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Growth in Stock Price as the ERM Linchpin

By Damon Levine, CFA

Actuaries

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Abstract

Nothing sends executives and frontline managers running faster than selling your enterprise risk management (ERM) program as the brakes or guardrails in some metaphorical car race. To truly influence strategic decision-making at the highest levels of the company and embed a risk management mentality in all business lines, risk managers must fundamentally change both their approach and their messaging. We must move away from the "defensive" angle so often emphasized in ERM and convey that in addition to downside protection we can visibly create value and exploit risk-intelligent opportunity. This paper introduces the Stock Value Approach (SVA) to ERM as a solution to these common challenges and provides a robust and practical approach to risk identification and assessment. SVA builds buy-in by design, allows for consistent risk quantification across all risk types, and promotes a risk-reward view that informs strategic decision-making with the primary goal of growing company value.

Keywords: ERM, stock growth, risk-adjusted compensation, strategy, risk appetite, simulation

Growth in Stock Price as the ERM Linchpin

1. Introduction

In many companies enterprise risk management (ERM) is regarded primarily as protection against severely adverse events or, worse yet, as a sort of appendage created mostly to satisfy the expectations of various external stakeholders. The motivations and structure of an ERM program are typically artifacts of a company's culture, industry practices, management style, and, for some businesses, the regulatory environment. In some cases this leads to the view of ERM as a defensive protocol. This is an unfortunate state of affairs and blunts the potential for an ERM framework to link strategy with risk-intelligent decision-making and create long-term company value.

Risk managers must move away from the all-too-common view of ERM as a constraining force or a conservative overlay to business practices. Because company performance and value are inexorably intertwined with uncertainty, risk and volatility, ERM is the natural approach for managing these quantities and driving company value.

This paper introduces the *Stock Value Approach* (SVA) to ERM. SVA weaves the goal of share price growth into the "DNA" of an ERM framework and provides a basis for risk-intelligent, strategic decision-making. For concreteness we illustrate SVA's application to an insurance company, but the approach is well-suited for any public company. Some of the concepts addressed in this paper include:

- Robust and practical risk identification and quantification that build buy-in from the "ground floor" and tie into analyst and investor perceptions
- A mapping of a company's risk universe to the drivers of stock value
- Quantification of all risk types with the same set of key metrics
- Optimization that links strategic decision-making with stock growth and analyst perception while meeting the expectations of policyholders, regulators and rating agencies
- A link between risk management and financial planning processes
- Risk-adjusted compensation.

Perhaps the biggest strength of SVA is its ability to model the distribution of single metric that captures intrinsic company value as a function of either the current risk profile or a hypothetical profile assuming proposed or candidate strategic choices and risk responses.

2. Overview: ERM and the Stock Value Approach

In possibly its most succinct description, ERM is a set of processes and methods that enables a company to modify the shapes of the distributions (i.e., probability density functions) of its key performance metrics.[1] A "road map" of sorts for this paper is provided on the next page. It offers a glimpse of how SVA leads to the ability to affect these distributions through the proper selection of a company's business goals, risk metrics, strategic decisions, risk-based forecasting and compensation approaches.

The Stock Value Approach to ERM

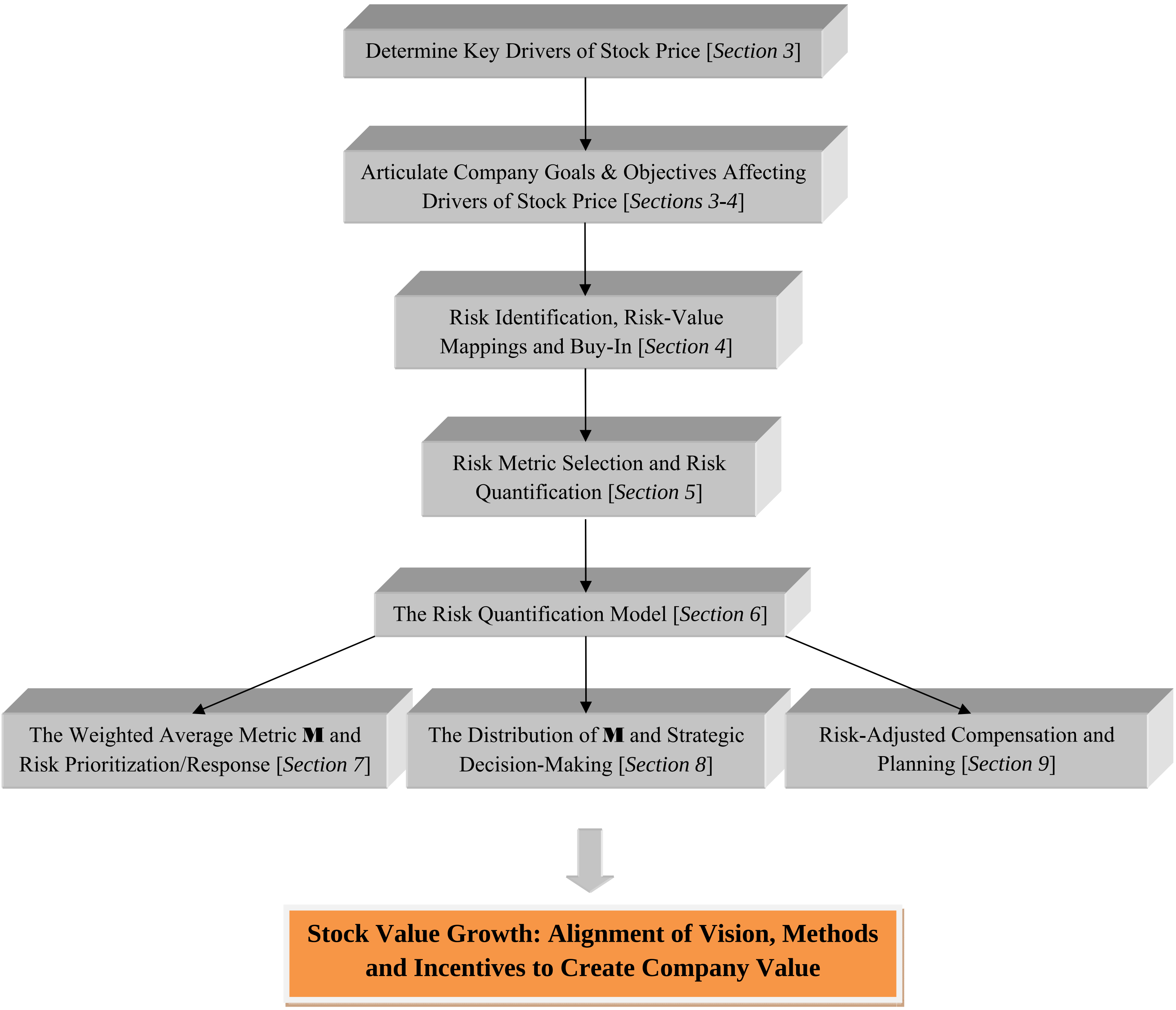


Exhibit I: The Stock Value Approach to ERM—*The progression of concepts and capabilities leading to the ultimate goal of stock value growth.*

In the SVA, the primary quantities of interest are those that drive an increase in value of the company stock. These metrics are uncertain quantities and have their own (statistical) distributions or curves. To reiterate some of the concepts of Exhibit I, SVA equips a company with the tools to influence the shapes of its performance curves by enabling the following:

1. Articulation of the quantities or metrics that most influence the valuation of the company stock price (***Section 3: Drivers of Stock Price***)
2. Robust processes to identify the risks and challenges that drive variation of the quantities in (1) and build buy-in across the company (***Section 4: Risk Identification and the Risk-Value Mapping***)
3. Risk quantification methods and an enterprise risk model that make informed and careful use of probability to assess potential impact of the risks and challenges in (2) on the quantities in (1) (***Section 5: Probability and the Scenario Approach*** *and* ***Section 6: The Risk Quantification Model***)
4. Understanding of the distributions of the key performance metrics and linkages across risk appetite, strategic decision-making, risk response and stress-tested assumptions (***Section 7: The Weighted Average Metric M*** *and* ***Section 8: Informing Strategic Decision-Making***)
5. Alignment of ERM, financial planning and compensation incentives (***Section 9: Risk-Adjusted Compensation and the Plan Process***)

Risk response and strategic decisions will be driven by those factors that affect stock value and also by constraints such as the regulatory environment and various self-imposed conditions (e.g., relating to customer satisfaction, liquidity or targeted financial ratings). By using such an approach for setting its tactical or strategic course, a company using SVA ensures a connection between decision-making and value creation while adhering to key internal and external requirements.

For ERM to drive value it must look to those metrics, distributions and strategic decisions that are *right* for the particular company's goals and risk appetite. The remainder of this paper details how SVA provides a clear path toward the *right metrics*, the *right distributions*, and the *right strategic decisions*.

3. Drivers of Stock Price

In our hypothetical public insurer ("the Company") the Risk Management department (RM) facilitates a discussion with the Investor Relations department (IR) and addresses the following questions:

1. Are there specific valuation models that you feel our analysts use commonly? (e.g., earnings per share, EBITDA, dividend discount model,[2] price-to-sales or price-to-earnings multiples)
2. What are the key drivers for our stock valuation? (e.g., next two years of earnings, growth expected over three years, new product rollouts, new geographies)

IR feels that the *dividend discount model* and *price-to-earnings ratio* are the most commonly used valuation models by analysts tracking the Company. They suggest the following are key drivers for sentiment on our valuation: execution of communicated strategies and goals (mainly increasing sales in Latin America and achieving the return on equity (ROE) target for the warranty division as described at Investor Day), strong cash flow, earnings growth and earnings diversification.

As a result, SVA will seek to manage the Company's risks, challenges, and factors affecting the outlook and perception of future dividends and earnings quality/growth. The Company will also manage risks affecting strategic execution and performance volatility around sales goals for Latin America and the warranty division ROE target as well as quality and growth of cash flows. Because the Company is a public insurer, SVA will also manage risks relating to the capacity to pay policyholder benefits, its capital position, and regulatory compliance.

4. Risk Identification and the Risk-Value Mapping

SVA views *risk* as any potential condition, scenario or event that can affect the attainment of a business goal, company performance or strategic execution. In other words, risk is what creates uncertainty, variation or volatility around planned or expected business results or objectives. This interpretation naturally includes upside as well as downside. If upside is excluded from risk models, then the modeled probability of missing performance targets will likely be overstated.

This view of risk suggests that one may identify risk by first envisioning a desired future state and then listing potential events or challenges that might be encountered in the pursuit of that state. This ideal future includes the attainment of the Company's goals and the "compliance" with various constraints including rules, regulations and expectations from insurance regulators, rating agencies, and other external stakeholders. SVA primarily identifies risks by seeking out internal subject matter experts (SMEs) and conducting a "risk interview."

Continuing with our example, RM works with IR, SMEs and management to describe the "ideal future state" in terms of the Company's main goals for the next year. The goals are shown below with their short-hand title in capitals:

I. DIV: Create investor confidence of continued growth in dividends.
II. EARN: Achieve earnings growth of 5 percent versus last year.[3]
III. CASH: Achieve an increase of 7 percent in net cash flow versus last year.
IV. LATAM: Demonstrate a more diversified product portfolio by expanding LATAM sales to at least 5 percent of Company sales.
V. ROE: Meet the ROE target of 14 percent for the warranty division.
VI. BEST: Maintain capital levels that target A ratings from A.M. Best for all legal entities.
VII. RCAP: Maintain a level of liquid "risk capital" at the holding company level that provides high confidence in the ability to operate as a *going concern* for the next four quarters, including the ability to pay benefits and satisfy typical cash flow needs and expenses (this capital level is determined to be sufficient in 99.5 percent of risk scenarios as quantified in the enterprise risk model).

Through risk interviews, RM documents, for each objective above, the necessary steps to reach it, and the various obstacles, challenges or risks that may assist, hinder or otherwise affect this effort. We work backward in time from the business objective to determine what critical-to-success (CtS) goals will allow us to achieve the objective. We might describe two to five such CtS goals for each objective. That same "*back-step*" idea should then be applied to the CtS goals to help inform what tasks or smaller "sub-goals" must be accomplished in order to help ensure attainment of the CtS goals.

This is where risk comes in: We identify the potential obstacles to achieving the various goals, sub-goals and tasks, as well as challenges or conditions that may affect the quality of our execution or the attainment of our objectives. This includes internal and external risks as both must be identified and, if deemed appropriate, actively managed.

This analysis is performed for each of the Company's goals (numbered I through VII). Project planning illustrated in the above approach helps to identify risks and factors affecting success or performance. The result is a long list of risks, conditions and factors that may affect performance or attainment of these goals. The following is a list of each enterprise goal followed by an example of an associated CtS goal and related risks.

DIV CtS goal: "Provide investors and analysts with confidence of long-term operating earnings growth rate above 7 percent." At risk due to health care products exposure to regulatory risk and pricing effects, potential timing challenges for launch of LATAM product, and decreasing sales in group life insurance line.

EARN CtS goal: "Maintain momentum in our new product lines of tablet insurance and 3D printing warranties." At risk due to potential "commoditization" of the tablet insurance market, high rates of malfunctions in specific brands of 3D printers, and inefficiencies in claims processing.

CASH CtS goal: "Reduce number of ventures with large upfront cash investments, reduce exposure to products with volatile claims, and increase sales in fee-based products." At risk due to claims variation in disability insurance lines, misaligned new business development incentives/compensation and marketing effectiveness.

LATAM CtS goal: "Roll out training and IT infrastructure by end of Q1." At risk due to resource/planning challenges in both the Sales and IT departments.

ROE CtS goal: "Reduce expenses by 5 percent versus last year." At risk due to protracted contract negotiations, IT legacy systems, and sub-optimal vendor negotiated rates for print marketing materials.

BEST CtS goal: "Forecast accurate statutory financials and link to capital management." At risk due to poor assumptions in the planning process and highly volatile claims in the homeowners insurance product line.

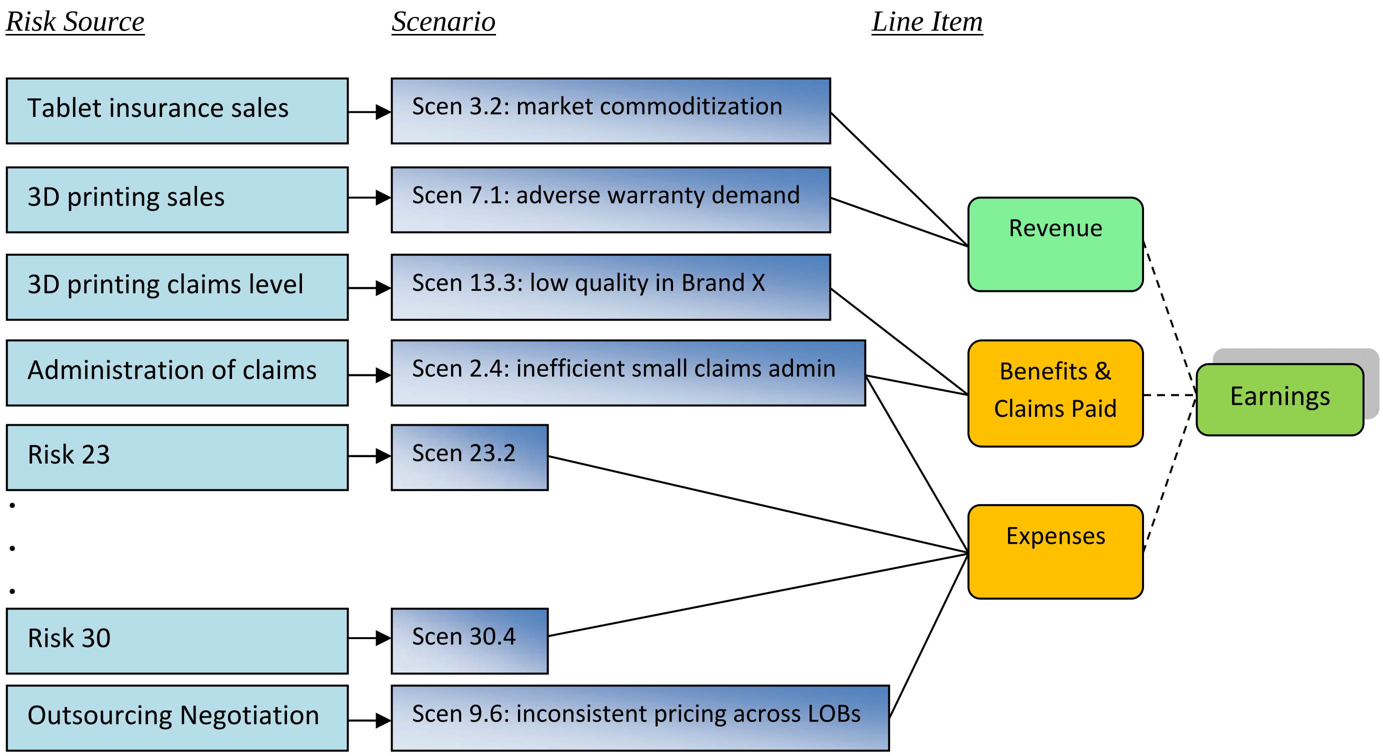
RCAP CtS goal: "Establish a capital management policy that dynamically links to the risk profile as described in the enterprise risk model." At risk due to response time related to changes in portfolio credit risk and uncertainty in the catastrophe reinsurance program structure.

The above is a subset of the risks identified in this process. Note that each risk affects the outcome of one of the Company's seven main goals, and each of these goals ties to a specific driver of Company value. This may be described as a "mapping" of each risk to a value driver. For example, it has been seen that IT legacy systems may affect the CtS goal of reducing expenses by 5 percent versus last year and therefore affect the ROE goal. The achieved ROE is known to inform the analyst models and therefore drive the Company's stock valuation.

This mapping idea can be applied to the full collection of risks identified by the above process, and a pictorial representation (a "risk-value mapping") of each risk's link to a value driver is a powerful tool for risk communication. Such a mapping might also show risk source, risk scenarios, probability and expected impact.

The following exhibit illustrates this concept for the earnings goal (EARN) described earlier in this section. In this example some risks are labeled numerically and refer to a (hypothetical) risk inventory where the full description is available. Each risk source is shown below with what is regarded as the critical scenario. If a greater level of detail is desired one might include all modeled scenarios for each risk source.

Exhibit II: Risk-Value Mapping for Earnings



By focusing on drivers of stock price our risk identification highlights many strategic, operational and insurance risks. This inclusion of many "internal" factors in the Company's sphere of influence is a very important benefit. In many ERM programs, risk identification places far too much emphasis on "external" or *force majeure* risks that the company cannot affect. This may make ERM a largely irrelevant exercise: Too much focus is placed on risks that cannot realistically be managed. SVA's emphasis on stock value drivers when identifying risk leads to inclusion of many sources of performance variability that the company may influence with obvious rewards.

The Company also identifies risks that do not necessarily map to value drivers in the manner above. These may include legal, regulatory, and compliance risks. Though the risk-value mapping does not necessarily make sense for this subset of the risk universe, the concepts of CtS goals and the *back-step* idea still apply.

5. Probability and the Scenario Approach

5.1 Probability Preliminaries

If the need should arise it is the job of RM to educate SMEs on the subject of probability. It is important to make basic concepts and definitions clear prior to a risk interview. For SVA these include:

- If an event A is a subset of event B then $p(A) \leq p(B)$. Note that "A is a subset of B" is equivalent to saying "event A implies event B."
- Events A and B are said to be *mutually exclusive* if they cannot occur simultaneously.
- For any events A and B, $A \cap B$ is the *intersection* of A and B and is the set of events where both A and B occur simultaneously; $A \cup B$ is the *union* of A and B and is the set of events where either A or B occurs (this includes when they both occur).
- For any events A and B, $p(A \cup B) = p(A) + p(B) - p(A \cap B)$.
- For *independent* events A and B, $p(A \cap B) = p(A)p(B)$. Intuitively, saying events are independent means that the occurrence of one event does not change the probability of the other occurring.
- The "*conditional probability* of A given B" is the probability that A occurs assuming B has occurred and is written $p(A|B)$, and we have $p(A|B) = p(A \cap B)/p(B)$.
- For any event A, the *complement* of A refers to the event "A does not occur" and is written as A^c. We have $p(A^c) = 1 - p(A)$.
- For any events A and B, $p(A) = p(A|B)p(B) + p(A|B^c)p(B^c)$.

The notion of conditional probability will play an important role in risk quantification and simulation within SVA. Given a particular risk source we will conduct a risk interview to form several scenarios that represent a variety of potential ways the risk may manifest or "play out." The probabilities of the individual scenarios will be of interest, and these will be estimated as various sets of conditional probabilities. Generally we will consider several potential events that are external to the company and typically out of its control. We look at those "macro" factors or events that might influence or change our estimates of the various risk scenarios. If we model a risk source with scenarios $S_1 \ldots S_k$ then we estimate $p(S_1) \ldots p(S_k)$ assuming a particular macro event occurs; i.e., we assume a condition is in effect next year and then ask the SMEs for probability estimates. We then repeat these estimates assuming a different macro event is in effect. These macro events might relate to the economy, hurricane seasons, pandemics, or other events that influence manifestation of the risk source.

This concept allows SVA to capture correlation in an intuitive way and is further explored in Section 5.3.

5.2 When to Quantify

In many cases an identified risk need not be quantified or further assessed. It may be clear without additional analysis that a particular response is warranted. Consider the CASH goal and one of the main identified risks described as “misaligned incentives/compensation.” Though this is a legitimate risk it is unlikely that an effort to quantify this risk would yield any meaningful discoveries. Assuming that aligning sales incentives with the CASH goal will not be a resource drain or cause an undue expense increase it is perhaps an easy decision to revamp the incentive/compensation structure. In our example, the Company simply chooses to heavily weigh the bonus formula in favor of cash generation in the first year of a new product or initiative; perhaps new business development contributors in the Company were sometimes rewarded for closing deals that required large upfront investments without tangible reward.

Mitigations for some key risks might only be well-managed after a significant resource or economic investment. In some circumstances the potential impact of a risk may not be well-understood. In either of these cases risk quantification will help assess priority and possible risk response. At the Company both management and the board feel that disability claims variation is a critical risk and they have requested that the risk be quantified to confirm or refute this view. The next section demonstrates the risk interview process leading to the quantification of this risk.

5.3 Risk Interview Process and Output

A risk interview will be conducted by RM with content coming from the relevant SMEs. The typical output of the risk interview is:

a) A set of scenarios $S_1 \ldots S_k$ that reflect a range of potential outcomes for the risk in question, including upside if relevant. The scenarios should be *mutually exclusive* (none of the scenarios can occur at the same time) and they should approximate a full range of outcomes for the risk in question.

b) Impacts for each scenario described as estimated deviations from Plan (i.e., budget or baseline forecast) for key income statement and balance sheet items, including cash flows, capital, reserves etc. in each scenario; e.g., sales are 10 percent less than the Plan forecast, loss ratio is 100 basis points higher than Plan, $50,000 additional expenses versus Plan, etc.

c) Determination of those macro events (“states of the world”) W1, W2, etc., which might influence the likelihood of the various scenarios (i.e., affect our estimates of their probabilities) possibly including economic, pandemic, or natural disaster scenarios.

d) For each macro event in (c), a set of (conditional) probability estimates of each scenario $S_1 \ldots S_k$. If, for example, we have described two macro events, then, using the notation for conditional probability, the first set of probabilities, based on assuming W1, is $p(S_1 \mid W1)$, $p(S_2 \mid W1)$, …, $p(S_k \mid W1)$ and the second set, assuming W2, is $p(S_1 \mid W2)$, $p(S_2 \mid W2)$, …, $p(S_k \mid W2)$. Each set of probabilities sums to 1.

It is understood that this type of scenario modeling is an approximation of what may in reality be a “continuum” of results. This is essentially creating a discrete estimate of a continuous variable. Visually this can be seen when one forms a histogram (for some metric) based on a large sample from a normal population; the histogram will have the approximate shape of the normal distribution (bell-shaped curve).

In the case of disability claims risk the SMEs include representatives from the underwriting, actuarial, finance, and claims administration departments within the disability line of business (LOB). We begin by looking at the claims level assumed in the Plan, $5 million, and consider potential upside and downside deviation from that level.

After some discussion we arrive at five scenarios: S_1, S_2, S_3, S_4 and S_5. We are careful to consider both upside and downside and ensure that these scenarios span the full range of results. In addition they are mutually exclusive. Impacts are described as percent deviations in the dollar amount of claims. Expense effects are also considered but not shown below. The scenarios and corresponding impacts are:

S_1 (severe adverse scenario): claims level double Plan or $10 million

S_2 (adverse scenario): claims level 150 percent of Plan ($7.5 million)

S_3 (moderate downside scenario): claims level 120 percent of Plan ($6 million)

S_4 (moderate upside scenario): claims level 80 percent of Plan ($4 million)

S_5 (optimistic scenario): claims level 50 percent of Plan ($2.5 million).

Next we consider states of the world that might affect the likelihood of these scenarios. It is determined that the economic environment is the key macro event we should consider. The SMEs explain that a poor economy is often linked to higher claims; this is referred to as "economic morbidity." We define W1 as the economy being in more or less the same condition next year as it is today. W2 is a small improvement and W3 is a recession. Now probabilities are assigned to the five scenarios assuming each of the above states in turn. It is estimated that:

$p(S_1 \mid W1) = 5\%$, $p(S_2 \mid W1) = 10\%$, $p(S_3 \mid W1) = 40\%$, $p(S_4 \mid W1) = 30\%$, and $p(S_5 \mid W1) = 15\%$

$p(S_1 \mid W2) = 5\%$, $p(S_2 \mid W2) = 5\%$, $p(S_3 \mid W2) = 40\%$, $p(S_4 \mid W2) = 35\%$, and $p(S_5 \mid W2) = 15\%$

$p(S_1 \mid W3) = 10\%$, $p(S_2 \mid W3) = 15\%$, $p(S_3 \mid W3) = 40\%$, $p(S_4 \mid W3) = 25\%$, and $p(S_5 \mid W3) = 10\%$.

It is important to note that these scenarios indicate specific ("exact") dollar levels of claims that are extremely unlikely to manifest. The thrust of this modeling is that the actual level of claims seen in the next year will be "close" to one of these specific scenario values. They serve as approximate neighborhoods of potential claims results. A more realistic approach might be to supply ranges of claims in each scenario as opposed to using point estimates. Then, if a scenario is modeled, one may randomly assign some value in the indicated range for claims. This alternative methodology is discussed more in Section 8.2.

5.4 Selection of Risk Metrics

The above example is rather simplified in that it only shows impacts to a single metric, namely claims. In the quantification of any scenario we typically want to be able to estimate impacts to additional quantities of interest. We will design a risk quantification approach with the capability of quantifying several metrics of interest; in particular, it will calculate metrics that are most critical to stock price growth.

Recall that in Sections 3 and 4 the Company determined those quantities and related goals that are the key drivers of stock valuation as:

I. DIV: Provide analysts with confidence of long-term operating earnings growth rate above 7 percent.
II. EARN: Achieve earnings growth of 5 percent versus last year.
III. CASH: Achieve an increase of 7 percent in net cash flow versus last year.
IV. LATAM: Demonstrate a more diversified product portfolio by expanding LATAM sales to at least 5 percent of Company sales.
V. ROE: Meet the ROE target of 14 percent for the warranty division.
VI. BEST: Maintain capital levels that target A ratings from A.M. Best for all legal entities.

VII. RCAP: Maintain a level of liquid “risk capital” at the holding company level that provides high confidence in the ability to operate as a going concern for the next four quarters, including the ability to pay benefits and satisfy typical cash flow needs and expenses.

RM facilitates discussions with management, the board, IR, and Strategy groups to determine appropriate metrics to track progress and risk relating to these goals, and the Company decides on risk-based forecasts of the following metrics to assess the risks to achieving the seven goals: I) two years of operating earnings, II) earnings growth versus last year, III) net cash flow, IV) LATAM sales, V) ROE for warranty division, VI) shortfall versus A-rated target capital, and VII) shortfall versus targeted level of risk capital. The shortfalls in VI and VII are defined as min(0, modeled value – target value) so shortfalls are negative values and a zero corresponds to a target being met or exceeded. This ensures that for all metrics above, a larger numerical value is a better result. These metrics are denoted m_1, m_2, …, m_7.

6. The Risk Quantification Model

6.1 Model Goals and Methodology

Each company will customize its own enterprise risk model to perform quantification of its risk universe in an effort to characterize its risk profile, prioritize risk mitigation action, and aid in strategic decision-making. Ideally a risk quantification model (RQM) should:

- Include the financial Plan (i.e., budget or baseline forecast)
- Have the necessary level of detail to enable modeling of the metrics m_1, m_2, …, m_7 and allow for the “shocking” of those metrics as well as other key income statement and balance sheet items
- Include accounting logic that will appropriately adjust key financial quantities such as earnings, reserves, capital, etc. as a function of the shocked values
- Reflect correlation and causality
- Capture risk interaction (i.e., effects of simultaneous risk scenario occurrence)
- Model risk scenarios in a manner consistent with the views of the SMEs.

In our example, the Company uses Excel to create an RQM that includes five years of forecast income statements and balance sheets with a terminal value included in the final year of projected earnings. The first year of this forecast is identical to the Plan, and the model is separated into several lines of business. Within this Excel file, there is a single sheet (or “tab”) that contains the five-year baseline (best-estimate) forecast of income statements and balance sheets for each modeled LOB. Another sheet aggregates these to form enterprise financials.

An RQM may also include sheets that aggregate the above sheets into business units or legal entities, whichever proves more useful. In any event, the Plan is used for the first year (or whatever the Plan time horizon) and then reasonable extrapolation/growth assumptions are used to forecast the remaining time period through the fifth year. This set of forecast income statements and balance sheets, which is consistent with the Plan (e.g., in the first year), is referred to as the “baseline” or “baseline forecast” in what follows.

The power of the RQM derives from the ability to quantify the effects of shocking or changing key items within the baseline. We leave the baseline preserved in one part of the spreadsheet and in another we capture risk through the scenario estimates of income statements and balance sheets, i.e., we form the estimated scenario financials or “shocked forecast.”

The Company is often interested in risks to sales, claims, expenses and earnings. When a risk affects these items we ensure that the risk interview describes the risk scenario impacts to sales, claims and expenses, either as dollar or percent changes versus the baseline forecast. The shocked forecast is formed by applying the dollar or percent impacts/changes to the baseline and then applying accounting rules (including tax rates and GAAP or statutory rules) and Excel model logic. A scenario value for earnings simply "falls out" of the model as a function of the shocked forecast (scenario values of sales, claims and expenses) and the embedded accounting in the model. Other important details include scenario effects on net earned premium, reserves and capital. Model logic must address these items in terms of formulas that strike a balance between simplicity and robustness.

As a simple example of this "shocked forecast" approach to risk quantification, assume a risk has been analyzed and a particular severely adverse scenario for this risk source was described with the following impacts during a risk interview: a) -25 percent impact, versus baseline, on net earned premium, b) 30 percent increase in claims, and c) 20 percent increase in expenses. Exhibit III shows how these shocks are used to quantify the effect on after-tax GAAP earnings.

Exhibit III

Simplified Example of the Risk Quantification Method (figures in $millions)			
	Baseline Forecast		Shocked Forecast
1. Net Earned Premium	500.0		375.0
2. Claims	200.0		260.0
3. Expenses	100.0		120.0
4. Pre-tax GAAP Earnings [*1*-*2*-*3*]	200.0		-5.0
5. After-tax GAAP Earnings [*465%]**	130.0		-3.3

In the risk interview for the above source of risk, the SMEs described impact to sales and then, based on earned income patterns, estimated the resulting impact to net earned premium. A robust RQM will have corresponding detail on statutory accounting, reserves, capital and key balance sheet items including invested assets and a portfolio yield assumption. Additionally, several years of financials will be included and shocks may in some cases have direct or secondary effects over multiple model years. This approach to modeling is crucial for SVA, and Appendix I provides a more detailed example.

It is critical that the model has the level of detail required to estimate both baseline and scenario values for those metrics described in Section 5.4. This capability must exist in each of the sheets (lines of business) in the model. This is an important consideration during the risk interview process and it is recommended that the resulting quantification is reviewed by the SMEs and revised as need be. By showing the SMEs what the quantification looks like after the risk interview, and allowing for revision, buy-in to the process is relatively easy to obtain.

In many situations the RQM will need to show forecast financials when two or more risk scenarios are in effect. For example, a scenario may model sales as 10 percent lower than baseline while another scenario has sales 5 percent lower than baseline. What is the combined effect when these scenarios occur simultaneously? For ease of communication and calculation one might assume an additive effect (15 percent lower sales in this example) but this is an area of potential customization and it might make sense to have spreadsheet logic that takes a more sophisticated approach in general or only in reference to specific combinations of modeled scenarios.

All risk types may be quantified in the same manner. Even notoriously hard-to-quantify risks such as operational or reputational risks can be assessed in an interview, any described shocks (e.g., to sales or expenses) are captured in the model, and their effect on earnings and other metrics is captured by model logic.

6.2 Stochastic Simulation

The Company has captured many risk sources in the RQM using risk interviews and the scenario approach. Because each risk source is modeled through scenarios with specific probabilities, it is straightforward to simulate the outcome (i.e., a particular scenario) using a random number in a spreadsheet such as Excel.

The model contains macro factors relating to the economy and other risk sources that affect the probability estimates of the various other modeled scenarios including those relating to insurance risk, operational risk, financial risk, etc. Recall that Section 5.3 describes how the states of the macro factors will determine which sets of probability to use for these other modeled risk sources. The macro factors themselves are modeled with a scenario approach but they only have one set of probability estimates. We'll now show how the macro factors can be simulated first, and then, using their simulated states, simulate the other risk sources.

The Company has interviewed SMEs on the economy to determine five risk scenarios (scenarios 1-5) with probabilities of 35 percent, 25 percent, 20 percent, 15 percent and 5 percent. To simulate the outcome of this macro factor we generate a random number, r, from (0,1). We use the following rule: if $r < 0.35$ then scenario 1 occurs; if $0.35 \leq r < 0.60$ then scenario 2; if $0.60 \leq r < 0.80$ then scenario 3; $0.80 \leq r < 0.95$ then scenario 4; and if $r \geq 0.95$ then scenario 5. This rule or mapping only requires that the region or sub-interval of (0,1) associated with a particular scenario has a width equal to the probability of that scenario (e.g., the sub-interval [0.35, 0.60) has a width of 0.25, the probability of scenario 2). In Excel, one may use the "rand" function to generate these random numbers.

The above method can be used to simulate the states of any other macro factors, e.g., pandemic risk or regulatory regime. Once the states of the macro factors are known we are then able to identify which probability sets will be used to simulate the (non-macro) risk sources captured in the RQM. In this manner we are able to capture key relationships (e.g., correlations) across various risk sources.

The Company modeled claims variation in its trade credit insurance business with three scenarios where their probabilities depend on only a single macro factor: the state of the economy. (These are conditional probabilities where the conditioning event is the state of the economy.) Once that state is determined we then know which specific probability set to use. In this example let us assume that the simulated economy state is "scenario 2" and this implies the trade credit scenarios have probabilities 20 percent, 45 percent and 35 percent. We can then use a random digit s from (0,1) to simulate which of these three scenarios occurs. This is done using the mapping concept described above. Note that if this risk source has scenario probabilities that are influenced by more than one macro factor there must be some guidance about which probability scenario set is "activated" when the states of the macro factors point to using different probability sets.[4]

The above procedure is essentially a two-stage simulation: First macro factor states are simulated and then the other (non-macro) risks are simulated. In order to carry out this second step we observe the simulated macro factor states and note which probability sets they "activate" for each (non-macro) risk source. Appendix II provides more detail on this type of simulation.

7. The Weighted Average Metric M

We now introduce a single metric defined as a function of the metrics from Section 5.4. This will enable analysis that takes into account all of the most important risk-reward metrics in a single quantity.

Additionally, it will reflect the relative importance of its components as perceived by the Company.

Rather than using the metrics $m_1, m_2, \ldots, m_7$ directly in a weighted average, we will scale them to arrive at the metrics, $m^*_1, m^*_2, \ldots, m^*_7$. These scaled or normalized metrics will be used to form a (single) weighted average metric, M. This scaling is important because some of the metrics $m_1, m_2, \ldots, m_7$ are percentages and others are dollar amounts; care should be taken to ensure that the relative size differences do not unintentionally inflate the importance of some metrics versus others in a weighted average metric.

The Company decides to normalize or map the range of outcomes for each of the $m_1, m_2, \ldots, m_7$ to a 1-10 scale where "10" indicates superior performance and "1" represents significant underperformance. This mapping is a set of specified, objective rules defined individually for each metric. Then, based on the perceived levels of importance of each metric, the Company reaches consensus on priority weightings for the $m^*_1, m^*_2, \ldots, m^*_7$. Appendix III provides a simple example of this concept.

The result of this exercise is communicated as a single metric M, which is defined as a weighted average of the above seven quantities. Writing the respective weights as $w_1, w_2, \ldots, w_7$ (all positive) we have:

$$M = w_1 m^*_1 + w_2 m^*_2 + \ldots + w_7 m^*_7 = \Sigma\, w_i m^*_i \text{ where the sum is for } i=1 \text{ to } 7, \text{ and } \Sigma\, w_i = 1$$

In Exhibit II several risk scenarios potentially affecting earnings were described. Assuming risk interviews were carried out to determine the scenario impacts, the RQM is able to show the impact to Company earnings. Because the RQM captures all of the $m_1, m_2, \ldots, m_7$ (one of them being earnings) and their scaled counterparts $m^*_1, m^*_2, \ldots, m^*_7$, we are also able to quantify the impact of these scenarios to M. As a result, for the risk scenarios captured in the model we can prioritize or rank them based on:

- Impact to earnings
- Impact to a specific m_k (or m^*_k)
- Impact to M
- *Expected* impact to M (i.e., probability of the scenario multiplied by the impact to M).

Clearly, M contains significant information linking the Company's risk-reward profile to key drivers of stock value. When considering risk response one may analyze the various options by estimating the effect on M. It is possible that mitigation for certain risk scenarios shown in the rankings mentioned above can be addressed in a much more economical way than for others. One should consider the potential for additional (or alternative) mitigation action to improve the risk-reward profile of the Company.

Analysis of potential risk response and strategic decision-making can be improved by using the stochastic simulation approach described in Section 6.2. This allows the various metrics within the RQM to be captured as distributions. Because the metrics are uncertain quantities, being able to model their range of potential results and associated probabilities is a powerful decision tool. It is not precision or predictive power that makes this capability important. Rather, it is that this type of modeling promotes detailed analysis, discussion, and the ability to view decisions through a risk-reward "lens."

8. Informing Strategic Decision-Making

8.1 Risk-Reward Considerations and the Distribution of M

To bring to bear the full power of the RQM the scenario probabilities are used in a stochastic run to produce the distribution of M. This section describes this process and how to apply it to decision-making.

A single stochastic simulation of the RQM consists of these steps:

1. Simulate macro events with an appropriate number of random digits from (0,1).
2. Determine the activated probability sets for the other (non-macro) risk sources in the model.
3. Simulate the scenario for each of the risk sources in (2) with an appropriate number of random digits from (0,1).
4. Tabulate or "record" each of the model metrics, scaled metrics and M, for each modeled LOB and in the aggregate (Company level sheet in the RQM).

After the third step above, the model shows a specific scenario as being in effect for each risk source. If these are labeled numerically then this modeled *state* can be described as a vector where each element is a positive integer that indicates the scenario in effect for the respective risk source.

The Company has modeled three macro factors and 27 other risk sources so a single simulation models financials for a "state vector" (x_1, x_2, x_3, …, x_{30}) where the *n*th element of the vector, x_n, indicates scenario x_n is in effect for risk *n*. As an example, the (simulated) state vector (**2**,3,1,…,**4**) indicates scenario **2** is in effect for *risk source 1* and scenario **4** is in effect for and *risk source 30*.

Through efficient macro coding in Excel (using VBA) one can ensure reasonable run times. Each simulation in the run consists of a (random) state vector and the associated values of the metrics at the LOB and enterprise levels. After completing the run the Company is able to calculate percentiles for all metrics. Note that from a probability standpoint we interpret the results empirically: if a specific metric result (e.g., earnings between $100M and $105M) occurs N times out of large M simulations, we interpret the probability of that metric result as N/M. M must be a sufficiently large number as described below.

We ensure *consistency across runs* by making the run size (number of simulations) sufficiently large. The Company did a run of 10,000 simulations and computed percentiles for all metrics. It then did another run of 10,000 simulations but noticed the percentiles are not as close as desired. In particular, the median earnings value from the first run was 5 percent different from that of the second run. As a result the Company tried larger and larger simulations in each run until it reached the desired level of stability. It was found that including 20,000 simulations in each run is sufficient as it leads to percentiles for all metrics being approximately the same across runs.

Knowing the percentiles of a quantity technically means we know the cumulative distribution function and can therefore determine the probability that the quantity falls in any range or subset of its complete set of outcomes as modeled in the RQM.

The Company is considering two potential reinsurance programs to mitigate its catastrophe exposure: Program A and Program B. In a large run the Company assumes Program A is implemented and determines the distribution of M. Another run assumes Program B is in place and finds the resulting distribution of M. To make sure to have as fair a comparison as possible, we ensure the states of the macro factors in the *n*th state vector in the first run match those of the *n*th state vector from the second run. In other words, the first three elements of the *n*th state vector from the first run are identical to the first three elements of the *n*th state vector of the second run for n=1,2, … ,20,000; this ensures they capture the same macro states.

There are many ways to use this information to help guide the decision of A versus B. Broadly speaking, potential approaches fall into two camps: 1) a calculation is defined as a real number where a larger value is interpreted as the superior choice on a risk-reward basis, and 2) one numerical value is used to assess reward while another is used to assess risk. This second approach has been frequently employed in portfolio allocation decisions as part of the efficient frontier, where candidate allocations are represented in an X-Y plot where a measure of risk is shown on the X-axis and expected reward is on the Y-axis. It is possible to consider three or more "dimensions" in such analysis but this is typically not tractable.

The Company decides to employ two approaches and check for alignment in the implied "better" choice. Method I uses the expected value of M (average value of M over all simulations) and Method II looks at both the median of M and the downside standard deviation of M (i.e., a standard deviation calculation that only includes values falling below the mean value of M).

The run assuming Program A yields an expected value of M of M_A and the run assuming Program B yields M_B. They find $M_A > M_B$ and this suggests Program A as the correct choice according to Method I.

Method II shows "ordered pairs" or "points" (X_A,Y_A) and (X_B,Y_B), where the first element of the pair is the downside standard deviation and the second element is the median value of M. It is observed that while the risk measure X_B is much larger than X_A, the reward measure Y_B is only slightly larger than Y_A. Based on the Company's degree of risk aversion (attitude toward risk-reward trade-offs) they interpret this as also confirming Program A as the superior choice.

If the above two approaches yielded conflicting recommendations then additional considerations or methods would have been necessary. Note that the RQM reflects expenses and several reward metrics so the cost of a proposed reinsurance program is baked into the analysis and can be weighed versus the resulting (expected) benefits (based on various metrics) across a range of normal and stress scenarios. In this manner the RQM can be used to inform a wide variety of "return on investment" considerations.

The Company also uses the above methods to aid its product allocation decisions. The current allocation to the various product lines is up for debate, and the consensus is that some minor changes in allocation should be implemented in the near term. The Company decides a specific LOB is no longer aligned with its business model and will be targeted to have a 5 percent reduction in allocated capital in the next year. It must decide which of the Company's other 10 LOBs will get the 5 percent increase.

The Company runs the RQM 10 times and assesses the results under Method I. In each run it selects a different LOB to get the increased allocation and observe the run results. Because it is a "one-dimensional" approach it is able to rank the 10 alternative LOBs from most to least "deserving" extra capital. The Company also employs Method II to show the various ordered pairs corresponding to each of the 10 options. Through a collaborative and somewhat subjective effort it then ranks these options based on Method II results. The Company decides to focus on the top two LOBs in each method.

Under Method I the two "optimal" LOBs to pick up the slack are the warranty line and the homeowners insurance line. Method II shows warranty and trade credit as the best candidates. The Company essentially has two options at this point. It may either select the single LOB that appeared in the top two spots under both methods (i.e., warranty) or it can choose to analyze the three LOBs represented by employing additional analysis and information.

The RQM may be used to compute a tremendous array of metrics. Other companies may choose metrics different from those above to guide their decision-making. These might include:

- Expected shortfall versus the Plan value of M
- Conditional expectations of M assuming Plan earnings forecast is missed
- The ratio of median M to shortfall versus median at the 5^{th} percentile level
- Metrics similar to the above but based on one of the $\{m_k\}$.

The Company also uses the model to compute a type of risk-adjusted capital. Its approach is to create a metric that aligns with the investor's view of risk and return. Sophisticated investors (e.g., an institutional investor with a very large share of the Company's stock) will often gauge whether a stock is rich or undervalued by projecting a company's future free cash flows. If they are on the mark then they have the "true" valuation of the stock. Risk from their viewpoint is downside deviation from this baseline stream of (projected) free cash flows.

In light of the above view the Company includes a metric in the RQM, company value (CV), which is the present value of future distributable earnings (the equivalent of free cash flows for an insurance company) where the interest rate used for discounting is an estimate of the Company's weighted average cost of capital. In a large run the Company is able to look at the CV in each simulation and calculate its shortfall or excess versus the baseline CV. In simulations with severely adverse events, the scenario CV is much less than the baseline value and the (positive) dollar *shortfall* is significant.

In the *n*th simulation the value Δ_n = (baseline CV – CV in simulation *n*) is calculated and recorded. In a large run we look at the 95^{th} percentile of all the Δ values. This shortfall versus the baseline CV is denoted RAC_{ENT} as it captures a notion of risk-adjusted capital (RAC) for the enterprise. This is not the typical notion of RAC for an insurance company as it does not relate to required capital and does not reflect the risk of failing to meet obligations to policyholders. (The Company manages those risks through other metrics and processes.) This RAC captures downside volatility in reference to the baseline distributable earnings stream and thus reflects the investor's view of risk when investing in the stock. The Company considers the Plan value of Company distributable earnings, DE_{ENT}, as a return or reward measure and defines $R_{ENT} = DE_{ENT} / RAC_{ENT}$. So R_{ENT} is a return on risk-adjusted capital or a so-called RORAC measure.

This measure is used to inform product allocation decisions and supplements other decision tools in the Company's ERM framework. The RQM is able to apply the above approach in relation to metrics for a specific product or LOB "X". This leads to calculation of R_X for each of the LOBs or product lines and they can be ranked on this RORAC measure. If R_X is much larger than R_Y then it may make a case (especially from the investor's point of view) for favoring additional investment in LOB X over LOB Y.

New products are also assessed using the RORAC measure. The Company determines R_{ENT} based on its (actual) current portfolio of products and then does a run of the RQM assuming the new product is now part of the Company's portfolio. This second, hypothetical run yields a value of R^*_{ENT}. Note that if there is any diversification benefit gained by adding this new product then it should show up in this RORAC calculation. If R^*_{ENT} exceeds R_{ENT} then this is a case for strongly considering the product, assuming it aligns with risk appetite (described in Section 8.3). If R^*_{ENT} is less than R_{ENT} then the Company expects that a strong business case would point to other clear benefits.

It is important to keep in mind that while the "one-dimensional" metrics are easy to compare and provide an objective ranking, they necessarily lose some informational content. They typically cannot convey as much risk-reward meaning as a well-chosen pair of metrics. However, using a multidimensional approach does require some subjectivity (e.g., capturing risk-aversion concepts) in assessing superior options.

8.2 A Quantum Approach: Embedding Additional Uncertainty in Modeling

Quantum mechanics is a branch of physics that deals with extremely small particles such as electrons. A key theme of this discipline is that when it comes to this incredibly small realm, nature is inherently uncertain. Mathematical models that accurately capture quantum reality are often based on probabilistic approaches that underscore the concept that there is no notion of "exact" location on this "nanoscopic" scale. The honest risk manager readily admits that the modeled distributions of risk sources are also uncertain and this can be reflected in risk quantification.

Quantitative modeling as described in this paper is clearly not an exact science. If a scenario has an impact of

$10 million in increased sales (versus baseline) then an alternative approach to this type of quantification is to show the scenario impact as a range. For example, instead of the "point estimate" of $10 million we might use the range (8M, 12M), i.e., the scenario describes a sales impact of between 8M and 12M and if this scenario is activated in the model we might assign the exact impact by using a uniform random draw in this interval.[6] Alternatively, we might assume that within the range the distribution is normal, triangular or some other form. This range concept has the benefit of potentially predicting the future value should the risk manifest and also allows for a more meaningful assignment of probability.

Returning to the example of disability claims modeling in Section 5.3 we may replace the point estimates with ranges as follows:

S_1: claims of $9 million or more

S_2: claims of $7 million to $9 million

S_3: claims of $5 million to $6 million

S_4: claims of $3 million to $4 million

S_5: claims of $2.5 million or less.

Because each scenario is an interval or range of claims they can actually occur; this is in contrast to a point estimate that essentially has zero probability for this (basically) continuous quantity. We then have a sound basis for assigning positive probabilities to each scenario and expecting them to sum to 1 because together these scenarios span the full range of possible results and they are mutually exclusive.

This concept has two consequences that may be of interest to a company: 1) a fully continuous risk model, and 2) a powerful way to stress test model assumptions and their relation to strategic decisions.

To run the RQM as a fully continuous model we employ the two-stage simulation of Section 6.2 (and Appendix II) to determine which scenarios have occurred and then, for each scenario that manifests, we randomly pick a value within each of the impact ranges. As mentioned above, an impact range may be specified as having a uniform, normal, triangular or other statistical distribution. In many cases it would technically be a truncated distribution since many distributions, including the normal, are unbounded.

If the traditional, "discrete" (non-continuous) RQM has been used to arrive at a risk ranking, determine a risk response, or to make a strategic decision, one can use this range concept to inject uncertainty into the numerical assumptions that underlie the scenario impact estimates and inform the Company's decisions.

For example, if the Company assumes a particular cost savings in its RQM modeling of an acquisition, one may "perturb" the amount of the savings as well as the timing of the savings to gauge the effect on value and its implications for valuation of the target. Assuming the savings was modeled as $10 million per year beginning in year 3 we can run the model with savings as the range (4M, 12M) and the year the savings begins as (2,4) with some assumptions on the distribution within the ranges. Then we can observe if the acquisition still looks favorable or how much the purchase price would need to be reduced in order to still be attractive.

Another example involves stress testing product allocation decisions. We might stochastically run the RQM to determine that a proposed product (Product X) looks superior on a risk-reward basis when compared to the proposed Product Y. We then apply the above perturbation idea to the specific assumptions and parameters underlying the modeled behavior of X and Y and re-run the model. If the new run reverses the conclusion, i.e., now Y looks superior to X, then we know that the conclusion is very sensitive to these assumptions and additional analysis of the assumptions of supplementary considerations must be made in order to make an informed decision.

8.3 The Role of Risk Appetite

Many interpretations of the term "risk appetite" can be found in guidance from regulators and rating agencies as well as white papers from consulting firms and actuarial bodies. SVA interprets risk appetite as 1) an articulation of the company's business model, 2) a description of the relative degree of comfort with various risk exposures, 3) a set of enterprise-level *risk appetite statements*, 4) related metrics that assess risk-reward trade-offs in light of the risk appetite statements, and 5) risk tolerances and limits at the LOB level that align with the risk appetite statements.

Historically, the definition of a "risk appetite statement" has also been less than clear. SVA takes the view that a risk appetite statement expresses a set of enterprise-level goals and possibly a relative priority of these goals and other competing objectives. In some cases the statement includes a confidence level for goal attainment. Common metrics for a risk appetite statement include earnings, capital, loss exposures, and targeted debt or financial strength ratings.

A Protiviti white paper[5] explains that risk appetite includes articulation of the following:

- Acceptable or on-strategy risks the company is willing to accept because the risk taken is sufficiently compensated
- Undesirable or off-strategy risks for which the company has low or zero tolerance
- Targets, ranges or floors within which management runs the business and undertakes risk including a) strategic parameters including product and M&A preferences, b) financial parameters describing acceptable levels of loss or variability in key metrics, and c) operating parameters including capacity management, R&D investment, safety or quality targets, and customer concentrations.

While the metric M embodies the critical performance goals for a company, it is silent on the subject of a strategy's alignment or misalignment with the company's risk appetite. As an initial screen for strategic decisions regarding new products, ventures and transactions, it is imperative that an assessment of this alignment (or lack thereof) be part of the collection of ERM processes.

9. Risk-Adjusted Compensation and Planning

The risk-adjusted compensation scheme presented here has two benefits: 1) it provides a reward based on absolute performance; and 2) it gives a clear incentive for quality risk-based performance forecasting.

If a compensation approach does not meet (1) then it is possible that it provides a bigger payout for a worse result, possibly with the intention of rewarding superior "risk-adjusted performance." This will often not sit well with the board, investors or a compensation committee. It may create conflicts of interest or lead to incentives that are misaligned with company goals.

Some companies relate compensation to an objective measure of the risk exposure taken in attaining the actual performance level. This is sometimes seen in banks using the value-at-risk (VAR) concept but it is unlikely that sectors outside of investments can find any similar metric that captures the risk exposure experienced during the bonus time horizon (measurement period). For this reason our methodology incorporates risk by rewarding robust and accurate Plan forecasts through the second attribute, (2), above.

These forecasts are done using a scenario approach, in the RQM, and capture the potential volatility of the metrics on which the executive's bonus will be based.

In SVA bonus compensation is based on performance versus Plan as well as the quality of the risk-based forecasting provided during the Plan process. Actual performance relative to Plan is used to define the *present value* of the bonus while the quality of the risk-based forecasting defines the split of this present value between cash payment and restricted stock awards. Each metric that the bonus is a function of must be forecast using a scenario approach as detailed below.

As a simple example, assume in a specific LOB an employee's bonus is based only on sales in his LOB. Further assume their forecast for sales shows a variety of potential outcomes and is presented as 10 intervals for sales results $I_1, I_2, \ldots, I_{10}$ each with a modeled probability p(actual sales in I_j) = 10%. The intervals have "successively larger" values, meaning that all values in I_1 are less than those in I_2 and all values in I_2 are less than those in I_3, etc. The Plan will still state a point estimate for sales perhaps being close to the mean or median value implied by the 10 intervals.

Let the actual level of sales be S and denote the Plan value of sales as Sp. Defining a factor F=S/Sp we then set the *present value* of the bonus for the employee as P = F*target percent*base salary where *target percent* is a fixed percent possibly based on employee grade level. We then determine how to split P into cash compensation and restricted stock awards. If the actual sales level falls into none of the $I_1, I_2, \ldots, I_{10}$ then the bonus is delivered as 100 percent restricted stock, with the present value (restricted stock valuation) methodology set by the Compensation department/committee.

If the actual sales level lies in one of the $I_1, I_2, \ldots, I_{10}$, say I_x, then the percent paid in restricted stock is "distance" defined as 10|x-y| percent, where y is the integer between 1 and 10 such that I_y contains Sp, the Plan value for sales, and |x-y| is the absolute value of x-y. This methodology rewards accurate probability-based forecasting.

In general we will look at several performance measures in the determination of the bonus. Assume an executive's bonus relates to metrics $m_1, m_2, \ldots, m_j$ and they have respective weightings in the bonus formula w_1, w_2, etc. In this case Plan forecasting would include scenario-based risk analysis using the interval approach above for each of the metrics $m_1, m_2, \ldots, m_j$. Of course these projections are provided prior to the start of the bonus's measurement period. By observing where actual values fall in the intervals we may compute the "distance" metric above (the "10|x-y|" calculation) for each metric. These are denoted d_1, d_2, etc. Recall these distance metrics take on values that are multiples of 10 percent between 0 and 1: 0 percent, 10 percent, 20 percent, … , 90 percent, 100 percent.

The above scenario-based forecasting uses the RQM to model risk and volatility around the various metrics that are forecast in the Plan. In the Plan process, there are still the traditional point estimates of the various metrics (the "Plan values") but scenarios show potential variance versus those "best estimates."

For each metric m_i we define a factor showing actual versus Plan performance: f_i = actual value of m_i / Plan value for m_i.

The Compensation department determines appropriate percent weights (summing to 1) w_1, w_2, etc. that capture the relative importance of the various m_i in the bonus formula and define the *present value* of the bonus as F*target percent*base salary where $F = \Sigma w_i f_i = w_1 f_1 + w_2 f_2 + \ldots + w_j f_j$.

The portion of the bonus paid in restricted stock is $R = \Sigma w_i d_i = w_1 d_1 + w_2 d_2 + \ldots + w_j d_j$, with the balance paid in cash. Some companies may decide to cap F in order to avoid very large payouts when performance is far superior to forecasts.

The compensation method presented here always provides a bonus of larger (present) value for better absolute performance and also rewards for the quality of the upfront risk-based forecasting that occurs as part of the Plan process. It may make sense that some of the metrics and weights above capture important enterprise performance goals (e.g., enterprise ROE or earnings) while others may relate to specific goals at the employee's LOB.

This approach to compensation and planning creates strong linkages across the Plan process, employee compensation incentives, company stock growth, and risk-intelligent analysis. This helps to create the ideal culture to embed value-adding ERM into the DNA of a company.

Appendix I: Illustrative Financial Detail in the Risk Quantification Model

	Baseline			*Scenario X in Effect*		
Line of Business Financials	**Year Ended Dec 1 2013**	**2014**	**2015**	**Year Ended Dec 1 2013**	**2014**	**2015**
(in thousands)						
Revenues						
Net Earned Premiums	$ 178,027	$ 175,611	$ 174,168	$ 178,027	$ 156,756	$ 156,522
Fees & Other Income	362	458	480	362	458	480
Net investment income	54,425	49,058	45,371	54,425	48,699	44,534
Amortization of deferred gain on disposal of business	-	-	-	-	-	-
Segment revenues	232,814	225,127	220,019	232,814	205,912	201,536
Benefits, losses and expenses						
- Policyholder benefits (Net of Reinsurance)	121,516	124,157	120,657	121,516	110,826	108,432
Expenses						
- Amortization of DAC and VOBA	484	52	31	484	52	31
- Commissions	23,092	21,987	21,874	23,092	19,632	19,663
- Other Variable Expenses (% of Net Earned Premiums)	24,479	23,708	22,642	24,479	21,162	20,348
- Other Variable Expenses (% of Claims)	9,114	9,312	8,446	9,114	8,312	7,590
- Fixed Expenses	29,266	27,805	27,888	29,266	27,805	27,888
- One-time Expenses	-	-	-	-	-	-
Segment benefits, losses and expenses	207,951	207,021	201,537	207,951	187,790	183,953
Pre-tax Operating Income	24,863	18,106	18,482	24,863	18,122	17,583
Income taxes	8,523	6,174	6,339	8,523	6,180	6,031
Net Operating Income	**$ 16,341**	**$ 11,932**	**$ 12,143**	**$ 16,341**	**$ 11,942**	**$ 11,552**
Realized gains on investments, net of tax	-	-	-	-	-	-
GAAP only income item, net of tax	-	-	-	-	-	-
Net Income	**$ 16,341**	**$ 11,932**	**$ 12,143**	**$ 16,341**	**$ 11,942**	**$ 11,552**
GAAP to STAT Income Differences		(2,831)	(1,010)		(2,563)	(803)
Change in Required Capital (year over year)		(13,814)	(9,504)		(17,525)	(10,190)
Distributable Earnings		**$ 22,914**	**$ 20,637**		**$ 26,905**	**$ 20,940**
Assets						
Cash and Investments	905,773	875,152	834,120	905,773	862,122	813,182
Reinsurance recoverables	12,725	11,554	11,612	12,725	11,554	11,612
DAC and VOBA	3,856	3,804	3,772	3,856	3,804	3,772
Other assets	27,001	10,000	10,125	27,001	10,000	10,125
Segment Assets	949,355	900,510	859,629	949,355	887,480	838,692
Liabilities & Equity						
Future policy benefits and expenses	-	-	-	-	-	-
Unearned premiums	1,443	1,479	1,516	1,443	1,479	1,516
Claims and benefits payable	761,425	723,167	690,374	761,425	714,116	674,310
Other Liabilities	18,001	18,361	18,730	18,001	18,361	18,730
Segment Liabilities	780,869	743,007	710,620	780,869	733,957	694,556
Segment Stockholders' Equity	168,486	157,503	149,009	168,486	153,523	144,136
STAT Segment Required Capital	142,345	128,532	119,027	142,345	124,820	114,630
Capital Swept to Corporate		22,914	20,637		26,905	20,940

The above exhibit shows the first few years of a risk quantification model with the attributes described in the paper. Note that the first numerical column is a set of actual values while the next two columns are projections consistent with the financial Plan. The first three numerical columns are the baseline projection while the next three show the approximated ("shocked") values of the financials assuming scenario X occurs. The actual values for 2013 are, of course, unchanged in the scenario X financials. Such line-level sheets add up to the enterprise-level financials.

To arrive at the scenario X financials one makes use of the risk interview output. In this example it is evident that the SMEs described scenario effects on items including net earned premium, policyholder benefits, and expenses. Basic accounting rules captured in Excel formulas ensure that these "shocked values" will flow through various formula cells to arrive at key metrics including segment revenues, net operating earnings and distributable earnings.[7]

Appendix II: Model Simulation

Given a risk source modeled with three scenarios S1, S2, and S3 with probabilities 60 percent, 30 percent and 10 percent, respectively, we may use Excel to randomly simulate the specific scenario outcome for this risk source by generating a random digit "r" in (0,1) using the "=rand()" formula and employing the rule: 0<r<.6→ S1, .6<r<.9→ S2, and r>.9→ S3.

Note that r falls somewhere between 0 and 1 so we may represent the above procedure with a number line where specific sub-intervals correspond to the three scenarios:

if r in (0,0.6) then S1 occurs						*if r in (0.6,0.9) then S2 occurs*			*r>0.9-->S3*	
0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

The width of the first sub-interval (from 0 to 0.6) is equal to the probability of S1 and similarly the widths of (0.6,0.9) and (0.9,1) are equal to the probabilities of S2 and S3, respectively.

In the RQM we first determine the state of the world by simulating scenarios for macro events such as the state of the economy. The macro events describe any state of the world that would influence our estimates of probabilities for scenarios relating to the other (non-macro) risks captured in the RQM. Then, based on the simulated macro events we are able to identify which probabilities are to be used to simulate the other risk sources.

As an example we will model two macro factors: economy and the fate of a proposed regulation. Assume the state of the economy next year is modeled using four scenarios, and the fate of a proposed regulation is modeled with two scenarios that represent the proposal either becoming law or not becoming law next year. We further assume that for the economy the scenarios have respective probabilities of 0.2, 0.4, 0.1 and 0.3, while the regulation probabilities are 0.4 and 0.6 for "becomes law" and "does not become law."

The following shows how we may then carry out our two-stage simulation.

Generate two random numbers, r1 and r2, from (0,1) to simulate the states of the two macro factors:

Economy: r1 = 0.6218

0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
P(S1) = 0.2		*P(S2) = 0.4*				*P(S3) = 0.1*	*P(S4) = 0.3*			

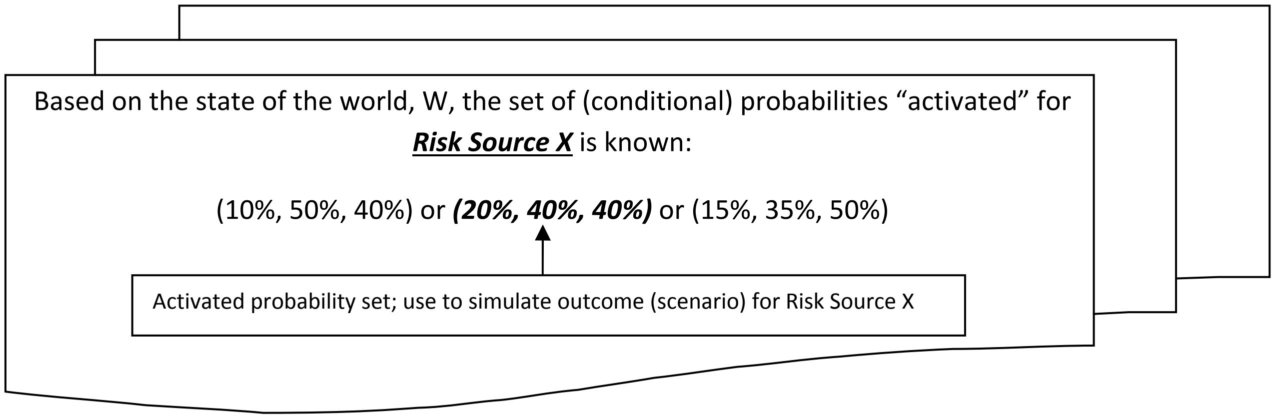
Scenario 3 is simulated for the economy.

Proposed Regulation: r2 = 0.1404

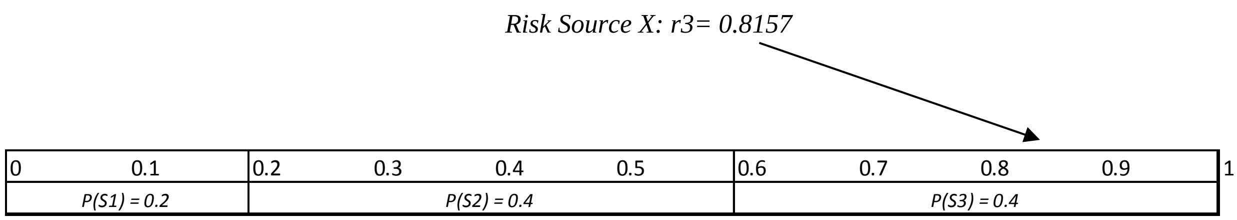
0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
P(S1) = 0.4				*P(S2) = 0.6*						

Scenario 1 is simulated for the regulation: it is simulated to become law next year.

Now in our illustrative RQM we know the state of the world is W ={scenario 3 for the economy and the proposed regulation becomes law}. As a result, we now know which probability sets to use when we then simulate all the other (non-macro) risk sources (Risk Source X, Y, …) in the model:



Simulate outcome for Risk Source X with random digit r3.



Scenario 3 is simulated for Risk Source X.

Simulate all other risk sources in a similar way employing their respective activated probability sets.

Appendix III: Scaling of Metrics and the Choice of Weights

A simple example will illustrate the practical problems one may encounter with metrics of different scale or magnitude.

Suppose a company is focused solely on the following performance metrics:

1. R = ROE a large and capital-intensive LOB
2. I = total company net operating income

R is measured as a percent, and I is a dollar amount. It is known that I will be in the millions.

It is intuitive for management to assign weights to express the relative importance of these two quantities. Perhaps the company regards the metric R as a bit less important than I and feels that 40 percent of overall "success" is captured by R and 60 percent is captured by I. One may naively attempt to form a weighted average metric M = 0.40R + 0.60I as a measure of success or performance.

This has obvious problems due the very different magnitudes of the metrics. Clearly M will be driven almost entirely by I because I is in the *millions* while R is a number very likely less than 1. This will make the achieved value of R (the ROE), for all practical purposes, irrelevant to the value of M.

It is mathematically possible to adjust for this by making the weight of R very large compared to that of I. For example, perhaps the weight of R would be 0.999999 and the weight for I would be 0.000001; this might allow the company to capture something like the 40 percent/60 percent idea mentioned above. This is clearly not intuitive and starts to feel a bit like solving a system of equations.

Scaling or normalizing these metrics avoids the problem and allows for an intuitive approach. The company can set up a rule or mapping that rates the possible outcomes for R on a scale from 1 to 10 where "10" means superior performance and "1" is significant underperformance. A different mapping would rate the outcomes for I on a 1-10 scale. These "normalized" metrics (which assume values from 1 to 10) are written at R* and I*. Such mappings might be defined as metric ranges (intervals) corresponding to each rating 1, 2, …, 10. For example, if R < 0% then R*= 1 and if 0% < R <3% then R*= 2, etc.

Now one may form the weighted average metric **M** = 0.40R* + 0.60I*, and this captures the intended, intuitive opinion of the relative importance of the original metrics and avoids the problem of the relative magnitude of R and I.

Notes

1. This description is found in James Lam's *Enterprise Risk Management: From Incentives to Controls*.

2. The dividend discount model (DDM) is a method of valuing a company's stock price based on the theory that the value of a stock is the present value of its future dividend payments. The valuation under this approach is sometimes expressed as D/(r-g) where D is next year's (planned) dividend, g is the constant growth rate in perpetuity expected for the dividends, and r is the constant cost of equity capital for the company.

3. Insurance companies may include both GAAP and/or statutory earnings among their set of primary metrics depending on company goals. For public insurers it is likely that both are important.

4. This is a minor issue and can be addressed in at least two ways. Assume a risk source has been modeled with scenarios (s1, s2, …) whose assumed probabilities depend on two macro factors, F1 and F2. For simplicity, assume F1 is modeled with two scenarios that are the occurrence or non-occurrence of a specific "major event" (X) next year. Similarly, F2 has two scenarios that are the occurrence or non-occurrence of a (different) specific event (Y) next year. If X occurs we use probabilities p1, p2, … for scenarios s1, s2, … and if Y occurs we use probabilities q1, q2, …. If *both* events occur we may either a) have a pre-defined rule that tells us which "trumps" the other; i.e., define if the p1, p2, … or the q1, q2, …. would be in effect, or b) have a *third* probability set that is activated by this occurrence of both events and it is different from the p1, p2,… and the q1, q2, ….

5. From Protiviti's *Defining Risk Appetite*, available at *http://www.protiviti.com/en-US/Documents/White-Papers/Risk-Solutions/Defining-Risk-Appetite-Early-Mover-Protiviti.pdf*.

6. One might assume that the impact is a uniform random variable on the interval (8 million, 12 million) that can be simulated (in millions) as 8 + 4r where r is a random draw from [0,1] generated in Excel by "=rand()".

7. New-York-based ERM consultant Sim Segal advocates this modeling approach as a solution to many common ERM and risk quantification challenges.

Disclaimer: The views expressed in this paper are my own and not necessarily those of my employer, Assurant Inc.