An Alternative to Capital Allocation[1]

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1. Introduction

Management needs performance measurement tools for planning and strategic decision-making. Good performance measurement tools bring discipline to the business planning process and can help to align corporate objectives with management incentive plans. Capital allocation procedures are a common way to fulfill some of these needs. Recent developments in capital allocation methods originated from work on tail events, catastrophes and capital adequacy. Borrowing from capital adequacy analysis, practitioners developed new approaches to allocating capital based on how business segments contribute to solvency (or insolvency) risk.

New capital allocation procedures finally, it seemed, gave insurance managers information that has eluded the industry for years—an accounting of the inputs to (capital) and the output from (returns) the production of their firm. Balance sheets and income statements can now be prepared for business segments based on their share of the firm's capital and their corresponding operating results. Business units, lines of business and/or regions, can now be run and managed as autonomous entities yet still benefit from the diversifying safety net of the firm's other operations and capital.

We will illustrate a current approach to capital allocation, referred to herein as the "tail contribution analysis" (TCA), using TCA to evaluate the impact of changes in an insurer's operations by allocating capital to individual lines of business. We will highlight a common problem in the implementation of the procedure arising from reserve volatility and briefly note the failure of the methodology to account for a firm's changing levels of risk under various strategies.

We will then introduce an alternative method for analyzing business segments and strategies called "economic profit analysis" (EPA). We will discuss EPA's key feature, "volatility replication," an intuitively appealing process of building investor expectations and capital market information into the risk and return measurements used to evaluate strategic decisions. Finally, we will illustrate the benefit of EPA in overcoming the problems of TCA and thereby providing concise reliable information for business decision-making.

1.1 Background Information

The analysis underlying this paper and a companion paper on capital adequacy, "A Multi-Stakeholder Approach to Capital Adequacy" by Painter and Isaac, is based on a fictional company, Falcon Insurance Company (Falcon), a stock insurance company

writing a mix of commercial and personal lines business. Details on the firm are shown below and in Appendix 1.

TABLE 1
Falcon Insurance Company Summary Data by Line of Business

	Commercial A	Personal A	Commercial B	Personal B	Total
2006 Business Plan ($000s)					
Net Written Premium	860,697	608,322	942,523	466,625	2,878,167
Net Earned Premium	786,663	611,378	875,297	457,902	2,731,240
Loss & LAE	539,385	415,402	606,258	269,879	1,830,924
Expenses	258,209	212,913	270,504	154,919	896,545
Combined Ratio	98.6	102.9	98.0	92.1	98.2

In both the TCA and EPA sections of the paper, capital is measured in terms of the economic net worth of the firm,[2] and returns are measured by growth in the economic net worth of the firm. Economic net worth (ENW) is simply the market value of assets less the present value of liabilities.[3] Unless noted otherwise, references to "capital" herein are assumed to be ENW.

2. A Current Approach to Capital Allocation: Tail Contribution Analysis

2.1 Introduction

TCA is an adaptation of capital *adequacy* analysis for the purpose of capital *allocation*. It is a logical extension from the higher level (company view) to a more refined level (business segments). Extending a consistent approach from capital adequacy to capital allocation processes of the firm is appealing, but as shown in Painter and Isaac, there is no simple single period measure to explain real world capital management practices of insurers, and the extension of these capital adequacy measures to capital allocation creates other inconsistencies.

2.2 Methodology

TCA, as the name implies, focuses on the capital required in anticipation of low frequency/high severity outcomes, i.e., the "tails" of the distribution of possible results. These tail scenarios are said to "consume" capital when an insurer's obligations exceed the operating revenue generated by the business. Capital adequacy analysis examines

[2] Economic net worth is adjusted when appropriate to exclude the value of deferred tax assets.

[3] Projected cash flows discounted based on the U.S. Treasury spot curve.

how likely these scenarios are, and how much capital the firm must hold to achieve a desired level of security.

When extended to business segment analysis, TCA examines the relative contributions of business segments to the tail scenarios. Segments that account for large shares of the tail scenarios consume more capital and therefore receive larger allocations of the firm's required capital. Naturally, segments that do not consume as much capital receive smaller allocations. The impact of investment operations, diversification benefits and small residual values are typically prorated across the firm's segments. The final allocation of "required" capital is the basis for allocating the firm's actual carried capital to the desired segments. A business segment's returns can then be reviewed relative to its allocated capital to determine if it provides an appropriate return on capital (creates value) or an insufficient return on capital (destroys value).

Falcon's capital adequacy was first assessed using a one-year projection and a 99.8 percent tail value-at-risk (TVaR). In other words, a level of capital required was determined such that Falcon could remain solvent[4] in all but a 1-in-500[5] year (or worse) scenario. TVaR is a commonly accepted risk metric that has increased in popularity recently because it exhibits certain mathematical properties that are consistent with how we think about risk. Risk metrics that have these properties are referred to as coherent or coherent risk measures.[6] For our purposes it is sufficient to know that these measures help to eliminate certain logical inconsistencies that might have arisen had a different risk measure been used.

2.3 Tail Contribution Analysis Results

We first solved for Falcon's required capital by modeling 10,000 scenarios over a one-year time horizon and identifying the bottom 0.2 percent of all scenarios (the 20 worst scenarios). Operating results in these scenarios were significantly negative and represent situations in which Falcon would have to rely on its capital to meet its obligations, i.e., these scenarios consume capital. Falcon's 99.8 percent TVaR is simply the average capital consumed by the 20 worst scenarios, $1.1 billion.[7] Hence, if Falcon holds $1.1 billion of economic capital,[8] it is expected to withstand at least 99.8 percent of all scenarios, i.e., roughly a 1-in-500-year result.

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[4] See Isaac and Painter for a more comprehensive analysis of Falcon's required capital including a discussion of why insurers may be more concerned with the capital required to remain investment grade rather than the lower standard of merely being solvent.

[5] 499/500 = 99.8%.

[6] Numerous references on TVaR and coherent risk measures are available including several listed in the references.

[7] Falcon's required economic capital was $1,072,115,000.

[8] Falcon holds $2.9 billion of economic capital, nearly three times the required level based on the one-year TVaR approach. The companion paper "A Multi-Stakeholder Approach to Capital Adequacy" by Painter and Isaac,

Once the $1.1 billion capital requirement was determined, we turned our attention to allocating Falcon's capital to its four major lines of business (LOB). The allocation procedure utilized the same techniques and the same 20 scenarios from the 99.8 percent TVaR calculation for capital adequacy. We allocated Falcon's total capital to LOB based on the mean amount of capital consumed by each of the four lines in the 20 tail scenarios. That is, Falcon's actual economic capital, $2.9 billion, was spread to each LOB in the same proportions as the allocation of required capital. (See Table 2.)

TABLE 2
Tail Contribution Analysis—Capital Allocation Results[9]

Line of Business	Allocated Economic Capital	Carried Economic Capital	Average Return	Return on Equity
Commercial A	394,453	1,071,754	65,129	6.1%
Personal A	252,169	685,160	10,800	1.6%
Commercial B	331,932	901,882	76,462	8.5%
Personal B	93,561	254,213	34,276	13.5%
Total	1,072,115	2,913,010	186,667	6.4%

Over the one-year projection, the Commercial A and Personal A segments underperformed relative to Falcon's average return on capital. We tested the hypothesis that exiting these lines would increase Falcon's return on equity (ROE); a discussion of that analysis follows below. In each case, the new business for the line was eliminated while all other assumptions were held at their original levels. In practice, a more realistic test might include changes in loss ratio, expense ratio or other assumptions. However, in the interest of brevity, we have excluded these considerations from the example herein.

demonstrates the rationale for the seemingly redundant capitalization of Falcon Insurance Company. Briefly, insurers maintain higher levels of capitalization for many reasons including: (1) desired financial strength ratings; (2) to support growth; or (3) in recognition of time horizons greater than one year.

[9] Again the seemingly large redundancy in Falcon's capitalization is appropriate. Interested readers can refer to Isaac and Painter for additional information. Furthermore, the level of capitalization does not alter the relative contributions of each line to Falcon's results; hence the results of the TCA allocation are not affected by the firm's capital.

2.3.1 Test 1—Runoff Personal A

The runoff of Personal A business yielded the expected result: (1) a 14 percent decrease in Falcon's overall required capital; and (2) a slight increase in Falcon's overall ROE, from 6.4 percent to 6.6 percent. Falcon's capital allocations before and after the change in Personal A are shown below in Table 3.

TABLE 3
Capital Allocations—Original Assumptions and Running Off Personal A[10]

	Original Assumptions		Runoff Personal A		
Line of Business	Allocated Economic Capital	Carried Economic Capital	Allocated Economic Capital	Carried Economic Capital	Change in Allocated Capital
Commercial A	394,453	1,071,754	405,280	1,101,172	3%
Personal A	252,169	685,160	90,587	246,131	-64%
Commercial B	331,932	901,882	342,057	929,392	3%
Personal B	93,561	254,213	82,229	223,421	-12%
Total	1,072,115	2,913,010	920,152	2,913,010	0%

The change in Personal A business (a 21 percent decrease in overall net written premium) reduced Falcon's required economic capital by 14 percent, from $1,072 million to $920 million. Applying the 14 percent change to the carried economic capital would release approximately $400 million of total capital; note that we have not factored the release of capital into the return calculations discussed below.

TABLE 4
Return on Equity

	Original Assumptions		Runoff Personal A	
Line of Business	Average Return	Return on Equity	Average Return	Return on Equity
Commercial A	65,129	6.1%	70,838	6.4%
Personal A	10,800	1.6%	4,777	1.9%
Commercial B	76,462	8.5%	81,344	8.8%
Personal B	34,276	13.5%	34,518	15.4%
Total	186,667	6.4%	191,477	6.6%

[10] Throughout this analysis we have shown results of various capital allocation calculations. In several cases individual business segment assumptions have been revised to show the impact of a particular strategy for that segment. Note, however, that such changes will alter the allocation to ALL segments because of the proration of investment returns, diversification benefits and other residual effects across the operations of the firm.

Falcon's returns increased by approximately $5 million, from $186.7 million to $191.5 million, with the runoff of the Personal A business, for an ROE improvement of 0.2 percent.[11] In other words, Falcon's management would correctly conclude that Personal A was destroying value and that the firm's overall results would improve by reducing that business. Note that in reaching this conclusion, the TCA method assumes that Falcon's cost-of-capital does not change. However, if the expected volatility of Falcon's earnings changes as a result of the runoff, we would expect Falcon's investors to demand a different return on their money. TCA as applied above accounts for a change in return but it does not address the change in risk inherent in the strategy.

Before introducing EPA, our alternative to TCA, we explore another aspect of the TCA methodology and demonstrate one risk of an unintended result, using the Commercial A line of business.

2.3.2 Test 2—Runoff Commercial A

Falcon's Commercial A business, like its Personal A line, produced a lower than average ROE in the initial allocation analysis,[12] suggesting that a reduction in the line might lead to an overall improvement in Falcon's results (as was the case with Personal A). We will demonstrate that running off the Commercial A business does not add value; instead it unexpectedly destroys value. We will resolve this dichotomy by splitting the line's tail contributions (i.e., consumption of capital) into reserve and future business components, which can be vastly different. Further, we will argue that business planning decisions should be based on expected future contributions rather than past or embedded results that are largely beyond the control (in economic terms) of management.

The runoff of Commercial A business yielded both expected and unexpected results. Falcon's overall required capital decreased as expected; however the firm's ROE, which was expected to increase, instead decreased significantly. Falcon's capital allocations before and after the runoff of Commercial A business are shown below in Table 5.

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[11] Alternatively, we could apply the 14 percent capital release to Falcon's carried capital, thus reducing it from $2.9 billion to $2.5 billion. Falcon's $191 million return on the lower capital base yields an ROE of 7.7percent, up from 6.4 percent with the ongoing Personal A business. In either case, we have not measured the return that investors in the market demand for taking risk. Instead, we have simply assumed a particular capitalization based on a somewhat arbitrary standard of remaining solvent under a series of tail scenarios.

[12] In this example, we have assumed that the outlook for Commercial A business has improved from prior levels. The business is profitable relative to the capital required to support that business. Reserves from past business are volatile and produce large capital allocations that create the appearance of underperformance for the LOB.

TABLE 5
Capital Allocations—Original Assumptions and Running Off Commercial A

	Original Assumptions		Runoff Commercial A		
Line of Business	Allocated Economic Capital	Carried Economic Capital	Allocated Economic Capital	Carried Economic Capital	Change in Allocated Capital
Commercial A	394,453	1,071,754	242,952	660,117	-38%
Personal A	252,169	685,160	254,440	691,330	1%
Commercial B	331,932	901,882	362,419	984,717	9%
Personal B	93,561	254,213	87,296	237,190	-7%
Total	1,072,115	2,913,010	947,107	2,913,010	0%

The runoff of Commercial A business reduced Falcon's required economic capital by 12 percent from $1,072 million to $947 million. Applying that 12 percent decrease to the total economic capital would release approximately $340 million of capital; again we note that this potential capital release was not included in the return calculations in the table below.

Contrary to our expectation, Falcon's returns deteriorated significantly with the runoff of Commercial A business as shown below in Table 6.

TABLE 6
Return on Equity

	Original Assumptions		Runoff Commercial A	
Line of Business	Average Return	Return on Equity	Average Return	Return on Equity
Commercial A	65,129	6.1%	27,729	4.2%
Personal A	10,800	1.6%	5,845	0.8%
Commercial B	76,462	8.5%	71,220	7.2%
Personal B	34,276	13.5%	32,093	13.5%
Total	186,667	6.4%	136,886	4.7%

Falcon's returns decreased by $50 million, from $186.7 million to $136.9 million, with the runoff of the Commercial A business, resulting in a 1.7 percent hit to the firm's ROE from 6.4 percent to 4.7 percent.[13] The one-year TCA methodology overallocates capital to the Commercial A business and leads Falcon to incorrectly conclude that reducing this business will improve overall returns. In the following section, we will

[13] Even if we release capital in proportion to the 12 percent reduction in required capital (approximately $340 million); Falcon's ROE still falls from 6.4 percent to 5.3 percent if the Commercial A business is put into runoff.

show that the overallocation of capital was caused by reserve volatility and that the expected contribution of *future* Commercial A business is favorable.

2.4 Commercial A: Reserves versus Future Business

Recall that the TVaR modeling of Falcon's scenarios was based on a one-year projection, including any change in the economic value of existing reserves. Reserves were discounted and were assumed to be free of any systematic margin. It is important to understand that the reserves were not held constant, in fact they were subject to random volatility, and other factors such as changes in inflation and/or the discount rate used to determine their market value. As such, the reserves contributed to the TVaR calculation and ultimately to the capital allocated to each LOB.

We contend that such allocations are inappropriate for planning business growth strategies and therefore they should not factor into the capital allocation. If reserves are properly stated, there is very little that management can do to alter the economic impact of past business. By splitting the Commercial A capital allocation into past and future business we can illustrate how consideration of the reserve runoff led to the incorrect decision to reduce the Commercial A business.

The majority of the Commercial A allocation is attributable to its new business; of course this relationship changes when the business is put into runoff. The capital changes are in line with expectations and we note that the capital allocated to future business (Table 7) in the runoff scenario, is the capital supporting the runoff of Falcon's unearned premium reserve.

TABLE 7
Commercial A Capital Allocations—Past and Future Business

	Original Assumptions		Runoff Commercial A		
Line of Business	**Allocated Economic Capital**	**Carried Economic Capital**	**Allocated Economic Capital**	**Carried Economic Capital**	**Change in Allocated Capital**
Commercial A					
Reserves	127,812	347,274	139,521	379,089	9%
Future Business	266,641	724,481	103,431	281,028	-61%
Total	394,453	1,071,754	242,952	660,117	-38%

The key difference lies in the returns attributed to the runoff of past business versus Falcon's new Commercial A business. The runoff returns reflect the unwinding of the discount on reserves and the return generated by assets underlying the reserves and the allocated capital. These returns are lower than that of the new business and are

largely—and most critically—beyond direct control of management. However, when the capital and associated returns are combined into a single allocation for Commercial A, they mask the relatively good returns of the line's future business.

TABLE 8
Return on Equity—Past and Future Business

	Original Assumptions		Runoff Commercial A	
Line of Business	**Average Return**	**Return on Equity**	**Average Return**	**Return on Equity**
Commercial A				
Reserves	1,987	0.6%	(12)	0.0%
Future Business	63,143	8.7%	27,741	9.9%
Total	65,129	6.1%	27,729	4.2%

In Table 8, we see the split of Commercial A's overall 6.1 percent ROE into past and future business. Note that Commercial A's expected return on future business, 8.7 percent, is greater than Falcon's overall expected ROE of 6.4 percent. Thus Falcon should grow—not reduce—its Commercial A business.

2.5 Tail Contribution Analysis—Conclusions

We have applied the TCA method using a TVaR approach to allocate Falcon's capital and draw conclusions about certain business segments. Falcon correctly decided to withdraw from the Personal A business, thereby increasing the firm's ROE. We note, however, that this decision was based on the assumption that the firm's cost-of-capital was the same before and after the change. Alternatively, Falcon could release capital equivalent to the reduction in the one-year 99.8 percent TVaR required capital, but it is unclear how that relates to their investors' required return. TCA leaves management in the uneasy position of evaluating a risk/reward tradeoff (Should Personal A go into runoff?) with information only on the expected reward and nebulous assumptions about risk.

The suboptimal results of the Commercial A analysis were less subtle, i.e., a 25 percent reduction in ROE. The impact of past business (i.e., reserves) on tail scenarios can be significant and should be considered in capital adequacy analyses. However, when capital adequacy techniques are recast for use in capital allocation exercises, they must adapt to measure the prospective factors that management can control. Otherwise these analyses risk doing more harm than good.

3. An Alternative to Capital Allocation: Economic Profit Analysis

3.1 Introduction

The discussion of capital allocation using TCA exposed several problems, including: (1) the difficulty in incorporating risk and changes in the cost-of-capital of various strategies; and (2) the inappropriate focus on past business. Add to that the short one-year projection horizon often used in capital adequacy analyses and carried over into capital allocation procedures.

EPA overcomes these problems. Furthermore, EPA is no more difficult to implement and includes features that relate risk taking to the capital markets, thus eliminating the criticism of TCA wherein changing risk and the cost-of-capital was not rigorously addressed. EPA is not a capital allocation procedure per se; instead strategic decisions or business segments are analyzed prospectively and on a marginal basis. Hence, there should be no distortions from past business. Finally, EPA is adaptable to different planning horizons and as such it can be synchronized with the firm's overall business planning process.[14]

3.2 Methodology

EPA is a process of determining and comparing the economic profits associated with various strategies or business segments to identify those that provide return commensurate with their risk. Recall that ROEs used above in the TCA method measured only the return of a segment under the assumption that there was no change in risk or the cost-of-capital. Volatility replication is the key feature of EPA which sets it apart from TCA and other cost-of-capital methodologies; it provides a framework for measuring risk and incorporates it into the calculation of economic profit or loss.

Volatility replication is a simple concept based on the idea that investors may choose to invest elsewhere if the expected return on an alternative investment with an equivalent risk is greater than a particular insurance company's expected return. By modeling Falcon's operations over four years (in this example) we can project a range of possibilities for the firm's ending ENW. Similarly, we can solve a simple regression problem to identify a leveraged portfolio of securities that replicates the volatility of Falcon's ending ENW. In other words, an investor could have held Falcon stock or the volatility-replicating portfolio and been exposed to the same degree of risk over the period. Because the risks have been set equal, a rational investor would choose the

[14] To be fair, TVaR methods can be adapted to multi-year horizons, but in practice there is a tendency to apply them over one year, perhaps because a one-year horizon is often used in capital-adequacy analyses.

strategy that produces the larger expected return (growth in ENW). Further details concerning the volatility replicating portfolio can be found in Appendix 2.[15]

Note that when Falcon's operations change, the distribution of ending ENW will also change, and a new volatility-replicating portfolio will be identified. Thus the expected return that Falcon must beat—the cost-of-capital—is tailored to the particular strategy implemented. We express the cost-of-capital in dollars[16] and conclude that economic profits are achieved when Falcon's expected growth in ENW surpasses that of the volatility-replicating portfolio.

Unlike TCA, the EPA process does not require an explicit allocation of capital to business segment and therefore does not require the production of segment level financial statements. We acknowledge that some managers may prefer such an approach and for them the EPA process can be expanded for this purpose. However, we envision the strategic planning process utilizing EPA to establish overall objectives for the firm. Those objectives could then be disseminated throughout the organization in the form of traditional growth targets and underwriting ratios rather than in vague ENW jargon that may be meaningless to those not directly involved in the planning process.

We applied the procedure to Falcon in two ways: (1) we completed four runs in which each major line of business was separately assumed to grow by approximately $100 million above the baseline plan; and (2) we tested the runoff strategies for Personal A and Commercial A from the first section of the paper on TCA.

3.3 Economic Profit Analysis Results

The EPA methodology provides a single measure—economic profit/(loss)—for each strategy tested. Strategies with positive economic profits create value and should be undertaken whereas negative results indicate value destruction and should be avoided.

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[15] Also see, Isaac, Daniel and Nathan Babcock, "Beyond the Frontier: Using a DFA Model to Derive the Cost of Capital," ASTIN Colloquium, July 2001.

[16] The return on the volatility replicating portfolio compounded for n-years times the starting ENW gives the target that Falcon must exceed to generate an economic profit.

TABLE 9
Cumulative Increase in Economic Profit (4 Years)[17]

Line of Business	Additional Return	Additional Required Return	Excess Economic Profit	Conclusion
Commercial A	28,228	1,602	26,626	Value Created
Personal A	(5,562)	1,828	(7,390)	Value Destroyed
Commercial B	29,925	1,492	28,433	Value Created
Personal B	26,149	968	25,181	Value Created

Note that these figures are changes from the baseline scenario.

The initial screening of Falcon's business shows value creation in all areas except the Personal A business. Note that the Commercial A business, previously identified as below average by the TCA methodology, creates value according to EPA; a conclusion that was eventually reached by decomposing the TCA capital allocation into past and future business.

The following two sections reevaluate the below-average strategies as previously identified correctly (Personal A) and incorrectly (Commercial A) via TCA. First, we review the impact of exiting the Personal A line of business. Recall that this strategy showed a surprisingly small improvement in Falcon's overall performance under TCA, in part due to the failure to account for the change in Falcon's risk profile. Second, we revisit the question of exiting the Commercial A business and demonstrate the value destruction of such a strategy; a characteristic that was initially missed by the TCA method.

3.4 Runoff Analyses Personal A and Commercial A

We tested the Personal A and Commercial A runoff strategies from the TCA analysis using the EPA method. Note that these are significant changes in Falcon's operations, with Personal A and Commercial A business accounting for 21 percent and 30 percent of premium, respectively. Unlike the $100 million marginal premium test used for each line, these strategic changes result in significant changes in Falcon's cost-of-capital as well as in their returns, as shown below:

[17] The strategies tested in this example deviate only slightly from the baseline scenario (total premium increases by only 3%); as such there is very little change in overall volatility and therefore the changes in the cost-of-capital are small.

TABLE 10
Runoff Test Results (4 Years)

Line of Business	Additional Return	Additional Required Return	Excess Economic Profit	Conclusion
Runoff Personal A	33,803	(11,592)	45,395	Value Created
Runoff Commerical A	(243,866)	(15,225)	(228,641)	Value Destroyed

Running off the Personal A business creates value for Falcon in two ways. First, the Personal A business is being written at a small underwriting loss. Elimination of that business increased Falcon's returns by $34 million over four years versus the baseline projections. Second, Falcon's overall volatility decreased, resulting in a $12 million reduction in the return demanded by Falcon's investors over the period. The higher return and lower cost-of-capital combine to generate a $45 million improvement in Falcon's economic profit over four years. Hence, withdrawing from the Personal A market created value for Falcon.

Conversely, running off the Commercial A business destroys value. This business generates significant returns; running it off would reduce growth in ENW by $244 million relative to Falcon's baseline plan. The savings in required return is too small, $15 million, to justify forgoing $244 million of growth in ENW. The strategy would result in an economic loss of $229 million over the period and therefore should be avoided.

3.5 Economic Profit Analysis—Conclusions

The EPA method, unlike TCA, correctly differentiated between the lines that created value and those that did not. Under EPA, the planning process for Falcon's Commercial A business focused on issues under management's control, i.e., the outlook for future business. Reserve volatility, which is a concern for capital adequacy analysis and which was inappropriately included in the TCA method,[18] does not impact the EPA calculation. Thus, the misclassification of Commercial A business as an underachieving line – based on reserve volatility that occurred under TCA – was avoided.

[18] Reserve volatility is clearly an issue, for which capital must be held, i.e., it is a capital adequacy issue. However, because there is very little that management can do to affect the economic value of reserves, they should not factor it into prospective decision making.

4. Conclusions

Tail Contribution Analysis although logical and intuitively appealing for capital adequacy analysis can be problematic when carried over into capital allocation for business performance measurement. TCA measures tail risk from all sources, some of which may be largely beyond management's control. Reserve volatility ***in economic terms*** is a classic example.

Management exerts considerable control over future business, but can do little to change the economic value of its reserves. When TCA assigns capital based on reserve volatility, it creates a hurdle for new business which is based on the risk and reward expectations of a different block of business!

Furthermore, on the measurement of risk, TCA comes up lame before even getting out of the gate. TCA selects a level of security in terms of "99 percent TVaR" or a "1-in-250 year event," etc. without analyzing risk. Instead a standard meant to convey a "high level of confidence" is arbitrarily selected and becomes the basis by which business segment capital consumption is measured. Little or no consideration is given to the fact that firms operate with capital that differs vastly from that required by these standards.[19]

EPA overcomes these issues. EPA is a prospective analysis of changes in risk and reward. EPA specifically analyzes risk by relating volatility to the capital markets with a volatility replicating portfolio.

Volatility replication is a key feature of EPA. Volatility replication matches the volatility of an insurer's ENW to the volatility of a basket of securities. Because these strategies have equivalent risks, the investor will choose the insurer's stock only if it provides a better return than the volatility replicating portfolio. In other words, the insurer's cost-of-capital is equal to the expected return on the volatility-replicating portfolio.

Through volatility replication EPA achieves two advantages over TCA: (1) risk is explicitly measured and accounted for in the analysis; and (2) the cost-of-capital is tailored to the volatility of the strategy being considered. Hence the cost-of-capital is related to real world market returns and adjusts to the varying levels of risk inherent in either small incremental changes in a firm's strategy (e.g., the $100 million premium test for Falcon) or large restructuring of the operations (e.g., running off Commercial A business).

[19] Or they increase the one year confidence level to more closely match their carried capital.

Appendix 1: Description of Falcon Insurance Company

Falcon Insurance Company is a fictional multi-line property casualty insurer developed for use in this paper using NAIC Statutory Annual Statement data. As such, it represents a realistic financial position of a mid-cap P&C insurer. A four-year business plan was selected for Falcon based on the authors' judgment using four broad business segments, Personal Lines A and B, and Commercial Lines A and B where appropriate. A summary of Falcon's financial statements and business plan appears in the tables below.

Balance Sheet

Balance Sheet in $000 as of:					
	12/31/2005	12/31/2006	12/31/2007	12/31/2008	12/31/2009
Invested Assets	6,218,789	6,441,400	6,789,482	7,159,983	7,519,707
Loss & LAE Reserves	3,655,520	3,607,737	3,752,538	3,911,168	4,056,640
Unearned premium	1,292,439	1,439,365	1,459,669	1,478,344	1,494,531
Statutory Surplus	1,780,431	1,933,323	2,120,102	2,323,279	2,427,272

Income Statement

Income Statement in $000s				
	2006	2007	2008	2009
Net Written Premium	2,878,167	2,916,011	2,950,782	2,980,739
Net Earned Premium	2,731,241	2,895,708	2,932,107	2,964,552
Net Investment Income	285,087	308,238	329,577	352,231
Incurred Loss & LAE	1,828,832	1,947,456	1,978,133	2,016,140
Expenses	896,545	907,653	917,891	926,710
Taxes	99,773	115,533	122,054	125,955
Statutory Net Income	191,177	233,304	243,605	247,977
Loss Ratio	67.0%	67.3%	67.5%	68.0%
Expense ratio	31.1%	31.1%	31.1%	31.1%
Combined Ratio	98.1	98.4	98.6	99.1
Avg. Investment Yield	4.5%	4.7%	4.7%	4.8%

Cash Flow

Cash Flow in $000s				
	2006	**2007**	**2008**	**2009**
Collected Premium	2,861,257	2,905,642	2,941,255	2,972,531
Paid Loss & LAE	1,876,616	1,802,654	1,819,503	1,870,667
Expenses Paid	896,545	907,653	917,891	926,710
Underwriting Cash Flow (pre-tax)	88,096	195,335	203,861	175,153
Net Investment Cash Flow	229,890	249,358	271,680	293,521
Taxes Paid	110,572	115,490	122,056	126,191
Net Operating Cash Flow	207,415	329,203	353,484	342,484

Business Segments

Projected Net Written Premium				
	2006	**2007**	**2008**	**2009**
Commercial A	860,697	877,386	892,238	904,821
Personal A	608,322	604,719	601,083	596,972
Commercial B	942,523	961,592	978,587	993,036
Personal B	466,625	472,314	478,874	485,909
Total	2,878,167	2,916,011	2,950,782	2,980,739

Expected Loss & LAE Ratio				
	2006	**2007**	**2008**	**2009**
Commercial A	68.6%	68.7%	68.7%	69.0%
Personal A	68.0%	68.5%	69.1%	69.8%
Commercial B	69.3%	69.4%	69.4%	69.7%
Personal B	58.9%	59.2%	59.4%	59.9%
Total	67.0%	67.3%	67.5%	68.0%

Expected Expense Ratio				
	2006	**2007**	**2008**	**2009**
Commercial A	30.0%	30.0%	30.0%	30.1%
Personal A	35.0%	35.0%	35.0%	35.1%
Commercial B	28.7%	28.7%	28.7%	28.8%
Personal B	33.2%	33.2%	33.2%	33.3%
Total	31.1%	31.1%	31.1%	31.2%

Appendix 2: Volatility Replicating Portfolios

In "Beyond the Frontier: Using a DFA Model to Derive the Cost of Capital," Isaac and Babcock argued that a strategy's cost of capital should have three basic properties: (1) it should increase with the strategy's systemic risk; (2) it should be related to the returns available from other financial instruments; and (3) it should be related to the length of the project.[20] Based on these desired properties, we suggested a four-step approach. First, the asset-only efficient frontier is determined. Second, we use a DFA model to calculate the financial results, in particular the ending ENW, for the corporate strategy under consideration. Third, for each portfolio on the efficient frontier, we determine the amount that could have been invested to best duplicate the company's financial results. For strategies with no interim dividends, this can be seen as solving a linear regression of the form:

$$\mathbf{Y} = \mathbf{m} * \mathbf{X},$$

where **X** and **Y** are the cumulative return factor for the benchmark under consideration and the ending ENW, respectively, for the by-scenario results and **m** is the initial investment in the potential benchmark. Finally, the strategy's benchmark is the portfolio which minimizes the resulting error term (i.e. $\mathbf{Y} - \mathbf{m} * \mathbf{X}$ in the above equation).

There was a major problem with this approach: it created a maximum average hurdle rate. Specifically, since each of the portfolios on the efficient frontier is a direct combination of the available investments, the maximum average hurdle rate is the expected return on the single investment with the highest return, typically stocks. The problem with this arises when the company considers "corporate strategies" that invest a larger and larger portion of its assets into this same category. At first, this increase is matched with an increase in the benchmark's allocation to this asset class. At some point, though, this allocation reaches the 100 person maximum. Since insurance companies' assets are usually several times their available capital, this tends to happen well before the company is investing exclusively in this asset category. Therefore, any further increase in the company's investment in this category leads to higher returns and associated risk, without a corresponding increase in the cost of capital.

In order to address this concern, we have extended the methodology by allowing an investment into a risk-free asset. Specifically, the methodology now looks at combinations of both: (1) the efficient portfolios discussed in the previous section; and

[20] For a complete discussion of the procedure, see Isaac and Babcock (2001).

(2) investing or borrowing at the risk-free rate.[21] By allowing the investors to borrow money, this change eliminates the maximum hurdle rate problem. It is also useful to note that, for the simple example described above, this portfolio leveraging changes the linear regression to one of the form:

$$\mathbf{Y} = (\mathbf{m} * \mathbf{X}) + \mathbf{b},$$

where **b** is the ending value of funds invested in the risk-free asset by the shareholders at the beginning of the evaluation period and the other terms are as previously defined.[22] The shareholders are now able to "leverage down" (i.e., $\mathbf{b} > 0$) their investment in the benchmark portfolio by investing a portion of their capital in the risk-free asset and investing a reduced amount in the benchmark under consideration. Similarly, the shareholders can "leverage up" (i.e., $\mathbf{b} < 0$) their investment by borrowing at the risk-free rate and investing both their initial capital and the proceeds of the loan into the benchmark portfolio.

[21] It is useful to note that this is very similar to the procedure used in the Capital Asset Pricing Model (CAPM) to derive the efficient market line. The one difference is that we are using all the portfolios on the frontier, while CAPM only uses the tangent point.

[22] The **b** term can be seen as an ending amount since all of the other variables in the expression (i.e., X and Y) are cumulative return factors. In order to convert **b** into the initial investment backing it, we simply divide by the cumulative return on the risk-free asset. It is this revised amount, and NOT **b** itself, that was used in this paper to calculate leverage ratios.

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