Coordination of a three-tier supply chain using options contracts

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Short abstract
In this research, we examine the impact of put and call options contract on supply chain member profits under stochastic supply and demand conditions for a three player supply chain. Our findings show that supply chain coordination using option contracts is sensitive to demand trends. The managerial implications of this finding are that supply chains must lean forward (use call options) in in growth markets, lean backward (use put options) in declining markets, and stand upright (balanced put vs. call) at potential turning points. This coordinated leaning can be operationalized through the use of multi-party options contracts.

Keywords: Options Contracts, Supply Chain Coordination

Topics: Supply Chain, Outsourcing and Procurement

Methodology: Simulation Modelling

Purpose
The use of procurement options contracts for coordinating supply chain partners can yield significant benefits over more traditional fixed quantity contracts and flexible buy-back contracts. The benefits accrue to the coordinated partners as supply chain surplus is generated through reduction in double marginalization. With this framework, partners are incentivized through optionality, motivated by cooperation and controlled using contracts. In this research, we examine the impact of various contract option structures on supply chain profits using a multi-period simulation model. Specifically, we examine put and call options using fixed and flexible order quantities under stochastic supply and demand conditions for a three player supply chain; a retailer, manufacturer and supplier.

Background
Coordination in a two-tier retailer-led supply chains through options contracts was investigated by Wang (2007). Using the two entity supply chain in a single period model as a framework, they derived optional parameter ranges for the call option. Zhao et. al. (2010) applied a cooperative game theory model to explore implementation issues for supply chain coordination using flexible quantity call options contracts between a retailer and a manufacturer. Gomez-Padilla and Mishina (2009) used simulation to investigate the benefits of put and call options contracts compared to fixed quantity and buy-back contracts for a two tier, multi-period supply chain model between a retailer...
and multiple suppliers. An options contracts approach to coordination between, a manufacturer and supplier, when the supplier’s production quantity is uncertain was explored by Xu (2010).

**Relevance and Contribution**

Given the current industry environment, where cooperative relations are sought between potential partners, the motivation to define and understand the conditions that foster cooperation in such a complex setting is a compelling and worthy research objective. Our study synthesizes several different approaches to modelling supply chain coordination through the use of contract options. In this study, we apply the Naish bargaining solution in the context of a 3-player cooperative game to determine the necessary conditions for which a core is non-empty, thus laying the foundation for coordination of the entire chain. We use simulation to explore the impact of operational decisions and various contract designs over multiple periods.

**Findings**

Our findings show that supply chain coordination can be achieved in a three-tier, multi-period supply chain, that significant supply chain surplus is captured by using option contracts and that different demand trends require different contract structures to increase performance of the overall supply chain. Specifically, we found that call options enhance supply chain performance for upward trending demand, put options enhance supply chain performance for downward trending demand, and a full collar (put and call) options contracts enhance supply chain performance at inflection points in demand.

**References**


