Credit & Surety Pricing and the Effects of Financial Market Convergence

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Abstract:

This paper describes how the convergence of the insurance and financial markets is affecting Credit & Surety insurance. It explains why prior experience has become an unreliable measure of exposure and how this paradigm shift affects the pricing of Credit & Surety products. It proposes a new exposure based method for analyzing Credit & Surety that combines the best practices of insurance and financial market pricing theory. Discussions about its implementation as well as sample calculations for, both primary and reinsurance pricing are included. This paper also discusses the new breed of Commercial Surety bonds that have been recently developed to compete with traditional financial products. Finally, the paper addresses the need for better and more sophisticated risk management techniques for the industry.

1 Introduction

There is a revolution occurring in Credit & Surety. The convergence of the insurance and financial markets is resulting in dramatic changes to these insurance products. There has been an explosion of new forms and some new coverages as insurers attempt to compete with financial institutions. There is new creativity to coverage structures as insurers rethink traditional practices and their applicability in today's environment. Increased competition by financial institutions for business that was traditionally considered insurance is the end result. All of these changes present new opportunities and new risks for the industry. The final outcome must be a revolution in our practices, which affects the actuarial profession in two ways.

First, as our products become increasingly sophisticated, our risk management practices must keep pace. We cannot rely on naïve diversification as much as we have in the past. This became apparent in the past year as unprecedented credit events educated us as to the true nature of our exposures and the weaknesses of our current risk management systems. Most Credit & Surety insurers have since made a concerted effort to improve their credit risk management systems to suit the new environment.

Second, convergence has resulted in competition between the insurance and financial industries, creating arbitrage opportunities between insurance and financial markets pricing theories. Insurance and financial markets pricing theories are very different and can produce completely different results for the same risk. Recent experience has shown that insurers, more often than not, are the losers when arbitrage occurs. Many insurers have witnessed entire segments of their portfolio perform poorly, particularly with regards to their new products. This has caused some Credit & Surety insurers to reconsider what they write and how, and for others to reconsider whether they want to be in this business at all.

The challenges that actuaries currently face in both risk evaluation and risk management are problems that the financial markets have already conquered. So, financial markets theory is the natural place for actuaries to turn for solutions. Over the past few years, financial markets theory has been finding its way into Credit & Surety insurers and reinsurers alike. This paper describes the financial market theories that can be applied to Credit and Surety, the benefits they bring, and how they could be implemented.

2 History & Current Events

Surety is unique in the insurance industry in that it is the only three-party insurance instrument. It is a performance obligation, meaning it is a joint undertaking between the principal and the surety to fulfill the performance of a contractual obligation. The principal is primarily responsible for the obligation and the surety guarantees fulfillment. If the principal fails to fulfil the obligation, then the surety steps into the shoes of the principal to complete the obligation. Surety obligations are divided into two general categories. Contract Surety guarantees the completion of a construction project, such as a road or building. Contract Surety is the largest segment of the Surety market because all government construction must be bonded. All other Surety products are called Commercial or Miscellaneous Surety. This covers a wide assortment of obligations, such as Bail bonds, the delivery of natural gas paid for in advance, the environmental reclamation of a strip mine, or the proper administration of a self-insured Worker's Compensation program. This is a smaller, but rapidly growing, segment of the Surety market.

Credit Insurance is a demand obligation, meaning it indemnifies the insured for un-collectable receivables if there is default. It is commonly used in retail, since many stores do not pay for the merchandise on their shelves until they themselves sell it to consumers. Another common

use is in shipping, since merchandise is typically not paid for until it is delivered and inspected. Note that the majority of the Credit Insurance market is outside the United States. However, the US credit insurance market is growing rapidly. Inside the United States, companies typically use banking products such as loans and letters of credit instead of credit insurance.

Financial Guarantee Insurance is a demand obligation that consists of two distinct categories. The first involves policies that insure against defaults of financial obligations, such as insurance guaranteeing payment of the principal and interest of a municipal bond. The second involves insurance against certain fluctuations of the financial markets, such as insurance ensuring a minimum performance for an investment. Note that in many states, this second category is not permissible because it lacks a valid insurable interest. Financial Guarantee insurance was regulated in the 1980s because of New York State's concerns that the line's rising popularity and enormous policy limits could result in insurer defaults that would swamp the state's insolvency fund. So, New York regulated the line, requiring that Financial Guarantee writers be well-capitalized mono-line insurers that are not eligible for insolvency fund protection. Today, New York's strict regulations effectively control how Financial Guarantees are written. However, the other states and the rating agencies also work to exert their influence over the line, significantly complicating the regulatory landscape.

Closely related to Financial Guarantees is a collection of minor lines that often are treated separately. These include Residual Value, Mortgage Guarantee, Credit Unemployment, Student Loan Guarantees and many life insurance schemes. These are often considered separate from Financial Guarantee simply because they were already regulated when the Financial Guarantee regulations were written. However, it pays to do research when working in these lines because Financial Guarantee regulations are still evolving and different states have different opinions.

Credit Derivatives are financial instruments that pay when default occurs, whether or not the default results in a loss. Credit Derivatives are financial products, and as such do not require that a valid insurable interest exist. The most common Credit Derivative pays out on default the notional amount of a bond in exchange for receipt of the actual bond, so the loss is the difference between the notional of the bond and the market value of the underlying security. Credit Derivatives can be quite complex. They do not require underlying securities, so they are ideal hedging instruments for credit insurance risk. They also can be constructed to have additional triggers, such as a rise in the price of gas or a fluctuation in currency rates.

Traditionally, Surety Bonds, Credit Insurance, Financial Guarantees and Credit Derivatives have been distinct products. In the past few years, the boundaries between these products have blurred considerably. They are now part of a continuous spectrum of products that insure financially related obligations. They start with Surety, where the insurer is entitled to be very active in managing the insured risk, and end with Credit Derivatives, where the insurer is entirely passive. This blurring has enabled products from different financial sectors to compete with each other. It also permits insurers to tailor make products of varying insurer supervision, fiduciary duty, and regulatory control.

The biggest development in the past few years has been the explosion of the Commercial Surety market. Commercial Surety products traditionally have been relatively simple bonds with modest limits, such as Bail bonds and License & Permit bonds. But, recently they have evolved into sophisticated financial products with complex triggers and limits of hundreds of millions of dollars. One area that has generated increasing activity in recent years has been the use of Commercial Surety to mimic other types of financial instruments. In many cases, the Commercial Surety obligations tread very close to Financial Guarantees as defined by the New York State Department of Insurance. For this reason, the insurance industry has begun to call them "Synthetic Financial Guarantees."

The simplest financial market application of Commercial Surety involves using bonds to secretly credit enhance financial products. For example, banks frequently are involved in the short-term leasing industry. Banks typically securitize their lease portfolios, paying hefty rates if the portfolio contains many poor or mediocre credits. But, in this scenario, the bank requires the lessors to purchase Surety bonds that guarantee that all lease payments will be made. This enhances the credit quality of the portfolio, dramatically reducing the risk of loss. The bank now pays significantly lower rates for the securitization. This ultimately is cheaper for the lessees because insurers charge less than the capital markets to assume this risk, allegedly because insurers are able to wield influence over the risk. The insurance products would appear to be standard Lease Bonds, except for the fact that the ulterior motive is to credit enhance a financial instrument.

The applications can get significantly more complicated. But, part of the additional complication is due to the fact that knowledge of the intricacies of insurance law is very important. Whether the policy is enforceable in the manner for which it is intended depends on much more than just the wording of the policy. For example, suppose Eastern Power Company sells one year of electricity to Western Power Company for $100mm, to be paid in advance on January 1, 2003. Simultaneously, Western Power sells the same one year of electricity to Eastern Power for $105mm, to be paid in arrears on January 1, 2004. The two contracts cancel each other out, resulting in no effect other than the difference in payment terms. Western Power also purchases a Surety bond that guarantees that Eastern Power will pay the $105mm they owe. What this deal effectively reduces to is that Western Power has loaned Eastern Power $100mm at 5% and convinced an insurer to take the default risk. Here, a lack of full disclosure to the insurer would be very material in the advent of a loss. Surety is a performance obligation and the Surety could argue that the performance of the underlying obligation was never intended, so they owe nothing.

Commercial Surety has dramatically grown in popularity. Commercial Surety is now being used to secure letters of credit, to secure bank lines, and to enhance credit. Favorable historic loss ratios and limited abilities to grow other parts of the book has created the incentive for most major Surety writers to grow their Commercial Surety books. Furthermore, clients have flocked to Commercial Surety because they offer straightforward financial protection in a favorable regulatory environment. The ability of the market to arbitrage the various rating methodologies has also been a key factor.

The ability to use Commercial Surety for arbitrage purposes has revealed striking differences in how the various markets price their products. For example, it is not unusual for insurers to see Commercial Surety bonds that sell for a quarter of what Credit Derivatives sell for, with nearly identical terms. The problem that causes this discrepancy is that insurers generally do not differentiate risks as well as the financial markets do. Insurance pricing focuses primarily on making sure that the overall rate is adequate while financial market pricing focuses more on risk differentiation. This difference can be best demonstrated via the data each industry uses for establishing rate relativities. Insurance rate relativities are generally based on the company's own limited experience while financial market rate relativities are based on long periods of rating agency (industry) data. The larger data set enables the financial industry to calculate relativities that have a greater resolution than what the insurance industry calculates, creating the arbitrage opportunity. The result is the fact that insurers typically overprice short term / good credits and underprice long term / poor credits, compared to the financial markets.

Recent events, particularly those involving the use of Commercial Surety bonds to mimic Financial Guarantees, have gone a long way toward dulling the popularity of these new products for both insurer and insured alike. Several insurance companies are currently addressing severe anti-selection problems in their portfolio. Several others are in court dealing with the fact that insurers and financial institutions have different customs and practices for their products – a fact that has significantly confused their customers. Insurers have reacted to these problems by either pulling out of the Credit & Surety market entirely or

by significantly curtailing their Commercial Surety writings. But, these problems have not killed the demand for Commercial Surety bonds, and the reduced supply probably will not last long.

3 Credit Risk Management

Credit risk management practices of the financial markets have always been more advanced than that of the insurance industry. Until recently, insurance credit risk management has been largely limited to purchasing reinsurance and managing the book to a targeted loss ratio. In contrast, credit risk management in the financial markets is a wide collection of tools. The similarity of Credit & Surety insurance to financial markets products permits the insurance industry to borrow financial market's risk management techniques. Several techniques transfer particularly well.

The first requirement is to make sure that the portfolio is not excessively exposed to any single credit event. The most cost-effective way to do this is by implementing concentration limits by counter party, industry sector and country. These concentration limits must take into consideration the quality of the credit risks. Since poorer credits have higher frequencies and severities during economic downturns, it is important to have the concentration limits be lower for poorer quality risks. In this way it is possible to keep the expected loss for an event relatively constant throughout the portfolio. It is also important to take correlation into consideration when establishing concentration limits. Setting all of the concentration limits lower than an independence analysis would suggest, or establishing a tiered system of concentration limits can achieve this.

Since the portfolio and the economy are both always changing, it is also important to have mechanisms for repositioning the portfolio over time. Three methods are commonly used. First, it is important to manage bond durations by counter party, industry sector and country. An insurer who manages their durations well can progressively reduce their exposure to a deteriorating segment of the business by not writing new bonds. This is known as an "orderly exit." Second, covenants can be placed in the contracts that require the insureds to post collateral if certain thresholds are breached. These thresholds can be established to generally coincide with the deterioration of that part of the portfolio, keeping the total exposure under the concentration limits and withdrawing the exposure while the risks are still solvent. However, covenants are losing their effectiveness because they are becoming too popular of a solution, contributing to the trend of marginally solvent companies crashing dramatically into bankruptcy. Third, the partial derivatives of the expected loss relative to changes in various economic indices measure the sensitivity of the portfolio to macroeconomic events. In financial market risk management theory, the partial derivatives are known as the "Greeks" because a particular Greek letter typically represents each distinct partial derivative. Analysis of the Greeks assists insurers in managing their risk to macroeconomic events, such as a rise in interest rates.

Insurers are also getting better at actively managing their credit risk profile with reinsurance, retrocessions, credit default swaps, and other financial instruments. This is a powerful technique for managing the portfolio because it is able to change the risk profile after the fact. But, it is more difficult to implement in practice than it appears. Reinsurance is becoming increasingly expensive and credit markets are not that liquid. Thus, the required credit protection is often not affordable or available. This is because the names that have exhausted the credit capacity of the insurance company have also generally exhausted the credit capacity of the other credit markets as well. Furthermore, the insurer always runs the risk of having the reinsurance/swap cost more than the premium the insurer collected. For this reason it is important that the pricing of the insurance product specifically incorporate the cost of any risk transfer or hedging activity. Also, those using hedges must note that they are often inefficient. The trigger for the insurance policy and the trigger for the hedge are usually

slightly different. This inefficiency must be factored into the hedge and the premium charged for the insurance product if hedges are being used. Finally, reinsurance and hedge transactions are usually conducted with reinsurance & financial institutions. This is a problem because most reinsurance & financial institutions are themselves peak credit risks in the insurance portfolio. The insurance company must also manage what would happen if the counter party goes bankrupt, causing the reinsurance or hedge to fail.

While substantial similarities between insurance companies and financial institutions enable the insurance industry to borrow liberally from financial risk management theory, there is also an important difference to note. For financial institutions, credit risk is highly correlated and dominates the portfolio. Credit risk management practices focus on fencing in this risk. For insurance companies, credit risk diversifies with the other risks that the insurer writes, such as CAT (Catastrophe) covers. Insurance credit risk management can take advantage of this diversification.

Credit risk management in financial institutions focuses on fencing in the potential damage from highly correlated losses. Periodically, defaults occur in a highly correlated way and this is known as the credit cycle. The cycle begins when bad economic news causes a large amount of money to flee the credit markets, resulting in the cost of credit to suddenly and dramatically increase. This causes many companies that were only barely surviving to fail simultaneously. Their failure in turn adds additional financial stress to their creditors, customers and suppliers, causing more failures. The failures ripple through the market, taking out many of the financially weak and some of the financially strong. Credit cycles often center about the specific countries and industry sectors that generated the initial bad economic news. Financial risk management is heavily focused on quantifying the amount of loss the institution is potentially exposed to when credit becomes scarce, causing counter-parties to go bankrupt. It is managed in a manner very similar to the way insurers manage earthquakes.

When insurers manage the credit cycle, they have the added luxury that the credit cycle and the underwriting cycle are natural hedges; that is, they anti-correlate. Both are driven by the availability of capital. When capital is scarce and credit dries up, counter parties go bankrupt and financial markets suffer catastrophic losses. However, when capital is scarce and capacity dries up, insurance premiums rise and insurance markets are at their most profitable. The opposite relationship holds when capital is plentiful. As a result, it is possible for insurers to implement a risk management strategy that integrates credit-related products, other insurance products and the investment portfolio results. This strategy aims to immunize the portfolio by balancing the effect of the credit and underwriting cycles. Currently this idea is more theory than practice, although several companies are implementing risk aggregation models that would permit them to implement such a risk management strategy. These models are effectively detailed DFA (Dynamic Financial Analysis) models of the corporation and all of its parts.

It is often thought that the only goal of risk management is in making sure that the company survives to see tomorrow. But, an equally important goal is to be able to determine which products add value. Traditionally, "value" has been measured via profit & loss reports. But this approach is really only able to identify which products are unprofitable or under-performing relative to historic norms. It is not able to reliably identify the products that create a drag on the stock price. In order to identify these products, a system that measures a product's contribution to the ROE (Return on Equity) is required. Several companies are experimenting with such a measurement system.

The reason most insurance companies today are not able to identify the products that decrease their ROE is because most companies do not have the risk measurement systems capable of quantifying the amount of capital each risk requires. The question becomes particularly complicated for Credit & Surety products since these have many risk characteristics that the other lines can often downplay, such as correlation and hedging

activities. The most immediate obstacle is the fact that some companies do not yet capture the information required for such an analysis. The new risk management techniques are extremely data intensive, and sophisticated inventory systems are required to implement them.

The risk profile for Credit & Surety is extremely complicated. It is easy for the insurer to accidentally take on an unacceptable amount of risk, requiring the utilization of an unacceptable amount of capital. It is also easy to make simple mistakes, such as paying more for reinsurance than the amount you collected, quickly dooming the insurer to certain loss. Measuring profitability requires understanding how much capital the risk requires relative to the profit that the risk generates and including the effects of all of the reinsurance and hedging purchased. This comparison can only be done within the framework of an advanced risk management system.

4. Pricing

4.1 Traditional Approach to Pricing

Credit & Surety has always been viewed as a form of property insurance because it shares the defining characteristics of property business. Most important is the fact that the severity distribution is relative to the limit of insurance. But, it also shares numerous other characteristics: there is a very wide variation in the limits commonly purchased (several orders of magnitude), Credit & Surety is subject to large shock losses, as well as catastrophes (known as the "loss cycle").

However, Credit & Surety does have distinguishing characteristics of its own. First is the fact that the loss cycle (the catastrophe) is not random, but appears at eight to twelve year intervals. This means that the way the loss cycle is incorporated into the pricing is different than regular property catastrophe pricing. Second is the fact that Credit & Surety underwriting requires more judgment than other types of property underwriting because insurers understand the causes of fire much better than the causes of insolvency. As a result, there can be enormous variations in experience from one insurer to another as underwriting practices differ. Third is the fact that Credit & Surety is "underwritten to a zero loss ratio." This does not mean that insurers have years without losses. What it implies is that the goal of Credit & Surety is to actively monitor the risks and to proactively respond to problems in order to prevent losses from happening. As a result, Credit & Surety underwriting focuses primarily on reducing loss frequency (i.e. default risk). Therefore, when the loss experience of two primary companies differs, most of the difference is in their frequencies.

Because of the similarities between Credit & Surety and property, most actuaries approach Credit & Surety pricing in the same manner as the other property lines. Both experience rating and exposure rating methods are commonly used. The benefit of having two different methodologies is that when the assumptions underlying one methodology fail, then the other methodology can generally be relied upon. But for Credit & Surety, the assumptions underlying both methodologies are equally questionable. Thus, Credit & Surety pricing has always been somewhat of an art form. The fact that Credit & Surety pricing requires this judgment is a particular weakness during a soft market, because it is not unusual for market pressures to compromise actuarial judgement.

Experience rating is theoretically appealing because it calculates the correct rate for a portfolio based on its own experience. This means that we do not need to make many assumptions about the applicability of the data when we price. But experience rating does have weaknesses. Primarily, it is a demanding methodology with regards to data quantity and quality. It requires reasonably extensive data, restricting its applicability to larger volumes of business and longer time intervals. It also requires reasonably good quality data. Shock

losses need to be massaged to match long-term expectations and the loss cycle needs to be carefully built in. But shock losses and loss cycles are rare, so actuaries must chose between long time periods full of ancient data or short time periods that lack credible experience. The adjustments required to get around these problems are judgmental and threaten the credibility of the analysis. It is unfortunate that experience rating's major weakness is Credit & Surety's major characteristic.

Exposure rating is theoretically appealing because it permits the use of industry experience. This permits the experience of shorter time periods to be more credible. Furthermore, the way Credit & Surety is underwritten means that industry severity data should not need to be manipulated when applied in an exposure rating. Only the frequency estimates should require judgement. However, both are difficult to calculate in practice. First, sharing of data is not common in the Credit & Surety industry. There is not a lot of experience available, and those who do have books large enough to have credible experience want to use this as a competitive advantage over those who do not. Furthermore, when experience is shared (for ex. Surety Association of America (SAA) or reinsurers), it usually is without the corresponding exposure values. So, it is difficult to compile industry data. The industry also does not have a uniform standard for recording data. There are a wide variety of definitions for "loss" and an even wider variety of definitions for "exposure." So, if and when one is able to compile a collection of industry experience, it does not have quite as much meaning as we would like. This reduces the selection of exposure rating parameters to an act of judgement.

Historically, experience rating has been the approach used by insurers when reviewing the rate adequacy of their book and by reinsurers when pricing reinsurance. This is because the lack of credible exposure rating parameters is generally a greater problem than the judgement required for experience rating. Primary companies have always used some form of exposure rating for pricing individual insureds, but they seldom even look at this data when reviewing the profitability of their entire portfolio. This is partly due to the fact that exposure rating systems typically require so many soft factors that the results are unsuitable for the purpose of portfolio analysis. Portfolio reviews are almost exclusively performed via experience rating. This is in stark contrast to the financial markets that rely heavily on the exposure rating when performing portfolio analyses.

4.2 Introducing Financial Market Theory

Combining traditional exposure rating with modern financial markets pricing theory results in a Credit & Surety pricing methodology that is considerably more flexible than traditional insurance pricing methodologies. This development is made possible by the fact that insurers and reinsurers are now adopting financial markets risk management methodologies, making new data available for pricing. The mixed approach combines the best practices of both theories.

The characteristic that most distinguishes financial markets pricing theory from insurance pricing theory is the way exposure is measured. Credit & Surety insurance currently follows the property tradition by using the policy limit or a PML (probable maximum loss) as the exposure base. The financial markets use an exposure base that is significantly more sophisticated. As with insurance, it starts with the policy limit modified to reflect the value realistically exposed. This effectively gives us a PML. The financial markets then further modify the quantity to reflect the credit rating of the counter party. Better credit ratings have lower losses with respect to the amount exposed. Finally, correlation is introduced to get the correct measure of aggregate risk.

The goal of the financial markets approach to exposure measurement is to precisely quantify the expected loss of a risk with as little subjective judgement as possible. This would appear to be impossible when you consider all of the qualitative risk assessments that must go into

the analysis. For this reason, the financial markets have established the use of public credit ratings as a way of validating the judgement of the analysts. The credit ratings contain all of the judgmental factors so that the other components can be entirely objective. Making the credit ratings public knowledge permits analysts to be able to compare their assessments with those of other analysts and ensure that their assessments are not wildly different from the rest of the market. The consistency in approach and public application compensates for the necessary subjectivity of financial markets pricing. Credit & Surety pricing could benefit from this approach towards pricing. The change would also enable insurers to incorporate their Credit & Surety exposures into their credit risk management framework, giving them a more complete picture of the risk their company has to stress from the financial markets.

However, there are differences between the two markets that hinder the combining of their theories. Two important differences are the fact that insurance often has triggers that differ materially from simple financial default and insurers have significantly more control over the risk. For example, if a construction company defaults, then the Surety will look for ways to keep projects going forward either by loaning money to the contractor or by finding a replacement contractor. The loss will emerge over time according to decisions the Surety makes about how to handle it. It is even possible for default to ultimately result in no loss at all. On the other hand, in the financial markets, default results in payment according to the obligation. Therefore, while the risk profiles of insurers are strongly correlated with the risk profile of the financial market, they are also markedly different.

Another important difference between insurance and financial markets theory that must be reflected is the fact that insurance companies regularly review their base rate while the financial markets do not. Financial markets price each risk separately, but they do not review the portfolio in total and calculate base rate changes. Financial markets pricing theory focuses more on differentiating risks than on making sure that the aggregate return is adequate. In financial markets theory, the company does not attempt to set the average return but rather lets market forces dictate what that return should be. It is assumed that the rate is adequate because market forces will push all unprofitable business into the lower credit ratings. The goal then is to provide the risk differentiation information required to make the market operate efficiently. In order for this theory to be useful to insurers, the financial market's ability to differentiate risks must be married with the insurance market's ability to measure whether the correct aggregate premium is collected.

The differences between insurance and the financial market can be incorporated into the pricing by using the financial markets pricing as a benchmark and adding a deviation factor for the insurance differences. In its most general form, the expected loss as an insurance product can be represented as follows:

Insurance Policy E[L] = f(Financial Instrument E[L], α)

Here, α represents a factor measuring the differences in the loss triggers and other advantages of writing insurance. The value for α should vary with the type of product being modeled. The function used to apply α could model expected loss in total, frequency and severity separately, or some variation thereof. Refer to the Appendix 1, Page 2 for a simple example.

Establishing a value for α that is appropriate for the insurance product is critical to this exercise. Two main approaches are possible. The first is to use the historical data of that product and to back into the α's that reconcile the experience and benchmark. In other words, estimate the expected loss as a financial product (using historical exposures and ratings at a given point in time) and compare that number to historical surety losses developed to ultimate for the same time period. The second is to establish α judgmentally by comparing that

product to others for which α is known. For example, if $f(E[L],\alpha) = \alpha E[L]$, then a general rule of thumb is: For high risk Commercial Surety (bonds that act as financial instruments), α is one. For very low risk Commercial Surety, α is close to zero. For Contract Surety and Credit Insurance, α is somewhere in the middle.

Credit Default Swaps are the preferred benchmark because Credit Default Swaps are standardized and actively traded on the open market. This permits the insurance company to see what the market's consensus opinion of that credit's risk is without having to adjust the data for specialized terms and conditions. This is called the "price discovery process." The riskiness implied by the market price can then be compared to the riskiness as measured by the commercial credit ratings and the riskiness as measured by the insurer's own credit models. Another benefit is that the market reacts to information faster than any other credit rating process. This makes the pricing more responsive to current events and the ability to keep up with the market prevents arbitrage opportunities. Finally, Credit Default Swaps are becoming an increasingly popular tool for hedging credit risk exposures. Using Credit Default Swaps as the basis for the pricing and risk management process makes the hedging calculations easier.

The calculations can be accomplished with varying sophistication. This paper presents a simplistic approach that can be applied to any Credit & Surety product. The calculations in this paper will be based on the following definitions:

Notional Amount = Exposure

This is the sum of all of the bond limits for that principal. (Contract Surety sometimes uses Work on Hand.) This amount goes by many names, including: Aggregate Bonded Liability, Aggregate Penal Sum, and Un-exonerated Bond Amount.

Default Rate = Probability of Default as a Financial Instrument

Default means that the company was not able to continue servicing its debt. The default rates for securities are based on their credit ratings from credit rating agencies such as Moodys and Standard & Poor. Companies that are un-rated by the rating agencies can be rated using computer programs such as KMV rating and Moody's Risc Calc. Moody's Idealized Defaults Rate table is presented in Appendix 1, Page 3 of this paper.

Please note that we used a somewhat narrower definition of default rates in this paper. Moodys and S&P, at times, use a broader definition of default rates depending on the purpose of the exercise.

α = Probability of Loss as a Surety Product / Probability of Default as a Financial Instrument

The loss triggers for surety are stricter than those assumed in the definition of default for a pure financial instrument. For example, a missed interest payment or a restructuring of debt would trigger a financial default. On the other hand, the contractor or the commercial surety principal has to be bankrupt for a surety default to take place. Therefore, a relativity factor needs to be applied to get the correct frequency for the product being priced.

1 - Recovery Rate = Severity

One minus the recovery rate equals the expected severity. It is stated as a percentage of the exposure. The recovery rate should be based on the type of bond (Contract, Low Risk Commercial, Workers Compensation, etc). Note that recovery rates are correlated with default rates – poor quality credits have both higher frequencies and higher severities.

Expected Loss = Notional Amount x Default Rate x α x (1- Recovery Rate)

This is the expected loss for the principal. Including α permits us to reflect the bond's unique characteristics in the pricing. Omitting α gives us the expected loss for a comparable credit default swap.

When applying these formulae for risk management purposes, it is important to take into account the correlation within and between industry sectors. Correlation also exists between regions/countries and between Credit & Surety insurance and the company investment portfolio. It is important to include all sources of credit risk in this calculation, including all corporate bonds that your investment department has purchased. There are several methodologies to perform this calculation. Two are frequently used:

a. Downgrade the credit ratings of securities in sectors that have exceeded specific concentration thresholds. For ex: 10% concentration → one-notch down grade, 15% concentration → two-notch down grade, et cetera. This gives correlation a cost (the cost of the required hedge) enabling underwriters to manage correlation within the pricing formulae and creating a disincentive for adding more of this risk.

b. Create a simulation model that accurately reflects the characteristics of the original portfolio, including correlation. Note that many different options exist for the design of the correlation engine.

Finally, it is important to note that pricing is not independent of risk management. The outputs of the pricing exercise are the inputs for the risk management system. For this reason, it is important to design any pricing system so that both needs are met. In general, the output from the pricing exercise should contain the following:

- Average portfolio default rate and rating
- A distribution of default rates (or ratings)
- Average notional amount
- Expected loss
- A distribution of losses
- Expected excess loss
- A distribution of excess losses

4.3 Primary Insurance Application

Most primary companies use industry based rating tables for small risks, such as the Surety Association of America's Surety Loss Cost tables, and their own proprietary rating systems for large risks. Increasingly, these proprietary systems refer to the credit rating of the risk being insured.

One can use a modified credit default swap pricing methodology as the approach for pricing bonds. Consider the example of an insured that wants to insure a $25mm receivable from a power company, payable in 5 years. (Appendix 1, Page 1) It is a high-risk bond that behaves very much like a financial guarantee. Suppose the power company has a Moody's credit rating of Baa3. Referring to Moody's Default Rate table, the five-year default rate for Baa3 credits is 3.05%. Since the insurance policy behaves similarly to a financial guarantee, α is chosen to be one. The expected loss is thus $686K. Reflecting five years of investment income gives us a discounted expected loss of $538K.

4.4 Proportional Reinsurance Application

Both quota share and surplus share reinsurance are common in Credit & Surety. Quota share reinsurance is the easiest to price since cedants are able to provide all of the pricing information listed in section 4.2. The most difficult part of the quota share pricing exercise is in modeling the commission terms, since they generally are a function of the treaty results. When computing the appropriate aggregate loss distribution, it is critical to accurately reflect the correlation within the portfolio. Surplus share reinsurance is more difficult to price because the ceded amount varies with the bond limit. A standard way to approach this is to restate the exposure profile to reflect the surplus share terms and to then price the treaty as if it were a 100% quota share.

It is increasingly common for reinsurers to request a complete listing of all of the credits in the portfolios so that the reinsurer can incorporate the information in their credit risk management system. This detail of data also enables the reinsurer to independently assess the adequacy of the primary company risk evaluation and management process. Lead reinsurers typically review the historical accuracy of the cedant's pricing relative to the results that insurer experienced. The reinsurer calculates a cedant specific α in addition to the $\alpha's$ it uses for the products to adjust for the primary's underwriting quality. The pricing then proceeds as described above.

4.5 Excess Reinsurance Application

The credit default swap approach can also be an effective way to approach the pricing of excess reinsurance. Consider the example of a portfolio presented in Appendix 1, Page 2. Excess reinsurance covers losses occurring this year, so the term is always one no matter what the length of the underlying obligations are. (Beware of the optional tail coverage!) We look up this product in the pricing tables to get the default values for α and the recovery rate. This information is then enough to compute the expected loss for the excess reinsurance layers.

A major benefit of this methodology is that the relationship between pricing and risk management is considerably clearer. It is now obvious to the cedant how different risk management rules will affect their reinsurance costs. For example, two observations are immediately apparent in the sample exhibit on Appendix 1, Page 2.

First, credit A could potentially cause a loss that greatly exceeds the amount of excess reinsurance purchased. The insurer did not purchase enough excess reinsurance to adequately protect itself. But, high layer reinsurance is expensive, especially if it is not well used. Just like lines of credit issued by banks, reinsurers typically charge capacity fees for excess layers that have low activity because they might be used. A more cost effective way to manage the portfolio is to not let any one risk get that large in the first place.

Second, credits A, B and C all have inadequate credit quality for their size. Notice how the expected loss for the 5x5 layer is almost entirely due to these three risks. It is unlikely that these three risks are able to support all of a reinsurer's capital and frictional costs by themselves. So, the 5x5 layer is probably uneconomical for the cedant. A more cost effective way to manage the portfolio is to place lower maximum limits on poor credits and to establish an orderly exit process to address deteriorating credits.

Incorporating additional information into the exhibit enables us to perform even more analyses. For example, comparing the direct premiums collected for the bonds with the ground up expected loss calculation gives us a diagnostic for reviewing α. Other information

that is potentially useful includes bond type, industry group, collateral, hedges, retrocessions, and the Greeks.

4.6 Agg-Stop Application

Aggregate stop loss reinsurance (Agg-stops) is the insurance version of a collateralized debt obligation (CDO). Both involve collecting a large portfolio of risks and then the slicing the portfolio into horizontal tranches. Since correlated risk exacerbates aggregate loss, most of the correlated risk ends up residing in the upper tranches while most of the uncorrelated risk ends up residing in the lower tranches. Therefore, the function of Agg-stops for Credit & Surety portfolios is to strip the correlation from the portfolio. And since the correlated risk is the largest consumer of credit capacity, Agg-stops release significant amounts of credit capacity for the primary insurer, but at the cost of consuming significant amounts of credit capacity from the reinsurer.

Since the risk in an Agg-stop treaty is almost entirely correlated risk, it is critical that the model used for pricing Agg-stops has a sophisticated treatment of correlation. Typically a simulation model is used such that industry group could accurately model each necessary term, such as sub limits. Simulations also permit the reinsurer to analyze the effect of including the treaty in their portfolio. This permits the reinsurer to more accurately assess their cost of capital loads for the treaty.

A simulation model involves stochastically generating frequency, exposures and severities. For homogenous portfolios, the simulation model can be relatively simple. If we assume that all of the correlation is the result of frequency, then the key to the model is the frequency simulation. A commonly used approach in this situation is the Binomial Model. It is best described by example: We simulate the frequency of loss for 100 correlated risks as 50 uncorrelated risks, adjusting the expected severities so that the expected total loss is correct. We established number 50 by applying the Method of Moments to an estimated aggregate variance. After the frequency is simulated, then for each simulated event, the sizes of the exposures are modeled, usually from a Lognormal distribution fitted to the exposure profile and scaled as required by the Binomial Model. Finally, the loss severities are modeled as a percentage of the exposure, usually from a Gamma or a Pareto.

5 Specific Issues

5.1 Frequency

The ability to get improved frequency estimates is a key reason why many insurers have begun to adopt the credit scoring algorithms of the rating agencies. One major advantage rating agency algorithms have over other pricing methodologies is that the rating agencies have the most complete and longest running histories publicly available. A second major advantage is that the rating agencies are relatively quick to reflect any changes in probabilities of default in their credit ratings. This allows financial companies to continually revise their assessment of the quality of their portfolio without having to continually re-rate all of the credits themselves. Alternatively, an even more responsive indicator of change is the credit spreads in the market. A credit spread is the difference between the rate for treasury notes and the rate for a similar bond issued by the company. Since credit spreads rise monotonically as credit ratings fall, the market's spreads can be used to establish the market's consensus credit rating. The credit derivative market is a common place for financial institutions to get consistent information about credit spreads. It is estimated that up to 90% of the activity on the credit derivative market is solely for "price discovery" purposes.

While the credit scoring approach has its benefits, it also has its limitations. For example, it is important to remember that credit ratings are designed for assessing the pricing of debt instruments, not insurance. Also, rating agencies have also been known to approach the same calculations in different ways for different publications, depending on what the information is intended for. Rating agency information must be used with caution.

If pulling default statistics from a publication, it is important to note precisely what the statistics measure. This is not always clear. Sometimes the statistics are pure frequency statistics and sometimes they measure expected loss costs. Furthermore, since frequency and severity strongly correlate, the different default statistics are not always easily distinguished. A detailed knowledge of how the statistics were calculated and the assumptions underlying them is necessary before attempting to use them in pricing.

Credit ratings have a fair amount of subjectivity to them. Rating agencies judgmentally segregate the credits into rating categories and then calculate statistics on the categories. The subjectivity of the data means that there are trends that must be identified and compensated for. For example, from 1984 to 1991, the annual default rate for Moodys B1 rated securities always stayed within the range of 4.36% to 8.54%. From 1992 to 2000, the annual default rate for Moodys rated B1 securities always stayed within the range of 0.00% to 4.57%. Was this the result of a changing economic environment or a change in the definition of a B1 security? A review of the aggregate default rate for all corporate bond issuers demonstrates that the two periods were not significantly different. Therefore, we can conclude that the change in experience is due, at least in part, to a change in the definition of a B1 security.

While credit-scoring models can be used to improve credit default rate predictions, they cannot always produce accurate frequency predictions for the insurance products we are pricing. This is because the insurance industry's definitions of credit default can differ markedly. To a rating agency, default means the failure to service debt. To an insurer it can mean many things, such as the failure to pay a bill or the failure to fulfil a bonded obligation. Insurance default rates can be greater or less than commercial debt default rates, depending on the nature of the insured obligation. For this reason, it is best to use credit-scoring models with great care in order to be useful in surety pricing.

5.2 Severity

Severity (recovery rates) can be analyzed using data and models similar to those used for frequency. Recovery rates vary with both credit rating and debt seniority, thus they are specific to the insured and the instrument being priced. Severity distributions are harder to fit than frequency distributions because they are more complex. For frequency, we only need to be concerned about the average probability of default. While for severity, we need the full distribution. However, the increased complexity of fitting severity curves is partly mitigated by the fact that Credit & Surety underwriting places an overwhelming focus on frequency.
When pricing for retentions or excess layers, it is important to put a distribution around the average recovery rate. Then, the expected loss cost for each exposure in the portfolio is calculated using the Limited Expected Values of the recovery rate distribution. Typically, a Beta distribution is used if it is impossible for the loss to exceed the notional amount. If it is possible for the loss to exceed the notional amount (i.e.: Contract Surety), then property distributions typically are used. If the list of exposures is not known, then a LogNormal distribution is typically used for representing the distribution of potential exposure sizes.

For primary insurers, an accurate representation of the recovery rate distribution is essential if the insured has a significant retention or posts significant collateral. The recovery rate curves will determine how much credit to give to the collateral and retention. Inaccurate curves

increase the risk of over/under pricing the business. A review of the insurer's hit ratios by retention would indicate whether inaccuracies exist.

Establishing accurate recovery rate distributions for new products pose a particularly difficult challenge. This is generally accomplished by borrowing distributions from other related products. Insurers can improve the variety of their severity distributions in the following manner: First, fit a recovery rate distribution for each category that has sufficient experience. Use the same form of distribution for each fit so that the equations are identical and only the parameters change. Plot the parameters onto a grid, labeling each point with the product that generated it. Then, recovery rate curves for new products can be selected judgmentally from the grid by placing a point onto the grid that makes sense relative to the existing portfolio of products.

For reinsurers, the exact shape of the recovery rate distribution is often not that important. For most reinsurance applications, only the mean and variance of the recovery rate distributions are significant. This is because we are applying the same curve to a large number of exposures and the Law of Large Numbers smoothes out the inaccuracies of the distribution. It is important that the first two moments are correct, but the higher moments are often smoothed out. However, note that the Law of Large Numbers breaks down in the high excess layers. If pricing these layers, it is important that the tail of the recovery distribution be adequately represented otherwise the layers will be under-priced.

Reinsurers must also pay attention to whether the distribution of exposures is changing or can change. A trend in average exposure size will materially effect the excess severity distribution. Furthermore, the existence of excess reinsurance often provides the incentive for cedants to put the coverage to greater use. An excess layer that does not currently have many exposures in it may have significantly more by the end of the term. Therefore, it is common for reinsurers to charge a capacity fee (similar to the fee banks charge for keeping lines of credit open) for excess layers that are lightly exposed. This pays for the potential for the cedant to write more bonds that expose the layer. Note that such a fee is not required if the layer is written on a cessions basis.

5.3 Loss Cycle

The loss cycle is when Credit & Surety loss activity dramatically increases. During a loss cycle, loss ratios typically are double or treble their historic levels. Loss cycles generally are caused by credit cycles but may also be caused by other contagious events, such as a rapid contraction in the amount of government spending on capital projects. Loss cycles typically focus around a particular industry and region, meaning that there are multiple overlapping cycles that could potentially affect an insurer's results. Preparing the insurance company for future loss cycles is one of the most difficult tasks a Credit & Surety actuary must perform.

Surety & Credit has two main loss cycles. First, large contractors and most non-construction companies finance their operations through credit. A contraction of the credit market causes the less stable corporations to fail. However, small contractors tend to finance their operations by kiting funds from one job to the next. A reduction in the amount of new construction has the same effect on this market as a contraction of credit has on the market as a whole. Typically, the availability of credit drives the loss cycle for the large Contract Surety, Commercial Surety and Credit insurance markets while the amount of new construction drives the loss cycle for the small Contract Surety market.

Financial Guarantees and Credit Derivatives also have loss cycles that are largely driven by the credit cycle, and thus are strongly correlated with large contractors and Commercial Surety. However, a large part of the Financial Guarantee market is municipals and these

behave very differently. The risk for municipals is that the politicians do not want subject the public to the pain required for them to maintain their financial obligations.

The existence of the loss cycle complicates the pricing of these products. The actuary must keep both the long term and short-term horizons in mind when pricing. For example, if the loss ratio averages 30% in normal years and 80% during a loss cycle, and if the loss cycle comes once every decade and lasts for two years, then the long-term loss ratio is 40% (= 0.8 x 30% + 0.2 x 80%). Therefore, in order to make money over the long term, an insurance company must charge between 10% and 33% more for its products than it would if it was taking purely a myopic view towards pricing (depending on whether expenses are loaded as fixed or variable). The market does not easily support such pricing. Thus, strict discipline by actuaries and underwriters is required.

In reinsurance, managing the horizons also consists of paying attention to the "banks" that insurers have developed with the reinsurer. The bank is the amount of excess funds that the reinsurer has collected over the good years in order to pay for the bad. Without the building up of banks, reinsurers cannot be profitable over the long term. Reinsurance rates should reflect the size of the bank that the insurer has. Returning to the above example, if the insurer has a fully funded bank, then the reinsurer can charge a rate contemplating a 30% loss ratio. But, if the insurer has no bank at all, then the reinsurer should charge a rate contemplating a 40% loss ratio (or higher).

Even if the insurer/reinsurer intends to withdraw from the market when the loss cycle begins, they generally do not get a chance to withdraw until their contracts end. That means that the insurers & reinsurers must first witness the beginning of the loss cycle before knowing it is time to withdraw, and by then it is generally too late to avoid the bulk of it. The loss cycle is relatively short – it is over before much action can be taken.

Loss cycles also have another insidious side that make identifying them particularly difficult. Loss cycles have the tendency to be devastating to insureds that already have open credit-related claims, meaning that these claims are severely exacerbated and the resulting extraordinary loss is recorded with the date of the original claim. Therefore, the loss cycle is actually much shorter than the actuarial loss experience suggests. For example, in the most recent loss cycle, losses grew in 2000, peaked in 2001 and may have begun to decline in 2002. But, the loss cycle was not apparent to the market until late 2001. Most of the losses in 2001 and all of the losses in 2000 are due to the aggravation of losses that already were in claim. In the context of the actuarial loss history, the loss cycle was not identifiable until it was already half over.

The loss cycle has often been compared to hurricanes and other natural catastrophes and they both are managed in similar ways. But, they are very different to a pricing actuary. Unlike most other catastrophes, the loss cycle is not a Poisson process. If we have a loss cycle this year, then it will be a few years before we have another one. Loss cycles require weak companies and excessive competition. It takes time for these economic conditions to redevelop once a loss cycle occurs. However, the fact that there are many different types of loss cycles makes the time between loss cycles very difficult to predict. For example, the time between the last two Contract Surety cycles was about 13 years (1987 to 2000). But, if we include Commercial Surety, the period drastically shortens. The last Commercial Surety loss cycle (credit cycle) was in 1992. The fact that we have multiple different types of loss cycles does add some Poisson-style risk to the pricing, but does not make it a full Poisson process.

Understanding the loss cycle is a vital part of the pricing process. It ultimately determines whether the insurer makes money or not. It is a particularly difficult component to price because the long time periods which separate loss cycles limits the usefulness of loss histories. Predictions are as much art as science and crystal balls invariably find their way into the process. Some actuaries have expressed their confidence in the new economy and that

the durations between loss cycles are increasing. Others point to the increasing reliance businesses have on the credit markets as a fundamental destabilizing force, which should shorten the durations between loss cycles and increase their severities. Today, there is no consensus. The only general conclusion that can be drawn is the fact that insurers tend to be too optimistic. Historically, too many have found themselves with inadequate banks when the loss cycle begins.

6 Conclusion

There are many new products at the intersection of the insurance and financial markets, and some of the traditional insurance products now have financial flavors. The traditional insurance methods for evaluating and managing these risks have become out-dated. The goal of this paper is not to give a definitive proposal, but to invite actuaries, underwriters and senior managers to look at these products from a new perspective. The biggest danger to insurance is in not changing. This was made very evident by the enormous exposures insurers had to Enron and by the fact that many of the resulting claims by Enron's obligees were entirely unanticipated. In conclusion, we strongly believe that following the lead of financial markets could help the insurance industry quantify and manage Credit & Surety risks more effectively and more efficiently. This will ensure the long-term availability of sufficient capital, and thus capacity, for this line of business.

Acknowledgements

The authors would like to gratefully acknowledge Scott Orr, Frank Bonner, Marianne Wilbert, Scott MacColl, John Boulton, Kathleen Miller-Boreman, Roger Amrein for reviewing early drafts of this work and offering their feedback. We would like to thank Nick Pastor, David Smith and Chris Walker of the CAS Ratemaking Committee for providing constructive feedback. Finally, we thank our spouses Dr. Latha Cherath and Ms. Akiko Ito for their support and encouragement. The authors remain solely responsible for errors that still exist in the paper.

Credit & Surety Pricing and the Effects of Financial Market Convergence

The Calculation of Expected Loss

(1)	Principal	XYZ Inc.
(2)	Credit Rating	Baa3
(3)	Industry	Power
(4)	Exposure	25,000,000
(5)	Duration [A single payment of $25mm is due in 5 years.]	5
(6)	Moody's Default Rate	3.05%
(7)	Average Recovery Rate [Default value for high risk bonds]	10%
(8)	α [Bond is a no-recourse demand obligaton.]	100%
(9)	Expected Loss = (4) x (6) x [1 - (7)] x (8)	686,250
(10)	Discount (@ 5%)	0.784
(11)	PV(Expected Loss) = (9) x (10)	537,695

Credit & Surety Pricing and the Effects of Financial Market Convergence

The Calculation of Expected Loss for XOL Reinsurance

(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
											Reinsurance Loss		
Index	Name of Credit	Notional Amount	Term	S&P Rating	Moody Rating	Selected Rating	Default Rate	α	Recovery Rate	Ground Up Expected Loss	1M X 1M	3M X 2M	5M X 5M
1	A	20,000,000	1.000	B+	B2	B2	7.160%	70%	10%	902,160	50,120	150,360	250,600
2	B	12,000,000	1.000	B+	B1	B1	4.680%	70%	10%	353,808	32,760	98,280	163,800
3	C	9,000,000	1.000	B	B3	B3	11.620%	70%	10%	658,854	81,340	244,020	252,154
4	D	8,000,000	1.000	BB+	Ba1	Ba1	0.870%	70%	10%	43,848	6,090	18,270	13,398
5	F	7,500,000	1.000	BBB	Baa2	Baa2	0.170%	70%	10%	8,033	1,190	3,570	2,083
6	G	7,000,000	1.000	BB+	Ba1	Ba1	0.870%	70%	10%	38,367	6,090	18,270	7,917
7	H	7,000,000	1.000	A	A2	A2	0.011%	70%	10%	479	76	228	99
8	I	6,800,000	1.000	BB+	Ba1	Ba1	0.870%	70%	10%	37,271	6,090	18,270	6,821
9	J	6,500,000	1.000	BB+	Ba1	Ba1	0.870%	70%	10%	35,627	6,090	18,270	5,177
10	K	6,000,000	1.000	A	A2	A2	0.011%	70%	10%	411	76	228	30
11	L	5,000,000	1.000	BB	Ba1	Ba1	0.870%	70%	10%	27,405	6,090	15,225	-
12	M	5,000,000	1.000	BBB	Baa2	Baa2	0.170%	70%	10%	5,355	1,190	2,975	-
13	N	5,000,000	1.000	BBB-	Baa3	Baa3	0.420%	70%	10%	13,230	2,940	7,350	-
14	O	4,000,000	1.000	BB-	Ba1	Ba1	0.870%	70%	10%	21,924	6,090	9,744	-
15	P	3,500,000	1.000	B+	B1	B1	4.680%	70%	10%	103,194	32,760	37,674	-
16	Q	2,000,000	1.000	AA	Aa2	Aa2	0.001%	70%	10%	17	8	-	-
17	R	2,000,000	1.000	BB+	Ba1	Ba1	0.870%	70%	10%	10,962	4,872	-	-
18	S	1,500,000	1.000	BB	Ba2	Ba2	1.560%	70%	10%	14,742	3,822	-	-
19	T	1,500,000	1.000	B	B2	B2	7.160%	70%	10%	67,662	17,542	-	-
20	U	1,500,000	1.000	BBB-	Baa3	Baa3	0.420%	70%	10%	3,969	1,029	-	-
										Expected Loss in Layer:	266,265	642,735	702,078

Notes: (10) = (2) x (7) x (8) x [1-(9)]
(11) = (7) x (8) x Min[Max[(2)x[1-(9)]-1M,0],1M]
(11) = (7) x (8) x Min[Max[(2)x[1-(9)]-2M,0],3M]
(12) = (7) x (8) x Min[Max[(2)x[1-(9)]-5M,0],5M]

Credit & Surety Pricing and the Effects of Financial Market Convergence

Moodys Idealized Corporate Default Table

	Life of Asset										
	0	1	2	3	4	5	6	7	8	9	10
NoDef	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Aaa	0.000%	0.000%	0.000%	0.001%	0.002%	0.003%	0.004%	0.005%	0.007%	0.008%	0.010%
Aa1	0.000%	0.001%	0.003%	0.010%	0.021%	0.031%	0.042%	0.054%	0.067%	0.082%	0.100%
Aa2	0.000%	0.001%	0.008%	0.026%	0.047%	0.068%	0.089%	0.111%	0.135%	0.164%	0.200%
Aa3	0.000%	0.003%	0.019%	0.059%	0.101%	0.142%	0.183%	0.227%	0.272%	0.327%	0.400%
A1	0.000%	0.006%	0.037%	0.117%	0.189%	0.261%	0.330%	0.406%	0.480%	0.573%	0.700%
A2	0.000%	0.011%	0.070%	0.222%	0.345%	0.467%	0.583%	0.710%	0.829%	0.982%	1.200%
A3	0.000%	0.039%	0.150%	0.360%	0.540%	0.730%	0.910%	1.110%	1.300%	1.520%	1.800%
Baa1	0.000%	0.090%	0.280%	0.560%	0.830%	1.100%	1.370%	1.670%	1.970%	2.270%	2.600%
Baa2	0.000%	0.170%	0.470%	0.830%	1.200%	1.580%	1.970%	2.410%	2.850%	3.240%	3.600%
Baa3	0.000%	0.420%	1.050%	1.710%	2.380%	3.050%	3.700%	4.330%	4.970%	5.570%	6.100%
Ba1	0.000%	0.870%	2.020%	3.130%	4.200%	5.280%	6.250%	7.060%	7.890%	8.690%	9.400%
Ba2	0.000%	1.560%	3.470%	5.180%	6.800%	8.410%	9.770%	10.700%	11.660%	12.650%	13.500%
Ba3	0.000%	2.810%	5.510%	7.870%	9.790%	11.860%	13.490%	14.620%	15.710%	16.710%	17.660%
B1	0.000%	4.680%	8.380%	11.580%	13.850%	16.120%	17.890%	19.130%	20.230%	21.240%	22.200%
B2	0.000%	7.160%	11.670%	15.550%	18.130%	20.710%	22.650%	24.010%	25.150%	26.220%	27.200%
B3	0.000%	11.620%	16.610%	21.030%	24.040%	27.050%	29.200%	31.000%	32.580%	33.780%	34.900%