MODELING STRATEGIES FOR FINANCIAL HEDGING

José Carlos Arias (PhD, DBA)
Professor of Management Science at the European Business School, Cambridge, UK
2nd Floor, 147 St. John Street, London, UK
Email: josecarlosarias@saycocorporativo.com

Abstract

The predominance of existing research related to hedging strategies relative to the futures markets is typically concerned with agricultural, foreign exchange (forex), and petroleum products. This brief research attempts to offer some insight relative to the mathematical modeling techniques which financial hedging strategists employ in order to be successful at mitigating risk. Modeling volatility within the financial markets has not received a great deal of academic attention. Siddique and Harvey undertook a study of autoregressive conditional skewness which utilized GARCH techniques wherein they concluded that autoregressive models might be successful at modeling time-series variations relative to asset pricing such as stock returns but not necessarily for futures and related hedging strategies.[1] Their use and application of GARCH (1,1,1)-M models successfully modeled skewness in a given financial market and this has some application in the futures market both long and short strategies exist as well. **Key words**: Financial Hedging, Strategy, Models, Finance, Econometrics

Garch Modeling

GARCH or Generalized Auto Regressive Conditional Heteroskedasticity is a modeling technique that allows researchers to predict for variances. According to the GARCH Toolbox, GARCH, "…is a mechanism that includes past variances in the explanation of future variances".[2] GARCH is a time-series modeling device to measure heteroscedacity which is time related variance and this model is effective at predicting volatility in a given market. Volatility in the futures market is always associated with risk. GARCH methodology is very effective at examining and determining the nature of risk in the financial markets and certainly in the futures markets.[3] GARCH models and techniques are particularly useful in commodities markets, for example, because commodity prices are subject to excessive amounts of volatility in ways that other financial markets are not.

Predicting, managing, and leveraging the uncertainty in futures market is however vital if a comprehensive market strategy is going to be developed that enables an entity to efficiently control, or at least manage, the cost-basis of its investments or operating expenses. GARCH techniques can be used to construct models that control, to some degree, conditional variances related to futures as well as spot market prices and allow better management of financial or commodities portfolios. The following model introduces the basis for a hypothetical GARCH model:

- GARCH (1, 1) model

The model for traditional hedging techniques

$$(S_t - S_{t-1}) = \varpi_0 + \varpi_1 (F_t - F_{t-1}) + \varepsilon_t$$

$$\varepsilon_t | \phi_{t+1} \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \sum_{j=1}^{\rho} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2$$

S_t	Spot price
S_{t-1}	Time elapsed spot price
F_t	Future price
$F_t - F_{t-1}$	The price difference of the future after 3 months
β_j, α_i	Beta, Alpha
ϖ_0	
ϖ_1	hedging ratio
ε_t	Standard error

[1] Siddique, A. and Harvey, C. Autoregressive Conditional Skewness. National Bureau of Economic Research, Cambridge; 1999: 17.

[2] Garch Toolbox. The Math Works, Inc; Natick, MA; 2006: 15.

[3] Ibid, 15

ϕ_{t-1}	
σ_t^2	

Clearly, the GARCH model allows for a high degree of risk mitigation in the futures market because of its predictive capacity.

Durban-Watson

The Durban-Watson test is the standard method for predicting or measuring auto-correlation phenomena which are important in futures markets that are so critical to hedging strategies. Various techniques are used in the Durban-Watson test to correct for autocorrelation such as applying a parameter to address this factor in the data before regression is performed.[4] However, weighted regression lines often fail this test. That said then the Durban-Watson test is effective in forecasting through its standard time series analysis when appropriate confidence levels have been established. Additionally, the Durban-Watson test is just as effective at modeling predictive behavior of markets when beset by events that affect change in the time series such as sudden exchange rate fluctuations.[5] This application of the Durbin-Watson test can be used to factor in risk for independent market variables such as interest rates or currency exchange rates by predicting the effect that certain scenarios might have on the particular industry being hedged both in terms of the relative spot markets and the futures markets.

Omega Function in Modelling

The Omega function has several uses in mathematics but in hedging specific applications, its f=Ω(g) wherein f expresses constraints g in a given manner has some relevance to risk determination in both financial and commodities markets where hedging typically takes place. Shadwick, Cascon, and Keating make some use of the Omega function where they develop a working model to display cumulative distribution based on a financial application of the Omega function.[6] In their model they let f represent a financial instrument, in this case it could be any form of currency, commodity or otherwise, and the variable, D=(a,b, etc…) defines the domain of F. These researchers manage risk according to the Omega function by determining a return level, r=L in (a,b, etc…) which becomes their loss threshold.[7] While their model is extensive, the application and relevance to managing risk within the financial markets relative to exchange rate risk is clear in that by determining loss thresholds in advance, certain limiters on purchase instruments can be predetermined. This work on the Omega function has led to other extended research on Omega as it applies to financial instruments where Shadwick, Cascon, and Keatings' original definition of Omega is reworked into a new model termed the Sharpe-Omega:[8]

$$\text{Sharpe-Omega} = \frac{\text{Expected Return} - \text{Threshold}}{\text{Put Option Price}}$$

These researchers essentially redefine Omega in the financial risk management model to represent:

$$\Omega(L) = \frac{C(L)}{P(L)}$$

C(L) represents a call option device while P(L) would be a put option.

These and other statistical models are able to offer greater insight into the financial hedging strategies employed by both private and public firms in order to mitigate market and investment risks. These models indicate that a model specifically designed for and customized to each particular market and accounting not only for price fluctuations but also for market variables such as interest rates and exchange rates is plausible for every industry competitor that employs hedging strategies.

Other researchers have applied the GARCH(1,1) model to forecasting volatility with some success in the futures market. One such model that has been demonstrated

[4]Myers, J. L., & Well, A. D. Research Design and Statistical Analysis. Mahwah, NJ: Lawrence Erlbaum Associates; 2003: 18-22.

[5]Kim, S., In, F., & Viney, C. "Modelling Linkages between Australian Financial Futures Markets." Australian Journal of Management, 26/1(2001): 19.

[6]Shadwick, W., Cascon, A. and Keating, C. The Omega Function. The Finance Development Centre, London; 2003: 2.

[7]Shadwick, W., Cascon, A. and Keating, C. The Omega Function. The Finance Development Centre, London; 2003: 2-3

[8]Kazemi, H., Schneeweis, T. and Gupta, R. "Omega as a Performance Measure." CISDM, University of Massachusetts, 06/15(2003).

effectively is the following volatility model of Watkins and McAleer:[9]

$$r_t = \mu + \varphi r_{t-1} + \varepsilon_t, \quad |\varphi| < 1, \tag{1}$$

and the conditional variance of ε_t is:

$$\varepsilon_t = \eta_t \sqrt{h_t}\,, \tag{2}$$

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}\,, \tag{3}$$

These researchers successfully applied this model to daily returns volatility of two separate futures markets in commodities. Their success proves that every hedging entity can adapt these models to develop a functional model that can accurately incorporate intervention related to exchange rate fluctuations into a futures volatility model that works to effectively hedge each entities particular needs and constraints.

References

Garch Toolbox. The Math Works, Inc; Natick, MA; 2006.

Kazemi, H., Schneeweis, T. and Gupta, R. "Omega as a Performance Measure." CISDM, University of Massachusetts, 06/15(2003).

Kim, S., In, F., & Viney, C. "Modelling Linkages between Australian Financial Futures Markets." Australian Journal of Management, 26/1(2001): 19.

Myers, J. L., & Well, A. D. Research Design and Statistical Analysis. Mahwah, NJ: Lawrence Erlbaum Associates; 2003.

Siddique, A. and Harvey, C. Autoregressive Conditional Skewness. National Bureau of Economic Research, Cambridge; 1999.

Shadwick, W., Cascon, A. and Keating, C. The Omega Function. The Finance Development Centre, London; 2003.

Watkins, C. and McAleer, M. "Modelling Time-Varying Volatility in Non-Ferrous Metals Markets." The International Modelling and Software Society, (2002): 1-6.

[9] Watkins, C. and McAleer, M. "Modelling Time-Varying Volatility in Non-Ferrous Metals Markets." The International Modelling and Software Society, (2002): 1-6.