CHAPTER 2

2.0 LITERATURE REVIEW

Theoretically, hedging in the futures market will downsize the price (volatility) risk exposed towards traders. The effectiveness of the hedging strategy (hedging performance) is measured by computing the risk reduction achieved by the hedging portfolio, as compared to an unhedged portfolio. There is extensive literature concerning hedging performance within the risk minimization context. However, some believe that true hedging performance should be measured by considering both risk and return aspects. This risk and return aspect works within the investor's utility maximization framework or the Markowitz mean variance framework.

2.1 MEAN VARIANCE FRAMEWORK

The mean-variance framework plays a vital role in making sense of financial theories, especially the portfolio theory. Together the hedging and portfolio theory will establish the hedging performance measurement framework. Working (1953) emphasizes that hedgers not only aim to reduce risk but also consider the profit maximization goal, since market participants do not constantly engage in hedging. Furthermore, hedgers are only able to achieve risk reduction inconsistently and sometimes receive less price risk protection or no protection at all (Graf, 1953). Such evidence highlights the importance of measuring the hedging performance over time.

Working and Graf argue that hedging performance can be evaluated based on the trade off between risk and return or commonly refers to the mean variance framework.

In the conventional mean variance framework, both risk and return elements play a vital function in maximizing the investor's utility function. The framework has two basic assumptions, namely, normality features in asset returns and the quadratic utility function. Some research rationalizes the conceptual hedging performance measurement within the mean variance paradigm such as Hilrenth (1979) and Howard and D'Antonio (1984). In addition, several emphasize estimating the optimal hedging ratio (refer to proportion of futures contract against spot contract), for example, in Anderson and Danthine (1981, 1983), Ho (1984), Marcus and Modest (1984), Karp (1986), Karp (1987), Duffie and Richardson (1991), Schweizer (1992) and Myers and Hanson (1996). The empirical evidence fallaciously conjectures that the hedging ratio is a time in varying process, however, Karp (1987) argues the finding and proves the dynamic behaviour of the hedging ratio. He adopted a variation of the linear exponential Gaussian (LEG) control in determining the dynamic optimal hedge. The LEG model assumes that crop production is a stochastic process and the results prove that the model successfully handles the dynamic optimal requirement drawn within the mean variance framework. In addition, Karp (1987) highlights the drawback of previous assumptions that suggest that hedging decisions are constant overtime. The rationality that the hedging ratio has a dynamic process is based on two justifications. First, optimal hedging decisions change over time due to the asymmetry of information available on the market. At any point of time, new information enters the market and may influence the market participants hedging decisions. Considering this new information, it will also give some indication towards the future movement of commodity or stock market prices (market expectation). Based on market expectations, market participants will make the decision to either hedge more or less. Second, from a producer's perspective they are uncertain of their level of production. The level of crop production may vary and achieving a certain level of crop production consistently is quite impossible.[5] There are times when farmers need to hedge more and, at other times, they need to hedge less. Furthermore, hedgers need to revise their position when the liquidity constraints change (Lien, 2003). Hedgers will have a larger hedging position when they have fewer liquidity constraints. Therefore, it may be concluded that a dynamic hedging decision makes more sense than a constant one. Consistent with Karp (1987), similar results were exhibited in Dufffie and Richardson (1991), Schweizer (1992), and Myers and Hanson (1996). Dufffie and Richardson (1991) and Schweizer (1992) applied an exponential Brownian motion to model the hedging ratio while Myers and Hanson (1996) introduced a parsimony optimal dynamic hedging model that relaxed a few strict assumptions set by previous researchers. Their model does not require a negative exponential utility function and the variables are not random normally distributed. Their results capture the same hedging ratio characteristic as Karp (1987).

Much later, several researchers used more advanced methodology within the mean variance context in the foreign currency market (Kroner and Sultan, 1993 and Gagnon *et al.*, 1998), interest rate market (Gagnon and Lypny, 1995) and stock index

[5] Level of production varies – depends on external factors (e.g. climate, technology, biological cycle, etc).

market (Yang and Allen, 2004, Shi and Irwin, 2005; and In and Kim, 2006) *inter alia*. To estimate a dynamic hedging ratio and further evaluate hedging effectiveness, a few researchers applied GARCH models ranging from CCC in Kroner and Sultan (1993); GJR and BEKK in Gagnon and Lypny (1995); GARCH (1,1) in Gagnon *et al.* (1998) and BEKK in Yang and Allen (2004). Obviously, the empirical findings validate the non-monotonic behaviour of the hedging ratio and the GARCH model gives a better hedging performance estimation (investment utility function) than the traditional one. In contrast, Shi and Irwin expanded the Bayesian theoretical perspective by introducing a model that included market participants' subjective view (market expectation). Although the Bayesian model has been ignored by some researchers (those just focusing on the parameter certainty equivalent model), it assumes that the hedger's main goal is to maximize their investor's utility function under the mean-variance framework. For both bullish and bearish markets, the model gives a superior result in determining the optimal hedging position compared to the PCE Bayesian model. Gjerde (1987) introduced the size of initial position and individual risk preference into mean variance hedging performance measurement. Using a conceptual illustration, he highlights the importance of including these two factors into hedging performances models. Alternatively, In and Kim (2006) shift the researchers attention from the econometric models to a mathematical tool wavelet analysis for estimating the hedging ratio in eight different time horizons. The model is able to capture the signalling presence in both tested markets.

In a standard minimum variance framework, market participants are more interested in variance reduction (also known as two side risk). Bawa (1975, 1978), Fishburn (1977), and Yizhaki (1982) demonstrate the Lower Partial Moment approach in estimating optimal hedging ratio. This technique is valid, as firms tend to focus on downside risk (Adams and Montesi, 1995). A little different from the conventional framework, the techniques emphasize reducing the risk element with a slight target-return element rather than focussing on maximizing the utility function. In addition, the lower partial moment estimates the hedging ratio encompassing the stochastic dominance concept, however, the ratio will converge to the mean variance hedging ratio if both spot and futures returns are normally distributed and futures prices is a pure martingale process (Lien and Tse, 1998). There is not much empirical evidence to support this approach in the hedging ratio estimation process (see, De Jong *et al*., 1997; Chen *et al.,* 2001; Lien and Tse, 2001; Demirer and Lien, 2003). A robust downsize risk evaluation investigating ten different futures markets was presented by Demirer and Lien (2002). They concluded that short hedgers are less active in futures trading activities. A conservative hedger always prepares for the worse case scenario and hedges less than the optimistic ones. As such, when the one-sided risk[6] is considered, the long hedgers will benefit more than the short hedgers. When comparing between futures and option contracts, Lien and Tse (2001) infer that futures currency contracts tend to be superior in downsizing the one-sided risk compared to the option currency contract. A contrast in performance was reported when the hedgers are more optimistic.

[6]One-sided risk (downsize risk) refers to investor's main concern with below target return (Li and Wu,2007).

Alternatively, Yitzhaki (1982, 1983) and Shalit and Yitzhaki (1984) introduced the Mean-Gini Framework (henceforth MEG) to overcome the drawback in the mean variance framework. The approach has more flexible assumptions and an efficient portfolio construction within the stochastic-dominance paradigm. The MEG approach allows the modelling of various risk aversion investors in one model (Shalit, 1995). However, there has been very little attention given to the implementation of this approach within the hedging performance context other than some literature presented by Cheung *et al.* (1990) on the currency market, Shalit (1995) on a few metal commodities markets[7], Kolb and Okunev (1992) on currency, commodities and the stock market, and, more recently, Shaffer and Demaskey (2005) on developing and developed currency markets. It is said that the MEG model tends to outperform the normal mean variance model but that the difference is relatively small (Cheung et al., 1990). The MEG model can cater for the capital market equilibrium and the hedging ratio derived from its second-degree stochastic dominance efficient set, hence, the model is expected to perform better than its counterpart model (Yitzhaki (1982, 1983) and Shalit and Yitzhaki (1984)). In addition, Shalit (1995) measured the hedging ratio determined by the MEG and common mean variance framework. He highlighted that the MEG hedging ratio only approaches the mean variance hedging ratio when the futures price has a Gaussian or normal distribution. A more comprehensive comparison using the cumulative distribution function (nonparametric empirical versus kernel distribution function) was demonstrated by Shaffer and Demaskey (2005), who claim that kernel estimation does give a superior hedging ratio estimation but not in terms of its hedging effectiveness.

[7] Gold, copper, silver and aluminium traded on New York Commodity exchange.

2.2 MINIMUM VARIANCE FRAMEWORK

The current broad attention has been given by researchers to explore the minimum variance concept rather than the mean variance concept. They infer that the success of hedging strategy can be measured via the effectiveness of the strategy in mitigating the price risk rather than aiming to maximize the investor utility function. The reasoning of such overwhelming evidence for the minimum variance framework is explained in Chapter 3 (Theoretical Framework). From a risk minimization perspective, researchers estimate the second moments of both spot and futures returns then derive the hedging ratio. Moreover, these estimations (variance, covariance and hedging ratio) are used to determine the variance of hedge portfolios and unhedged portfolios. Ultimately, the risk reduction or minimization is able to show the effectiveness of the hedging strategy applied. Thus, the hedging ratio or optimal hedging contract is an important parameter that directly influences the hedging portfolio returns, variances and strategy performance. Researchers have been involved in intense debates as to whether the hedging ratio is having a monotonic or non-monotonic process. The debate continues for both the mean variance and minimum variance paradigm.

2.2.1 Conventional Static Model (OLS)

Traditionally, the minimum variance hedging ratio refers to the slope of changes in futures prices concerning the changes in the spot prices. This slope is also known as the myopic hedging ratio. Ederington (1979) used this classical methodology (OLS) to estimate the hedging ratio in the Government National Mortgage Association. Such methods do not consider the surrounding information that may influence the changes in hedging decision or that may alter the ratio to be time varying. Hence, such monotonic estimations are proven to give a biased hedging ratio that lead to an inaccurate percentage of risk minimization (Ederington and Salas, 2007). However, Lien (2005) proves conceptually that the OLS model is able to estimate similar to other dynamic GARCH models when the estimation sample size is large. In addition, the two homogeneous sub-samples will further generate a superior OLS ratio than the ECM model. Apart from the OLS, some researchers include the VAR and VECM mean model to estimate the static hedging ratio (Yang and Allen, 2004; Floros and Vougas, 2004; Kumar, Singh and Pandey, 2008).

2.2.2 ARCH and GARCH Framework

Overwhelming empirical evidence indicates that heteroscedasticity and serial correlation issues exist in most of the financial data. Thus, both these issues cause the conventional estimation to be less appropriate because OLS assumes that variance and covariance of spot and futures tend to be monotonic in fashion, whereas the

Autoregressive Conditional Heteroscedasticity (ARCH henceforth) framework provides a way to overcome these issues. Over time, more empirical evidence suggests that the time factor presented in most spot and futures returns could affect the hedging decision. If so, the hedging decision follows a dynamic fashion. Another concern that is equally important and needs to be considered is which model gives the most accurate estimation of the true volatility characteristic in the spot and futures market. This framework offers various ranges from indirect to direct second moment modelling approaches. The indirect hedging performance approach can be achieved using the univariate ARCH and GARCH framework, which can be modelled on the mean and variance-covariance. Cecchetti, Cumby and Figlewski (1988) are among the pioneers to examine the hedging performance in Treasury bonds and T-bond market using the univariate ARCH family framework.

Engle (1982) and Bollerslev (1986) developed a more general model (GARCH), which is an extension of the ARCH model. The model considers the dynamic conditional second moment. The GARCH framework acknowledges the time factor in estimating the second moment return and allows capturing its own long run shocks. In addition, the model is a flexible model as it can cater for the fat tail characteristic posture in most spot and futures prices. More researchers have used the GARCH framework to model the higher moments in the variety commodity markets (Baillie and Myers, 1991; Frackler,1992; Bera, Gracia and Poh, 1997; Yang and Awokuse, 2002 and Foster and Whitemen, 2002), and developed financial markets (Bollerslevs,1987; Baillie and Bollerslev,1989; Wilkinson, Rose and Young, 1999; Mili and Abid, 2004), while only Mili and Abid (2004), and Ford, Pok and Poshakwale (2005) studied the developing market *inter alia*.

Many ranges of advanced GARCH models were introduced to improve the second moment estimation process. Allowing for the information element, the GARCH models are able to estimate the variance and covariance matrices. Subsequently, using those matrices, the hedging ratio and its performance can be computed indirectly. In hedging performance measurement, the estimation process is closely related to model the behaviour of return in both spot and futures markets. Consequently, previous researchers preferred to adopt the general BEKK model in their hedging performance study (see Appendix A for a detailed summary on hedging performance investigation using the BEKK model). Additionally, the model is found to be more flexible and it can be tailored according to the researcher's requirement. Moschini and Myers (2002), and Ford, Pok and Poshakwale (2005) demonstrated the flexibility of the BEKK model by imposing a restriction to test the equality of the constant or non-constant hedging ratio hypothesis. They infer the superiority of the non-constant hedging ratio than the constant one. Additionally, the model also allows the asymmetric effect on hedging performance results to be tested (see Brooks, Hendry, and Persand (2002);Malo and Kanto (2005); and Switzer and El-Khoury (2006)). The evidence supports that the asymmetric BEKK model promised a better risk reduction result, however, the improvement is relatively smaller than the symmetric BEKK model. Encompassing the BEKK model, Lee and Yoder (2007) introduced the regime shift effect within the hedging performance result in the Corn and Nickel market. They found that the regime switching BEKK model has marginally improvement in reducing the hedged portfolio than the general BEKK model.

A part of BEKK, the Diagonal Vector (henceforth DVECH) model is another model that has been applied by researchers in the hedging performance context because of the improved parsimony features. Other examples, such as Baillie and Myers (1991), and Mili and Abid (2004) applied the DVECH model, and Hassan and Malik (2007) applied the Vector or VECH model in determining the hedging performance in various derivative markets *inter alia*. Apart from the simplicity of the DVECH model, it is considered to be the best model that fits the six commodity markets (Baillie and Myers, 1991). Additionally, Yang and Awokuse (2002) adopted the MGARCH model to evaluate the risk reduction performance in storable and non-storable commodities market. They infer that the non-storable commodities markets tend to have less favourable performance than the storable commodity market. In sum, most of the findings exhibited the outstanding performance of the indirect dynamic model compared to the static conventional model. Furthermore, the evidence confirms the non-static behaviour in risk and hedging decision hypothesis.

Apart from the indirect model, the GARCH framework offers modelling of hedging performance using a direct model. This is achieved by taking the squared correlation between the spot and futures returns. This approach is simple, therefore, it is justifiable and effortless to model the correlation directly rather than model the second moments and compute the risk reduction manually. Lien *et al.* (2002) are among the few researchers who modelled the correlation using the constant correlation model (CCC model), and assumed that it behaves in a monotonic fashion. Because of the extensive evidence portraying the time varying feature in the hedging ratio, there is a high tendency for correlation between spot and futures to behave in such manner. Engle (2002) introduced the latest dynamic conditional correlation model (DCC model), which proved the dynamic features in correlations between the NASDAQ and Dow Jones volatility. However, there have been limited studies exploring this model in the hedging performance measurement context (see Appendix B for the detailed summary on hedging effectiveness research using the CCC and DCC model).

In the multivariate GARCH framework, both the mean and variance specification models play integral roles before proceeding to hedging performance analysis. Similar to variance specification, there are various ranges of mean return specification models, ranging from a simple constant to an error correction model. Baillie and Myers (1991), Ford, Pok and Poshakwale (2005) documented the mean specification via the constant or intercept model, while, Lien, Tse and Tsui (2002), and Floros and Vougas (2004) considered the VAR specification, which focused on short run behaviour in both spot and futures returns. Empirical evidence highlights the existence of a long run relationship between spot and futures returns in Lien and Tse (1999), Wilkinson, Rose and Young (1999), Moschini and Myers (2002), Yang and Awokuse (2002), Lien (2004), and Mili and Abid (2004) *inter alia*. Lien (2004) specified that if the Error Correction term is not included in the mean return specification the model tends to be inaccurate and drives to a lower hedging ratio.

Similarly, Wilkinson, Rose and Young (1999) and Floros and Vougas (2004) found that the ECM model tends to give a lower hedging ratio than the conventional ones. All these empirical studies applied a mean specification to model both spot and futures returns. However, the multiple mean specifications documented in Lien and Tse (1999), and Moschini and Myers (2002), was rarely examined by other researchers. Lien and Tse (1999) included the VAR, Error Correction and Fractional cointegration in multi-horizon hedging strategy and infer that Error Correction model has the best performance in hedging ratio estimation in higher time horizons. Meanwhile, Moschini and Myers (2002) combined the seasonal dummy and cointegration error term model in spot prices, however, they adopted a simple constant model for futures prices mean specification. The results fail to verify both seasonal and near expiry effect in non-constant hedging ratio estimation.

Another matter that is reasonably discussed in hedging performance estimation studies is the asymmetric effect. It is well documented that negative and positive innovation influences the return volatility differently. Researchers claim that negative innovation makes the volatility much higher than positive innovation. These effects are known as the famous leverage effect (demonstrated in Glostern *et al.,* 1993). However, the economic perspective highlights two components of the asymmetric effect including the leverage effect and volatility feedback. Using the leverage effect as the basis to infer the asymmetric effect in volatility tends to be inadequate (proven in Bekaert and Wu, 2000). How can we distinguish between the leverage effect and volatility feedback? Volatility feedback refers to a large positive innovation that will subsequently increase the market volatility and further push the price downward, which translates into a higher rate of return (Campbell and Hentchel, 1992). In addition, a basic pillar of volatility feedback, either positive or negative innovation, will create a persistency in return volatility that will create an abnormal return opportunity (Bekaert and Wu, 2000). The leverage effect only concerns larger sizes of volatility occurring after negative innovation and not positive innovation. However, more attention has been given to testing the asymmetric effect in volatility using the leverage effect vis-à-vis volatility feedback. Only Cappiello *el al.* (2006) demonstrate both the asymmetric effect in the correlations for multi-countries equity and bond returns, while Bekaert and Wu (2000) for the Nikkei stock volatility return. Their evidence infers the existence of volatility feedback as well as the leverage effect in the tested series. A reasonable number of researchers have examined the asymmetric effect in the hedging performance context via the leverage effect, including Gagnon and Lypny (1995), Lien (2004), Brooks *et al.* (2002), Menue and Tarro (2003), Switzer and El-Khoury (2006) and Floros and Vougas (2006). The results exhibit a significant asymmetric effect on the hedging ratio but no effect on the hedging performance (Lien, 2004). In contrast, other studies infer the importance of the asymmetric effect in both the hedging ratio and hedging performance estimation, however, the impact is minimal. As such, this research will not attempt to test the asymmetric effect in CPO hedging performance consistency.

Generally, the GARCH framework does provide many fancy hedging ratio and performance estimation models. These include the general VECH to the BEKK model (to generate the variance and covariance matrices), a direct constant and dynamic conditional correlation model with a simple short run and a combination of short and long run mean models. Most of the evidence assumes a hedging strategy under one type of futures contract and with a single hedging period. However, market participants may implement multi-type futures contracts or cross-market hedging strategies with multi horizon periods. Tunara and Tan (2002) demonstrate hedging ratio estimation in multi jet fuel and currency futures markets using a simple regression model and Scholes-Williams estimation model in several emerging countries. Noting the weak result given in the OLS regression models, they admit that the reliability of the estimation result is vague. In a multi-period hedging strategy, the finding supports that hedgers will hedge less and that a longer hedging horizon gives superior performance for a shorter period (Brailsfrod *et al.,* 2001). In a similar context, Haigh and Holt (2002) introduced a dynamic programming GARCH model that allows for multi-horizons in one model. Their test results show that various ranges of hedging ratios were generated when the strategies period was revised across horizons, however, the magnitude was small.

2.3 STRUCTURAL BREAKS

The world has experienced a number of economic crises that affected many macroeconomic variables and financial series. These crises may alter the movement of economic series, especially macroeconomic variables such as GDP growth, inflation and exchange rates. Recent markets tend to be more volatile, caused by the response of market participants to the information (e.g. unexpected events) occurring in the markets. Sometimes the market is calmer but not all the time. There are various sources of volatility that may push the financial or economic series into different volatility regimes (from a high to low state volatility and vice versa). Hence, the affected movement may be translated into a higher or lower volatility experienced in those variables. Brenner and Galai (1989) specify that inflation rate, unemployment, and economic policy are among the factors that are likely to alter the market volatility. Therefore, plausibly, many unexpected events can cause some unanticipated changes or shifts in these variables volatility.

Common unexpected events include global crisis, oil price shock, pre and post war effect, Asian Financial Crisis, regional revised exchange rate policy, and technology bubble, etc. Some highlight that the regime shift is due to internal monetary policy, government intervention, political stability, a country's economic situation or productivity capacity. However, the existing body of evidence documenting these structural breaks is mostly related to international events (global crisis, gulf war, etc.), and the national events (including political, social or financial atmosphere). Particularly, some of these national events caused a regime shift in volatility, and most were mainly concerned with international events (see Andreou and Ghysels; 2002). This empirical evidence also supports the significant events that may affect different types of countries in various ways. Certain world events may affect the developed countries more than the emerging countries. Interestingly, Aggrawal, Inclan and Leal (1999) infer that international events such as the Gulf war only caused a regime shift in Singapore, Japan, the US, the World index and the Emerging index variance, but did not affect the individual developing countries specifically. Generally, this omission of any possible breaks could affect the macroeconomic variables movement uniquely towards the developing countries rather than the more advanced countries.

2.3.1 Implication of Structural breaks

Since the researchers recognized the possibility of regime shift or structural changes in the economic and financial series, more effort was made to investigate the repercussions of non-inclusion of these structural breaks in the linear or non-linear modelling process. From an econometric perspective, it has been empirically proven that structural breaks do influence the series behaviour and volatility estimation accuracy. They acknowledge the presence of structural breaks in most macroeconomic variables and the resonance consequences towards volatility clustering features.

a) Random hypothesis effect

The preliminary effect indicates that ignorance of structural change may lead to falsely concluding the actual characteristic of the tested series distribution. According to Perron (1989, 1990), an inaccurate conclusion of having a unit root might be made when there is no allowance of structural change in the series trend function. This further makes the series appear to be stationary at a higher order. In addition, this erroneous finding is further worsened when the sequential cointegration test is carried out, and, finally, inference of a spurious existence of a cointegration relationship between tested series. Inclusion of the structural breaks in the unit root test hypothesis may be turned into rejecting the existence of the unit root at I(0) in the aforementioned series. To alleviate this, Zivot and Andrews (1992) allow a break presence in their alternative random walk hypothesis testing. Also, much later, Vogelsang and Perron (1998) introduced some flexibility with a break in both the null and alternative hypotheses specified under the unit root test. Moreover, being less restrictive in the number of breaks, Perron (1997), and Lumsdaine and Papell (1997) established a test to cater for such flexibility in their alternative unit root hypothesis test. They emphasized that understating the amount of breaks existing in a series may lead to a misleading characteristic of the tested series. As such, it is essential that a precise number of structural breaks are included in this stationary testing procedure. Bekaert *et al.* (2002), and Chaudhuri and Wu (2003) concur that without structural breaks it will lead to a spurious conclusion of the non-stationary of tested series at its level. In contrast, Roche and McQuinn (2003) found a similar conclusion in both wheat and barley prices from Britain and Ireland, which turned out to be integrated at 1 using the conventional ADF test, Zivot and Andrews (1992), and Perron (1997). Within a long run context, it may experience some changes throughout a longer horizon. The Gregory and Hansen (1996 a and b) test investigates the presence of such a shift in a longer run process. The Gregory and Hansen cointegration test is empirically proven to strengthen the existence of series long run relationships and is suggested to be a complement test together with the other structural break tests (refer Carrion-I-Silvestre and Sanso, 2006).

b) Inaccurate volatility persistency estimation effect

There are a few salient features for a good volatility clustering model specified in Engle and Patton (2001). Commonly, it is essential for researchers to consider six characteristics in modelling the second moment of financial or economic series including volatility persistency, mean reverting, asymmetric term, exogenous variables that may contain some information that can influence the volatility of tested series (such as day to day effect, seasonal, etc.), non normality probabilities that validate the relevancy of the GARCH process and, finally, a good volatility model is able to forecast the future return and risk. Based on these characteristics, generally, most basic volatility clustering models can cater for volatility persistency estimation and are further able to make some precise forecasting of the aforesaid series expected returns and risks. A good estimation model is essential because with a market model participants can predict future volatility and forecast the market direction, thereby enabling them to anticipate their future potential risk exposure and return.

Previously, in random walk hypothesis testing, it is crucial to detect any structural shift that exists in the series. If there is any, then the inclusion of those breaks may overwhelmingly reject the null hypothesis of the random hypothesis testing. What will happen to the non-linear estimation process (within the ARCH or GARCH framework) if we ignore these breaks? Deibold (1986) is among the first to argue the accuracy of the GARCH model in posturing the tested series volatility without structural changes. He highlights that the presence of structural breaks in volatility may wrongly estimate the volatility persistency parameters. Since then, more attention has been given to the seriousness of the non-inclusion of structural breaks in the volatility estimation process within macroeconomic variables. Rich empirical evidence testing the implication of structural breaks in macroeconomic variables includes GDP growth (see Fang and Miller, 2008;and Fang, Miller and Lee, 2008), exchange rates (Malik, 2003), interest rates (Gray,1996 and Chan *et al*., 1992), inflation rates (Benati and Kapetanious, 2002) and stock index (Aggrawal, Incland and Leal, 1999) *inter alia*. Most evidence infers that the structural break may fallaciously overestimate the volatility persistency parameter. Similar effects were reported in firm base examination (see Zhang, Russell and Tsay, 2001). In contrast, Chan *et al*. were unsuccessful in proving the significant impact of predetermined structural breaks in the US short-term interest rate. In addition, Gray establishes that a less volatile regime will have fewer implications on the news entering the market, however, the volatility is more persistent than the higher volatility regime. Most of the above evidence focuses on the existence of structural breaks in variance estimation, however, Ho and Wan (2002) provide evidence of covariance estimation of stock returns for four countries.

Other than volatility persistency measurements via the GARCH process, researchers can further investigate the time series persistency through examining a series of short or long memory properties. A comprehensive survey was done on long memory modelling with structural breaks (refer Banerjee and Urga, 2005). A financial and economic series is said to have long memory features when the series has either a hyperbolically decaying autocorrelation function (time domain) or when it is possible to obtain similar information within a certain range of periods against all information within specified intervals (refers to frequency domain). Some empirical evidence is able to highlight the significance of structural breaks in long memory properties identification (Lobato and Savin, 1998; Granger and Hyung, 1999; Morana and Beltratti, 2004; Martens, Dijk and De Pooter, 2004; Rapach and Strauss, 2008). The evidence supports the consensus that when researchers omit structural change it will deceive the volatility persistency result and may wrongly conclude the long memory of volatility estimation parameters (Rapach and Strauss, 2008). In addition, Morana and Beltratti (2004) infer that a different persistency parameter estimation is generated when long memory properties with structural breaks are measured. Their results clearly exhibit a downward bias on the exchange rates series when structural breaks are not included in the modelling procedure.

Apart from the estimation model, measuring the model forecasting ability is vital since a good volatility clustering model is able to forecast future series correctly.. Hence, accurate estimation parameters are able to forecast series risk and return flawlessly. Since a non-structural break will affect the accuracy of the volatility persistency estimation, the estimation will further affect the forecasting results. Inaccurate forecasting results will cause an error in market timing performance (Pesaran and Timmermann, 2004). They found that when the ex post regime shift variance is larger than the ex ante ones, a less precise forecasting result will occur. Furthermore, Morana and Belratti (2004) specify that the inclusion of a structural break in the volatility model will give a superior result since the model is able to posture the true behaviour of the market volatility characteristic in the long run. However, an outstanding forecast performance is only applicable in the long-term memory process and not in the short-term process. They argue that volatility modelling with a structural shift will not constantly outperform the non-inclusion break model. Similarly, Martens, Dijk and De Pooter (2004) forecast that performance does not favour out of sample forecasting test results. Nevertheless, sufficient literature supports the outstanding forecasting performance when a regime shift is taken into consideration in the volility modelling process (see West and Cho, 1995; Pesaran and Timmermann, 2004; Starica and Granger, 2005; and Rapach and Strauss, 2008). Generally, there is well-documented empirical evidence explaining the severity of the non-inclusion of a structural break that will lead to less accuracy in volatility persistency and affects the forecasting measurement (less error). Intuitively, when the volatility and persistency parameters are spuriously estimated, we may conjecture that the hedging ratio and hedging performance will also be affected. A misleading hedging ratio will further effect a fallacious conclusion on the optimal proportion of futures contract market participants needed to hedge against the spot contracts When the under or overestimated hedging ratio is generated, a less precise hedging performance is measured. Therefore, a good hedging performance measurement needs to consider the potential structural changes in its measurement model. A large body of literature focuses on the omission of a structural break within the volatility of the macroeconomic variables. There is very limited literature that explores the implication of a structural break in hedging performance measurement. Only Lee and Yoder (2007) consider the bivariate Markov regime switching GARCH model (modified version by Gray, 1996) to estimate hedging ratios in the corn and nickel futures market. Their Markov version allows capturing any regime shift in variables that follow a first order, two-state Markov process (high and low state regime). However, when structural change is considered in the volatility model it is translated into a trivial improvement in hedging risk reduction performance. Similarly, Wei-Choun *et. al* (2009) demonstrate the structural break effect in M-GARCH model to evaluate the hedging effectiveness in KOSTAR Index futures. Using a Bayesian approach, Meligkotsidou and Vrontos (2008) include the structural breaks effect into risk factors estimation in hedge fund returns.

Apart from the consequences for omitting structural breaks in volatility clustering estimation results, it is also vital to detect the accurate structural number and dates (Pastor and Stambaugh, 2001). Therefore, another vital concern is identifying the exact number of breaks in the second moment modelling process. In considering these implications, the breaks identification test is an essential process before proceeding any further in the estimation modelling procedure. Considering the critical process of the structural changes test identification, an overwhelming range of procedures has been introduced over the years. Quandt (1958, 1960) was among the pioneers to introduce a structural changes test (Sup F test) where the break is assumed to be unknown. The test is able to detect a structural break specified under its alternative hypothesis. Subsequently, another issue follows, whether single or multi structural breaks are raised;if we underestimate or overestimate the structural breaks, it will further influence the accuracy of the estimation process (Banerjee and Urga, 2005). The Sup F test has been further improvised by adding more structural breaks in its alternative hypothesis testing (refer Andrew, 1993). In light of multi structural breaks, Bai and Perron (1998) introduced a technique that allows inferring the presence of multi breaks in series using multi linear regression. Furthermore, they recommend a dynamic programming algorithm for estimating more than two structural breaks in 2003. However, neither procedure allows for any structural change in the series variance and if the series mean undergoes structural changes, the variance may possibly exhibit some changes too. Inclan and Tiao's (1994) algorithm established a test to identify these changes within a variance series. Furthermore, this Inclan and Tiao Iterated Cumulative Sum of Square residual algorithm procedures (henceforth IT ICSS) suffers a smaller size distortion and is considerably more powerful because the test is able to identify minor changes in variance in a large number of observations (Andreou and Ghysels, 2002). Consequently, later, Sanso, Arago and Carrion (2004) overcame the IT ICSS test weakness and developed the k_1 and k_2 test.

Many researchers documented the IT ICSS in inferring the presence of structural changes in the stock market (Granger and Hyung, 1999; Aggrawal, Inclan and Leal, 1999), GDP growth (Fang and Miller, 2008), foreign exchange return (Malik, 2003) and combining financial and foreign exchange return (Andreou and Ghysels, 2002) volatility *inter alia*. In addition, a modified IT ICSS test is used in Rapach and Strauss (2008). Both authors highlight the importance of a structural break in the exchange rate return modelling within the GARCH framework in Canada, Denmark, Germany, Japan, Norway, Switzerland, and the US and UK exchange markets. The aforementioned evidence only focused on structural changes in variance, unlike Granger and Hyung

(1999), who concurrently adopted Bai and Perron and the IT ICSS test for detecting the existence of any change in mean and variance in the S&P 500 stock market. Meanwhile, Fang, Miller and Lee (2008) implemented Bai and Perron, and the modified version of the IT ICSS test to assess the instability of GDP growth during great moderation in Canada, Germany, Italy, Japan, the UK and the US. However, Rapach and Wohar (2006) suggest the Bai and Perron procedure as a basic test in detecting any structural changes in mean return. They adopted this procedure in their parsimony linear modelling for S&P 500 real return with structural changes.

2.4 CONCLUSION

Table 2.1: Summary of empirical evidence according to various estimation models

Mean Variance Framework	Minimum Variance Framework	Estimation model	Notes
Yang and Allen, 2004; Floros and Vougas, 2004	Ederington (1979) and many more.	**OLS**	**(fallaciously conclude a static hedging decision)**
		GARCH Framework	
		Mean Specification:	
	Baillie and Myers (1991), Ford, Pok and Poshakwale (2005), Floros and Vougas (2006)	Constant	
Yang and Allen, 2004; Floros and Vougas, 2004	Lien, Tse and Tsui (2002),	VAR	
Yang and Allen, 2004; Floros and Vougas, 2004; Kroner and Sultan, 1993;	Lien and Tse (1999), Wilkinson, Rose and Young (1999), Moschini and Myers (2002), Lien (2004) and Mili and Abid (2004), Floros and Vougas (2006), Brooks et al. (2002), Switzer and El-Khoury (2006), Menue and Tarro (2003), Yang and Awokuse (2002).	VECM	The results are mixed and VECM model out performed other mean models.
		Variance Specification:	
Kroner and Sultan, 1993; Gagnon et al. 1998; and Yang and Allen, 2004	(Baillie and Myers, 1991; Frackler, 1992; Bera, Gracia and Poh, 1997; Foster and	Symmetric models: GARCH, DVECH, VECH, BEKK and CCC	Symmetric models: GARCH, DVECH, VECH, BEKK and CCC

	Whitemen, 2002, Bollerslevs,1987; Baillie and Bollerslev,1989; Wilkinson, Rose and Young,1999; Mili and Abid, 2004, Lien et al. (2002) and Ford, Pok and Poshakwale (2005),		(Note: dynamic models performed better than conventional model)
Gagnon and Lypny, 1995;	Lien (2004), Brooks et al. (2002), Menue and Tarro (2003), Switzer and El-Khoury (2006) and Floros and Vougas (2006),	Asymmetric model: GJRGARCH, BEKK-A,	Asymmetric model: GJRGARCH, BEKK-A, (Note: Significant effect on hedging ratio estimation but minimal on performance)
Nil	Lee and Yoder (2007) regime switching model. Wei-Choun et al (2009) – MGARCH Model.	Structural break	Markov Switching model better than general model
Karp (1987), Lien and Tse (2000), Yitzhaki (1982, 1983), Shalit and Yitzhaki (1984), De Jong et al. 1997; Chen et al. 2001; Demirer and Lien, 2003, Cheung *et al.* (1990), Shalit (1995), Kolb and Okunev (1992), Shaffer and Demaskey (2005)		**Alternative Model:** Bayesian model, Wavelet Analysis, Value at risk,linear exponential Gaussian model, lower partial moment, Mean Gini Approach	

A summary of the reviewed literature is presented in Table 2.1. The summary is segregated into mean variance and minimum variance framework. Commonly, most of the literature examines the hedging performance in the less restrictive minimum variance paradigm and not many in the mean variance paradigm. Only a few studies were conducted to strengthen the hedging performance conceptual framework. Numerous studies were interested in examining various measurements (either in the

GARCH symmetric or asymmetric models) that give the most optimal performance estimation results. Although the literature proves the asymmetric effect has an implication on the hedging performance, the effect is very similar to the symmetric models estimation results. Consequently, this research will not cover the asymmetric effect in the performance analysis. The main question is whether there is any significant impact on both hedging performances if we use different mean modelling specifications. Subsequently, little effort has been given to identifying the momentous consequences of different mean specification models or the effect of hedging effectiveness in various econometric modelling. Furthermore, there has been minimal attention that focuses on hedging effectiveness in both the risk minimization and utility maximization framework concurrently. Consequently, this research attempts to investigate the effect of different mean specifications (Intercept, VAR and VECM) applied in three GARCH models on hedging effectiveness in the crude palm oil futures market. The BEKK model represents the indirect GARCH approach while both the Constant Correlation Model and the Dynamic Condition Correlation model represent the direct GARCH approach. Furthermore, the hedging performance will be examined based on the variance reduction comparison achieved in the hedging position and utility maximization function with in-sample and out-sample data for each model.

From the structural break perspective, there are two issues that need to be addressed in most economic and financial second moment economic modelling process. First, the issue of including or omitting the structural break in the second moment modelling process. If there are some structural changes, another concern of equal significance arises, that of identifying the correct number of structural breaks in the tested series. If the series experience structural changes, without these changes, first we may conclude that the series is non-stationary at level. Second, when modelling the series of the second moment, the spurious persistency of variance estimated could possibly be achieved. When variance persistence is spuriously estimated, this leads to a subsequent effect, that is, less efficiency in forecasting activity (Rapach and Strauss, 2008). Additionally, Fang, Miller and Lee (2008) prove that modelling the second moment with breaks will transform the leptokurtic unconditional second moment into the mesokurtic conditional second moment. Finally, misleading estimation of the second moments parameter may either under- or overestimate the hedging performance. However, this research will not try to address the first consequence but will focus on the remaining omission break effect. Hence, we extend our investigation to establishing the severity of the non-inclusion of structural breaks in hedging performance evaluation. Understandably, it is considered prudent to examine any structural breaks experience by series before proceeding to the actual second moment modelling activities.

The main motivation for this research is to explore the resonance of various econometric models, and how they may potentially affect the hedging performance measurement results. Furthermore, we investigate the consistency of hedging performance using the most reasonable econometric model that best captures the true best hedging performance characteristics. Thus, this research will extend the existing literature in a number of ways. First, the research aims to explore the implication of various mean specifications. It then proceeds to seek the effect of both the direct and indirect GARCH models hedging performances analysis. Additionally, the study adds to the existing empirical evidence on emerging commodity futures market, as the sample used is the Malaysian Crude palm oil futures market. Unlike previous studies, which exhibit the hedging performance in more advanced commodity markets. The study will further complement previous research on issues of structural breaks with applications on financial and macroeconomic series from developed markets. The study considers the application of structural break tests on the commodity returns series from an emerging market such as Malaysia. We further investigate the existence of potential breaks in the mean and variance of the returns series, as well as in the cointegration relationship between the spot and future series, and suggest that these breaks need to be incorporated in the BEKK variance-covariance model specification to provide correct hedging performance inference. Ultimately, based on the hedging performance estimation (focus on risk minimization framework) generated in both general and BEKK with the structural break model, we analyse the performance consistency across various significant events throughout the research sampling period.