



## Operational risk of option hedging

Sovan Mitra

Glasgow Caledonian University, Glasgow School for Business and Society, Cowcaddens Road, Glasgow G4 0BA, Scotland, United Kingdom



### ARTICLE INFO

#### Article history:

Accepted 9 April 2013

Available online xxxx

#### Keywords:

Operational risk  
Hedging  
Options  
Option pricing  
Risk management  
Risk measures  
Value at Risk  
Half normal distribution  
Quantile  
Operational Value at Risk

### ABSTRACT

Operational risk is increasingly being recognised as a significant area of risk and regulation, yet there exists relatively little research on it. In this paper we show that operational risk represents a fundamental risk to option hedging and investigate it by proposing a new theoretical model. We derive an exposure indicator for the operational risk of option hedging and the resulting operational risk distribution. We obtain analytical results for various risk measures including the Value at Risk equation; this includes deriving a new analytical result for the quantile function of the half-normal distributions (which will be of interest to Statisticians in general). We determine an analytical solution to the price of options under operational risk. We conduct numerical experiments on empirical option data to validate our model and estimate the operational Value at Risk for option hedging.

© 2013 Elsevier B.V. All rights reserved.

### 1. Introduction and outline of paper

The events of the global credit crunch and past financial crises have demonstrated the necessity for adequate risk management and measurement (see for instance Kabir and Hassan, 2005; Mitra and Date, 2010; Mitra and Ji, 2010; Stonham, 1999). Operational risk has become increasingly important as banks and regulators are recognising that adequate risk management must incorporate operational risk. Regulation has been adapted in response to financial crises (such as the credit crunch) but also to take into account operational risk. The Basel 2 Accord requires operational risk management in risk regulation. In Basel 2.5 there has been an increased emphasis on credit risk; now capital charges of institutions are calibrated to ratings from recognised credit agencies such as Standard and Poor's. Both Basel 2.5 and 3 introduce new regulation with a greater emphasis on credit and market risk; however there still exists a necessity to manage and regulate operational risk. For instance, Basel 3 discusses protecting against model and measurement error risks.

Some commentators have speculated that the global credit crunch and other significant losses in industry (e.g. Long Term Capital Management) have been partly attributed to operational risk. In particular, institutions assumed that models themselves did not contain any inherent model risk, or that sufficient systems and controls were in place to limit losses. Despite the importance of operational risk, the research literature is scarce and tends to focus on modelling

the impact on an entire department or institution (to be discussed in more detail in Section 2), rather than the sources and causes. This significantly limits our ability to understand operational risk but also disadvantages practitioners from effectively managing operational risk.

One area of operational risk that has not been investigated is option hedging. Option hedging is typically executed to limit risks from financial positions (a more detailed explanation of option hedging will be provided in Section 3.1). Operational risk has increased over the years as financial markets have become increasingly deregulated and more sophisticated. This has led to an increase in the quantity and reliance upon operational activities, leading to potentially higher losses from operational risks. For instance, most banks nowadays use advanced I.T. systems that operate on a global basis and employ sophisticated financial models. A simple operational risk such as data entry error may propagate throughout an entire system, affecting many investments.

Option hedging contains significant operational risk, for instance, due to the high volume of activity involved there can exist risks due to (for example) accounting reconciliation, data entry, and failed reporting, thus increasing probability of making errors in the process of rebalancing. This will be discussed in more detail in Section 3.1. In this paper we show that option hedging contains significant operational risk and that it is theoretically or fundamentally difficult to reduce it without incurring hedging errors. Furthermore, the operational risk of option hedging can be amplified due to the low margin requirements in option trading.

We propose a method of modelling the operational risk of option hedging; we derive an exposure indicator, the operational risk

E-mail address: [sovan.mitra@gcu.ac.uk](mailto:sovan.mitra@gcu.ac.uk).

distribution for option hedging and analytical expressions for frequently used risk measures e.g. Value at Risk. We also derive a solution to the price of options in the presence of operational risk. To the best of our knowledge there is no literature on the operational risk of option hedging and so all the contributions in this paper represent firsts in the area.

The outline of the paper is as follows: in the next section we introduce operational risk and review current operational risk measurement methods. In the next section we explain the fundamental causes of operational risk in option hedging and then introduce our model. We propose our exposure indicator, deriving the operational risk distribution, operational risk measures (such as Value at Risk) and the price of options under operational risk. In the next section we conduct numerical experiments with our operational risk model using empirical option data, and we estimate the operational Value at Risk for a range of parameter values. We finally end with a conclusion.

## 2. Introduction to operational risk

In this section we introduce operational risk and review current operational risk measures. Due to the newness of operational risk there does not exist a consensus definition on operational risk (Loader, 2002); in fact many companies have their own definitions (Loader, 2002). For instance, some firms consider it to be the residual risk once market and credit risk is removed, others consider it to be risks associated with post-transaction clearing and settlement processes (Loader, 2002). Examples of operational risk therefore include I.T. failure (physical or software), damage to physical assets (e.g. through natural disasters) and administration errors (e.g. incorrect data entry). For the purposes of discussion we must clarify our operational risk definition. The Basel Committee's definition on operational risk is 'The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events'. This is the definition of operational risk we will follow.

Currently there is little literature on operational risk measurement. The 3 main operational risk measurement methods are: the basic indicator approach, the standardised approach and the advanced measurement approach. We will now review each method. In the basic indicator approach and the standardised approach, the amount of capital (also called capital charge)  $\kappa$  required to be held by an institution is held to absorb potential operational risk losses. The general method of obtaining  $\kappa$  is to:

1. identify an exposure indicator and calculate its value; and
2. multiply the exposure indicator by some percentage to obtain  $\kappa$ .

The motivations for such an approach are firstly analytical tractability as operational risk modelling can become highly intractable (see for instance the advanced measurement approaches to be covered later). Secondly, this approach can be implemented using data that is easily available: the exposure indicator e.g. gross income. We then assume that our operational risk is only a proportion of the exposure indicator's value and so we multiply it by a percentage to give  $\kappa$ .

The basic indicator approach's capital  $\kappa_{BIA}$  is given by Chorafas (2004)

$$\kappa_{BIA} = \alpha E,$$

where  $\alpha$  is a constant and  $E$  is the exposure indicator for an entire institution. The constant  $\alpha$  is a fixed percentage (currently set by Basel at 15%). Gross income is chosen as an exposure indicator for operational risk because it is an approximate indicator of the scale of business operations, which in turn should reflect the scale of operational risk exposure.

The standardised approach (SA) measures operational risk by dividing a financial institution into 8 business lines (corporate finance, trading and sales, retail banking, commercial banking, payment and settlement, agency services, asset management, and retail brokerage). The SA capital required  $\kappa_{SA}$  is derived by a similar approach to  $\kappa_{BIA}$ :

$$\kappa_{SA} = \sum_{i=1}^8 \beta_i E_i,$$

where  $E_i$  is our exposure indicator for each business line  $i$  (where  $i = 1, \dots, 8$ ) and  $\beta_i$  is a constant analogous to  $\alpha$  but for each business line  $i$ . Hence  $\beta_i$  represents a fixed percentage and Basel has set its range from 12 to 18%; for more details on percentage choices the reader is referred to Chorafas (2004). The term  $E_i$  could represent the gross income from each business line.

The Advanced Measurement Approach (AMA) is the most sophisticated method of all operational risk measures. Currently there is no definitive AMA measure; however there exist 3 sub-groups: scenarios, loss distribution approach (LD) and scorecard. In the LD approach the aim is to obtain a probability distribution of losses for the operational risk of the entire institution (Shevchenko and Wuthrich, 2006). This requires identifying the loss distribution for operational events and combining them into one overall operational risk distribution. Scorecard operational risk measures are qualitative and subjective measures: for a given operational risk factor we assign a probability and subjectively assign an impact score upon the institution.

In conclusion, the basic indicator approach is the most analytically tractable and the easiest to implement of all operational risk measures. The SA is analytically tractable, takes into account variations of operational risk at business line level but is more difficult to implement as it has more demanding data requirements. The AMA approaches are in general more difficult to implement due to data requirements and modelling issues. For instance, in the LD method we would need to model and calibrate the distribution of every operational event type and combine them into 1 overall distribution. This is analytically and computationally a non-trivial task.

## 3. Operational risk model for option hedging

In this section we explain the fundamental or theoretical causes of operational risk in option hedging and then develop our operational risk model for option hedging. We propose an exposure indicator for the operational risk of option hedging, which allows us to derive the operational risk distribution and operational risk measures. We further develop the model to determine the price of options when we include operational risk.

### 3.1. Operational risk in option hedging

Options are an important derivative instrument (see for instance Mitra, 2010a,b). The literature on the operational risk of option hedging is practically non-existent, yet option hedging contains significant operational risk. To understand the operational risk in option hedging we must first understand the causes of it in the option hedging process, which we will now explain.

To hedge out a European call option  $C(t)$  we use a hedging portfolio  $V(t)$  (see for instance Mitra, 2011 for an example) and we must have

$$V(t) = C(t), \forall t \leq T, \quad (1)$$

where  $T$  is the option expiration time. This condition ensures that our hedging portfolio  $V(t)$  yields the same payoff as  $C(t)$  at  $T$ , that is

$$V(T) = \max(S(T) - K, 0),$$

Download English Version:

<https://daneshyari.com/en/article/5054442>

Download Persian Version:

<https://daneshyari.com/article/5054442>

[Daneshyari.com](https://daneshyari.com)