CHAPTER THREE

INTRODUCTION TO THE DISCOUNTED CASH FLOW APPROACH

By Stephen P. D'Arcy, FCAS

INTRODUCTION

The property-liability insurance industry has moved, by choice or otherwise, from a time when there was general agreement on a standard profit margin as a percentage of premium to a time when it is difficult to know what the profit margin truly is or should be. That we have not yet arrived at a point where there is a new consensus should be obvious, for then this book would not be necessary. This chapter aims to provide a simple introduction to the concept of discounted cash flow analysis, which is widely accepted in the field of finance as the proper approach in a variety of applications.

INSURANCE AND THE CAPITAL MARKETS

Assume that you have a significant sum of money available to invest and are considering your alternatives. The array of choices includes bonds of differing maturities and credit worthiness, equities with different dividends and price volatilities and an almost unlimited number of other investments in such categories as real estate, futures, and options. In addition, you have the opportunity to underwrite insurance. Viewed in this manner, it seems apparent that you would invest in the insurance business only if the return on your investment, which would include both underwriting and investment income, were commensurate with the other investment alternatives with similar risk characteristics available to you.

Although it could be argued that an insurance company does not really make the choice each year about whether to write insurance or instead simply to become an investment fund, that is, in essence, the choice that is being made in the capital markets. If the insurance industry is not earning a return high enough to compensate investors with a market level return (that rate paid on investments with similar risk characteristics), new capital will not be invested in insurance and the capital that can be withdrawn from the insurance industry will be. This trend will continue either until the industry has no capital remaining, an unfortunate possibility for Lloyd's of London right now, or until the return improves enough so investors are convinced that a competitive return will be earned.

Mutual insurance companies may appear to represent an entirely different form of financial institution, with a different set of objectives from proprietary insurers.

However, in essence, mutuals can be viewed as simply a combination contract or tied product, in which an individual's investment (as owner) and insuring (as policyholder) decisions are made together. If the cost of insurance becomes too high or the return on investment too low, the mutual will lose its business and its owners. Since the decisions are tied together, though, and the cost of searching for a new insurer and investment may turn out to be higher than searching for a single alternative alone, then the adjustment process to the appropriate level of earnings in a mutual may take longer than in a proprietary insurer. In addition, when a policyholder leaves a mutual company, capital contributed to the firm is, in practice, forfeited. This makes a difference in the investment decision. Also, there is evidence that management in a mutual insurer is less subject to the vicissitudes of a competitive economy than other forms of ownership.

Insurance is an extremely complex financial transaction, with stochastic payment streams that extend over many years, unique financial accounting provisions, a myriad of regulatory requirements, intricate tax regulations, a product susceptible to significant large losses and a market structure unlike any other industry. These factors combine to make it very difficult to measure the returns earned on the insurance business and the risk characteristics associated with these returns. In light of these difficulties, alternative methods for establishing profit margins are frequently used in the insurance business. To the extent that these models ignore investment income completely, they are fatally flawed, as the insurance business, which in general collects premiums well before losses are paid, functions as a financial intermediary and invests funds prior to disbursement. The rate of return earned on those funds is a vital component of the insurance transaction.

To the extent that the alternative models incorporate an historical investment income value, they are usable only as long as the investment markets do not deviate much from their historical levels. In stable financial times, interest rates and the market risk premium (the additional return earned by investment in a portfolio of equities that reflects the risk characteristics of the stock market as a whole) may remain fairly constant for decades. In that case, the profit margins determined based on historical financial values will be reasonably accurate. However, these models will not be appropriate when significant shifts occur in financial markets. Given the degree of volatility in interest rates and market returns recently, a model premised on stability is unlikely to be very reliable.

In this paper I will espouse the use of discounted cash flow analysis to establish the appropriate underwriting profit margins for property-casualty insurance. Discounted cash flow models are one of the forms of financial pricing models that combine underwriting and investment returns and also incorporate risk considerations in establishing the target return on capital figure. Other financial pricing models that have been used to establish underwriting profit margins include the Capital Asset Pricing Model and the Option Pricing Model. However, the Discounted Cash Flow approach is more robust than the Capital Asset Pricing Model, since it is not limited to valuing only systematic risk, and more intuitive, with the parameters more easily calculated, than the Option Pricing Model.

Essentially, the Discounted Cash Flow approach establishes a floor level for the underwriting profit margin at which the Net Present Value of writing the insurance policy is zero. An insurer would not write a policy if the underwriting profit margin were below that level. In a world of perfect competition and information, the industry underwriting profit margin would converge on that value. However, those assumptions are not necessary for the Discounted Cash Flow approach to be useful.

PRESENT VALUE AND NET PRESENT VALUE

The Present Value of a series of cash flows is:

$$PV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}$$

where CF = cash flow
t = time
r = discount rate

The Present Value calculation is generally performed only on the cash inflows from an investment, ignoring the outflows, which are the actual investment made in the project. The Net Present Value calculation considers both the inflows and outflows, and, since most projects require an up-front investment of capital at time zero, the Net Present Value calculation is:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

When using the Net Present Value decision process, a firm should invest in a project that has a positive NPV and avoid any negative NPV projects. Thus, when applying the NPV approach to insurance, an insurer should only write a policy if the NPV is greater than zero.

The standard criticisms of the NPV approach are that cash flows are uncertain, there may be different views as to the proper discount rate and projects are assumed to be independent. The first two criticisms are assumed to be resolved by the market process. Because cash flows are uncertain, they are discounted at a rate that reflects this uncertainty rather than at the risk-free rate. Although there may be disagreement over the appropriate interest rate to use for discounting, as there are differences in opinion in valuing any asset, the market clearing rate, the rate that balances supply and demand, is the rate to use. This assumption works well for widely traded assets, but approximations are needed to value projects that are not publicly traded. The third criticism, that projects are really not independent, is valid. The cash flows included in the valuation of any one project should reflect the impact on other projects as well. However, this is a difficult task to accomplish.

To begin with an overly simplified example, in order to focus on the methodology involved in the NPV approach, assume that you have the opportunity to invest \$100 million in insurance for one year. Your \$100 million investment will allow you to write \$200 million of premiums, on one year policies that are all effective the same day, for a line of business that settles all claims at the end of one year. Thus, there will be no unearned premium or loss reserves at the end of the year. The expense ratio on this business will be 25 percent and all expenses will be paid when the policies are written. If two further unrealistic assumptions are made, first that the losses are known with certainty, so you assume no risk in writing these policies, and second that all capital is invested in risk-free assets, then all cash flows can be discounted at the risk-free rate. The NPV calculation for this decision is:

$$NPV = -S + \frac{(S + P(1-ER))r_f}{1+r_f} + \frac{P(1-ER-LR)+S}{1+r_f}$$

where S = Investment (Surplus)
P = Premiums
ER = Expense Ratio
LR = Loss Ratio
r_f = Risk-Free Interest Rate

If, for example, this business could be written at a 75 percent loss ratio (including loss adjustment expenses), and the one year risk-free interest rate is 7 percent, then the NPV of this business would be:

$$NPV = -100 + \frac{(100+200(1-.25)).07}{1.07} + \frac{200(1-.25-.75)+100}{1.07} = 9.81$$

This calculation indicates that the investor would increase the value of his or her holdings by \$9.81 million by writing this business. Thus, this is an investment that should be undertaken. The discounted cash flow approach can also be used to determine the lowest underwriting profit margin that would be profitable for an insurer by solving for the underwriting profit margin at which the *NPV* is zero. Any underwriting profit margin above that value would have a positive *NPV*. The business should not be written at the zero *NPV* underwriting profit margin, or at any lower value. For this example, the break-even underwriting profit margin is negative 5.25 percent. Thus, the business should be written as long as the loss ratio is less than 80.25 percent.

This example assumed that there was no risk to either the underwriting or the investments. However, the insurance transaction obviously entails risk and that must be incorporated in the calculation. One method of incorporating risk in a financial transaction is to utilize a risk-adjusted discount rate. For example, assume that an investment has an expected cash flow of $100 at the end of one year, and the riskiness of the outcomes is such that the market requires a 12 percent discount rate, as opposed to a risk-free 7 percent rate. In this case, the Present Value of the cash flow is:

$$PV = \frac{100}{1.12} = 89.29$$

The $100 is divided by 1.12, which discounts for both the riskiness of the cash flow and the time value of money. Since we know that the time value of money, for a risk-free investment, is 7 percent, then the adjustment for risk is:

$$\text{Adjustment for Risk} = \frac{1.12}{1.07} = 1.0467$$

CERTAINTY-EQUIVALENT VALUES

The Certainty-Equivalent Value of a risky cash flow is the amount that is just large enough that an investor would be indifferent between receiving the Certainty-Equivalent Value and receiving the results of the risky cash flow. In this example, the Certainty-Equivalent cash flow one year from now is:

$$CEQ = \frac{100}{1.0467} = 95.54$$

This amount, $95.54, is termed the Certainty-Equivalent of the risky cash flow with an expected value of $100 since the investor is considered indifferent between the expected value of $100 and $95.54 for certain, each payable at the end of one year. The Present Value of this Certainty-Equivalent is:

$$PV = \frac{95.54}{1.07} = 89.29$$

This is the same as the Present Value when discounted for both risk and the time value of money simultaneously. The advantage of the Certainty-Equivalent method is that the risk adjustment and the time value of money adjustment are separated, rather than combined. This makes the adjustments easier to understand and usable in situations where the combined method is not feasible.

The Certainty-Equivalent method can be applied to the *NPV* insurance calculation with risk introduced into both the investment and underwriting aspects of the business. First, the insurer might elect to invest in risky, rather than risk-free securities. In that case, the numerator of the second term of that equation would be $(S + P(1 - ER))r$ instead of

$(S + P(1 - ER))r_f$, where r is the expected rate of return on the risky assets. Then, the denominator would have to reflect the risk associated with risky investments. This adjustment is not straightforward, since the initial investment has, in essence, been leveraged, creating greater risk, and therefore requiring a greater increase in the discount rate than the increase in expected return would generate.

However, the Certainty-Equivalent amount of that risky investment outcome is, by definition, $(S + P(1 - ER))r_f$. The financial markets equate the risky outcome with this risk-free outcome, since both represent the current market rates of return. Thus, the second step in the calculation, dividing the Certainty-Equivalent by the risk-free rate, yields the same result as calculated when there is no risk.

Incorporating underwriting risk has a definite effect on the results, though. Returning to the situation in which the expected loss ratio is 75 percent, the expected losses are \$150 million. The Certainty-Equivalent of this value is the amount that would make the insurer indifferent between that certain payment and the uncertain amount that has an expected value of \$150 million. Obviously this amount exceeds \$150 million. Any insurer would gladly pay, for example, \$145 million for certain in lieu of losses that are uncertain but with an expected value of \$150 million. Remember that these payments are contemporaneous, both being made at the end of one year. The Certainty-Equivalent amount depends on the riskiness of the loss payments. The greater the chance of a significant loss in excess of \$150 million, for example from a natural disaster, the larger the Certainty-Equivalent value will be. The adjustment cannot be looked up in a financial newspaper, as interest rates are, as insurance losses are not widely traded assets. An appropriate value for the Certainty-Equivalent would be what payment a reinsurer would be willing to accept at the end of one year in return for the agreement to pay whatever the losses turned out to be at that time. Let's assume that the Certainty-Equivalent value is \$160.5 million, which means that the insurer is indifferent between the risky loss payout value with an expected value of \$150 million and a certain payout of \$160.5 million. In this case, the NPV of the insurance business is:

$$NPV = -100 + \frac{(100 + 200(1-.25)).07}{1.07} + \frac{200 - 50 - 160.5 + 100}{1.07} = 0$$

Therefore, simply by reflecting the riskiness of underwriting in this example, the NPV changes from \$9.81 million to zero, going from an investment that an individual would make to one to which an investor would be indifferent.

CONCLUSION

Applying the Net Present Value approach to insurance pricing creates many additional complications beyond determining the Certainty-Equivalent of the losses. One major complication involves accounting for taxes, as the insurance transaction exposes the investor to an additional layer of taxation that would not be incurred if an investor elected simply to invest capital in securities rather than writing insurance. Also, insurance transactions span many years, so the timing of capital inflows and outflows is not clear cut. Additionally, determining the correct amount invested is difficult, as statutory accounting distorts the economic value of an insurer. These and other difficulties have, to date, hindered the development of a widely accepted financial pricing technique for property casualty insurance, leading to the adoption of alternative techniques that ignore investment income or make an arbitrary adjustment for investment income. Despite the obstacles to developing a financial pricing model, this approach is the only one that can provide insurers with the information they need to price business correctly in volatile financial conditions. Thus, the work goes on to perfect such an approach.