Chapter 1

Introduction

1.1 Credit Risk

Credit risk or *default risk* refers to the possibility that the borrower will fail to service or repay debt on time. Default occurs when a borrower cannot fulfill key financial obligations, such as making interest payments to bondholders or repaying bank loans. The most fundamental example of a credit-linked security is a corporate bond.

The risk of default affects virtually every financial contract. Therefore, the pricing of credit risk has received increasing attention recently from practitioners, academics, and regulators. Practitioners need to quantify credit risk accurately in the market in order to be properly compensated for bearing it. Academics need to develop a strong modelling framework for credit risk, and regulators have a great interest in whether and how credit-sensitive transactions should be regulated. One can often read in academic literature comments such as "The modelling of credit risk, credit derivatives and non-hedgeable securities in general, is currently in a poor state" (Wilmott, (1998)). "Unlike market risk, the modelling of credit risk is a very difficult task because credit risk is not the simple manifestation of one single source or driver of the risky event" (Ong, (1999)). "The current situation with credit derivatives is still awaiting its Black-Scholes, there is no consensus on the best way of pricing them [credit derivatives]" (James, (1998)). The focus has mainly been on defaultable debt,

derivatives on financial securities subject to credit risk and, more recently credit derivatives. The pricing of credit risk is essential to the valuation and hedging of each of these types of securities, therefore a model of credit risk must be developed.

Over the past decade, credit markets have seen tremendous growth in both geographical reach and range of new products. As a result, it has become imperative for market participants to understand credit risk and how to monitor and properly manage it. The taking of credit risk is a fundamental function of banks. For example, when a bank extends a loan to a customer, it is exposed to the risk that the customer will default on the loan. Traditionally, banks have dealt with this risk by requiring borrowers to meet certain underwriting standards. Another traditional approach used by banks to manage credit risk is to diversify the risk across different borrowers in different geographical regions and different industries. The development of markets for securitised assets and for loan sales has provided banks with another method for managing credit risk. This method allows banks to sell some of their loans into securitised pools or directly to outside investors. Although these methods reduce banks' credit risk exposure, they do not provide a formal method for valuing credit risk.

It is not only banks that are exposed to credit risk but investors in corporate, municipal and sovereign bonds as well. There is always a chance that a bond issuer will not meet its obligations to pay principal and interest. Although this risk is small for the typical high-grade borrower, investors are still exposed to credit spread risk, the risk of a decline in a bond's credit rating. A bond's credit rating is a general measure of the credit risk of the issuing firm. Rating agencies, like Standard & Poor's (S&P), Moody's, Fitch Ibca and Duffs & Phelps categorize bonds from the best rating AAA/Aaa to the worst rating C. A downgrade in a credit rating usually results in an immediate drop in the value of the bond. A bond issuer's cost of borrowing crucially depends on his credit rating. Therefore, not only does a downgrade in a credit rating affect bond investors, it also increases the bond issuer's cost of borrowing. Participants in the various bond markets have developed an informal model of credit risk that determines the *credit risk premium* associated with bonds of differing credit quality. The credit risk premium is the spread over default-free securities, such as government bonds, that bonds of differing credit ratings trade at. The credit spread

is commonly expressed as a yield differential and it indicates the compensation to the lender attributable to credit risk.

The massive growth of the OTC derivatives market has led to a heightened awareness among banks of another type of credit risk: counterparty risk. Counterparty risk represents the risk that a party with a negative mark-to-market value on an OTC contract will default on their obligations to the other party of the contract. To deal with this counterparty risk, some banks insist on doing business only with highly rated counterparties. In this case, the OTC derivatives are traded at market rates that do not reflect the credit rating differences between the counterparties. A major development in the OTC derivatives market has been the setting up of AAA-rated special-purpose credit subsidiaries by the major investment banks. For example, in December 1991, Merrill Lynch launched Merrill Lynch Derivative Products and in early 1993, Salomon Brothers set up Swapco. The AAA-rated subsidiary essentially guarantees derivative transactions between the parent investment bank and credit-sensitive counterparties. However, the setting up of these AAA-rated subsidiaries does not address the banks' evaluation of risky counterparties that it trades with.

1.2 Credit Derivatives

Recent developments in the derivatives market have revolved around instruments that are used to trade credit risk, which in the process, is separated from other features of a financial instrument. These instruments, known as credit derivatives, are derivatives on the credit risk of a given bond, loan or issuer. The advent of credit derivatives has made most banks realize that more formal models of credit risk must be developed to price and trade these instruments. It has become clear to most banks that the traditional methods of managing credit risk, such as underwriting, diversification, loan sales and asset securitisation offer only a partial solution to controlling credit risk exposure.

Broadly defined, a *credit derivative* is a financial contract outlining either a certain or a potential exchange of payments in which at least one leg is linked to the performance of a specified underlying credit-sensitive asset or liability. The underlying market instruments include bank loans, corporate, emerging market, and municipal debt, convertible securities as well as the credit exposures

generated from other derivatives-linked activities.

Credit derivatives provide users with an efficient means of hedging or acquiring credit risk. They permit investors to manage credit exposures by separating their views on credit from other market variables without jeopardizing relationships with borrowers; they also provide access to those investors who may be precluded from the underlying debt markets. Credit derivatives could also allow a company whose business depends substantially on another company to gain some protection from the other company's failure. Companies planning to issue debt can use credit derivatives to lock in a maximum financing rate at some issuance time in the future. Clearly, credit derivatives have many potential uses.

The market for credit derivatives has grown rapidly over the past few years. It was virtually nonexistent in 1994, had reached an estimated $20 billion by 1995, jumped to $350 billion by 1998 and was estimated at $740 billion by end of 2000.[1] This growth has been driven by the ability of credit derivatives to provide valuable new methods for managing credit risk.

The potential users of credit derivatives include commercial and investment banks, insurance companies, corporations, money managers, mutual funds, hedge funds and pension funds.

1.3 Evolution of Credit Derivatives

Credit derivatives have been in existence for a long period of time in the form of letters of credit (LCs), loan guarantees, bond insurance and option-embedded corporate debt securities. Under an LC, an issuer pays a bank an annual fee in exchange for the bank's promise to make debt payments in case of default. Under a bond insurance contract, a debt issuer pays an insurer to guarantee performance on a bond. Under an option embedded contract, a debt issuer or a debt holder has the right to redeem the debt prior to maturity at a pre-specified price in response to a credit rating change. The following table[2] shows the evolution of credit derivatives.

[1] These numbers were taken from a 1999 survey by the British Bankers' Association.

[2] This table was adapted from Beder-Iacono (1997).

TIME	EVENTS
1750's	Standby letters of credit and performance bonds were widely used in trade finance
1840's	London Guarantee and Accident Co & New York Guaranty Co were formed to issue credit insurance
1840's	Governments become large guarantors of bonds for railway construction
1900's	Export credit insurance began to be widely used
1900's	Letters of credit emerge
1960's	Increase in government guarantees
1960's	Foreign Credit Insurance Association begins to offer foreign political and commercial guarantees
1970's	State insurance guaranty fund system begins
1970's	Government National Mortgage Association (GNMA) begins issuing guaranteed pass-through mortgages
1970's	AMBAC Financial Group begins to insure municipal bonds
1970's	Farmer Home Administration (FmHA) begins guaranteeing loans made by commercial lenders
1980's	Credit supported commercial paper begins to be issued
1980's	Callable and puttable floating rate notes issued
1990's	First credit default swaps and credit-linked notes

Table 1.1: Evolution of credit derivatives

1.4 Credit Derivative Structures

In this section, we describe a variety of common credit derivatives and their uses in financial markets.

1.4.1 Credit Swap

A credit swap enables two parties to swap the credit risk associated with a reference security (or a portfolio of securities) without transferring the security itself. The credit risk buyer receives a fee, or periodic fixed payments from the credit seller. In exchange, the credit buyer promises to make a payment if the reference security experiences a credit event. A credit event may be a rating downgrade, in which case the credit swap is called a *rating option*, or it may be default, in which case the credit swap is called a *default swap* or *default option*. The contingent default payment can be linked to the price movement of the underlying asset, or it can be a fixed predetermined level based on the expectation of the loss rate.

Default swaps can be used to free up credit lines by reducing exposure to a single borrower or group of borrowers without the borrower's knowledge or consent (which may be required when loans are sold outright). Similarly, investors who need to protect themselves against default but cannot or do not want to sell the particular security, for accounting, regulatory, liquidity or tax reasons, can buy a credit default swap. Companies that have available credit lines but are unable to lend or invest because of balance sheet constraints can sell default swaps without breaching balance sheet limits.

1.4.2 Spread Swap

Buying a credit swap can virtually eliminate credit exposure, but this transaction also reduces return. Credit portfolio managers can achieve revenue-neutral diversification and increase risk-adjusted return by exchanging default obligations that are not closely correlated. A *spread swap* or *exchange option* is an instrument in which two parties exchange default obligations. Suppose A is exposed to B's default and X is exposed to Y's default. A and X exchange default obligations, possibly for a fee, so that A recompenses X for any adverse

consequence of Y's default and X similarly recompenses A for losses resulting from B's default. Assume the default probabilities of B and Y are not jointly related; a spread swap is equivalent to an exchange of default swaps on B and Y. If Y is chosen to be a risk-free issuer, then a spread swap becomes a default swap.

1.4.3 Total Return Swap

Two parties enter into a *total return swap* in order to swap all the economic risks associated with a reference security, that is both market and credit risk, without transferring the security itself. The receiver in the swap will be long of the total economic risk of the security, and will receive the positive cash flows from that asset (coupons or dividends, plus any appreciation in capital value). The payer in the swap will be paid some spread over a reference rate such as Libor, as well as any depreciation in the capital value.

For investors seeking exposures to a specific asset, total return swaps are the synthetic equivalent of buying the asset and locking in term financing. For investors seeking to eliminate exposure to a specific asset, total return swaps are the synthetic equivalent of selling the asset and locking in a return.

1.4.4 Credit Spread Option

A *credit spread call (put) option* gives the purchaser the right but not the obligation to buy (sell) an underlying credit-risk-sensitive asset or credit spread at a predetermined price for a predetermined period of time. For example, a corporate note issuer might purchase a credit spread put to hedge the risk of widening spreads.

1.4.5 Credit Linked Note

Credit linked notes are debt instruments issued by highly rated issuers in which the coupon or the redemption value of the note is linked to the performance of a reference asset or index. They can be used by the seller to hedge against credit risk and by the buyer to achieve higher yields.

Credit linked notes on multiple assets can be used to enhance return as well as reduce risk. A *first-of-default credit note* is an instrument whose default is linked to a basket of high credit rated assets. In the event that any one of the reference credits defaults, the redemption value of the structured note is reduced by either a predetermined amount or the fall in value of the defaulted security. In effect, it may have a default risk equivalent to a credit rating below the minimal credit rating imposed upon the investor by regulations, even though each of the component assets has a credit rating exceeding this threshold. In the present regulatory environment, the investors would be allowed to hold the first-of-default note, thereby circumventing the minimal rating regulations. On the other hand, a *last-of-default note* is an instrument where default is triggered only when all reference credits default. Consequently, this may have a default risk equivalent to a higher credit level than any of the assets comprising the note.

1.5 Modelling Issues

As mentioned previously, the most fundamental example of a credit linked security is a corporate bond. The price of a corporate bond is subject to three types of risk:

1. Interest rate risk - this is the most essential part for the valuation of any security in fixed income markets. There are several models dealing with interest rates, most notably the Heath-Jarrow-Morton (1992), model, which provides a universal framework for interest rate risk modelling and risk management.

2. Credit risk or the likelihood of default - this risk pertains to the pure possibility of the bond entering default, irrespective of the magnitude of the loss from default. Default risk may be reflected in the borrower's credit rating or other macroeconomic variables. In general, credit ratings provide a good proxy for the default risk. Likelihood of default increases as credit rating decreases.

3. Recovery risk - different seniority debt for a particular firm can have dif-

ferent recovery rates in the event of default. This is difficult to model because it also depends on the market value of residual assets of a firm in default.

These three factors are the features that must go into a stochastic default-risky bond model. The first requirement is often over-looked, as it does not directly pertain to default.[3] The requirement is crucial because the value of default-risky bonds is as much a function of risk-free rates as it is a function of credit spreads. In practice, most default-risky bond models do not model the risk-free rate directly, but specify a class of stochastic interest rate models that could be used. A default-risky bond model should also have the ability to price any contingent claim whose cash flow is subject to default.

[3]Although risk-free rates and default probabilities may be correlated.