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Life Expectancies Comparison for Life Equity

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Abstract

There is an industry which purchases whole life policies from individuals who no longer seek protection from debts or providing financial support for others after death. That industry usually offers a price above the surrender value of the policy, yet expects the individual will expire relatively soon resulting in a financial gain. Life Equity is a small company offering to purchase such policies. As a smaller company they rely on third party underwriter's life expectancies reports to determine the valuation for a individual policy on which to offer a purchase price. The objective of the project is to determine statistically which of these if these third party reports reflect a financial gain for Life Equity. Currently Life Equity uses under writer reports from AVS, 21st Services, EMSI (which is now LSI), and Fasano and Associates. Using statistical analysis form 5000 purchases, this paper will instruct Equity Life which third party underwriter reports provided maximum profits.

Introduction

This semester I have taken an internship at Life Equity. The company's primary business is buying life insurance policies from the insured of the policy at a price usually higher than the cash surrender value (if any) but less than the face amount. In exchange, Life Equity receives the life insurance proceeds upon the death of the insured to make a profit. Life insurance usually serves as a tool to provide financial support to the beneficiary of the policyholder's choice when the insured should pass away. The insurance proceeds can allow the loved ones of the insured to live off of it for a while till they can fend for themselves or pay off loans and expenses if the insured passes away by a specific point in time.

There are situations where the insured's demand for life insurance may change along with their life changes. Such as when the person they originally were going to give the money to no longer needs it or all expenses are paid off. In these situations, the insured can surrender their policy and receive surrender cash value but they have to pay a high amount of surrender charge. The alternative for the insured is selling their life insurance policy to a life settlement company like Life Equity who usually provides a price higher than the cash surrender value to avoid the high back-end loadings. Once bought, Life Equity becomes the new policy holder and beneficiary who will be entitled to the insurance proceeds payable by the insurance company upon the death of the insured. As the new policy owner and beneficiary under the life insurance policy, Life Equity will have to keep paying premiums if the settlement policy has not been paid up until the insured dies in order to receive the death benefits. The longer the insured survives, the more premiums will need to be invested by Life Equity. The strategy of Life Equity is to bid for life insurance where the insured is about to pass away from complications or terminal illnesses before the policy ends so that a profit can be made.

The company determines the value of life policies based on the life expectancy estimates (LES) provided by many underwriters such as 21st Services, AVS, EMSI (which is now a part of LSI), and Fasano and Associates. Life Equity trusts the underwriters based on their experience but has never evaluated the accuracy of the LES provided. Life equity receives life expectancy reports containing information about the insured that are used to determine the length of his or her life. The report comprises of the possible seller's birthdate, gender, weight, height, the mean and median months predicted to live, if the person is a smoker or not, and medical issues the insured has. All are the factors in determining the life of an individual.

Process to Calculate Life Expectancy

The life expectancy is determined by mortality tables and medical records. The mortality tables, sometimes called actuary tables, are easy to access and even can be seen on the website www.soa.org ("Actuarial Tables, Calculators & Modeling Tools" 2018.) The tables are calculated with algorithms by actuaries that determine rates of death of a person. The four major factors affecting the rates are age, gender, smoking, and health. Hence why all of these factors are on a life expectancy report. There are different tables for all the combinations of those variables. The algorithms are determined by looking at a large group of people matching the factors. The actuaries do not follow the whole life of the big group. This is because "the resulting life table would reflect historical conditions that may no longer apply. Instead, one generally works with a period, or current, life table. This summarizes the mortality experience of persons of all ages in a short period, typically one year or three years." (Strauss, 2017.) Once the actuaries calculate different rates for scenarios, they are added into a table. These tables are calculated every couple of years to consider the new conditions. Underwriters then use this information and other medical information to determine the life expectancies.

The underwriters use similar processes but have a couple of differences. AVS uses medical evaluation and a debit and credit model used in the standard life insurance industry to calculate the life expectancy. A nurse will look at a paper and determine relevancy and then writes a medical summary. Then it goes to the underwriter who uses the debit and credit model (AVS Underwriting, 2017.) Fasano's approach is unique in using medical professionals to review and analyze medical files based on their judgment. The physicians combine clinical experience with research and insurance medicine expertise (Fasano Associates, 2018.) EMSI(now LSI) uses Medical directors who specialize in life settlements. It also adds debits and credits to various health conditions (Baur, 2015). Lastly, twenty-first also uses medical information for the debit and credit system. The underwriters then use the four main medical factors to determine the mortality curve a person belongs to and the life expectancy (Longevity Services, Inc, 2018).

Literature

There is a fair amount of research out there on which medical underwriting is the best. The top three being AVS, 21st services, and Fasano. A study completed in the year 2012 by the European Life Settlement Association states that 21st services offer the closest comparison of actual death to predicted deaths. The average for 21st is just under 80 months, while AVS and Fasano are averaging a little under 110 months (Bechmann, 2012.) According to Alexander Braun and Jianhua XU, 21st services provides shorter LES on average than all of the other three underwriters. (Braun, Alexander, and Jianhua, 2017.)

Data

Life Equity has several underwriters that they use to supply the reports including 21st service, AVS, Coventry, Elevation, EMSI, Fasano, ISC, LSI, Midwest, and Predictive

Recourses. In the report, some of these are not mentioned because of different reasons. ISC and Midwest are no longer in business; therefore, reporting on the accuracy of them would be irrelevant for Life Equity's future business. Elevation and Predicative Life contained under one hundred policies, and therefore I felt that I couldn't determine accuracy over so little data. Lastly, EMSI is now LSI. Therefore, there is data for EMSI to look at and analysis but for LSI there is very little, and no one has passed away in the group so far. The big groups that I focus on in this study are 21st services, AVS, Fasano, and EMSI.

The sample group consists of all the LE reports that Life Equity have encountered. The total sample group is 6,816 reports. This consists of people that have passed away and are still alive. The number of being still alive are 1534 in AVS, 1503 in 21st, 668 in EMSI, and 1662 in Fasano. The people that have passed away are 455 in AVS, 393 in 21st, 240 in EMSI, and 298 in Fasano.

Graph 1 Sample Size of Each Underwriter's Reports

LE Accuracy Evaluation Methods

To evaluate the accuracy of the life insurance purchased by Life Equity, I will use several measures including the average difference between predicted and actual life expectancy of each underwriter, A/E ratio, and measure of total fracture of life settlement policies where the insured survived the expected death date.

The difference between predicted and actual life expectancy can only be calculated correctly when the insured of settlement policies has died. The difference between predicted and actual life expectancy can be directly derive from the LE report the actual death year and projected death year for those who has reported as dead by 2018. I derive the average differences for each underwriter in each year. The positive difference refers to the insured living shorter than the projected death year. Life Equity can benefit from a positive difference by paying less premiums than expected when purchasing the policy. In contrast, the negative difference refers to the insured living longer than the projected death year. This causes Life Equity to incur loss from paying extra premiums than expected. The closer to zero the difference is, the more accurate the company is. However, there is potential bias in this measure because the measure does not contain the insured who is still alive beyond 2018. If many insureds who outlived 2018 also outlived their projected death year, this measure would overestimate the difference.

I also used another measure, A/E ratio, which is the actual number of deaths over the expected number of deaths during a certain amount of time. It is commonly used in actuarial practice to assess the quality of LE forecasts by tracking the ratio of the actual number of deaths to the expected number of deaths over time.

$$\frac{A}{E} = \frac{\sum_{i=N}^{N} 1\{\tau_x^i < t\}}{\sum_{i=1\ t}^{n} q_x^{(i)}}$$

In a portfolio size *N*, we denote the *{\tau_x <t}* as the individual's realized remaining lifetime and *q* as the individually estimated *t*- year mortality probability. The numerator is the indicator function that takes the value one if an individual *i* died before time t and 0 otherwise. In other words, *A* is the actual number of deaths while *E* is the expected number of deaths over a time *t*. As time progresses, there will come a time when all people will die so the ratio theoretically should get closer and closer to one over time. The ratios closer to one when compared to other underwriters is the desired value for Life Equity. Then to compare the accuracy of the of each underwriter's LE report by the end of each year, I added all the A/E ratios together for an underwriting year and subtracted that by the number of years till 2018 or *N*.

$$N - \sum \frac{A}{E}$$

A/E ratio measures the percent of people who are actually dead over people that are predicted to die by that year. $1 - A/E$ ratio measure the percent of people who were expected to die and did not pass away by that year. When this occurs, Life Equity has to pay additional premiums than expected. I used the summation of $1 - A/E$ ratio across each year to evaluate the total percentage of people who sold their life insurance policy to Life Equity in a specific year and outlived their expected years by up to each of the following year. This number will give a ratio above one that shows people still alive that were expected to be gone. By adding together the A/E ratios, it represents the percentage of the life settlement policies for which Life Equity

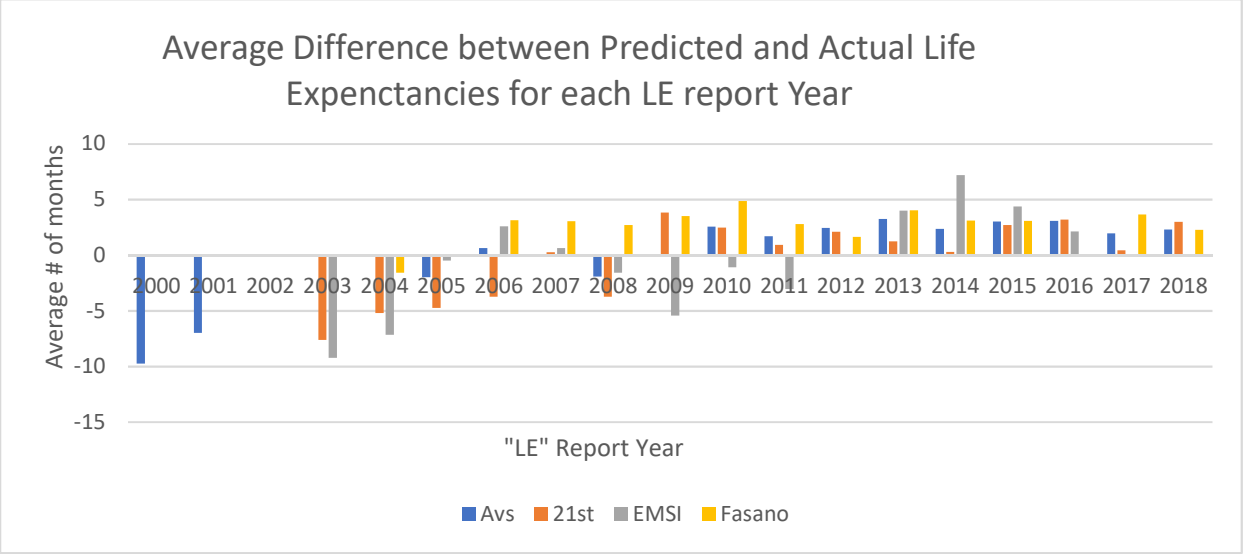
paid more continuing premiums than expected. The lower the value, the lower percentage of policies that Life Equity must pay continuing premiums not planned.

The next set of data I used was the mean or the average. X is calculated by taking the death of a person and then subtracting that from the predicted date of death. This would determine the number of months the prediction was wrong. I then added those numbers together and divided by n.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

During the process, I also used the median which is merely ordering the data together and picking the middle term. To check the relevancy of the mean I conducted a t-test.

Results



Graph 2

Graph 2:

The graph above shows the average difference between predicted and actual life expectances for each underwriter by each year. The years are from 2000 to 2018. First, I took everyone that has passed away. I then subtracted actual date of death from projected date of death. I split the averages up by the report year of each underwriting company and then I took the mean. At the beginning of the graph, underwriting companies would predict the life expectancy of the insured before the insured actually passed away. Later, the reports starting averaging predictions after the person's actual death. In the past ten years AVS seems to stay consistently positive or above the graph. Again there is potential bias in this measure because the measure does not contain insureds who are still alive beyond 2018. If many insureds who outlived 2018, also outlived their projected death year, this measure would overestimate the difference.

Mean and Median of Average Difference between Predicted and Actual death with a T-Test

	Mean	Median		T-Test	Fasano	21st	EMSI
AVS	2.17	1.84		AVS	0.001	0.255	8.93E-10
21st	1.93	1.57		21st	.00003		1.21E-08
EMSI	-0.97	2.97		Fasano			2.03E-13
Fasano	3.04	2.98					

Table 1

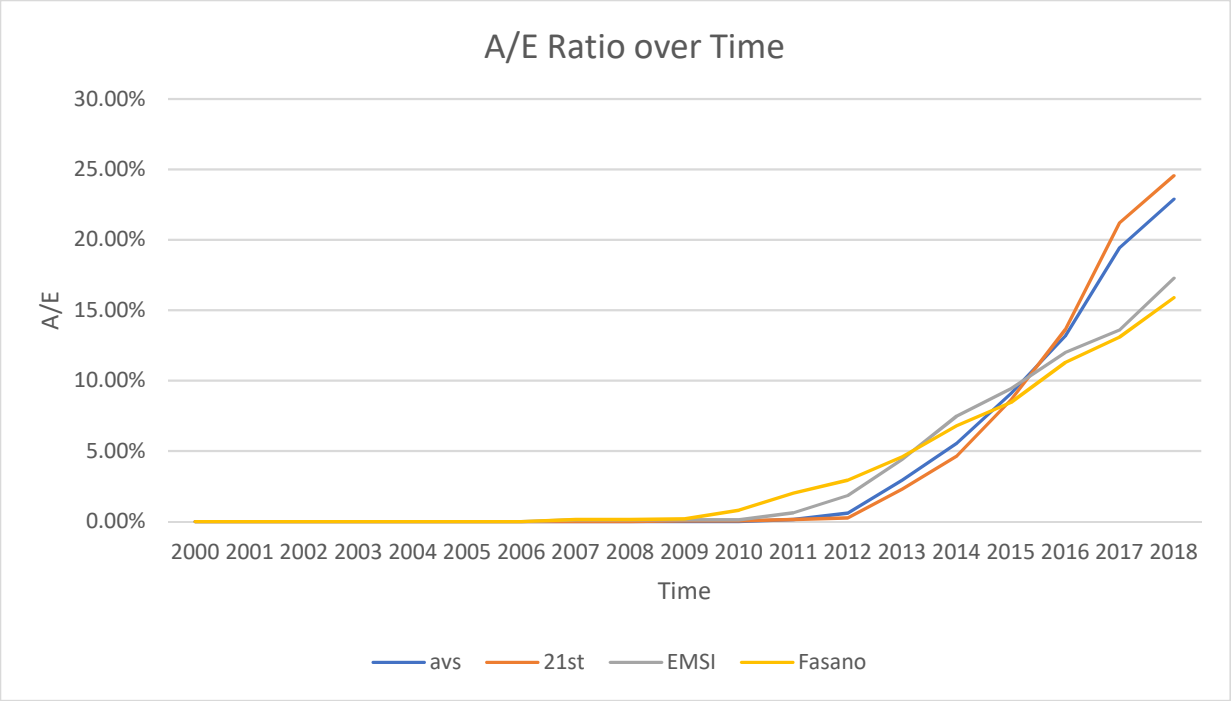
Table 1: The table contains the overall mean and median of the data in graph 2 with a t-test. I took every person that has passed away up to 2018 and split them up only by underwriter. I then again took the difference between potential and expected. Lastly, I calculated the mean of each underwriter. The values contained in the t-test are p-values. The null hypothesis is that mean 1 is

the same as mean 2 and there is no relevance. I calculated the p-values in excel. The p-values are all under 0.05 which allows the null hypothesis to be rejected except for Fasano and 21st. Therefor I can say with 95% confidence that it mean 1 is greater than mean 2 and that the data set is good.

	Percentage of prediction of death past actual
AVS	80.2575%
21st	75.4527%
EMSI	44.9664%
Fasano	78.0059%

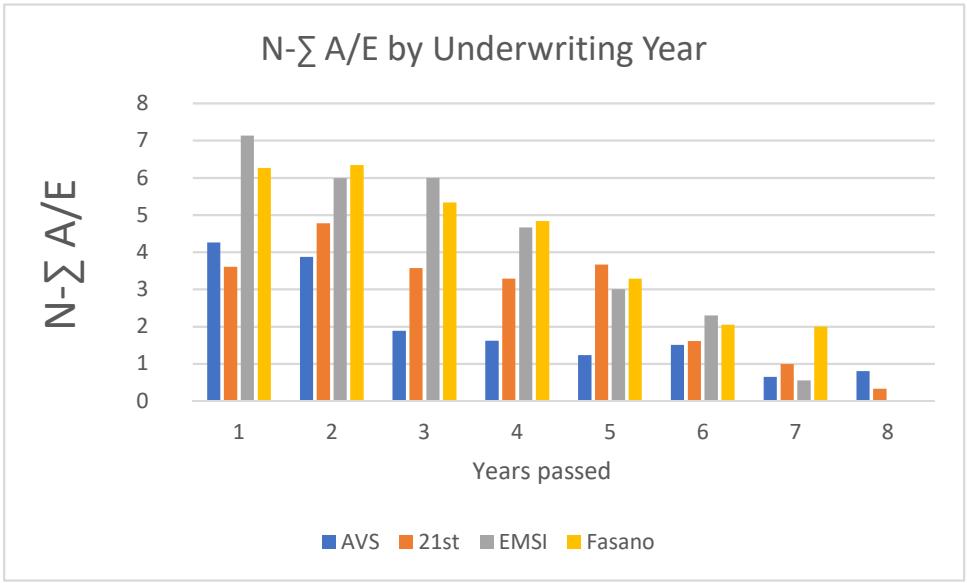
Table 2

Table 2: The sample size was all those that passed away by the end of 2018. The percentage shows which companies are better at predicting after the expecting date opposed to predicting before the actual date of death. The numerator is when death occurs before predicted death. The denominator is total deaths. The closer the percentage is at 100, the more wanted the underwriter becomes to Life Equity. By predicting after, less premiums payments are made than expected, so that means more money.



Graph 3:A/E Ratio over Time Including every Underwriting Year

Graph 3: The above graph shows the A/E Ratio. For each year I took the people that passed away that year and divided it by the total people that are expected to die by 2040. The faster the A/E ratio climbs to one the better.



Graph 4: Amount of People that were expected to die but still live

Graph 4: The graph above shows the N-A/E ratio overall. Starting from 2010 to 2018. A/E ratio for each underwriting year are located in appendix section C. I took each underwriting year, and with a sample size of every report Life Equity owns, calculated the A/E for each underwriting year until 2018. I then added up those ratios and divided by the number of years till 2018. That gave me the values above.

Conclusion

- First off there isn't a large difference between the big-name competitors. In graph 3 there is less than a 10% difference between all four. Also graph 3 is not close to one for the A/E ratio, therefore the data can change in the next couple of year.
- Out of the top competitors in underwriters according to the data obtained from Life Equity, I would say that AVS is the best company. In graph two, the average for AVS has been below 4 for the past 11 years of actual death compared to predicted. It is also in the positive range currently suggesting that its predictions are later than actual death. This means that Life Equity is ending up with more money than calculated. This is also seen by the percentage of table 2. In graph 4, AVS is usually the lower number which means there are less people living past expected date of death and in correlation less money for Life Equity to spend.
- After AVS I would pick 21st. In 2018 for the A/E ratio in graph 3, it is also slightly closer to one than AVS It is usually above AVS but there are a couple of times in the appendix section C that 21st has a better A/E ratio than AVS. The underwriting years at the begging of the year shown from appendix C suggest that 21st was the better company but as years went on by 2015 AVS became the better company. Overall 21st also has the better mean compared to

AVS shown in table 1. According to the graphs bellow, 21st does not usually have that great of a difference from AVS. Therefore, the top two companies, listed in order are, AVS and 21st.

- I think Fasano and EMSI are not a strong pick. EMSI did not contain as much data as the other three so that data can be biased compared to the other three. If Life Equity wants to buy the reports from EMSI (now LSI) and Fasano, then I suggest adding a couple months themselves to the report. When doing the calculations adding a couple of months give a more accurate representation of what the profit will be at the end.

Future Extensions

In future extensions of the problem, one could look at the A/E ratio applied to different characteristics that make up the underwriting. The four ones being the gender, smoking vs. non-smoking, weight, and height. I would go through and see how accurate the mean, median, mode, and A/E ratio is by looking at each category. Another thing would also to look at the life insurance policy value. If a person had more money in the policy would that mean that there is the possibility that they live longer? Is there even a correlation between the two factors? In the future, I would like to create a code that can run through the data points and be able to determine all these factors. That way when mortality tables change it is an easy task to see how the underwriting companies compares to each other. I would also like to have more data that involve the company LSI because the one study done on it showed promising results. Finally, I was unable to obtain information on how exactly each underwriting company assigned debits and credits to medical issues. I would try to find other legal avenues of obtaining that information and trying to make an LE equation to see if I could do better.

Appendix

A) Data table for graph 1

	0	1	2	3	4	5	6	7	8	9	10
AVS	4	6	0	0	1	20	73	71	19	43	146
EMSI	0	0	0	4	59	57	145	124	80	31	17
21st services	0	1	0	2	15	17	42	54	25	171	112
Fasano	0	0	1	1	13	72	265	295	98	300	373
	11	12	13	14	15	16	17	18	19		
AVS	291	285	128	128	323	234	158	69	1		
EMSI	17	5	65	75	67	73	11				
21st services	159	257	99	12	683	257	48	46			
Fasano	44	16	128	115	90	28	109	39	12		

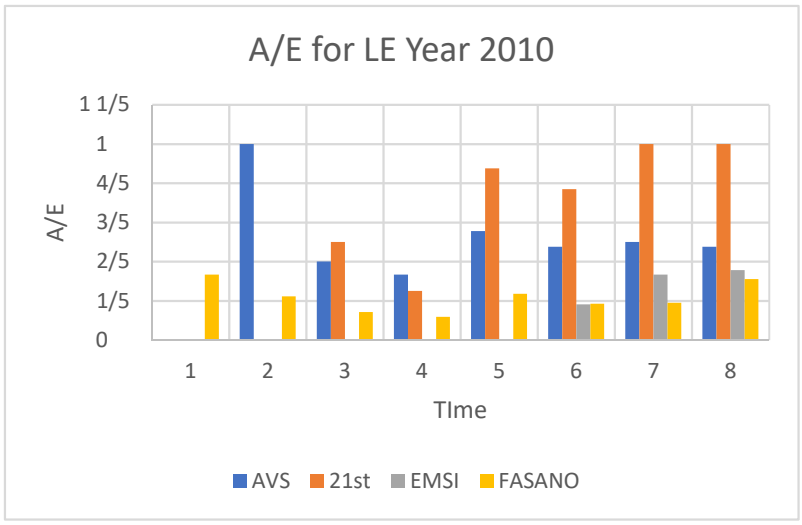
The table below is the breakdown of the sample group by year. Each year there is new reports are made. Since EMSI is now LSI the reports slowly decrease and then ends.

B) Data for graph 3

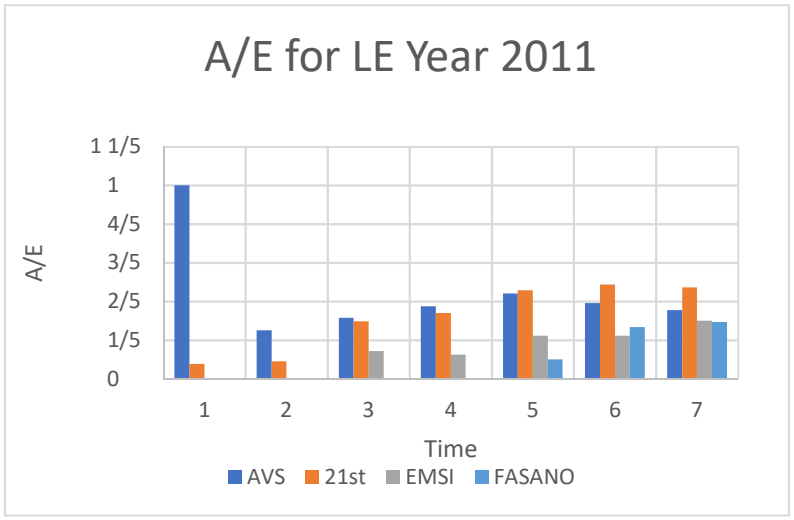
n-∑A/E	2010	2011	2012	2013	2014	2015	2016	2017
AVS	4 1/4	3 7/8	1 8/9	1 3/5	1 1/4	1 1/2	2/3	4/5
21st	3 3/5	4 7/9	3 4/7	3 2/7	3 2/3	1 3/5	1	1/3
EMSI	7 1/8	6	6	4 2/3	3	2 2/7	5/9	0
Fasano	6 1/4	6 1/3	5 1/3	4 5/6	3 2/7	2	2	0

C)

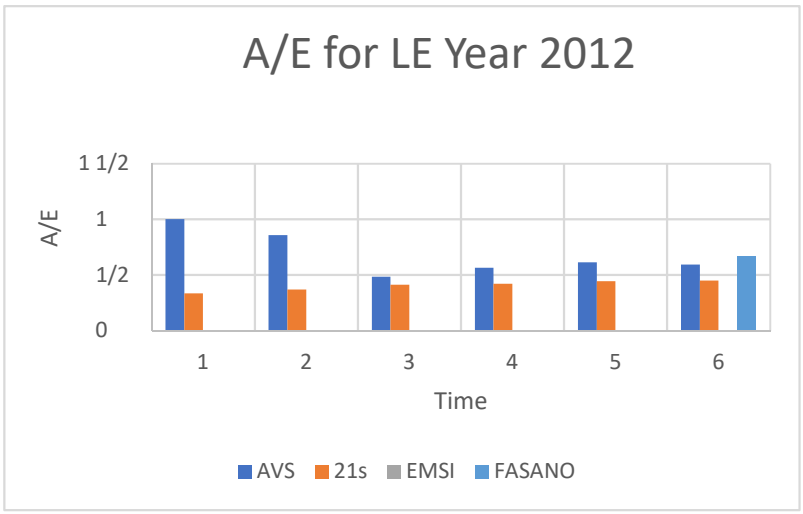
Set of graphs displaying A/E ratio for each underwriting year. The sample size is every report that Life Equity has written. The time frame is as years pass from the original underwriting date till 2018. The closer the bar is to one is better. The underwriting company that stays consistently above the other underwrites suggests the better underwriting year for the company. Also, the company with the lowest number on the graph suggest a accurate company that isn't wasting as much money as the other companies



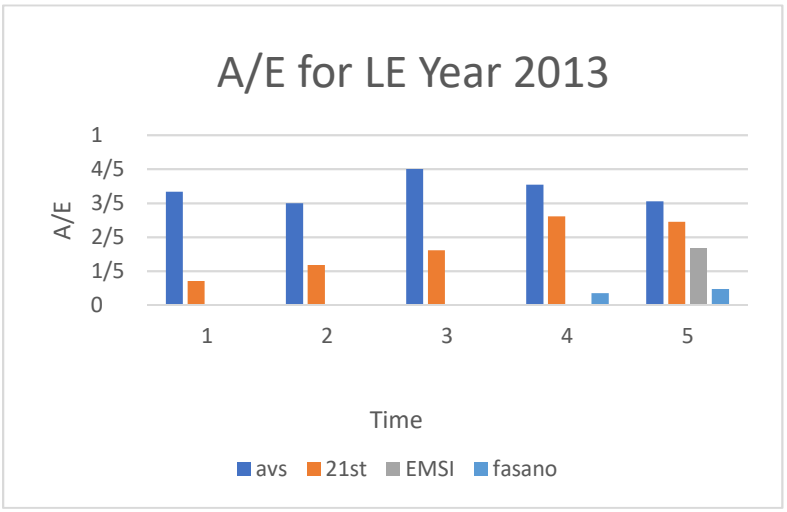
	n-∑A/E
AVS	4 1/4
21st	3 3/5
EMSI	7 1/8
Fasano	6 1/4



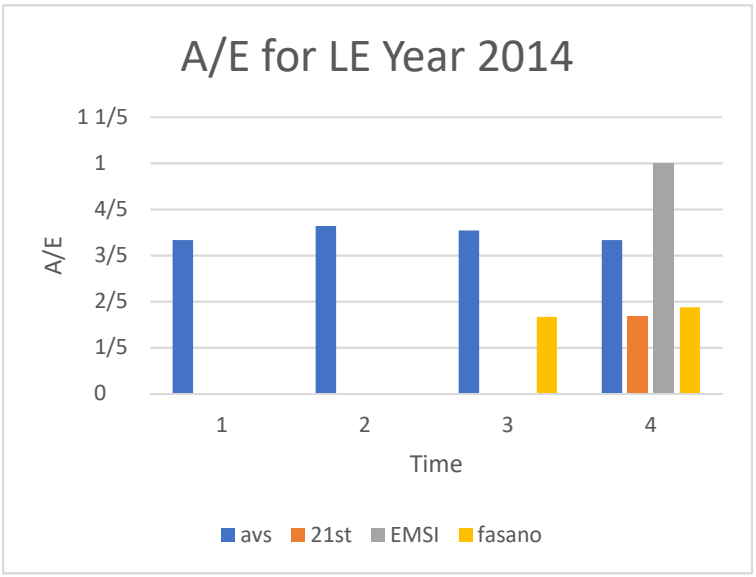
	n-∑A/E
AVS	3 7/8
21st	4 7/9
EMSI	6
Fasano	6 1/3



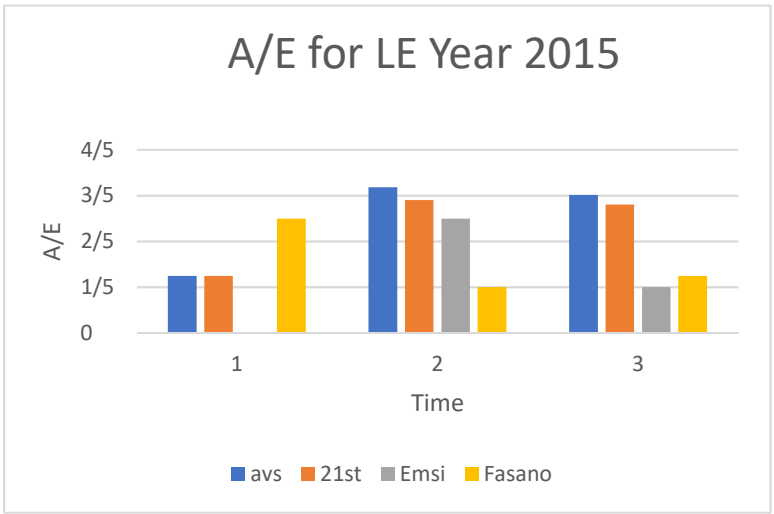
	n-∑A/E
AVS	1 8/9
21st	3 4/7
EMSI	6
Fasano	5 1/3



	n-∑A/E
AVS	1 3/5
21st	3 2/7
EMSI	4 2/3
Fasano	4 5/6



	n-∑A/E
AVS	1 1/2
21st	1 3/5
EMSI	2 2/7
Fasano	2



	n-∑A/E
AVS	1 1/4
21st	3 2/3
EMSI	3
Fasano	3 2/7

D) Data for Appendix C graphs

2010	1	2	3	4	5	6	7	8
avs	0	1	2/5	1/3	5/9	1/2	1/2	1/2
21st	0	0	1/2	1/4	7/8	7/9	1	1
EMSI	0	0	0	0	0	1/5	1/3	1/3
fasano	1/3	2/9	1/7	1/8	1/4	1/5	1/5	1/3
2011	1	2	3	4	5	6	7	8
avs	1	1/4	1/3	3/8	4/9	2/5	1/3	
21st	0	0	2/7	1/3	1/2	1/2	1/2	
EMSI	0	0	1/7	1/8	2/9	2/9	2/7	
fasano	0	0	0	0	0	1/4	2/7	
2012	1	2	3	4	5	6	7	8
avs	1	6/7	1/2	4/7	3/5	3/5		
21st	1/3	3/8	2/5	3/7	4/9	4/9		
EMSI	0	0	0	0	0	0		
fasano	0	0	0	0	0	2/3		
2013	1	2	3	4	5	6	7	8
avs	2/3	3/5	4/5	5/7	3/5			
21st	1/7	1/4	1/3	1/2	1/2			
EMSI	0	0	0	0	1/3			
fasano	0	0	0	0	0			
2014	1	2	3	4	5	6	7	8
avs	2/3	5/7	5/7	2/3				
21st	0	0	0	1/3				
EMSI	0	0	0	1				
fasano	0	0	1/3	3/8				
2015	1	2	3	4	5	6	7	8
avs	1/4	2/3	3/5					
21st	1/4	4/7	5/9					
EMSI	0	1/2	1/5					
fasano	1/2	1/5	1/4					
2016	1	2	3	4	5	6	7	8
avs	3/4	3/5						
21st	3/5	2/5						
EMSI	1	4/9						
fasano	0	0						

2017	1	2	3	4	5	6	7	8
avs	1/5							
21st	2/3							
EMSI	0							
fasano	0							

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