# Using Probability and Monte Carlo Simulations

## Part Two: Differentiating between Random versus Trending Markets and Understanding Volatility and Risk

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A Monte Carlo simulation is simply a probability test in which the "coin" is tossed so many times that actual empirical results may be achieved. In part one, we evaluated the use of probability theory is setting trading limits. In this article, we will look at how Monte Carlo simulations can help us to understand the difference between trending and random markets, and improve our grasp of volatility and risk.

For example, let's toss a coin that has a 50/50 probability of coming up heads or tails. Both heads and tails pays $1.00. After 100 tosses, we'll evaluate the probability of losing $5.00. (We might also have the computer toss the coin 100 times in 1000 tests and plot the results).

Let's take a graphic look at how this may apply to the market. Chart 1 shows the result of a Monte Carlo simulation. A price distribution curve for a theoretical futures contract, this chart has a starting price of $300, and moves with no bias direction — that is, with an average change of zero percent but with a standard deviation of 0.018.

We then ran 1,000 simulations of what price we could expect after 65 days of market activity. The result was that we would have a mean expectation of $300 and a standard deviation of about 35, which gives us 95 percent confidence that the price will be between $230 and $370.

According to statisticians, if we have a market which also started out at $300 per unit, but ended up after 65 days, outside 2 standard deviations of the random case — that is, either above $370 or below $230, we can assume that the market has a "bias" or is trending in one direction or another.

With this in mind, we will now look at prices for another set of 1000 Monte Carlo simulations over 65 days of activity, but this time, with an upside average bias of a third of a percent and the same degree of volatility. (See Chart 2 this page). The average or mean expectation in this case is $372, which is outside of the "random" simulation range.

Now let's see how Monte Carlo simulations can help us understand volatility. Volatility is in effect the standard deviation of the daily rate of change on an annualized basis. Thus, if we look back to our assumption for this theoretical futures contract of .018 per day, on an annualized basis this equates to 29 percent, calculated as follows:

**Annual Volatility = Standard Deviation of Daily Rate of Change x $\sqrt{255}$**

**Annualized Volatility = $0.18 \times \sqrt{255}$**

**Annualized Volatility = .29, 29%**

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Chart 1

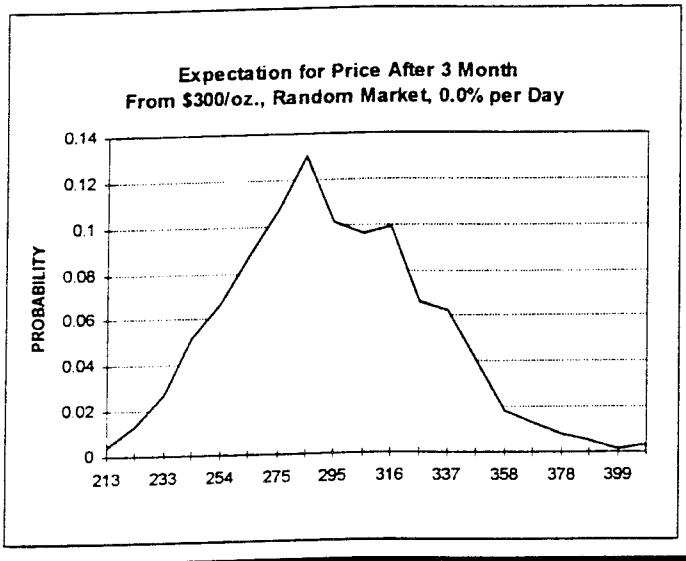
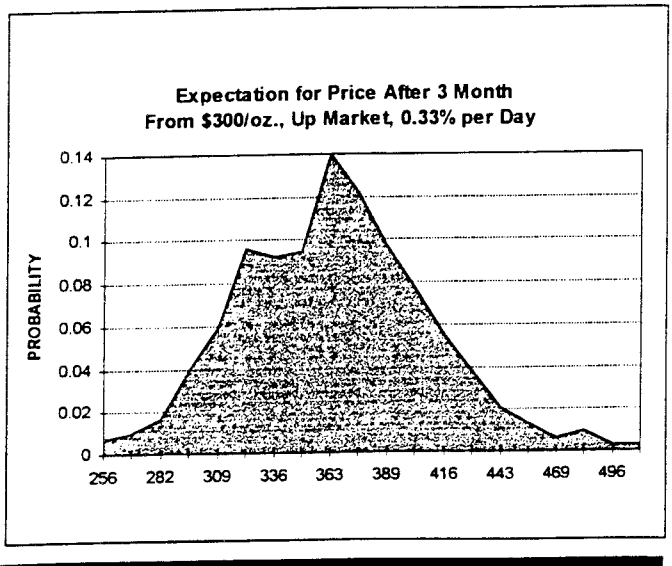



Chart 2



## *Technical Applications*

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As one would expect, natural gas conforms to the same rules. The table below shows the daily percent price changes for natural gas first nearby contracts since the inception of the contract. Not surprisingly, the median daily rate of change is dead on zero.

| Table 1: Natural Gas Daily Rate Of Change Statistics | |
|---|---|
| Average | 0.001 |
| Median | 0.000 |
| Minimum | -0.176 |
| Maximum | 0.279 |
| StdDev | 0.030 |

Another application of interest to those with power exposure for this approach is to view what reasonable price changes might be and reasonable expectations for market highs and lows in cases where we don't have a lot of market data.

Let's say we can make an assumption that electricity, delivered at a particular location and at a particular time of day, is nominally averaging at about 3 cents per kilowatt hour and for the sake of discussion, that the standard deviation of daily rate of change is about half that of natural gas. Using these assumptions, we can then generate a bell curve which will tell us what kind of distribution we might expect over the next year as shown in Chart 4. Thus, a hedger of an instrument for which we did not have a good price history can still be viewed from a statistical basis.

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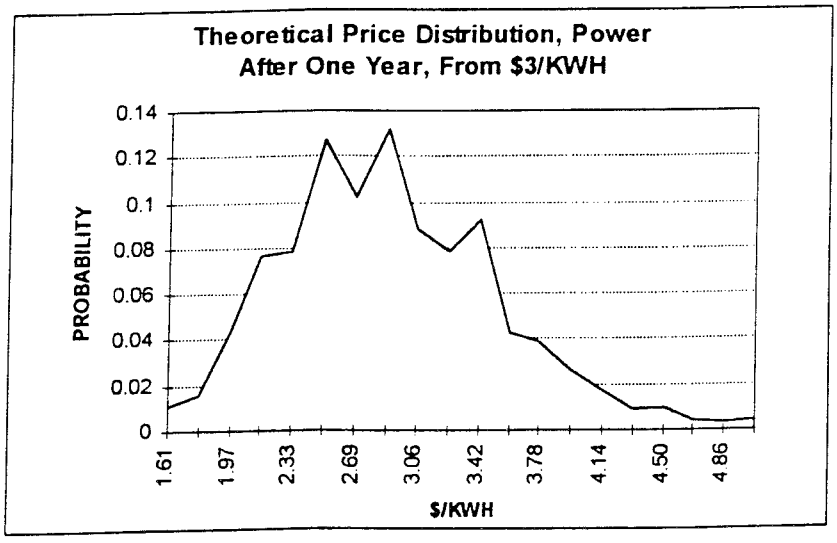
## Chart 4




| Percentile | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% | 45% |
|---|---|---|---|---|---|---|---|---|---|
| Price | 2.08 | 2.24 | 2.34 | 2.45 | 2.56 | 2.62 | 2.69 | 2.78 | 2.87 |
| Percentile | 50% | 55% | 60% | 65% | 70% | 75% | 80% | 85% | 95% |
| Price | 2.93 | 3.00 | 3.09 | 3.19 | 3.31 | 3.40 | 3.52 | 3.61 | 4.12 |

## NEWS

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The NYMEX Chairman told Knight-Ridder Financial News that both electricity futures contracts are expected to be approved by the CFTC in mid-November, and could be launched as early as February 1996.

## SIMEX Accepts Advice

After its difficult experience with Barings, a panel of six futures experts has issued many recommendations to the Singapore International Monetary Exchange (SIMEX) on ways to improve its regulatory oversight.

The panel recommended that SIMEX modernize its clearing policies, and systems to accommodate real-time clearing and settlement, as well as advanced risk management systems. The group also suggested that the exchange set rules to ensure that customer funds are protected.

SIMEX asked that the panel be established after UK bank Barings plc collapsed following a number of losses at the exchange.

The group was headed by John Gilmore, a partner at Goldman Sachs and Co. They advised SIMEX to incorporate the Windsor Declaration that relate to exchanges as well as trade clearing houses. The Declaration was created following the Barings debacle and was adopted by regulators from 16 countries.

The panel also recommended: that SIMEX establish confidential information-sharing arrangements with other markets; that a senior officer of a clearing member firm be obligated to register with SIMEX; enhanced market surveillance and that the surveillance department report to members at the highest level of SIMEX; that SIMEX appoint a risk management committee to address market surveillance issues; and that a reporting system be established to enable the exchange to determine the owner of large positions.