A Multiordering Newsvendor Model with Dynamic Forecast Evolution

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We consider a newsvendor who dynamically updates her forecast of the market demand over a finite planning horizon. The forecast evolves according to the martingale model of forecast evolution (MMFE). The newsvendor can place multiple orders with increasing ordering cost over time to satisfy demand that realizes at the end of the planning horizon. In this context, we explore the trade-off between improving demand forecast and increasing ordering cost. We show that the optimal ordering policy is a state-dependent base-stock policy and analytically characterize that the base-stock level depends on the information state in a linear (log-linear) fashion for additive (multiplicative) MMFE. We also study a benchmark model where the newsvendor is restricted to order only once. By comparing the multiordering and single-ordering models, we quantify the impact of the multiordering strategy on the newsvendor’s expected profit and risk exposure.

Key words: newsvendor; MMFE; forecast evolution; dynamic ordering

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1. Introduction

Creative businesses, such as those in toy and fashion industries, have difficulty matching supply and demand due to high demand uncertainty, long supply lead times, and short selling seasons. Firms commit to orders well in advance of the selling season (e.g., up to nine months in the apparel industry) in face of high uncertainty as initial demand forecasts available for planning are highly inaccurate due to the unpredictable nature of customer preferences and constantly changing market trends (Fisher et al. 1994, Boyaci and Özer 2010, Wang and Tomlin 2009). At the same time, new information about demand gradually becomes available and the uncertainty resolves as the selling season approaches. To take advantage of more accurate demand information, firms may need to postpone their order commitment until closer to the selling season. This requires the use of more flexible production technologies and facilities or more responsive suppliers, which are often more expensive. As such, many apparel (Agrawal et al. 2002) and toy (Wong et al. 2005) companies respond to constantly evolving market information by ordering from a portfolio of sources that differ in lead times and costs. In this context, an optimally designed portfolio of early and late orders may help achieve better operational performance.

This research studies a multiordering strategy for a firm that sells a seasonal product. We formulate a dynamic newsvendor model. The newsvendor has multiple opportunities to place orders at different times before the demand is realized. Multiple ordering options can be found in several practical contexts: it can be that the newsvendor sources from multiple suppliers that require different lead times and costs (Yan et al. 2003); or that the newsvendor produces in-house using multiple technologies with different costs and lead times (Donohue 2000); or that the newsvendor orders from a single supplier offering a menu of advance purchase discounts (Tang et al. 2004). Early orders are cheaper but are exposed to higher demand uncertainty, and late orders incur cost premiums. To reduce demand uncertainty, the newsvendor constantly updates her demand forecast based on market information observed over time, before demand is realized. The information can be expert estimates (Fisher and Raman 1996), market research reports (Donohue 2000), retail test results (Fisher and Rajaram 2000), etc., which are valuable in forecasting the final demand. To model such demand information and