Selective Hedging Strategies for Oil Stockpiling

*Won-Cheol Yun**
Department of Economics and Finance, Hanyang University,
17 Haengdang-dong, Seongdong-gu, Seoul, 133-791, South Korea

Abstract

As a feasible option for improving the economics and operational efficiency of stockpiling by public agency, this study suggests simple selective hedging strategies using forward contracts. The main advantage of these selective hedging strategies over the previous ones is not to predict future spot prices, but to utilize the sign and magnitude of basis easily available to the public. Using the weekly spot and forward prices of WTI for the period of October 1997 to August 2002, this study adopts an ex ante out-of-sample analysis to examine selective hedging performances compared to no-hedge and minimum-variance routine hedging strategies. To some extent, selective hedging strategies dominate the traditional routine hedging strategy, but does not improve upon the expected returns of no-hedge case, which is mainly due to the data characteristics of out-of-sample period used in this analysis.

Keywords: Selective Hedging, Forward Contracts, Oil Stockpiling

*Corresponding author. Tel: +82-2-2290-1028, fax: +82-2-2296-9587
E-mail address: wcyun@hanyang.ac.kr (W.-C. Yun).

1. Introduction

"Oil stockpiling" is defined as an activity related to reserve a certain level of crude oil and/or oil products in designated areas to respond to supply disruptions or price hikes, and to make drawdown in occasional emergencies. In major countries of the world, the strategic petroleum reserve (SPR) programs have been launched and operated by governments or public agencies. For example, the United States SPR is the largest stockpile of government-owned emergency crude oil in the world. Established in the aftermath of the 1973-1974 oil embargo, the SPR provides the President with a powerful response option should a disruption in commercial oil supplies threaten the U.S. economy. It also allows the U.S. to meet part of its International Energy Agency (IEA) obligation to maintain emergency oil stocks, and it provides a national defense fuel reserve.[1]

The Republic of Korea (ROK) is also participating in the IEA, and the Korea National Petroleum Corporation has taken charge of domestic oil stockpiling for supply security. As of February 2004, the level of oil reserve amounts to 109-day consumption including 54-day consumption by public sector and 55-day consumption by private sector. It is expected for ROK to acquire 141 millions barrels by 2008 under the third Oil Stockpile Plan.

One of key issues related to the SPR program in ROK would be its economics and financing the required budgets. Due to the lack of budgets, it takes more time to fill out the target level of oil reserve. In addition, the SPR program requires a considerable amount of operation and maintenance costs. As a result, the voices of publics and experts are arousing and asking for the change of oil stockpiling policy. It is suggested that the SPR policy should be transformed from the static concept of dead-stock into the dynamic concept of put-through. That is, the current practice of oil stockpiling should be a more market- and profit-oriented system, and at the same time satisfy the minimum requirements of SPR program.

One of feasible options for improving the economics and/or operational

---

[1] The public agencies involved in SPR programs include JNOC of Japan, EBV of Germany, COVA of Netherlands, CPSSP and SAGESS of France, CARBURA of Switzerland, FDO of Denmark, etc. Any IEA member should meet the obligation of making reserve of 90-day consumption based on its consumption of previous year.

efficiency of oil stockpiling program would be to utilize the forwarding opportunities by various instruments of derivatives. For this purpose, this study suggests various selective hedging strategies with forward contracting. In addition, the comparative performances of selective hedging strategies are quantitatively analyzed compared to the cases of no-hedge and traditional routine hedging strategies with minimum-variance hedge ratio.

This paper is organized as follows. The next section briefly surveys the literature on selective hedging, and describes selective hedging model incorporating time-varying basis relationship. The third section explains the data used, and present the empirical results. The fourth section summarizes the results, and makes some implications based on the results.

2. Selective Hedging Model

2.1. Literature Review

The terminology of "selective hedging" is first labeled by Stulz (1996). This refers to hedging strategy based on the hedger's market expectations by which he may chose to hedge only part of his position or not at all. Contrary to this concept, the term "blind hedging" or routine hedging corresponds to the practice of not deviating from a fully planned hedging strategy, with volumes, contracts, and entry and exit points established prior to the execution of the hedge (NYMEX, 2004). In a selective hedging, the execution of the overall strategy can be fine-tuned to better reflect ongoing cash market conditions. Thus, if continuously increasing prices were assumed, it is unlikely that a producer would blindly stick to his losing short hedges, rather than liquidate early to contain his future losses. A selective hedging, for example, might link the volume to be hedged to an ongoing assessment of the cash-futures or cash-forward basis relationship and the perceived likelihood of a reduction in posted prices.

As explained below, the selective hedging basically involves forecasting future spot prices. A trader decides whether to hedge or not according to price expectations. For instance, a future cash buyer would take a long position in futures or forward with a certain maturity when a forecasted spot price prevailing at maturity exceeds the current futures or forward price with the given maturity. Contrary to this, his cash position is left unhedged when the forecasted spot price is below the current futures or forward price. Alternatively, a commodity holder hedges if price are expected to fall, and does not hedge if prices are expected to rise.

As implied above, selective hedging introduces an additional speculative element to hedging (Leuthold et al., 1989). Selective hedging by companies appears to be widespread. This common hedging procedure is often done to prevent large losses, and it can relate to optimal hedging rather than simply minimizing risk. Obviously, it is assumed that the trader must have skills in anticipating future price movements. Several studies present some evidence of the real world practice of selective hedging (Dolde, 1993; Bodnar et al., 1998; Brown, 2001; Brown et al., 2001; Naik and Yadav, 2002; Glaum, 2002). According to Brown et al. (2001), some firms appear to have a statistically significant ability to selectively hedge. However, the average economic significance of the gains is small. Thus, it is concluded that senior managers and boards of directors should reevaluate whether selective hedging increases shareholder wealth.

Empirical studies of selective hedging try to verify whether selective hedging yields higher returns for commodity storage or lower costs for input procurement than a policy of always hedging the corresponding resources. Obviously, this topic is directly related to how to forecast future spot prices accurately. To be a winner of selective hedging, one needs to build a fine forecasting model and to estimate it properly.[2] In fact, empirical results on the performances of selective hedging appear to be mixed. Closely related to this study, Linn and Zhu (2002) suggest that selective hedging for natural gas users is not likely to be an optimal strategy. A strategy of no-hedge appears to be the least cost strategy during the seasonal phase when natural gas prices are falling. In addition, during the seasonal phase when natural gas prices are rising, the least cost strategy is to always hedge for horizons out to six months.

The literature presents different views as to the optimal course of action for international portfolio management. Perold and Schulman (1988) point out that complete hedging is optimal due to the low impact of currency hedging on expected returns and the substantial reduction in volatility. Filatov and Rappoport (1992) show

[2] By the way, we can answer this self-contradictive question so easily! Many scholars have tried, but failed to forecast stock prices, interest rates, exchange rates, and various commodity prices. That is, there seems to be in consensus that markets are efficient and nobody can succeed to beat the markets consistently.

that selective hedging dominates complete hedging.[3] However, the relevance of the empirical results may be dubious due to the lack of diversification of the portfolios considered by the authors (Beltratti et al., 1999). The authors note that optimal hedging strategy is dependent on the currency of denomination and on the composition of the optimal portfolio. This argument challenges the theory proposed by Black (1990) which suggests the existence of a universal hedge ratio that is optimal for all the investors.

Glen and Jorion (1993) perform a more extensive analysis for the period 1974-1990. The main findings are that selective hedging outperforms the cases of unhedged, hedged and universally hedged portfolios of only-bond and bond-stock. However, it does not improve upon the results obtained by unhedged, hedged and universally hedged optimized portfolios of stocks. This is consistent with Solnik (1998) and Filatov and Rappoport (1992), confirming that the effects of hedging policy are more relevant for bonds than for stocks. Glen and Jorion (1993) also point out that selective hedging is not superior to the cases of unhedged, hedged and partially hedged passive indices of stocks, bonds and stocks and bonds. This finding implies the importance of the interaction between optimal hedging and overall portfolio composition.

According to Beltratti et al. (1999), the main results of this large literature suggest that selective hedging in the context of overall portfolio optimization is relevant mainly for bonds, not stocks. Especially, static selective hedging of otherwise passive indices is not very appropriate, which confirms the importance of the interactions between exchange rates and bond returns. Also, there is not enough evidence about dynamic hedging policies, which however seem to be effective even in the context of passive portfolios.

Beltratti et al. (1999) perform a dynamic analysis with scenario modeling of selective hedging strategies. The authors find that selective hedging is not always the best policy since a simple mixed rule based on complete hedging may be better from a dynamic point of view. More importantly, transaction costs are always crucial in determining the overall profitability. However, transaction costs influence the ordering

[3] The authors also present the findings that complete hedging was optimal for a US investor for the period 1980-1989 while selective hedging was optimal for a non-US investor over the same period.

of the strategies only at the monthly horizon, which makes selective hedging an inferior policy.

As noticed above, there are few successful stories related to selective hedging. As one of examples, Eun and Resnick (1997) find that the selective hedging strategy based on random walk model exhibits superior performance in comparison with the unhedged and routine hedging strategies under all parameter estimation techniques. These results imply that the random walk model provides a good estimate of next period's spot rate of exchange.

2.2. Model Specification

In this point, a question naturally arises: Can we classify the previous versions of selective hedging as a *bona fide* hedge? The answer may be yes because a hedge need not to involve predicting future price movements, but only evaluating the appropriateness of current spot price easily available to the public. Then, a trader can eliminate the greater risk of price-level volatility by assuming much smaller basis risk. This section presents an alternative approach for selective hedging based on the current spot-forward basis relationship. Basically, this approach does not involve predicting future spot prices, and thus overcomes the limitation inherent in the previous studies of selective hedging.

For expositional purpose, this study first assumes a simple stockpiling business primarily carried out by a government's agent. That is, the agent repeats releasing the reserved oil for sales to oil refineries and buying back new stocks of oil for stockpiling. This practice is comparable to the common business by a commodity elevator. Ignoring the agent's drawdown activity, this is equivalent to the business by a future cash buyer of resources. Denoting s_i and s_{i+t} as spot prices at time i and i+t, and E( ) as an expectation operator, the expected dollar return per one barrel of this simple sales and buy between time i and i+t is thus expressed as:

$$E(R_{is}) = s_i - s_{i+t} \quad (1)$$

Assuming hedging against adverse price movements via forward contracts, the routine trading rules using domestic oil reserve and facilities are as follows. When oil price is assumed to be higher than normal, the agent releases and sells the reserved oil, and simultaneously takes a long position in forward market to protect against price increase during the period of filling out the reserve. This situation usually occurs in a backwardation when spot price is above forward price and nearby forward prices are above distant forward prices. Denoting $f_{i,j}$ and $f_{i+t,j}$ as forward prices with delivery month j at time i and i+t, the expected dollar return of the portfolio composed of one-barrel oil and optimal ratio of forward position with delivery month j between time i and i+t is stated as:

$$E(R_{ip}) = (s_i - s_{i+t}) - h_i(f_{i,j} - f_{i+t,j}) \quad (2)$$

where h_i is the well-known minimum-variance hedge ratio which can be estimated by regressing forward price differences (or rates of return on forward position) on spot price differences (or rates of return on spot position). When the agent follows this hedging strategy without considering the relationship between spot and forward prices, we call it as a “routine hedging.”

Conversely, when oil price appears to be lower than normal, the agent additionally buys new stocks of oil and takes a short forward position to offset the loss from price decrease which might incur an opportunity loss. This situation takes place in a contango when spot price is below forward price and nearby forward prices are below distant forward prices. The expected dollar return of this situation is thus given by:

$$E(R_{ip}) = -(s_i - s_{i+t}) + h_i(f_{i,j} - f_{i+t,j}) \quad (3)$$

In order to develop selective hedging rules, the relationship between spot and forward prices is considered. For this purpose, denote $B_{i,j} = s_i - f_{i,j}$ as the basis prevailing at time i. When $B_{i,j} > 0$ implying backwardation, the agent is assumed to release the reserved oil and take a long forward position adjusted by hedge ratio. Otherwise, he does not take any forward position. This scenario assumes the expected return given by Eq. (2), and is referred to as a “positive-only strategy” (S1). Alternatively, when $B_{i,j} < 0$ reflecting contango, the agent would buy additional stocks of oil and take a short forward position. Otherwise, he does not take any forward position. This scenario yields the expected return given by Eq. (3), denoting it as a “negative-only strategy” (S2). As a third scenario, these two strategies are merged into forming a “both-direction strategy” (S3). With this selective hedging strategy, the agent is assumed to change taking positions in spot and forward markets according to the sign of basis.

Now, consider some variants of the selective hedging strategies presented above. These variants simply follow the same rules as those explained above, except that they also take into account some triggering rules. That is, the agent sells the reserved oil and takes a long forward position only when $B_{i,j} > TV_k$, which is referred to as a variant of "positive-only strategy" (T1) and the relevant return is provided by Eq. (2). Here, TV_k stands for various trigger values of certain amount of dollar per barrel. Similarly, he procures additional oil and takes a short forward position only when $B_{i,j} < -TV_k$, representing a variant of "negative-only strategy" (T2) and the relevant return is provided by Eq. (3). Consequently, combining T1 with T2 results in a variant of "both-direction strategy" (T3).

In sum, selective hedging strategies are classified without considering any trigger value: positive-only strategy (S1); negative-only strategy (S2); and both-direction strategy (S3). The corresponding selective hedging strategies based on different levels of trigger values are also considered: positive-only strategy (T1); negative-only strategy (T2); and both-direction strategy (T3). The trigger values of $0.5/barrel, $1.0/barrel and $1.5/barrel are arbitrarily chosen in this study. To compare the hedging performances by different strategy, this study adopts a cash-only (or no-hedge) strategy without forward hedging in Eq. (1) and a routine hedging strategy using minimum-variance hedge ratio in Eq. (2) as base cases. Table 1 compares the characteristics by trading strategy.

With respect to these selective hedging strategies, the optimal hedge position is assumed to consider simultaneously the risk reduction effect and the expected return from the commitments in the spot and forward positions. Theoretically, it is possible for the forward position to be equal and opposite to the spot position as in the traditional hedge. Alternatively, the sum of speculative component and pure hedging component may be null in the context of optimal hedging approach (not minimum-risk approach) , so the optimal hedging position is to take no position in the forward market. Doing nothing is sometimes considered to be the best practice. Also, it is plausible for forward position to be on the same side of spot market (Leuthold et al., 1989). For instance, a cash producer may have a long position in the forward market. Alternatively, a future cash buyer may have a short position in the foward market.[4]

[4] This situation is commonly termed as a "Texas hedge." In the States, selective hedging

3. Empirical Analysis

3.1. Data

This study uses every Friday spot and forward prices of West Texas Intermediate (WTI) for the period October 1997 to August 2002. The data set is provided by Goldman Sachs, and comes from the settlement quotations of New York time. This weekly data set has 257 observations, and is reduced to 206 observations by deleting the last 52 observation for differencing up to 12 months of hedging period. For ex ante analysis, the whole sample period is divided into the first sub-sample period of October 1997 to October 1999 (106 observations) for estimating hedge ratios and the second out-of-sample period of October 1999 to September 2001 (100 observations).

Figure 1 shows the price series of spot and forward with delivery of three, six, nine and twelve months for the whole sample period. As noticed in Figure 1, contangos dominate when spot prices are relatively low, and backwardations appear when spot prices are higher than normal level. Apparently, the absolute values of basis in backwardation are much larger than those in contango. This phenomenon occurs because when oil prices fluctuate in abnormally high level oil producers aggressively enter forward market to fix their selling prices above a certain level, and thus accumulatively increase short positions, which result in decreasing distant forward prices further than nearby forward prices.

Table 2 presents the descriptive statistics of the data used in this study. The prices are stated in terms of US dollar per barrel. The mean weekly spot prices for the first sub-sample and the second sub-sample (out-of-sample) periods are \$16.42/barrel and \$28.85/barrel, respectively. The corresponding values for forward prices are higher in the first sub-sample and lower in the second sub-sample than those of spot prices. These figures show that the first-half and the second-half of sample period correspond to the periods of low (contangos) and high (backwardations) oil prices, respectively . In

---

is considered as a speculative activity, not a hedging activity under current Internal Revenue Service (IRS) rulings. However, Yun et al. (1995) argue that selective hedging should be treated as a hedging behavior in a broader sense in that it helps to correct market imbalances.

terms of standard deviations, spot prices appear to be more volatile than forward prices with different delivery months, which will yield the minimum-variance hedge ratio with a value greater than unity. Both spot and forward price data exhibit positive skewness and soundly reject normality, which is confirmed by Jarque-Bera test statistics.[5]

3.2. Procedure

To compare the performances of hedging strategies, the spot and forward price data are transformed into the rates of return on spot and forward positions, given by:

$$r_{is} = 100(\ln s_i - \ln s_{i+t}) \quad (4)$$

$$r_{if} = 100(\ln f_i - \ln f_{i+t}) \quad (5)$$

Note that the rates of return on forward position is calculated by rolling over the most nearby (one-month) forward contracts, not by using the prices of time i and i+t of distant forward contracts corresponding to each delivery month.

The spot rates of return in Eq. (4) are regressed on the forward rates of return in Eq. (5) in order to estimate the minimum-variance hedge ratios. Based on the regression model shown in Eq. (6), the estimated coefficient in Eq. (7) is equivalent to the optimal ratio of forward to spot positions:

$$r_{is} = \alpha + \beta r_{if} + \varepsilon_i \quad (6)$$

$$\widehat{\beta} = h_i^* = \mathrm{Cov}(r_{is}, r_{if}) / \mathrm{Var}(r_{if}) \quad (7)$$

Here, a simple way of ordinary least square (OLS) regression to estimate hedge ratios is considered, but it would not be difficult to retrieve a handful of fine-tuned hedge ratios from more sophisticated econometric models such as VAR, VECM, GARCH, etc.[6] This

---

[5] The Jarque-Bera statistics is used to test the hypothesis that a given set of data is drawn from a normal distribution. Under the null hypothesis of a normal distribution, this statistic is distributed as chi-squared with 2 degrees of freedom (Jarque and Bera, 1987).

[6] In fact, the performances of hedging strategies based on different techniques for estimating hedge ratio are mixed. Among many studies, Moosa (2003) investigates the effect of the choice of the model on the effectiveness of futures. The results show that model specification has little effect on the hedging effectiveness. What matters most is the correlation between the prices of the unhedged position and the hedging instrument.

would be a major topic of research that is not carried out here since the main goal of this study is just to evaluate the comparative performances of the various hedging strategies, especially the comparative advantage between routine and selective strategies.

Related to the estimation of hedge ratios, this study adopts a simple dynamic rule by rolling over the first-half sub-sample and renewing hedge ratios each week. That is, the hedge ratio at time i is estimated by using the data covering time i-t through time i-1. As new spot and forward prices are available in the markets, the hedge ratio at time i +1 is estimated by using the data spanning time i-t+1 through time i. This updating process to obtain hedge ratios continues until the last week of out-of-sample period. Although this study does not explicitly consider a possible time-varying mean and/or variance of data by using a GARCH-type model, it is likely to incorporate new information into an agent's hedging decision.

The return on cash-only strategy denoted by Eq. (1) is thus changed to the rate of return stated by Eq. (4). Similarly, the corresponding rates of return on the routine and various selective hedging strategies depending on the basis signs are calculated by Eq. (8) and Eq. (9), respectively:

$$r_{ip} = r_{is} - h_i^* r_{if} \qquad (8)$$

$$r_{ip} = -r_{is} + h_i^* r_{if} \qquad (9)$$

3.3. Empirical Results

To examine the ex ante out-of-sample hedging performances by different hedging strategy and period, this study uses various measures of mean and standard deviations of rate of return, hedging effectiveness, Sharpe ratio, and the expected utility based on mean and variance of returns.[7]

Table 3 shows the means of rates of return by various hedging strategy and period. In terms of expected rates of return, the cash-only or no-hedge strategy outperforms the routine and the selective hedging strategies regardless of hedging periods except for one-month hedging program. This finding stems from the

[7] Ex post in-sample analysis is also performed for the whole sample period, and the results are basically similar with those of the ex ante out-of-sample analysis reported here. The results are available upon request.

down-trending characteristics of out-of-sample period basically reflecting backwardations. That is, when a market is downside from top, the simple sales and buy in spot market would produce more returns than continuous or occasional hedging trades.[8] Compared to the routine hedging strategy, the positive-only selective hedging strategy (S1) produces higher expected rates of return regardless of hedging periods. And, the both-direction selective hedging strategy (S3) outperforms the positive-only selective hedging strategy (S1). Considering the triggering rule, it is founded that when the basis level of backwardation is greater than \$0.5/barrel, it is optimal for hedgers to use the positive-only selective hedging strategy (T1).

Table 4 presents the standard deviations of rates of return by hedging strategy and period. The cash-only strategy shows the highest standard deviations, implying that the volatility of returns without hedging is noticeable. By adopting the routine hedging strategy, we could reduce substantial amount of volatility of returns by 90% to 98 % depending upon hedging periods shown in Table 5. Table 5 summarizes the measures of hedging effectiveness, which defines the percentage reduction in variance to unhedged position (Ederington, 1979). More importantly, the positive-only (S1) and the both-direction (S3) hedging strategies marginally decrease the standard deviations of rates of return irrespective of hedging periods.[9] In addition, the use of triggering rule could reduce the volatilities of returns further. As confirmed in Table 5, the reductions amount to 95% to 99% by hedging period. It should be noticed that the results of T1, T2 and T3 with trigger value of \$1.5/barrel could be spurious since the effective observations are only six out of 100 samples for all hedging periods.

---

[8] As shown in Figure 1, the out-of-sample period represents “Late Bull/Early Top” and “Late Top/Early Bear” situations in industrial terminology. The former is characterized by rising but more volatile prices, and large backwardations inside and outside spread. The latter corresponds to the times of random and volatile prices with sharp falls and less strong rallies. It also shows high volume, continuing backwardations with occasional vicious bear squeezes.

[9] Although the negative-only hedging strategy (S2) shows the lowest standard deviations, the results could be misleading since the observations of hedging activated are very limited. The numbers of activation are seven (1-month), six (3-month), three (6-month), one (9-month), and one (12-month) out of 100 samples, respectively.

Table 6 shows the Sharpe ratios of returns by hedging strategy and period. The Sharpe ratio is used to evaluate the risk-adjusted performance of portfolios or mutual funds. This ratio is calculated by subtracting return on risk-free asset from return on portfolio, and dividing it by standard deviation of portfolio (Sharpe, 1966). Here, the rates of U.S. three-month certificate of deposit are used for a proxy of returns on risk-free asset.[10] The return and the standard deviation of portfolio correspond to those of cash-only strategy and various hedging strategies.

As shown in Table 6, the cash-only strategy dominates all the routine and selective hedging strategies regardless of hedging periods. As mentioned before, this result comes from the peculiarity of out-of-sample period. One thing to notice is that the both-direction selective hedging strategy (S3) is expected to produce better Sharpe ratios than the routine-hedging strategy. However, the selective hedging strategies would deteriorate with higher trigger values.

Table 7 tabulates the expected utilities measured by the mean and variance of portfolio returns. The expected utility is simply calculated by subtracting the variance of portfolio adjusted by risk aversion coefficient from the expected return on portfolio (Markowitz, 1952). This utility measure takes account for trader's risk-averse attitude and return-risk tradeoff at the same time. Assuming the degree of risk aversion equals to one, the cash-only strategy shows the poorest results. Compared to the routine hedging strategy, the selective hedging strategies of S1, S2 and S3 yield higher utilities. In addition, the selective hedging strategies based on triggering rule outperform the simple selective hedging strategies regardless of hedging periods. These results contradict those of the above analysis in terms of Sharpe ratios. Therefore, it suggests that the comparative performance of various hedging strategies is sensitive to the characteristics of out-of-sample data. Also, when we consider return (in terms of mean) as well as risk (in terms of standard deviation) as the measure of hedging performance, the choice of the risk-averse degree could be a determinant of empirical results.

[10] For a short time horizon, a risk-free rate of zero is assumed to calculate the Sharpe ratio. This practice will not have a serious impact on the results since short-term risk-free rate is small (Jorion, 1985, 1986; Eun and Resnick, 1988, 1994, 1997).

4. Conclusions

The current policy of oil stockpiling by Korean government's agency is based on the static concept of dead-stock. However, the recent changes in economic environment is requiring a transition to the dynamic concept of flow-stock. This study suggests simple selective hedging strategies using forward contracts as a feasible option for improving the economics and operational efficiency of stockpiling, and quantitatively analyzes their performances compared to no-hedge and routine hedging strategies.

Unlike the selective hedging strategies proposed by previous studies, this approach does not involve any forecasting of future spot prices, which might contradict the genuine concept of hedging. Instead, an agent easily makes his hedging decision according to a simple and objective rule, which is based on the sign and magnitude of the relationship between spot and forward prices. Thus, the main advantage of these selective hedging strategies over the previous ones is not to predict future spot prices, which seems to be impossible.

For empirical testing, this study adopts an ex ante out-of-sample analysis using the weekly spot and forward prices of WTI for the period of October 1997 to August 2002. To some extent, this study verifies the comparative advantage of selective hedging strategies over the traditional routine hedging. The empirical results show that the selective trading strategies would increase the expected values of returns and decrease their volatilities compared to those of routine hedging strategy. In addition, the selective trading strategies using a simple triggering rule could increase the improvements. However, a selective hedging does not improve upon the expected returns from cash-only or no-hedge strategy, which is attributable to the downturn market phase of out-of-sample period. Based on these results, it is suggested that in order to stabilize the values of domestic oil reserve, it is necessary to actively utilize the stockpiling facilities and the reserved oil combined with appropriate forward positions.

References

Beltratti, A., Laurent, A., Zenios, S., 1999. Scenario Modeling of Selective Hedging Strategies. Working Paper, Financial Institutions Center, University of Pennsylvania.

Black, F., 1990. Equilibrium exchange rate hedging. Journal of Finance 45, 899-907.

Bodnar, G., Hayt, G., Marston, R., 1998. Wharton survey of financial risk management by US non-financial firms. Financial Management 27, 70-91.

Brown, G., 2001. Managing foreign exchange risk with derivatives. Journal of Financial Economics 60, 401-448.

Brown, G., Crabb, P., Haushalter, D., 2001. Are firms successful at Selective hedging? Working Paper, University of North Carolina at Chapel Hill.

Dolde, W., 1993. The trajectory of corporate risk management. Journal of Applied Corporate Finance 6, 33-41.

Ederington, L., 1979. The Hedging Performance of the New Futures Markets. Journal of Finance 34, 157-170.

Eun, C., Resnick, B., 1988. Exchange rate uncertainty, forward contracts and international portfolio selection. Journal of Finance 43, 197-215.

Eun, C., Resnick, B., 1994. International diversification of investment portfolios: US and Japanese perspectives. Management Science 40, 140-161.

Eun, C., Resnick, B., 1997. International equity investment with selective hedging strategies. Journal of International Financial Markets, Institutions and Money 7, 21-42.

Filatov, V., Rappoport, P., 1992. Is complete hedging optimal for international bond portfolios?" Financial Analysts Journal July-August, 37-47.

Glen, J., Jorion, P., 1993. Currency hedging for international portfolio. Journal of Finance 48, 1865-1886.

Glaum, M., 2002. The determinants of selective hedging: Evidence from German non-financial corporations. Working Paper, Justus-Liebig-Universitat Giessen.

Jarque, C., Bera, A., 1987. A test for Normality of Observations and Regression Residuals. International Statistical Review 55, 163-172.

Jorion, P., 1985. International portfolio analysis. Journal of Business 58, 259-278.

Jorion, P., 1986. Bayes-Stein estimation for portfolio analysis. Journal of Financial and

Quantitative Analysis 21, 279-292.

Leuthold, R., Junkus, L., Cordier, J., 1989. The Theory and Practice of Futures Markets, Lexington Book.

Linn, S., Zhu, Z., 2002. Can Selective Hedging Pay?: Price Forecasting and Selective Hedging of Natural Gas Requirement. Working Paper, University of Oklahoma.

Markowitz, H., 1952. Portfolio Selection. Journal of Finance 7, 77-91.

Moosa, I., 2003. The Sensitivity of the Optimal Hedge Ratio to Model Specification. Finance Letters 1, 15-20.

Naik, N., Yadav, P., 2003. Risk management with derivatives by dealers and market quality in government bond markets. Journal of Finance 58, 1873-1904.

NYMEX, 2004. A Guide to Energy Hedging. New York, U.S.

Perold, A., Schulman, E., 1988. The free lunch in currency hedging: Implications for investment policy and performance standards. Financial Analysts Journal 44, 45-50.

Sharpe, W., 1966. Mutual fund performance. Journal of Business 1, 119-138.

Solnik, B., 1998. Global asset management. Journal of Portfolio Management 8, 43-51.

Stulz, R., 1996. Rethinking risk management. Journal of Applied Corporate Finance 9, 8-24.

Yun, W., Purcell, W., McGuirk, A., Kenyon, D., 1995. Implications of Trade Mix to Price Discovery and Market Effectiveness in Live Cattle Futures. Journal of Futures Markets 15, 373-394.

Figure 1. WTI Spot and Forward Prices by Delivery Month

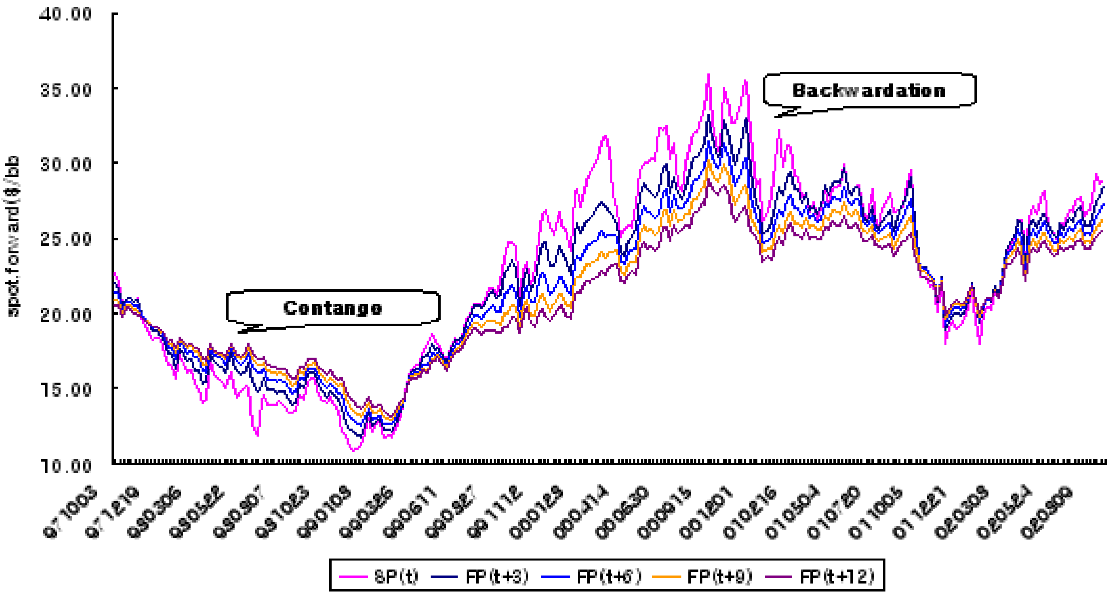

Table 1. Comparison of Hedging Strategies

Strategy	Market	Trading	Selectivity/Triggering
Cash-Only	-	Cash sell & buy	-
Routine-hedging	-	Cash sell & forward buy	Routine
S1 (Positive-Only)	Backwardation	Cash sell & forward buy	Selective
	Contango	Do nothing	
S2 (Negative-Only)	Backwardation	Do nothing	Selective
	Contango	Cash buy & forward sell	
S3 (Both-Direction)	Backwardation	Cash sell & forward buy	Selective
	Contango	Cash buy & forward sell	
T1 (Positive-Only)	Backwardation	Cash sell & forward buy	Selective/Triggering
	Contango	Do nothing	
T2 (Negative-Only)	Backwardation	Do nothing	Selective/Triggering
	Contango	Cash buy & forward sell	
T3 (Both-Direction)	Backwardation	Cash sell & forward buy	Selective/Triggering
	Contango	Cash buy & forward sell	

Table 2. Descriptive Statistics

Strategy	Mean	Std. Dev.	Skewness	Kurtosis	J-B Stat.
First Sub-Sample					
Spot Price	16.42	3.40	0.53	-0.45	57.48
1-Month Forward	16.61	3.25	0.49	-0.51	58.60
3-Month Forward	16.82	2.92	0.33	-0.62	59.76
6-Month Forward	16.96	2.45	0.06	-0.72	61.14
9-Month Forward	17.02	2.10	-0.14	-0.68	60.25
12-Month Forward	17.08	1.84	-0.26	-0.55	56.98
Out-of-Sample					
Spot Price	28.85	2.90	0.25	-0.10	41.18
1-Month Forward	28.32	2.67	0.20	0.15	34.54
3-Month Forward	27.39	2.50	0.03	-0.03	38.18
6-Month Forward	26.16	2.45	-0.25	-0.19	43.41
9-Month Forward	25.15	2.40	-0.43	-0.23	46.39
12-Month Forward	24.28	2.33	-0.52	-0.32	50.43
Whole Sample					
Spot Price	22.45	6.98	-0.01	-1.36	163.31
1-Month Forward	22.30	6.58	-0.03	-1.37	163.75
3-Month Forward	21.95	5.95	-0.02	-1.34	161.91
6-Month Forward	21.42	5.22	0.03	-1.30	158.54
9-Month Forward	20.97	4.65	0.09	-1.27	156.61
12-Month Forward	20.58	4.17	0.14	-1.24	155.06

Note: The null hypothesis of normality is rejected at 1% significance level for all data.

Table 3. Means of Returns by Hedging Strategy and Period (%)

Strategy	1	3	6	9	12
Cash-Only	-0.43	1.44	6.03	7.43	9.37
Routine-hedging	0.07	0.27	0.45	0.55	0.69
S1 (Positive-Only)	0.16	0.56	0.69	0.90	1.06
S2 (Negative-Only)	0.09	0.30	0.23	0.32	0.32
S3 (Both-Direction)	0.25	0.86	0.92	1.23	1.38
	TV = 0.5				
T1 (Positive-Only)	0.73	0.85	1.06	1.12	1.12
T2 (Negative-Only)	0.03	0.08	0.07	0.07	0.07
T3 (Both-Direction)	0.76	0.93	1.14	1.20	1.20
	TV = 1.0				
T1 (Positive-Only)	0.65	0.81	0.94	0.89	0.98
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	0.65	0.81	0.94	0.89	0.98
	TV = 1.5				
T1 (Positive-Only)	0.27	0.33	0.28	0.38	0.44
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	0.27	0.33	0.28	0.38	0.44

Note: “-“ implies the number is discarded due to the lack of effective observation.

Table 4. Standard Deviations of Returns by Hedging Strategy and Period (%)

Strategy	1	3	6	9	12
Cash-Only	8.65	13.41	18.31	19.95	21.52
Routine-hedging	2.66	2.96	2.78	2.76	2.84
S1 (Positive-Only)	2.57	2.72	2.60	2.46	2.51
S2 (Negative-Only)	0.64	1.02	0.80	0.89	0.94
S3 (Both-Direction)	2.65	2.84	2.66	2.50	2.55
	TV = 0.5				
T1 (Positive-Only)	1.85	2.02	1.84	1.95	2.12
T2 (Negative-Only)	0.25	0.57	0.52	0.54	0.53
T3 (Both-Direction)	1.86	2.07	1.87	1.98	2.15
	TV = 1.0				
T1 (Positive-Only)	1.60	1.79	1.77	1.88	2.09
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	1.60	1.79	1.77	1.88	2.09
	TV = 1.5				
T1 (Positive-Only)	1.11	1.37	1.16	1.54	1.78
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	1.11	1.37	1.16	1.54	1.78

Note: “-“ implies the number is discarded due to the lack of effective observation.

Table 5. Hedging Effectiveness of Returns by Hedging Strategy and Period

Strategy	1	3	6	9	12
Cash-Only	-	-	-	-	-
Routine-hedging	0.9052	0.9513	0.9770	0.9809	0.9826
S1 (Positive-Only)	0.9113	0.9589	0.9799	0.9848	0.9864
S2 (Negative-Only)	0.9945	0.9942	0.9981	0.9980	0.9981
S3 (Both-Direction)	0.9062	0.9550	0.9789	0.9843	0.9859
	TV = 0.5				
T1 (Positive-Only)	0.9541	0.9773	0.9899	0.9904	0.9903
T2 (Negative- Only)	0.9992	0.9982	0.9992	0.9993	0.9994
T3 (Both-Direction)	0.9539	0.9763	0.9895	0.9901	0.9900
	TV = 1.0				
T1 (Positive-Only)	0.9657	0.9821	0.9907	0.9911	0.9905
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	0.9657	0.9821	0.9907	0.9911	0.9905
	TV = 1.5				
T1 (Positive-Only)	0.9834	0.9896	0.9960	0.9941	0.9931
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	0.9834	0.9896	0.9960	0.9941	0.9931

Note: “-“ implies the number is discarded due to the lack of effective observation.

Table 6. Sharpe Ratios of Returns by Hedging Strategy and Period

Strategy	1	3	6	9	12
Cash-Only	-0.10	0.00	0.17	0.16	0.17
Routine-hedging	-0.15	-0.39	-0.86	-1.34	-1.75
S1 (Positive-Only)	-0.12	-0.31	-0.82	-1.36	-1.83
S2 (Negative-Only)	-0.59	-1.09	-3.24	-4.42	-5.66
S3 (Both-Direction)	-0.08	-0.19	-0.72	-1.21	-1.68
	TV = 0.5				
T1 (Positive-Only)	0.14	-0.28	-0.96	-1.60	-2.14
T2 (Negative-Only)	-1.76	-2.36	-5.30	-7.75	-10.62
T3 (Both-Direction)	0.16	-0.23	-0.90	-1.54	-2.08
	TV = 1.0				
T1 (Positive-Only)	0.11	-0.34	-1.07	-1.78	-2.23
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	0.11	-0.34	-1.07	-1.78	-2.23
	TV = 1.5				
T1 (Positive-Only)	-0.18	-0.79	-2.19	-2.52	-2.93
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	-0.18	-0.79	-2.19	-2.52	-2.93

Note: “-“ implies the number is discarded due to the lack of effective observation.

Table 7. M-V Utilities of Returns by Hedging Strategy and Period

Strategy	1	3	6	9	12
Cash-Only	-75.20	-178.48	-329.39	-390.46	-453.82
Routine-hedging	-7.01	-8.50	-7.27	-7.05	-7.37
S1 (Positive-Only)	-6.47	-6.83	-6.07	-5.14	-5.25
S2 (Negative-Only)	-0.32	-0.74	-0.41	-0.47	-0.57
S3 (Both-Direction)	-6.76	-7.22	-6.16	-5.03	-5.14
	TV = 0.5				
T1 (Positive-Only)	-2.70	-3.24	-2.33	-2.69	-3.39
T2 (Negative-Only)	-0.03	-0.24	-0.20	-0.21	-0.20
T3 (Both-Direction)	-2.68	-3.34	-2.37	-2.73	-3.42
	TV = 1.0				
T1 (Positive-Only)	-1.91	-2.41	-2.18	-2.65	-3.40
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	-1.91	-2.41	-2.18	-2.65	-3.40
	TV = 1.5				
T1 (Positive-Only)	-0.97	-1.55	-1.07	-1.99	-2.74
T2 (Negative-Only)	-	-	-	-	-
T3 (Both-Direction)	-0.97	-1.55	-1.07	-1.99	-2.74

Note: “-“ implies the number is discarded due to the lack of effective observation.