Summary

Risk Management at the Interface of Operations and Finance

Flexibility is inherent in the decision-making process of all firms. This flexibility, if utilized optimally, can generate value for the firm and its supply chain partners. This research develops models to value operational flexibility in a number of scenarios. The scenarios considered cover a spectrum of decision-making problems facing firms, including dual sourcing, offshoring/reshoring production, transporting commodities and switching between production states. We utilize options theory and stochastic control theory to develop models that allow for the valuation of operational flexibility in the considered scenarios. Valuing this flexibility consequently yields the optimal strategies/policies that the firm should adhere to in order to realize this value. This research contributes to the literature on flexibility and risk management at the interface of operations and finance. From an application perspective, the thesis contributes to the literature on sourcing, offshoring and ocean freight transportation. From a methodological perspective, the thesis also contributes to the literature on stochastic control and options valuation. The thesis consists of four main chapters (excluding introduction and conclusion chapters), each a working paper tackling a different scenario. The following paragraphs summarize each of the chapters.

Transporting Commodities: Hedging against Price, Demand and Freight Rate Risk with Options

Like options on stocks, options on commodities provide firms with protection against adverse price movements. Many firms procure a commodity at offshore locations and transport it via ocean freight. Increased globalization and increased demand for ocean-based transportation has resulted in ocean freight itself becoming a volatile commodity. In this chapter, we consider a commodity processor and develop models to determine the firms optimal hedging policy. The models allow for three sources of uncertainty; demand, commodity spot price and freight rate. The optimal hedging policies are variants of the classical newsvendor critical fractile. We show that partially procuring the commodity and its freight through option contracts, rather than entirely on the volatile spot market creates value, even for a risk-neutral firm. We then perform extensive numerical experiments to study the influence of the underlying parameters on the optimal hedging policies and value creation.

Dual Sourcing: Optimal Procurement Policy with Option Hedging against Freight Rate Risk

This chapter investigates the role of options in providing protection against volatile ocean freight rates for a commodity processor that employs a dual-sourcing strategy. Procuring the commodity offshore results in lower procurement costs when compared to procuring the commodity in the domestic market, but entails a transportation cost. Transportation of goods from offshore markets typically involves ocean freight. Ocean freight rates have become highly volatile. We develop models that integrate the firm's optimal options position and optimal sourcing decision, taking into account volatile ocean transportation costs. We develop a model for a commodity processor that hires tankers, restricting the firm to charter an integer number of tankers to reflect reality. We also develop a model for a commodity processor that charters container ships. Tankers are cargo ships that are typically used to transport fluids such as crude oil, while container ships are cargo ships that carry their entire load in truck-size containers. We determine the firm's optimal options position for each model, and conduct numerical studies. Our studies highlight the importance of explicitly accounting for the cost. Our studies demonstrate the cost-effectiveness of utilizing options on the freight rate and a dual-sourcing strategy. Our studies also shed some light on the popularity of 'mega ships'.

Valuing Optimal Switching Options with the Moving-boundary Method

The primary contribution of this chapter is the development of a stochastic control-based methodology to tackle the optimal-switching problem. Specifically, we extend the Moving Boundary Method to tackle such problems. The Moving Boundary Method has been successfully applied to optimal-stopping problems. Optimal-switching problems can be thought of as sequences of optimal-stopping problems and possess complicating features, making an extension of the Moving-Boundary Method to tackle such problems non-trivial. The method is then applied to problems in the sourcing and energy domains.

A Stochastic Control Approach to Operationalizing Offshore Production Decisions

As a result of increased globalization, firms tend to offshore parts of their production to benefit from raw material price and labor cost differences across various locations, increasing the flexibility of their supply chains. These price differences, however, are not static. For example, in the past China had the lowest labor rates in the world, but increased global competition has driven drown labor rates in many countries. In this chapter, we consider a firm that can produce in two locations: either domestic or offshore. The firm has an uncertain offshore profit margin which makes the offshoring strategy risky. Using switching options we propose an optimal hedging policy that tells the manager when the firm should produce in the offshore facility and when it should produce in the

domestic one. We then extend the policy from bang-bang to the proportional policy in which we determine what proportion of the firm's production should be offshored at any point in time. To do this we formulate the problem based on stochastic impulse control.