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An Optimal Financial and Operational Model for Supply Chain Firms Facing Global Market Uncertainty

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Abstract

This paper develops an integrated framework to analyze the interaction between operational and financial decisions in a supply chain operating under global market uncertainty. While previous studies in supply chain management have mainly focused on logistics coordination and operational efficiency, relatively little attention has been given to financial decisions, such as capital structure, debt financing, and bankruptcy timing, within interconnected supply chain systems. Motivated by the increasing financial vulnerability of firms in volatile economic environments, this study proposes a model that simultaneously examines optimal exit (bankruptcy) strategies and optimal financing decisions for firms connected through supply-chain relationships. The model considers a supply chain consisting of one downstream firm (DF), representing a retailer, and multiple upstream firms (UFs), representing suppliers that make relation-specific investments to provide inputs for production. The downstream firm combines these inputs to produce an output good sold in a competitive market. The market price of the output good follows a geometric Brownian motion, introducing stochastic uncertainty into the system. As a result, both the supply chain's joint profit and the individual firm's value become uncertain over time. To address this uncertainty, the study employs a Real Option Approach (ROA) to derive the combined value of the supply chain and determine optimal bankruptcy thresholds for both upstream and downstream firms. Each firm also determines its optimal debt level by maximizing total firm value, defined as the sum of equity and debt values. Analytical solutions for firm values, optimal debt levels, and default thresholds are derived, while Monte Carlo simulations are used to estimate optimal bankruptcy timing under stochastic price dynamics. The results show that financial decisions among supply chain members are highly interdependent. Market competition and structural parameters, such as input substitutability and returns to scale, significantly influence optimal debt levels and bankruptcy thresholds. Overall, the study highlights the importance of coordinated financial and operational decision-making to improve supply chain resilience amid global uncertainty.

Keywords: **Supply Chain; Market Uncertainty; Real Options; Financial Decision; Exit Strategy**