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Value of a put option to the risk-averse newsvendor

Frank Chen & Mahmut Parlar

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Abstract

In this paper we consider an extension of the single-period inventory model with stochastic demand where a put option can be purchased to reduce losses resulting from low demand. The newsvendor not only chooses the order quantity but also determines the “strike price” and/or the “strike quantity” of the put option. As the buyer of the put option, the newsvendor pays the option writer an amount that equals the expected option payoff plus a risk premium and receives from the option writer the strike price (adjusted for salvage value) for each unit that the demand falls below the strike quantity. The newsvendor is risk-averse and attempts to maximize an expected utility function. We show that: (i) the same order quantity maximizes the expected profit with or without the option; and (ii) the strike price and strike quantity do not affect the newsvendor's maximum expected profit but they do affect the variance of the profit. We use concepts from stochastic dominance theory to prove the following

result: if the newsvendor uses the expected profit maximizing order quantity and if she has a quadratic utility function, then maximizing her expected utility is equivalent to minimizing the variance of the profit. Sensitivity analysis results indicate that under poor economic conditions (low sale price/high purchase cost) it may not be optimal to purchase the option. We also find that when the option writer assumes a higher risk/return for the random option payoff (that he pays the newsvendor) the newsvendor can reduce her profit uncertainty by choosing the strike price or strike quantity optimally.

Keywords:

Newsvendor model | put option | stochastic dominance

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Notes

[1]It is important to note the shortcomings associated with the quadratic utility function: It displays increasing risk aversion (Pratt, 1964; Arrow, 1971) and it is increasing only for $\Pi < a_1/(2a_2)$. However, quadratic utility is widely used in financial modeling since it approximates many concave utility functions such as the logarithmic utility; see Levy and Sarnat (1984, p. 245). A simpler (and equivalent) form of the quadratic utility function $u(\Pi) = \Pi - a_2\Pi^2$ has also been commonly used in inventory literature; see, Lau (1980b) and Lau and Lau (1999).

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