Fixed Income and Credit Risk: Structural and Reduced-Form Models

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ABSTRACT

Credit risk—the risk that a borrower will fail to meet contractual obligations—is the most fundamental risk in finance, preceding even equity risk in the capital structure hierarchy. The systematic analysis of credit risk in corporate bonds and loans accelerated after Merton's (1974) foundational application of option pricing theory to corporate default: viewing equity as a call option on the firm's assets and corporate debt as a position in the risk-free bond minus a put option on the firm's assets provides the first theoretical model of credit spreads as compensation for default risk. This structural approach—relating default probability to observable firm characteristics (asset volatility, leverage, asset value)—was extended by Black and Cox (1976), Leland (1994), and others. Reduced-form models (Jarrow and Turnbull, 1995; Duffie and Singleton, 1999) take default intensity as an exogenous stochastic process, fitting term structures of credit spreads more flexibly than structural models. This paper reviews structural and reduced-form credit risk models, the credit default swap market that has revolutionized credit risk trading, credit spread determinants, and the contagion dynamics that make credit risk systemic.

Keywords: Credit Risk; Structural Model; Merton; Reduced-Form Model; Credit Default Swap; Credit Spread; Default Probability; Fixed Income.

1. INTRODUCTION

Corporate bonds and loans constitute the world's largest asset class by value, substantially exceeding equity market capitalization. The pricing of credit risk—the spread above the risk-free rate that borrowers must pay to compensate lenders for default risk—determines the cost of corporate capital and the distribution of economic returns between debt and equity investors. Yield spreads on corporate bonds above equivalent-maturity Treasury bonds reflect compensation for multiple factors: expected default loss (probability of default multiplied by loss given default), uncertainty about default timing, liquidity premium, and tax effects. The credit spread puzzle (Huang and Huang, 2012)—that default risk accounts for only a fraction of observed corporate bond yield spreads, with the remainder attributable to liquidity and tax factors—has driven substantial model development.

2. STRUCTURAL MODELS

2.1 Merton's Model

Merton (1974) in the Journal of Finance (29(2): 449–470) extended the Black-Scholes option framework to corporate liabilities by viewing the firm's capital structure as contingent claims on the firm's asset value. In the simplest version, a firm with asset value V, financed by equity E and zero-coupon debt with face value D and maturity T, defaults at maturity if $V(T) < D$. Equity holders receive $\max(V(T) - D, 0)$—a European call option on the firm's assets. Debt holders receive $\min(V(T), D) = D - \max(D - V(T), 0)$—the face value minus a European put option with the same parameters. This contingent claims framework enables computation of theoretical credit spreads from observable inputs: current asset value, asset volatility, leverage, and debt maturity.

2.2 Extended Structural Models

Extensions of Merton's model address its unrealistic assumption that default can only occur at debt maturity. Black and Cox (1976) introduced a default boundary at which default occurs when the asset value hits a threshold—enabling default at any time before maturity. Leland (1994) in the Journal of Finance derived the optimal capital structure (optimal default boundary and coupon choice) as the solution to the firm's value maximization problem, integrating structural credit modeling with dynamic capital structure theory. Collin-Dufresne, Goldstein, and Martin (2001) test structural model predictions against observed credit spread changes and find that the standard variables (leverage, interest rates, equity volatility) explain only about 25% of credit spread change variation—the 'credit spread puzzle'—with the residual showing common factor structure suggesting systemic or liquidity factors.

3. CREDIT DEFAULT SWAPS

Table 1. Credit default swap mechanics and market significance.

CDS Feature	Description	Market Significance
Protection buyer	Pays periodic premium (CDS spread); receives face value on credit event	Hedges credit exposure; enables short credit positions without bond short-selling
Protection seller	Receives premium; pays face value minus recovery on credit event	Earns credit risk premium; alternative to holding corporate bonds
Credit event	Default, restructuring, bankruptcy, failure to pay trigger settlement	ISDA definition; determinations committee resolves contested events
Market size	~$9 trillion notional outstanding (BIS, 2022); down from ~$60T pre-crisis	Critical for credit risk transfer; CDS spreads as real-time default probability signal

4. SYSTEMIC CREDIT RISK

The 2008 financial crisis demonstrated that credit risk is not merely a bilateral lender-borrower problem but a systemic risk that propagates through interconnected financial networks. AIG's concentrated CDS protection writing—approximately $440 billion in CDS protection sold across diverse counterparties—created a systemic node whose failure would have disabled credit risk hedging across the financial system, motivating its government rescue. The concentration of CDO (collateralized debt obligation) tranching risk in systemically important institutions amplified rather than distributed credit risk, creating correlated exposures that the diversification rationale for CDO structures assumed were uncorrelated. Brunnermeier (2009) in the Journal of Economic Perspectives documents these crisis amplification mechanisms, identifying fire sale dynamics and funding liquidity risk as the primary channels through which individual credit events escalated into systemic crisis.

5. CONCLUSION

Credit risk modeling has advanced substantially from Merton's foundational structural model to sophisticated reduced-form and hybrid frameworks that better fit empirical credit spread term structures. The credit default swap market has transformed credit risk management by enabling credit risk trading without bond position requirements, providing real-time market-based default probability signals, and concentrating credit risk in new systemic nodes. The credit spread puzzle—that default risk accounts for only a fraction of observed spreads—motivates continued research into liquidity risk, tax effects, and market microstructure factors that jointly determine credit spreads. Future research should examine how machine learning models trained on alternative data (supply chain networks, text-based news sentiment, satellite economic activity data) improve default prediction relative to traditional accounting-based credit scoring approaches.

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