

# Confronting Uncertainty: Intelligent Risk Management with Futures

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## Introduction

In the past, institutions seeking to insulate themselves from the ravages of inflation have included real estate in their portfolio as a risk management diversification strategy. The events of the late eighties and early nineties have shown that this strategy was not without its drawbacks. In particular, real estate is difficult to value, has inadequate liquidity, and is not traded on a regulated exchange. What institutional investors really need is a way to achieve the positive aspects of real estate without suffering its drawbacks.

Real assets combine the best attributes of real estate and exchange traded products. Real assets — represented as exchange-traded futures — appreciate during inflationary periods; financial assets lose value during these times. It therefore seems necessary to include real assets in any prudent investment program and risk managed diversification strategy.

However, simply diversifying a portfolio with real assets does not completely solve the problem of risk management. Real assets in particular and futures in general have their own peculiarities. The institutional responsibility of maximizing gain and minimizing risk must still be addressed, now in a more complicated framework. New quantitative approaches to risk management have provided new sets of tools and techniques — and new sets of problems in determining when these techniques are applicable.

This chapter, written from the perspective of a financial advisor, addresses the benefits and pitfalls of utilizing new quantitative approaches to confront risk and uncertainty in a portfolio of futures and real assets. We first show how traditional time-value and diversification techniques can fail, and then discuss how the newer quantitative approaches can be used. Finally, we conclude with a discussion on the place of real assets within an overall strategy for institutional risk management.

## Real Assets and Futures

A future involves the obligation to take or make delivery of an underlying commodity by a certain time, according to agreed-upon rules of trade. A future can be a contract on real assets — a kind of derivative security with respect to “things” such as gold, corn, or oil, or it can be a contract on a financial asset such as an interest rate, index, or currency.

The concept of a future as a proxy for real assets is as old as civilization, and predates the use of money represented by coins and cash. Ancient Sumerian tablets of the period before 2000 B.C. show that money was represented by a contract of delivery for precious metals or produce. Princes routinely engaged in trade to maintain their style of living, as one tablet indicates (see Reference 1):

Twenty manehs of silver, the price of wool, the property of Belshazzar, the son of the king...All the property of Nadin-Merodach ...shall be the security of Belshazzar, until Belshazzar receive in full the money as well as the interest upon it.... Four manehs of silver produce five drachmas of silver per month.

In those days, interest rates were dependent on the commodity: they ranged from 5%-20% for precious metals and 20-33% on produce.

Markets and exchanges evolved as trade became more organized and centralized. Probably the first modern regulated futures market was in Japan during the Tokagawa era (1603-1868). When the princes and other land-owning nobles needed to raise cash to maintain their style of living, they would sell their rice crop. However, some of the nobles just ran out of cash, since regularly scheduled deliveries were not possible (deliveries depended on the particular rice crop). To compensate for this risk, the nobles issued rice coupons against supplies that they had stored. Merchants bought the rice coupons against anticipated needs, and under the regulation of the Shogunate, formed a centralized market place where the coupons can be traded.

The role of trading futures of real and financial assets should not be underestimated in world trade today. Most economists estimate that nearly 60% of the entire value of world trade is in trading real assets alone (see Reference 2). In 1993, over 750,000,000 futures contracts were traded on the world's futures exchanges. The size of the market indicates that it can easily accommodate institutional participation.

## Futures and Risk Management

Certainly every institutional manager has read something about the futures industry, and is familiar with the economic justification for the existence of futures, namely risk transference. Unfortunately, much of the public discussion portrays the risk in trading futures in extreme terms.

If risk is a function of the magnitude and frequency of surprising price movements (the price volatility), then statistics show that the risk associated with futures is much smaller than the risk associated with stocks. The reason for the perception of extreme risk is due to the use of margin — a small “good faith” deposit that has to be put up when entering a trade. This margin requirement could amount to as little as 2% of the value of the contract. (Imagine what would happen to a stock portfolio at that margin level.) Low margin provides the illusion of great gain; on the other hand, low margin exaggerates risk. The trader could always reduce the risk

associated with low margins by simply depositing the full amount for the contract: this would be a fully collateralized investment.

Traditional risk management techniques for futures involve a combination of time-value techniques (which depend on market timing) and diversification techniques (which depend on the characteristics of a portfolio). The difficult problem is to use both of these techniques in a consistent way that does not constrain profit.

A time-value technique is a form of insurance that is designed to limit a loss due to an unforeseen market movement. Typical examples are the use of options and stop-loss limit orders.

A limit order is actually like a short-term option. A limit order in an increasing market should be designed to capture profit and insure against a loss by “automatically” being filled when there is a “surprising” decline in price below a specified threshold. The problem with limit orders is in specifying the price thresholds: if we trace prices too closely, the usual statistical price fluctuations can signal the exit of a good trade — the worst of both worlds with limited gain and insured loss. This implies that limit orders should be applied with dynamically changing thresholds.

There is a known risk in the purchase of call or put options: the trader can only lose the price of the option. However, the problem in managing the risk of a portfolio of futures now becomes the (somewhat more difficult) problem of managing a portfolio of options.

Other examples of time-value techniques are volatility controls (exit a trade when the volatility exceeds a threshold) and position control (exit a trade or reduce position size when the trading profit exceeds a certain threshold). In general, when using time-value techniques, risk management is reduced to market timing.

Diversification techniques spread risk across a portfolio — represented by a weighted sum of assets. The motivation behind this technique is due to the use of the standard deviation (the square root of the variance of the returns) as a proxy for risk (as measured by return volatility): with reasonable assumptions, it can be shown that the standard deviation of a portfolio is always less than or equal to the square root of the number of assets times the standard deviation of the riskiest asset (the asset with the largest standard deviation). In a sense, risk is “averaged” and can be reduced further if the assets are negatively correlated with each other.

Since diversification techniques work best with independent or uncorrelated assets, the risk management problem is reduced to a statistical problem. In some sense, the use of diversification techniques with real assets is more natural than its use with stocks: pork bellies are clearly different than orange juice; soybeans march to a different drum than aluminum. Over long time periods, correlation statistics also bear this out. Risk management is reduced to computing correlation.

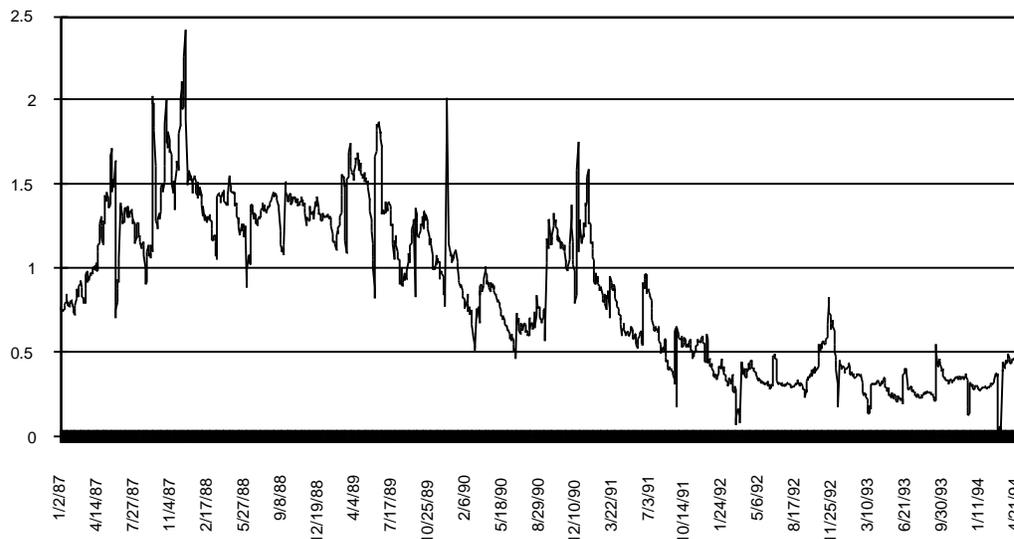
Even with this discipline, these traditional risk management techniques may not work. The reason for this is that in the real world, markets change: the derived rules and statistical correlations may not only fluctuate, but may radically change. Market statistics are *non-stationary*. This is more

apparent in the futures market than in other markets, since many commodities depend on factors that are known to be statistically difficult to quantify (like the weather).

## Time-Value Techniques for Risk Management in Non-Stationary Markets: Examples

Here are a few examples where the non-stationarity of markets can have drastic effects on risk management.

The first example is the so-called TED Spread (the difference between the T-Bill Future Price - Eurodollar Future Price). Figure 1 shows the time series from January 1987 to April 1994.



**Figure 1. TED Spread.**

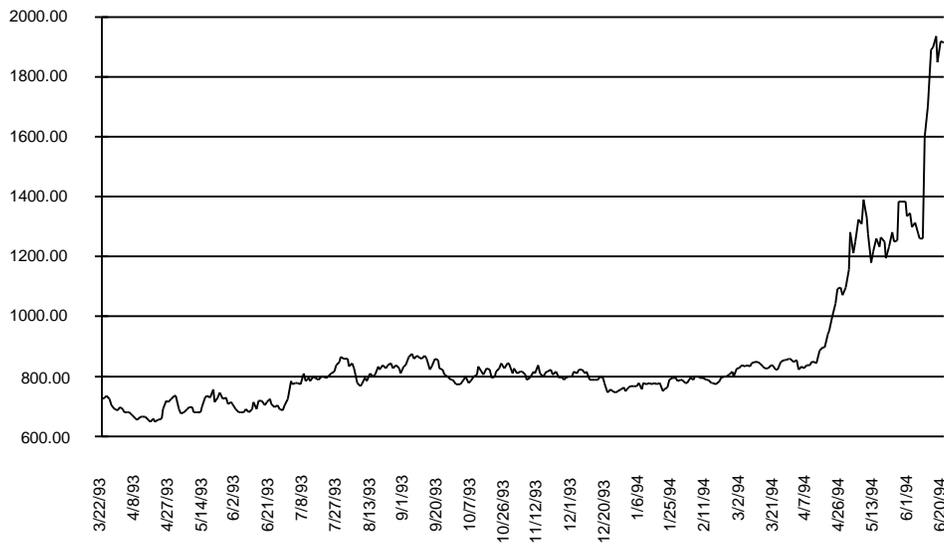
In 1990, many models were developed (using historical economic relationships as well as time series statistics) that relied on the fact that the TED Spread rarely went below 0.5: if it did, it represented a significant buy opportunity. This opportunity was “corroborated” by the rally in October 1990. On the other hand, the next time this “opportunity” occurred (in August 1991), the expected “rally” did not occur. In fact the entire statistical profile seemed to have changed radically.

The second example is the British Pound from January 1982 to July 1994 (Figure 2). This example shows what happens when a model disastrously extrapolates a positive trend. Here, time value techniques offer insurance in the beginning which — because of the sharp drop in September 1982 — probably would wipe out all profits.



**Figure 2. British Pound.**

The same phenomenon with the exact opposite trend is shown by the third example in Figure 3 (Coffee from March 1993 to July 1994). Again, a time-value risk management strategy would limit the loss in June (while insuring a possible profit if the trade was entered before) but could also sacrifice the profits made in July. Again, one problem in market timing is: when a trend is going your way, when do you leave? Here, an early departure has severe consequences. How many times in history has coffee tripled?



**Figure 3. Coffee.**

The problem with the time-value risk management techniques is that the thresholds became no longer valid. The market did not behave as expected. On the other hand, these risk management techniques prevented disaster. Without any rigorous stop-loss strategy, losses would be protected, not gains.

It turns out that the same conclusion is also true of the diversification techniques. Statistical correlations change. The problem of market timing is not addressed with diversification techniques: the problem of market participation is the key problem. Do we participate or not in an asset or asset class?

## Diversification Techniques for Risk Management in Non-Stationary Markets

Different futures have different expected returns and expected risks: usually, the higher the risk, the higher the potential return, and the lower the risk, the lower the potential return. Some futures may behave similarly to other real assets. For example, one would expect that the prices of precious metals “move” the same way: they all go up or they all go down. The statistical parameter that represents these co-movements is the covariance matrix (and is related to the correlation discussed above): for  $n$  assets, there are  $n(n+1)/2$  parameters that must be estimated in the covariance matrix.

The diversification problem may be stated as follows: Given a set of futures (that includes its expected return and the covariance matrix of returns), find the best mix of futures to place in a portfolio. What makes the problem hard is that these  $n(n+1)/2$  parameters can change.

We can express this problem more formally using a vector notation:

Given  $n$  real assets, with their returns,  $\mathbf{r} = (r_1, r_2, \dots, r_n)$

Find a vector of portfolio weights  $\mathbf{w} = (w_1, \dots, w_n)$

that maximizes the return  $\mathbf{r} \cdot \mathbf{w} = \sum r_k w_k$

and minimizes the risk  $(\mathbf{w}^T \cdot \mathbf{C} \cdot \mathbf{w})^{1/2} = (\sum \sum w_k c_{jk} w_j)^{1/2}$

subject to the asset constraints

$$\min_k = w_k = \text{Max}_k$$

$$\sum w_k = N$$

In the above representations, the index  $k$  ranges from from 1 to  $n$ ,  $n$  being the number of futures in the portfolio.

The diversification problem was first stated this way over 35 years ago by Markowitz (see Reference 3). In the above representation,  $\mathbf{C}$  is a symmetric  $n$ -by- $n$  covariance between the returns:  $c(i,j)$  is the return covariance between the returns of asset  $i$  and asset  $j$ :

$$c(i,j) = s_i s_j r_{ij}$$

where  $r_{ij}$  is the correlation coefficient between the returns of asset  $i$  and asset  $j$ , and  $s_i$  is the standard deviation of return on asset  $i$ . The degree of collateralization  $N$  — indicates how much the portfolio can be margined. If  $N=1$ , then the portfolio is “fully collateralized” or “fully leveraged”; if  $N>1$  it is margined; if  $N= 0$  it is “risk neutral.”

The expression for risk is nonlinear: it based on the standard deviation of returns. Consequently, the computational requirements associated with computing the best portfolio weights for the “optimal” or “most efficient” portfolio increases with the number of parameters that must be supplied and estimated. For example, for 10 assets, 20 asset constraints must be provided and 55 covariances must be estimated. For 100 assets, 200 asset constraints must be provided and nearly 5000 covariances must be estimated. If we “linearize” risk (by using the single or multiple index versions of the capital asset pricing model) then the number of parameters that need to be estimated can reduced considerably.

The original formulation of the diversification problem can be made more complicated by the addition of other constraints, such as a specification for short sales (defined if the weights can be negative) and sector constraints (a generalization of the asset constraints). To make matters more difficult, we can also specify different return and risk measures (for example, a return based on geometric compounding, and risks based on investor utility functions).

## New Approaches

All quantitative models developed over the last several years take advantage of the increasing speed and decreasing cost of computation. Today, standard statistical techniques for estimating expected returns (multilinear regression) and standard optimization techniques for finding the best weights (linear and quadratic programming) that used to be mainframe-based can be performed on spreadsheets.

Traditional risk management diversification models are based on “mean-variance” portfolio optimization: standard mean return and variance (standard deviation) based risk measures are used with simple asset and sector constraints. More “exotic” return and risk measures, coupled with non-traditional constraints could lead to non-differentiable, non-convex (and even non-continuous) representations. One reason why these more “exotic” models have not been routinely used was because they are difficult to specify and are not amenable to the standard algorithms. The availability of these techniques, together with the availability of computational power, improves quantitative risk management by allowing model development to take place over shorter time horizons with more data.

Some of the newer approaches used for risk management include (see Reference 4):

***Neural Networks.*** The goal of neural network “supervised learning” is to build systems that learn adaptively from a database of case profiles. In order to learn, the database must contain a set of input patterns and corresponding output patterns. Learning consists of building a neural network that correctly associates each input pattern with its corresponding output pattern. One goal of this neural network concerns its ability to generalize, by associating input patterns that are not in the case database with the most suitable output pattern. Once built and verified, these neural networks can be used as pattern classifiers.

Neural networks are similar to statistical discriminant functions and supervised learning is a form of nonlinear regression. Consequently, neural networks are primarily used to create nonlinear forecasting models for statistical parameters, such as futures returns and covariances. The problem with applying neural network models for risk management is similar to the problem with applying traditional time-value models: statistics may change. The advantage in applying neural network models is in ability to recognize a nonlinear pattern that a multiple regression model might miss.

***Rule-Based Expert Systems.*** Expert systems model the judgment, experience and knowledge of an expert: it is only as “smart” as the expert it is modeled on. Expert systems can be used to implement time-value and diversification strategies represented as rules — with the rules permitting the representation of uncertainty. However, since there are no trading rules that are true in all markets, the problem here is reduced to finding good rules that work in specific markets, and in finding profiles that can indicate the most appropriate market condition. Rules can also be updated with statistical or neural network techniques. In some sense, an expert system is a kind of econometric model that is based on qualified judgments. Again, the problem is non-stationarity of the market: rules must be dynamic.

Other approaches, especially useful for creating new diversification strategies with “exotic” constraints and non-traditional risk and return measures, are algorithms inspired by Darwin (and the theory of evolution) and Boltzmann (and the theory of statistical thermodynamics). In these approaches, a portfolio is considered an evolving system, and as the portfolio “evolves,” it produces portfolios that have better and better expected performance. These approaches include (see Reference 5):

**Genetic algorithms.** Here, a solution to the portfolio problem is drawn from a population of “parent” portfolios. A new portfolio is created from the parent portfolio by “breeding” and “mutation” operations, where “survival-of-the-fittest” criteria keeps the best children portfolios as parents for the next generation. Eventually, the population stabilizes with a “superior” portfolio.

**Simulated Annealing.** Here, an initial portfolio is considered to be a random state in a high temperature fluid. As the fluid cools (or “anneals”), new states are generated as a function of the previous state and of the temperature. As the temperature approaches absolute zero, the portfolio converges to an optimal state.

**Dynamic Search Space Reduction.** This technique views the portfolio problem as a search. Here, the idea is to reduce the size of the search region dynamically.

## Conclusion: Institutional Risk Management and Futures

Time-value techniques and diversification techniques — the traditional approaches to risk management using futures — are designed to be insurance measures that lock in profits and limit losses (when they work best), and try to avoid disaster.

Some risk management techniques work better than other risk management techniques. Reasons for this include:

- Incompleteness of the risk management model
- Too much reliance on stationary parameters and thresholds
- Too much reliance on market timing
- Too much reliance on stationary judgments

We believe that the newer risk management techniques discussed above are more appropriate, because:

- There is more emphasis on modeling nonlinear market dynamics
- There is more emphasis on diversification techniques
- It is assumed that the parameters and thresholds will change and evolve

As discussed above, real assets should be included as part of a diversification strategy for institutional investors. For institutional investors, investing in real assets offer

- A hedge against inflation
- Competitive returns over time
- Returns negatively correlation to stocks and bonds (most pronounced during periods of volatile inflation)
- Liquidity not found in real estate
- The security of using exchange traded contracts
- Ease of valuation

Real assets — represented by exchange-traded futures — combine the best attributes of real estate and exchange traded products. A diversification strategy — implemented by holding a basket of real assets — can help institutions manage risk and capture price increases. When this basket represents real assets traded on regulated exchanges, the problems connected with liquidity and valuation almost disappear.

Many participants in the institutional investment community are comfortable with benchmarks for performance evaluation. Using a well recognized index as a benchmark is key to supplying investors with a quantifiable measure of price fluctuation. (Using a benchmark is virtually impossible with real estate, since there is no recognized index.) For real assets, this benchmark index can also be considered a proxy for inflation.

However, as we have seen, simply diversifying a portfolio with a basket of real assets does not completely solve the problem of risk management. The institutional responsibility of maximizing gain and minimizing risk must still be addressed, now in a more complicated framework. Here is where the new quantitative approaches to risk management are most beneficial: in creating better diversification strategies. For example, the return on an index of real assets can be greatly enhanced (and the periods of negative returns on the index reduced) by actively managing the components of the index using the new approaches to risk management discussed above.

An example of a product that was already developed using many of the techniques discussed above is the Managed Index Overlay Program offered by Tamiso & Company. This program uses the components of a commodity index to construct a portfolio of real assets. It is designed to outperform the underlying benchmark while having a lower risk profile than that of stocks.

It is expected that institutional participation in these types of risk management products should increase, as more institutions become aware of their benefits.

## References

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## **BioSketch**

### **Robert M. Tamiso**

Mr. Tamiso has been in the securities business for thirty-five years. He is the head of Tamiso & Company — a firm organized in 1979 and which is one of the oldest companies in the managed futures industry. Mr. Tamiso is a Commodity Pool Operator as well as a Commodity Trading Advisor. He is also a member of the Managed Futures Industry and the National Futures Association.

Mr. Tamiso began his career as a securities analyst and spent an extended period of time in investment banking. He is a Senior Member of the *New York Society of Security Analysts*, a Chartered Financial Analyst, (CFA) and a member of the *Association for Investment Management and Research*.