European Journal of Management and Business Economics 25 (2016) 2–7

European Journal of Management and Business Economics

www.elsevier.es/ejmbe

Article

Hedging foreign exchange rate risk: Multi-currency diversification

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ARTICLE INFO

Article history:
Received 13 September 2015
Accepted 10 November 2015
Available online 31 December 2015

JEL classification:
G 11
G 32
C 63

Keywords:
Cross-hedging
Conditional Value-at-Risk
Value-at-Risk
Multi-currency diversification
Multiobjective genetic algorithm

ABSTRACT

This article proposes a multi-currency cross-hedging strategy that minimizes the exchange risk. The use of derivatives in small and medium-sized enterprises (SMEs) is not common but, despite its complexity, can be interesting for those with international activities. In particular, the reduction in the exchange risk borne through the use of natural multi-currency cross-hedging is measured, considering Conditional Value-at-Risk (CVaR) and Value-at-Risk (VaR) for measuring market risk instead of the variance. CVaR is minimized using linear programmes, while a multiobjective genetic algorithm is designed for minimizing VaR, considering two scenarios for each currency. The results obtained show that the optimal hedge strategy that minimizes VaR is different from the minimum CVaR hedge strategy. A very interesting point is that, just by investing in other currencies, a significant risk reduction in VaR and CVaR can be obtained.

Introduction

Over the last few decades, changes in exchange rates have been a major risk for companies around the world. This is particularly true for firms with foreign currency-based activities, such as imports and exports, and corporate cash flows. Thus firm value is dependent on exchange rates, rendering the management of foreign exchange rate risk an important corporate objective and activity. It is accepted that a firm exhibits exchange rate exposure if its value is affected by changes in exchange rates (Adler and Dumas, 1984). The main hedging motives are the minimization of the impact of foreign exchange rate fluctuations on the variability of the firm's operational cash flow and the reduction of the probability of financial distress and bankruptcy (Hagelin, 2003; Solomon & Joseph, 2000). This and other similar problems have been widely analyzed in the related literature. It is not only corporations that exhibit exchange rate exposure. Individuals can also be affected; for example, when they apply for a multi-currency mortgage.

Both corporations and individuals wish to protect themselves and reduce the risk in an effective way. While in many cases it would clearly be more effective to hedge a long currency position using currency futures, there are situations where currency cross-hedging may be appropriate. A medium size company that operates in two or three countries with different currency simultaneously can reduce its income risk by engaging in a hedging activity of assets correlated with the foreign rate. The use of derivatives in small and medium-sized enterprises (SMEs) is not very common (Pennings and Garcia, 2004) and becomes more complicated because of their nature. Given this complexity, multi-currency cross-hedging can be more appropriate.

In general, cross-hedging is a hedging strategy where future contracts on different deliverable instruments are used. Corporations and individuals that have exposure to two or more currencies simultaneously can use cross-hedging. An efficient approach to hedging this risk exposure is to first exploit the natural cross-hedge that arises from the non-zero correlation between the different currency exposures, and then to use derivatives to hedge the residual risk.

There are different ways to measure the risk to hedge. The classical measurement of risk is the variance, but nowadays researchers and practitioners tend to focus on Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR) as market risk measures. The VaR of a portfolio is the lowest amount which the loss will not exceed with probability $1-\alpha$. CVaR is the conditional expectation of losses above the VaR.

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http://dx.doi.org/10.1016/j.redee.2015.11.003
2444-8451/

VaR became very popular due to the fact that Basel Committee assumed VaR as a risk measurement and that the regulatory capital for a loan is correlated to its marginal contribution to VaR. However, the use and acceptance of CVaR have increased because, in contrast to VaR, it meets expected properties. It informs us about how much we could lose if the portfolio return falls beyond VaR. Moreover, it is a convex risk measurement which makes it easy to use to set optimal strategies in optimization problems. Alfaro-Cid, Baixauli-Soler, and Fernández-Blanco (2011), Baixauli-Soler, Alfaro-Cid, and Fernández-Blanco (2010) and Baixauli-Soler, Alfaro-Cid, and Fernández-Blanco (2011) used several risk measures and different approaches to solve classical portfolio optimization problems, and, among other conclusions, they showed that using the variance as risk measure provides the same results than using CVaR. Therefore, using both simultaneously in multiobjective problems is not recommended.

In this context, the main aim of this paper is to establish the reduction in the exchange risk borne through the use of natural multi-currency cross-hedging considering VaR and CVaR as measures of market risk. For this, the mid exchange rates for 10 developed market currencies against the euro from January 1999 to December 2009 were used.

The approach presented in this paper is useful for implementing a multi-currency hedge strategy and it contributes to the literature in several ways. Firstly, it combines the use of VaR and CVaR as measures of risk with the use of multi-currency cross-hedging as instrument of hedging. The majority of papers in the literature use variance and derivatives, mainly current futures, for these purposes. Secondly, the approach of minimum hedge ratio and the mean-risk hedge are used. Thirdly, a multiobjective genetic algorithm is proposed to determine a mean-VaR hedge ratio.

The paper is organized as follows. The second section explains the determination of the hedge ratio and considers different measures of risk. The third section sets out the methodology to compute the mean-CVaR and mean-VaR hedge ratios. The fourth section describes the multiobjective genetic algorithm used to obtain mean-VaR hedge ratio. The fifth section presents the data and empirical results. Finally, the last section summarizes the main findings of the research.

Hedging the foreign exchange risk

The hedge decision requires us to establish both the optimal hedge ratio and the risk measure that needs to be reduced.

Optimal hedge ratio

Suppose that there is a set of two currencies with returns r_0 and r_1. Cross-hedging implies that a short (long) position in a currency is used to hedge a long (short) position in the other, assuming that both currencies are positively correlated. Cross-hedging could exploit the correlation with more than one currency in order to reduce the hedge portfolio risk. In the case of n currencies the hedge portfolio return can be expressed as,

$$r_h = r_0 + \sum_{i=1}^{n} h_i r_i \quad (1)$$

where r_0 represents a long or short position in a currency, r_i represents a long o short position in a currency i in order to hedge and r_h represents the hedge portfolio return. One of the most important issues in hedging refers to the determination of the optimal hedge ratios, h_i. The optimal hedge ratio depends critically on the particular objective function to be optimized and the measure of risk considered. Depending on the objective function the problem to solve is single-objective, since the risk of the hedge portfolio return is minimized, or multiobjective, because the risk and the expected return of the hedge portfolio are minimized/maximized simultaneously.

The most widely used optimal hedge ratio is the so-called minimum-variance (MV) hedge ratio. This is a single objective problem where the risk, measured with the variance, is minimized. This MV hedge ratio is derived by minimizing the variance of the hedged portfolio and it is quite simple to understand and estimate. Nevertheless, the MV hedge ratio ignores the expected return of the hedged portfolio and so, in general, the MV hedge ratio is not consistent with the mean-variance framework. To make this hedge ratio consistent with the mean-variance framework, it is necessary to include the expected return on the hedged portfolio in the objective function explicitly (Chen, Lee, & Shrestha, 2008). Under return-risk hedge ratios, expected return and risk of the hedged portfolio are considered. Companies determine the expected returns and risk, and as a consequence, the optimal hedging is obtained. When variance is used to measure risk, this approach is called mean-variance hedge ratio.

Measures of risk to hedge

The different measures of portfolio risk can be characterized in several ways. The most important characteristics refer to the coherence of the proposed measure and to its ability to deal with the asymmetry of the returns function distribution.

Following Artzner, Delbaen, Erber, and Heath (1999), a risk measurement can be viewed as a single number $\rho(r)$ assigned to the distribution of the portfolio return r. It is said that a risk measurement is coherent if it satisfies four properties: monotonicity, translation invariance, homogeneity and subadditivity. Standard deviation and CVaR satisfy the four properties while VaR satisfies three of them but it does not satisfy subadditivity under certain conditions. An optimization problem that includes non-coherent measures is usually ill-posed, in the sense of Hamard (Alexander, Coleman, & Li, 2006), which means that it does not have a single and exact solution.

Risk measures can be also classified in symmetric and asymmetric measures. Symmetric measures are those that do not take into consideration the asymmetry of the return function distribution, such as variance or standard deviation. Their use is only appropriate when those functions are normally distributed or, at least, symmetric. Asymmetric risk measures are those that take into consideration the skewness and kurtosis of the return function distribution (Harris & Shen, 2006). Among them, VaR and CVaR.

Some of the advantages of VaR are that it takes into account the asymmetric risk, a temporal period and a confidence level. VaR can be defined as the maximum expected loss within an investment horizon of n days with an error probability of α%. By definition, VaR is a quantile of the probability distribution of the portfolio value. Let $f(r_h)$ be the probability distribution function of the future portfolio return and α the significant level (usually 1% or 5%), VaR is implicitly defined in the following equation,

$$\int_{-\infty}^{\mathrm{VaR}} f(r_h)dr = \alpha$$

VaR can be computed by using an analytic method or Delta Normal, a Montecarlo method or a historical simulation method. The analytic method assumes that returns are normally distributed and that VaR is proportional to the variance. In the Montecarlo method, simulations are carried out to generate returns assuming that the return distribution function is known and not necessarily symmetric. Finally, the historical simulation method does not make any assumption regarding the return distribution function. It is based on the idea that past behaviour is a good predictor of future