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Optimal corporate hedging using options with basis and production risk☆

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ABSTRACT

We investigate the optimal hedging strategy for a firm using options, where the role of production and basis risk are considered. Contrary to the existing literature, we find that the exercise price which minimizes the shortfall of the hedged portfolio is primarily affected by the amount of cash spent on the hedging. Also, we decompose the effect of production and basis risk showing that the former affects hedging effectiveness while the latter drives the choice of the optimal contract. Fitting the model parameters to match a financial turmoil scenario confirms that suboptimal option moneyness leads to a non-negligible economic loss.

1. Introduction

The two major global crises—the default of subprime mortgages and the European sovereign debt downfall—that have characterized recent years have produced, among other effects, a dramatic soaring of volatility. In these circumstances, it is fundamental for firms to have effective hedging strategies

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set up so as to avoid the disruptive consequences of price jumps. As evidence of its relevance, over the last 30 years risk management has attracted the attention of a large body of financial literature, which has investigated both the theory and the practice of firm hedging. Among these studies, scholars have investigated theoretical hedging motivations, the empirical determinants for firms to protect against market risks and the type of instruments—mainly, financial derivatives—used to this purpose. Within the last topic, firms can basically opt between linear (e.g., forwards, futures and swaps) and non-linear (e.g., options) instruments. The optimality of the one type relative to the other has been discussed thoroughly in the literature, as well as the optimal hedging strategy when linear instruments are chosen. Surprisingly, in spite of its widespread use in firm hedging strategies, little research has been conducted on the determination of an optimal hedging policy using options.[1]

In this paper we study how firms can optimally choose an option contract so as to minimize the inherent risk exposure. As risk management with options—unlike linear financial derivatives—involves a hedging cost, the investigation of this optimality requires a constraint given by the firm's budget. Also, the "optimality" itself needs to be somehow defined. In the case of linear hedging, as for futures, the most common approach is to minimize the variance of the hedged position, computing the so-called minimum variance hedge ratio (Ederington, 1979; Johnson, 1960; Stein, 1961). However, this approach is not applicable to option hedging, as the hedged position—that is the combined position of the exposure (i.e., the naked position) and the derivatives—is very different. In linear hedging, the hedged position does not have a directional risk, as the potential gains (losses) from the derivatives offset the losses (gains) on the naked position, leaving the hedger with virtually no uncertainty.[2] Through option hedging, however, firms may set a floor to the losses (i.e., neutralizing the downside risk), but the right to exercise the derivative contract leaves the potential upside unaffected. The hedged position is therefore asymmetric and the hedging efficiency cannot be evaluated through the conventional variance.

Based on this reasoning, Ahn, Boudoukh, Richardson, and Whitelaw (1999) propose a value-at-risk (VaR) approach to option hedging. The authors consider a firm facing only price risk (i.e., the uncertainty of future price), since the production is taken as certain.[3] In this framework, the optimal option hedging strategy is represented by the contract (i.e., the put option strike price) that minimizes the VaR of the hedged position. Option hedging necessarily leads to a trade-off between the effectiveness of the insurance (the amount of hedged risk) and its cost (the option premium). Interestingly, the authors show that, for reasonable levels of the expense which the firm devotes to the hedging program, the optimal option contract (i.e., the put option strike price) is independent of the hedging cost. This finding, which is an important insight, holds under the assumption of absence of production risk and when VaR is recognized to be the proper risk measure.

However, it has been largely shown (Brown and Toft, 2002; Moschini and Lapan, 1995) that the corporate risk exposure has a highly non-linear shape, and this convex exposure is more efficiently hedged via non-linear instruments.[4] The more relevant reason for this non-linearity is the correlation between the production and the price risk.[5] Lapan, Moschini, and Hanson (1991) show that the optimal hedge for a firm facing only price risk is ensured by forward (linear) contracts, while Sakong, Hayes, and Hallam (1993) and Moschini and Lapan (1995) find that the opposite is true when the firm has to also cope with production uncertainty.[6] In other words, the presence of quantity (production) risk is

[1] Bodnar, Hayt, and Marston (1998) document that among derivative users, 68 percent of US firms use options.

[2] Such a perfect hedge is a pure theoretical concept, as in practice the hedger with futures always trades off price risk with basis risk.

[3] The authors assume that the firm enters in a derivative contract written on the exact same type of asset exposed to risk.

[4] The superior hedging performance of non-linear instruments is also evidenced in the context of financial portfolios (e.g., Topaloglou, Vladimirou, & Zenios, 2011).

[5] The non-linear exposure function may also result from a non-zero correlation between non-hedgeable (short-selling and borrowing constraints) and hedgeable (price) risks, as in Adler and Detemple's (1988) model.

[6] The same argument is reached by Brown and Toft (2002). However Adam (2009) finds little empirical support to this conclusion, as in his study the role of production uncertainty moderately explains option hedging. We stress that this evidence should be considered prudently, since he analyzes 69 gold mining companies, and production risk in the gold industry is very modest (the standard deviation of the world gold production from 1990 to 2009 is only 3.22 percent—production data is obtained from 2010 US geological survey).