Life Settlement Financial, LLC
Knowledge Base Response to "Why is it Difficult to Game the Longevity Cost Calculator?"

2.0 Could you explain why it is difficult to game the system? I accept that it is difficult to produce a pure Type III. However, it seems that participants have no incentives to provide accurate answers, and therefore the GoM scores are unreliable?

This is a reasonable and valid question that has frequently been asked. The answers are both mathematically based as well as practically.

The 95 questions in the original National Long-Term Care Survey (NLTCS) have a minimum of two answers, some with as many as seven possible answers. The actual number of possible answers is about 175 with over 3.5 million covariants. In order to manage that many covariants the model's author, P.J. Eric Stallard, devised a system whereby he divides the characteristics of responses into four Grade of Membership categories. The algorithms that create the Grade of Membership (GoM) scores are based on the various combinations of covariants of these 175 responses and their interrelationships in a three dimensional model. Not only is the number of possibilities staggering, but the combinations themselves are often counterintuitive. If one were randomly producing answers, the resultant GoM scores could also be random, with a mixture of GoM scores of I thru IV.

The notion that one can play or "game" the system in order to tweak their score is impractical. The results, as stated are often counterintuitive and the result is thus not predictable. One can make the argument that if a string of answers are given that shows the insured to have significant impairments, that it is likely that a proxy will be needed. A proxy related to the insured may have the incentive to paint the picture of a health compromised person if they fully comprehend the reason for the survey. A non-relative or objective proxy will often actually paint a better picture of health than actual. Seniors themselves will often portray themselves as healthier than they actually are.

In addition to providing an Life expectancy estimate, the completed LCC questionnaire scores each insured using the four level Grade of Membership (GoM) system. The interrelationship of an insured's activity of daily living (ADL) impairments, instrumental activity of daily living (IADL) impairments, and possible cognitive impairment affect those GoM scores and the trajectory of the individual's survival curve used to price a settlement offer. To quantify the health changes, the model generates both time varying and time invariant GoM scores, where the time invariant GoM scores characterize the predicted health status of each person at the time they are/were in the youngest age-group in the model, which for the current implementation was age-group 65–69. In both cases, the interpretation of the GoM scores is invariant over time. In the following, we describe the health status characteristics summarized by the GoM scores.

Components of the LCC Questionnaire (only 1 & 2 have ICD 9 Codes)

- Medical conditions
- Medical conditions past 12 months
- Subjective health status

- Habits/behaviors
- Height, weight, BMI
- Activities of Daily Living (ADL)
- Instrumental Activities of Daily Living (IADL)
- Range of Motion
- Short Portable Mental Status Questionnaire (SPMSQ)
- Proxy respondent

Top 20 elements ranked using Chi-Square divided by degrees of freedom (d.f.)

I. ADL Limitations-Outside mobility
2. IADL Limitations-Grocery shopping
3. IADL Limitations-Travel
4. IADL Limitations-Laundry
5. 5 year survival status
6. IADL Limitations-Cooking
7. Residence type: Institutional vs. noninstitutional
8. IADL Limitations-Light housework
9. IADL Limitations-Managing money
10. IADL Limitations-Taking medications
11. IADL Limitations-Phoning
12. ADL Personal Assistance Level-Bathing
13. ADL Personal Assistance Level-Indoor mobility
14. ADL Personal Assistance Level-Continence
15. Race
16. ADL Personal Assistance Level-Transferring in/out of bed
17. Proxy interview
18. ADL Personal Assistance Level-Dressing
19. ADL Personal Assistance Level-Toileting
20. Medical-Circulation trouble in arms or leg, previous 12 months

<u>Characteristics of GoM Pure Types</u>

GoM 1 (also referred to as “Pure Type I” or “Type I”, with the Arabic or Roman numerals designating the rank ordering of the states by health status) refers to the healthiest component of the population. GoM 2, 3, and 4 capture a range of health problems that occur at different ages, with progressive and graded transitions from GoM 2 to GoM 3 and 4. GoM 2 refers to persons who have numerous medical problems, but few, if any ADL or other functional problems, or cognitive impairment.

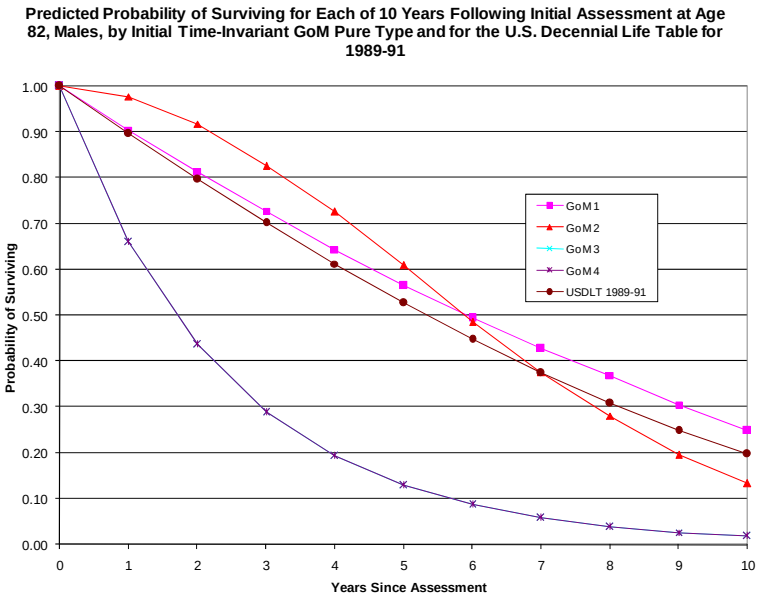
An important aspect of the model is that the individual GoM scores are fractional and sum to 1.0 when added over all four components. This is true for both the time varying and time invariant GoM scores, which implies that the deterioration in health status over age can only be represented by a reduction in GoM 1 and compensating increases in some combination of GoM 2, 3, and 4.

Persons with initial strong scores (i.e., close to 1.0, or 100%) on GoM 2 will live longer than traditional LE providers estimate; although this changes at older ages where these persons exhibit transitions to strong scores on GoM 4. Persons with initial strong scores on GoM 3 have minor medical problems, but mild/moderate cognitive impairments,

usually not indicated in their medical records, although this also changes at older ages where these persons exhibit transitions to strong scores on GoM 4. Strong scores on GoM 4 identify people who have more serious medical problems, combined with serious ADL and/or cognitive impairments, also which are not usually indicated in their medical records. Persons with initial strong scores on GoM 3 and GoM 4 have shorter LE's than those issued by traditional LE underwriters.

Recall that the LE is the area under the relevant survival curve for the person or population for which the LE is being calculated. Thus, differences in LE between persons or groups of persons are best understood by examining the associated survival curves. This is illustrated in Figure 1 which displays plots of the predicted survival curves for males assessed at age 82 (i.e., age at last birthday is 82; the midpoint of the five year age interval 80–84 years used in model estimation) for the next 10 years following the assessment, with a separate curve shown for each of the four time invariant GoM pure types and also for comparison the survival curve from the U.S. Decennial Life Table (USDLT) for 1989–91[i].

Figure 1



It should be noted that in Figure 1, by age 82 the GoM III and IV scores have merged and are represented as a single survival function curve.

According to the USDLT, the male LE at age 82 was 6.2 years. This value was less than the LE's of 6.9 and 6.3 years for GoM 1 and 2, but was substantially higher than the LE's of 2.5 years each for GoM 3 and 4 (these LE-values were the same because an initial GoM 3 "converted" to GoM 4 prior to age 82).

Given that both the survival curve and its slope are used to price an offer or value a component policy within a life settlement portfolio (the former for premium costs, the latter for death benefit offsets), it is important to accurately estimate these quantities. Armed with this knowledge, an underwriter could price an offer to outbid the competition, win the policy, but not pay the full price indicated by alternative

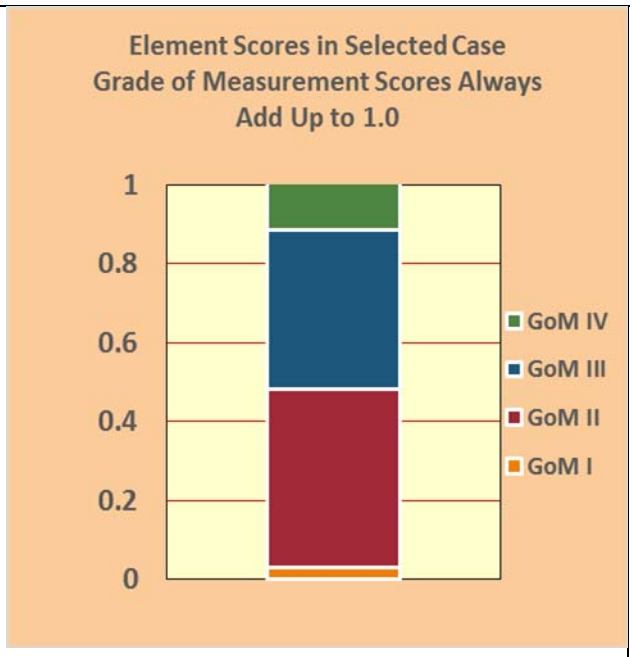
commercially available proprietary pricing models. The same pricing differential would be manifest as a valuation error in the life settlement portfolio application.

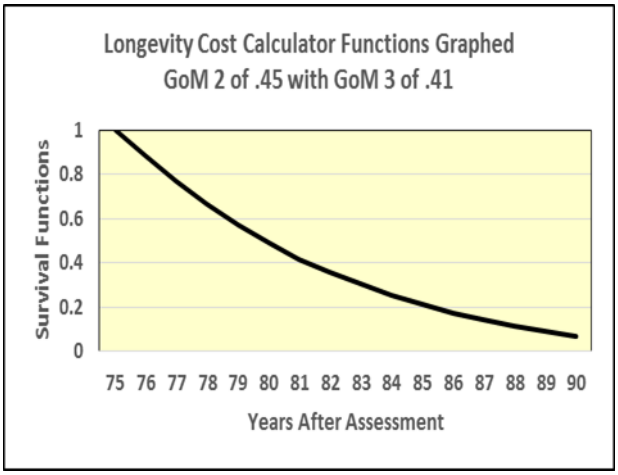
In Figure 1, an initial GoM 2 had approximately a 16% greater likelihood of surviving through years 1 through 5 until the lines converged at year 6, near the 6.2 year LE. On the other hand, an initial GoM 3 or 4 had approximately a 75% lower likelihood of surviving through years 1 through 5, with corresponding reductions for persons who had initial *fractional* scores on GoM 3 or 4, with complementary *fractional* scores on GoM 1 and/or 2. Again, we note that the sum of all four fractional scores must equal 1.0 (100%), with the GoM scores for any given individual derived from his/her answers to up to 76 questions on the web-based or telephonic interview (selected from 95 questions in the original analysis; see Stallard)[ii].

Interpretation of GoM Scores

Based upon the above description it would seem easy to interpret GoM scores. Why that is wrong is that the score is the sum of an individual's GoM 1 thru 4 scores after the algorithms sort through the 3.5 million possible covariants. Even when you have an individual's GoM 1 thru 4 scores it is easy to jump to incorrect conclusions. For example, an individual with a GoM 3 of 0.41 would seem like a good candidate to have a much shorter life expectancy and an individual with a GoM 2 score of .0.45. In fact these are two of the scores for the same person. What really matters are the survival functions and the slope/trajectory of the curve that they present to a properly constructed stochastic pricing model. The data for this example is below.

Female 75	6.20	GOM I: 0.0000000	GOM II: 0.45108
		GOM III: 0.40592	GOM IV: 0.14298
75	1.00000		
76	0.883044	11.70%	
77	0.76987	12.82%	
78	0.66344	13.82%	
79	0.571723	13.82%	
80	0.492061	13.93%	
81	0.418687	14.91%	
82	0.356254	14.91%	
83	0.302791	15.01%	
84	0.25445	15.96%	
85	0.211382	16.93%	
86	0.173518	17.91%	
87	0.140722	18.90%	
88	0.112673	19.93%	
89	0.088582	21.38%	
90	0.068345	22.85%	





Longevity Cost Calculator Telephonic Assessments

Among the documents that must be signed in the life settlement application and agreement are statements regarding the truthfulness of answers to all questions. Insureds as well as proxies are advised that entering false information renders them subject to prosecution under current law in most states. While this may not discourage all, it certainly will impact the cohort involved with life settlements.

A further point is that before each telephonic LCC assessment the insured and or their proxy has signed a release form acknowledging they will submit to an interview, but nothing about the context of the interview is disclosed. The interviewers are trained to be casual and the process is usually smooth and conversational. The 76 LCC assessment questions are medical, activities of daily living (ADLs), instrumental activities of daily living (IADLs), cognitive, range of motion and behavioral. At the end of the interview the insured/proxy is thanked, but no information or score results are provided.

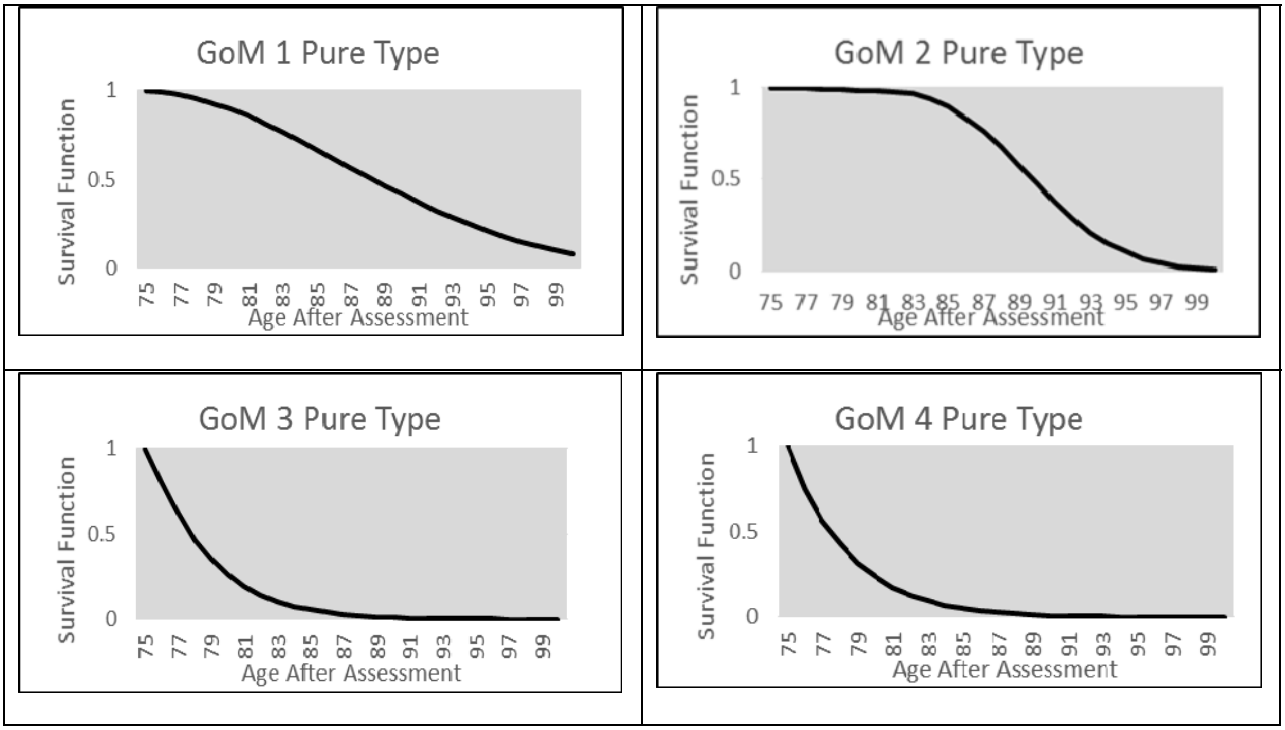
As part of the due diligence screening the results of the LCC assessment are compared electronically to the insured's medical records provided by their attending physician(s). Going forward LSF will use a medical taxonomy to compare words, phrases and ICD 9 codes obtained from OCR scanned documents. This process has two purposes: 1) to identify inconsistencies between LCC answers and items obtained from the Insured's medical records. And 2) to identify and challenge differences between commercial life expectancy reports and between the reports and the insured's medical records.

Creation of GoM Pure Type Scores in the LCC Model

A member of our staff and then Chief Underwriter, Dr. Bob Rosenberg, was assigned the task of entering responses to manipulating the LCC model to develop 1.0 pure type GoM 1 thru 4 scores and related survival curves. Dr. Rosenberg was very familiar with the interaction of the questions in the LCC model and was part of the team that re-validated the model after it was rewritten in web based code in 2009. In the process of creating pure type model scores Dr. Rosenberg found it relatively easy to create the pure types GoM 1, GoM 2 and GoM 4. Each of these took approximately 25 renditions

of the model to achieve the pure type score. However the GoM III required 155 tries. Many times when he thought he could change an answer to achieve the result he wanted the score would go the opposite direction. The interrelationships are so complex as to be counterintuitive, even for someone who understands the questions and many of the interrelationships.

Below are four survival function curves representing Grade of Membership Pure Types of GoM 1 thru 4.



A GoM 1 pure type is not dissimilar from the survival curve from the US Decennial Tables or 2008 Variable Basic Tables at standard by gender by age. A GoM 2 pure type will live healthier for longer, but ultimately end up about the same place as a GoM 1 at age 97. Stochastically the GoM 2 has a much higher probability of requiring premium payments for much longer and it will be longer before a death benefit will be collected – thereby lowering the internal rate of return on that policy. GoM 3 and 4 individuals look similar and require the fewest premium payments, a shorter wait to collect a death benefit and thus offer the highest internal rates of return.

[i] National Center for Health Statistics (NCHS), 1997. U.S. Decennial Life Tables for 1989–91. Vol. 1, no. 1. National Center for Health Statistics, Hyattsville, MD.

[ii] Stallard, E., 2007. Trajectories of Morbidity, Disability, and Mortality among the U.S. Elderly Population: Evidence from the 1984-1999 NLTCS. *North American Actuarial Journal* 11(3):16–53. http://www.soa.org/library/journals/north-american-actuarial-journal/2007/july/naaj0703-2.pdf