Great Expectations

As the baseball season begins anew and pennant fever sweeps all cities and burgs across the land not named "Chicago," let us recall the hitter's lament: "They give you a round ball and a round bat, and tell you to hit it square!"

How different is this from the workaday problems faced by traders in all financial markets, few of whom are as well-compensated as a .225-hitting shortstop? Consider these textbook identities:

- Nominal interest rates $\equiv$ real interest rates plus the ***expected*** rate of inflation
- Forward interest rates $\equiv$ ***expected*** changes in future supply demand balance for credit
- Common stock prices $\equiv$ the present value of ***expected*** dividends
- Currency rate changes = f(***expected*** differential inflation rates)

The key word is "expected." And not your expectations either – they don't count -- but the market's expectations. These numbers are not published anywhere, nor are they available on your quote screen. Moreover, each of the identities above has more than one unknown variable, which means we must either infer expectations from available price data, or we must fix at least one of the variables to solve for the other.

Physical Market Tension

A technique to infer price expectations in physical commodity markets uses three dimensions of market price behavior: trend, volatility, and convenience yield (see "Measuring Market Tension," *Futures*, February 1996). Central to the calculations for volatility and trend is the Adaptive Moving Average (MA), where N is the number of days between 4 and 29 that minimizes the function

$$\frac{1}{N} * \sum_{i=1}^{N} \frac{N}{Vol^2} * |(P - MA)| * |\Delta MA|$$

where Vol is the N-day high/low/close volatility, defined as

$$\sum_{i=1}^{N} \left[\frac{\left[.5 * \left(\ln\left(\frac{\max(H, C_{t-1})}{\min(L, C_{t-1})}\right)\right)^2 - .39 * \left(\ln\left(\frac{C}{C_{t-1}}\right)\right)^2\right] * 260}{N} \right]^{1/2}$$

where H, L, and C are high, low, and close, respectively. Once the Adaptive Moving Average is calculated, the trend is defined as the volatility-adjusted oscillator around this central tendency. In the construction of the index, the trend's "zero point" occurs when the price and the Adaptive Moving Average are equal.

$$Trend \equiv \frac{\left(\frac{(P - MA)}{Vol}\right)}{P}$$

The volatility component used in index construction is the ratio of implied volatility to the measure above; this provides us with a reading on the strength of the market's anxiety level. For the purposes of index construction, the "zero point" occurs when the market's implied volatility level is equal to the high/low/close volatility level.

The convenience yield in physical markets is defined as

$$\left[1+\frac{(M_2 - M_1 - Carry)}{M_1}\right]^{\frac{360}{d}} - 1$$

where M_2 and M_1 represent the nearby and spot futures contracts, respectively, Carry represents the combined physical and capital storage costs of maintaining inventories, and d represents the holding period. This measure is at a "zero point" when the market is in perfect carry, when $M_2 = M_1 + \text{Carry}$.

Just as the trend and volatility measures define price and uncertainty expectations in the market, the convenience yield defines the shape of the forward curve in physical commodity markets. A market in backwardation implies that sellers are anxious to lock in current prices and buyers are expecting price decreases soon.

Financial Parallels

Financial markets do not have physical costs of carry, only well-known and well-defined financial holding costs. Forward curves in bond and stock index futures reflect these costs to the extent that arbitrage is virtually impossible. For example, the fair value of a stock index future is the underlying index plus the capital cost of holding the stocks less the value of the dividends on the stocks. Should the premium of the future exceed the fair value by an amount in excess of the transaction costs involved, arbitrageurs sell the futures and buy the stocks. The difference in capital costs between months is known and can be hedged, and any expectations for dividend changes are reflected in the price of the stocks. Therefore, arbitrage assures us that the spread between different months of stock index futures is devoid of information. The same hold true for bond futures because we can lock in the costs of financing bonds across different maturities.

The ability to arbitrage intermonth spreads collapses when we move to short-term interest rate futures: we wind up financing short-term instruments with short-term rates, and this puts us right back into the two-unknowns-in-one-equation conundrum with which your evil eighth-grade algebra teacher cursed your eternal soul. Consider the simple case of the spread between the active September and December 1997 Eurodollar contracts. Each contract bears a basis relationship to its underlying certificates of deposit, but their relationship to each other is a function of the short-term rate that will be prevailing when September is the spot rate. In order to fix the spread, we must fix the September rate, and this implies supernatural powers.

However, just as the intermonth curve in the physicals provides us with convenience yields, the intermonth curve in the short-term rates provides us with forward rates. The forward rate between a 90-day and 180-day Eurodollar is calculated as

$$\frac{(1+r_{180})^2}{(1+r_{90})} - 1$$

It also defines a set of expectations, which we can summarize in the table below

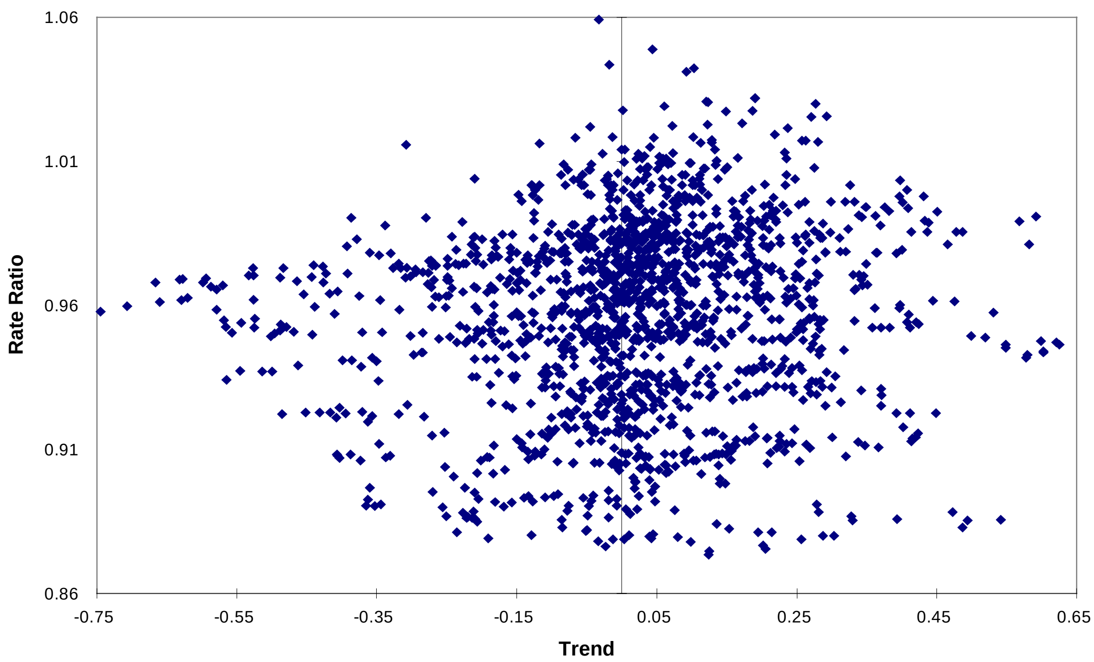
	Yield Curve Slope	Rate Expectation
Forward > 180	Positive	Rising
Forward < 180	Negative	Falling
Forward = 180	Linear	Neutral

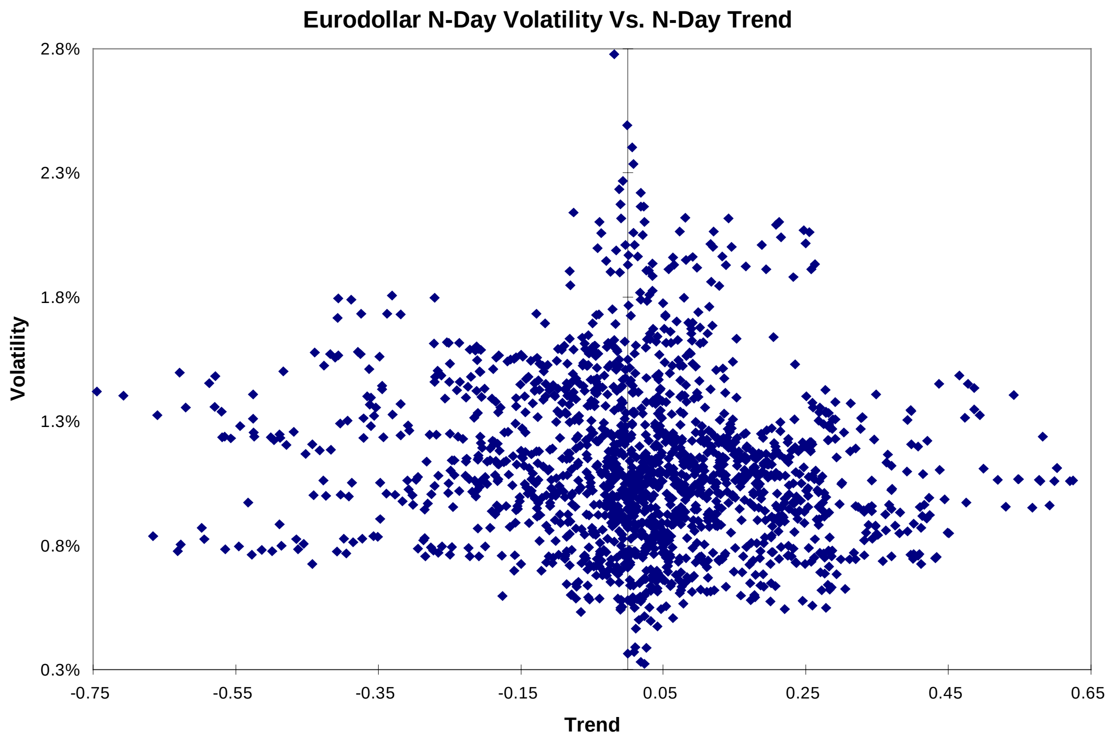
Financial Market Tension

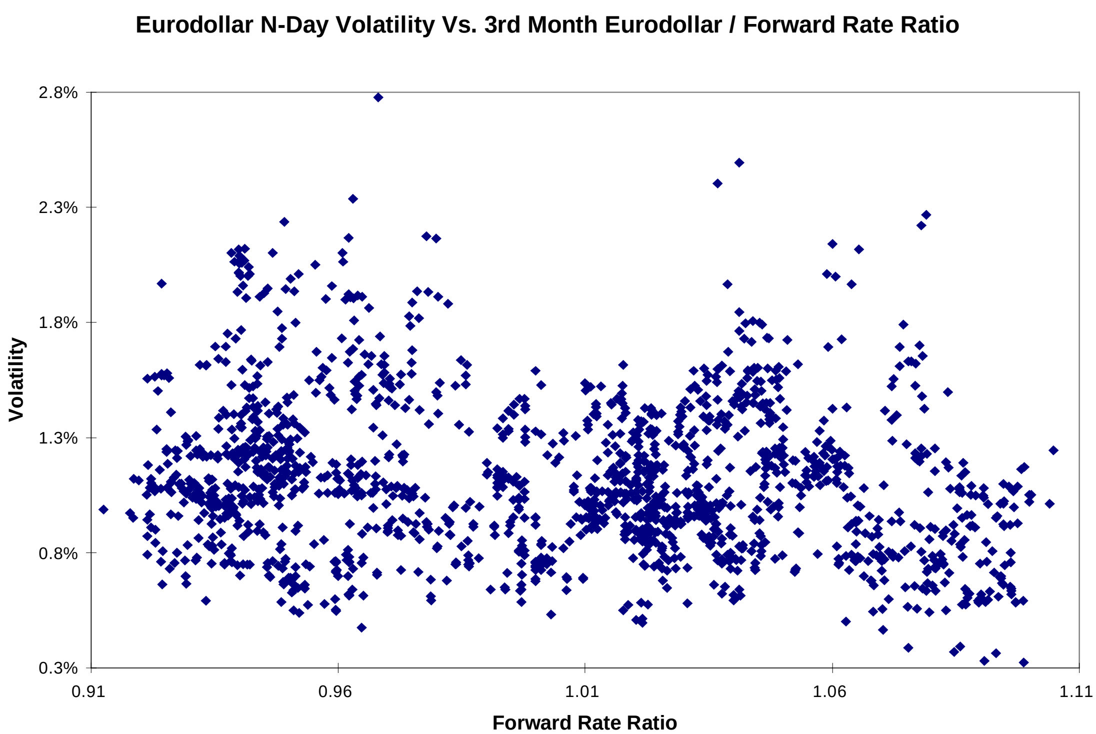
Thus armed, we can set about substituting the forward rate information for the convenience yield information in the Market Tension Index and create a new indicator, the EuroTension Index (ETI). Two markets, the Eurodollar and the Euromark, will be examined from the August 1990 inception of LIFFE Euromark option trading to the end of 1996. For reference purposes, the second nearby contract (September 1997 at point of publication) will be considered the active trading contract.

First, we should familiarize ourselves with the data and convince ourselves that the three dimensions of trading are sufficiently unrelated to one another (orthogonal) that we are not being redundant in our analysis. This is demonstrated for the Eurodollar in the three graphs below; the relationships between the three components of the ETI for the Euromark are similarly random.

3rd Nearby Eurodollar / Forward Rate Ratio Vs. N-Day Trend

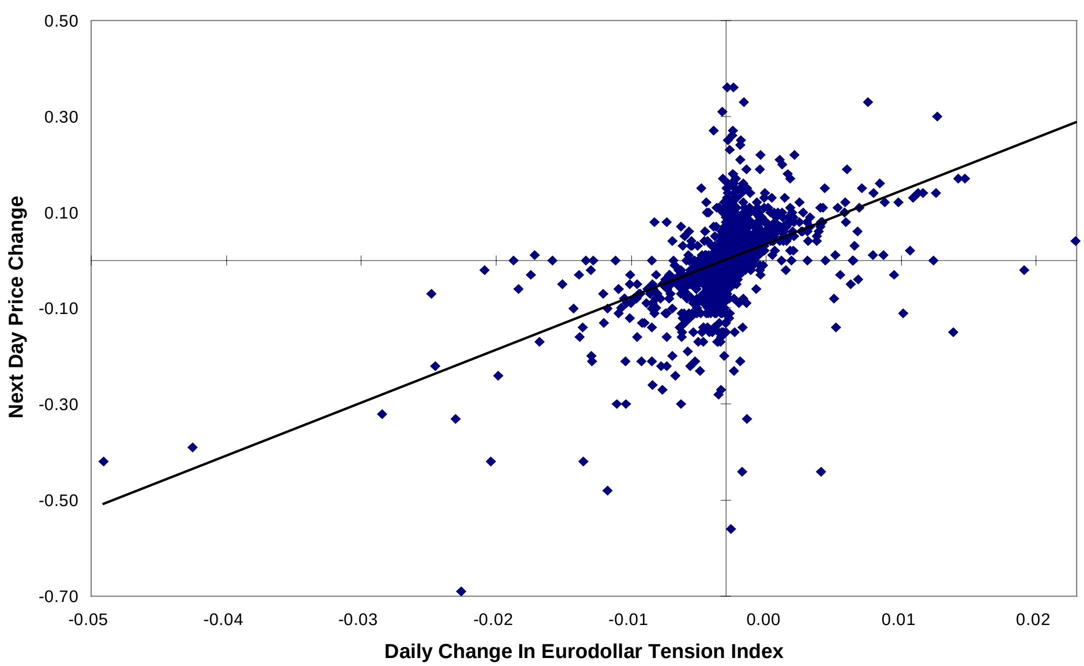




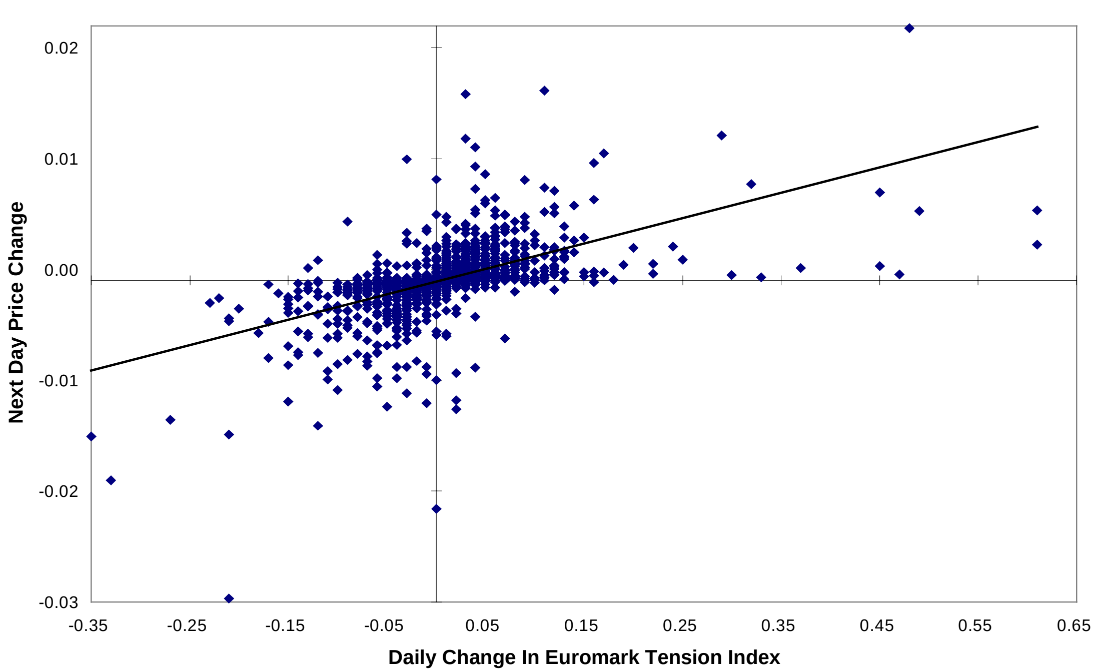


We can combine the three components – the implied/theoretical volatility ratio, the forward rate ratio, and the trend oscillator – into the unified EuroTension Index. The two graphs below depict the relationship between daily ETI changes and daily price changes for both the Eurodollar and the Euromark.

Eurodollar Price Change Vs. Eurodollar Tension Index Change



Euromark Price Change Vs. Euromark Tension Index Change



While the change in the ETI is the most important determinant of the price change, its ordinal level is important as well. Combining the two into a single-equation regression model produces the following set of statistical relationships:

$$\Delta ED = 1.595 * ETI_{t-1} + 11.779 * \Delta \mathrm{ETI}, R^2 = .275$$
$$\Delta EM = 1.622 * ETI_{t-1} + 14.544 * \Delta \mathrm{ETI}, R^2 = .331$$

Currency Implications

Now the game gets interesting. The formula for determining a currency future on the Chicago Mercantile Exchange is:

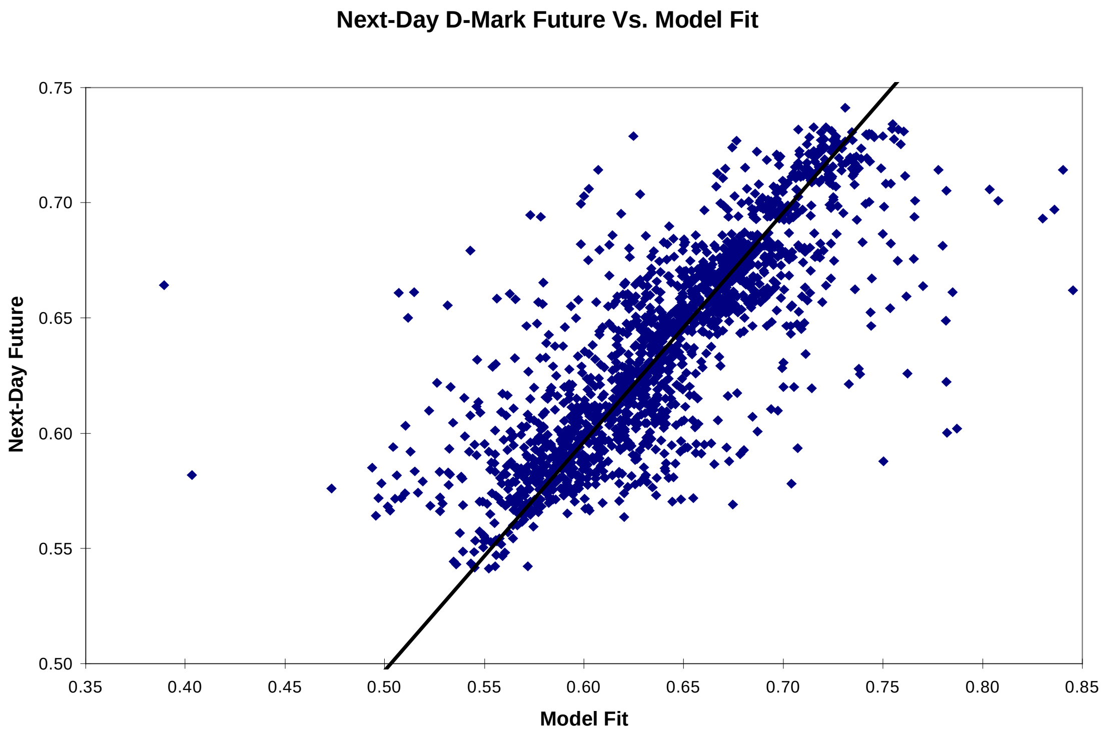
$$\frac{1}{Spot * \frac{1 + (R^{\wedge}{}_{us} + R^{e}{}_{us}) * \frac{d}{360}}{1 + (R^{\wedge}{}_{for} + R^{e}{}_{for}) * \frac{d}{360}}}$$

where $R^{\wedge}_{us}$ and $R^{\wedge}_{for}$ represent real U.S. and foreign interest rates, respectively, and R^{e}_{us} and R^{e}_{for} represent U.S. and foreign expected inflation, respectively. This is a simple decomposition of the nominal interest rates that we can trade with the Eurodollar and Euromark. Since the real rate of interest at any maturity must be equal around the world in order to foreclose arbitrage opportunities, nominal rates must differ only by expected rates of inflation.

However, the equation above has three unknowns, the change in the spot rate and the changes in both inflationary expectations; we do not need to know the real rates of interest at the contract maturity since they must be equal. Since we can infer movements in both nominal interest rates through their ETI measures, we can fix the relationship between two of the three unknowns:

$$\frac{1}{Spot * \frac{f(EDTI, \Delta EDTI)}{f(EMTI, \Delta EMTI)}}$$

Therefore, given a fixed spot value of the Deutsche mark and a real-time calculation of the EuroTension indices, we should be able to infer the market's inflationary expectations and therefore be able to project the one-day ahead value of the future. This relationship is shown in the graph below.



The ability of the ETI to capture these market tendencies is unsurprising given its reliance upon the information content already present in the markets. However, these markets are influenced in the extreme by all sorts of random and unpredictable events that are simply impossible to account for, such as government reports and offhand remarks by central bankers. What is truly remarkable is how quickly the markets absorb all of these shocks, adjust their expectation structures, and eliminate arbitrage opportunities.