



## Operational hedging against adverse circumstances<sup>☆</sup>

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### ABSTRACT

This paper investigates operational hedging against severe disruptions to normal operations. It offers a new method to evaluate the extent that operations policy serves as a hedge against adverse circumstances. We apply the proposed method to explore how supply chain characteristics affect the responses of airlines to the acute demand fall off after the September 11 terrorist attacks. Results indicate that operational hedging vehicles (fleet standardization, high-fleet utilization, an aircraft ownership policy rather than leasing, and international operations) are more powerful in protecting firms than using financial instruments. The study contributes in guiding managers as to how operations policy can serve as an imperative factor in mitigating exposures to low-end performance levels.

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## 1. Introduction

The utilization of operations to manage risks has recently attracted considerable attention and a growing interest in applying risk management concepts to manage the operations of firms. In particular, several studies focus on risk arising from disruptions to normal activities of supply chains and their consequences (e.g., Papadakis and Ziemba, 2001; Lewis, 2003; Hendricks and Singhal, 2005; Kleindorfer and Saad, 2005). Major sources of disruption arise from exogenous hazards, such as earthquakes,

tornadoes and flooding, political instability, and terrorist attacks. Prior studies focus on risk management as well as on the structural and temporal pathology of operational failure. This study extends this line of research and investigates to what extent can operations policy serve as a hedge for firms facing uncertain adverse circumstances. In particular, we examine the relative impact of operational hedging vehicles compared with financial hedging vehicles.

We focus on the airline industry to investigate how attributes of operations policy, such as technology and capacity choices, affect firms' performance under adverse circumstances. The September 11 terrorist attacks provide an ultimate setting for gaining insights into the operational vehicles employed by airline carriers to reduce damage. In this study, we introduce a method to evaluate firms' total hedging level and then investigate their operational and financial determinants. We concentrate on the role of operations management in mitigating firms' exposure to

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financial distress under adverse circumstances, together with the utilization of financial instruments to manage risks.

Evaluating firms' total hedging level, we follow Hendricks and Singhal (2005) in our reliance on financial performance. We build on Stulz (1996), who argues that "the primary goal of risk management is to eliminate the probability of costly *lower-tail outcomes*" [pp. 23–24, emphasis added]. The underlying assumption is that distribution of firms' *low-end* performance levels under unfavorable circumstances signals their capabilities to protect themselves against poor performance levels. Employing time-series cash flow data for estimating performance distributions, we formalize Stulz's argument and introduce a concept of *lower-tail stochastic-dominance (LSD)*. The LSD comparison is a variation of traditional stochastic-dominance widely used in micro-economics, except that it applies to adverse lower-tail performance—see detailed discussion in Section 3. The LSD concept provides a means to examine the influence of both operational choices and financial instruments on mitigating the exposure to financial distress under adverse circumstances. We use data from nine U.S. airlines over 44 quarters from 1990 through 2000 and apply the LSD concept to rank the total hedging level of the airlines.

The empirical results offer a ranking of U.S. airlines according to their total hedging level using LSD, in which Southwest and Skywest were the most hedged, whereas America West and US Airways were the least hedged. We then demonstrate the effectiveness of the LSD concept by showing that more hedged airlines responded better (less badly) to the demand fall off following the September 11 terrorist attacks. A higher rank of total hedging level is positively and significantly correlated with increased cash flow from operations and less depressed stock returns after the attacks.

Being aware of the small sample size implied by the airline industry, a series of robustness checks is performed to validate the proposed hedging rank and its outcome. We show that the hedging rank (i) differs from conventional risk measures because it concentrates on hedging against adverse circumstances, not on variation-reduction process control, (ii) is independent on the choice of cash flow as the primary variable for the analysis, (iii) is robust to the classification of low-end tails of the performance distributions, and, (iv) does not serve as an expected performance measure because it captures ability to reduce the probability of low-end performance levels, not to perform well on favorable events. In addition, we use both streams of cash flow and investors' response to the events on September 11 to corroborate the evidence on hedging against the adverse consequences of the attacks. Taken as a whole, the proposed rank reflects capability to hedge against the disruptions to normal airline operations caused by the terrorist attacks.

Searching for operational and financial vehicles used to alleviate the firm's exposure to lower-tail performance under severe disruptions, findings indicate several hedging vehicles. Specifically, results indicate that higher fleet standardization, higher fleet utilization (i.e., lower excess capacity), an aircraft ownership policy (rather than

leasing), international operations, and cash holdings increase the hedging level of airlines and provide tools to better respond to the unfavorable event. In contrast, financial leverage and financial derivatives used to protect from fuel price volatility are insignificantly associated with the hedging rank. The findings indicate that operating hedging vehicles are more powerful in protecting airlines than using financial instruments.

Examining operational and financial vehicles separately, however, emphasizes the role of operations policy in risk management. Financial leverage and financial derivatives used to protect from fuel price volatility are significantly associated with the hedging rank when operational hedging vehicles are omitted, but this significance disappears in the presence of operational hedging vehicles. In contrast with financial hedging against market risks and volatility in commodity prices documented in the finance literature, the findings emphasize the important role of operational vehicles in hedging against adverse circumstances.

Overall, the findings provide firms with operational management guidance as to how to mitigate exposures to low-end performance levels under adverse circumstances. This study contributes to the operations management literature in two ways. First, it supports evidence concerning operational vehicles for mitigating firms' exposure to adverse circumstances firms want to avoid. The findings extend our knowledge as to how airlines employ their operations to better respond to a dramatic demand fall off and, thus, highlight operational hedging. The results highlight the substantial role of the operations function in hedging against adverse circumstances, above and beyond financial instruments. Second, it introduces the LSD concept for comparing firms' hedging levels. This concept can be further applied to investigate the use of operations to hedge firms' downside performance in various industries and settings.

This paper is organized as follows: Section 2 discusses potential means for operational hedging in the airline industry; Section 3 introduces the concept of *lower-tail stochastic-dominance* and applies it to the airline industry; and Section 4 demonstrates the validation of the proposed hedging measure. Section 5 examines operational and financial vehicles of hedging; and Section 6 provides a summary.

## 2. Vehicles of operational hedging

While the finance literature investigates various types of financial derivatives for hedging against market risks (i.e., changes in currency exchange rates, commodity prices, and interest rates), there is limited evidence concerning the way firms use their operations to hedge against the risk of substantial demand fall off due to adverse situations. Abundant hedging research has investigated the use of financial derivatives as hedge instruments (e.g., Brown, 2001; Geczy et al., 1997; Guay, 1999). However, Guay and Kothari (2003) report that firms only use derivatives to fine-tune an overall risk management program that is likely to include operational hedges. Specifically, an operational hedge is interpreted as

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