SOCIETY OF ACTUARIES

ERM Symposium
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3F - Research Paper Session: Holistic Approach to Setting Risk Limits: ERM for the Masses

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ENTERPRISE RISK MANAGEMENT

ERM

Symposium

Where Cutting Edge Theory Meets State of the Art Practice

Holistic Approach to Setting Risk Limits: ERM for the Masses

John Burkett – Deloitte Bermuda

Call Paper Announcement

- The Casualty Actuarial Society (CAS) is pleased to extend a call for papers on the topic of "Solving Problems Using a Dynamic Risk Modeling Process." In this call paper program, participants will use the Public Access DFA Dynamo 4 Model to illustrate how the Dynamic Risk Modeling process can be applied to solve real world P&C Insurance problems…
- Unlike previous DFA/ERM calls, this call will focus on the use of the Dynamic Risk Modeling PROCESS. Each participant will be expected to use the same DFA model and describe the process by which they solved a specified problem.

Dynamoo Background

- DynaMOO Insurance Group ("DIG") was originally founded as a cooperative aimed at protecting local farmers from weather related losses in 1935. The original structure was a mutual where the policyholders owned the business. During the early 1950s, DIG expanded its underwriting to include Workers Compensation and Homeowners lines of business, and effectively ceased to write weather related lines of business in the late 1960s. However, it has retained its mutual ownership structure.

Dynamoo Business Model

- DIG's business model is aimed at providing quality insurance protection to its policyholders. DIG prides itself on supplying superior claims handling services and consistently ranks extremely high in satisfaction surveys that target claims satisfaction.
- As such, DIG's business model is built around its claims management services. It strongly prefers lines of business and groups of policies that are relatively high frequency so that it can "play to its strength".
- DIG currently operates two (2) lines of business:
  - Workers Compensation – DIG writes approximately $8.5m of Workers Compensation business in selected states.
  - Homeowners – DIG writes approximately $2.5m of Homeowners business in selected states.

Insurance Constraints

- The geographical spread is limited to select states so that its claims handling services are not spread “too thin”.
- Annual policy growth is restricted to 3.5% per year. This is a rule of thumb that was developed as a risk acceptance requirement to keep the company in compliance with its risk tolerance.
- The growth in business is restricted so that DIG can maintain the highest quality of claims management services to its policyholders (it takes approximately 6 months for a new claims officer to complete internal DIG claims training and move to handling claims).
- The claims handling teams are very closely tied to the two lines of business given the different nature of Workers Compensation and Homeowners claims, thus resulting in little or no cross functional support.

Investment Constraints

- The current investment portfolio is structured for short term capital preservation and liquidity. Investments include $10 million in cash, $15 million in bonds maturing in 1 to 5 years, and $15 million in bonds maturing in less than 1 year.
- Historically, investment in equities has not been allowed. This position was established as a risk acceptance requirement to keep the company in compliance with its risk tolerance.

Risk Tolerance – Original Approach

- Historically, DIG did not have an enterprise wide statement of risk tolerance. DIG management has historically placed the protection of its policyholders through unquestioned solvency among its primary goals. This was believed to be achieved through a conservative approach and focus on short term surplus preservation in all operations.
- Recently, DIG management has observed the evolution of more sophisticated analytic tools that can provide them with greater insight into the overall effectiveness of their risk assessment policies.

Risk Tolerance – Holistic Approach

- Risk Based Capital is the vehicle used by insurance regulators to monitor company solvency. DIG will explore utilizing the Risk Based Capital concept as a holistic risk measurement. To simplify the calculations, we (the authors) have used a simplified approach to define the Required Solvency Level. We have defined Required Solvency Level as 30% of loss reserves plus unearned premium reserves. If surplus falls below the Required Solvency Level, DIG's regulators will force the company to take action.

- Management does not want to approach a surplus level where they are in danger of having regulatory action taken. As such, they are managing DIG to a solvency margin in excess of the Required Solvency Level. DIG management has set such a desired minimum at 175% of the Required Solvency Level ("RSL"). We define this level as the Management Solvency Margin Level ("MSML"). DIG tracks its actual Solvency Margin which is defined as surplus divided by RSL to ensure they are not approaching the MSML.

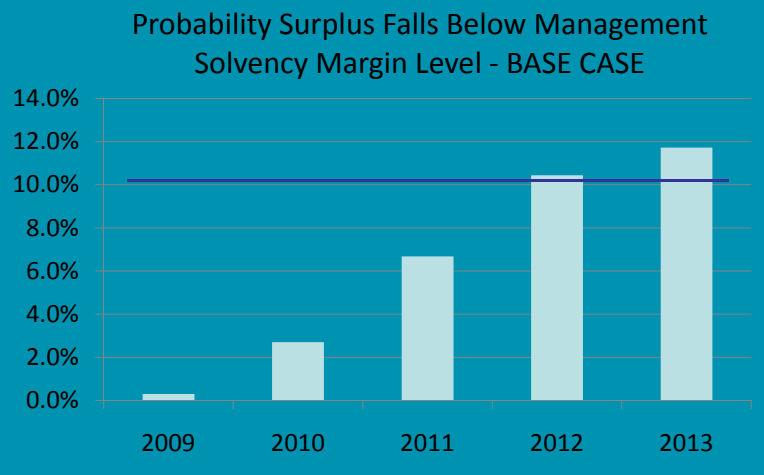
Base Case – Initial Findings

- We defined our Base Case as including DIG's current investment portfolio and current XOL protection. In order to stress test DIG's risk limits, we assumed the currently allowed maximum policy growth rate of 3.5%.

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
Expected value of solvency margin	233%	224%	220%	217%	217%
Avg deficiency relative to MSML	(635)	(1,335)	(1,478)	(1,740)	(2,067)

- While DIG management was pleased by the average growth of surplus over time, they were surprised by the amount of risk embedded in their current selection of risk limits when viewed from an enterprise wide perspective. After seeing these results, DIG management has decided they would like to keep the probability of surplus falling below the Management Solvency Margin Level at or below 10% over both a one year and a five year time horizon. Further, management was concerned with the downward trend in the expected value of the solvency margin

Base Case – MSML Summary



Risk Tolerance – Holistic Approach

- In the past, DIG management focused on one year underwriting results and its goal was to achieve short term surplus preservation. The company did not possess the necessary tools for a rigorous enterprise wide view or a rigorous multi-year view.
- DIG has decided to introduce a long term statement of risk tolerance. DIG has determined that modeled surplus should exceed the Required Solvency Level 99.9% of the time measured over five years. In addition, modeled surplus should exceed the Management Solvency Margin Level 90% of the time measured over five years.

Revisiting Risk Limits

- After seeing these results, DIG management has chosen to undertake a review of the effects of changing various risk limits. The desired outcome is to identify a holistic risk management framework that will continue the long term growth of surplus but with a reduction in risk over the five year period.
- This risk limit review, and the associated risk / reward tradeoffs, is first explored on a stand-alone risk basis. Later in the evaluation process, combinations of changes in the risk limits from the Base Case are examined.
- Reinsurance (currently XOL cover purchased for homeowners line)
- Growth Limit (currently capped at 3.5% policy growth)
- Equity Investments (currently not allowed)
- Bond Duration (currently short duration with significant cash holdings)

Impact of XOL Reinsurance

- As expected, the expected surplus position at the end of 2013 under the 'internal XOL' approach is greater than the 'external XOL'. This supports the Group's expectations of retaining the expected ceded profits within the DIG. However, there was surprise that the probability of surplus falling below the solvency margin increased by 19% (from 11.7% to 13.9%) and, consequently, it was decided that such an increase did not support dropping the reinsurance cover.

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
Expected value of solvency margin	233%	224%	220%	217%	217%
Avg deficiency relative to MSML	(635)	(1,335)	(1,478)	(1,740)	(2,067)

Internal Reinsurance	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.6%	4.3%	9.6%	13.0%	13.9%
Expected value of surplus	18,336	19,584	21,109	22,888	25,121
Expected value of solvency margin	227%	219%	214%	212%	213%
Avg deficiency relative to MSML	(787)	(1,418)	(1,577)	(1,946)	(2,220)

Impact of Growth

- As such, DIG has significant capital constraints which potentially impede its ability to grow. Effectively, its capital requirements (driven by solvency pressures) can easily exceed its capital generation ability. DIG has decided to view this as a strategic advantage instead of a disadvantage and has deliberately constrained its growth rate.
- Given the training the DIG claim administrators receive, it takes a significant amount of time for a newly hired claims manager to progress through training and reach the front line of actively managing claims. In this situation, DIG cannot 'ramp up' its front line claims managers and cannot afford a significant increase in the volume of claims.
- The current business plan has the company growing at 3.5% per annum (policy count) over the next 5 years.

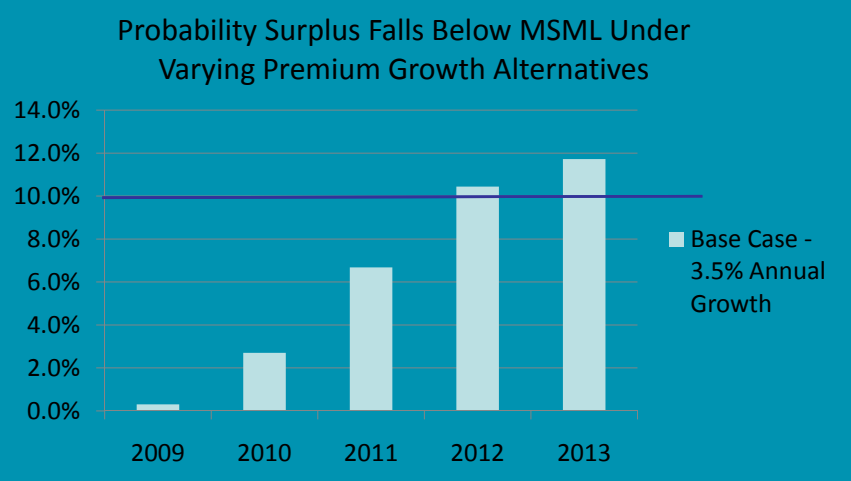
Impact of Growth

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
Expected value of solvency margin	233%	224%	220%	217%	217%
Avg deficiency relative to MSML	(635)	(1,335)	(1,478)	(1,740)	(2,067)

No growth	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.2%	1.5%	3.8%	6.4%	8.7%
Expected value of surplus	18,590	19,664	20,716	21,665	22,662
Expected value of solvency margin	238%	234%	231%	228%	226%
Avg deficiency relative to MSML	(634)	(1,268)	(1,253)	(1,556)	(1,884)

5% Growth	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.4%	3.5%	8.9%	12.5%	13.0%
Expected value of surplus	18,500	19,775	21,448	23,532	26,276
Expected value of solvency margin	231%	220%	215%	212%	214%
Avg deficiency relative to MSML	(6,481)	(7,019)	(7,737)	(8,483)	(9,381)

Impact of Growth



Equity Investments

- DIG has never allowed equities within their investment policy statement. The addition of equities has never been thought of as being consistent with the firm's conservative approach. DIG's current asset manager has been told that the investments belong to their policyholders, and investment in risky assets is therefore inappropriate.
- In the spirit of re-evaluating all current risk limits, DIG modeled the case of a 10% investment in equities. The positive effects of diversification in the portfolio produced results that surprised DIG management. A modest asset allocation to equities both increased expected surplus and reduced the risk of violating MSML over the five year horizon.

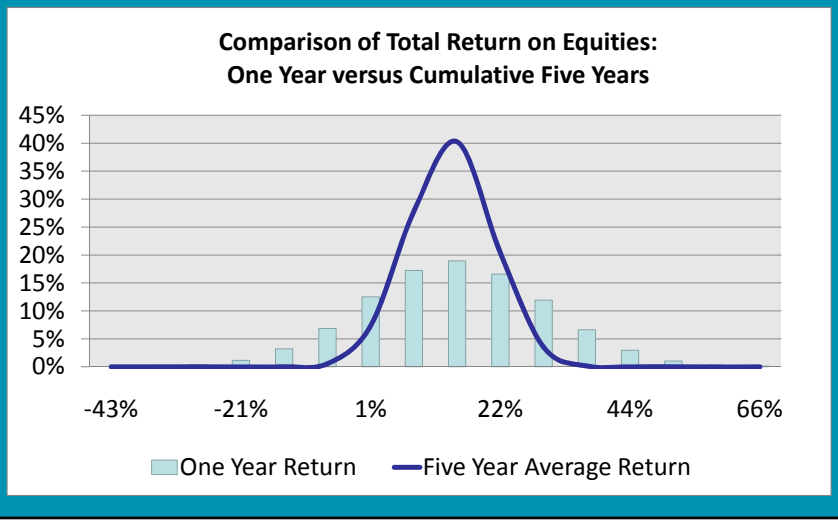
Equity Investments

Base case	**2009**	**2010**	**2011**	**2012**	**2013**
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
Expected value of solvency margin	233%	224%	220%	217%	217%
Avg deficiency relative to MSML	(635)	(1,335)	(1,478)	(1,740)	(2,067)
10% Equities	**2009**	**2010**	**2011**	**2012**	**2013**
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.2%	2.0%	3.4%	4.4%	4.7%
Expected value of surplus	18,948	20,641	22,652	24,950	27,790
Expected value of solvency margin	238%	235%	234%	236%	241%
Avg deficiency relative to MSML	(1,179)	(1,236)	(1,433)	(1,769)	(1,905)

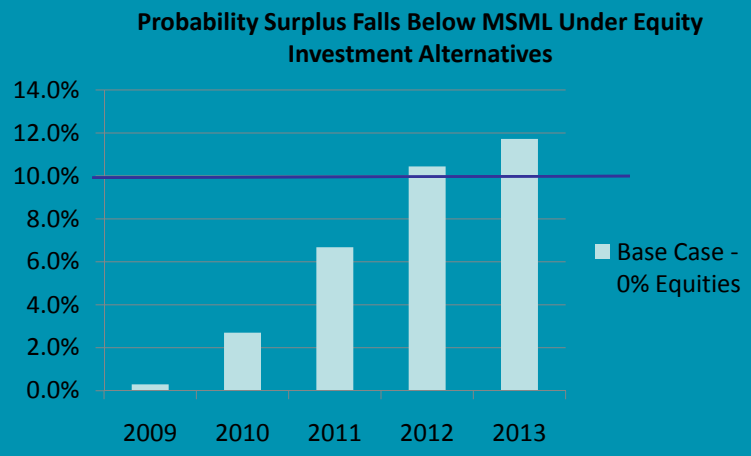
Equity Investments

- DIG management is appropriately skeptical of any unexpected results that are generated by the Dynamo model. In particular, the expected risk premium and assumed volatility for equities within the Dynamo model were called into question. The initial equities scenario assumed an expected market return for stocks at 8.5% above the risk free rate.
- After discussion with DIG management, an additional model run was performed with more pessimistic assumptions for future equity performance. Here the expected market return for stocks was modeled at 1.5% above the risk free rate. In addition, the volatility of equity returns was increased from 15% to 30%.

Equity Investments



Equity Investments



Bond Duration

- DIG has historically maintained a short duration, highly liquid portfolio. It was decided to consider a longer duration fixed income portfolio, while maintaining the same amount of cash historically carried.
- In the past, DIG has considered a short duration portfolio to be safer because of its reduced sensitivity to movement in interest rates.

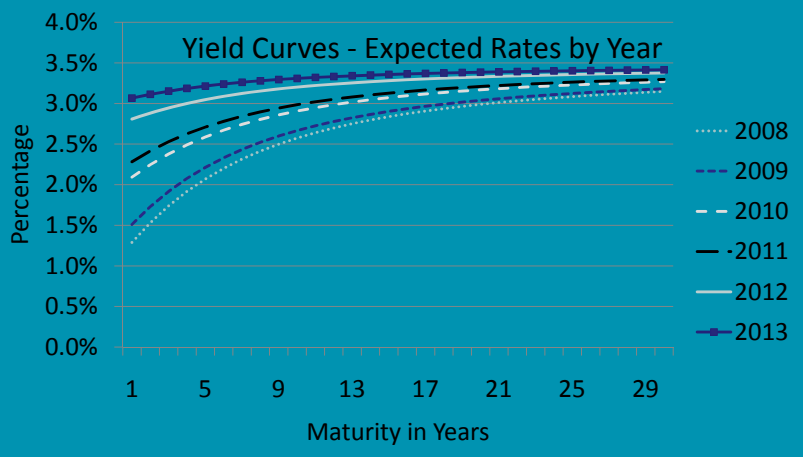
	Base Case	Longer Duration
Cash	25%	25%
Bonds (< 1 year)	38%	13%
Bonds (1-5 years)	38%	13%
Bonds (6-10 years	0%	25%
Bonds (10-20 years)	0%	25%
Total	100%	100%

Bond Duration

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
Expected value of solvency margin	233%	224%	220%	217%	217%
Avg deficiency relative to MSML	(635)	(1,335)	(1,478)	(1,740)	(2,067)

Long duration	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.2%	2.0%	4.6%	6.8%	7.4%
Expected value of surplus	18,740	20,094	21,770	23,711	26,101
Expected value of solvency margin	236%	228%	225%	224%	226%
Avg deficiency relative to MSML	(788)	(1,243)	(1,338)	(1,576)	(1,862)

Bond Duration



Equities & Longer Duration

- Based upon the initial analysis utilizing the Dynamo model, DIG is considering two significant changes to their current investment strategy. These changes include a modest investment in equities and an increase in the average duration of the fixed income portfolio. At this point, we have only tested each of these changes in isolation. Dynamo provides a tool for better understanding the combined effects of making both of these changes.

Equities & Longer Duration

Long duration	**2009**	**2010**	**2011**	**2012**	**2013**
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.2%	2.0%	4.6%	6.8%	7.4%
Expected value of surplus	18,740	20,094	21,770	23,711	26,101
Expected value of solvency margin	236%	228%	225%	224%	226%
Avg deficiency relative to MSML	(788)	(1,243)	(1,338)	(1,576)	(1,862)

10% Equities pessimistic assmptns	**2009**	**2010**	**2011**	**2012**	**2013**
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.2%	2.9%	5.9%	8.6%	9.6%
Expected value of surplus	18,668	20,042	21,688	23,576	25,953
Expected value of solvency margin	235%	228%	224%	223%	225%
Avg deficiency relative to MSML	(1,018)	(1,284)	(1,516)	(1,800)	(2,093)

Long Dur + 10% Equ pessimistic	**2009**	**2010**	**2011**	**2012**	**2013**
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.1%	2.1%	4.1%	5.6%	6.1%
Expected value of surplus	18,882	20,396	22,249	24,378	27,012
Expected value of solvency margin	237%	232%	230%	231%	234%
Avg deficiency relative to MSML	(1,319)	(1,265)	(1,399)	(1,708)	(1,889)

Equities & Longer Duration

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
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Long Dur + 10% Equ pessimistic	2009	2010	2011	2012	2013
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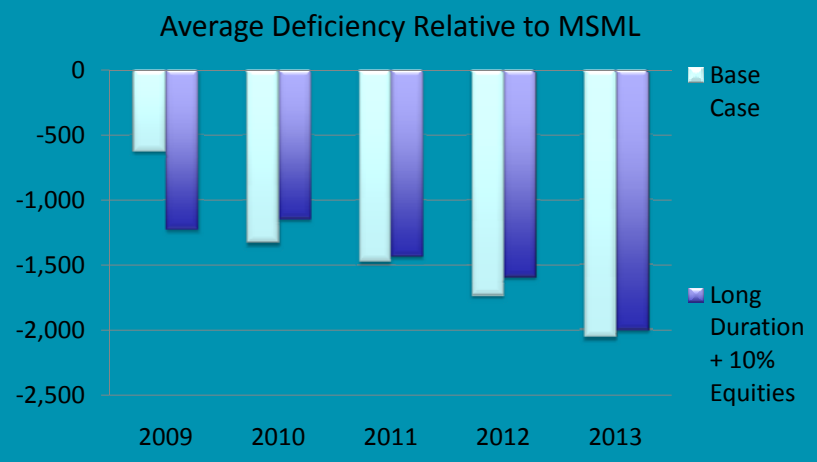
Equities & Longer Duration



Other Combinations

Base case	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.3%	2.7%	6.7%	10.4%	11.7%
Expected value of surplus	18,526	19,738	21,210	22,913	25,047
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Long Dur + 10% Equ pessimistic	2009	2010	2011	2012	2013
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Expected value of surplus	18,882	20,396	22,249	24,378	27,012
Expected value of solvency margin	237%	232%	230%	231%	234%
Avg deficiency relative to MSML	(1,319)	(1,265)	(1,399)	(1,708)	(1,889)

Long Dur + 10% Equ +5% growth	2009	2010	2011	2012	2013
Surplus falls below RLS	0.0%	0.0%	0.0%	0.0%	0.0%
Surplus falls below MSML	0.1%	1.8%	3.1%	3.6%	3.1%
Expected value of surplus	19,135	21,029	23,436	26,343	30,034
Expected value of solvency margin	249%	238%	234%	235%	237%
Avg deficiency relative to MSML	(1,236)	(1,203)	(1,386)	(1,731)	(1,984)

Other Combinations

- When comparing the new investment strategy to the new investment strategy with 5% growth, the risk reward tradeoff appears favorable.
- Recall that the 5% growth cap was rejected earlier in this paper because DIG was attempting to reduce the violation of MSML to below 10% over a five year period. This is now possible with 5% growth in conjunction with the new investment strategy. By considering the changes together, DIG is able to reap the expected rewards of faster growth when market conditions are favorable, while maintaining an acceptable enterprise wide risk profile for the company.
- As mentioned earlier in the paper, DIG's capacity to effectively handle claims is a consideration in the policy growth constraint. Before increasing the growth constraint to 5%, DIG will need to increase its claims handling capacity. DIG will also re-evaluate enforcement of underwriting standards to ensure that the possibility of faster growth does not lead to deterioration in the underwriting book.
- At this point, the mathematically minded reader may point out that DIG could have initially constructed a grid of all possible combinations of changes.

Other Combinations

- For our highly simplified example, this creates 24 (=3x2x2x2) different possible combinations. A more realistic setting would likely lead to a much higher number of possible combinations. The number of possible combinations can quickly become impractical and lead to a “black box” approach. Note also that our considered options are special cases of variables better defined as continuous. If one blindly attempts a strictly mathematical approach the problem very quickly becomes intractable.
- In reality, our chosen approach is more an attempt to build management confidence in the holistic approach and its benefits. By initially considering individual changes, DIG management was better able to understand underlying factors in the risk reward tradeoff for each proposed change. Only later in the process did DIG management begin to selectively consider combinations of changes.

	Number of Options Considered
Growth	3
Reinsurance	2
Equities	2
Bond Duration	2