Resolving Principal–Agent Misalignment in Decentralized Supply Chain Governance: A Mechanism Design Approach to Incentive-Compatible Contract Structuring

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Abstract. Principal–agent misalignment in decentralized supply chains constitutes a persistent source of operational inefficiency, characterized by information asymmetry, moral hazard, and adverse selection in inter-organizational contracting. This study develops a mechanism design framework to engineer incentive-compatible contract structures that reconcile divergent objective functions between supply chain principals and downstream agents. Drawing on a multi-tier dataset of 412 manufacturing firms across three continents (2019–2023), we employ a combination of structural equation modeling and iterative Nash bargaining simulations to derive equilibrium contract parameters. Empirical results demonstrate that properly calibrated performance-contingent transfer schedules reduce coordination losses by 31.4% and improve supply chain surplus distribution equity by 22.7%. The findings provide actionable contract architecture guidelines for operations managers and procurement executives navigating high-complexity, multi-agent supply network environments.

Keywords: principal–agent theory, mechanism design, incentive-compatible contracting, supply chain governance, information asymmetry, Nash bargaining equilibrium, moral hazard mitigation, decentralized operations management, performance-contingent transfer schedules

Introduction

The structural fragmentation of contemporary global supply chains has intensified the severity of principal–agent conflicts that arise when strategically autonomous firms must coordinate resource allocation, risk-sharing, and performance accountability across

organizational boundaries. In decentralized supply chain architectures—where upstream principals delegate procurement, production, or fulfillment responsibilities to downstream agents operating under private information—the misalignment of incentive structures frequently produces suboptimal systemic outcomes, including demand signal distortion, quality shirking, and opportunistic renegotiation. As of 2024–2026, accelerating supply chain regionalization, the proliferation of contract manufacturing arrangements, and growing reliance on platform-mediated logistics ecosystems have collectively elevated the practical urgency of resolving these governance deficiencies at scale. The theoretical foundations of principal–agent analysis, originating in the seminal works of Ross (1973), Holmström (1979), and Grossman and Hart (1983), have established that optimal contracting under asymmetric information requires the careful design of incentive schedules that render truthful revelation and cooperative effort individually rational for the agent. However, the operationalization of these theoretical prescriptions in realistic multi-tier supply chain settings remains markedly underdeveloped. Existing contract models frequently abstract away agent heterogeneity, dynamic renegotiation risk, and the multi-dimensional nature of supply chain performance metrics—limitations that substantially reduce their prescriptive validity for practicing managers. Mechanism design theory offers a rigorous extension of classical contract theory by inverting the problem formulation: rather than optimizing agent behavior within a fixed contract, the designer engineers the contracting environment itself to induce desired outcomes as dominant-strategy or Bayesian–Nash equilibria. Applied to supply chain governance, this paradigm permits the systematic construction of transfer payment schedules, performance thresholds, and penalty-bonus structures that are simultaneously incentive-compatible, individually rational, and operationally feasible. This paper addresses the following central research question: How can mechanism design principles be operationalized to construct incentive-compatible contract architectures that measurably reduce principal–agent coordination losses in decentralized multi-tier supply chains? To answer this question, the study proceeds as follows. Section 2 provides a structured review of principal–agent theory and mechanism design as applied to supply chain contracting, identifying critical gaps in the extant literature. Section 3 presents the formal theoretical model, deriving equilibrium contract parameters under conditions of bilateral moral hazard and adverse selection. Section 4 describes the empirical methodology, including dataset construction, structural equation modeling specification, and Nash bargaining simulation design. Section 5 reports the quantitative findings and tests the proposed contract architecture against benchmark coordination mechanisms. Section 6 discusses the managerial implications of the derived incentive structures for procurement strategy, supplier relationship management, and supply chain risk governance. Section 7 concludes with limitations, boundary conditions, and directions for future research in dynamic mechanism design and digital contract enforcement.

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