

Efficient Frontier of New Business

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Abstract

The importance of linking Enterprise Risk Management (ERM) with the strategic planning process has been well recognized in recent years. The current practice to achieve the linkage between ERM and strategy is to validate that the new business sales target is within each business's risk tolerance derived from the firm's overall risk appetite. The risk tolerance is effective in setting the boundary conditions; however it doesn't go further to articulate a strategy that would best balance value creation and capital efficiency. More specifically, the risk appetite framework alone cannot identify a set of ideal combinations of growth rates of the firm's businesses given its unique risk profile. To identify the ideal combinations this paper attempts to create a new tool: an efficient frontier of new business.

The author constructed a hypothetical life insurance company with three lines of business: individual life, individual annuity, and group life. The firm's overall embedded value and economic capital are modeled against a universe of possible growth rates of the three lines of business in a typical three year planning horizon. The modeling considered not only the impact of growth on capital, expense, margin, persistency, and underwriting, it also reflected the natural hedging between businesses such as the mortality/longevity hedging of the life and annuity business, and the long and short guarantees between the individual and group business. The modeling was subject to a number of constraints including minimum capital ratio, target profitability, and the firm's risk appetite. The author will show that an efficient frontier emerged where given a level of economic capital, a certain combination of growth rates of the three businesses resulted in the best value creation.

New business sales are typically set by the businesses leaders in the strategic planning process. They normally have a view of the target business mix and use tools such as capital allocation to steer the company to this target. However, this view is often derived by simple extrapolation of the pricing results and/or understanding of risk diversification of the current businesses. The ERM function can use the efficient frontier of new business to provide a more rigorous analysis of the impact of growth rates on the firm's overall capital efficiency and value creation, hence forming a feedback loop with the businesses in the planning process to optimize the growth strategy.

Introduction

In the 2008-2009 market crash, a number of financial institutions reached the brink of bankruptcy and needed government bailout despite having an ERM practice. What prevented ERM to truly work in avoiding disasters as pointed out by many in recent literature, among other factors, is the lack of linkage between ERM and strategic planning. Perhaps the risky strategies adopted by companies were not fully vetted through the ERM process. A sound linkage between the two goes beyond preventing disasters, it

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improves decision making by helping management better understand the firm's core competency and better balance risk and return for the plan years.

At the core of ERM is a risk appetite framework which articulates the type and level of risk the company is willing and able to take to achieve its long term goals. Risk appetite is typically expressed as risk tolerances and limits in terms of certain risk measures such as capital and earnings volatility. Risk tolerance often refers to the tolerance for each risk category or each line of business on the enterprise level. Risk limits are specified at the individual business level. They are the tolerances at the enterprise level translated to the business operations. The risk appetite framework expressed through risk tolerances and limits acts as guidelines for risk taking activities throughout the enterprise. The risk managers at the business level are responsible for monitoring the various risks and ensure that they do not exceed the risk limits consistent with the overall risk appetite of the enterprise.

But how is it related to the strategic planning process? In a typical life insurance company, the planning process is an annual activity where the company defines its goals and the strategies to achieve these goals in a three to five year horizon. A significant part of the strategy is defined in terms of concrete financial measures such as earnings, capital ratio, or free cash flow generation. One of the most important aspects of the strategy is the sales plan from each business operation. The amount of new business sales is usually carefully planned out by the leaders in each business based on company's overall growth strategy as well as their best assessment of the competitive positions of the product lines and the economic conditions in the planning horizon.

The amount of new sales is generally constrained by a number of internal and external factors including the consumption of regulatory or economic capital allocated to the business. The risk function typically measures the capital requirement by taking a snapshot of the current balance sheet and allocates the requirement down to the business unit and risk type level. The allocation of capital reflects the diversification benefits when combining all the business units and risk types together on the enterprise level. This paints a picture of how capital is currently allocated.

Senior management usually has a view of what business mix they would prefer three to five years down the road given the company's growth ambition and the risk profile of each business. This preference can be expressed in terms of future capital allocations down at the business level. It represents the risk appetite of the company in terms of where it wants to take on risk.

During the planning process, the risk function examines the various risk measures including capital requirement both at the enterprise, the business, and risk type level at the end of the planning horizon taking into account the planned new business. If the risk measures are within the tolerances and limits, the sales plans of the business units receive the green light from a risk perspective.

However, assuming at the end of the planning horizon the company achieves its target business mix, are we certain that it will have the optimal risk and return profile? The target business mix of the company is a major part of the business strategy and yet it is often derived based on linear extrapolation of the current risk and reward relationship. In reality, the ideal business mix yielding the optimal risk profile

for the company depends on many factors including diversification of the businesses, profitability, and the interaction of the two.

Profit is not a linear function of sales. Fast growth can sometimes lead to higher acquisition expenses and lower quality of the business acquired in terms of higher anti-selection or lapses, eroding profitability and increasing risk. Current diversification between the businesses can change in a nonlinear way depending on the relative size of the underlying businesses due to natural hedging of risks. Moreover, only systemic risks can be hedged away such as mortality improvement trend in the life and annuity business. Non systemic risks such as anti selection cannot be hedged. For example, a life and an annuity business of reasonable sizes can provide some offset of systemic mortality risk. However, if too much growth in the businesses leads to anti-selection, then it is possible to have high mortality in the life business and high longevity in the annuity business at the same time. Not only profitability erodes, diversification benefit is also reduced.

Given this dynamics between sales volume, profitability, and risk diversification, and the importance of the target business mix as a core business strategy, perhaps more rigors need to be applied in finding the optimal mix in the strategic planning exercise. Moreover, a rigorous analysis of what combinations of sales from the businesses produce the ideal risk profile provides a more convincing argument to the leaders of the business units as to why it is crucial to target a sales amount. It also more effectively helps enforcing the risk tolerances and limits that are designed to steer the company to its ideal mix.

Technically finding the optimal business mix is similar to determining the optimal asset mix in a typical strategic asset allocation exercise, where a common approach is to find the efficient frontier among all the possible allocations. The allocations on the efficient frontier have the best return for a given risk level. Similarly in new business planning, there is a universe of possible growth strategies with different combinations of sales amount from each business. Each combination will result in a different business mix, a different capital allocation, and consequently a different risk profile at the end of the planning horizon. Unlike assets where risk and return for a given asset class and the correlation between asset classes are a linear function of the amount allocated to a asset class, the risk/return profile for a given business and the correlation between businesses vary in a nonlinear way depending on the growth rate of each business. This paper will demonstrate that despite the additional complexity, out of the universe of possible combinations of the planned sales of the businesses, there exists an efficient frontier of new business. For a given risk level, the combination of sales identified on the efficient frontier would produce the best return for the company.

The rest of this paper will be structured as follows: we will construct a hypothetical company with an individual life, an individual annuity, and a group life business. The company's risk and return measures will be modeled at the end of a typical strategic planning horizon assuming various combinations of sales for the three businesses. Out of these combinations, we will demonstrate that an efficient frontier emerges which optimizes the company's return measure given a certain level of risk. We will then dive deeper into the interaction of sales volume, profitability, policyholder behavior, and anti-selection to gain insights of how it impacts company's risk profile. We will finish with some final comments.

The Hypothetical Life Company

Our hypothetical life insurance company has three major businesses: individual whole life, deferred immediate annuity (DIA) and group life insurance. The whole life product is a regular non-participating whole life product with guaranteed premium and cash value. The death benefit is reduced to half at age 70. The primary distribution channel for this business is the company's own agency force and they have been particularly successful in the wealthy segment of the whole life market. The company has been in this business for about 10 years and the average age of this business currently is about 55. It is the company's biggest business with \$5 billion reserve on the in-force block.

The DIA business is a business the company is trying to grow. It offers longevity protection for older lives with an average issue age around 65. On average a policyholder has a deferral period of 10 years and begins taking annuity payment at age 75. The company believes it can complement the whole life business particularly due to the opportunity of some natural hedging of mortality risk. The company has been in this business for only a year but already has \$1 billion of reserve on its books. The business is primarily distributed through independent broker dealers who with the right incentive can grow sales at a rapid pace.

The group life business is offered to large employers through broker dealers as well. Compared to the individual life business, it is generally re-priced annually with no long term guarantees. The face amount is also generally lower and underwriting is limited. The business tends to be less sticky especially in the current competitive environment where groups can easily switch insurers. The company has been in this business for 5 years and currently has \$700 million of reserve on its book. It is also looking to grow this business since it is regarded generally as a lower risk and higher margin business.

Strategic Planning

The company is currently undergoing its annual strategic planning exercise where it is trying to determine its growth strategy in the next three years. The sales will need to maintain at a certain minimum level to keep the sales channel viable. However since it consumes capital to write new business, the sales amount is bounded by the company's ability to maintain a minimum capital ratio. The company is very well capitalized at the moment and it is in a growing mode. Hence, it determined a rather large range of sales for each of its three businesses, as shown in Table 1 below:

Business	Current in-force In Reserves (\$millions)	Sales Range in the next 3 years in Premiums (\$millions)	New Business Pricing IRR	Liability Duration (Years)
Individual Whole Life	5,000	900 – 2,700	10%	8
DIA	1,000	2,000 – 8,000	9%	17
Group Life	700	500 – 1,500	12%	1

Table 1: Range of Sales

Given the company's growth ambition, each business responds by setting a higher sales goal than previous years in this year's plan. The ERM function in the company is involved to ensure no excessive risk is taken in the plan. In addition, it is asked to advise senior management and business leaders from a holistic perspective what growth plan would result in an optimal risk/return profile at the end of the planning horizon.

The Risk and Return Measure

Many metrics can serve as the risk and return measure. For a life insurance company where the liabilities tend to be long, we chose to use embedded value and the runoff economic capital to measure return and risk.

Embedded value (EV) is defined to be the average of the present values of distributable earnings discounted at company's hurdle rate over a large number of scenarios. For measuring the embedded value for any given growth plan, we project the distributable earnings starting three years into the future for 60 years to allow any material earnings to emerge.

The economic capital (EC) is also defined in the context of the same scenario set and in the same 60 year horizon. For each scenario, we calculate the present value of the greatest statutory surplus shortfall of any future projection period. The EC is then defined to be the average of the worst 1%, or CTE 99, of the present values of the greatest shortfalls.

Thus, the EC captures the insolvency risk over the long run and the EV is the expectation of value of the business over a large number of scenarios and over a long period of time.

The Scenario Set

The scenario set used in the EV and EC calculations is a key assumption. Each scenario is a real world realization of the various risk factors over the 60 year horizon.

The economic risks under consideration are interest rate and default risk. Since the asset portfolios supporting the liabilities are mostly fixed income assets and our chosen metrics are all based on the statutory framework, whether it is distributable earnings or surplus shortfall, the interest and default risk are sufficient in describing the variability of the statutory financials. The scenarios of these two risks and their correlation are calibrated to historical ranges. There are scenarios with sustained low interest rate as well as scenarios with rising rates.

The insurance risks in the scenario set include mortality, longevity or annuity mortality, and catastrophic risk. We separate each of the mortality and longevity risk into two parts: systemic and non-systemic. The systemic part of the risk represents the overall level and trend of mortality of the insured. The systemic risks of mortality in the life and annuity business are negatively correlated, i.e. higher systemic mortality in the life business corresponds to lower systemic longevity in the annuity business. The non-systemic part of the risk represents company specific factors such as underwriting and anti-selection. The non-systemic mortality and longevity are not necessarily correlated with each other but they are both positively correlated to high volume of sales when sales growth crosses a threshold in their respective business. We will discuss more on this point in the next section.

The catastrophic risk captures the effect of pandemic, terrorism, or some other disasters. The group life business is more exposed to this risk due to the company's geographical concentration of large employers in major metropolitan areas.

Modeling and Other Assumptions

Besides product features, the modeling also reflects the following dynamics:

- 1) Reinvestment and disinvestment risk. Assets are initially duration matched with liabilities. However, positive intermittent cash flows need to be reinvested and negative cash flows need to be met by cash inflows from other businesses or selling assets. The financial impact of reinvesting in low interest rate environment and selling in a rising interest rate environment is simulated;
- 2) Dynamic policyholder behavior risk. One of the primary risks in the whole life business is disintermediation where policyholders surrender their policies when interest rate rises beyond a certain level. Not only does the company lose business which takes a long time to breakeven, it is also forced to sell assets at a loss. Therefore, we assume lapse rate increases with interest rate to reflect policyholder's option to choose products priced in a higher rate environment.

Expenses especially acquisition expenses are set consistent with pricing which generates statutory IRR of 9-12%. However, what makes modeling more complex is that profitability doesn't remain constant with sales volume. If growing too fast, at some point profitability could decline and change the risk/return relationship. A McKinsey study conducted in 1994² suggested that there is a maximum sustainable growth rate for life insurance companies and exceeding this rate can "lock it into a slow but relentless spiral of decline".

Productivity of the sales agencies depends on its ability to reach the company's target market segment. If the sales force is too occupied with stretched sales target, they could reach out to customers who are less suitable for what the product is designed. This could result in higher anti-selection or higher lapses in the future. Sales managers would have less time recruiting and training new staff, perhaps leading to lower compensation and higher attrition. In order to help the sales force, the company would have to offer more bonus and benefits to retain staff. Not only acquisition cost can potentially creep up, the company can hurt its reputation in the long run. Growing too fast can also put pressure on the company's back office. Quality of some key functions such as underwriting could suffer as a consequence.

With all the above dynamics in mind, in modeling, we slightly increased certain assumptions only when the sales volume approaches to the high end of the sales ranges.

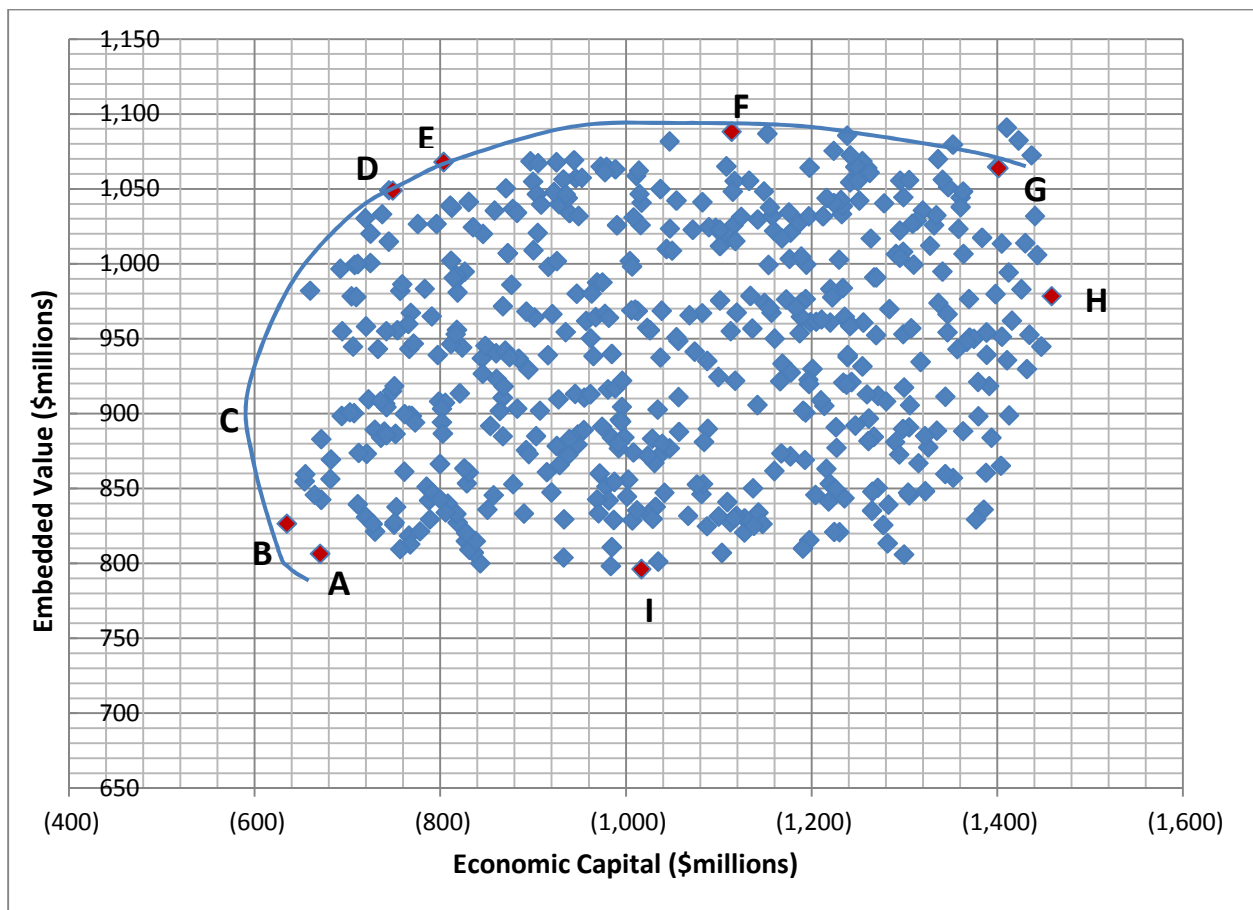
- 1) The acquisition expenses were increased by a few percentages to reflect the added costs of the sales force.

² A. Doman et al., "The Dynamics of Managing a Life Insurance Company", 1994 International System Dynamics Conference

- 2) Positive correlations were assumed between the non-systemic portion of the mortality/longevity and sales volume when it crosses a threshold. This is to reflect higher anti-selection for the individual life and annuity business when sales reach beyond the company's traditional market segment. And quality of underwriting may decline for the whole life business.
- 3) Increased lapse rate for the whole life business. High sales target can lead to sales people go after individuals who are less suitable for the product.
- 4) Increased lapse rate for the group life business. To meet sales target, the company could attract groups who are more price-sensitive and can be lured away to other insurers.

Modeling Results and the Efficient Frontier

In order to gain an understanding of the resulting risk profile of the company after adding different combinations of sales of the three businesses, we randomly selected 500 such combinations in the range defined in Table 1 and calculated the resulting embedded value and economic capital for the whole company at the end of the three years planning horizon. Due to runtime, some of the results of the 500 data points are obtained by interpolation. However, we believe this approximation does not alter the conclusion of this paper. The modeling result is shown in Graph 1 below:



Graph 1: Efficient Frontier of New Business

Each point on Graph 1 represents the EC and EV produced by a unique combination of sales from each of the three businesses. For example, point “A” at the lower left corner on the graph shows that if, in premium, we sell \$4 billion of DIA, \$1 billion of whole life, and \$574 million of group life in the next three years, we would have a capital requirement of \$671 million and an EV of \$807 million.

The curve denoted by “ABCDEFGH” sketches the boundary of these 500 points on the graph. It is the efficient frontier of new business sales. For any given EC or risk level, the point on the efficient frontier represents the combination of sales that maximize EV. The points of interests are “A”, “B”, “C”, “D”, “E”, “F”, “G”, “H”, and “I”. Table 2 shows the sales in premium, EC and the EV corresponding to these points.

Point	Sales in 3 years			EC	EV
	DIA	WL	Group Life		
A	3,938	1,001	574	(671)	807
B	2,998	943	677	(635)	827
C				(600)	910
D	4,187	997	1,463	(749)	1,049
E	5,610	1,023	1,492	(804)	1,068
F	7,316	1,777	1,484	(1,114)	1,088
G	7,628	2,501	1,352	(1,401)	1,064
H	7,836	2,675	1,023	(1,459)	978
I	3,479	1,865	508	(1,017)	796

Table 2: Points of Interests

Point “A” and “B” have low EC and EV. They are the low risk and low return points. They both have moderate DIA and whole life sales and low group life sales. Point “I” has similar group and DIA sales, but much higher whole life sales. This combination appears to generate similar EV compared to “A” or “B” but take on much more risk. Interestingly since there is already a bigger whole life in-force block, this reveals that growing DIA much faster than whole life, as suggested in point “A” and “B” compared to “I”, allows more opportunity to naturally hedge systemic mortality/longevity risk between the two businesses.

From point “A” and “B” and going up the efficient frontier, theoretically there exists a point “C” whose risk is minimized even though our sample size is not big enough to capture such a risk minimizing point.

Point “D” is close to the optimal risk return profile with low EC and high EV. One immediate observation is that the group life sales represented by this point are approaching the highest possible. This reflects the fact that the group life business essentially offers no long term guarantees. The company’s risk exposure is a sequence of one year uncertainty in mortality, interest rate, and default risk which is substantially reduced due to the company’s ability to re-price the contracts on an annual basis. Even a disaster such as a pandemic would not have a long lasting impact.

There is another unique feature about the group business worth discussing. As mentioned before, if sales are too high, profitability can suffer due to higher expenses and lapses. This is true for all three businesses. As for risk, when sales are too high, the risks in the individual businesses also increase due to anti-selection and the long term guarantees in these products. However, this is not true for the group business. Fast growth can erode profitability but the business won't become inherently more risky due to the ability to always re-price. Thus, growing the group life business is a major contributor of the optimal risk profile represented by point "D".

Comparing "D" and "B", they have similar whole life sales, but "D" represents substantially more DIA and group life sales. When adding longevity dominated annuity business and mortality dominated group life business, the risk wouldn't have risen meaningfully if there was strong risk offsetting effect. However, the EC of "D" is actually much larger than that of "B", suggesting that the risk offsetting effect of DIA and group life is not as significant. However, if we compare "D" and "E", the EC of "E" is only marginally increased in spite of having larger DIA and whole life sales. This suggests there is stronger natural hedging between the DIA and the whole life business. Therefore, to allow for stronger risk offsets, matching a risky business with a high but opposite risk works better than with a low but opposite risk. Putting it in another way, sometimes in order to lower the overall risk, the company needs to take on more not less risk in a given business.

Point	DIA	WL	Group Life	EC	EV
Lower DIA sales	3,402	1,059	933	(707)	900
Higher DIA sales	3,630	1,017	922	(694)	898

Table 3: Two points in the simulation with similar WL and Group Life sales

Another example is illustrated in Table 3. When growing within the sustainable rates with the whole life and group sales being roughly equal, adding more DIA sales can even reduce the overall risk of the company even though from a standalone perspective the DIA business is less profitable with substantial longevity risk. This is attributable to the strong natural hedging of systemic mortality/longevity risk between the already fairly sizeable whole life business and the fast growing DIA business.

For point "F" and "G" on Graph 1, not only they have very high group sales, they also have almost doubled the DIA and whole life sales compared to "D" and "E". Surprisingly, their EVs did not grow with the increased EC. The culprit is too much growth of the DIA and whole life businesses. Once sales go beyond a certain point, profitability starts to erode and the non systemic mortality/longevity risks such as anti-selection start to increase and unlike the systemic risks, they cannot be hedged away.

The efficient frontier can also reveal the optimal relative sizes of the businesses with offsetting risk. What also makes "D" on Graph 1 optimal is that the growth rates of DIA and whole life are such that after three years the relative sizes of the life and annuity business allow the most natural hedging of systemic mortality/longevity risk.

Conclusions

The growth plans in the strategic planning process have been traditionally determined by senior business leaders who hold a view on the company's target business mix which is sometimes expressed as desired capital allocations or budgets of its portfolio of businesses. This allocation or budget can be translated to risk appetite which is acting to steer the company to its target mix during the strategic planning years and beyond. However, this target mix of business is often derived from simple pricing results and understanding of risk diversification of the in-force business. The optimal risk/return profile of the company at the end of the planning horizon will depend on the relative sizes of its portfolio of businesses and the complex dynamics between growth rate, expenses, systemic risks, policyholder elections, and anti-selection. In this paper, we proposed a more rigorous analysis: efficient frontier of new business to find the optimal risk/return profile given the company's growth ambition and a set of constraints.

In the efficient frontier of new business constructed for the hypothetical life company, we demonstrated that we can indeed use it to identify a number of optimal combinations of sales from the three businesses, which produced the best embedded value given the company's comfort level of risk. In addition, we showed that we can use this analysis to identify sustainable growth rates or relative sizes of the businesses on the enterprise level given the company's unique portfolio of businesses. We are also able to gain insights into the natural hedging effect between the individual life, group life and the individual annuity business and discover the point at which the natural hedging effect fades and the non systemic risks dominate. An important finding, although somewhat counter intuitive, is that sometimes the company needs to grow a less profitable business with substantial risk in order to lower its overall risk and improve its risk and return relationship.

The efficient frontier of new business can also serve as a powerful communication tool for the ERM function to give feedback to the business leaders on their view of target business mix. Armed with the insights gained from this analysis, the ERM function and the business can work together to refine the growth plan to steer the company towards the optimal risk/return profile in the strategic planning process.