Hedging with Statistics: A Three Step Process

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Many firms, when faced with the challenges of hedging logically, do not know where to start. Some vainly attempt to forecast long term prices in order to decide upon a reasonable strategy, while others react in panicked frenzy to price environments that appear attractive and those which appear threatening.

This article explains how to leave behind hedging approaches that rely on forecasts or require experienced traders to execute. Such a program involves three major steps: (1) determining exposures and risk appetite relative to those exposures, (2) setting up a passive mechanical approach to hedging using statistics, and (3) selecting reasonable instruments in order to execute hedges properly.

Basic Assumptions

While it is possible to forecast short term events, we do not believe that it is feasible to forecast events further out, nor rational to rely on such forecasts for medium term hedging[1]. The reason for this is the "butterfly effect" that asserts that small changes in initial conditions, while virtually having no impact in the short run, can have a great impact over a longer term. Consequently, we maintain that a logical, strategic hedge plan should be supported by an analytic, statistical approach.

Let's look at how small changes in initial conditions can magnify an ultimate result.

In the example below, we multiply 8 x 2 and get 16. However, as we take the number 16, raise it only to the 4th power, we see a difference in the two results of $662.00. If we then square that number, we see a difference of nearly 90 million. How can this possibly be?

Calculation 1	Calculation 2	
$8	$8	
$2	$2	Difference
$16	$16	$0
$65,536	$66,198	$662
4.29E+09	4.38E+09	$87,196,272

[1] Medium term defined as 6 to 18 months.

Well, in Calculation 2, 8 is actually 8.0085, 2 is actually 2.003. Thus, we have differences at the third decimal place and beyond. If we decide to simply carry a few more decimal places, we still run into the same problem sooner or later in that none of our computational abilities are infinite.

Have you ever played a game of billiards? If so, you likely take into account the gravitational field of all the persons in the room. If anybody moves, the gravitational field of that person will impact the ultimate outcome of the game. Do you disagree? If so, we are both correct.

Laws of physics show that a gravitational field from a spectator's body at the edge of pool table does not significantly alter a trajectory of a careening ball if there are two impacts only. But after only nine impacts, the perturbation caused by a person moving in the room becomes important.

The energy markets, with all the factors of human behavior, vicissitudes of exploration and production, and weather, is much more complicated than a model with only a few billiard balls on a flat surface.

The world's most capable computer can not compute to an infinite number of decimal places. No matter how astute your trading group, no group of fallible persons can accurately and consistently take into consideration all the factors that can impact the market in the medium term. We often say that in order to be a true fundamentalist, we must have the mind of God.

This is why we have come to rely upon qualitative, statistical methods for the longer term hedging profiles that we establish.

Statistical, Three Step Process

It is critical to a risk management program's success to safeguard against depending upon long term forecasting or correct predictions about fundamentals. Also, in many companies it is important to ensure the program does not require previous trading experience for successful execution.

Most commodity markets are random in the long run. Even so, prices do exist within a fairly finite distribution. Weather, politics, other external factors and random events can trend the market in a given year or season, but eventually prices balance out. We call this phenomenon "mean reverting". This characteristic allows us to make purposeful assessments about current prices in relation to the central tendency of the market as a whole.

Consider the following table of the six-month strips for the natural gas market during the past five years.

See that the strip has only been above $2.76 5% of the time,

Percentiles of Six Month NG Forward

%	6 Month Strip	6 Month Settle
0	1.44	1.52
2.5	1.53	1.54
5	1.58	1.54
10	1.69	1.57
90	2.55	2.76
95	2.76	2.84
97.5	2.86	2.85
100	3.28	2.85

while the averages of any consecutive six months' settles have been above $2.76 10% of the time. So, we can judge that a producer hedging the six month strip above $2.76 is fairly "safe" 90% of the time.

The author's approach has been to develop a statistical methodology that determines prime statistical fix-forward points by evaluating the "highest" of a set of probabilities over a range of time frames to determine prices at which producers are advised to fix forward and the "lowest" for consumers. Additionally, when price probabilities are unfavorable, as when they are on the wrong side of the mean, and it is dangerous to fix price, we identify high probability points at which to buy price protection (calls, puts, floors, etc.) also using a statistical methodology.

Step One: Determining Exposures And Risk Appetite

What Are Your Volumes?

The first aspect in defining exposures is much more simple than calculating a value at risk. When defining your exposures, a straightforward enumeration of the volumes of oil, gas or other is sufficient. It is always a good idea, in addition to a general understanding of what you will be producing or consuming, to have an 18 month, month by month profile.

The next step is to break the exposures down by index or price publication. For example, you may list your gas by the Inside

Ferc index upon which it is purchased or sold.

Defining a Default Case

Next, we determine a base or default case for how our commodity will be bought or sold in a neutral market environment. A neutral market applies whenever prices are neither too high nor too low to pose either an opportunity or difficulty.

In developing a default case, we seek to establish tactics that will reduce the volatility in our portfolio without substantively altering the average market price that we will receive over time.

Correlation Issues

It is then important to determine the extent to which our base exposures correlate with exchange traded instruments. Even if we plan to execute all of our business through a market maker, in order to achieve ease of execution and good credit terms, we may transact business in exchange denominated settlements. So, we determine the extent to which our portfolio correlates with these exchange denominated settlement types[2].

Reduce Volatility by Diversification

Next, we evaluate ways to reduce the volatility in our portfolio through diversification. Diversification can be achieved a number of different ways. The most obvious is to settle some of our exposure based on exchange traded instruments, such as

...evaluate ways to reduce the volatility...
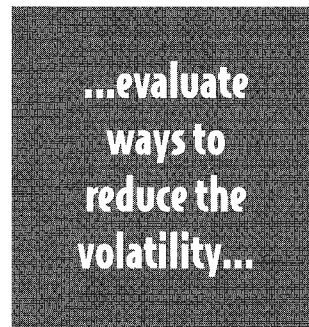
NYMEX, while keeping another portion of our exposure always settled otherwise. We would choose indices that go in and out of correlation with NYMEX or have low correlations with NYMEX, to balance out the portfolio.

Other ways to diversify and reduce volatility are to settle a portion of your portfolio on an average price basis as opposed to, for example, last three day and to dollar cost average the forward curve as opposed to spot.

Step Two: Developing a Mechanical Approach, Using Statistics

How Much to Hedge

Once the base case is established and policies are set to monitor any deviations from the base case, we handle both very attractive and adverse price situations.

How much volume might we hedge from a practical standpoint? As a primary rule, we never hedge more volume than we will actually consume or produce. Nominally 80% is an advisable, maximum limit.

How much less we want to hedge depends on three major factors. These are comfort level, liquidity, and externally imposed objectives. If we are a moderate sized, privately held firm, we may feel comfortable hedging up to 80% of our volume. On the other hand, if answering to a regulator or to stockholders, we may wish to limit volumes to nominally 50% of the total to allow a full market float on the other half.

In addition are liquidity considerations. For example, a medium size utility purchasing 60 BCF a year, may feel much more comfortable hedging 80% than a large utility purchasing 6 to 8 times that amount. Hedging 3 BCF a month is a much easier proposition in terms of getting the deal done than 30 BCF.

Over and above this, we must impose external requirements. We may need to ensure a high cash flow in order to meet debt service, in which case we hedge more than otherwise to accomplish our goals.

Risk Appetite and Trade Offs

Volumes established, we determine how to trade off, ensuring attractive price versus a better than market price. Put differently, how aggressively do we wish to protect a particular budget or *acceptable price* versus *capture opportunities*, suffering through adverse periods when a hedge is missed?

Think of the decision process in terms of percentage budget hedging versus percentage competitive hedging. A company that is purely driven by a need, for example, to satisfy debt service, would be considered a 100% budget hedger. A company that had no debt, is highly capitalized and only cares about achieving better prices than the competition, is purely a competitive hedger and has 100% competitive considerations. The bottom line, however, is one can not choose 100% of each, with a passive, mechanical system.

...Level 4 hedgers waited for better prices...

To assist our clients in determining their risk appetite, we have established five levels of hedger from Level 1, purely budget, to Level 3 50/50 to Level 5 at purely competitive.

As an example, in February to April of 1997, with our approach, Level 2 consumer hedgers fixed forward and bought calls, and so were 100% protected as the market rose to very high levels. More cautious Level 4 hedgers, requiring more evidence to step in and hedge, only covered nominally 50% of their exposures.

Conversely, late in 1997, Level 2 producers hedged most of their exposure during the month of September, and some in October. Conversely, the Level 4 hedgers waited for better prices, placing most of their hedges in late October and early November, having been more cautious and waited longer.
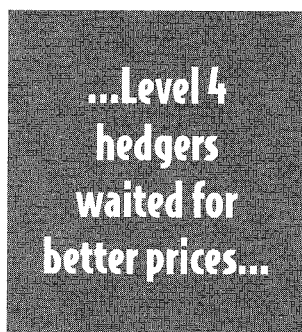
So we can see that the Level 2's are more oriented towards avoiding poor prices, and the Level 4's to obtaining attractive prices.

We can, of course, become more elegant with risk appetite definition. We may feel more comfortable risking option premiums than risking larger costs associated with fixing forward. So we may choose to be a Level 1 on buying calls and a Level 4 on fixing forward.

With a statistical approach, we may tailor the hedge rules to fit our specific cost and bene-fit balance.

When to Hedge

"When" is never a good question in the sense that the only good time to hedge is when market structure and the prices associ-

ated with such market structure call for hedges to be placed.

We may not appropriately say we will always do our hedging in the fourth quarter for the planning cycle, because we may not achieve our hedge targets and goals in that particular time frame. Thus, we always encourage hedgers to divorce themselves from an arbitrary schedule.

That said, once we are in a statistical zone that calls for hedging, the "when" question is answered by one's risk appetite. The more one is budget driven, the sooner and faster one places one's hedges.

At What Price

"What price to hedge?" can be answered statistically. When prices are at a statistically attractive level, say at the 10th percentile for consumers or the 90th percentile for producers, one has probabilities in one's favor and may think favorably about fixing forward. (Other hedging must be determined by trading methods as opposed to statistical or objective methods.)

Along the same lines, buying price protection would take place as prices threatened to move into areas that are considered statistically unattractive. For consumers, this point may be somewhere at or above market average and vice versa for producers.

Our risk appetite determines the degree to which we hedge in a particular strip (i.e., the 6 month strip) with or without the support of other strips (i.e., the 3 or 12).

Again, the more budget driven, the lower the level of statistical confirmation needed to hedge.

Step Three: Selecting Reasonable Instruments

Once we have determined how much, when and at what price, we choose instruments to execute the hedge in real time.

Often traders' choices pose more costs to their firms because we seek to save money or time in the short run, rather than taking an objective, longer view. A simple example is that an at-the-money option, while more expensive, has a greater probability of exercise than one deep out-of-the-money option.

When fixing forward, it is very important to remember that collars are a fixed price mechanism, not a protective mechanism. A collar fixes a range as opposed to a discrete price. So, whenever fixed prices are called for we can begin with wide collars, move to more narrow collars, and end with swaps as the market goes in our favor.

Similarly, in options' strategies, we can follow a parallel increase in aggressiveness as prices threaten to go against us. If we are relatively unsure about the probabilities, say, the first time prices move against the market mean, we may protect some volume with compound

options, a knock in option, or perhaps even a ladder strategy. As prices continue to move against us, say, as prices approach 0.50 standard deviations against the mean, we may increase our level of aggression to vanilla options, at-the-money.

Becoming familiar with how derivatives work, and ways in which the functionality of derivatives may be modified to suit us better, are important in order to have a rigorous risk management program.

Summary

So, the steps that we generally recommend in order to have a sound strategic hedge program, after giving up the idea that we can foretell the longer term future, are as follows: determine your exposures and related risk appetite, develop a structured approach to hedging using statistics, and choose reasonable instruments with which to execute your program.

Cynthia A. Kase is president of Kase and Company, Inc., which, in addition to providing short term forecasts and trading software, offers a strategic computerized hedge model and related advisory service for the energies. See www.kaseco.com for further information.