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Cross Hedging of Various Asset Classes : Review and Analysis

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Abstract

Cross hedging has emerged as an effective tool to reduce price risk for different classes where a direct hedge through futures market is not available. Many studies have been conducted to explore the correlation between different asset classes like currency, commodity, stocks, and stock index, insurance and inflation derivatives and analyze the maximum risk reduction possible with different portfolios and combinations. This review paper has attempted to analyze the several studies conducted on cross hedging ranging from simple currency and commodity derivatives to complex inflation and insurance derivatives. The methodology used for these studies and also the effectiveness of these techniques have been studied and analyzed. Cross hedges have been found to be more effective than direct hedges effetiveness of hedging is judged by finding optimal hedge ratio with different models like minimum valance model, Daily Dynamic Conditonal Correlation (DCC) - GARCH, traditional cross hedging, multiplicative cross hedging & Bayesian Procedures.

1. Introduction

MANY COMMODITIES AND financial assets do not have a futures market; hence, it is not possible to reduce price risk through hedging. An alternative is provided by cross hedging, where the asset is hedged using the futures market of another asset with a similar price movement. Although the two assets may not be identical, they are correlated enough, to create a hedged position. This works as long as the prices move in the same direction.

Thus before deciding on the cross hedging, the most important point is that all possible alternatives for cross hedging and the risks associated with them should be analyzed. The historical relationship between local cash price and the future price series considered for cross hedging should be determined to understand the alternative markets and techniques available to hedge price risk. For this, data of the historical cash price and future price should be collected and analyzed.

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Cross hedging can only be successful in reducing price risk ,when the asset to be cross hedged and the future price used for cross hedging moves in a predictable manner and hedged price risk is less than the unhedged price risk. Another important criteria for cross hedging to be successful is that large quantities of the asset to be cross hedged needs to be traded to match the cross hedged futures contract size specifications.

II. Review of Literature on Cross Hedging

This paper reviews several studies done on cross hedging from 1981 to 2013. Starting from simple currency cross hedging, commodity cross hedging, commodity-currency cross hedging , stock cross hedging to several complex and innovative cross hedging done on insurance, inflation,stock index and exchange traded funds derivatives, it has been observed that researchers are exploring creative asset combinations to manage risk, rather than a simple direct hedge through a futures market.

2.1 *Currency cross hedging*

In previous studies conducted by Dale(1981), Hill and Schneeweis (1981, 1982), Grammmtikos and Saunders (1983), it has been discussed how major currency exposures are hedged using direct hedges with currency future contracts in the same currency. With the recent changes in the nature and volume of third world trade and capital flows, the need to hedge minor currencies from LDCs (Least Developing Countries) has also arisen. This makes cross hedging a must, as direct hedge in these minor currencies is generally not available.Hence, Benet (1990) used a variety of commodity future contracts to cross hedge minor currency foreign exchange exposures, for which no forward or futures contracts exist.

Eaker and Grant (1987) examined simple cross hedges for currencies with and without future contracts, portfolio hedges, multiple hedges and commodity hedges are to provide empirical evidence on effectiveness of cross-hedging in reducing foreign exchange risk. Their findings suggests cross hedging as a useful risk reducing technique, but less effective than similar asset hedges. Also in some cases, hedged positions are found to be riskier than unhedged positions due to inter-temporal instability.

Braga, Martina and Meilke (1989) studied the effectiveness of cross hedge as compared to direct hedge for Italian Lira and US dollar exchange rate. Instead of using the traditional Italian Lira-US$ forward market contract to hedge the Lira- Dollar exchange rate, cross hedging is done with DM futures. This paper proves the earlier findings by (Eaker and Grant, 1987) otherwise; as they were based on the concept of using the cross hedge, only where there is no forward or futures direct hedge possible and also that, it is considered to be inferior as compared to the direct hedge.

Ghosh (1996) extended the traditional price change hedge ratio method and applied the theory of co-integration in cross hedging the spot exchange risk of Italian Lira, Belgian Franc and Dutch guilder with US Dollar Index futures contracts. In the past studies, the short run deviations and last

period's equilibrium error have been ignored. This study indicates the superiority of error correction method to the traditional method, in estimating the hedge ratio, through the likelihood ratio test and out-of-sample forecasts. Through this method hedgers are able to manage their portfolio risk at a lower cost.

Further,Wong (1996) examined the cross hedging of foreign exchange exposure, of an international firm in an incomplete financial market, where no suitable hedging instrument was available in the home currency. This was managed by cross hedging with a currency forward contract between the currency to be hedged and a third currency accessible to the firm. Cross hedging opportunities are available since triangular parity conditions exist between the three currencies- home, foreign and the third currency. This study further shows that if the spot exchange rate of home currency against the third currency and that of the third currency and the foreign currency have a positive or negative correlation, the firm's optimal forward position is either an over hedge or an under hedge. This further depends on whether the firms Arrow-Pratt measure of relative risk aversion is less (greater) or greater (less) than unity, respectively.

There has been a massive increase in FDI and FIIs to the emerging countries in the recent years. Hence hedging currency risk in the foreign investment is considered to be important. Aggarwal and Demaskey (1997) explored the hedging of currency risk in cross border portfolio investments in Emerging Markets in Asia with derivatives in major currencies. It has been observed from previous studies of Perold and Schulman (1988), Glen and Jorion (1993), Kritzman(1993) and Eaker , Grant and Woodard(1993), that hedged portfolios offer better risk/return performance as compared to unhedged ones.

Mun and Morgan (1997) in their study investigated the comparative performance of five major currency futures for cross hedging exchange rate risk of local currencies with respect to US dollar and then identify performance rankings by composition method of currency futures and thereby suggest an approach that can facilitate bank managers compare cross-hedging performance of major currency futures and thus identify the optimal cross-hedging strategy. This study also intends to analyze the exchange rate risk faced by depository financial institutions in a selected group of emerging Asian economies of Indonesia, Thailand, Korea, Malaysia and Singapore. In case of Singapore, Indonesia and Thailand, empirical findings indicate a better performance of minimum variance cross-hedge with a futures portfolio, but in case of Korea and Malaysia, a better performance is suggested by minimum variance cross hedge with one currency futures of German Mark futures for Korea, and Canadian dollar futures for Malaysia respectively. Among all the composition methods examined, the joint naive cross hedge performs the worst.

Wong (2003) developed an expected utility model for multinational firms facing foreign exchange exposure. Since there was no currency derivative

market between the home and the foreign currency, currency futures and options market between the home currency and the third currency is explored since a triangular parity exists between the three currencies. Besides, he also studied the optimal cross hedging strategies using both futures and options, for currency mismatching, even in case of linear cash flows.

With the unification of European Economic Community (EEC), trade between EEC countries and LDCs (Least Developing Countries) was risky, due to uncertain fluctuations in currency and weaker economies. Daigler examined the cross currency hedging for EEC and some selected LDC countries in this study. The Pound, Mark and Swiss Franc futures are being used as hedging vehicles with the cash rates from other EEC countries being used as currencies to be hedged. This study provides evidence that there exists relationships between currencies within EEC and also that non future currencies can be hedged with currencies outside EEC. Hedge from LDC currencies show the effectiveness for trading arrangements denominated with LDC currencies. This study provides interesting relationships between trade with EEC countries and with LDC countries and that of EEC unification, which earlier had not been explored.

2.2 *Commodity cross hedging*

Blake and Catlett (1984) cross hedged both US Hay and New Mexico Alfalfa Hay with corn futures contract effectively and found gross returns increase per ton of Hay. Correlation, Regression and Multiple regression analysis were used in the study. Correlation analysis between US Hay price and corn futures price was found significant. Regression analysis was used to determine coverage ratio of tons of Hay per corn futures contract and multiple regression analysis was used to determine the optimal corn futures contract month to cross hedge each spot monthly Hay price.

Vukina and Anderson (1993) investigated the cross commodity hedging possibilities between fishmeal (a processed renewable natural resource) and soyabean meal (a natural agricultural commodity). A dynamic hedging model was designed, based on state-space time series price forecasts, and its performance was compared with cash marketing, and with static and routine hedging.

Graff, Schroeder, Jones and Dhuyvetter (1997) studied the market for cross hedging of several agriculture commodities such as alfalfa, cull cows, sunflower, milo (grain sorghum), milfeed and feeder cattle and also suggested applicable strategies for the same. These techniques were suitable for both short hedgers trying to fix selling prices, and long hedgers trying to reduce input price variability.

Franken and Parcell (2002) have studied the mitigation of ethanol output price risk through cross hedging with New York Mercantile Exchange (NYMEX) unleaded gasoline futures for 1-, 4-, 8-, 12-, 16-, 20-, 24-, and 28-week hedge period, since there was no actively traded ethanol futures market existing. US ethanol industry has expanded due to low commodity prices

and increased use of alternative fuels. The findings of the research suggest that for some horizons, one-to-one cross hedge ratio has not been found appropriate.

Foster and Whitman (2002) followed Lence and Hayes(1994) to study the cross-hedging of soyabean harvest of a Iowa farmer with Chicago futures contract. The study used the time series method for postulating spot and future prices and calculated predictive densities and optimal hedges through numerical Bayesian procedures. The numerical approach accommodated alternative views on trends versus no trend, levels versus logarithms, uncertainty about estimation risk and non-sample information like difference between spot price of soyabean in Iowa and Chicago and tendency of the basis to be large in spring and shrinking of basis as expiration of futures contract nears.

Parcell, Boessen, Altman and Sanders (2008) explore the corn and soyabean meal futures contracts to cross hedge Fishmeal price risk. Soyabean meal futures have been used to cross hedge fishmeal price previously by Vukina and Anderson (1993), Kristofersson, and Anderson (2004). Although, cross hedge coefficients evaluated in this study are consistent with the previous studies, in the current study, corn futures have been found to be much more effective in reducing variability of fishmeal price as compared to soya bean meal futures.

Kawaller (2010) concludes that companies exposed to raw material price risk should go for cross hedging and that cross hedging works well when offsets are not perfectly aligned.

In risk management, generally imperfect hedging instruments are available, resulting into basis risk. Ankirchner, Dimitro, Heyne and Pigorsch (2011) have tried to optimally cross hedge risk when the spread between the hedging instrument and the risk is stationary. In the short term the optimal correlation is close to the cross correlation to the log returns but in the long term the position can be fully hedged optimally.Explicit formulas for the hedge error are derived for linear risk positions but for non-linear positions, numerically efficient estimates are obtained in the study. Finally, the study also demonstrates that in situations where the spread may not be stationary, mean reversion of the spread is better than completely neglecting it.

Axel, Muller and Nolte (2011) studied the cross hedging of jet fuel price risk with crude oil futures in an incomplete financial market. It has been observed that in an incomplete financial market, a basis risk, which has been in earlier studied, modelled under traditional additive cross hedging models. Here, a different modelling for basis risk is used, where basis risk and price risk is combined in a multiplicative manner. It is found that a positive prudence is a sufficient and necessary condition for under hedging in an unbiased market. The new multiplicative cross hedging model is found to be superior in stating the price series and also creating better and effective optimal cross hedges.

Adams and Gerner (2012) studied the performance of cross hedging of jet fuel spot price exposure with many oil forward contracts using Brent, WTI, heating oil and gas oil. This empirical study is based on econometrics models used for stock index futures market and foreign exchange, and uses extensive back testing. This study investigates the effect of maturity on the cross hedging performance of jet fuel. The results show that Brent oil as a cross hedge is not optimal for time horizons of less than and equal to three months, and indicates that for short term cross hedging, gas oil forward contracts are more efficient as compared to WTI and Brent contracts, which are more efficient in longer horizon cross hedging.

Kin, Brorsen and Yoon research to reduce large price risk of winter canola in the Southern Great Plains, resulted in the findings, that soyabean oil futures are the optimal futures contract to cross hedge winter canola.

Koeman studies cross hedging of international milk derivative product which is exposed to currency fluctuations. This study is especially important from the perspective of New Zealand economy where a dollar change in the price of milk-derived products results in gain or loss of $NZ 1, 00,000 for sharemilkers and dairy owner operators (from Dairy NZ Economic Surveys), hence severe impact on the NZ economy. Hence, this paper, explores hedging possibilities for New Zealand Milk products, New Zealand (NZD) Whole Milk Powder (WMP) and Skim Milk Powder (SMP). The findings suggest that hedging is difficult for New Zealand Milk products as tradable commodities with low correlation exist. In addition, WMP spot prices can be hedged with NZ whole milk powder futures with only 40% efficiency and hedging skim milk powder with non-fat dry milk futures is only with 18% hedging efficiency.

Keung, Horowitz and Hoang (2001) in their article *Cross Hedging and Forward-Contract Pricing of Electricity,* studied the problem of a risk-averse electric power marketer, who offers a fixed price forward contract to provide electricity, purchased from an unpredictable and volatile emerging spot energy market. In order to hedge against the spot price volatility, cross hedging is used to reduce the contract's profit variance and to determine the forward contract price as a risk adjusted price (i.e. baseline price plus risk premium.)This paper focusses on the estimation of the spot price relationship between two wholesale energy markets for cross hedging, forward contract's risk-adjusted price and the optimal hedge.

2.3 *Commodity-currency cross hedge*

Rahman (2001) for cotton-seed meal, Franken (2003) for ethanol and Adams (2012) for jet-fuel used cross hedging on highly correlated assets since there was an undeveloped derivative market available with insufficient liquidity to carry on hedging trades.

Bowman (2005) studied the effectiveness of commodity-currency cross hedges. For this,currencies should be defined as commodity currencies as already studies by Chen and Rogoff (2003) and Cashin, Ceìspedes and

Sahay (2004).Commodity futures are effectively use to hedge two commodity currencies Australian Dollar and Papua New Guinea. It was found that multiple commodity hedges improved performance and a four commodity basket hedge was found effective for both the currencies. Earlier commodity currency cross hedges were also studied by Eaker and Grant (1987) and Demaskey and Pearce (1998).

Tunaru and Tan empirically studied, the hedging techniques for jet fuel or kerosene, used by an airline company, based in an emerging economy or a market intermediary offering contract on this commodity. Two main directions were indicated by the study for minimum risk hedging. One is by cross hedging the commodity by using a futures contract on another commodity or a basket of commodities greatly correlated with jet fuel. Another is to use future contract on kerosene in Tokyo and thereby transforming the problem into cross hedging the currency.

2.4 *Stock cross hedging*

Brooks, Davies and Kim (2006) study the efficiency of cross hedging of a single stock future contract that does not have options or exchange traded contract embedded on it. A new technique for hedging exposure is proposed here, where a portfolio of single stock futures contract is used as a hedging instrument. This selection is based on how closely related;the underlying firm characteristics are with that of the single stock. The study explores the use of cross-sectional characteristics to construct the hedge or constructing a hedge based on return correlations only. Best hedging performance is found through a portfolio that is hedged with market index futures and a single stock future matched, by both cross-sectional matching characteristics, and historical return correlation. Optimal hedge ratio is re-estimated at each rolling window with the chosen single stock future being retained for the whole out-of-sample period.

Zhang studied the effectiveness of cross hedging of an international stock portfolio with different exchange rate forward future contracts and also the correct choice of base currency for improving hedging effectiveness. This study has been carried out by generating daily dynamic conditional correlation (DCC) - GARCH hedge ratios from the combined estimation of seven developed countries. USD is chosen as the base currency and effective cross hedging is provided by Canadian and Australian dollars forwards, both in-sample and out of sample. If AUD is also taken as the base currency, incomparable in sample results are obtained. Findings of this study suggest that the results of multi-currency risk managements are greatly affected by the choice of base currency, and also the number and type of cross-rates to hedge.

2.5 *Stock index cross hedging*

Kolanovic, Silvestrini, Lee and Naito (2012) studied the impact of using Volatility Index VIX for cross hedging S& P 500, which is the most actively hedged global index. Since, VIX represents a short term implied volatility of

S&P 500; it is highly correlated to equities, foreign exchange rates, credits, and commodities and hence may serve as an optimal cross hedge for all these assets class. The effectiveness of cross hedging can be judged if the proxy hedge costs less, is more liquid and provides better entry points as compared to a direct hedge. It is understood that the negative impact of 'crowded hedge' unwinds can also be avoided by cross-asset tracking risk, and lead-lag relationship between assets, can also provide better entry points. The methodology adopted is a simple comparison of S& P Option hedge and VIX hedge to find out which is cheaper. This is done by comparing the VIX call spreads prices and S & P 500 put spreads prices. This paper also proposes the study of divergence between S& P 500 and VIX, to identify attractive entry levels, in future researches.

2.6 *Cross hedging of Index Exchange Traded Funds*

Alexander and Barbosa (2007) conduct an empirical study of hedging and cross hedging of four largest US Index Exchange Traded Funds (ETFs).If each ETF position is hedged with its own index futures, hedging is less effective around the time of dividend payment. Besides, the study also explores how a long position on one ETF can be offset by a short position on another correlated ETF, and also how best to hedge portfolios of ETFs with one index futures. The study indicates the superiority of minimum variance hedge over naive 1:1 future hedge, although choice of econometric hedge ratio is found irrelevant, and also cross hedged portfolio returns appear, nearer to normality than future hedged portfolios. The findings are useful for hedge fund managers employing tax arbitrage or leveraged long-short equity strategies, and to ETF market makers' since market risk of inventories and bid-ask spread can be most effectively reduced by hedging.

2.7 *Insurance derivative cross hedging*

Ankirchner, Imkeller and Popier (2007), studied the optimal cross hedging of the static risk associated with the insurance derivatives with a tradable financial asset. Here, instead of a positive correlation, the authors have studied the negative correlation of climate risk exposures of different agents on finance and insurance market. This is achieved by studying the static risk associated with the insurance derivative with the reduced risk attained through dynamic investment into the correlated asset.

2.8 *Cross hedging of variable annuities*

Ankirchner and Schneider (2013) explored the cross hedging of variable annuities which are very risky products. Although, Solvency II requires that adequate hedging strategies to be developed, these strategies can be highly imperfect due to market frictions like basis, liquidity and model risks. It was observed that during the financial crisis in 2008, it was the basis risk which created the most imperfection in hedging strategies, followed by the liquidity risk. The authors study the basis and the liquidity risks and propose an efficient minimal variance hedging strategy.

2.9 *Cross hedging of contingent claims*

Ankirchner, Allee and Heyne (2011) studied cross hedging of contingent claims with basis risk. The study explored the correlation between hedging instrument and the underlying of the contingent claim to be random. The study assumes that the correlation process evolves according to a stochastic differential equation, with values between -1 and 1.An integrabilitycondition is derived on the correlation process, which describes and computes the quadratic hedge, by a simple hedging formula, which can be directly implemented.

2.10 *Inflation derivatives cross hedging*

Lemaire and Palidda (2013) explored the cross hedging of inflation derivatives on commodities, due to the strong impact of exogenous oil price shocks on inflation. The market for inflation derivatives has grown due to the revival of primary inflation linked bond market. This study investigates whether the zero coupon inflation indexed swap prices incorporate the exogenous shocks on oil futures market. An empirical estimation of a four factor model for both inflation and nominal rates, and a two factor model for commodities is proposed, by using prices of oil future contracts and inflation breakeven rates.

2.11 *Bayesian Optimal Hedging Model*

Shi and Irwin (2008) studied the selective hedging behavior through a Bayesian optimal hedging model and explained the large cross sectional and time series variation of hedging positions. It is found that the optimal position of the hedger is effected by subjective market views, especially, when the hedger speculates on the future market price directions, and is not optimistic about effectiveness of hedging.

III. Conclusion

The review of the above literature gives insight into the various dimensions of cross hedging. Starting from hedging major currency exposures, with a direct hedge, studies have been done on hedging even minor currencies exposures. In some cases, cross hedges have been found to be more effective than direct hedges. Studies have also shown that cross hedging has been done between foreign currency and a third currency (where a triangular parity condition existed between home, foreign and third currency) since, no hedging instrument was available with the home currency. Moving on to commodities, cross hedging has been conducted on various commodities like US Hay, New Mexico Alfalfa Hay with corn futures; between fishmeal and soyabean meal and corn futures; ethanol with unleaded gasoline futures; jet fuel price risk with crude oil, Brent, WTI, heating oil and gasoil futures; winter canola with soyabean oil futures to name a few. Researchers have even explored conducting cross currency-commodity hedging in case of strong correlation between currency and commodity. A few studies have also been done on cross hedging stock portfolio with exchange rate futures and also with market index futures. In

one of the studies, cross hedging effectiveness of four largest US Index Exchange Traded Funds (ETFs) has also been conducted. The trend also indicates that research is now being conducted on cross hedging of complex derivatives like insurance derivatives, inflation derivatives, variable annuities and contingent claims with any strongly correlated asset like commodities, currencies etc. Effectiveness of hedging has been judged by finding the optimal hedge ratio with different models like minimum variance model, DCC -GARCH, traditional cross hedging, multiplicative cross hedging model and Bayesian procedures. Overall, the idea has been to select an asset with a strong correlation and which ultimately reduces the hedging cost. The study of cross hedging of S&P 500 Index with VIX leaves scope for further research on finding the divergence between S&P 500 and VIX. For future researches, cross hedging on complex derivatives can be explored more with new asset classes.

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