretariat @actuaries.ca* (the website provides access to members only). □

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Benchmarking Universal Life and Indexed UL Products: **Recent Trends and Issues**

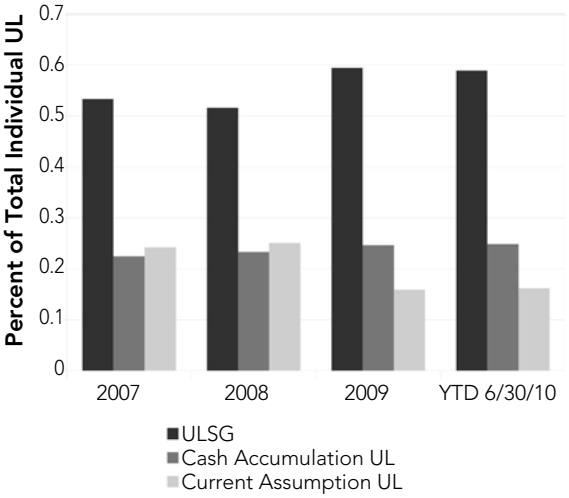
By Susan J. Saip

Milliman's fourth annual comprehensive survey of leading Universal Life (UL) insurers explores issues relative to the UL market. The survey provides carriers with a benchmark to evaluate processes and practices relative to those prevalent in the industry. UL insurance accounted for 42 percent of U.S. individual life sales (based on annualized premium) for calendar year 2010,[1] continuing to play a significant role in the life insurance market. The scope of the survey included UL with secondary guarantees (ULSG), cash accumulation UL, current assumption UL, and indexed UL (IUL) products. A record 29 carriers of UL products participated in this annual survey. This article highlights some of the key findings of the study.

Susan J. Saip, FSA, MAAA, is consulting actuary for Milliman, Inc. She can be contacted at: sue.saip@milliman.com.

Sales

The mix of sales (excluding IUL sales) reported by survey participants for calendar years 2007 through 2009 and for 2010 as of June 30 (YTD June 30, 2010) is shown in the following chart. For purposes of the survey, sales were defined as the sum of recurring premiums plus 10 percent of single premiums. The most significant change during the survey period was seen for 2009 relative to prior periods, with a shift from current assumption UL primarily to ULSG sales.



Average amounts per policy reported by survey participants for all UL types except current assumption UL increased from 2009 to YTD June 30, 2010 on a premium basis. On a face amount basis, average amounts per policy increased for ULSG and IUL, but decreased for cash accumulation UL and current assumption UL. From 2009 to YTD June 30, 2010, the total individual UL average premium per policy dropped from $12,607 to $10,235. The significant drop in current assumption UL average premium per policy more than offset the increases reported for ULSG and cash accumulation UL. The total individual UL average face amount per policy increased from $395,874 to $406,913. From 2009 to YTD June 30, 2010, IUL average premium per policy increased from $8,397 to $9,370 and average face amount per policy increased from $354,963 to $409,247. The highest average amount per policy (based on premium) among the UL product types was reported for current assumption UL (in 2007 and 2009), IUL (in 2008), and cash accumulation UL (YTD June 30, 2010). The highest average per policy (based on face amount) among the UL product types was reported for current assumption UL sales in all four reporting periods of the survey.

A weighted average issue age was determined for sales of survey participants based on the midpoint of specified issue age ranges. In general, average ages dropped from 2009 to YTD June 30, 2010 for all products except cash accumulation UL and IUL sales to females. The most significant drop was for ULSG sales measured on a face amount basis. This may be indicative of lower stranger-owned life insurance (STOLI) activity. The following table summarizes the average ages calculated based on sales reported by issue age range and gender for 2009 and YTD June 30, 2010.

Gender	ULSG	Cash Accumulation UL	Current Assumption UL	IUL
Based on 2009 Sales, Premium				
Male	62	52	63	53
Female	64	48	63	54
Based on 2009 Sales, Face Amount				
Male	56	41	55	46
Female	57	38	54	44
Based on YTD June 30, 2010 Sales, Premium				
Male	61	53	59	53
Female	63	51	63	55
Based on YTD June 30, 2010 Sales, Face Amount				
Male	52	43	53	46
Female	52	40	53	45

The average sales distribution by underwriting class for all UL products shifted in the first half of 2010 relative to that for 2009. When sales are measured on a premium basis, generally there was movement to better underwriting classes for ULSG and current assumption UL, and movement to lower underwriting classes for cash accumulation UL and IUL. There was generally a movement to better underwriting classes for all UL product types except IUL when sales are measured on a face amount basis.

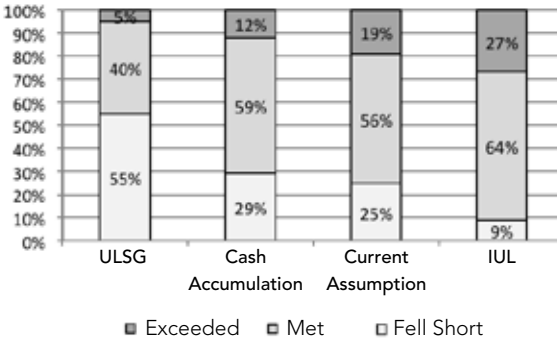
Sales data is becoming more available on UL/IUL products with long-term care (LTC) riders as more and more companies begin to offer and track such products. Nine survey participants reported total UL/IUL sales with LTC rider by LTC rider type elected. The distribution of sales by rider type elected was similar for survey participants between 2009 and YTD June 30, 2010. Rider type refers to the election of an LTC accelerated benefit rider (ABR) only, ABR and extension of benefits (EOB) rider, or ABR, EOB rider, and inflation protection rider. Fifteen of the 29 participants now have or expect to introduce LTC accelerated benefit riders in the next 12 to 24 months. In 2009 and YTD June 30, 2010, the highest averages sales of LTC ABR riders reported by survey participants were for ULSG products based on both premium and face amount. Average size per policy was the highest for cash accumulation UL product with LTC riders (based on premium) and for IUL policies with LTC riders (based on face amount). The survey also profiles sales data by distribution channel, premium type, and by issue age ranges and gender. The availability of this information is expected to grow over time, in step with increased sales of combination UL/LTC products.

Profit Measures

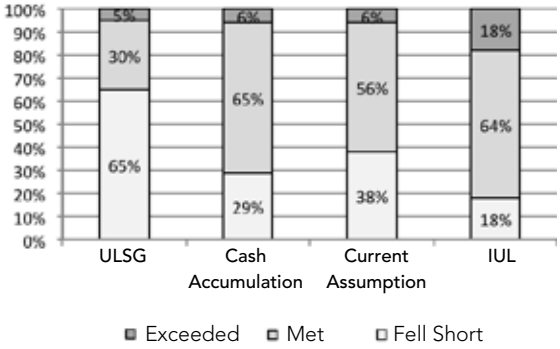
The predominant profit measure reported by survey participants continues to be an after-tax, after-capital statutory return on investment/internal rate of return (ROI/IRR). Few participants changed their profit goals or measures because of the recent economic environment. The median ROI/IRR profit target reported was 12 percent for all products, except cash accumulation UL with a median of 11.6 percent.

Only 45 percent of survey respondents met their profit goals on UL with secondary guarantee products in 2009. This figure dropped to 35 percent during the first half of 2010. The following charts show the percentage of survey participants reporting they fell short of, met, or exceeded their profit goals by UL product type.

Actual 2009 Results Relative To Profit Goals



Actual YTD June 30, 2010 Results Relative To Profit Goals



Target Surplus

The majority of survey participants continue to set target surplus relevant to pricing new UL sales issued today on an NAIC basis. The overall NAIC risk-based capital percent of company action level ranged from 200 percent to 350 percent for ULSG, from 250 percent to 350 percent for cash accumulation and IUL markets, and from 200 percent to 521 percent for current assumption markets. Few participants indicate they are well prepared for the changes to the C-3 component of risk-based capital.

CONTINUED ON **PAGE 18**

Reserves

Most respondents to the survey expect that principles-based reserves (PBR) will be in place in 2014 at the earliest. Participants' comments regarding their outlook on the impact of PBR were primarily related to the expectation of a reduction in reserves. The majority of participants have not examined the underwriting criteria scoring system or any other actuarially sound method for establishing a valuation mortality table. Of those responding, 40 percent reported the credibility of mortality on their UL business at 80 percent or greater.

Risk Management

Twelve of the 29 survey participants are reacting to the current marketplace by repricing and 10 are riding it out. More than 40 percent of those responding reported little or no implications of the recent financial crisis on capital solutions. Others reported implications that relate to limited external funding solution availability and/or costs.

Underwriting

Table-shaving programs are offered by 13 of the 29 participants, and all except one reported their programs will be continued.

The most popular underwriting tools being used by survey participants, especially at the older ages, are tele-underwriting/telephonic screening (20), cognitive impairment testing (20), prescription drug database searches (19), activities of daily living (ADL) measures (18), and additional questions on applications (16).

A number of participants (8) have special simplified underwriting products and each described a different special market where the product is used. This is a slight increase relative to responses to last year's survey.

Product Design

Secondary guarantee designs of ULSG products were fairly evenly split between the three most common structures: shadow account with a single fund (8), shadow account with multiple funds (6), and minimum scheduled premium design (6).

Ten participants repriced their ULSG design in the last 12 months, and nearly all reported that premium rates on the new basis versus the old basis increased. Fourteen participants expect to modify their secondary guarantee products in the next 12 months.

Ten survey participants currently offer a long-term care (LTC) accelerated benefit rider. Five additional companies expect to develop an LTC combination product in the next 12 to 24 months, which when coupled with the 10 companies already offering LTC riders, implies that nearly 52 percent of survey respondents expect to market LTC combination plans within two years.

Twenty-two survey participants currently offer a living benefit or expect to offer a living benefit in the next 12 months. In nearly all cases, participants are providing an accelerated death benefit, primarily for terminal illness.

Compensation

A significant number of companies participating in the survey do not vary commissions and marketing allowables by product type. Median commissions, as well as the range of commissions, were similar between ULSG and cash accumulation UL. IUL products had higher first-year and slightly lower renewal commissions. Current assumption UL products had the highest first-year and renewal commissions. The following chart shows a summary of the median compensation reported by survey participants by UL product type.

Component	Median Commission			
	ULSG	Cash Accumulation	Current Assumption	IUL
Typical first-year commission: up to target	90%	90%	115%	115%
Typical first-year commission: excess	3.00%	3.00%	3.50%	3.25%
Typical renewal commission	3.00%	3.41%	4.00%	2.89%
Marketing allowable	21.85%	17.00%	21.85%	21.85%

Rolling target premiums are most common in IUL compensation programs, with 64 percent of IUL respondents rolling target premiums. Target premiums are commonly rolled for two years. For all other product types, at most 38 percent of respondents roll target premiums.

Pricing

The use of stochastic modeling to evaluate ULSG investment risk is used by 12 out of 21 participants. This level of use is a slight increase over what has been reported for the past several years, but is still surprisingly low given the industry's greater awareness of the risks involved in ULSG products and the movement from a formula-based valuation framework to a principles-based approach.

Twelve survey participants reported that their mortality assumptions are strictly based on company experience. The majority of the remaining responses indicated various combinations of company experience, industry tables, consultants' recommendations, and guidance from reinsurers in developing mortality assumptions. The following table summarizes the basis of mortality assumptions reported by survey participants.

The majority of survey participants reported that the slope of their mortality assumption is more similar to the 2001 Valuation Basic Table (VBT) than the 1975–1980 Select & Ultimate Table or the 2008 VBT. Most participants vary their preferred to standard ratio by issue age and/or by duration. Nearly two-thirds of the companies assume that preferred to standard rates eventually converge and one-third assume they do not converge. Sixteen of the 29 participants do not assume mortality improvement in pricing UL/IUL products.

Illustration Testing

Seventeen of the 29 survey participants reported they find illustration actuary requirements create constraints in UL/IUL pricing. The constraints are more severe for certain product types according to the majority of participants. Solutions reported to overcome illustration actuary challenges were varied and range from increasing charges to opting not to illustrate products where constraints are severe.

Conclusion

The constantly changing issues and challenges of the UL market make it increasingly important for UL insurers to keep track of industry practices and processes. The UL/IUL survey is a useful tool for this purpose and enables UL carriers to see where they stand compared to competitors.

A complimentary copy of the executive summary of the March 2011 Universal Life and Indexed Universal Life Issues report may be found at *http://insight.milliman.com/article.php?cntid=7614* □

END NOTES

[1] LIMRA International, Inc.

Number of Responses	Basis of Mortality Assumptions			
	Company Experience	Industry Tables	Consultants Recommendations	Reinsurer's Guidance
12	X			
3	X	X	X	
3	X		X	
3	X			X
2	X	X		
2			X	
1	X		X	X
1			X	X
1		X		

In fact, correlation risk is among the most complex market risks to measure and to model. It is dynamic, time variant, and conditional on factors both within and outside the market. It is non-linear. Dependence relationships between market variables can be drastically different in the normal ranges and in the tail. It is also asymmetric. The upper and lower tail can have very different dependence relationships.

I organize this article as follows. The first section looks at how equity correlation evolved in recent years. The second section introduces some common mathematical measures of correlation. Then using two of the measures introduced, the third section examines the correlation of S&P 500 vs. Russell 2000, Nasdaq Composite, TSX Composite, and SBBIG in two consecutive eras: 1981–1997 and 1998–2010. This empirical study focuses on important correlation characteristics such as time variant, conditional and asymmetric tail dependence. The subsequent section reviews some of the latest research on correlation models with these characteristics (Mathematical formulae are avoided as much as possible to make this article more readable). And finally, the fifth section discusses the implications of these findings to VA hedging.

Recent Market History

The financial crisis in 2008 is still vivid in our memories. Both inter- and intra-equity index correlation spiked, reaching historical highs in many markets. But let's not forget that correlation has been quietly moving up long before the crisis.

For the past five years or so, market participants have observed a slow upward trend in correlation, which has been partly attributed to the increasing globalization of international economies. The use of exchange-traded funds (ETFs) in the United States could be contributing to the gradual rise within major equity markets as well. When investors buy an ETF in a large size, they are essentially just buying a basket of stocks. Imagine if everyone traded only the ETF that tracks the S&P 500, and there was no independent trading of the single stocks, then the correlation would have gone to one. Hedging activities such as VA hedging programs could also be a factor contributing to the rise in correlation levels.

Since the financial crisis, there have been growing interests among investors to track and trade equity correlation. CBOE, the biggest U.S. options market, introduced the Implied Correlation index in July, 2009 to track correlation for the S&P 500 Index. The gauge is similar to the exchange's VIX index.

Hedge funds are now being launched dedicated to trading equity index correlation. Their strategy involves the use of so called disperse trade and correlation swaps. In fact, they believe that correlation deserves to be an asset class of its own.

Common Measures of Correlation

Like volatility, correlation is not directly observable in the market. It can only be estimated in the context of a model. Therefore, there are many measures of correlation ranging from the simple linear correlation to the more sophisticated ones based on advanced models.

Pearson's correlation

Perhaps the most familiar measure of correlation between two random variables is the Pearson product-moment correlation coefficient, or Pearson's correlation. It is obtained by dividing the covariance of the two variables by the product of their standard deviations.

Expressed in mathematical terms, the Pearson's correlation coefficient $\rho_{X,Y}$ between two random variables X and Y with expected values μ_X and μ_Y and standard deviations τ_X and τ_Y is defined as:

$$\rho_{X,Y} = \frac{cov(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$

Pearson's correlation describes the linear association between two random variables. But it is not scale-invariant, meaning that it doesn't always produce a unique number when the random variables are scaled. Other measures such as Kendall's tau and Spearman's rho are scale-invariant and they are generally more appropriate for non-normal distributions. Interested readers can refer to chapter five of the book *An Introduction to Copulas*, by Roger Nelson.

CONTINUED ON **PAGE 22**

"In fact, they believe that correlation deserves to be an asset class of its own."

The rolling correlation estimator

When estimating Pearson's correlation for equity returns based on historical data, the estimate will keep changing over time as new data is incorporated into the estimate. A rolling correlation estimator at time t based on the most recent n observations can be defined as follows for returns with zero mean:

$$\hat{\rho}_{XY,t} = \frac{\sum_{s=t-n-1}^{t-1} \bar{X}_s \bar{Y}_s}{\sqrt{\left(\sum_{s=t-n-1}^{t-1} \bar{X}_s{}^2\right)\left(\left(\sum_{s=t-n-1}^{t-1} \bar{Y}_s{}^2\right)\right.}}$$

Where $\bar{X}_5$ and $\bar{Y}_5$ are samples from random variables X and Y.

This rolling estimator is used in this article to study correlations between S&P 500 and four other indices over the past three decades. There are many other rolling estimators. For example, RiskMetrics uses an estimator with an exponential smoother which puts greater weight on more recent data.

Tail dependence measure

Although Pearson's correlation is widely used, its limitation is obvious. It tries to capture the dependence relationship between two random variables with one number while dependence relationships can be very different in the normal ranges and in the tail. Clearly an average number does not describe associations in the extreme values.

Coles, Heffernan, and Tawn (1999) proposed a tail dependence measure χ for two random variables X and Y, defined as a limit of a conditional probability:

$$\chi = \lim_{u \to 1} \Pr\left(F_X(X) > u \mid F_Y(Y) > u\right)$$

Where F_X and F_Y are the distribution functions of random variables X and Y, and u is the quantile of their distributions. $\chi = 0$ indicates tail or asymptotic independence. $\chi > 0$ suggests asymptotically dependence, with higher values indicating stronger dependence.

For convenience, an asymptotically equivalent function $\chi(u)$ was defined and served as a quantile dependent measure of dependence:

$$\chi(u) = 2 - \frac{\log \Pr\left(F_X(X) < u, F_Y(Y) < u\right)}{\log \Pr\left(F_X(X) < u\right)}$$

It can be shown: $\chi = \lim_{u \to 1} \chi(u)$. $\chi(u)$ serves as a measure for dependence at quantile level u. Higher value indicates stronger dependence at a particular quantile level. In this article, the author uses $\chi(u)$ to study the dependence relationships of S&P 500 and four other indices in the upper and lower tail in two consecutive eras of 1981–1997 and 1998–2010.

Copula

An overview of correlation wouldn't be complete without at least mentioning copula. Copula is a joint distribution function of standard uniform random variables. Since any random variable can be transformed into a uniform random variable by its distribution function, copula can be used to construct multivariate distribution functions using only their one-dimensional marginal distribution functions.

Precisely because of this feature, copulas are capable of fully specifying the dependence structure of two or more random variables. It is therefore not surprising that they are widely used in dependence research. One of the research disciplines termed Extreme Value Theory built on a special kind of copula deals almost exclusively with studying the dependence structure in the tails. Interested readers can refer to Roger Nelson's book *An Introduction to Copulas* for more details about copulas.

Empirical Study of Index Correlation

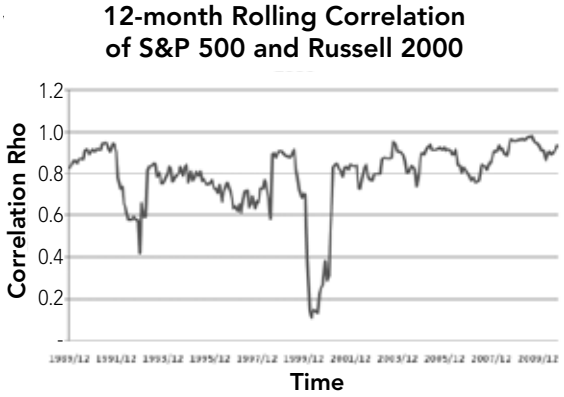
Realizing that correlation between random variables can be dynamic, time-variant, and drastically different in the tails, I studied the index correlation of the monthly de-trended log returns of S&P 500 with the following four indices: Russell 2000, Nasdaq Composite,

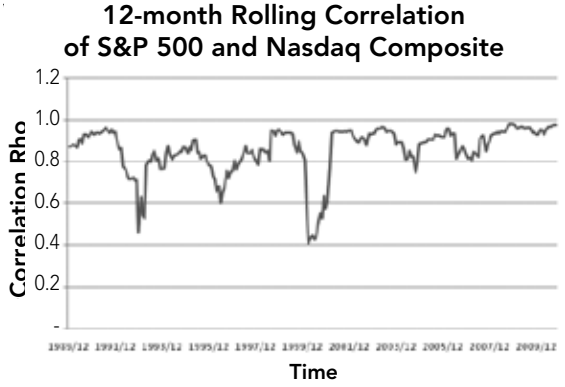
TSX (Toronto Stock Exchange) Composite and Citi Broad Investment Grade Index (Formerly known as SBBIG. We will use SBBIG in this article). S&P 500 is perhaps the most representative of the overall U.S. stock market. Russell 2000 represents the U.S. small cap stocks, Nasdaq reflects the technology sector, and TSX gives some international flavor. And finally, the SBBIG represents the U.S. bond market.

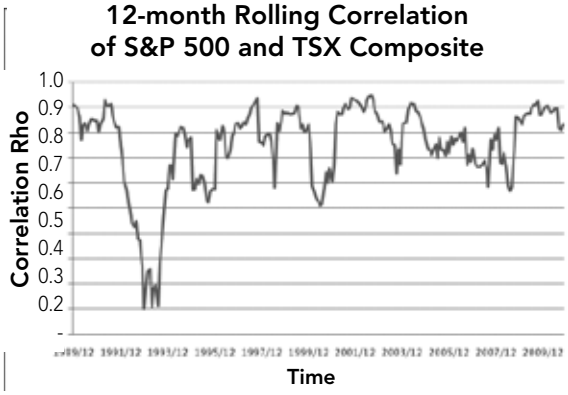
I studied the period of 1981–2010 which experienced the 1987 crash, the pop of the Internet bubble of 2000, the 2008 market collapse, and of course, the recessions after each major market crash. There were periods full of spectacular market returns during this period also, so I had no trouble finding both the upper and lower tails. In fact, to study tail dependence, I further divided this period into two sub periods: 1981–1997 and 1998–2010. The rationale is that the second sub period really saw an elevated level of financial innovation and integration of global economies. I want to see if there is a meaningful difference in tail dependence of the two sub periods.

Dynamic and time-variant index correlation

Figure 1 shows the 12-month rolling correlation (defined in the previous section) of S&P500 with the four other indices during the period of 1989–2010. One immediate observation is that the correlations between different indices are indeed highly dependent on time. In fact, there are periods that correlations are highly volatile. The assumption of constant correlation is probably an over-simplification.







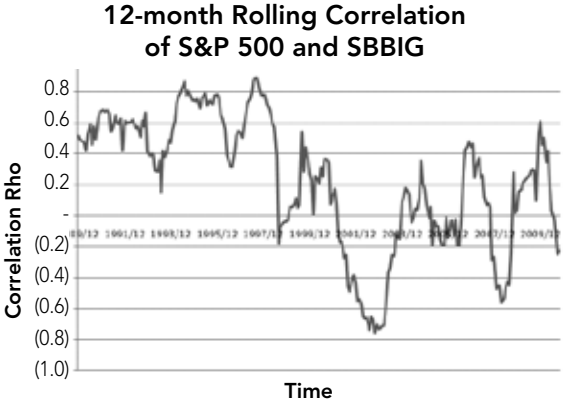


Figure 1: 12-month rolling correlation

Further inspection reveals that there are some periods in which Russell, Nasdaq and TSX's correlation with S&P 500 first increased but was followed by a sharp spike down to very low levels. This happened around

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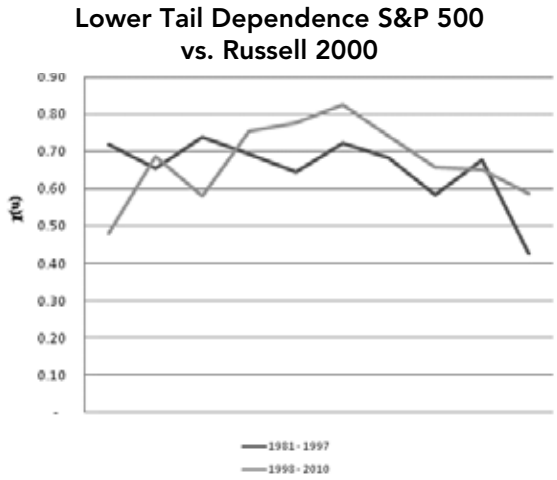
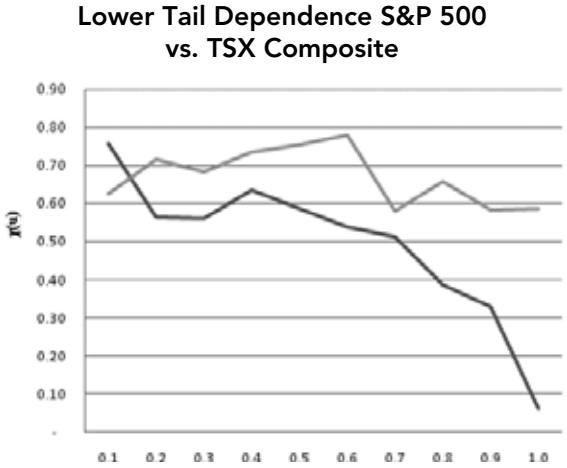
Yuhong (Jason) Xue, FSA, MAA, is an officer of Retirement Solutions at the Guardian Life Insurance of America in New York, NY. He can be reached at yuhong_xue@glic.com.

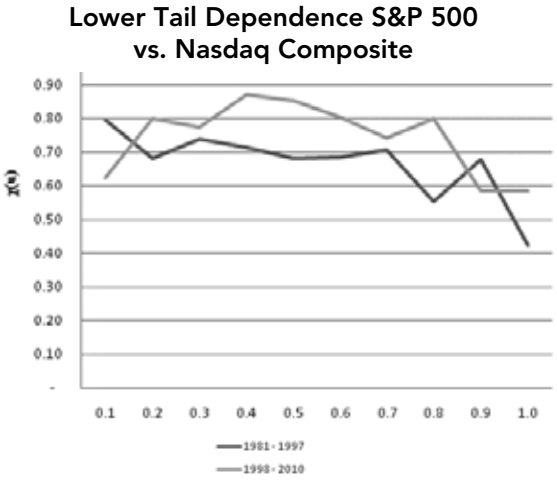
1992 when the U.S. economy was just climbing out of recession and then again in 1999 when the Internet bubble reached its peak. It is also interesting to see the distinct levels of correlation between S&P and SBBIG for the two sub periods of 1989–1997 and 1998–2010 with positive correlation in the first but directionless correlation in the second.

Tail Dependence of Index Returns

Now let's turn our attention to the correlation of upper and lower tails of the index returns of the past 40 years. I plotted function χ (u) to indicate strength of quantile dependence for the four pairs of indices. I observed χ (u) when u approaches 1 to understand the level of correlation in the upper or lower tail. (I negated the de-trended log returns to study the lower tail.) Figure 2 shows the results of the lower tail.







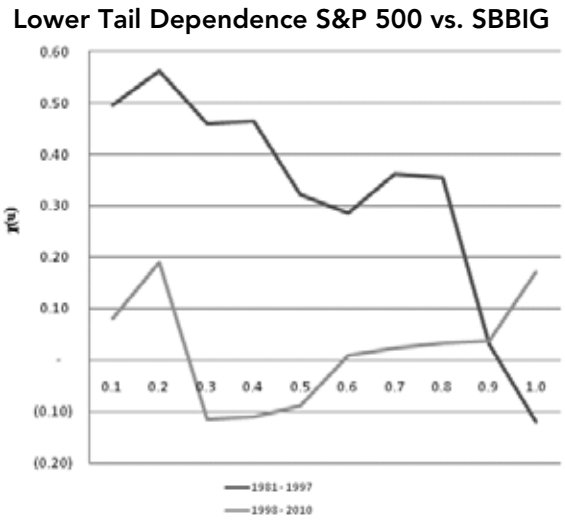


Figure 2: function χ (u) of index returns in the lower tail

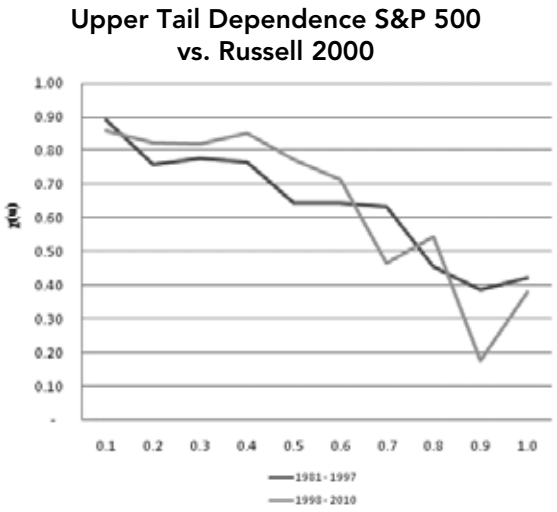
The dependence pairs of Russell/S&P and Nasdaq/S&P show a similar pattern with no obvious difference between the two sub periods in quantile less than 0.9. When u or quantile goes to one, however, the sub period of 1998–2010 shows a stronger dependence indicating a higher tendency for these indices to move sharply lower together than the previous sub period of 1981–1997.

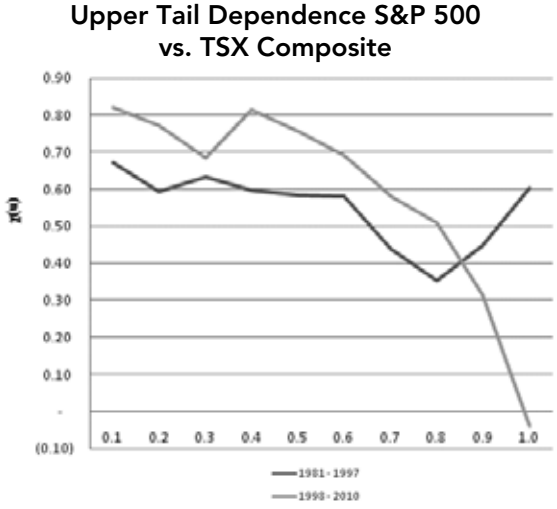
As for the correlation of TSX and S&P, the recent sub period almost always has a stronger dependence than the previous one. Even more interesting is that when u goes to one in the lower tail, the sub period of

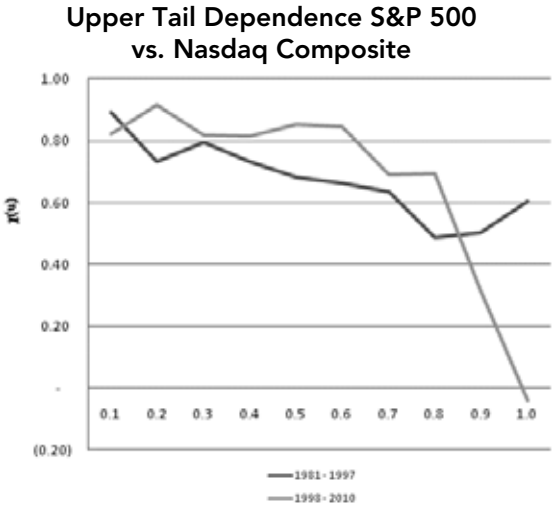
1981–1997 shows no dependence while the recent sub period observed a strong dependence, perhaps evidence of globalization in the past 20 years or so.

Figure 2 shows that during 1981–1997, there is strong correlation between equity (S&P) and bond (SBBIG) in the normal ranges ($u<0.8$) but no dependence in the lower tail. The opposite is true for the sub period of 1998–2010 with no apparent dependence in the normal ranges but dependence (although not a strong one) in the extreme lower tail, an indication that equity and bond returns would both drop sharply in a market crash.

What about the upper tail? Is it a mirror image of the lower? Figure 3 plots χ (u) in the upper tail.







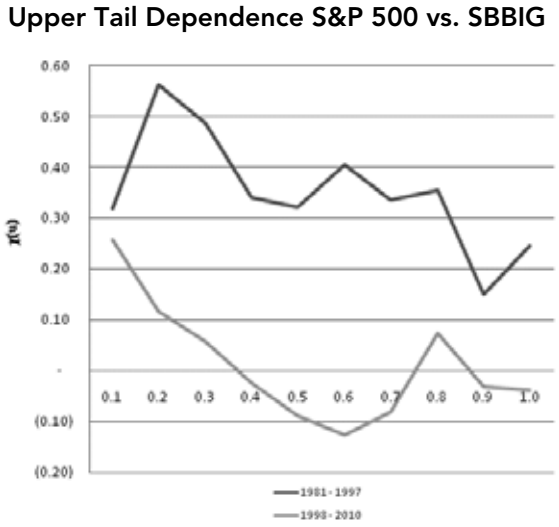


Figure 3: function χ (u) of index returns in the upper tail

The answer: it is far from a mirror image, highlighting the fact that tail dependence is asymmetric for index returns.

The correlations of S&P and Russell over the two sub periods are roughly the same, with a little stronger dependence in the normal ranges than in the upper tail. But when we look at the correlation structures of S&P/

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Nasdaq and S&P/TSX in the upper tail, it is a different story. In the normal ranges, the dependence structure during 1998–2010 is stronger than during 1981–1997. However, in the upper tail, the 1998–2010 data shows no dependence while the 1981–1997 returns demonstrate strong dependence. Is it an indication that in the recent two decades large U.S. cap stocks underperform domestic and international growth stocks in a breakout situation?

In the normal ranges, in the period of 1981–1997, the correlation between equity and bond tend to be higher than the subsequent period. However, in the tails, during 1998–2010, although there is clear lower tail dependence, the upper tail shows no evidence of dependence. And the opposite is true for the period of 1981–1997.

From this empirical study summarized by Figures 1, 2 and 3, we see four facts about the correlation structures between the studied indices:

1. They are dynamic and time-variant.

2. They are very different in the normal ranges and in the tails.

3. Dependence relationships can be very different in the upper and lower tails, i.e., asymmetric.

4. Dependence relationships are different for the two sub periods, both in the normal ranges and in the tail, suggesting dependence is conditional on macro economic factors outside the market.

Latest Research in Correlation Modeling

Given the above four facts about index correlations, it is apparent that the simple stochastic equity process where returns of different indices are linked by a constant correlation matrix will not reflect the true nature of correlation and, therefore, will not model multivariate returns adequately for some applications.

"… suggesting dependence is conditional on macro economic factors."

There is much academic research devoted in creating stochastic equity models that incorporate these characteristics about correlation. Perhaps the simplest that models time-variant correlation is the so-called multivariate GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model which can be expressed as follows in the two variables case:

$$cov_n = \omega + \alpha x_{n-1} y_{n-1} + \beta cov_{n-1}$$

Where cov_n is covariance between random variable X and Y at time n, and are return estimates of X and Y respectively at time n-1, and α, β and ω are parameters to be estimated.

There are many specifications of multivariate GARCH models, such as the one proposed by Kroner and Ng (1998). The model allows for asymmetric effects in both the variances and covariance. However, these GARCH models are complex and hard to estimate.

Engle (2002) proposed a model called Dynamic Conditional Correlation (DCC) which has the flexibility of univariate GARCH, but not the complexity of conventional multivariate GARCH. These models can be estimated in two steps—the first is a series of univariate GARCH estimates and the second the correlation estimate. These models capture the time dynamics and also allow for asymmetry in correlation.

Stefanova and Elkamhia (2008) introduced a comprehensive approach to modeling stochastic correlation, asymmetric dynamics and tail dependence all at the same time. The modeling allows explicit asymmetric dependence in the tails by using copula functions. Stochastic correlation between risky funds is achieved through a multivariate diffusion process.

In addition, stochastic correlation in this model is a function of macroeconomic and market variables. Two variables were chosen to ultimately drive asset correlations along with other dynamics. The VIX is selected to

represent the overall market conditions. And to incorporate the effect of the business cycle on correlation, the Chicago Fed National Activity Index (CFNAI) was chosen. The index synthesizes information on various macroeconomic factors. It is a weighted average of 85 indicators of national economic activity, ranging from production, employment, housing and consumption, income, sales, orders and inventories.

Implications to VA Hedging

What does all this mean for VA hedging?

Hedging models tend to make assumptions of correlation based on long-term historical averages. But what we have seen is that correlation is highly dependent on time and can change rather quickly and stay at high or low levels for some time. For hedging models with long-term assumptions, this means hedging breakages. One option is to update the correlation assumptions more frequently and calculate an estimator either based on implied correlation observed in the market or on a historical calculation that gives more weights to the most recent data. One can also hedge some correlation risks in the market place. Financial instruments such as basket options can be used to hedge equity to equity correlation; and correlation swaps can be used to hedge equity to interest rate correlation.

For every hedging model, there is an underlying stochastic equity model generating future scenarios. This model typically uses a constant correlation matrix to link the projected asset returns. This means that the model thinks correlation is exactly the same at all future times with no regard to volatility, market crash/peak, or future economic conditions. Of course this is an over simplification. One remedy is to model correlations stochastically by adopting an approach that reflects all of the characteristics of correlation observed in this article. Stefanova and Elkamhia (2011) discovered that by adopting such a model in determining asset allocation dynamically, investors are able to achieve better long-term results. But no research has been done so far to show whether it reduces hedging breakages and leads to better overall results.

Some of the current VA hedging approaches involve some type of automatic asset allocation between VA's equity and bond funds to reduce volatility of the account value. This approach works as long as equity and bond correlation remains low and directionless. We have seen this is indeed the case in the past 20 years in the normal data ranges. At the lower tail though, the correlation turns positive. Moreover, for the period of 1981–1997 there is positive correlation even in the normal ranges. Would this approach still work if we experience a period of strong equity and bond correlation? More research is needed to answer this question. ◻

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