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Optimal hedge ratio in a biased forward market under liquidity constraints☆

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ABSTRACT

The paper[1] investigates corporate hedging behavior in a theoretical model focusing on two important influencing factors: liquidity constraints affecting the funding opportunity of the firm and the extent of available hedging position, and speculative motive of risk management based on a bias of forward market. The optimal hedge ratio is analyzed in the function of three determining factors of the corporate utility function: the risk aversion ratio of the firm, the expected value of the hedge position, and the financing costs due to the hedging itself. The large empirical evidence of corporate over- and underhedge can be better understood in the presented framework.

1. Introduction

Corporate risk management has an essential role in practice (Walter, 2014), its relevance is explained from different aspects in the financial theories. The main reason for corporate hedging in all of the theories is some imperfectness of the markets (Hommel, 2005): the presence of taxes (Smith and Stulz, 1985), transaction costs (Dufey és Srinivasulu, 1984), the asymmetric information among market participants (Myers and Majluf, 1984; Tirole, 2006), or financial distresses caused by unavailable financing (Smith and Stulz, 1985; Froot et al., 1993; Tirole, 2006).

Even the models based on the lack of financing neglect the financial consequences (upfront paying obligations, maturity mismatches, mark-to-market settlements of derivative positions, or cash-collaterals) of the hedging itself. Although the analysis of Froot et al., (1993) mentions the trade-off between the variability of future cash-flow and the fluctuation of cash in the interim period if the hedging position is to be financed, they do not analyze this problem further.

Models considering liquidity risk of hedging appeared in the early 2000's, by modeling either the possible liquidation of the hedging position in case of a failed margin call (Deep, 2002), or calculating the financing costs deriving from the credit spread to be paid to collateralize the loss of the position (Korn, 2003).

Rampini et al., (2014) analyze the contradiction between the theory and the empirical experience of the hedging behavior of financially constrained firms. They point that in contrast to the theory suggesting more risk management in case of more

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constraints, the larger and financially more stable corporations were found to hedge more. They model the trade-off between financing and risk management in a dynamic setting based on the collateralization need of all obligations.

The speculative motive of "hedging" appeared in the works of many authors (e.g. Holthauser, 1979; Rolfo, 1980), but the models usually assume an unbiased forward/futures market, therefore a zero expected return of the hedging position. Expected return, however, can derive from comparative advantage of some firms (Stulz, 1996) or better information of the management (Conlon et al., 2015) that can be used to enhance corporate value and leads to selective hedging. On the other hand, uncovered interest rate parity is found to fail in the pre-crisis period (Darvas, 2009) and persistent deviations even from the covered interest rate parity were detected after the crisis (Du et al., 2016) in most of the currencies, suggesting that speculation also has a role in FX-risk management. The effect of speculation on the currency futures market is investigated by Hossfeld and Röthig (2016).

The paper is structured as te following: first, the model of corporate hedging decision is presented, then an analytical solution is given for the lower and upper bound of the optimal hedge ratio. The next part quantifies the effect of the influencing factors through some simulations using predetermined sets of the parameters. The results show that the expected value of the hedge position has a crucial role in the hedging decision, causing both under- and overhedge to be optimal even for risk-averse firms.

2. The model

The model (Dömötör, 2014) assumes a company being exposed to the change in the market price of its product, so its revenue and profit bear market risk. We assume furthermore that hedging of this open position in the form of forward agreements is available on the market. The spot price (S) follows geometric Brownian motion (GBM) with an expected drift of μ and volatility of σ. According to the stochastic calculus the change of the forward price[2] (F) also follows a GBM according to Eq. (1):

$$dF = (\mu - r)Fdt + \sigma F dw \tag{1}$$

where r stands for the risk-free logreturn and dw - the change of the Wiener process - is a normal distributed random variable.

In contrast to the models of Deep (2002) and Korn (2003), Eq. (1) is not supposed to be a martingale, so the drift rate can differ from zero in either direction, depending on the relation between μ and r.

The model is built up as follows: the company decides at time 0 about the hedging amount (h), in our case the amount sold on forward, given the production quantity of Q. The maturity of the forward agreement and realization of the production are at time 2, and during the lifetime of the derivative position the unrealized loss is to be collateralized at time 1. We suppose, the firm can borrow the amount of the collateral from the market at a given credit spread and after the placed collateral the risk-free return is paid. The hedge ratio is unchanged in both periods. The behavioral model is discrete; as it reflects better the corporate hedging practice, and it contains lognormally distributed market price, based on Eq. (1), similarly to the method of Monte Carlo simulations.

The corporate profit (π) is realized at time 2:

$$\pi = S_2{}^{*}Q - c(Q) + h^{*}(F_0 - S_2) + k^{*}\min\left[h^{*}\frac{(F_0 - F_1)}{1 + r_{eff}}; 0\right] \tag{2}$$

The cost (c) is a function of Q, the indices refer to the time, r_{eff} is the risk-free effective return and k stands for the credit spread to be paid (above the effective return) by the hedging company, k is considered to be constant.

The corporate decision making is to be modeled in a risk-return framework, so an increasing and concave - reflecting a decreasing marginal utility (risk aversion[3]) - corporate utility function is supposed, and the aim of the company is the maximization of its expected value. The model applies a CRRA (constant relative risk aversion) type utility function:

$$U(\pi) = \frac{\pi^{1-\gamma}}{1-\gamma} \tag{3}$$

where γ is a measure of the risk aversion.[4]

The optimal hedge amount (h), which maximizes the expected utility, meets the following requirement:

$$E\left[U'(\pi)^{*}\left(F_0 - S_2 + k^{*}\min\left[0; \frac{F_0 - F_1}{1 + re_{ff}}\right]\right)\right] = 0 \tag{4}$$

Eq. (4) can be written in the next form:

$$E\left[U'(\pi)\right]^{*}E\left[F_0 - S_2 + k^{*}\min\left[0; \frac{F_0 - F_1}{1 + r_{eff}}\right]\right] = -\mathrm{cov}\left(U'(\pi); F_0 - S_2 + k^{*}\min\left[0; \frac{F_0 - F_1}{1 + re_{ff}}\right]\right) \tag{5}$$

[2] Trading related costs, like transaction costs related to market liquidity (Váradi et al., 2012) are disregarded.

[3] For more about risk appetite, see Berlinger-Váradi (2015).

[4] Optimal hedge according to several riskiness measures is analyzed by Eshani and Lien (2015).