The Financial Crisis: An Actuary's View

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The subprime mortgage crisis has been an active topic of discussion by actuaries both at conferences and via email discussion groups. As quantitative analysts, actuaries can use both their analytical tools as well as their general knowledge of risk to shed light on the current crisis. In a recent Casualty Actuarial Society VALCON[1] list email, Gary Venter distributed foreclosure rates for cohorts of subprime mortgages organized by origination year[2]. Venter noted that when the data are transposed, they have the form of a loss development triangle, a standard tool applied by Property and Casualty actuaries to estimate ultimate liabilities. He provided some qualitative insights and conclusions that could be drawn by an actuary from the information. Below is a further elaboration of insights that can be drawn by applying actuarial techniques to the data. The insights derived from the data are augmented by results from recent publications on the topic of subprime mortgages. The author's conclusion is that subprime mortgages constituted a Ponzi scheme and the crisis could have been avoided.

The foreclosure rate data is presented (Table 1) with one adjustment to the original data: the values on the diagonal, which were evaluated as of September, were divided by 0.75 to bring them to an annual basis, consistent with all the others entries.[3]

When the data is transposed, so that rows represent year of origin, and columns represent development age (the number of years after the origin year, with one denoting the origin year), the loss development factor method, also known as the chain-ladder method can be applied to estimate ultimate foreclosure rates for each origin year. An estimate of these ultimate rates may provide insight into the magnitude of the subprime mortgage problem. In order to apply the chain ladder method, cumulative foreclosure rates are needed. These are shown in Table 2.
Table 3 displays the age-to-age factors, or the factor needed to bring the cumulate rate as of a given age for a given year to a maturity of one year beyond the given age.

At the bottom of Table 3 are the age to ultimate factors. These are the cumulative product of the age-to-age factors starting from the oldest maturity and working backwards to the youngest maturity. They are a key component of the estimate of ultimate rates. As foreclosure rates as of 9 years (the oldest year for which we have data) from origination do not appear to be at ultimate, i.e., further development will likely occur, a "tail factor" is needed. The inverse power curve described by Sherman (Sherman, 1987) was used to estimate this tail.

Table 4 displays the application of the age-to-ultimate factors. Using the chain-ladder technique, foreclosure rates are estimated to be in excess of 40% for 2006 and over two thirds for 2007.

Estimated ultimates derived form the chain ladder method, or any other actuarial development techniques are very uncertain. The estimates are considered especially unstable for data of low maturity, such as that of the 2007 and 2006 years. Moreover, some of the assumptions underlying the chain ladder may be violated, adding yet additional uncertainty to the estimates.

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[1] The VALCON list is a list sponsored by the Committee on the Theory of Risk of the Casualty Actuarial Society and is a list that is subscribed to by actuaries and insurance professionals. The community of subscribers share research, ideas and musings related to the **Val**uation of **Con**tingent obligations.

[2] Data from Barth et al.

[3] For the adjustment to be reasonable, the foreclosures must occur uniformly throughout the year. That this assumption may not hold is a limitation on the analysis affecting the uncertainty of results.

Venter (1998) describes techniques that can be used to test whether the chain-ladder assumptions are violated.[4] When a test was performed, the age 1-2 (also referred to age 12 months to 24 months) factor violated the chain-ladder assumptions. As a result,[5] the analysis for the 2007 year was adjusted. The results are shown in Table 5. The estimated rate after adjustment for 2007 exceeds 50%. The use of this adjustment addresses the violation of certain assumptions underlying the chair-ladder technique. It does not significantly reduce the uncertainty in the estimates, which given the sparseness and variability of the data and the crude assumptions needed to adjust the 2007 foreclosure year's rates to an annual basis, is quite large.

The estimates in Table 5 based on the chain ladder (with adjustment) show a dramatic increase between 2004 and 2007. Under a scenario of real estate price depreciation, such default rates could be expected to be ruinous.

Though these estimates have limitations, the sharp deterioration in foreclosure rates in 2006 and 2007 is consistent with other sources of information on these years. The anecdotal evidence supports the claim that the 2006 and 2007 years will be particularly bad, as there was more froth in these years. In a November 2, 2008 articles entitled "Was There a Loan it did not Like?" NY Times reporter Morgenson describes the travails of a senior underwriter at WAMU who at the height of the bubble was pressured to approve loans that she felt were obviously flawed, and in some cases blatantly fraudulent.

From the analytical perspective, the research of Demyanyk and Helmert (2008) suggests a significant degradation in loan quality in 2006 and 2007. According to Demyanyk and Hemert, the deterioration in foreclosure rates should have been known to the mortgage lenders as early as 2005, based on loan information that is routinely collected. Their analysis applied logistic regression to loan level data and found that the quality of loans declined for six consecutive years. Demyanyk and Helmert also observe that low subsequent price appreciation (and depreciation) contributes about 2 to 4 percentage points to default rates 12 months after origination. They state "Problems could have been detected long before the crisis, but they were masked by house price apprecia tion".

Moreover, the problem with subprime mortgages appears to be inherent in their design, as they were not designed to be held to maturity, with interest and principal being completely discharged by the debtor. According to Gorton (2008), serial refinancing was intended and built into the product when the mortgages were sold. To protect the lender from the "risky borrower", the loans were structured to be held for a relatively short period (two to three years) and then refinanced. As price apprecia tion of the underlying asset was expected, the refinancing was expected to occur before the rates of an ARM or of a mortgage with an initial teaser rate were adjusted upwards and the mortgage payment exceed the debtor's resources. However, the refinancing was at the option of the lender so if houses failed to appreciate the borrower faced the risk of being stuck in a mortgage that under any realistic scenario exceeded his/her ability to pay. According to Gorton "The appreciation of the house became the basis for refinancing every two to three years".

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[4] One of the tests involves an application of regression analysis. The incremental rates for a given maturity are regressed on the cumulative rates for the prior maturity. If the constant is significant, and/or the coefficient is not significant (typically at the 95% level) the assumptions are likely to be violated.
[5] The fitted age 1-to-2 regression parameters were used to adjust the 2007 rates to age 24, and then the chain ladder technique was applied.

The scenario is reminiscent of another speculative bubble based on the expectation of real estate price appreciation without end, and the anticipation of fantastic wealth based on the appreciation. The scheme is described in some detail by John Kenneth Galbraith in his landmark book, *The Great Crash*. The real estate bubble occurred in Florida (one of the states most seriously affected by the latest real estate bubble), a state with a congenial winter climate, where people of means were expected to avail themselves of an improved transportation system and spend their winters there in increasing numbers. Land was bought sight unseen, motivated by the belief that it would be resold at a handsome profit. In Galbraith's words, the real estate investors "proceeded to build a world of speculative make-believe. This is a world inhabited by people who do not have to be persuaded to believe, but by people who want an excuse to believe" (p. 8). One of the culprits in the debacle was Mr. Charles Ponzi, who sold real estate in Florida after he jumped bail while being prosecuted for the better known pyramid scheme that bears his name.

It is the belief of this author that the subprime mortgage mess was none other than a Ponzi scheme repackaged into 21st century financial engineering clothes. What makes this scheme particularly disastrous is that the 21st century Ponzi mortgages were packaged and sold to investors and then trillions of dollars of derivatives were constructed based on the underlying mortgages, magnifying the problem by orders of magnitude.

The most brilliant analysts can run their option pricing, value-at-risk and dynamic analysis models to their heart's content. If the fundamental principals underlying an investment are consistent with those of well known speculative bubble schemes, the scenario is virtually guaranteed to come to a bad end.

References

Barth J., Li T., Phumiwisana T. and Yago G, "A Short History of the Subprime Mortgage Market Meltdown", GH Bank Housing Journal
Demyanyk and Hemert, Understanding the Subprime Mortgage Crisis, SSRN paper, August 2008, ssrn.com/abstract=1020396
Gorton, G, "The Subprime Panic", National Bureau of Economic Research, October 2008
Sherman, R, "Extrapolating, Smoothing and Interpolating Developmnt Factors", *Proceedings of The Casualty Actuarial Society*, 1984
Venter, G, "Testing the Assumptions of Age-to Age Factors", *Proceedings of The Casualty Actuarial Society*, 1997

Exhibits

Table 1
Foreclosure Rate Data

	Origination Year								
Foreclosure Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.013	0.015	0.019	0.011	0.008	0.009	0.010	0.026	0.040
1	0.063	0.069	0.072	0.055	0.041	0.039	0.064	0.103	
2	0.055	0.060	0.058	0.046	0.031	0.017	0.062		
3	0.049	0.034	0.042	0.024	0.022	0.025			
4	0.023	0.025	0.019	0.016	0.011				
5	0.021	0.012	0.012	0.008					
6	0.008	0.007	0.006						
7	0.006	0.004							
8	0.003								

Table 2

Cumulative Default Rates @12/31/07

Year	Development Age 1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.000	9.000
1999	0.013	0.076	0.131	0.179	0.202	0.223	0.231	0.236	0.239
2000	0.015	0.084	0.144	0.177	0.202	0.214	0.221	0.225	
2001	0.019	0.090	0.148	0.191	0.209	0.221	0.228		
2002	0.011	0.066	0.111	0.135	0.151	0.158			
2003	0.008	0.050	0.081	0.103	0.114				
2004	0.009	0.048	0.064	0.089					
2005	0.010	0.074	0.136						
2006	0.026	0.128							
2007	0.040								

Table 3

Age-toAge Factors

Year	Development Age 12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	Tail
1999	5.869	1.714	1.371	1.128	1.101	1.035	1.024	1.012	
2000	5.573	1.719	1.233	1.141	1.059	1.033	1.018		
2001	4.876	1.644	1.285	1.099	1.056	1.029			
2002	6.150	1.691	1.213	1.116	1.052				
2003	6.049	1.627	1.276	1.107					
2004	5.570	1.344	1.383						
2005	7.577	1.845							
2006	5.005								
Average	5.834	1.698	1.294	1.118	1.067	1.032	1.021	1.012	
Selected	5.800	1.700	1.300	1.100	1.067	1.032	1.021	1.012	1.0453
Age to Ultimate	16.779	2.893	1.702	1.309	1.19	1.115	1.08	1.058	1.0453

Table 4

Default Rates Developed to Ultimate

Year	*Current Year End Defaullt Rate*	*Age To Ultimate*	*Ultimate Default Rate*
	(1)	*(2)*	*(3)=(1)*(2)*
1999	0.239	1.058	0.253
2000	0.225	1.058	0.238
2001	0.228	1.080	0.246
2002	0.158	1.115	0.177
2003	0.114	1.190	0.136
2004	0.089	1.309	0.117
2005	0.136	1.702	0.231
2006	0.128	2.893	0.371
2007	0.040	16.779	0.673

Notes:
(1) All rates adjusted to 12 month basis by dividing by .75

Table 5

Adjusted Default Rates Developed to Ultimate

Year	*Adj Current Year End Defaullt Rate*	*Age To Ultimate*	*Ultimate Default Rate*
	(1)	*(2)*	*(3)=(1)*(2)*
1999	0.239	1.058	0.253
2000	0.225	1.058	0.238
2001	0.228	1.080	0.246
2002	0.158	1.115	0.177
2003	0.114	1.190	0.136
2004	0.089	1.309	0.117
2005	0.136	1.702	0.231
2006	0.128	2.893	0.371
2007	0.187	2.893	0.540

Notes:
(1) 2007 rate adjusted to age 24 using:
.02 + 3.129 * Age 1 rate + age 1 rate